NEVF

New England Vegetable and Fruit Conference

2011 Proceedings

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New England Vegetable and & Berry Growers Association
and
Massachusetts Fruit Grower's Association

and

Maine Organic Farmers and Gardeners Association (MOFGA)

Innovative Crop Rotation Systems: Targeting Weed Control and Soil Health

David Fisher
Natural Roots Farm
888 Shelburne Falls Rd.
Conway, MA 01341
413-369-4269
csa@naturalroots.com

We have designed crop rotations on our farm to meet our management goals. Our primary goals are to minimize weed pressure, to nurture the health of the soil, and ultimately to raise top quality produce. There are several secondary goals, which rise or decline in priority in response to the changing conditions we face. These secondary goals may include things like creating beneficial insect habitat or reducing off-farm inputs by diversifying production.

At its most basic level, our rotation employs a two-field system. Quite simply, in any given field we will grow vegetables one year, and rest the field from production the next. We till seven acres on our farm and crop half of those, or 3 ½ acres, each year. The other 3 ½ acres are fallow. The management of the fallow field is key to attaining our primary goals of minimizing weed pressure and nurturing soil health, so I would like to focus on the management of the fallow field.

The start of this cycle, however, begins with the establishment of a cover crop in the vegetable production year. The precise timing of the sowing of the cover crops may vary based on the conditions we face and is influenced by our various goals. For instance, one of our goals is to have zero weed seed set in our fields. If we are feeling concerned with weed pressure, we may delay establishing cover crops in our vegetable beds until later in the summer. Once we establish cover crops in the vegetable fields, we forgo any further opportunities to control weeds with mechanical cultivation. If weeds do become established amongst the cover crops we sow, then labor-intensive hand weeding is the only option we have left to prevent these weeds from setting seed. Delaying cover crop seeding will give us more opportunities to cultivate the soil and kill germinating weeds later into the season. On the flip side, if building organic matter in our sandy soils is feeling most important, we may establish cover crops as early as possible, making for the longest possible period of protecting the soil from erosion, compaction, and building soil structure and organic matter. This would mean under sowing cover crop seed at the time of the last cultivation of each crop (just prior to the point at which the crop will be too large to straddle with the riding cultivator). The final pass with the cultivator incorporates the seed into the soil and the cover crop will emerge in the understory of the vegetables. Usually we do not under sow crops like lettuce, bok choy, or Napa cabbage, or other short-season crops like arugula, dill, or cilantro for fear of seeds or young sprouts becoming lodged in the head or bunch of the harvested crop. Instead we will wait until these crops are harvested off, renovate the bed and then seed our covers. Whether earlier or later, we like to see the entire farm seeded to cover crop by the end of August. As temperatures cool at this point in the season we don’t see nearly as much weed germination as we do in June and July. Also most annual weeds, which do emerge amongst the cover crops, do not have time to mature viable seed before freezing. We don’t want to wait any later than the end of August because we want allow ample time for a thick sod to carpet the growing fields before winter sets in. By establishing a thick cover before winter we will effectively smother any winter weeds, which may germinate very late in the season or very early in the following spring. Furthermore, any soil that is not firmly held in place by the root system of a cover crop will be vulnerable to erosion in the event of flooding, which is not uncommon in our bottomland fields during hurricane season.

Now, what cover crops we choose to sow will also vary based on the changing conditions of the farm. For many years we raised sheep and would overseed a forage mix for them to graze during the fallow year. For several years we grew oats in the fallow fields for grain or straw to feed and bed our working horses with or for crop mulch. In preparation for the early-seeded oat crop we would overseed our vegetables with crimson clover - a good choice for a cover crop that will neither overwinter nor compete with vegetable crops. At this point in time, we are mainly over seeding with biennial cover crops: either rye and vetch or rye and sweet clover because they are easy to manage in the fallow year.

After the snows of winter recede, these over seeded biennial cover crops are already thickly carpeting the now fallow fields. Our first task is to spread soil amendments - a light dose of a custom blend of rock minerals, trace minerals, inoculants, and other probiotics. We like to feed this blend to the cover crops in more frequent, smaller doses in the hope of having the soil biology and the growing covers digest the minerals to make them more available to the vegetable crops to follow while not overwhelming them with too large of a dose.

Before they grow a foot tall, while they are in a strictly vegetative state, we will clip the cover crops with the sickle bar mower partly to encourage the rye to tiller and regrow with a thicker crown and root system, and partly to set back any “winter weeds,” such as shepherds purse, which may threaten to set seed early in the spring.

After clipping we will let the cover crop continue to grow until it reaches its reproductive stage. When the rye has headed out and is shedding pollen from its yellow anthers, most of the plants energy is directed upwards towards its reproductive process. It is in a vulnerable state, which makes it an ideal time to kill it with the sickle bar mower. At this stage we have also grown the maximum amount of biomass from the rye and have a high carbon to nitrogen ratio. Conveniently the vetch and sweet clover are also coming into full bloom around this time and have fixed their maximum potential of nitrogen into the soil.

After mow-killing these biennials we are ready to turn them into the soil with the moldboard plow. By turning under a healthy dose of carbon and nitrogen into our well aerated and quickly warming sandy soils, we have excellent conditions for sheet composting. In addition, the fibrous roots of the rye and the taproot of the legumes have made an incredible contribution towards improving the structure of our soil. Now we experience a biological population explosion in the soil. Respiration can almost be seen as early morning mists rise from the active soils and earthworm castings cover the surface of the field.

This is the point in the rotation where we turn our attention towards field-scale weed control with a bare fallow period. Approaching the summer solstice there is ample sunlight and warmth for prime conditions to germinate weed seeds. At the first signs of germination we will till the field thoroughly, but shallowly, about one to two inches, usually with a spring tooth harrow. We hitch a cultipacker in tandem to firm the seedbed immediately to promote the next round of weed seed germination as quickly as possible, thereby getting as many successions of weed germination in the bare fallow period as possible. We may maintain this bare fallow period for as much as eight weeks, lightly harrowing the field every 7 to 14 days, depending on the germination we see.

In early August we prepare to sow the fallow fields to another round of cover crops. For those fields, which will be planted to early vegetable crops in the following year, we will spread another round of amendments. We use the same custom dry blend layered into a manure spreader full of compost. Once spread, we work the compost and amendments into the soil with one last pass of the springtooth harrow. For those fields, which will be planted to later vegetable crops in the following year, we will wait to spread amendments until the next spring, partly due to our limited production of compost.

Finally we will drill all of the fallow fields to their second round of cover crops for the season. In the fields which will be growing early vegetables in the next season we will sow oats and peas, which will reliably die back over winter. This enables us to plant early after a quick tillage of the winterkilled residue in the following spring. In the fields which will be growing late-planted vegetables in the next season, we will sow another biennial cover crop – usually rye and vetch or rye and sweet clover again. These biennials will survive overwinter and will provide the same weed competitive cover late in the fall and early in the next spring. In the spring of the next crop year, we will spread our compost and amendments right into the vigorously growing cover crops. Again, we count on these covers to help digest another dose of amendments and make them more available to the vegetables to follow. We manage these biennials just as we did in the previous fallow year, only instead of beginning the bare fallow period after tillage, we begin planting our vegetable crops.

Before long the cycle repeats itself, and this is how we use rotations to achieve our goals of minimizing weed pressure and nurturing soil health.

USING CROP ROTATIONS TO MANAGE WEEDS

Bradley A. Majek
majek@AESOP.Rutgers.edu

Department of Plant Science
Rutgers Agricultural Research & Extension Center
121 Northville Road
Bridgeton, NJ 08302

Crop rotation is beneficial for many different horticultural, soil, and pest control related reasons. Producing different crops at different times of the year provides an opportunity to utilize different or left over nutrients and soil moisture. Using a legume crop in the rotation can increase soil fertility by the legume crops ability to fix and store nitrogen. Alfalfa's deep tap root can penetrate and break up a hard pan in the soil profile. Perennial grass hay crops increase soil organic matter and improve soil structure when they renew their root systems twice annually. Crop rotation can have a significant impact on plant disease pressure or insect pressure in a field.

The affects of crop rotation on weeds is less apparent. Certainly a field that is plowed and tilled annually in early and mid spring for years will exhaust the seed bank of winter annuals that bloom and set seed in late spring. More commonly, crop rotations are chosen to reduce disease or insect problems, or to improve soil fertility and tilth. The herbicides used in each crop should be chosen to control the weeds in that field and not carry over to affect the next crop. The use of herbicides with rotation restrictions can limit the choice of crops that can be planted the following year.

A crop rotation can also be designed to target a specific "hard to control" weed such as Canada thistle or yellow nutsedge. By choosing crops that allow the weed to be treated with effective herbicides repeatedly, and/or a rotation that provides the opportunity to control the weed during the reproductive time of year, improved weed control can be obtained.

Canada thistle is a herbaceous perennial weed with deep spreading roots. Control can be obtained with a glyphosate product, with Stinger, or Basagran. Glyphosate products are effective when Canada thistle is in bloom in early summer, and in early fall on fall regrowth of the weed. A crop rotation of early season snap beans treated with Basagran, followed by fall broccoli treated with Stinger in year 1, sweet corn treated with Stinger, followed by a glyphosate product in early fall in year 2, and by matted row strawberries, treated with Stinger in year 3 can control Canada thistle.

Yellow nutsedge is the number one weed in horticultural crops worldwide. The weed sprouts from tubers and grows vigorously, spreading with rhizomes that curve upward initiating new plants in late spring and early summer. When the nights begin to lengthen in early August, yellow nutsedge initiates a new burst of rhizome growth. These rhizomes grow angling downward, and by early September, the tips swell and produce new tubers. As the nights lengthen further in early fall, the weed senesces, and the new dormant tubers sprout randomly in the late spring in following years.

The key to controlling yellow nutsedge is preventing new tuber formation for several years, which occurs in August and early September. Planning a crop rotation so that the crop is harvested before August, so tillage can be used to keep the field nutsedge free in late summer, or the planting of crops that can be treated with herbicides that effectively control nutsdge can eliminate the weed as a problem in the field. Dual Magnum, Basagran, and Sandea are among our most effective yellow nutsedge herbicides. A crop rotation of early cucumbers treated with Sandea, followed by late summer snap beans treated with Dual Magnum and Basagran in year 1, followed by tomatoes treated with Sandea in year 2, early sweet corn treated with Dual Magnum and Basagran followed by tillage in year 3, and pumpkins treated with Sandea in year 4 targets yellow nutsedge in every crop. Four years without tuber production can reduce the yellow nutsedge population in a field to where it is only an occasional weed that can be cultivated or rouged by hand weeding.

Residual herbicides have a section on the label that lists the period of time that must elapse between application and the planting of other crops in the rotation. A table summarizing the plant-back restrictions for most herbicides is included in the Commercial Vegetable Production Recommendation guide used in the mid Atlantic states. Use this table when planning crop rotations and weed control programs BEFORE applying herbicides! Consider using herbicides that have no or short plant-back restrictions, or herbicides labeled for used on likely follow crops to increase crop rotation flexibility.

For example an early cucumber crop treated with Command and Sandea should have very good weed control, but late summer follow crops would be limited to snap beans. If Prefar was used in the cucumbers, weed control may not be quite as good, but late summer follow crop options would be numerous. Lettuce crops, onion crops, cole crops, parsley, and summer squash or a second cucumber crop (not recommended) are among the crops that are listed on the Prefar label. Consult your local Cooperative Extension Agent for additional help choosing crop rotations.

What I've Learned About the Economics of Reduced Tillage

John H Gill
Gill Corn Farms, Inc.
1875 Hurley Mt. Rd.
PO Box 225
Hurley, NY 12443
845-331-1187 office
John@gillfarms.com

Gill Farms has 1600 tillable acres, sweet corn is the main crop with 100 acres mixed vegetables, 150 grain corn, 1350 sweet corn. In spring of 2008 a 12 row Unverferth model 130 zone builder was purchased. 1200 acres were planted in 2008 using the zone-builder. We transitioned to zone tillage for cost savings, benefits to soil and yield increase.

Conventional Tillage

The way we did our conventional tillage for our spring planting soil preparation on 1500 acres of corn was to use three tractors and three 5 bottom plows. The three tractors and plows will do 20 acres each, a total of 60 acres a day. The fuel usage for each would be 75 gallons a day, a total of 225gal/day. The cost of fuel at $4.50/gal times the 225gallons would give you a cost of $1012.50/day. For 1500 acres at 60 acres a day it would take 25 days and a total of $25,312.50 worth of fuel for plowing. The labor involved 3 men working a 10 hour day at $11.00/hr, for 25 days. The cost of labor to plow would be $8,250.00. The total cost to plow using the machinery ($25,312.50) and labor ($8,250.00) is $33,562.50.

The disking took 1 tractor and disk to do 100 acres/day/double cut and use 100 gallons of fuel a day at cost of $450.00/day. The acres disked totaled 3000 acres. The total fuel cost for the 3000 acres at $4.50/gallon comes to $13,500.00. The labor for this involved 1 man working a 10 hour day at $13.00/hr for 30 days at a total cost of $3,900.00. The total cost to disk using the machinery ($13,500.00) and labor ($3,900.00) is $17,400.00.

To roller harrow took 1 tractor and roller harrow to do 50 acres/day and 35 gallons of fuel a day at a cost of $157.50/day. It would do 300 acres in 6 days using 210 gallons of fuel totaling $945.00. The labor involved 1 man working a 5 hour day at $11.00/hr for a total of $330.00. The total cost to roller harrow using the machinery ($945.00) and labor ($330.00) is $1,275.00.

The total cost for spring planting soil preparation using the conventional tillage by adding the three totals would be plowing ($33,562.50), disking ($17,400.00) and roller harrowing ($1,275.00) is $52,237.50.

The fall soil preparation in the conventional method used a tractor and disk to disk in stuble. It would do 80 acres/day and use 80 gallons of fuel a day at cost of $360.00/day.

This would take 18.75 days to do 1500 acres and use 1500 gallons total at a cost of $6,750.00.

The labor involved 1 man working a 10 hour day at $13.00/hr for 18.75days for a cost of $2,437.50. The total cost to disk using the machinery ($6,750.00) and labor ($2,437.50) is $9,187.50.

The v-ripping involved 3 tractors to do 30 acres/day using 80 gallons of fuel a day for each. Three tractors used a total of 240gal/day at a cost of $4.50/gal for a total cost of $1,080.00/day. It took 16.67 days times the $1,080.00/day gives you a total cost of fuel of $18,003.60. The labor involved 3 men working a 10 hour day at $11.00/hr for 16.67 days. The cost of labor to v-rip would be $5,501.10. The total cost to v–rip using the machinery ($18,003.60) and labor ($5,501.10) is $23,504.70.

The total cost for the fall soil preparation using the conventional method by adding the two totals of disking ($9,187.50) and v-ripping ($23,504.70) is $32,692.20.

The cost for using conventional tillage of soil preparation in spring was ($52,237.50) and for fall was ($32,692.20) making the overall cost a total of $84,929.70.

Zone Tillage

Using the zone tillage method of soil preparation before spring planting on the 1500 acres, we would use 1 tractor and disk that would do 100 acres/day for 15 days. It used 100 gallons of fuel a day for a total of 1500 gallons at a cost of $6,750.00. The labor involved 1 man working a 10 hour day at $13.00/hr for 15 days for a cost of $1,950.00. The total cost for disking using the machinery ($6,750.00) and labor ($1,950.00) is $8,700.00.

The zone tilling involved 1 tractor that would do 50 acres/day for 30 days. It used 40 gallons of fuel a day for a total of 1200 gallons at a cost of $5,400.00. The labor involved 1 man working a 5 hour day at $11.00/hr for 30 days for a cost of $1,650.00. The cost for tilling using the machinery ($5,400.00) and labor ($1,650.00) is $7,050.00.

The cost for the spring planting soil preparation using the zone tillage method by adding the disking ($8,700.00) and zone tilling ($7,050.00) totals $15,750.00.

The fall soil preparation in the zone tillage method used a tractor and disk to disk in stuble and a cover crop. The tractor had to go over the 1500 acres twice and it did 80 acres/day for 37.5 days. It used 80 gallons of fuel a day for a total 3,000 gallons at a cost of $13,500.00. The labor involved 1 man working a 10 hour day at $13.00/hr for 37.5 days for a cost of $4,875.00. The total cost for the fall soil preparation by adding the machinery ($13,500.00) and the labor ($4.875.00) is $18,375.00.

The overall cost for using the zone tillage method by adding the spring planting soil preparation ($15,750.00) and the fall soil preparation ($18,375.00) is $34,125.00.

Looking at the cost of the zone tillage ($34,125.00) compared to the conventional tillage ($84,929.70), a savings of $50,804.70 is realized by the use of the zone tillage method.

Using Reduced Tillage at Parlee Farms

Mark Parlee
Parlee Farms, Tyngsboro MA
www.parleefarms.com

At Parlee Farms, we farm approximately 100 acres along the Merrimack River in Tyngsboro, MA. We are primarily a pick-your-own fruit farm with our major crops being Apples, Blueberries, Strawberries, Peaches, and Cherries. We also grow 25 acres of corn and pumpkins. This land is seeded down to winter rye which is harvested into round bales at the end of May. The land is then prepared for planting using our two-row Unverferth Zone Builder. Three modifications were made to our two-row Pequea Planter:

1. Dawn Row Cleaners were added;
2. Seed Firmers were installed;
3. One of the closer wheels on each planting unit was replaced with a finger-type closer wheel.

The many advantages of Zone Building has been discussed before. Following are some of the advantages that I see:

1. Prepare fields in much less time;
2. Breakup plow pan;
3. Preserve organic matter in soil;
4. Preserve organic matter on surface for less soil contact with pumpkins;
5. Increased organic matter allows for better utilization of fertilizer.

Overall, the Zone Builder has allowed us to increase the quality and the quantity of our corn and pumpkin production without any increased labor.

Profitable Matted Row Strawberries – Getting Started

David T. Handley, Vegetable and Small Fruits Specialist
University of Maine Cooperative Extension
Highmoor Farm, P.O. Box 179, Monmouth, Maine 04259
(207) 933-2100 david.handley@maine.edu

The matted row system for strawberry production has been both successful and profitable in cold growing regions for many years. Despite some recent adoption of other production systems adapted from warmer climates, the matted row system has remained widely planted in northern regions because of its proven advantages. These include relatively low initial investment costs, adaptation to cold climates, and the ability to maintain the planting for several years. The matted row system works well because it exploits the natural growing habit of the strawberry plant, optimizing both its vegetative characteristics and its fruiting potential to produce a profitable crop with a relatively low level of inputs.

Yields from matted row strawberries vary widely, ranging from 3000 pounds per acre to nearly 20,000 pounds per acre. The differences in production tend to be the result of management. Following good management practices, especially in regards to variety selection, plant stands, nutrient management, water management and pest management will maximize crop yield and prolong the profitable life of the planting.

Selecting A Planting Site

Selecting an appropriate planting site is the first critical decision that must be made. Planting strawberries in a poor or marginal site will result in poor plant stand, poor plant vigor and poor yields. While strawberries can tolerate a variety of soil types, they grow best in a deep sandy loam, rich in organic matter. The soil must be well drained. Avoid areas that remain wet late into the spring. Strawberries produce best if they receive full sunlight and are planted on a gradual slope. This helps to prevent frost injury by allowing cold air to drain away from the plants. Do not plant strawberries in an area where tomatoes, potatoes, peppers, or eggplant have been grown in the past four years. These crops carry a root rot (*Verticillium*) which also attacks strawberries. Do not plant strawberries into recently plowed grass or sod areas. This can lead to devastating weed problems and damage by white grubs, a common turf pest, which will feed upon strawberry roots. Finally, choose a site where there is ready access to a water supply. Irrigation is important for good plant establishment, to maintain growth during dry periods, and is also used to prevent frost injury to strawberry flowers in the spring.

Preparing the Soil

Getting ready for strawberry planting may take two years, depending upon the condition of the site. Have the soil tested for pH and fertility. Strawberries prefer a soil pH of 5.8 to 6.2; this may require applications of ground limestone. Soil testing information is available at your Cooperative Extension office. If the organic matter level of the soil is low (less than 2%) and/or perennial weeds are a problem, a cover crop such as buckwheat, Sudan grass or oats can be sown and later plowed into the soil before it goes to seed. Applications of compost or barnyard manure and regular tilling for a full season can be used as an alternative to cover crops.

Fertilizer can be applied and worked into the soil prior to planting, or banded into the soil after planting. Rates should be determined through soil tests taken the previous fall. In general, a rate of approximately 30 lbs. of nitrogen, 60 lbs. of phosphorus (P_20_5) and 60 lbs. of potassium (K_2O) should be incorporated into the soil prior to planting (e.g. 300 pounds/acre of 10-20-20 or its equivalent). An additional 30 pounds of nitrogen per acre (e.g. 65 lbs. urea) should be applied over the plants in July to promote runner development. Another, lighter application of nitrogen may be applied in August to aid in flower bud development (e.g. 40 lbs. urea). Do not apply heavy applications of nitrogen in the fall. This will increase the likelihood of winter injury to the plants.

Planting and First Season Care

Plant strawberries in the spring as soon as the soil can be prepared. Purchase only certified disease-free plants from a reputable nursery. Plants should have large crowns and lots of healthy, light-colored roots.

Strawberries should be planted deep enough to bring the soil half way up the compressed stem or crown. Pack the soil firmly around the plants, and irrigate immediately after planting. Mechanical transplanters are available that work very well and greatly speed up planting.

The strawberry crowns should be initially planted 18 inches apart within rows, with 48 to 52 inches between rows. This will require about 7300 crowns per acre. These plants will produce runners during the summer that will root and fill out the rows. The width of the plant row should be limited to 24 inches to maintain easy access in the planting. Runner plants that grow outside the 24-inch row width should be pinned back into the row or removed if the plants become too crowded (less than 6 inches between plants). Varieties known to produce few runners can be initially spaced closer together (12 to 16 inches) within the row to compensate. This will require that a higher number of plants be ordered and therefore will increase planting costs.

Matted rows may be established on raised beds. This improves drainage and air circulation, reducing disease problems, and it makes harvesting the fruit easier. Raised beds should be six to ten inches high, and one to two feet across. The disadvantages of raised beds include added labor and equipment costs, and an increased potential for drought and winter injury to the plants.

All flower blossoms that emerge during the planting year should be pinched off. This encourages runner growth and plant vigor and leads to better yields next year. Because of the initial wide spacing of the crowns the planting year crop would be very small, difficult to harvest and thus of little value.

The new planting should be irrigated after planting and regularly thereafter to insure optimum growth. One to two inches of water per week is ideal. Increasingly, growers are using trickle irrigation in matted row strawberry plantings. One or two lines of trickle tube is either buried 3-4 inches under the bed prior to planting or laid on top of the bed just after planting. Trickle irrigation is a more efficient method of getting water to the plants and, unlike overhead irrigation, doesn't soak the foliage, which can encourage disease problems. Trickle lines can also be used to deliver soluble fertilizers to the plants. However, trickle irrigation will not provide frost protection as overhead irrigation can, and care must be taken to avoid damaging the trickle lines during the renovation process.

Mulching

Mulch should be applied over strawberries in the late fall to protect the plants from extreme winter cold and from damage to the roots caused by rapid freezing and thawing of the soil. Straw is the most commonly used mulch, but any loose material that will provide cover without matting can be used, such as sawdust or wood shavings. Do not use hay, because it contains weed seeds, which will start to grow among the strawberries next spring.

Strawberry plants provide a good indication of when mulch should be applied. After a few hard frosts the leaves turn reddish and collapse down around the crowns. This is a sign that the plants are dormant (usually late November). Mulch should be applied anytime after that, but before the ground freezes. Two to five tons of straw per acre is recommended (approximately one ton of straw provides one inch of coverage per acre). Use the higher rates if your fields are exposed and do not get consistent snow cover. The mulch layer should be approximately 6 inches deep over the plants. Be discriminating about your source of straw. Straw from weedy fields will result in weed infestations in your strawberries.

In the early spring (late March-early April) the mulch should be pulled off the plants and placed into the aisles between rows. This creates a clean walkway and keeps the fruit dry and clean.

A light application of fertilizer may be applied after mulch removal to stimulate spring growth. Only 10 to 15 lbs of actual nitrogen is recommended to prevent excessive vegetative growth at this time, which can lead to fruit rot problems (e.g. 85 lbs./acre of calcium nitrate). Light applications (1 to 2 lbs./acre) of boron are also often applied in the spring to help fruit development.

Frost Protection

If a frost is predicted after the mulch has been removed irrigation should be set up to protect the flower buds. Set up sprinklers to provide complete coverage of the planting, and turn the water on when the temperature drops to 33° F. Continue to run the water until all the ice formed on the plants has completely melted. Frost nozzles are available for sprinklers that will provide protection using less water than regular nozzles, saving energy and preventing flooding.

Fabric, "floating' row covers may also be placed over the plants to provide some winter and frost protection. These lightweight fabrics create a greenhouse effect that will make the plants bloom and fruit earlier in the spring and produce larger yields. Rowcovers should be placed over the plants in the early fall. The plants and rowcovers may be covered with straw in late fall for additional winter protection. Remove the straw in early spring, or as soon as the snow melts. Leave the rowcovers on until the plants begin to bloom. This may occur 2 to 3 weeks earlier than plants without rowcovers, so you must be prepared to protect the flower buds from frost. Although the rowcovers will provide some frost protection, it is best to use irrigation over the rowcovers if the temperature drops below 30°F. Row covers may also be applied only in the early spring and removed when flowers first appear. This avoids the problems of trying to maintain the rowcovers over the winter, but the increased yield effects tend to be reduced.

Renewing the Planting
Strawberry beds can usually be carried over for three to five years. Annual bed renovation is a critical part of successful strawberry production with the matted row system. Renovation is primarily a plant thinning process carried out after harvest to stimulate healthy new vegetative growth. This in turn will promote a good crop for the following year. A strawberry bed that has had a productive season and that has vigorous plants, which are free from serious insect, disease, and weed problems should be carried over for another year. The renovation process will insure that such beds will have another good crop. All beds to be carried over should undergo the following steps beginning soon after harvest is complete.

1. Broadleaf Weed Control: If perennial broadleaf weeds (dandelion, daisy, etc.), and/or a high population of emerged annual broadleaf weeds (lambsquarter, pigweed) are present 2,4-D amine (Amine 4®) can be applied for control. 2,4-D is a post-emergent herbicide, which is effective on broadleaf perennial weeds. It will not control grasses, nor does it offer any pre-emergent control. If 2,4-D is not applied all broadleaf perennial weeds should be removed by hand.

2. Mowing: If 2,4-D was applied to the planting, wait four to five days following the application then mow off the leaves of the strawberries about 1 1/2 inches above the crowns. This allows time for the material to be taken in by the weeds. The leaves can be mowed immediately after harvest if 2,4-D is not applied. Mowing stimulates new leaf growth and may provide control of leave diseases. Removal of the leaf canopy also improves the distribution of fertilizers and herbicides. However, if the planting is stressed from drought or appears weak and will be carried over to next year in spite of this, than mowing can be eliminated from the renovation process. Mowing weak plants may inhibit recovery.

3. Fertilization: Apply fertilizer according to soil test recommendations. Soil testing kits and information are available from your county Cooperative Extension office. Typically about 40 pounds of actual nitrogen per acre is applied at this time (e.g. 87 lbs. of urea), with another 20 pounds of actual nitrogen applied four to six weeks later. Balanced fertilizers, such as 10-10-10, containing phosphorus and potassium may be used if soil tests indicate a need for these nutrients. Avoid over-fertilization with nitrogen. The resulting excessive growth on plants can lead to problems with winter injury, spider mite infestations and fruit rots, in addition to potential water contamination problems from soil leaching. Tissue nutrient analysis of leaves after renovation can offer more precise guidance to appropriate fertilizer rates for each field. Contact your state Extension specialist for information on tissue analysis. A very light application of nitrogen is often applied the following spring after removal of the mulch. Ten to 15 pounds of actual nitrogen at this time can help to stimulate early plant growth. Heavier applications should be avoided because this could cause excessive vegetative growth and increase the likelihood of fruit rot. Light applications of boron (1 to 2 lbs. per acre) and calcium may also provide some benefit to fruit development in the spring.

4. Plant Thinning: Strawberry rows should not be allowed to get more than 24 inches wide. Till the sides of the rows to narrow the beds back to a width of ten to twelve inches. Set the tiller so it incorporates the mowed leaves and fertilizer, and spreads about one inch of soil over the

remaining crowns. During the summer, new daughter plants should be allowed to root to fill out the row to the desired 24-inch width.

5. Pre-emergent Weed Control: To control annual weeds, terbacil (Sinbar 80WP) may be applied according to label directions. Terbacil is an effective pre-emergent herbicide with some post-emergent activity. It should be applied after mowing and tilling the beds, but before new growth begins. No more than 6 oz. of Sinbar may be applied in a single application, and no more than 8 oz. may be applied in one season. Sinbar can cause injury to strawberry plants. It is important to determine appropriate rates for each location. Certain strawberry varieties are especially sensitive to Sinbar, including Kent and Annapolis. Be sure to read and follow all precautions on the label.

6. Irrigation: Encourage optimal plant growth and get the most out of your fertilizers and herbicides by regular irrigation. Strawberries will grow best if they receive 1 1/2 inches of water per week during the growing season.

Do not delay the renovation process. Late renovation will delay the rooting of new runners needed to reestablish the bed. This will result in smaller plants and lower yields next year. Be vigilant! Be on the lookout for weeds, insects, spider mites and diseases throughout the year. Cultivation and/or sprays are likely to be necessary as the summer wears on.

Beds that will not be renovated and carried over should be plowed down and seeded to a suitable cover crop to reduce weed, insect and disease problems that have developed and to increase soil organic matter content. Ideally, beds that are plowed down should be rotated out of strawberries for at least three years. If properly managed, crop rotation will greatly reduce pest problems and improve the vigor and longevity of strawberry beds.

Growers who want to produce strawberries organically often forego the renovation process and simply plow the bed down after the first fruiting year, and have another bed planted that spring to harvest the following year. This prevents the build up of weeds in a field that will usually occur without the use of herbicides. While planting beds every year and not carrying over them beyond one harvest may cost the grower a bit more, the profit margin of a well-run organic strawberry bed can still be good.

For more detailed information on strawberry production, see the ***Strawberry Production Guide for the Northeast, Midwest and Eastern Canada***, published by the Natural Resource, Agriculture and Engineering Service (NRAES-88), and available through your University Cooperative Extension.

Where brand names are used it is for the reader's information. No endorsement is implied nor is any discrimination intended against products with similar ingredients. Always consult product label for rates, application instructions and safety precautions. Users of these products assume all associated risks.

Innovative Strawberry Growing Ideas

Cathy Heidenreich, Cornell University, Department of Horticulture, NYSAES-Cornell University, 630 West North Street, Geneva, NY 14456, mcm4@cornell.edu

What are some of the newer ideas in strawberry production in the Northeast and Canada? Are they meeting with success?

Not Your Father's Matted Rows

Plasticulture Strawberries

Ohio growers are having success using plasticulture production systems for strawberries. They are growing June-bearers and day-neutrals on black plastic using a 2-row per bed system. The typical production cycle is 2 years.

NY growers continue to experiment with plasticulture strawberries – both June-bearers grown in perennial systems and day neutrals grown as annuals or on a 2 year cycle. These are both grown on traditional black or white plastic mulch or on biodegradable mulch. Not all attempts have been successful but much progress is being made. Fertility issues affecting fruit quality, varieties and production systems suitable for NY are still under investigation.

Both Quebec and Ontario are having excellent success with plasticulture production of day neutrals.

Annual production systems using day neutrals are established in June using dormant crowns, and harvested from June until frost. These plantings were initially carried over for a spring crop but berry size was small. To capture earliness without compromising fruit size, a second production system was adopted where fall plantings are established using plug plants. There is some risk associated with fall planting as plants not sufficiently established tend to be more prone to frost injury. Wind breaks and/or fencing is used to encourage snow accumulation to protect plants during the winter.

Fields for fall or spring planting are fumigated in late summer before being fitted with raised beds/plastic. This allows for the earliest spring planting. The beds are 4-ft wide and 10" high and are covered with black plastic mulch. Two drip tapes run down each row under the plastic. Plants are spaced 8" in row and 16" between rows on the plastic (20,000 plants/A). 'Seascape' is the variety under production in these systems. Fall planted plug plants are overhead watered 2 times a day in addition to trickle irrigation during the first 2 weeks after planting. This is especially critical during warm August weather. Pre- emergent applications of Chateau and Sinbar are made only in the 2.5' wide alleyway area between the beds to help avoid any potential injury to the transplants. Runners are removed weekly. Pest issues include Tarnished Plant Bug, Two-Spotted Spider Mites, Powdery Mildew and Gray Mold. Harvest begins in early June; berries are picked every 2 days while they are bearing.

More information:

1. Dale, A. and Pritts, M. 1989. Day neutral Strawberries. http://www.omafra.gov.on.ca/english/crops/facts/89-099.htm
2. Nourse, Nate. 2012. Plasticulture 2012: June-bearing and Everbearing Strawberry Production with Dormant Plants. http://noursefarms.com/assets/2012-4_plastic.pdf
3. Poling, B., Krewer, K., and Powell Smith, J. 2005. Southeast Regional Strawberry Plasticulture Production Guide. http://www.smallfruits.org/SmallFruitsRegGuide/Guides/2005culturalguidepart1bs1.pdf

Hydroponic Strawberries
Interest in hydroponic strawberry production is growing in NY and across the Northeast. Both commercially available and owner/operator designed systems are currently in use in the field and under protected production in high tunnels.
Stackers - Commercial systems like hydrostackers are popular. The typical field stacker operation is a ¼ acre plot with 15,000 plants growing in an artificial potting medium. Each "stack" has 5 Styrofoam planting units that hold 4 plants each. These are assembled in rows with weed barrier below. Automated irrigation/fertilization/pesticide application systems are in place at the top and mid-level of each row of plants. Varieties under production include 'Seascape' and 'Albion'. Berries are typically harvested from mid-June to late October. Most operations are U-pick. Berry stems are cut with scissors allowing berries to drop gently into baskets (both scissors and baskets with liners provided). Alternatively, they may be purchased pre-picked from the farm stand. Some growers also sell at local farmers markets; berries not suitable for marketing as fresh fruit are often used to make value-added products also sold through the farm stand. Pest issues for this type of production system include American Robins, Gray Mold, Powdery Mildew, Tarnished Plant Bug, Leaf rollers/Skeletonizers and Two-Spotted Spider Mites. Vertical growing systems are also being used in commercial and DIY high tunnels. Pest issues here are minor compared to field production and chiefly include Two-Spotted Spider Mites and Powdery Mildew. *More information:* Hydro-Stacker Vertical Hydroponic Growing Systems - http://www.hydrostacker.com/ and Verti-gro - http://vertigro.com/.

DIY Hydroponic Systems - One enterprising NY grower designed and built his own hydroponic system and has used it successfully with both tomatoes and strawberries. Using lengths of square PVC pipe he plumbed an 8-row system in his high tunnel. 4 inch diameter holes were drilled at evenly spaced intervals along the pipe. Pipes are connected using T's. Dormant strawberry plants were planted in 4 inch open mesh weave pots filled with pebbles. These are set into the hole in the pipes. Water and nutrients are circulated through the system on a regular basis.
High Tunnel Strawberries
Day Neutrals - The season extension aspect of day neutrals is magnified when grown in a tunnel. Additionally, strawberries can fill valuable space where other crops would simply not fit. If they are treated as annuals, they just go into a regular rotation with other veg crops. Several production schemes are in use, including traditional matted rows, plasticulture, soil socks, hydroponics, etc. *More information*: Jett, L. 2006. Growing Strawberries in High Tunnels in Missouri. http://www.hightunnels.org/PDF/Growing_Strawberries_in_High_Tunnels.pdf; Rowley, D., Black, B., and Drost, D. 2010. High Tunnel Strawberry production. http://extension.usu.edu/files/publications/publication/Horticulture_HighTunnels_2010-01pr.pdf.

Not Your Mother's June-bearers
Day Neutral Strawberries
Unlike their June-bearing cousins that fruit once a season, day neutral strawberries flower and fruit continuously (for the most part) from mid-June until frost. They may be grown either in traditional matted row systems or in plasticulture or hydroponic systems. The first commercial day neutral strawberry varieties were released in the early 1980's by the Maryland Agricultural Experiment Station in conjunction with USDA-ARS. These were 'Tribute' and 'Tristar'. Other releases followed from the University of California Davis Breeding program, including 'Seascape' (1991) and 'Albion (2004)' which are the mainstays of day neutral production in the

Northeast. ‘Other new day neutral releases from the UC Davis breeding program (‘Monterey’, ‘Pacific’, ‘Palomar’, ‘Portola’, and ‘San Andreas’, 2009) have not been fully evaluated under NE growing conditions. One eastern NY grower who has trialed Portola and Monterey reports Portola looks to have the MOST promise, although Monterey is also good, but a bit late and not enough yield. Portola kept going even when Seascape petered out a bit.

You may also be asked information about growing cuttings and planting in the summer (Chandler) simply because many small growers in New England and eastern NY have such high value markets and are selling produce all winter long. Those very early season berries really bring a LOT of money and are worth just putting in a bit so that they can capitalize on them.

Alpine Strawberries

Alpine strawberries (*Fragaria vesca*) are a gourmet type strawberry also known as “Fraises des bois” (woods strawberries). They have recently come back under consideration as a potential commercial strawberry crop for sale to gourmet market outlets such as high end restaurants. They are available in red, white or yellow fruited open pollinated varieties. Fruits are small but highly fragrant. These berries are labor intensive in terms of harvesting. *More information:* Wellik, M. Growing Gourmet Strawberries Commercially.
http://www.thestrawberrystore.com/GrowingGourmetStrawberriesCommercially.pdf

Other Bright Ideas…

Strawberries on Raised Beds

Growers in western NY often have rocky heavy clay soils to deal with. Strawberry production is problematic for these growers because of drainage issues and root rot diseases. One commercial berry operation has gone exclusively to raised bed production for strawberries. This system, in conjunction with the use of resistant varieties, has made commercial strawberry production possible and profitable for their operation.

The next 2 bright ideas attempt to address weed control during the establishment year of perennial matted row strawberries while reducing cultivation and herbicide inputs and improving soil health.

No-till/Zone-till Strawberries

A 2009 Cornell University project focused on controlling weeds in strawberries during the establishment year by transplanting dormant berry plants into a killed cover crop (Winter rye, *S. cereale*, 80 lb/A). Results from this project indicated this technique showed great promise but revealed a significant barrier. Most growers had difficulty planting through the killed cover crop. This resulted in slower establishment during the first month and caused skips.

Another related Cornell project nearing completion compares no-till, zone till and conventional tillage strawberry production. An Unverferth ripper/stripper was used to create a 6” tilled zone in the cover crop and the berries were planted in that zone. Its sub-soiler loosens soil deeply followed by coulters and a rolling basket that prepare a6-10” wide seedbed. This technique allows the longer rooted strawberry plant to be correctly planted while still having minimum soil disturbance between the rows. By only tilling this narrow area, the chance of new weed seeds being brought to the surface for germination is reduced. Because the strawberry plants will get off to a good start, they should out-compete weed competitors in the tilled zone. The addition of the shank allows for improved water drainage therefore reducing disease pressure from soil borne diseases like Phytophthora fruit rot. The use of reduced tillage tools usually requires a single trip across a field for it to be fitted for planting – an important advantage that translates into less labor, reduced fuel consumption and a decreased risk of soil compaction.

Strawberries and Biofilm

Biotelo mulch film was used in Cornell research and demonstration trials on grower strawberry farms for planting year weed management trials. This mulch is made of Mater-Bi, a thermoplastic material mainly derived from corn starch. The mulch is certified compostable and is IFOAM approved for use by European organic farms. Novamont, the maker, has not yet pursued approval for use in U.S. organic systems. The MaterBi mulch is an embossed mulch film manufactured using the same technologies used to produce conventional plastic mulch film. Mater-Bi's physical and chemical properties are similar to those of traditional plastics, but Mater-Bi mulches biodegrade at a rate similar to pure cellulose. Biofilms degrade as soon as they are stretched during field application and continue to break down in soil after incorporation. For the demonstrations, we used a .6 mil Biotelo mulch film. The rolls were 48" wide and 5000' long. As of November 2008, the cost is $400/roll.

Biofilm decomposes more quickly when applied to soils with high organic matter content, so growers with plantings on sandy soil thought breakdown was slow. One Long Island grower in particular saw very little decomposition after 16 weeks. This is a problem as strawberry runners could not root through the intact biofilm. Growers with more organic soils were happier with the rate of decomposition and the degree of weed suppression. These growers reported that they did not need additional in-row herbicides, tilling, or hand labor during the first year growing season. Further, they felt that the berries grown on biofilm were more vigorous than the conventional matted row plant. *Sources of Biofilm*: Biobag USA, www.biobagusa.com, 1-800-959-2247 or Dubois Agrinovation, www.DuboisAg.com, 1-800-667-6279.

Strawberries and Bird Netting

One last comment on a probable production change is netting for birds in strawberries. Bird damage in strawberries was a HUGE concern this year in the Northeast region, and many growers are planning on netting strawberries in 2012. Remember, the scale of the planting is so much smaller in this area, that this type of intervention is not unreasonable for the value of the crop.

Strawberry Variety Review

David T. Handley, Vegetable & Small Fruit Specialist
University of Maine Cooperative Extension
P.O. Box 179, Monmouth Maine 04259-0179
david.handley@maine.edu

Early Season

Earliglow: An early berry of high quality. Fruit is firm with excellent flavor and color. Yields may be low in the Northeast. Fruit size tends to decrease as season progresses. Plants are vigorous runner producers and are resistant to red stele and Verticillium wilt.

Sable: From Nova Scotia. Medium to large fruit. Flavor is very good, but fruit are soft. Yield potential is high and picking period is long, but fruit size may decline sharply after the first harvests. Plants are vigorous, with some resistance to red stele.

Northeaster: Large, firm fruit with dark color strong flavor. Good yields for an early variety. Shy runner producer, but plants are vigorous and perform well on heavy soils. Resistant to red stele and Verticillium.

Evangeline: From Nova Scotia. A very early berry with a long conic shape and good flavor, but yield may be low in northern New England. Early flowering, so quite susceptible to frost injury. Plants are vigorous, but have no resistance to red stele or Verticillium wilt.

Wendy: From Nova Scotia. An early berry with good color, firmness and flavor. Yields have been very good. Not as early flowering as some other early varieties. Plants are vigorous and may have some tolerance to red stele. Some growers have reported problems with leaf spot.

Early-Midseason

Honeoye: From New York. Generally early ripening. High yielding. Large, very attractive fruit with firm flesh, but flavor may be tart or flat. Plants are vigorous and produce many runners. Very susceptible to red stele and no know resistance to Verticillium.

Annapolis: From Nova Scotia. Large fruit with good flavor and color, but somewhat soft. Very vigorous, free-running plants. Some winter injury reported. Some resistance to red stele.

Mira: From Nova Scotia. Large, firm, light red fruit with good quality. Plants have high yield potential and are vigorous with some resistance to red stele root rot and leaf diseases.

Brunswick: From Nova Scotia. Medium to large blocky fruit, attractive, dark red. Somewhat tender, and may be tart if not picked fully ripe. Very high yielding. Plants are vigorous with some resistance to red stele.

L'Amour: From New York. Large, bright red, firm, conic fruit with a fancy calyx. Yield has been variable across the region. Plants are vigorous but susceptible to red stele.

Darselect: French. Large, bright red, firm, uniform round-conic fruit with fancy calyx. Yields have been good. Flavor is sweet and mild. Plants are large, fairly vigorous, but very susceptible to leaf scorch.

Midseason

Cavendish: From Nova Scotia. Productive. Large, firm fruit with good flavor, but with an uneven ripening habit. High yield potential. Plants are moderately vigorous. Resistant to red stele and Verticillium, but susceptible to gray mold.

Kent: From Nova Scotia. High yielding. Large, attractive fruit with very good flavor. Plants are vigorous and good runner producers, but beds tend to run down after two or three seasons. No known resistance to red stele or Verticillium, susceptible to gray mold.

Jewel: From New York. Large, glossy, attractive fruit with firm texture. Very good yields. Moderate vigor and runner production. Some winter injury reported. Susceptible to red stele and Verticillium.

Mid-Late Season

Allstar: From USDA/ARS Berries are large, conical and light red to orange with mild, sweet flavor. The plants are vigorous and make runners freely. Resistant to red stele and Verticillium.

Cabot: From Nova Scotia. Very large, rough fruit, bright red, firm, but with tender skin. Plants need high vigor, i.e. good soil fertility. Plants have some resistance to red stele, but the fruit is susceptible to gray mold.

Sparkle: Excellent flavored fruit, but dark red and somewhat soft. Fruit size tends to decrease as season progresses. Plants are vigorous, copious runner producers with some resistance to red stele.

Mesabi: From Minnesota. Large attractive fruit and very good yields. Fruit tends to remain hidden under the foliage and may be tough to pick. Vigorous plants, resistant to red stele and leaf spot.

Late Season

Winona: From Minnesota. Large, firm, light-red fruit. Yields have been moderate, and some winter injury reported. Moderately vigorous plants with resistance to red stele root rot and tolerant of most leaf diseases.

Clancy: From New York. Large, dark red, round to conic fruit with good firmness. Vigorous, productive plants with some resistance to red stele.

Valley Sunset: From Nova Scotia. Large attractive fruit, with good color and firmness. Vigorous, very productive plants with a long harvest period.

Ovation: From USDA/ARS. Very late, with a more concentrated ripening period. Fruit are large and firm, slightly dark with good flavor, yields have been moderate. Vigorous plants with some root disease resistance.

How to Keep Your Fruit Clean and Safe: Good Agricultural Practices for Berries

Elizabeth A. Bihn, Ph.D., National GAPs Program, Cornell University
630 W. North Street, Geneva, NY, 14456; eab38@cornell.edu; 315.787.2625

Envision the best berry you have ever tasted. It likely had good color, nice shape, and when you ate it, it was juicy and sweet with just the right amount of tangy acid to balance the sugar. Whether or not the berry was safe to eat or was contaminated by bacteria, viruses or parasites, likely never crossed your mind. That is the sensation all consumers and all your customers want to have, absolute enjoyment associated with eating fresh, tasty, and safe berries. Now ask yourself, do high quality, tasty berries grow themselves? As farmers, do you simply sit in your house 10 months out of the year watching TV, knitting, or resting waiting for a great harvest to present itself, than gleefully walk to the field to reap the harvest? The obvious answer to both of these questions is no. Now consider why any farmer would take food safety for granted without ever having considered the risks involved or effort needed to produce safe fruit. The production environment as well as some common practices used in the production of berries can introduce food safety risks and need to be understood in order to be controlled. There is no such thing as zero risk when the fruit is eaten raw as is the case with most berries, but there are steps that can be taken to limit and reduce risks.

The first step to understanding risks on your farm is to consider your production practices including land selection, soil amendments before and during production, water use including irrigation and protective spray mixing, containers used for picking and packing, and any person involved in production, packing, and distribution. There are other facets that can be considered such as the sanitation of transportation vehicles, coolers, and display stands as well as the presence of wild and domestic animals in the production fields. Does field location, inputs, or practices introduce any microbiological, chemical or physical risks? Is your field downhill and downwind from a large dairy operation where manure run-off could enter your field? Have you used river water to frost protect your berries in late May when fruit has already started to develop or may be close to harvest? Does hand washing have anything to do with berry production or operating a pick your own operation? These are just a few questions that can help you assess your operation. If it is unclear what types of risks field location, inputs, and practices might introduce, there are many ways learn about produce safety. Aside from attending the food safety session at the Northeast Vegetable and Berry Conference, you can visit several extension program websites including the National Good Agricultural Practices Program at Cornell University at www.gaps.cornell.edu or the University of California, Davis, GAPs Program at http://ucgaps.ucdavis.edu/. There are many other Land-Grant University (LGU) sites that can be found by simply googling "GAPs" or "Good Agricultural Practices". In addition to websites and educational materials found on these websites, many LGUs provide in-person GAPs trainings. During the 2011-12 winter, Cornell Cooperative Extension , New York State Department of Agriculture and Markets, and National GAPs Program personnel will offer four (5) two-day food safety trainings throughout New York State. These trainings include an in-depth consideration of risks during fresh produce production as well as time for each participant to develop and write their own unique farm food safety plan. The dates and locations of these trainings are posted at www.gaps.cornell.edu. Those unable to make a training but still interested in developing their own farm food safety plan can consult A Food Safety Plan (Template) for You at http://safety.cfans.umn.edu/ available from the University of Minnesota.

Motivation to understand and implement food safety practices goes beyond the desire to grow, harvest and sell safe berries. Many wholesale fresh produce buyers require verification of food safety practices before they purchase fruits and vegetables from a supplier. Buyers require the farms to have a written food safety plan that has been implemented including record keeping sheets that document practices. They also require farms to have third party audits to verify the food safety plan and practices are in place and implemented properly. In addition to buyer requirements, the Food Safety Modernization Act requires the U.S. Food and Drug Administration (FDA) to develop a fresh produce regulation. The draft regulation is scheduled to be released in early 2012 and will focus on practices used during fresh fruit and vegetable production. Having a written and implemented farm food safety plan is not just good for the safety of the fresh produce you grow, but is also good for business with the ever increasing food safety pressure in the marketplace.

Lastly, there are many resources available to not just help you learn about GAPs but also implement and document them. A review of the websites above as well as others will help you locate record keeping sheets and other materials such as worker training videos (*Fruits, Vegetables, and Food Safety: Health and Hygiene on the Farm*). If you need help getting started, contact your local extension educator or knowledgeable farm consultant. The newly formed Produce Safety Alliance (PSA) is working on a nationwide curriculum to help farmers understand and implement GAPs as well as prepare for the upcoming FDA regulation.   The PSA has working committees that are open to participation by all those interested in this issue and information can be found at www.producesafetyalliance.cornell.edu. The PSA is particularly interested in having farmers participate in their working committees since farmers understand the most about production and the challenges involved in understanding and implementing GAPs.

Strawberry Insect Update and Review, December 2011

Alan T. Eaton Extension Specialist, Entomology
252 Spaulding Hall, 38 Academic Way, University of New Hampshire Durham, NH 03824
alan.eaton@unh.edu

The late summer 2011 New England invasion of **spotted wing drosophila** (SWD) introduced a new insect threat to our strawberry growers. It is unclear now how serious that will be next year, but growers should consider monitoring for this insect in their strawberry beds. Over the winter we will be developing a response plan in more detail. For now, monitoring with traps is the mainstay of our defense. It should begin just before the first fruit ripen, and continue through harvest. This insect lays eggs in ripe and ripening fruit, hastening their decomposition. Once the eggs are inside, we can't stop them with insecticides. I suggest checking traps twice a week, and applying an insecticide if low numbers are detected. Spraying may disrupt picking plans, and multiple treatments may be required. Early season fruit are less likely to be seriously affected than late fruit. Ever-bearers in late summer and fall are likely to receive the heaviest attacks. The insect can develop from egg to adult in less than 2 weeks, so there are **many** generations each year. The flies are tan colored, 2mm (1/12 inch) long. Adult male SWD's are easy to identify. The black spot on each wing is unique, and can be seen with a hand lens. Females require a microscope to identify. They have a saw-edged ovipositor (egg-layer), which is unique. None of our 39 other species of drosophilids have these characters. Destroying/preventing over-ripe fruit should really help, but has logistics problems!

SWD aside, I think **tarnished plant bug** is the most important arthropod pest of New England strawberries. Why don't more of you scout for it? It causes major losses, and is highly variable in numbers. Scouting can really pay off. TPB overwinters as an adult, and feeds on a huge range of plant species. It attacks flower buds, flowers, and young fruit, up to about 1/3 grown. The severity of attack varies greatly with location. If there is a lot of early succession vegetation nearby (especially alfalfa or fallow fields with weeds), expect very heavy pressure. If your bed is surrounded by woods, you can get very little TPB pressure. Nymphs do most of the injury. If you have alfalfa nearby, avoid mowing it when strawberries are in bloom, or have young green fruit present. That drives them into your strawberries, just when they are most vulnerable. Scouting details are in the New England Small Fruit Pest Management Guide. We now emphasize scouting shortly before bloom, when there are flower buds present. Pesticide choices keep changing; go to the guide for that. I still steer people away from Brigade; I've seen serious two spotted spider mite problems triggered by Brigade spraying.

To me, **clipper** (strawberry clipper, strawberry weevil, strawberry bud weevil) is much less serious than TPB. It has one gen./year, and overwinters as an adult. June bearing varieties are regularly attacked, but in day-neutral varieties, the fruit in late July and later are not hit (too late). Clipper only attacks the unopened flower buds. The female lays an egg in the bud, then clips it off. Inside, the tiny grub feeds and grows, emerging in mid-summer. Some varieties can compensate for some clipper injury, by making the remaining fruit larger. Jewell and Senecca compensate well, so clipper attack is less serious in those varieties. Moderately compensating varieties include Lateglow and Primetime. Some varieties show little or no compensation, including Earliglow, Cavendish, Northeaster, and Honeyoe. The edges of fields are usually hardest hit, especially when beds are new. They move into the bed about 30 feet (10 rows) each year, so older beds can have injury throughout. Scouting pays off for this pest, too. Details are in the guide. If scouting shows numbers are over the threshold, you might not need to treat the whole bed. I wouldn't bother to scout Jewell or Senecca for clipper.

I don't see much **two-spotted spider mite** (TSSM) injury, but some New England small fruit workers regularly see it. It can be serious in hot, dry years, where a bed is regularly coated with dust from a dirt road, or where predators have been killed. Scouting (especially leaf undersides) requires a hand lens or magnifying glass. Threshold: 15 or more infested leaves, out of 60. Be sure you check a number of spots across the field. The guide lists pesticide options.

White grubs: There are several species here. Unlike the weevil larvae, these have legs. In NH, we had serious problems in 2010 with Asiatic garden beetle (AGB) larvae in strawberries. That species strongly prefers to lay eggs in moist soil. That summer was so dry, the few attractive spots to lay eggs included irrigated strawberry beds, so many eggs were laid there. AGB larvae are very distinctive from other white grubs: they have bulbous maxillae right behind the mandibles. For all white grubs, <u>avoid planting strawberries where grass grew last year</u>, and control grassy weeds. That should be your first line of defense, not insecticides. If you use pesticides, identify the species of grubs first. They vary in susceptibility to our insecticides.

Black vine weevil (BVW) and its two smaller relatives can be very serious pests. The biology of these three species is virtually identical. Adults hide in soil or under leaf litter during the day, and come out to feed at night. In southern NH, they appear about July 1st. They chew notches in the edges of the leaves. They begin laying eggs about August 1, and continue into Fall if temperatures are mild. The eggs hatch into white, <u>legless</u> C-shaped grubs. They feed on the roots and crowns, and overwinter as larvae. In spring, the larvae are at their largest size, and feeding gets most intense. Controlling BVW can be very difficult. Chemicals (Brigade, Platinum) don't work too well. Insect-attacking nematodes can be effective (expensive!) but 1) You <u>must</u> use the correct species of nematodes, and apply at very high rate, 2) Timing is critical: May 15th to 25th, **or** Aug 28-Sept 10. 3) Avoid applying them on a hot, sunny day and irrigate just before & immediately after applying, or many will die. There are other problems, too.
I often recommend the "scorched earth" control option: destroy the infested bed, and make sure no plants that can support BVW larvae grow there for the next 2 years. Larval hosts: *Achilea*, *Adiantum*, *Asters*, *Astilbe*, *Azaleas*, *Begonia*, *Bergenia*, Blackberry, Calla lily, Christmas fern, *Cinquefoil*, *Cyclamen*, Dandelion, Dock, *Epimedium alpine, Epimedium grandiflora,* Hemlock, *Heuchera, Hosta, Hydrangea, Impatiens, Isoloma,* Lily of the valley, *Lythrum,* Mountain laurel, *Phlox,* Plantain, *Physostegia,* Primrose, Raspberry, *Rhododendron*, Rhubarb, *Sedum,* Strawberry, Sheep sorrel, Wood sorrel, *Taxus.* Move your new bed 100 yds away (farther is better).

A barrier fence of plastic sheeting stapled to (outside of) wood stakes can prevent adults from entering your new bed (they can't fly), especially if it is sticky or dusty. It works, but has logistical problems (you can't drive equipment over it, for example).

Sap beetles: I'm still frustrated by them… no really good answers. Do your best to keep the field free of over-ripe fruit. That odor strongly attracts them. Sanitation will help with spotted wing drosophila, too.

Weed Management in Tree Fruit

Bradley A. Majek majek@AESOP.Rutgers.edu
Rutgers Agricultural Research & Extension Center
121 Northville Road, Bridgeton, NJ 08302

A good orchard floor management program eliminates and prevents the reestablishment of undesirable vegetation. Weeds compete with fruit trees for water, nutrients, and light; serve as alternate hosts for diseases and harmful insects; harbor rodents; and impede harvest. Herbicides used to control weeds must have a good margin of crop safety to minimize the risk to the tree.
Choose herbicides for use in the tree row that are labeled, have adequate crop safety (Table 1), and control the weed species in your orchard (Table 3). Use the correct amount of residual herbicides for each soil type (Table 2). The use of a single herbicide repeatedly will lead to an increase in resistant weeds or weed species. The use of herbicide combinations, herbicide rotations, and sequential or spot treatments in a well-managed weed control program will eliminate or minimize problems. The recommended herbicides have been evaluated for crop safety and effectiveness
Weeds can be classified by their life cycle. Annuals live less than one year. Summer annuals germinate in the spring or early summer, grow, flower, produce seed, and die in the fall. Winter annuals germinate in late summer or in the fall, grow vegetatively through the fall, overwinter, flower, produce seed, and die in the spring. Biennial weeds live more than one year but less than two years, produce seed, and die. Perennial weeds live more than two years, and often reproduce vegetatively, as well as by seed. They can be much more difficult to control. Consider summer and winter annuals, biennials, and perennial weeds separately when planning a control program.

Residual herbicides remain in the soil and kill weeds through their roots for up to several months. Application should be made preemergence, or before weeds germinate. Weeds begin to compete with most crops within 2 to 4 weeks after they appear, and some products are effective only on germinating seeds. If weeds are present, a postemergence herbicide should be combined with the residual herbicide. Rainfall or overhead irrigation before weeds emerge is usually needed to move the herbicide into the soil and make it available to the weeds.

Non-residual herbicides kill weeds present at the time of application, but do not continue to control weeds that appear after treatment. These herbicides either degrade rapidly in the environment, or degrade slowly but are tightly bound to the soil and unavailable to plants after application. Non-residual herbicides kill weeds through their leaves are applied postemergence, or after they have germinated and emerged. Do not treat weeds that are dormant or under stress from drought, extreme heat, cold, or other adverse growing conditions. The optimum stage of growth depends on the herbicide used and the weed species. Most herbicides that enter the plant through the leaves need a minimum rain-free period after application for maximum effectiveness.

Selective postemergence herbicides kill only certain weeds. Plants that are not susceptible will not be harmed. Poast, Select, Fusilade DX and 2,4-D are examples of selective postemergence herbicides. Poast and Fusilade DX kill grasses. 2,4-D affects only broadleaf plants (including fruit trees).
Nonselective postemergence herbicides kill or injure any treated plant. They may be *contact* or *translocated. Contact* herbicides work only where they are placed. Thorough spray coverage is essential for good results. Roots of established perennial weeds may survive.
Translocated herbicides move in the weed after treatment. Application at the proper growth stage will often result in good control of the roots as well as tops of established and perennial weeds. Translocated herbicides work slowly to provide time for movement throughout the plant. Results may not be evident for several weeks.

Rely (glufosinate) has injured peaches and apples through mature brown bark and is not recommended due to the risk of fruit tree injury. The injury appeared as death of the cambium layer at the point of contact. The tree was killed when girdled by the injury.

Glyphosate products are non-selective translocated postemergence products that require special care in orchards. Glyphosate applied to one part of a tree can "translocate" to other parts of the tree and cause injury or death to the entire tree. Sub-lethal doses of the herbicide can be stored in the roots and move into the tree in subsequent years when the tree calls on stored energy reserves in the roots to establish a new leaf canopy each spring. Glyphosate injury can appear as a whitish yellowing of the shoot tip and new foliage, as malformed leaves similar to growth regulator herbicide injury, or both. Stunting of the growth is also usually observed.
Minor exposure to glyphosate, even through root suckers in apples, can result in the translocation of the herbicide into tree roots and result in chronic and debilitating injury. Both time of year and whether the accidentally treated root sucker is growing in dense shade or partial sun can affect the direction of glyphosate translocation. In late spring when the tree is growing rapidly, glyphosate is translocated from the treated leaves to the shoot tip(s) regardless of sun or shading of th root sucker. Early summer is a transistion period. By late summer apple root suckers in full or partial sun are exporting carbohydrates, and when treated with glyphosate are likely to translocate the herbicide into the roots. Root suckers in dense shade are carbohydrate sinks and do not move glyphosate into the roots. Always carry pruning shears when applying glyphosate products. Prune any accidental application to fruit tree foliage immediately. Use extreme caution after shoot growth has terminated in late spring or early summer.

Herbicide application should be accomplished with a "conventional" fixed-boom sprayer calibrated to accurately deliver 20 to 60 gallons of water per acre using flat fan nozzles and 30 to 40 psi, unless otherwise stated. **Herbicide rate recommendations are made on a broadcast basis** (amount of herbicide applied per sprayed acre). **CAUTION: Strict rate control is necessary.** Herbicides applied above recommended rates may cause crop damage. Residual herbicide rates must be matched with soil type and percentage of organic matter to obtain good weed control and crop safety (see Table 2).

Weed control in **newly planted orchards** should be planned to provide a maximum margin of crop safety. Tillage and/or herbicides prior to planting should control established biennial and perennial weeds. Apply a combination of herbicides to control annual grasses and broadleaf weeds. Apply in early spring after 1 to 2 inches of rainfall or irrigation has settled the soil around the roots of the newly planted trees, but before weeds emerge or tree buds break.

Apply herbicides to the tree row in **established orchards** twice annually, in late fall and in late spring. Herbicides applied in late October or early November control winter annuals, certain perennials, and early season summer annuals. Spring herbicide applications extend summer annual weed control through harvest. Advantages of two herbicide applications per year include:

1. Control of winter annual weeds, including camphorweed, wild lettuce and horseweed (marestail) and summer annual weed control for the same cost as most single application weed control programs.
2. Improved spring labor and equipment distribution requirements by controlling early summer annual weeds with residual herbicides applied the previous fall, thus delaying the need to spray in the spring until May or early June.
3. Increased consistency of weed control treatments, especially control of summer annual weeds when dry weather follows the spring herbicide application.
4. Decreased risk of crop injury, since each herbicide application must last less than a full year. Herbicides can be alternated and rates can be reduced or split to improve crop safety.
5. Decreased competition from established winter annual weeds and summer annual weed seedlings in March, April, and May for fertilizer and water when the trees begin to grow.

Late Fall Herbicide Applications should include a translocated postemergence herbicide, and a residual broadleaf herbicide. A residual grass herbicide may also be applied in the fall. Apply 2,4-D to control emerged winter annual broadleaf weeds tank-mixed with Princep for residual control. Consider a labeled glyphosate product if perennial weeds are present and treatment is recommended in the fall.
The use of a grass herbicide in the fall depends on the product chosen. Kerb 50WP is the only grass herbicide that *must* be applied in the fall, if it is used, to control certain cool season perennial grasses. An additional residual annual grass herbicide is needed in the spring to provide full season summer annual grass control following a fall application of Kerb 50WP. Solicam 90DF, Surflan 80WP, Devrinol 50WP and Prowl 4EC (non-bearing only) are annual grass herbicides that should be applied in late fall or as a split application, half in the fall and the second half in the spring. Use the split application when grass pressure is heavy for best results. The use of these herbicides in spring only has resulted in inconsistent weed control when dry weather followed the application.

Followup Late Spring Applications should include additional or a different residual broadleaf weed herbicide and a residual grass herbicide. Add a postemergence herbicide only if needed. Apply the second half of a split herbicide treatment of Solicam 80PF, Surflan 80WP, Devrinol 50PF or Prowl 3.3EC (non-bearing only) for annual grass control. Include 2,4-D if seedling annual broadleaf weeds are observed, Gramoxone Max to control annual grasses and broadleaf weed seedlings, or a labeled glyphosate product to control established annual or perennial grasses and broadleaf weeds. No postemergence herbicide may be needed in the spring if no weeds are present when the spring residual herbicides are applied.

Table 1. Crop Safety of Herbicides for Use in Tree Fruits.

	Apples		Peaches		Pears		Plums		Cherries	
	New	**Established**	**New**	**Established**	**New**	**Established**	**New**	**Established**	**New**	**Established**
Incorporated (residual)										
Treflan	—	—	L	L	—	—	L	L	—	—
Preemergence (residual)										
Alion	—	G	—	G	—	G	—	G	—	G
Chateau	G[1]	G	G[1]	G	G[1]	G	G[1]	G	G[1]	G
Devrinol	G	G	G	G	G	G	G	G	G	G
Dual Magnum	–	–	G	G	–	–	–	–	–	–
Gallery	G	–	G	–	G	–	G	–	G	–
Goal 2XL/Galigan 2E	G	G	G	G	G	G	G	G	G	G
Karmex	—	F/G	—	F/G	—	F/G	—	—	—	—
Matrix	—	G	—	G	—	G	—	G	—	G
Norosac/Casoron	L	G	L	G	L	L	L	L	L	L
Princep	—	F/G	—	F/G	—	F/G	—	L	—	L
Prowl	G	—	G	—	G	—	G	—	G	—
Sandea	—	G	—	—	—	—	—	—	—	—
Sinbar	—	F/G	—	F	—	—	—	—	—	—
Solicam	G	G	F/G	G	—	L	—	L	—	L
Surflan	G	G	G	G	G	G	G	G	G	G
Postemergence (selective)										
2,4-D[1]	F	G	F	G	F	G	F	G	F	G
Fusilade DX	G	—	G	G	G	—	G	G	G	G
Kerb	—	G	—	G	—	G	—	G	—	G
Poast	G	G	G	G	G	G	G	—	G	G
Select	G	—	G	—	G	—	G	—	G	—
Starane	—	G	—	—	—	G	—	—	—	—
Stinger	—	—	G	G	—	—	G	G	G	G
Postemergence (nonselective)										
Gramoxone Max[1]	G	G	G	G	G	G	G	G	G	G
glyphosate products[1]	G	G	G[2]	G[2]	G	G	G[2]	G[2]	G	G
Rely[2]	P	P	P	P	—	—	—	—	—	—

G = Good
F = Fair (use with care)
P = Poor (not recommended)
L = Labeled (data insufficient or not recommended)
[1]Do NOT allow spray to contact young green bark
[2]Do NOT allow spray to contact any part of tree, including mature bark (labeled for use only in New Jersey and certain other states)
— = NOT LABELED **(DO NOT USE)**

Table 2. Recommended Preemergence Herbicide Rates (in Active Ingredients) for Common Tree Fruit Soil Types.

Soil Type	Sand		Loamy Sand		Sandy Loam			Loam		Silt Loam		Clay Loam	
% Organic Matter	**0-1**	**1-2**	**0-1**	**1-2**	**0-1**	**1-2**	**2-4**	**1-2**	**2-4**	**1-2**	**2-4**	**1-2**	**2-4**
Preemergence (residual)													
Alion	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085	.065-.085
Chateau	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38	.19-.38
Devrinol[1]	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4
Dual Magnum	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2
Gallery	¾	¾	¾	¾	¾	¾	1	¾	1	1	1	1	1
Goal 2XL/Galigan 2E	2	2	2	2	2	2	2	2	2	2	2	2	2
Karmex[2]	—	—	—	—	—	1½	2	2	2½	2½	3	3	3
Kerb	2	2	2	2	2	2	2½	2½	3	3	3½	3½	4
Norosac/Casoron	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6
Princep[2]	—	—	—	—	—	2	2	2	3	2	3	3	4
Prowl	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4
Sandea	—	.03-.06	—	—	—	—	—	—	—	—	—	—	—
Sinbar[2]	—	—	—	—	—	1½	2	2	2½	2½	3	3	3
Solicam	—	—	—	2	—	2	2½	2½	2½	2½	3	3	4
Surflan[1]	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4

[1]Use the lower recommended rate when tank-mixing with another preemergence herbicide, unless annual grass pressure is severe.
[2]Use one-half the recommended rate when tank-mixing with another preemergence herbicide.
— = NOT LABELED **(DO NOT Use)**

Table 3. Herbicide Effectiveness on Major Annual Weeds in Tree Fruit.

Herbicide	Barnyardgrass	Crabgrass, large	Fall panicum	Foxtail sp.	Goosegrass	Johnsongrass (seedlings)	Yellow nutsedge	Carpetweed	Cocklebur, common	Cranesbill	Galinsoga, hairy	Jimsonweed	Lambsquarter, common	Morning glory sp.	Nightshade, eastern black	Shepherdspurse	Pigweed sp.	Purslane, common	Ragweed, common	Smartweed, Pennsylvania	Velvetleaf
Pre-emergence (residual)																					
Alion	F/G	F/G	–	F/G	F/G	–	P/F	G	–	–	G	G	G	F/G	–	G	G	G	F/G	–	G
Chateau	F	F	F	F	–	–	P	G	–	–	G	G	G	–	G	G	G	G	G	G	G
Dual Magnum	G	G	G	G	G	G	F/G	F	N	–	G	N	P	N	G	–	G	F/G	N	P	P
Gallery	N	N	N	N	N	N	N	F	–	–	G	G	G	G	G	G	G	G	G	G	G
Goal 2XL/Galigan 2E	F	F	F	F	–	–	P	G	–	–	G	G	G	–	G	G	G	G	G	G	G
Karmex	G	F/G	G	G	F/G	N	N	G	–	–	G	G	G	G	G	G	G	G	G	F	G
Matrix	G	F	F	G	P	–	G	–	F/G	–	–	F	F	F	P	G	G	F	P	P/F	F
Princep	F	P/F	F	G	F/G	P	N	–	F/G	–	G	G	G	G	G	G	F	G	G	G	–
Prowl	G	G	G	G	G	G	N	G	+	–	N	N	F/G	N	–	–	F/G	F/G	–	–	F/G
Sandea	N	N	N	N	N	N	G	P	G	–	G	G	P/F	P	–	G	F	G	F	N	G
Sinbar	G	G	G	G	G	–	P	G	–	G	G	G	G	G	G	G	F	G	G	G	G
Solicam	G	G	G	G	G	–	F	P	P	–	–	F	F	–	–	–	F	G	F/G	–	F
Surflan	G	G	G	G	G	G	N	F/G	N	–	N	N	F/G	N	P	N	F/G	F/G	N	P	P
Post-emergence (selective)																					
2,4-D	N	N	N	N	N	N	P	G	F/G	G	F/G	F	F/G	G	G	G	G	G	G	F	G
Fusilade DX	G	F/G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kerb	G	G	G	G	G	–	N	G	N	–	P	N	G	–	–	–	G	G	P	–	P
Poast	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Select	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Starane	P	P	P	P	P	P	P	–	G	–	P	P	P	G	P	G	P	G	P	F	G
Stinger	N	N	N	N	N	N	N	N	G	–	G	F	P	P	F	P	P	P	G	P	P
Postemergence (non-selective)																					
Gramoxone Max	F/G	F/G	F/G	G	F/G	F/G	P	G	G	–	G	G	F/G	F/G	P	G	G	F/G	G	F	G
glyphosate products	G	G	G	G	G	G	F	G	G	G	G	G	G	F	G	G	G	G	F	G	G
Rely	G	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G	G	F	G	G

G = good F = fair P = poor N = none – = not available

INNOVATIONS IN TREE FRUIT PRODUCTION IN ENGLAND, BELGIUM AND THE NETHERLANDS

Maurice Tougas
Tougas Family Farm
Northborough, MA 01532
Appleman.maurice@gmail.com

On July 24, 2011 a group of 42 IFTA members assembled in Maidstone, England to begin a week long tour of fruit growing enterprises in the southeast of England, The Netherlands and Belgium. Many were escaping triple digit temperatures which were dominating weather patterns in North America and were welcomed by comfortable coolness of England. The first couple of days were centered at the East Malling Research Center, the birthplace of dwarfing rootstocks. Growers were welcomed by EMR Charitable Trust Chair Will Sibley (aka "Grafter Will") who, along with IFTA past president Neil Manly, made arrangements for what was to be an opportunity for participants to see first hand many innovations being tested and practiced at EMR and by growers in the UK and northern Europe. All of us owe a debt of gratitude to the researchers at EMR who developed the first of the size controlling rootstocks known as the Malling series. Clearly "Grafter Will" is working to support the tradition of innovation that EMR is best known for during a time of dramatic change for the research station. EMR is no longer a government supported institution, but rather now a private research facility which survives with contracted research projects funded by a host of private and public resources. As such, some of the work conducted there is proprietary, that is, not open to the public at this time. Change at EMR is the name of the game, and most dramatic is the reduction in staffing from a high of 400 personnel, to presently 40.

At EMR much discussion centered on the “Concept Pear Orchard” with its 4 system comparison trial. Discussions regarding the development of the systems, irrigation management trials, organic production and “Zero residue” systems were featured. Visits to local pear and apple orchards as well as Leeds Castle and Cantebury rounded out the English segment of our visit.

From Maidstone onto Middleberg, Netherlands was our next destination. Our one interruption of our plan occurred while we waited for several hours for a disabled train in the Channel Tunnel to be towed. Things could have been worse if the Burger King at the station didn’t serve Budwieser! Midnight arrival at our newly constructed hotel in Middleberg left us no time or energy for the in-room saunas, whirlpool bath or showers built for 6! An early morning departure the next day left us wondering what could have been.

Covered cherry plantings are just being considered in much of North America. While on the post conference IFTA tour this past March we saw a Voen covered dormant orchard in Oregon and now in Netherlands again a Voen covered cherry orchard in the process of being “hibernated”, that is, covers being removed and put to rest for the year. With many participants farming in the more humid regions looking for options to prevent rain induced fruit cracking, this stop provided for enthusiastic conversation. Onto Verbeek nursery, one of the many fine fruit tree nurseries of this region. Detailed demonstrations of what it takes to produce and ship first class apple and pear trees was the highlight of this stop. Next onto an amazing pear orchard, complete with bin train rides thru the manicured orchards. The concept orchard systems demonstrated at EMR earlier in the week were seen as a commercial operation here. Second leaf, third leaf and older trees were dripping with magnificent pears. This was a sight to behold. Pear production now exceeds apple production in Belgium. With the use of Quince C rootstock, intensive systems similar to those used by apple grower is changing the “plant pears for heirs” attitude.

Belgium orchard visits featured a look at their adaptation of the French developed “le Mur fruitier”, or “The fruiting wall”. We were able to visit an orchard where dormant hedging was the pruning system being employed, plus visits to Carolus Nursery and orchards and the PC Fruit Research station outside St Truiden , Belgium. Koen Carolus toured us to several nursery stops where we viewed some of the nursery tree types Koen is developing to produce trees suited specifically to the needs of the particular orchard management systems. Suggesting later that growers utilizing the fruiting wall training system could produce fruit destined for specific markets by adjusting timing and degree of hedging. Too much to see in too short a time. In the next couple of years as labor issues intensify worldwide we’ll be taking a closer look at fruiting walls and other mechanized production systems.

Study tours like this are much of what IFTA is all about. The chance to make new friends and renew old friendships provides opportunities for members to combine intensive education with cultural experience. In my opinion, return on investment of these adventures is high, and not to be missed.

Are There Opportunities to Eliminate Early-Season Apple Scab Sprays?

Dan Cooley dcooley@psis.umass.edu
Department of Plant, Soil & Insect Sciences
University of Massachusetts, Amherst MA

The generally accepted method for controlling apple scab in the northeastern U.S. is to begin fungicide sprays as soon as green tissue is visible. This is based on the observation that primary inoculum of the fungus that causes scab, *Venturia inaequalis*, begins to be released at about the same time that apple tree growth begins in the spring. If these spores infect, within approximately two weeks a new generation of spores is produced, each single infection having the capacity to produce hundreds of spores, and each of these can cause a new infection. This cycle repeats as long as there is sensitive apple tissue and wet weather, and without fungicides epidemics can explode, destroying fruit and defoliating trees. The earlier the first infections hit an orchard, the more cycles and more damage in an epidemic. In the face of this risk, growers try to start scab management at green tip.

Nearly 20 years ago, MacHardy and colleagues found that when they tracked the development of scab inoculum, it did indeed start to develop at around green tip, but that most primary inoculum did not start to mature until early pink through bloom. They asked the question, "If only a very small percentage of the potential scab inoculum is mature at green tip early pink, where the amount of overwintering inoculum is very low, can any early-season infection periods be left unprotected by fungicide?" The scab fungus grows in fallen dead leaves over the winter, but only if infections were present when the leaves fell in the fall. In an orchard where there is little or no scab on leaves in the fall, there will be little or no primary inoculum the next spring. Scab spores do not travel very far, about 100 yards at the most, meaning that without abandon trees near an orchard the only source of primary inoculum comes from infections in the orchard. MacHardy suggested that in "clean" orchards with very little scab, the risk of scab buildup is very low until a high percentage of the primary inoculum is mature, starting at pink or after three infection periods, whichever comes first.

Researchers NH developed a way of measuring scab inoculum in the fall, called potential ascospore dose or PAD. PAD evaluations are done in fall after harvest by looking at terminal shoots and counting any scab lesions on leaves. PAD level is related to the timing of scab risk the next spring. As would be expected, in orchards where PAD is moderate to high, significant risk of infection exists at green tip, but in orchards where PAD is sufficiently low the first scab fungicide can be applied after the first three infection periods or pink (whichever comes first) without risk of scab development.

Growers can also decrease the overall risk of scab by using sanitation in orchards, using urea applications or flail chopping leaves in the late fall or early spring. These treatments may be combined to be even more effective. Estimates indicate that sanitation can reduce the amount of primary inoculum (ascospores) in a block by 70% to over 90%.

Reducing scab inoculum will make any scab management program more effective than it would otherwise be. Even in apparently clean orchards, sanitation reduces risk from undetected late-season scab development. A less obvious benefit comes in the form of reduced chance of resistance development. With less scab in an orchard, the odds that a mutant resistant to scab fungicides will survive and grow will decrease. Therefore, sanitation should be an annual practice in scab management programs.

It is interesting but understandable that sanitation and early-season fungicide delays have not been widely adopted. Both practices require work after harvest or in early spring, and may mean purchasing new equipment. At the same time, because scab has developed widespread resistance to DMI fungicides (Rally, Vintage, Procure, Indar, Inspire Super) and is developing resistance to strobilurin fungicides (Flint, Sovran), options to stop infections from developing into lesions are lacking. Growers and pathologists worry that if early-season scab infections develop, it will be difficult or impossible to prevent fruit damage.

Still, saving two or three fungicides in a year can save money and reduce pesticide use. If early-season fungicides can be eliminated without real risk of scab buildup it would be a useful tool in an IPM toolbox. With that in mind, we tested a conservative approach to delayed early-season fungicide applications in very low PAD blocks by delaying the first fungicide spay for scab until tight cluster or after two infection periods.

Of 14 blocks from 2008 to 2010 where early fungicides were delayed:

- 13 delayed blocks had fruit scab ≤ non-delayed blocks;
- overall scab incidence 2.6% in delay blocks vs. 5.0% in non-delay blocks;
- mean delay of 8.4 days to tight cluster;
- from 1 to 2 infection periods prior to first spray;
- savings of 1 to 2 fungicide applications relative to the delay block.
- average time of approximately 30 min. to do a PAD assessment in a 1 to 3 acre block.

These results indicate that the risk of scab buildup in low-inoculum blocks where scab sprays were delayed was very low. Whether the savings of one to two fungicides justify the expense of a PAD analysis is a decision for individual growers. We can say that **a delay should never be done without doing a PAD assessment!** Complicating this picture is the observation that heavy use of DMI fungicides may mask active scab. An orchard may appear to be free of active scab on leaves in the fall, but the fungus will start to grow in fallen leaves when DMI activity and leaf resistance have disappeared. Based on this, we recommend limiting PAD measurements to blocks with two or fewer DMI applications used no later than bloom.

Regardless of whether growers are considering delayed early-season fungicide applications, we recommend that a sanitation program be used regularly. IPM was originally conceived largely as a way to delay pest resistance development. A cornerstone of IPM is that multiple tactics be used. In apple scab management, this means that relying strictly on fungicides for scab management is bound to generate more resistance problems than using other management options such as leaf chopping and urea applications in sanitation. Sanitation can directly reduce the risk of scab and reduce the long-term chance of resistance development.

HOW WE GROW GREENS AT STAR LIGHT GARDENS
FOR WINTER PRODUCTION

Ty and David Zemelsky
Star Light Gardens
54 Fowler Ave, Durham, CT 06422
860.463.0166
e-mail: starlightgardens@comcast.net
website: starlightgardensct.com

Having fresh greens to sell during the winter months has been a cornerstone for Star Light Gardens since we started 12 years ago. Not only does it help with our cash flow during the slower times of winter, but it also forges new customer relationships with both restaurants and market goers for the rest of the growing season. We would like to discuss with you our choices of crops, growing methods, soil amendment issue, planting schedules, high and low tunnel considerations, harvest methods and other crops to consider for production.

Why Some Plants Don't Freeze
Frost resistant plants prevent water from freezing inside plant cells. Basically plants do this either by desiccation, so the water solution in the cell is so concentrated with other molecules that is it does not freeze, or by synthesizing the equivalent of antifreeze, either high concentrations of sugars or betaines. Thanks to Dr. Martin Gent

Choice of Crops
For the first 7-8 years of growing greens for winter harvest, we choose a wide range of crops in our high tunnels. Some crops faired better than others. Mizuna,arugula tatzoi and lettuce mix are fine for late summer, early fall. When the temperature drops seriously below freezing, none of these crops had much staying power for us. They would either turn to mush (lettuce) or get yellow (tatzoi) or fail to thrive(mizuna and lettuce). Having said all this, it should be pointed out that there are ways around these pitfalls, which we'll cover in more detail when we talk about planting schedule. The greens that worked the best all winter without any hesitation for us are red russian kale, claytonia and spinach. Let's talk briefly about each one of these choices. We call them our Winter Warriors (for obvious reasons)

Red Russian Kale, while slower by at least a week from mizuna, just keeps on thriving regardless of the temperature. Viable kale plants that are not even protected by row cover out in the field are common in the Spring. We are very happy with Johnny's kale, High Mowing's kale and Wild Garden Seed's.

Claytonia, sometimes is known as Minor's Lettuce by some. It grows wild in the Pacific Northwest. It received its common name by miners back in the day who would eat the plants to prevent scurvy while panning for gold in areas where they couldn't get fresh vegetables. Being cold hearty by nature, claytonia won't even think of germinating until it is cooler. With a little bit of planning, one could let last seasons crops go to seed and then have it start all over again the following late summer/early fall. It is not only gorgeous, but incredibly satisfying to eat. Its texture is profoundly crunchy and has a wonderful mild taste. Just before going to seed, it puts out a small, delicate white flower that is also edible. Claytonia takes a while to get established in the fall, but once it has done so, is happy to be cut several times.

Spinach is the glue (not literally) that holds everything else together. The demand for fresh winter spinach is inspiring. We are circling around several great varieties. Each of them has their own special appearance, taste and strengths. A whole workshop could easily be devoted to exploring all the varieties. We like Samish, Tyee, Regiment and Corvair. We're also trialing a few unknowns with interesting names like Raccoon and Crocodile.

Methods of Growing

Greens are grown in High and Low Tunnels. Spinach and claytonia are planted with an earthway seeder in rows that are 8" apart, so that we can easily cultivate with a dual wheeled, dual saddle-hoe. Kale is planted with the Johnny's 8 point seeder, using their second largest hole choice, and going over each area twice. Row cover is placed over everything, using hoops that we construct ourselves. Row cover is .9 oz per square yard. Heavier or multiple layers would be even better, so if you have them around, doubling up can really help. Row cover is removed during the day in order to maximize air circulation and light.

Soil Amendments

We have been incorporating alfalfa meal and fertrell feed-n-gro (3-2-1) into the bed after power harrowing. An inch of leaf compost is put on over that. Besides the usual benefits of compost, this particular method makes the compost into a mulch, and helps with the emergence of weeds, particularly chickweed. The best scenario is to get the soil prepared, wet it for ten days and then torch all the emerging weeds and quickly plant winter crops. Its really a race. So if you give the new seeds a head start, they can keep ahead of chick weed.

Planting Schedule

For late fall harvest, you should have everything planted by October 10-14 (depending on your location) Late lettuce and most other brassicas are fine if planted by early September, just don't count on them for the long hall. Spinach planted by October 15 will be ready by the end of the year. Now, in looking ahead to early spring there are a ton of varieties that need to be planted late in order to be a success later on. Carrots, chard, beets and lettuce are the most important. Pak choi comes in next. If one plants carrots too early, they will just go to seed and produce a big fibrous root that is inedible. The best time for planting carrots would be in early to mid November. In that way, they get established in the late fall and really begin in earnest the following March. Same for beets and chard. Lettuce if established in mid fall is very happy to winter over as small plants and do fine with cold weather if given protections from wind and snow. Johnny's 5 Star Greenhouse Variety works great, as does Morton's Mystery Mix from Frank Morton of Wild Garden Seed.

High Tunnels and/or Low Tunnels

One really important thing that you can say about low tunnels is that they are inexpensive and effective given certain parameters. Lately, I've come to the decision that a low tunnel is probably not as good a choice for someone over 60. It's not just the bending over to uncover them, but also the possibility of having to recover them if the plastic blows off in mid Winter. Not a pretty sight! With sandbags plentifully placed on each hoop, the possibility of them coming loose is minimized. Still, harvesting in a high tunnel feels like a luxury compared to the possibility of having to harvest in the rain, snow and wind. For late carrot plantings, as well as chard and beets, the low tunnel cannot be beat. Proper venting in early spring should be remembered, though. We've never had good luck with spinach in a low tunnel. Not sure why. So, rather than fight this one, we keep our spinach in the high tunnels only. Two layers of plastic are better than one. We've always saved old skins from our high tunnels and sliced them up in 10' x 45' foot sections. Make your tunnels 40'. Any longer and they are a big target for strong gust of wind. Use the extra 5' to wrap the ends. We use hoops from rainflo, prebent in a circle, every four feet.

High Tunnels: one layer of plastic works for us, with row cover on hoops to keep the air circulating. Gothic style makes for a self shoveling roof. Just make sure that you place your houses in such a way that they are at least 15' apart to allow for snow piles. Plugging air drafts is important, obviously. There's been a lot written about insulating around the parameter of each house. This is a great idea, which we've never tried, largely for economic considerations. Uninsulated houses work just fine.

Harvesting

At Star Light Gardens, we harvest in nets inside of laundry baskets either using a high quality knife or in some instances the Johnny's Harvester. For the past 4 years, we've delivered our greens to restaurants and farm markets unwashed. This is a wonderful thing for everyone. Firstly, the minute you wash greens is the moments that they start to deteriorate. Secondly, washing at any time of year is tedious and difficult to do correctly. In the winter, it is doubly difficult because running water can be an issue. It is for us. It is also great for the consumer, because their product stays fresher longer.

OTHER CROPS TO CONSIDER FOR HOOP HOUSES

Potatoes: planted in early April and protected from cold by row cover. Get a real jump on this popular crop. Raspberries, strawberries, black berries: there are a lot of people out there doing this. We're considering a fall planting of strawberries. (see latest issue of Growing for Market August 2011)
Flowers: haven't done this, but so many advantages from pest and frost protection.

Philosophically, we are very much in tune with season extension farming. Being able to provide real food that is locally grown 12 months of the year is a privilege for us. We are producing highest quality food with a zero carbon footprint (in the growing process) and using a minimal of energy to deliver this food to grateful customers.

RESOURCES

SEEDS

Fedco
Box 520/ Waterville,Maine 04903

Johnny's Selected Seeds
955 Benton Avenue/Winslow, Maine 04901 / www.johnnyseeds.com 1 800 854 2580
They are always friendly, great service and warranty policy.

Seed Savers Exchange
3094 North Winn Road,/ Decorah, Iowa 52101   Phone: (563) 382-5990

High Mowing /Wolcott, VT 05680
1 802 888 1800 / www.highmowingseeds.com

Wild Garden Seed
PO Box 1509 / Philomath. OR 97370   interesting brassicas-worth checking out

BOOKS AND OTHER READING MATTER

The Winter Harvest Manual by Eliot Coleman. A great resource book. Order from Fedco or directly from Eliot at Four Seasons Farm RR Box 14 Harborside, Me 04642

Caterpillar Tunnels
Lynn Bycznski
Growing for Market June/July 2010

Hoop house update: most profitable uses
Lynn Bycznski
Growing for Market January 2010

High Tunnels Manual
Tracey Frisch and Ted Bloomgren
a SARE grant with video. Manual is available free on line at
uvm.edu/vtvegandberry/videos/hightunnels.html

USEFUL WEB SITES

WWW.uvm.edu/vtvegandberry
WWW.longislandhort.cornell.edu/vegpath
www.uvm.edu/~susagctr/
/www.cefs.ncsu.edu/

IRRIGATION

Dripworks 1 800 522 3747 user friendly place, helps you figure out what you need to do
Rain-flo Irrigation/ East Earl, PA/   1 717 445 6976
Best prices on irrigation equipment and row cover. Fast delivery

GREENHOUSE SUPPLIES

Growell Greenhouses Cheshire, CT 1 203 272 8147 Mike Tripedino. Mike has walked me thru putting up my own house. He is friendly, very interested in helping people solve greenhouse problems. He will also send crews to erect houses and re-cover them

PUBLICATIONS

Growing for Market/ PO Box 3747 / Lawrence, KS 66046
An informative-thoughtful magazine. Often has useful articles about growing winter greens. Supportive of organic, sustainable agriculture. Also, many timely articles about market growers' issues and national issues. Editor Lynn Byczynski, is extremely ready to help you find useful books on their online store

Diversified Winter Production at Kilpatrick Family Farm

Michael Kilpatrick
518-300-4060
Michael@kilpatrickfamilyfarm.com

Winter production is very important for us. In fact, we start our planning for the next year's winter production in December, and are planting from the middle of April on for our winter sales. Our sales are a mix between CSA and Farmer's market which requires not only great diversity but also large -scale production. There are several categories of what we produce for our winter sales:

Root crops- We produce a huge array of roots. From Carrots to kohlrabi, to parsnips and diakon we grow pretty much all of them. Root crops are the bread and butter of winter markets- while not costing a lot to produce they make up a significant portion of our sales. Our goal is to have mature, prime crops to harvest in October and November. This allows them to sweeten up from frost and take advantage of ideal growing conditions in the fall, and us to finish with weekday summer markets before harvesting becomes a major endeavor. We store them dirty in plastic feed sacks and then barrel wash fresh each week so they look the freshest and brightest- this does make a difference in how many we sell. Sweet potatoes we harvest late September and store in an insulated garage at around 55 degrees.

Storage crops- These are crops like Leeks, Brussel sprouts, squashes, cabbage. Most of these are stored in the same root cellar with our roots; however, they have a different harvest schedule. Leeks and brussels we harvest more toward the end of November or even into December and they are placed upright in plastic bulb crates. This allows for adequate airflow around them so they don't go bad in storage. We grow a wide array of squash, but only plan on storing butternuts as they keep the best and sell well. We grow 2 types of cabbage- storage cabbage which we cut and put in bags in the root cellar and winter cabbage which we just leave in the field until we need it.

Storage greens- We plant lettuce, spinach, boc choi, chinese cabbage, kale and mache as late as we can and still get full size plants and then harvest and store them. Depending on the green we can get as much as 3 months of storage before they turn yellow. Greens that are planted this late and are subjected to multiple frosts tend to go into hibernation and concentrate sugars in their leaves therefore lasting much longer than a summer planting. Storing greens allows us to bunch up our greenhouse greens and therefore have a higher production of greens year round.

Greenhouse greens- We plant a mixture of spinaches, mesclun, chard, asian greens, herbs, and arugula for deep winter sales, seeding most the middle of October. Greenhouse greens are the Lindt truffles/ loss leaders of winter production. They are expensive to produce, taste awesome, and draw the customer in to buy other products. Our goal with winter greens is to bridge the gap between the storage greens and the overwintered greens in our mini-tunnels. One specialty green that we produce year-round in our prop house are microgreens, which are quick and relatively easy to grow.

Other crops- recently, we have started to freeze/process some of the summer's bounty. We planted more strawberries this year than we knew we could sell and froze 600 quarts- this will allow us to have strawberries all winter for our customers. We also froze tomatoes, rhubarb, raspberries and ginger. Our seconds on winter squash are baked and frozen in quart containers to be sold after we run out of squash in March. We also planted extra peppers and tomatoes and made our own salsa which we canned. These crops allow us to extend the summer bounty and bring unusual and exciting crops to market in the dead of winter.

Our goal is to have between 20 and 25 different crops on the table at any one time. As the winter rolls on and we start to run out of individual crops we will release other from storage to keep interest and have a full array. For example, we will keep the winter radishes in storage until we run out of regular red radishes and diakon. We will also keep different varieties of potatoes in storage and then release them in January as something new and exciting in the middle of the winter to get people to come in.

Winter production can be a great and profitable aspect of farming and also a great way to connect and stay in touch with your customer base year-round. Please follow the below URL or scan the QR code to access the custom resource page which has much more information on varieties, dates of planting and harvesting, storage, the presentation slides and other relevant resources.

www.kilpatrickfamilyfarm.com/NEVF

Measuring and Managing Soil Temperatures for Winter Growing

Paul & Sandy Arnold
Pleasant Valley Farm, 118 South Valley Road, Argyle NY 12809
(518) 638-6501 arnold.pvf@gmail.com

We have a small, diversified, family farm which we have grown vegetables on with organic methods for 23 years in upstate New York, zone 4. We raise over 40 types of vegetables and fruits which we sell year-round at farmers' markets, and this diversity gives us our stable income. Since the early 1990's, we have done season extension and grown greens in low tunnels all winter. Starting in 2006, we have utilized high tunnels to grow a variety of greens for the ever-expanding winter farmers' markets.

We had many questions for optimizing the production of winter greens in our two Rimol high tunnels (30' x 144' and 34' x 144'); we have chosen to grow in them with as little inputs as possible, so we use a single layer of poly, no heat, and automatic roll-up curtains (we have solar electric to cover that expense). In the winter of 2009, we performed our own extensive research with 44 dataloggers to determine the best techniques of multiple parameters and also debunk myths. Three styles of tunnels were used on 3 different farms: unheated high tunnels, ground-heated high tunnels, and unheated low tunnels; the dataloggers were from Cornell Cooperative Extension and they recorded the temperature every hour from January to April. The parameters we looked at were the temperatures for: Soil, outside, in the rafters, at plant height, one foot up from the ground, and six feet up from the ground.

Our main questions revolved around the use of row covers and whether multiple layers made any difference and how the height of the rowcovers above the ground affected the temperatures. Our tunnels have no heat in them except what is produced by the sun, so every extra degree of heat helps with winter growth. We also monitored temperatures on a crop with and without Biotello black plastic.

All of these dataloggers gave an overwhelming amount of data, much of which has yet to be analyzed. However, we found answers to many of the questions we were asking at the start of this endeavor. Some of the results are below:

- 4 Dataloggers at plant height (about 2" above ground): 1 Rowcover and no hoops; 2 Rowcover with 18" Hoops; 3 Rowcover in a 2-3' Hooped area; 4 Outside temp.
  Results: 5-10 degree increase in temp the closer the rowcover is to the ground; laying right on the crop is best for the night to keep the plants as warm as possible. Daytime peak temperatures were all about the same
- 3 Dataloggers measuring soil temperatures: 1 Biotello plastic under 18" hoped Swiss Chard; 2 No Biotello plastic under 18" hooped Swiss Chard; 3 Outside temp
  Results: Not much difference at night, but there was a daytime advantage to warm the soil from 5 to 10 degrees which means more growth
- 4 Dataloggers measuring temperatures at Plant Height (2"): 1 Heated tunnel with rowcover at 2'; 2 Unheated tunnel under 18" hoops; 3 Unheated tunnel with 2-3' tent; 4 Outside temp
  COLD NIGHT: 5 to 7 degree benefit from heat at night and 2 to 5 degrees in the daytime. Is the difference worth the cost of propane or oil? We stockpile our greens and get good yields without the heat.

YIELD DATA: In our first winter with the 30’x144’ high tunnel filled with spinach, it grossed over $16,000 which extrapolates to over $150,000 per acre. In the 2009-2010 winter, our weekly farmers’ market sales increased about $1200 per week due to the greens out of the two high tunnels and last winter, we perfected our systems partly due to the data from the dataloggers and increased to over $1400 per week.

This is a fast-growing business with lucrative winter markets and selling wonderful greens from high-tunnels and there is a lot more to learn to increase yields by temperature controls, rowcover specifics, venting, varieties, etc.

New Developments in Organic Plant Disease Management

Margaret Tuttle McGrath

Department of Plant Pathology and Plant-Microbe Biology, Cornell University
Long Island Horticultural Research and Extension Center,
3059 Sound Avenue, Riverhead, NY 11901. 631-727-3595. mtm3@cornell.edu

New resistant varieties and organic fungicides have become available recently for managing diseases in vegetable crops. These tools can be valuable additions to a foundation disease management program of practices with less potential for change, including land rotation and crop health. While these new developments are almost always useful, occasionally an important new development to be aware of is loss of effectiveness of resistant varieties due to pathogen evolution.

Several new resistant varieties are now available. More companies are marketing organic seed, and non-treated seed is now more readily available especially when requested well in advance of the growing season. Thus with more resistant vegetable varieties and greater availability, this important tool is becoming more usable for organic producers. Lists of resistant vegetable varieties are at: http://vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm . Selections of new varieties are listed below.

Tomato varieties with resistance to late blight are Defiant (Johnny's Seeds), Mountain Magic (Seedway), and Plum Regal (Seedway). This is an especially valuable development considering this disease has been occurring more often in the northeast, and it is the most destructive and most difficult disease to manage. These varieties have exhibited a high level of resistance to pathogen strains present recently in the northeast. Developing new late blight resistant varieties is a focus of several breeding programs. The focus at Cornell University is to develop varieties that are also resistant to early blight and Septoria leaf spot.

High Mowing Seeds has several new resistant varieties: Jade bean (resistant to BCMV, curly top virus, rust), Coban bean (anthracnose, BCMV), Capture F1 cabbage (black rot, Fusarium yellows), Tipoff F1 romanesco cauliflower (Fusarium yellows), Calylpso F1 celery (Fusarium wilt), Socrates F1 cucumber (powdery mildew, scab), Adam F1 and Calypso F1 cucumber (powdery mildew, downy mildew, CMV; also anthracnose and angular leaf spot for Calypso), Caribbean Gold F1 melon (powdery mildew, Fusarium wilt races 0,1,2), Olympus F1 pepper (bacterial leaf spot races 1-3), Catriona F1 pepper (TMV races 1-3), Milena F1 pepper (potato virus Y, TMV race 0, TSWV), Dunja F1 zucchini (powdery mildew, ZYMV, WMV, PRSV), Montesino F1 tomato (Fusarium wilt race 0, TMV), Toronjino F1 tomato and Sakura F1 tomato (Fulvia fulva races 1-5, Fusarium wilt races 0,1, TMV). Also there are several varieties resistant to multiple races of downy mildew of lettuce (Bolsachica, Boulder, Defender, Gaviota, Lovelock, Spock, Spretnak, and Sulu) and of spinach (Regiment F1, Palco F1, Pigeon F1, and Corvair F1).

Outstanding Seeds has several new pumpkin varieties with homozygous* resistance to powdery mildew (* resistance from both parents), which generally provides better suppression of this common disease than heterozygous or intermediate resistance. This company markets only non-treated seed.

New resistant varieties from Seedway include: Ambition, Opportune and Wyatt bean (resistant to BCMV; Wyatt is also resistant to 3 bacterial diseases); Expat and Typhoon YR cabbage (Fusarium yellows); Pay Dirt, Profit, Ka-Ching, and Silver Duchess sweet corn (Stewart's wilt and common rust; most also northern corn leaf blight); Python cucumber (several diseases); Ashley and Rakaia spinach (downy mildew, white rust); Napoli Tuscan, Fantasista and Samoa (harper type) melon (Fusarium wilt and powdery mildew; Podi virus also for Napoli); Dewlightful honeydew (powdery mildew); Archimedes bell pepper, Natasha sweet banana pepper and Ciclon jalapeno (bacterial spot; Phytophthora blight also for Archimedes), Delirio orange bell pepper (TSWV); Apollo, Cougar and Earlipack pumpkin (powdery mildew); Bigdena (greenhouse tunnel), BSS 832, Red Deuce, Monticello roma, Red Bounty, Solid Gold yellow grape, Sweet Treats pink cherry, Tachi roma, Volante tomato (Fusarium wilt; most have several other diseases as well); Dynasty diploid allsweet, Valentino diploid allsweet and Distinction triploid crimson watermelon (anthracnose and Fusarium wilt).

New resistant varieties from Siegers include: Dominator and Mongoose cucumber (several diseases); Archimedes and Intruder bell pepper (bacterial spot; Phytophthora blight); numbered pepper lines (10 bacterial spot races and TSWV); 7143 sweet corn (high resistance to common rust, Stewart's wilt, northern corn leaf blight); Charger and Tachi roma tomato (several diseases including Fusarium and Verticillium wilt); Sweet Polly and Super Pollenizer-5 watermelon (anthracnose and Fusarium wilt); Spineless Perfection zucchini (powdery mildew and virus).

There are new organic copper fungicides effective at lower rates of metallic copper equivalent than products developed previously. This is important considering concerns about copper effects on beneficial organisms and copper accumulation in soil. Badge X2 (Isagro-USA) is 23.8% copper oxychloride and 21.5% copper hydroxide in a dry flowable formulation; metallic copper equivalent is 28% by weight. It was registered and OMRI listed in 2009. A liquid formulation is not OMRI listed yet. The rationale behind having a combination is that copper oxychloride has better longevity and crop safety while copper hydroxide has faster action. Cueva (Certis USA) is 10% copper octanoate; metallic copper equivalent is 1.8% in a liquid flowable formulation. Nordox 75 WG (Brandt Consolidated) is 84% cuprous oxide; metallic copper equivalent is 75%. Nu-Cop HB (Agri Star) is 77% copper hydroxide; metallic copper equivalent is 50%. Rate range for tomato in lb product/A (lb metallic copper equivalent) is 0.75-1.75 (0.21-0.49) for Badge, 1-2 (0.5-1) for NuCop HB, and 2-4 (1-2) for NuCop 50WP.

There are new microbial fungicides and biochemical fungicides containing naturally occurring substances now available or expected in the near future. Most products of these types are defined by EPA as biopesticides because they are derived from natural materials. Recognizing that biopesticides tend to pose fewer risks than conventional pesticides, EPA has been encouraging their development and use. EPA generally requires less data to register a biopesticide than a conventional pesticide, but enough data about the composition, toxicity, degradation, and other characteristics of the pesticide to ensure that the product will not have adverse effects on human health or the environment. EPA can conduct the registration process more quickly with biopesticides, often taking less than a year, compared with an average of more than 3 years for conventional pesticides. Some biopesticides are defined as minimum risk pesticides through FIFRA Section 25(b) rule because their active and inert ingredients are generally recognized as safe (GRAS). These consequently are exempted from the regulation requirements of FIFRA and thus can be used on any labeled crops for any target since they do not need to be registered as a pesticide. 'Exempt from EPA registration' is stated on the label of these products. A description of some new products follows.

Regalia (developed by Marrone Bio Innovations) has a unique mode of action that induces disease resistance to several fungal and bacterial diseases in treated foliage. The active ingredient is an extract of Reynoutria sachalinensis (giant knotweed). The organic formulation, the only one now being sold in the US, was introduced in early 2010. New uses under recently issued 2ee label amendments include using Regalia applied in the transplant water or as a soil drench when transplanting tomatoes, peppers and cucurbits. A new label is expected in spring 2012 that will include drip irrigation applications.

Tenet (developed by Isagro and marketed by Sipcam) contains two beneficial fungi (Trichoderma asperellum, Trichoderma gamsii) with different modes of action against soil-borne pathogens (Phytophthora capsici, Rhizoctonia, Pythium and Verticillium) to control root and crown rot diseases.

Serenade Soil (developed by AgraQuest) is a new formulation of Serenade for application to field soil to manage soil-borne and seedling diseases caused by fungal pathogens (Rhizoctonia, Pythium, Fusarium, Verticillium, and Phytophthora.

MeloCon WG (developed by Certis USA) is a biological nematicide. The active ingredient (Paecilomyces lilacinus strain 251) is a naturally occurring beneficial soil fungus that attacks many species of plant parasitic nematodes at all stages, including eggs, nymphs, and adults. It is labeled for use in many different vegetable crops and can be applied to the soil in several ways, including plant hole drench, through drip irrigation, or sprayed onto the surface of the soil and incorporated. There is no restriction on the number of applications applied per crop.

TriTek (developed by Brandt Consolidated) is a new formulation of Saf-T-Side. Active ingredient is petroleum oil. It is a spray oil emulsion that functions as a fungicide, insecticide, and miticide.

AgriPhage is an interesting biological approach to managing bacterial diseases using bacterial viruses (aka bacteriophage or phage) that attack these pathogens. The organic product for tomato bacterial speck and spot is anticipated to be available before year end. The registration package for a product for black rot in cruciferous crops will be submitted soon. New formulations are more general than in the past when the company would use diseased tissue from the crop to be treated to develop a targeted product for the pathogen strain(s) present. AgriPhage is recommended applied once a week, more often (2 to 3 times) when disease pressure is high. It can be tank mixed with most organic fungicides and insecticides except copper or Oxidate as these will kill the virus. OmniLytics, Inc. is the company developing and directly marketing these products.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Before purchase, make sure product is registered in your state and approved by your certifier. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

POTENTIAL FOR BUMBLE BEES TO IMPROVE PRODUCTION OF PUMPKINS

Brian A. Nault, Derek R. Artz and Jessica D. Petersen
Department of Entomology, Cornell University, New York State Agricultural Experiment Station, 630 W. North St., Geneva, NY 14456; phone: (315)-787-2354; email: ban6@cornell.edu

Vine crops such as pumpkin, squash, cucumber and watermelon are some of New York's most valuable vegetable crops. These crops require pollination by bees or can produce higher yields when pollinated by bees. The most well known pollinator is the honey bee, *Apis mellifera*, and honey bee hives are placed in fields during the period these crops need to be pollinated. Unfortunately, Colony Collapse Disorder (CCD) continues to cause significant losses in populations of honey bees throughout the US, including New York. Worker bees from colonies affected by CCD leave their hives and never return. Neither the cause nor the cure for CCD has been positively identified. Fewer honey bee hives are now available for vine crop growers and the cost of renting hives has increased from approximately \$30 per hive to ≥\$55 per hive. Without a cure for CCD, it will continue to be difficult to find hives and more expensive to rent them, and growers will need other pollinators to service their vegetable crops. The common eastern bumble bee, *Bombus impatiens* (**Fig. 1**), is an abundant native pollinator in New York and is a perfect candidate. This article summarizes a couple major findings why the bumble bee appears to be an important pollinator of cucurbit crops like pumpkin.

Fig. 1. The common eastern bumble bee, *Bombus impatiens*

How Do Pollination Services from Bumble Bees Compare with Other Pollinators? The common eastern bumble bee is one of the most abundant bee species pollinating fresh-market vegetable crops in New York, especially pumpkin. The other common pollinators are the honey bee and the squash bee, *Peponapis pruinosa*. In New York from 2008-2010, we examined the effectiveness of each of these three species as pollinators of pumpkin. The study allowed each bee species to visit a female pumpkin flower 1, 2, 4 or 8 times. No other bees were allowed to visit these flowers. First, female pumpkin flowers were randomly selected the day before they opened and then covered with insect-proof screening, thereby excluding any floral visitors before initiating the treatments. The following morning, the insect-proof screening was removed and each "virgin" flower was exposed and the experiment initiated. After the required number of visits by a particular bee species, the flowers were securely covered again with insect-proof screening and tagged with the bee visitation treatment number. Fruit were harvested and weighed at the end of the season. <u>Based on our results in 2009, the eastern common bumble bee was the most effective pollinator of pumpkin among these three bee species</u> (**Fig. 2**). Similar results were observed in NY field trials in 2008 and 2010.

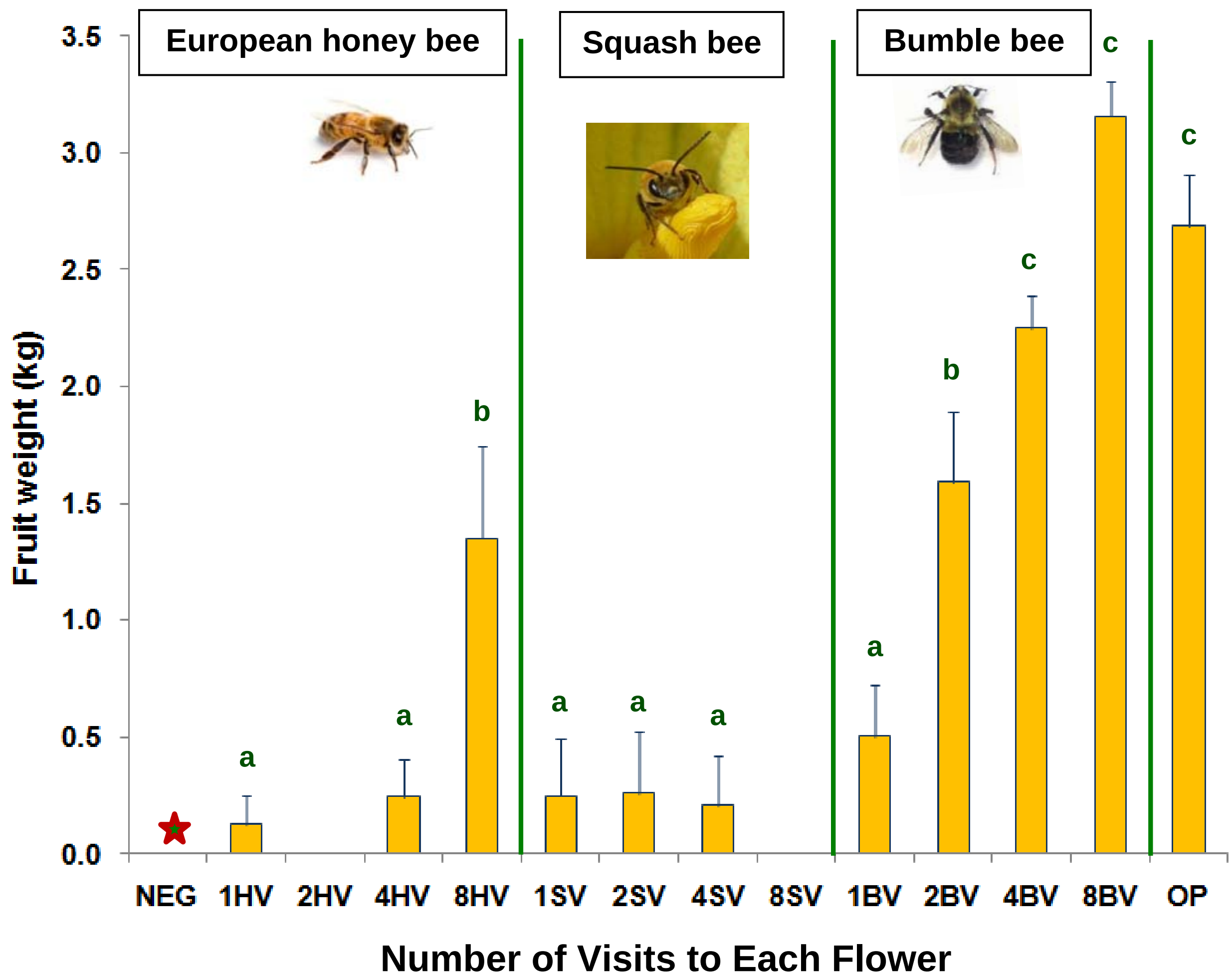


Fig. 2. Pumpkin (*Cucurbita pepo*, var. 'Mystic Plus') fruit weights resulting from controlled pollination by either the European honey bee (HV), squash bee (SV) or common eastern bumble bee (BV) after visiting female flowers 1, 2, 4 or 8 times in New York in 2009. NEG = flowers that were always bagged (negative control); OP= flowers not restricted to number of bee visits. Bars with different letters are significantly different (Mann-Whitney *U*-tests; $P < 0.001$).

Will Fruit Yield Increase if Bumble Bee Colonies are Placed in Fields? In the Finger Lakes Region of New York in 2011, we explored the potential of increasing pumpkin yields by supplementing fields with commercially produced common eastern bumble bees, honey bees or no bees. A total of 7, 10 and 7 commercial pumpkin fields were supplemented with bumble bees, honey bees or no bees, respectively. Bumble bees were acquired from Koppert Biological Systems, whereas honey bee hives were rented locally. Fields ranged in size from 1 to 25 acres. Therefore, numbers of bumble bee colonies and hives placed in each field depended on its size. For bumble bees, fields were stocked with one QUAD (= four colonies in a box) per 2 acres and honey bee supplemented fields were stocked at a density of 1 hive per 3 acres. All fields were separated from each other by at least 1 mile. Regardless of treatment, fields were avoided if they were near other fields that had honey bee hives.

The jack-o-lantern variety 'Gladiator' was selected as the variety for all locations. Ten 'Gladiator' seedlings were transplanted into each of three locations in the field (= total of 30 plants per field). Transplanting spanned a 3-week period in July. When the crop was mature, all marketable fruit were counted and weighed. Data were analyzed using an ANOVA and treatment means were then compared using a t-test at $P<0.05$.

The average fruit weight per pumpkin plant in fields supplemented with commercial bumble bees did not differ significantly from fruit weight in fields supplemented with honey bees or those that were not supplemented (**Fig. 3**). Although, there was a trend for numerically larger fruit yield to occur in bumble bee supplemented fields (16.5 lbs/plant), followed by honey bee supplemented fields (15.2 lbs/plant) and then non-supplemented ones (13.1 lbs/plant). In NY in 2009 and 2010, we observed a similar trend in greater 'Mystic Plus' fruit yield in small fields supplemented with bumble bees compared with fruit yield in those not supplemented.

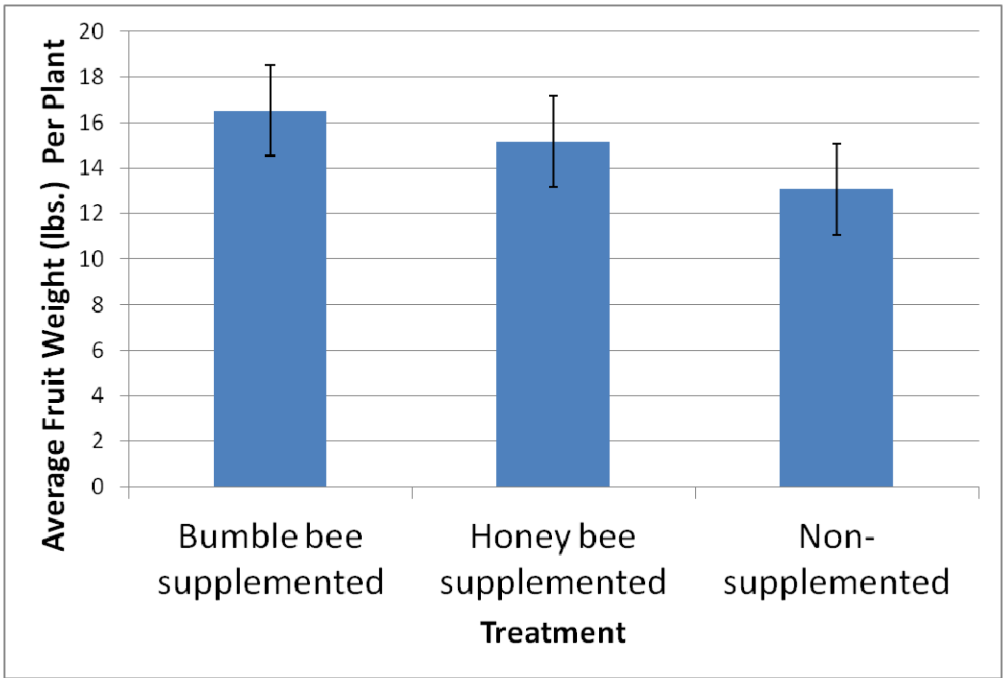


Fig. 3. Mean (± SEM) pumpkin, *Cucurbita pepo*, var. 'Gladiator', fruit yield from fields supplemented with commercial bumble bee colonies (n = 7), honey bee hives (n= 10) or were not supplemented (n = 7) in New York in 2011.

Future Research. The goal of our research is to investigate the potential for increasing the profitability and competitiveness of fresh-market vegetable farms by capitalizing on the superior pollination services provided by bumble bees. Pumpkin will be used as a model crop and there will be several objectives: 1) continue to compare fruit yield in fields augmented with either bumble bees, honey bees, or no commercial bees; 2) determine the impact of field size and amount of field bordered by woods and other habitats on bee visits to flowers and subsequently fruit yield; 3) conduct cost-benefit analyses for purchasing bumble bees, renting honey bees or relying entirely on wild bumble bees; and, 4) develop a Decision-Making Guide that can be used to decide whether to rely exclusively on wild bumble bees or to supplement fields with bumble bees or honey bees. Overall, we expect that the pollination services provided by bumble bees will lead to greater yields and lower production costs for vine crop growers in New York.

Pumpkin Evaluations at University of Maine Highmoor Farm 2009-2011

Mark Hutton (mark.hutton@maine.edu) and David Handley (david.handley@maine.edu)
University of Maine
Highmoor Farm, Monmouth ME

Pumpkin yield and fruit characteristics of pumpkins grown over three growing seasons (2009-2011) at the University of Maine Highmoor Farm, Monmouth Maine[z].

Cultivar	Year tested[y] 2009	2010	2011	Fruit/plant	Ave WT (lbs)	Min Wt (lbs)	Max Wt (lbs)	Shape 1=tall, 2=round, 3=oval	Color 1=light, 5=dark	Rib 1=none, 5=extensive	Uniformity 1=poor, 5=very	Overall 1=poor, 5=excellent
Challenger PMR	x		x	1.47	27.8	6.5	42.2	2.0	2.6	2.9	2.5	2.4
Champion		x	x	1.22	27.5	9.1	39.0	1.0	3.5	3.8	3.5	3.7
Rock Star	x	x	x	1.01	27.1	8.4	42.2	1.0	3.1	3.3	3.5	3.4
Mr Wrinkles	x	x	x	1.22	27.1	12.6	49.1	1.5	2.9	4.1	3.5	3.5
Apollo			x	1.65	26.8	16.1	37.9	2.0	4.0	4.0	4.0	5.0
Super Herc	x	x	x	1.20	25.7	10.6	38.7	2.0	3.4	2.8	4.5	3.3
Gold Medal	x	x	x	1.16	25.5	10.9	50.2	1.5	3.3	3.3	2.0	3.3
Phatso		x		1.07	25.1	10.4	40.9	1.0	2.6	3.1	2.0	3.5
Harvest King	x	x	x	1.05	25.0	7.7	43.4	1.0	2.7	3.3	2.0	3.3
King Midas	x	x	x	1.44	24.4	7.6	47.9	1.0	3.2	2.9	2.5	3.4
Diablo			x	1.45	24.0	14.1	36.8	2.5	3.5	3.5	2.5	3.0
Expert	x	x	x	1.11	22.9	11.2	34.1	1.5	4.1	4.3	4.5	3.5
Gold Gem	x	x	x	1.36	22.7	8.9	40.8	1.5	3.2	3.7	2.0	3.1
Gold Medallion	x	x	x	1.37	22.3	5.1	50.4	2.0	2.3	2.3	2.0	2.6
Phatso II	x			1.57	22.3	12.8	31.5	1.0	3.0	3.5	2.0	2.7
Mustang PMR	x	x	x	1.92	21.4	2.7	49.7	1.5	2.6	2.7	2.0	2.9
Big Rock	x	x	x	1.35	21.4	8.7	36.0	2.0	3.0	3.5	2.0	2.9
Camaro	x	x	x	1.51	20.9	7.1	44.1	2.0	1.9	1.7	2.5	2.4
Spartin	x	x	x	1.43	20.4	6.6	33.2	1.5	3.2	3.2	2.5	3.1
Warlock	x	x	x	1.75	19.6	7.4	41.9	1.5	3.8	1.7	3.5	3.4
Phatso Jr.	x			1.20	19.5	13.4	25.5	1.5	3.3	3.5	2.0	2.7
Gold Challenger	x	x	x	1.31	19.5	5.5	30.2	1.5	3.1	3.0	2.5	3.5

Rival PMR			x	1.75	19.3	9.9	30.6	1.5	3.0	2.5	2.0	2.0
New Rocket	x	x	x	1.72	18.7	5.6	35.9	1.0	3.5	3.5	3.0	3.5
Gladiator	x	x	x	1.61	18.6	7.6	38.7	2.0	3.6	3.1	3.5	3.8
Magic Lantern	x	x	x	1.84	18.6	9.1	39.8	2.0	4.0	3.2	3.5	4.1
Magic Wand	x	x	x	1.74	17.2	7.1	27.1	3.0	3.9	3.4	3.0	4.2
Octoberfest	x	x	x	1.81	17.2	5.4	35.8	2.0	3.2	2.5	1.0	3.2
20 Karat Gold	x	x		1.48	16.8	6.4	26.2	2.0	3.7	3.1	2.0	3.7
Hannibal	x	x	x	1.43	16.4	3.2	36.9	2.0	3.4	2.2	2.0	3.4
Corvette	x	x	x	1.91	16.2	5.9	27.1	2.0	2.0	1.9	3.5	2.7
Magician	x	x	x	2.23	14.3	6.4	23.2	2.0	3.3	3.4	3.0	3.5
Rocket	x	x		2.12	14.1	6.6	24.6	1.0	2.6	2.9	2.5	3.1
Charisma	x	x	x	1.76	13.6	5.9	23.0	3.0	3.7	3.8	3.5	3.3
Knucklehead	x	x	x	1.53	13.6	2.5	26.2	1.0	3.5	2.0	2.0	3.7
Racer	x	x		2.18	12.6	5.2	19.6	3.0	3.7	3.4	3.5	3.4
Siegers 170	x	x		2.31	11.1	5.2	16.8	2.0	4.1	1.6	2.5	4.0
Goosebumps	x	x	x	2.42	10.0	4.0	18.4	3.0	3.5	1.8	3.0	4.2
Siegers 168	x	x		2.58	8.0	3.4	15.3	2.0	3.8	1.0	2.5	4.3
Mystic Plus		x	x	2.90	5.8	2.5	9.2	2.5	4.0	2.6	5.0	4.5

[z]Plots consisted of 10 plants spaced 5' with-in the row and rows spaced 6' on center.

[y]Values presented are the averages of three replications of 10 fruit per plot harvested over each of the years evaluated.

More information and photos can be seen at the Highmoor farm website (http://umaine.edu/highmoor/research/).

Sustainable Pumpkin Production

Jamie Jones
Jones Family Farms
Shelton CT
jamie@jonesfamilyfarms.com

The Jones family farm is a 6th generation, 400 acre family farm in southwestern Connecticut. We currently grow strawberries, blueberries, vegetables, wine grapes, Christmas trees and pumpkins. Our goal is to direct market all of these crops to visitors to the farm. We have been growing pumpkins, gourds and winter squash for 25 years. In order to maintain consistent, high quality production of pumpkins, we have found it necessary to rotate our fields and keep our soils healthy. Below are some key points covered in the presentation.

- We plan to rotate away from pumpkins for two years after growing a field. We may grow strawberries, other non-cucurbit vegetables or cover crops such as sudax or buckwheat in the intervening two years.
- All fields are harrowed and seeded to winter rye for winter cover after harvest.
- We grow pumpkins on rolled winter rye. The rye planted the preceding fall is rolled flat in late May and pumpkins are planted throughout June depending on the variety's days to maturity.
- We employ a minimum tillage planting method, depending on the field, it is either zone tilled or planted directly into the rye, all done by hand.
- The rolled rye benefits are weed suppression, soil moisture retention and clean pumpkins. Soil compaction is minimized by the elimination of cultivation. One potential downside to the rye method is rodent damage to ripening fruit and this must be routinely scouted.
- Pollination is critical to fruit set. We have a bee keeper with some hives on our farm, but our observation is that wild bees do most of the pollinating. We are careful with our insecticide usage and try to leave habitat around the farm that ensures a healthy wild bee population.
- Today's customers expect a quality pumpkin with a solid stem. A well planned IPM program focused on disease control is necessary.
- Unique variety selection and presentation are important aspects of our October marketing efforts.

Disease and Resistance Management

T. Jude Boucher, University of Connecticut
24 Hyde Ave., Vernon, CT 06066
Jude.boucher@uconn.edu, 860-875-3331

Pumpkin disease management begins with cultural and preventative controls such as site selection, proper field preparations and use of resistant varieties, and by remembering that excess water is the enemy of your pumpkin planting. Think about it this way: in a dry year, any Boy Scout can grow great pumpkins…it's the wet seasons that separate the pros from the amateurs. Since many diseases are influenced by the duration of leaf wetness and humidity within the plant canopy, planting pumpkins on the top of a hill or in other open sites with good air circulation can limit disease infection and the speed of spread. Leaf wetness time can also be influenced by plant spacing, so crowding plants should be avoided. Fields should be located away from, and upwind of, early summer squash plantings, which tend to develop powdery mildew before pumpkin crops. This practice – along with the use of resistant varieties - can also slow disease transmission and delay initial fungicide applications. Choosing well-drained sites and not planting low areas prone to flooding can help reduce the potential for infection by fruit rot organisms. Improving drainage by using deep zone tillage or sub-soiling equipment can also help remove excess water, and cover crop residue in no-till and zone-till plantings has been shown to provide a protective barrier between the fruit and the ground.

Once preventive controls are tended to, there are four major diseases you can help manage with a good fungicide program: powdery mildew, Plectosporim blight, black rot and downy mildew (DM). Powdery mildew (PM) tends to be the most common and the most important in many years, so we design the spray schedule around it.

Start by scouting your pumpkin fields on a weekly basis. Check the underside of 50 older leaves per field for the first sign of PM, which usually appears as a small, white, round spot half the size of a dime. Time your first systemic fungicide application with the first sign of PM. Powdery mildew is almost always more severe on the undersurface of the leaves and deep in the plant canopy where humidity is high, so a systemic fungicide that moves through the plant or foliage is an important tool in managing this disease. The goal is to limit how fast the fungus forms spores and infects new foliage and stems, while simultaneously protecting the systemic tools that are so critical to combat this disease.

It is important to remember that systemic fungicides are very prone to resistance problems because they generally have a single method or mode-of-action in stopping infection by the fungus, and this fungus has a history of quickly adapting to new chemistry. To help slow or manage resistance there are several techniques you can use, but none are as important as limiting how frequently the fungus is exposed to each family or resistance group of systemic fungicide. Therefore, the very best resistance management strategy involves using one product from each group a single time per season, at roughly 10-day intervals. A protectant, such as Bravo, that has multiple modes-of-action and some efficacy against important fruit rot diseases should be mixed with the systemic to slow the development of resistance, while providing a broad range of disease protection. We currently have three groups of effective systemic chemistry to choose from: fungicide resistance groups 3, 7 and 13. In group 3, we have three products to choose from: Procure, Inspire Super and Rally. Recent fungicide efficacy studies have shown that Procure provides the best control in this group. We have a single product registered on pumpkins in both group 7 and 13: Pristine and Quintec, respectively. Of all the systemic products, Quintec is currently the most effective. Therefore, Quintec should be used in your first PM application, Procure in the second, and Pristine in the third. If additional applications are needed to protect the crop from PM until mid-September, then a combination (i.e. sulfur + Bravo) or a single protectant should be used (i.e. Bravo alone).

In wet years, Plectosporium blight and black rot are both serious threats to the fruit. Effective fungicide choices here include protectants such as Bravo, Dithane, and Manzate Pro-stick and the group 11 systemics Quardis, Cabrio, Flint and Pristine (groups 7 & 11). The group 11 systemics tend to be the most effective to combat Plecto.

In some years, downy mildew - which only attacks the foliage and not the fruit - may enter the region as early as late July or early August. Since DM is a water mold (like late blight and Phytophthora blight) and not a fungus, the fungicides mentioned above do not tend to work well to control it. What makes managing this disease more confusing is that, depending upon which strain of DM enters the region each year, different products will either be effective or fail to work. What works one year for a particular strain of DM may not work the next, and vice-versa. The only solution to this dilemma is to scout weekly for the first sign of this disease, and then try one of the following products when the disease first appears: Ranman, Presidio, Revus, Tanos, Curzate, Ridomil Gold/Bravo, or a phosphorus acid-type material such as ProPhyt. These can be mixed with the PM products unless the last application occurred just before DM appeared. Since multiple applications may be needed before September - when pumpkin fruit reach full size and foliage is no longer critical - and since any one product may or may not work in a given season, it is best to have two products on hand in late summer.

The same products used for DM may also reduce the aerial spread of Phytophthora blight. Unfortunately, they will not control the crown rot phase of the disease which is so destructive. Cultural methods that prevent water from standing in the field for 48 hours are more effective than fungicides at containing damage from Phytophthora blight.

Use of these practices and spray schedules has proved successful for the past 8 years on large pumpkin plantings in CT, where growers have achieved 90-99% marketable fruit in both wet and dry years.

Organic growers do not have this vast array of effective products to help manage the disease complex on pumpkins. Sulfur and mineral oils are relatively effective products that can help control PM. Copper may help with some fruit rots, but has been known to cause phytotoxicity problems on many of the newer pumpkin varieties.

Development of Stone Fruit IPM Guidelines for the Northeast

Lorraine Los, University of Connecticut
Department of Plant Science and Landscape Architecture
1390 Storrs Rd, Unit 4163, Storrs, CT 06269-4163
860-486-6449 lorraine.los@uconn.edu

In a 2009 survey, Connecticut growers identified the most important insect pests of stone fruits to be the catfacing insects (plant bugs and stink bugs), plum curculio, and peachtree borers. Other insects and mites considered to be less important include Japanese beetle, Oriental fruit moth, green peach aphids, and mites (European red mites and two-spotted spider mites). I have received funding from NE SARE to develop IPM guidelines for stone fruit pests in the Northeast region because such guidelines are not currently available.

Today's talk will focus on some of the major insect pests of stone fruits. Information will include life cycles, monitoring, cultural controls, mating disruption, use of degree days, and action thresholds. There will be a brief review of pesticide options (not included in this paper). Refer to the New England Tree Fruit Management Guide for effective pesticide options.

Catfacing Insects –Plant Bugs and Stink Bugs
Plant bugs that attack stone fruits include the Tarnished Plant Bug and the Oak/Hickory Bug Complex. **Stinkbugs** include the native species such as the brown, dusky and green stink bugs, as well as the new exotic species, the brown marmorated stink bug.

The **Tarnished Plant Bug (TPB)** feeds on over 100 different plant species. In New England it overwinters as an adult, usually in hedgerows outside the orchard, and is active from the bud stage to about three weeks after petal fall. Adults lay eggs in weeds and leguminous plants where the nymphs develop. The first generation adults move from these plants to stone fruits approximately mid-June to mid-July. There are 2-3 generations per year.
The **Oak/Hickory Bug Complex** (*Lygocoris spp.)* includes the white oak plant bug, the hickory plant bug, and *Lygocoris omnivagus* (no common name). These plant bugs overwinter as eggs on oak, hickory and other trees. They usually migrate to peaches in early to mid-June through July. They tend to be a sporadic occurrence in peach orchards depending on the site. More are expected in blocks with woody borders.
Plant Bug Injury - The type of injury caused by plant bugs depends upon the timing of the injury. If buds or blossoms are attacked, they will likely drop and "natural thinning" may occur. Fruit injury will occur if plant bug feeding occurs shuck-split or later. Plant bugs inject a toxin at the feeding site which causes fruit distortion called "cat-facing". The earlier in the season that the feeding occurs, usually the more severe the damage at harvest. Late season feeding may also result in stings with a gummy ooze.
Monitoring - White or pink sticky traps or beating trays (limb-jarring) can be used for monitoring adult plant bugs; however, no thresholds have been established. Sweep net sampling gives a good indication of catfacing insects present in the groundcover. The best way to monitor for plant bug injury is by direct fruit examination. Check 100-200 fruits per block for fresh injury; use a minimum of 10 fruit from 10 different trees. Check for other pest damage at the same time (such as plum curculio). An injury "threshold" is suggested at 1-2% of new damage

(or whatever your particular tolerance may be). Both old and new feeding should be recorded so that management programs can be adjusted or changed if needed.

Cultural Control -Groundcover Management – Research from Rutgers University has shown that plots with clean sod middles (free of broadleaf weeds) had fewer TPB in the ground cover than similar areas with broadleaf weeds. Two-thirds less TPB damage was found on peaches in clean sod blocks. Try to prevent broadleaved winter annual weeds and legumes in and around the orchard.

Chemical Control – The critical timing for TPB control is at petal fall, shuck fall and approximately 10 days after shuck fall. Applications at pink are often unnecessary because fruit injured at this time will likely abort. If treatments are necessary they should be applied during times of adult activity since this is the damaging stage in the orchard.

Stink Bugs – Native stink bugs such as the brown stink bug, dusky stink bug and green stink bug are relatively common in New England orchards. Adults overwinter in protected areas such as fence rows, under dead weeds, groundcover or stones and in the bark of orchard and other trees. The new invasive species, the brown marmorated stink bug (BMSB), has caused significant damage to pome and stone fruit crops in the Mid-Atlantic States for the last few years. It has been found in New England, but, as of yet, has not caused any crop damage. The BMSB overwinters as an adult in protected places, including houses, and that is where most of the New England sightings have occurred.

Stink Bug Injury – It is mostly the adults that injure fruit. Stink bug feeding damage is similar to that caused by plant bugs. Early feeding during bloom through shuck split will cause the flower or developing fruit to abort. Feeding from the shuck fall stage until fruit is about 1 inch in diameter will cause a catfacing similar to TPB. Feeding damage later in the season may result in depressed corky areas, bleeding spots of gum exuded out in droplets or strings, and various levels of cat-facing. Stink bug control is challenging because the insects tend to be highly mobile.

Cultural control – **Groundcover Management** – For native stink bugs (brown, green), groundcover management is very important, similar to the tarnished plant bug (see above). Research from Rutgers University has shown that plots with clean sod middles (free of broadleaf weeds) had fewer native stink bugs in the ground cover than similar areas with broadleaf weeds. See plant bug section (above) for more on groundcover management.

Monitoring – There has not been any success with sticky traps for monitoring of stink bugs. The best way to monitor for adults of the native stink bugs is by sweep sampling of the orchard floor or by limb jarring. A tentative threshold (Univ. of Arkansas) is that 1 stink bug/limb jar equates to approximately 1% of new damage. A pyramid shaped trap with a pheromone lure is being used for trapping of the BMSB. As of October, 2011, no BMSB were captured in these traps in Connecticut.

Plum Curculios (PC) overwinter as adults, usually in hedgerows, around the orchard perimeter. Adults lay eggs in the fruit and make a crescent shaped cut around the egg. The crescent shape is not as obvious on the peaches due to the fuzz, so you will need to scrape off the fuzz to see this.

Monitoring - The best way to monitor if the PC has arrived in the orchard is by direct examination of the fruit for injury or by the use of a beating tray (limb jarring) for adults. Monitoring should be done from bloom through at least two weeks after shuck fall. Concentrate monitoring along the edges and border rows of the block. A degree day model helps determine

when there should be no further immigration of PC adults into the orchard. This timing is when there is 308 degree days (base 50 ^{0} F) from **apple** petal fall.
Chemical Control - Treatments should begin at shuck-split stage if adults are present and causing fruit injury. No economic threshold has been established. An injury "threshold" is suggested at 1-2% of new damage (or whatever your particular tolerance may be).

Peachtree Borers – There are two species that attack stone fruits - **Peachtree Borer (PTB)** and **Lesser Peachtree Borer (LPTB).** They cause similar damage but are different in where and when they attack the trees. The peachtree borer has one generation per year and attacks healthy trees at the soil line. Tree vigor is reduced and small trees can be girdled or killed. The lesser peachtree borer has two generations per year and attacks scaffold limbs, especially those that are injured. They are often associated with Cytospora canker, pruning wounds, winter injury and mechanical damage. Both species overwinter as larvae that pupate and emerge during the summer.
Monitoring – Adults can be monitored using pheromone traps. Use at least 2 traps per block to determine adult flight. Install LPTB traps by petal fall and PTB traps by the first week of June. Populations seldom need treatment when trap catches peak at less than 10 moths/trap/week. Traps should always be used if mating disruption is employed (see below).
Monitoring for larvae or pupae will take more time but will be most helpful. For LPTB, inspect wounded areas on the upper trunk, scaffold limbs and branches for larvae and empty pupal cases protruding from the bark. It is easiest to find pupal cases during peak flight (associated with pheromone traps). Control is recommended if 1-2 larvae or empty pupal cases are found per tree. For PTB, inspect the base of the tree for gum containing frass and sawdust. It is best to do this during July through mid-August. Examine the soil at or near base of tree for cocoons and empty pupal cases. Control is recommended for trees up to 3 years old if any evidence of PTB is detected. In older orchards, control is recommended if 1 or more cocoons or empty pupal cases per tree are found. Suggested thresholds are from Virginia Tech.
Mating Disruption has been found to be an effective method for management of both borer species. Use Isomate PTB-Dual at a rate of 150 pheromone ties per acre. These should be installed at shucksplit before LPTB moth flight begins. Use a higher rate (200-250/A) for outside edges of border rows, areas that haven't been disrupted before and have high populations, and in blocks smaller than 5 acres (this is probably true for most stone fruit blocks in New England). If a block has GPTB infestations more than 30%, regardless of block size, use 200-250/A for the first year of treatment. In this situation, a trunk treatment of chlorpyrifos would also be advised for the first season to reduce the PTB population. Be sure to have pheromone traps in place for both PTB and LPTB. If the mating disruption is working, no moths should be captured in pheromone traps resulting in trap "shut-down".
Chemical control options include root dips for new plantings and sprays for trunk (PTB) and scaffold limbs (LPTB). The sprays for trunk and scaffold limbs are best applied with a hand-gun with low pressure and high volume. These can be applied post-harvest. Aim for the lower trunk at soil level for PTB and the upper trunk and scaffold limbs for LPTB. Although adult moths are not specifically targeted, insecticides used for other pests during the season may also provide some control.

Oriental Fruit Moth (OFM) overwinter as larvae on trees or in the ground. They pupate in the spring and begin to emerge around the ½ green stage of peach. There are 3-4 generations per year in New England. The first generation larvae are mostly found in twig terminals from May to July and cause wilted leaves and "flagging". The second and later generation larvae usually enter the fruit. Infested small fruit may drop from the tree but larger fruit tend to remain on the tree.

Monitoring – For first generation larvae, check terminals for "flagging". Count the number of flags per tree on at least 10 trees. There are currently no thresholds established but it will give you some idea of the level of infestation. For second and later generation larvae, check at least 200 fruit per block (10 per tree on 20 trees) for infested fruit. There are no thresholds but if you keep records throughout the season or year to year you can assess what management methods may be working or if you need to fine tune your approach. To monitor for adult moths, install pheromone traps at the half-inch green stage of peach. Use at least 1 trap per 10 acres. There is a suggested action threshold of >15 moths per trap per week for first generation and >10 per trap per week for second and later generations. Suggested trap thresholds are from Cornell University.

Mating disruption has been found to be effective for management of this pest and is economically justified if 2-3 sprays are normally applied, and if no other insecticide sprays are routinely needed for other pests after petal fall. For this reason, mating disruption may not be economical for the first brood, as plum curculio sprays at this time (if chosen correctly) would also control OFM. If you skip the first brood, mating disruption pheromones should be applied by mid-June before initiation of the second flight. The need for re-application depends on the residual field life of specific formulations which range from 30-90 days.

Chemical control – A number of pesticides are effective on OFM – see the New England Tree Fruit Management Guide. For the best timing of treatments, you will need to use pheromone traps and track degree days. To do this, check traps daily (placed at ½ inch green stage) until biofix. The biofix is the first sustained catch of 2 or more moths per trap. Then check weekly and calculate degree days (base 45^{0} F) from biofix date. The treatment timing is at beginning of egg hatch for each generation. The following information is from Penn State University.

DD Base 45^{0}F	Event	Action
150-200 DD	8-10% 1st gen. egg hatch	First treatment if >15 moths/trap/week
1150-1200 DD	8-10% 2nd gen. egg hatch	Treat if 10 moths/trap/week and/or fruit injury found
2100-2200 DD	8-10% 3rd gen. egg hatch	Treat if 10 moths/trap/week and/or fruit injury found

Spotted Wing Drosophila (SWD) – This new exotic pest arrived in most New England states (except for Vermont as of this writing) in late summer, 2011. SWD is a type of fruit fly that is a pest of most berry crops, grapes, and stone fruits, with a preference for softer-fleshed fruit. It was devastating to New England raspberry and grape crops in 2011 but was also found to a lesser extent on stone fruits. New England research and extension scientists will be developing recommendations for the 2012 season. Vinegar traps are used to trap adults.

Peach and Nectarine Varieties for the Northeast

by
Jerome L. Frecon
Agricultural Agent and Professor, Rutgers New Jersey Agricultural Experiment Station Cooperative Extension, Gloucester County, 1200 North Delsea Drive, Clayton, N.J. 08312 856.307.6450 Ext 1

Introduction and Methodology

Testing and evaluation of apricot, nectarine, peach, and plum varieties began in New Jersey in 1983. The evaluation of plums began with the receipt of aprium and pluot varieties from Dave Wilson Nurseries and plum varieties from the USDA plum breeding program in Byron Georgia in the late 80's. Apricot evaluations have been discontinued after repeated tree loss and lack of consistent productivity primarily due to low winter and spring temperatures.

Most peach, nectarine, and plum varieties have been received for testing from public and private fruit breeders, commercial nurseries, and individual growers. In recent year efforts have been made to limit testing of the varieties that have not been introduced for commercial introduction.

The major goal of the program is select the best varieties for our commercial peach industry in New Jersey and Pennsylvania. Another goal is to determine which varieties that have been introduced that are not adapted to our region or have major deficiencies of which our industry should be aware.

Six blocks of 722 cultivars of peaches and nectarines were maintained at ten orchard blocks and the Rutgers Agriculture Research Center in Upper Deerfield Township in southern New Jersey. Four tree replicates of each cultivar on the standard seedling rootstocks of Lovell, Guardian, Bailey and Halford are planted and evaluated. After 8 years of evaluation the poorest cultivars are removed from the oldest blocks. All blocks receive care and attention received in commercial orchards blocks. My technicians and I do planting and early tree training. Temperature records are collected at each site. Data of tree growth, flower set and flower characteristics are recorded in the spring. Growth rates, fruit set, disease resistance, and susceptibility data is collected during the growing season. After collection of flower set and fruit set data, a rating is given each cultivar on productivity relative to its ability to withstand spring frost and low winter temperatures. Fruit characteristics are recorded near and at harvest. Fruit data characteristics are recorded as ratings for flavor, red over color, attractiveness, firmness of flesh and skin, pubescence, free from pit or stone, flesh color, shape and any other unusual or distinguishing characteristics. All fruit samples are diameter sized and weighed. Fruit soluble solids and acidity are measured and recorded. Samples are stored for grower observations and the most promising are utilized for post harvest evaluation in the Postharvest Laboratory of Dr. Dan Ward[1]. All fruit is photographed for future reference and publication.

The following are written descriptions of the most important and promising peach and nectarine cultivars evaluated and planted in New Jersey. They are listed in order of ripening in southern New Jersey, mostly relative to Redhaven a Michigan cultivar that is still widely grown cultivar in New Jersey. Promising plum and plumcot cultivars will not be discussed in this presentation.

Groupings include:

1) Yellow-fleshed peach cultivars suggested for planting;
2) White-fleshed peach cultivars suggested for planting;
3) Yellow and white-fleshed fuzzless peach or nectarine cultivars suggested for planting;
4) Yellow and white-fleshed flat peach cultivars suggested for planting;
5) Promising or novel peach and nectarine varieties
6) Promising New Jersey varieties not introduced

[1] Extension Specialist in Pomology, Rutgers New Jersey Agricultural Experiment Station, Rutgers Agricultural Research and Extension Center, 121 Northville Drive, Bridgeton, N.J 08302-5919

SUGGESTED VARIETIES FOR PLANTING IN NEW JERSEY

Yellow-Fleshed Peach Varieties (In Order of Ripening)

June Maturity
Queencrest
Sunbrite -
Desiree™ NJ 350

July Maturity
Spring Prince
Spring Flame™ (Burchell D2.102) -
Flamin Fury® PF#5B
Ruby Prince
Harrow Dawn
Sentry
Glenglo
Flamin Fury® PF# 7
Summer Serenade
Vulcan
GaLa.
Flavorcrest
Vinegold
Early Loring
Redstar
Flamin Fury® PF 15A
Flamin Fury® PF Lucky 13
Blaze Prince
John Boy
Blazingstar
Flamin Fury® PF 14 Jersey

August Maturity
Starfire
Salem
Coralstar
Flamin Fury® PF 17
Bounty
Harrow Fair
Flamin Fury® PF 19-007
Flamin Fury® PF 20-007
Flamin Fury® PF#23
Contender
July Prince
Allstar
Flamin Fury® PF#24-007
Glowingstar
Scarlet Prince
Flamin Fury® PF Lucky 24 B
Gloria™ NJ 351
Flamin Fury® PF#25
Messina™ NJ 352
Flamin Fury® PF#27A

September Maturity
COLOR RATINGS ARE QUITE VARIABLE ON PEACHES RIPENING AFTER SEPTEMBER 1.
Flamin Fury® PF 28-007 -
Flame Prince
Autumn Star
Laurol
Victoria™NJ
Big Red

White-Fleshed Peach Varieties (In Order of Ripening)

June Maturity

Spring Snow
Manon

July Maturity
Scarlet Pearl

Sugar May
Southern Pearl.
Snow Bride

August Maturity
White Lady
Snow Beauty
Klondike White
Carolina Belle
Blushing Star
Sugar Giant
Opale
Snowfire

Benedicte
Lady Nancy
Snow King

September Maturity
Snow Giant
Yukon King

Yellow-Fleshed Nectarine Varieties (In Order of Ripening)

June Maturity
Mayfire

July Maturity

Easternglo -

Honeyblaze -
Honeykist
Harblaze
Harflame
Flamin Fury® PF 11
Summer Beaut
Flavortop

August Maturity

Sunglo
Jolly Red Giant
Redgold.
Fantasia.
Stark® Ovation

White-Fleshed Nectarine Varieties (In Order of Ripening)

July Maturity
Arctic Star
Jade
Silver Gem (NJ N100
Arctic Sweet
ArticGlo
Crimson Snow

August Maturity
Emeraude
Arctic Belle
Arctic Jay
Arctic Gold
Zephyr

September Maturity
Topaze
Arctic.

White And Yellow-Fleshed Flat Peach Varieties (In Order of Ripening)

Flat peaches are also known as "saucer" or "doughnut-type" peaches because of their round, oblate to squat appearance.

NJ F18 (NJ L10-72) –
NJ F15 (NJD 51-270)
Saturn

TangOs™ (NJ F16)
Galaxy

TangOs II™ (NJ F17)

Table 2 Relative Susceptibility of Peach and Nectarine Varieties to Bacterial Spot _Xanthomonas pruni_

Low or Less Susceptibility
Allstar
Autumn Star
Biscoe
Blazing Star
Blazeprince
Candor
Contender
Coralstar
Carolina Belle
Derby
Dixired
Earliglo
Early-Red-Fre
Empress
Flamin Fury PF# 1
Flamin Fury PF# 5B
Flamin Fury PF# 7
Flamin Fury PF# Lucky 12
Flamin Fury PF# Lucky 13
Flamin Fury PF # 14 Jersey
Flamin Fury PF# 15A
Flamin Fury PF #19-007
Flamin Fury PF# Lucky 24B
Flamin Fury PF# 28-007
Glenglo
Glowingstar
Harbelle
Harbinger
Harbrite
Harcrest
Harkin
Harrow Beauty
Harrow Dawn
Harrow Diamond
Harrow Fair
Madison
Manon
NJF14
NJF16
NJF17
NJ 350(Desiree)
NJ 351(Gloria)
NJ 352(Messina)
NJN100
Redhaven
Redkist
Redstar
Ruby Prince
Saturn
Sentry
Scarlet Pearl
Scarlet Prince
Sentinel
Spring Prince
Starfire
Sunbrite
Vinegold
Vulcan

Medium Susceptibility
Autumn Star
Articglo
Arctic Sweet
Bellaire
Blake
Blushing Star
Bounty
Carogem
Cresthaven
Crimson Snow

Earlired
Early Sunhaven
Early Loring
Easternglo
Elberta
Emeraude
Encore
Flameprince
Flamin Fury PF# 11
Flamin Fury PF# 17
Flamin Fury PF# 20-007
Flamin Fury PF#23
Flamin Fury PF# 24-007
Flamin Fury PF# 25
Flamin Fury PF # 27A
Fantasia
GaLa
Galaxy
Garnet Beauty
Glohaven
Harvester
Harblaze
Harflame
Jade
Jefferson
Jerseydawn
Jerseyglo
Jerseyqueen
Jim Dandee
John Boy
Late Sunhaven
Loring
NJF15
Parade
Queencrest
Raritan Rose
Ruston Red
Salem
Spring Snow
Stark Ovation
Sugar May
Summer Beaut
Summer Serenade
Triogem
Topaz
White Lady

High Susceptibility

Arctic Belle
Arctic Blaze
Arctic Jay
Arctic Gold
Arctic Star
Arctic Pride
Autumnglo
Autumn Lady
Babygold 5
Benedicte
Big Red
Fayette
Flavor Top
Flavorcrest
Glacier
Heavenly White
Honeyblaze
Honeykist
Honeyroyale
Jerseyland
Jerseyqueen
Johanna Sweet
Jolly Red Giant
Karlarose
Klondike
Lady Nancy
Laurol
Maygrand
Redgold
Rio Oso Gem
Snow Beauty
Snow Bride
Snowfire
Snowking
Snow Prince
Snowqueen
Snow Giant
Springold
Spring Flame
Sweet Dream
Sugar Lady
Sugar Giant
Suncrest
Sunglo
Sunhigh
Sweet Dream
Sweet Sue
Topaze
Yukon King
Zephyr

Other Promising Or Novel Peach Varieties (In Order of Ripening)

Raycrest -
Flamin Fury® 5D Big
Snow Prince
Westbrook
Carored
Arrington
Nustar
Flamin Fury® PF#10
Sweet Scarlet
Virgil
Country Sweet
Flamin Fury® 9A-007
Intrepid
Paul Friday 15B
Heavenly White
Sweet N UP
July Flame
Joanna Sweet
Beaumont
Sweet Blaze
Flamin Fury PF#22-007
Flamin Fury PF# 24C .
Sweet Dream
Sweet Breeze (EW 170
Ventura
Glacier White
Valley Sweet
China Pearl
Carolina Gold
Flamin Fury® PF 30-007
Paul Friday 36-007
Flamin Fury® PF 35-007
August Flame
Honey Royale
Arctic Blaze

Innovations in Peach Thinning

Tara A. Baugher, James R. Schupp, Paul Heinemann
Penn State University, tab36@psu.edu

Hand thinning is a necessary and costly management practice in peach production. Stone fruit producers are finding it increasingly difficult to find a workforce to manually thin fruit crops, and the cost of farm labor is increasing. The conventional method for adjusting cropload in peach and nectarine orchards is to remove excess fruit by hand at 35 to 40 days after full bloom. Plant growth regulators are available for thinning pome fruit; however, chemical thinning options for stone fruit are limited and unpredictable. Three years of research on chemical blossom thinners, reported at the 2007 New England Vegetable and Berry Conference, demonstrated that while the treatments often increased peach fruit size, they were inconsistent in reducing follow-up hand thinning requirement. An initial year of research on string blossom thinning was also reported, and the results indicated that mechanical thinning with this new technology from Germany reliably reduced labor requirement, reduced cropload, and increased fruit size beyond that achieved with conventional hand thinning at the green fruit stage.

In subsequent trials conducted over four seasons, string thinner cropload management technologies have been tested in four peach producing states, and detailed research on pruning modifications and application timing have provided information to guide producers in maximizing mechanical bloom thinning benefits. Technology adoption socioeconomic surveys and case study interviews were also conducted, and graduate students from both Penn State and Carnegie Mellon University designed and tested sensors to automatically adjust positioning of the thinning spindle relative to tree canopy distance and angle.

The string thinner evaluated in 2007 (Darwin 300, Fruit-Tec, Deggenhausertal, Germany) was designed to thin narrow vertical canopies and therefore was evaluated on peach trees trained to either a perpendicular V or quadrilateral V system; a prototype designed in 2008 was successfully tested to operate in a horizontal position for thinning trees trained to an open-center system. A “hybrid” string thinner (PT250) designed to adjust cropload in either vase or angled tree canopies was evaluated in fresh fruit and processing plantings in varying production systems in four U.S. growing regions in 2009 to 2011. Data were uniformly collected across regions to determine blossom removal rate, fruit set, labor required for follow-up green fruit hand thinning, fruit size distribution at harvest, yield, and economic impact.

Trials Conducted in Four U.S. Peach Growing Regions

String thinner trials with variable tree forms utilized by producers in California, Washington, South Carolina, and Pennsylvania demonstrated reduced labor costs compared to hand-thinned controls and increased crop value due to a larger distribution of fruit in marketable and higher market value sizes. Blossom removal ranged from 17% to 56%, hand thinning requirement was reduced by 19% to 100%, and fruit yield and size distribution improved in at least one string-thinning treatment per experiment. The savings in hand thinning requirement and increases in fruit size distribution realized in all trials increased the economic value of the peach crops beyond that of hand thinning alone. Gross income ranged from \$4267 to \$9127 per acre in processing plantings and \$5097 to \$12,288 per acre in fresh fruit plantings. Net positive economic impact from mechanical thinning (realized economic savings beyond hand thinning alone) ranged from $236 to $1490 per acre and $264 to $934 per acre, respectively, with the exception of one treatment in two processing peach trials in which the economic impact was negative. Economic impact also was negative in a hand blossom thinned control treatment. Increased fruit size had a greater positive impact for fresh market producers while labor savings and yield increases (due to larger fruit size) were of greater importance for canning peach growers.

In-Depth Studies on Bloom Stage and Pruning Modifications

Research in Pennsylvania orchards was conducted over two years on 'Sugar Giant' peach and 'Arctic Sweet' nectarine to evaluate string blossom thinner efficacy at variable stages of bloom development, ranging from pink to petal fall. Blossom removal at the pink stage of bloom development was lower than at other stages in 2008; however, a 150 rpm versus 120 rpm spindle rotation speed resulted in blossom removal similar to the 80% full bloom (FB) treatment in 2009. Blossom removal at the petal fall stage was similar to the open bloom stage. Flower density and fruit set of the bloom stage compared to hand thinned control treatments followed a similar trend, with the exception that there were fewer differences in 2009 and in lower canopy regions. Follow-up hand thinning time was reduced by all string thinning/year combinations except 'Arctic Sweet' at pink in 2008 and 2009 and at petal fall in 2009. The best treatments reduced follow-up hand thinning time compared to green fruit hand thinning alone by 51% and 41% for 'Sugar Giant' and by 42% and 22% for 'Arctic Sweet' in years 1 and 2, respectively. In 2008, the percentage of fruit in the '2 ¾ inch or greater' size category was increased by all bloom stage treatments in both cultivars. The 2009 size distribution of 'Arctic Sweet' fruit was unaffected, but the percentage of 'Sugar Giant' fruit in higher market value size categories was increased by the 80% FB and higher rpm pink treatments. Savings in hand thinning time and/or increases in fruit size in both years associated with the bloom stage treatments resulted in a net positive impact of $49 to $554 per acre compared to hand thinning alone.

Pennsylvania studies also were conducted over two seasons in peach orchards trained to perpendicular V or open center systems to evaluate possible pruning strategies to improve tree canopy access by string thinners. The objectives were to demonstrate if modifications in fruiting shoot orientation, pruning detail, and/or scaffold accessibility improved flower removal, reduced follow-up hand thinning requirement, and/or increased fruit size. Blossom removal was improved by either detailed pruning (elimination of short or excessively long shoots) or partial pruning (elimination of all shoots on the side of a limb inaccessible by the thinner spindle) in both training systems. Flower density and fruit set measurements revealed greater differences among pruning treatments compared to hand thinned control treatments, with both fruiting shoot orientation pruning modifications and detail pruning resulting in improved thinning. Thinning efficacy was unaffected by scaffold angle but increased as canopy accessibility ranking increased. Follow-up hand thinning time was reduced by all treatment, system/cultivar, and year combinations except standard pruning in an open center-trained 2009 trial. Detail pruning consistently improved fruit size compared to hand thinned control and other pruning treatments in both perpendicular V- and open center-trained orchard plots. The best treatments resulted in a thinning savings of $49 to $282 per acre in perpendicular V plantings and $11 to $19 per acre in open center plantings. Realized economic savings beyond hand thinning alone ranged from $191 $1163 per acre in perpendicular V trials and $11 to $119 per acre in open center trials.

Technology Adoption Surveys and Case Study Interviews

Participants in a technology adoption survey rated fruit thinning, harvesting, spraying, and monitoring crop and nutrient status the greatest areas of need to increase efficiency and precision in specialty crop enterprises, and among these, thinning and harvesting tended to receive the highest need scores. Case study interviews of 11 Pennsylvania growers and orchard managers who had thinned a total of 154 acres suggested that commercial adoption of mechanical string-thinning technology would have positive impacts on the work place. All case study cooperators reported that blossom string thinning impacted orchard management by making cropload management more efficient and by reducing follow-up hand thinning time. Eighty percent of the growers noted fruit from thinned trees were larger. Additional observations included the following: 1) hand thinning of peaches was completed earlier allowing more timely work in other crops, 2) employees were satisfied with mechanical thinning as it saved them time and minimized ladder use, and 3) the seasonal distribution of labor-intensive work was improved.

Sensor Technologies Developed by Graduate Students to Automate Positioning of the String Thinner Spindle

Reuben Dise, Penn State Department of Agricultural and Biological Engineering, and Matt Aasted, Carnegie Mellon University Robotics Institute, designed and compared two sensor-based systems for automating the positioning of the thinning spindle. The manually controlled mechanical string thinner requires the operator to constantly steer the tractor to maintain tree canopy engagement. To address this constraint, they tested ultrasonic and laser sensors to detect canopy shape and distance and automatically control the position of the string thinner. Based on blossom removal comparisons between automated and operator controlled string thinning, the automated systems were generally as good as a human at maintaining canopy engagement and may be economically viable methods of augmenting mechanical thinning. To view a video on this new technology, please visit www.abe.psu.edu/scri.

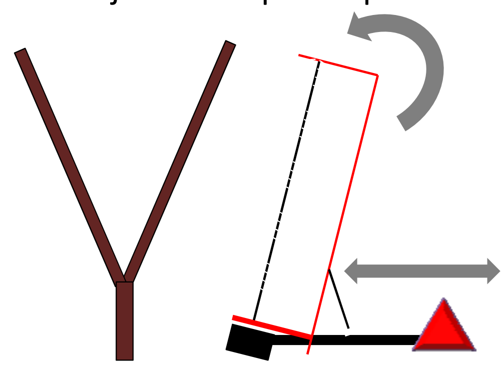
Summary

Mechanical thinning, being a physical removal technique, has greater predictability than chemical thinning. Since the effects of physical removal are immediately visible, the level of crop removal can be determined by comparing pre- and post-thinning flower or fruit counts. A grower can therefore assess the level of crop removal and adjust the machinery to increase or reduce thinning as needed. However, the ability to ascertain the optimal crop load level and thus obtain the optimal balance of yield and fruit size distribution is still required. Since the potential negative economic consequence of over-thinning a high value crop such as stone fruit is great, it may be a safer strategy to use non-selective mechanical thinners to reduce but not entirely replace hand thinning.

In trials conducted over the past four years, tree pruning and training modifications were shown to be factors that warrant special attention for obtaining the most consistent results from mechanical string thinning. Canopy accessibility by the string thinner can be improved by detail pruning to eliminate excessively long or short fruiting shoots, by pruning to remove shoots in less accessible regions of the canopy, and by tree training to maintain straight scaffolds. Given the current premiums for large fruit in the fresh fruit market, and the growing expense and potential shortage of farm labor, the application of mechanical thinners and adoption of narrow tree wall systems that enhance the benefits of this technology offer a near-term solution to these two critical components of fruit grower profitability.

Modifications to String Thinner to Automate Positioning:

A. Controller adjusts the spindle position

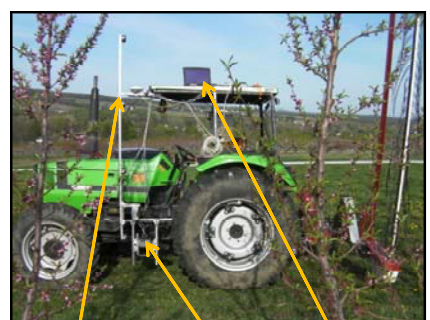


Two degrees of motion: angle of spindle, lateral position of spindle

B. Hydraulics and controls added

components:

C. Ultrasonic and laser sensors tested



components:

Japanese Plum Types, Plumcots, and Other Novel Interspecific Hybrids and Their Adaption to the Northeast

By
Jerome L. Frecon
Agricultural Agent and Professor 1, Rutgers New Jersey Agricultural Experiment Station, Clayton, N.J. 08312

The Japanese-type plum varieties adapted to the milder temperate climates of the Northeastern US are of great diversity. Many of these plum varieties are the result of interspecific hybridization. Most plums described as Japanese are the result of crosses of the species *Prunus americana, Prunus salicina* and *Prunus simonii.* More recently *Prunus angustifolia* has been used by southern breeders to improve adaptability.

Generally, the Japanese type plum varieties grow on upright spreading, spreading to drooping trees and produce round to heart-shaped fruit (pronounced apex) with yellow to red, to almost black skin color.

Plumcots are interspecific hybrids of Japanese plums *Prunus salicina* and apricots *Prunus armeniaca.* Plumcot is a generic term for these hybrids

Pluots® are later-generations that show more plum than apricot characteristics; the fruit's exterior has smooth skin closely resembling that of a plum. Pluots were developed by Floyd Zaiger, and "Pluot" is a registered trademark of Zaiger Genetics.

Apriums® are complex plum-apricot hybrids that show more apricot traits. Genetically they are one-fourth plum and three-fourths apricot. Aprium varieties were developed in the late 1980s by Floyd Zaiger, and "Aprium" is a registered trademark of Zaiger's Genetics

Prunus domestica or the European, or common garden, plum varieties are more upright in growth habit and produce oval- to ovate-shaped plums with blue to black skin color. Some varieties have a dry texture, very high sugar content, and are processed into prunes. For this reason, many of these cultivars are commonly called prunes. A botanical species, *insititia* or damson plum, is one of these cultivars. Varieties of the American, or wild, plum grow on spreading trees and produce small, round fruit of various colors. These later two species have not been extensively evaluated in New Jersey and thus will not be discussed.

Varieties

The Japanese type varieties grown on available rootstocks are generally short-lived and relatively unproductive (there are exceptions). The trees are easily stressed by many of the same problems affecting peach trees, namely winter injury, spring frost, moisture stress, nematodes, root rots, and short life. Some Japanese varieties also experience latent incompatibility with available rootstocks and decline slowly.

Fruitfulness is also a problem in Japanese plums because of bloom variability, pollen incompatibility, and sensitivity to variation in temperatures and sunlight. The Japanese varieties bloom earlier than other plum species. Plumcots generally bear earlier than most Japanese type plums. The following varieties are suggested for small commercial plantings. These will be discussed.

Early-Season: Japanese
Early Golden –
Methley.
Shiro.
Crimson Beauty (USDA BY 8158-50)
Mid-Season: Japanese
Au Rosa –
Santa Rosa.
Black Ruby
Red Ace. .
Redheart.
Ozark Premier.
Black Amber –
Wickson -
Queen Rosa -
Rubysweet
Late-Season: Japanese
Vanier.
South Dakota.
Ruby Queen.
Fortune –
Friar - September 10

There are many other Japanese and Japanese X American hybrid varieties that have not been observed or tested in New Jersey.

Plumcots
Spring Satin   (ripens with early Japanese)
Pluots (in order of ripening)(start with mid season Japanese)
Flavor Queen –
Dapple Dandy -
Flavor King –
Flavor Gem -
Flavor Grenade -
Flavor Heart -
Flavorich -
Aprium (with early season Japanese)
Tasty Rich
Honey Rich

Rootstocks
Myrobalan(Prunus divaricata) seedlings and *Myrobalan 29C* clonal stocks are the recommended rootstocks for all European plum varieties. They are also compatible with many Japanese and Japanese X American hybrid varieties, but tend to be shorter-lived on sandy or drought sensitive soils. They are more adapted and longer-lived on loamy or clay-loam soils.
Lovell and Halford peach seedlings are used on many Japanese plum varieties. Trees are short-lived and susceptible to most problems experienced with peach varieties. Japanese plum varieties on Lovell and Halford peach seedlings are better adapted to sandy soils than European varieties on Lovell or Halford peach seedlings.
Mariana 2624 clonal rootstock is compatible with most plum varieties. Trees of all varieties are more sensitive to low winter temperatures on this rootstock than other rootstocks.
Citation appears to be promising rootstock for semi-dwarf plum trees   *Krymsk 1.* A New rootstock from Russia has not been tested in New Jersey but is being offered with Japanese plums as very winter hardy and producing a semi dwarf tree.
Pumiselect is a dwarfing clonal selection of *Prunus pumila* sold with Japanese type plum.

Pollination
All Japanese plums benefit from cross-pollination. Methley, Shiro and Early Golden will set heavy crops in some years without cross-pollination. All other varieties should be planted as a design with at least three varieties.
Most European varieties require cross-pollination. Varieties described as self-fruitful will set better and more consistent crops with cross-pollination.
Do not pollinate Japanese plum varieties with European plum varieties.

Growing Cherries Under Cover

Mark Parlee
Parlee Farms, Tyngsboro MA
www.parleefarms.com

Parlee Farms grows 10 different varieties of Sweet Cherries on two acres of land. Our soils are mostly Merrimac Sandy Loam over sand or gravel, which is considered excessively well drained. We are currently towards the end of an evaluation to put one acre of this planting under cover.

Following are some of the key observations that have factored into this decision:

1. Cost estimate is $40,000-$45,000 per acre;
2. The amount of cracking varies significantly between varieties. Over the last three years, the cracking on Blackgold and Regina has been less than 10%.
3. The bird damage has been less than 5% using the control strategies we use in our sweet corn (squawker and windmills).
4. Bacterial Canker to date has been only a minor issue. We are, however, closely watching this problem as we are susceptible to frost damage at our location in the Merrimack Valley. Frost damage can exacerbate problems with Bacterial Canker.
5. The normal pick-your-own strategy of planting numerous varieties to span a longer season may not be required for sweet cherries. The pyo demand for cherries is such that if we can identify two or three varieties that ‘work’ with our soils and climate, this may be sufficient.

To sum things up, at Parlee Farms we have decided to not cover our cherries – hoping to keep losses less than 10% with the right varieties. As an alternative, we will probably replant 50% of the planting with varieties that have shown minimal losses in our location.

Strawberry Weed Management Options

Bradley A. Majek
majek@AESOP.Rutgers.edu
Rutgers Agricultural Research & Extension Center
121 Northville Road, Bridgeton, NJ 08302

Weed control is an essential part of strawberry culture. The crop is sensitive to competition for light, water, and nutrients. Weeds reduce yield by reducing plant stand, berry number and size, and by interfering with harvest. The public is rapidly discouraged by weeds in U-PICK strawberry fields. A weed control program for a new strawberry planting should combine all the effective cultural, chemical, and mechanical techniques available. The use of recommended herbicides alone is not likely to provide adequate control. Fumigation for disease control will reduce potential weed populations, but cannot completely replace other weed control operations.

Traditionally, the crop is grown using the matted row system in the northeast. Strawberry mother plants are transplanted in the spring. They are set about 15 to 28 inches apart in the row, with rows four to five feet apart. Flower clusters are removed the first year. Runners produce daughter plants during the summer. The result is a bed or row two to three feet wide by early fall. The plants are often mulched in late fall to protect the crowns from winter injury and the roots from damage caused by freezing and thawing of the soil. The mulch is removed or pulled off the plants and left between the rows in early spring to prevent the crop from contacting the soil and to reduce disease infestation. Immediately after harvest fields to be kept in production another year must be renovated. Old foliage is removed by mowing. Plant populations are reduced to maintain vigor and berry size by reducing row width and/or converting field to the ribbon row system by eliminating plants in center of the row. Fertilizer is spread to encourage vigorous growth, and additional herbicides are applied to control weeds for the remainder of the year.

The ribbon row is a modification of the matted row system that increases the number of plants set per acre. The plant density in the row is doubled, and a double rather than a single row is sometimes planted. The weed control program for the traditional matted row system of strawberry production and the higher density ribbon row system are similar. Both should be separated into two programs, one for newly planted fields and another for established plantings. Use care when spraying everbearing varieties to be sure all preharvest intervals are observed.

The annual system, commonly used in California and Florida, utilizes raised beds, plastic mulch, fumigation, and trickle irrigation. It has attracted attention in the northeast and some growers have switched, but there are drawbacks, especially for the direct marked grower. The flavorful strawberry varieties customers look forward, to do not respond to the more costly annual system with higher yields, and switching to the varieties grown in California and Florida can result in reduced customer satisfaction.

Weed control in strawberries is difficult, but results can be improved by advance planning. Conduct a weed survey and identify the weeds in the field before planting strawberries. Established perennial weeds, including yelow nutsedge, must be controlled BEFORE planting strawberries! Success may require action the year prior to planting or for several years before strawberries are established. Rotate to crops with effective recommended herbicides, and/or the use of nonselective systemic herbicides according to label instructions. Consult your local Cooperative Extension agent for cultural practices, crop rotations, and herbicide recommendations.

Perennial weeds can be controlled without herbicides but success requires diligence and an understanding of the reproductive cycle of the weed. Most perennial weeds reproduce vegetatively as well as by seed. Weeds that have vegetative reproductive structures such as nutrients, bulbs, rhizome, or tubers must be controlled during the period of the year when these structures are produced. In addition, repeated tillage drags these reproductive structures to the surface and exposes them to drying in midsummer and freezing in winter.

Weeds with extensive spreading root systems can be starved to death. Emerging shoots use food stored in the roots to grow leaves. The shoot uses food from the root for the first 7 to 10 days after emergence and begins to send food back to the root after 10 to 14 days. Till the field within 10 days of emergence of the weed to prevent the food supply in the root from being replaced. Continue to repeat the tillage until no regrowth occurs. Be diligent! The control of established perennial weeds using tillage will require months of regular timely tillage operations.

A single missed tillage can nullify months of effort. Cropping options are limited during the tillage period and the field is exposed to erosion by wind and water during the entire period. The most effective control programs for perennial weeds integrate the cultural and mechanical methods with the use of effective herbicide programs.

Utilize stale seedbeds when possible by preparing the field early for planting. Allow weeds to sprout, then till shallowly to control the seedlings and stimulate dormant weed seeds to germinate. Repeat as many times as possible to reduce the weed seed supply in the soil.

New plantings should be tilled immediately before transplanting and a preemergence residual such as Dacthal 6FL or Devrinol 50DF should be applied posttransplant to control annual grasses and certain annual broadleaf weeds. Use 1 to 2 gallons of Dacthal 6FL or 2 to 4 pounds of Devrinol 50DF per acre. Use lower rates on coarse textured soil low in organic matter and higher rates on fine textured soil and soil that is higher in organic matter. Irrigate if rainfall does not occur before weeds emerge to make the herbicide available to the emerging seedlings.

Sinbar 80DF can be applied at 2 dry ounces of product per acre after transplanting but before runners root to control many annual broadleaf weeds. Do NOT add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar 80DF label. If strawberry transplants are allowed to develop new foliage prior to applicaton, the spray must be followed immediately by 0.5 to 1.0 inches of irrigation or rainfall to wash the Sinbar 80 DF off the strawberry foliage, or unacceptable crop injury may result. University data has shown that more consistent weed control and less crop injury occurs when 0.05 lb/A, 1 dry ounce of Sinbar 80 DF is applied at 3 week intervals. Begin applications 3 to 6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height. Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

Apply 12 to 16 fluid ounces per acre SelectMax with nonionic surfactantto be 0.25% of the spray solution (1 quart per 100 gallons of sprat solution), or 1 to 2 pints per acre Poast postemergence with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) to control many annual and certain perennial grasses. Two applications may be needed to control certain perennial grasses. Follow label instructions. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 5 to 7 days of any other pesticide unless labeled as the risk of crop injury may be increased or reduced control of grasses may result.

Cultivate frequently and hoe as needed until runners appear. Widen the uncultivated strip in the row as runners grow. Set cultivators to throw soil into the row to anchor the runners and encourage rooting of the daughter plants. The optimum plant population for maximum strawberry yield and berry size is 4 to 5 plants per square foot in the matted row. Consider applying a supplemental preemergence herbicide in midsummer after the desired number of daughter plants have rooted. Use postemergence herbicides recommended for newly planted strawberries when susceptible weeds are observed. Hand pull weeds in the row that cannot be controlled with herbicides.

The weed control program options for established strawberries are limited to chemical weed control and hand weeding by the growth habit of the crop and cultural practices. Herbicides can be applied to established strawberries at three periods of the year; late fall, early spring, and in the summer during renovation.

Late fall herbicide treatments are applied to control emerged seedling winter annual weeds, and for pre,emergence control of annual weeds that germinate in early spring. Always apply 4 to 8 pounds of Devrinol 50DF per acre to prior to mulching to control annual grasses, certain annual broadleaf weeds, and volenteer small grain from the mulch, or be prepared to use a postemergence herbicide to control the volunteer grain in early spring. Devrinol can be tank-mixed with 3 to 4 dry ounces of Sinbar 80DF per acre to control additional annual broadleaf weeds in late fall and through harvest the following spring. Use lower rates on coarse textured sandy soils low in organic matter, and higher rates on fine textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive. Do NOT apply within 110 days of harvest. Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label. In addition, Chateau 51WDG can be applied at 3 dry ounces of product per acre to control wild pansy, also known as Johnny-Jump-Up, and other annual broadleaf weeds, provided the field was planted the previous spring. Fields that were renovated after harvest and will be harvested a second year cannot be treated with Chateau if Chateau was applied earlier the same year. Do not use more than 3 dry ounces of Chateau per acre per in one calander year.

Early spring herbicide treatments should be applied immediately after mulch is pulled off the row, and before the crop breaks winter dormancy. Apply Chateau 51WDG at the rate of 3 dry ounces per acre plus 1 to 1.5 quarts of a labeled 2,4-D amine product to control broadleaf weeds. Do not apply 2,4-D unless possible injury to the crop is acceptable. Do not apply 2,4-D between mid-August and winter dormancy, as it may reduce flower bud formation. In addition, Deverinol can also be applied if none was applied in late fall. If grass weeds appear, apply 6 to 8 fluid ounces per acre Select 2EC or 1 to 2 pints per acre Poast postemergence with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution). Follow label instructions. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased or reduced control of grasses may result. Observe all PreHarvest Intervals listed on the labels.

Renovation is the annual 'rejuvenation' of the planting. It is accomplished by the elimination of old diseased leaves and weak old plants and applying fertilizer and herbicides after harvest. The procedures for accomplishing these goals may differ, depending on the year, age, condition of the crop, and weeds in the field. Stimulate new growth after harvest by removing old foliage with a sharp rotary mower. Use care to avoid hitting crowns with the mower blades. Apply 1 to 1.5 quarts of a labeled 2,4-D amine product seven days before removing old leaf growth if most of the broadleaf weeds are taller than the crop, and apply 4 to 8 dry ounces of Sinbar apply immediately after mowing. The 2,4-D and the Sinbar can be tank-mixed and applied immediately after mowing if most broadleaf weeds are below the crop canopy. Irrigate within 2 days if rainfall does not occur after application to make the preemergence herbicide available to the emerging weed seedlings, but delay irrigation for 12 hours to allow time for herbicide penetration into the leaves or weed control may be reduced. Use care not to exceed the total recommended rate of any herbicide for an acre in one year.

A **Special Local-Needs Label 24(c)** has been approved for the use of **Stinger 3A** to control weeds in strawberries in New Jersey, New York, and certain other states. The use of this product is legal ONLY if a waiver of Liability has been signed by the grower, and returned to Dow AgroSciences. Apply 2 to 10.6 fluid ounces of Stinger 3A per acre in one or two applications during the spring to control certain annual and perennial broadleaf weeds. Observe a minimum preharvest interval (PHI) of 30 days. When two applications are used to control succeptible hard-to-kill perennial weeds, spray the first application in the spring at least 30 days before harvest and second application at renovation, after harvest. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds, but do not apply more than 5.3 fluid ounces in the spring before harvest or exceed 10.6 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. Do NOT tank-mix Stinger with other herbicides registered for use in strawberries. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions to avoid herbicide carryover.

Strawberry plants and weeds between the rows can be controlled chemically or mechanically. Heavy mulch between the rows conserves moisture, suppresses annual weeds, and keeps the fruit clean, but may interfere with cultivation equipment. A rolling coulter, a rotovator, or a directed shielded spray of Gramoxone Extra 2.5SC can be used to control unwanted vegetation between the beds. Rotate the nozzle up, to ninety degrees, to control the spray band width. Strawberry foliage, crowns, and weeds contacted by spray will be killed. Use shields and low pressure to avoid drift injury to adjacent plants. Weeds between the rows of plantings managed using the ribbon row system can be eliminated using the same techniques. WARNING: This weed control practice will kill strawberry crowns that are sprayed and thin the stand.

How Will New Food Safety Rules Impact Your PYO and Pre-Picked Markets?

Elizabeth A. Bihn, Ph.D., National GAPs Program, Cornell University
630 W. North Street, Geneva, NY, 14456; eab38@cornell.edu; 315.787.2625

Spoiler Alert! The answer to the question that is the title of this talk is…It depends! If that is all you needed to know feel free to attend a different session, but if you are interested in produce safety, the impact upcoming regulation might have, and how you can manage food safety practices on your farm to stay competitive, then this is the session for you. Below is a summary of some of the things that have impacted produce safety and the implementation of food safety practices on farms. Some farmers feel that food safety practices are not necessary on their farms or feel they will not be impacted by regulation because their operations are too small. This session will address these notions and lots of other produce safety issues.

In 1998, the Food and Drug Administration (FDA) published the *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables* that outlined Good Agricultural Practices (GAPs) and their importance to fresh produce safety. Over the past thirteen years, fresh produce growers have been motivated to adopt formal food safety practices such as GAPs mostly because wholesale buyers have demanded it. Consumers who buy directly from farms have been less demanding about understanding and verifying the farms food safety practices, so farms that direct market have been less likely to embrace a formal food safety program. This does not mean that small farms are less safe, since the only way to determine this is to understand food safety risks and evaluate farm practices with these risks in mind. It does mean that many small farm owners have not taken the time to review their farm practices to determine the impact they have on safety. This is a concern because farms could be using practices that are risky with no intention to understand or address the food safety risks. As food producers, all farmers should have a basic understanding of food safety and be willing to assess their practices to assure they are doing what they can to produce safe food.

On January 4, 2011, the Food Safety Modernization Act (FSMA) was signed into law by President Obama. The US FDA is scheduled to release a draft produce safety regulation early in 2012. Prior to this regulation, fresh produce has not been regulated for safety. Guidance from the FDA, such as the *Guide* mentioned above, has been voluntary. Looming federal regulation as well as changes within the produce industry has resulted in many growers reviewing their need to be engaged in produce safety. A subject of much discussion for small farm owners is the Tester Amendment included in the FSMA. Understanding how the Tester Amendment may impact farms is important for all fresh produce farm owners. Whether it is produce safety regulations or produce-associate foodborne illnesses, fresh produce growers should understand the implications and how they affect their operations.

The newly formed Produce Safety Alliance (PSA) is funded by the FDA and the United States Department of Agriculture to provide fundamental, science-based, on-farm food safety knowledge to fresh fruit and vegetable farmers with an emphasis on small scale operations. The PSA is developing a nation-wide food safety curriculum to help produce growers understand and implement food safety practices such as GAPs as well as prepare for the upcoming FDA regulation. Those interested in produce safety can join the working committees or simply sign up for the general listserv to stay informed of PSA activities at www.producesafetyalliance.cornell.edu. Participation in the PSA is one way for farmers to stay informed and prepared for the new regulation.

Pick Your Own (PYO) and pre-picked markets often straddle the line between direct and wholesale markets resulting in different pressure and requirement to adopt food safety practices. PYO operations usually function as direct markets. Customers come to the farm, pick the product, pay the farmer, and go home. Pre-picked markets also can be direct to consumer, with the farmer harvesting the commodities and selling them directly to the customer, but this is not always the case. Some pre-picked markets do sell to local retailers such as grocery stores interested in providing "locally grown" products. Some farms provide both PYO and Pre-Picked options, so they may serve both direct and wholesale markets. This may impact their need/desire to implement food safety practices and may even complicate the process. This workshop will discuss regulatory issues, changes in industry expectations, and how PYO and Pre-Picked Markets can address their produce safety needs. Knowledge is power and understanding the changing landscape of produce safety will help growers successfully navigate and implement practices that make sense for them and their markets.

Day Neutral Strawberries: Making it Work

David Pike
115 Mt. View Rd.
Farmington, Maine 04938
(207)778-2187
dcpike@beeline-online.net

With the recent release of new day neutral cultivars, we have the potential of providing fresh strawberries for 4 to 6 months instead of 1 month for short day-length varieties. Although day neutrals have been considered best for cooler climates, success is being observed from the Carolinas into Canada. The best production systems are still a work in progress. Following is a brief synopsis of the several systems that have succeeded on this farm.

Year #1: Varieties that do well for this area are: SEASCAPE, ALBION and SAN ANDREAS. Other varieties are PORTOLLA, which is light colored and lacks the flavor of the above varieties, and MONTEREY, which hasn't been tried on this farm as yet. For best yield, planting should be early May in this area. Plasticulture is preferred over matted row, as it reduces weeds and soil is warmer in the late season. Plant on crowned raised beds with drip tape buried at time of shaping and laying plastic. Bed size is best determined by equipment available. Broadcast dwarf perennial rye grass (living mulch) after plastic is laid and the ends are dressed. Rot till the grass seed for improved germination. Punch marks are made every 13 in. in plastic for plant location. Planting is done by hand with a planting tool, using dormant bare-root transplants. Grass is mowed, as needed, with mulching lawn mower. Edges can be mechanically trimmed or band sprayed with SCYTHE or AVENGER herbicide using a shielded sprayer. Remove early blossoms prior to mid-June to encourage crown development. Remove runners during growing season to allow maximum plant growth and more branch crowns. To reduce heat stress during July and August, the plastic can be sprayed with REFLECTIVE, a coating of calcium carbonate. That should mostly wash off by the end of summer during rain storms, re-exposing the black plastic for improved fall production. Normal harvest season in Maine is from mid-July to late October. Season extension is accomplished by using wire hoops and 1.2 oz. (or heavier) floating row cover(FRC). With FRC placed over the wire hoops, losses will be reduced during heavy rain storms, as the row cover will shed rain considerably. A low cost low tunnel may offer more protection. This is being tested by several growers and may be the way of the future. At the end of the harvest season remove the hoops and re-cover with FRC after plants go dormant. Now it's time to sit back and "LET IT SNOW-LET IT SNOW"!

Year #2 Since production now becomes more complicated, two different systems are possible.

A Review previous year results and make revisions as needed. Put in a new planting in year #2 and continue through harvest as per year #1 outline.

B The previous year's over-wintered planting will provide an early spring crop. Remove FRC, clip dead plant material and sweep the beds. Reset the wire hoops and replace the 1.2 oz. FRC to promote earlier spring crop. Set up drip system to fertigate and sprinklers for added frost protection. During early bloom, slip FRC to the side to put on protective and foliar sprays. Harvest should start one to two weeks ahead of short day-length strawberries. Now a decision must be made to either treat it as an annual system and destroy the bed or renovate to get a summer and fall crop. If renovating, mow the plants and cut off excess plant debris as soon as the short day-length crop starts to produce. Note: SEASCAPE does not respond as well as ALBION or SAN ANDREAS to renovation. While the short day-length plants are producing, the renovated plants are rejuvenating and will be producing shortly after the short day-length varieties are done. If managed properly, the berry size will be about 60-75% of the new planting's berry size. Leaf analysis is important for detecting nutrient deficiencies in order to maximize size and quality. At the end of the harvest season, pull out the plants or spray to destroy them and clean up the bare bed for a 3rd year of production.

Year #3 Since the year #1 plants were destroyed the previous fall, this bed can now be recycled to obtain another two years of production by placing new plants in between the old plant holes. Using a hand tool, make a slit about 2 inches inward from where the new plant is going to be and insert 15 to 25 gm of slow-release fertilizer or composted chicken manure. Be careful not to puncture the drip tape. Place new plant about 2 inches from fertilizer to prevent burning. It may be necessary to hand weed where the old plant was or spot spray with herbicide. Continue with this planting as outlined in years #1 and #2.

The new bed in year #2 will be harvested early and renovated as outlined in year #2 **B**. The life of a bed is 2 years if renovated and 4 years when it is recycled, providing income from the same bed for up to 4 years.

Summary:

Experimenting with Low Tunnels

Low tunnels are fairly expensive but may be economical because the bed is productive for four years. In the year of planting, the tunnel can be installed after the crop is established and before autumn rains. The tunnel, which is easily set up and taken down, can be used for the life of the bed (4 years). During rain storms the tunnel will be cost effective because of fewer reject soft berries. To reduce heat stress losses the Reflective coating can be applied prior to the tunnel installation. Plastic along the sides is rolled up for harvest and air flow and closed for severe winds, rain and cold temperatures. FRC can be placed over plastic for improved frost protection. A misting system tube can be installed along the ridge pipe of the tunnel frame for foliar and protective sprays. Landscape fabric can be placed between beds for a clean walking pathway.

Plug Plants

Small growers can make their own plug plants by taking off runner tips in early August. Place potting soil in tray and push tip into medium and mist several times a day until rooted. This can be done outdoors or in a protected greenhouse. In early September the plug plants can be planted. Remove blossoms prior to dormancy and later apply FRC for winter protection. This system should provide a great early spring through summer crop.

For the Birds, Or Not? Managing Bird Problems in Strawberries, December 2011

Alan T. Eaton Extension Specialist, Entomology
252 Spaulding Hall, 38 Academic Way, University of New Hampshire Durham, NH 03824
alan.eaton@unh.edu

Birds are intelligent pests (compared to fungi, weeds and insects, anyway), and they learn. Unless you rely on a complete exclusion method (netting, for example) vary the control methods you use, and combine several methods together. Birds quickly get used to scare techniques, so it helps to change them, and add new methods. Bird problems vary considerably from site to site, due to different crops, and differences in other food or resting/nesting cover nearby. It is important to identify which species of birds are giving you problems, because they vary in their behavior and preferences. It is helpful to handle problems before a strong feeding pattern develops on your crop. It is harder to stop a strong feeding pattern than one that is just starting.

Some birds tend to flock during the growing season. That means damage quickly becomes significant, with so many birds eating. Scare methods usually work better on flocking species than non-flocking ones. Here in New England, flocking species that attack small fruit include cedar waxwings, starlings, grackles, blackbirds, turkeys, Canada geese, and (sometimes) crows.

Other pest species tend to occur in resident pairs or small family groups (mom, dad and the kids). Resident pairs invest a lot in finding and defending a home territory from others of their species. They are very hard to scare away. Robin, catbird, mockingbird and orioles are examples of these. In strawberries, cedar waxwing, turkey, robin, blue jay and crow are our most common pest species, but others occur.

A good approach is to identify the birds causing the problem, and come up with a plan that works for those species.

Bird netting is the most effective tool we have to help with bird damage in small fruit. It is more appropriate for perennial crops like blueberries or grapes than strawberries, but there are some effective types for strawberries. Netting is expensive, but it can last for years. Most netting restricts your ability to move equipment through that field. This is something to think about before making a netting purchase. Most types are designed to be supported by a system of support wires. Recent minor modifications in netting design have made MAJOR improvements in the ease of setting up and taking down netting.

One of the new designs (smartnet) features reinforced edges, so that the sections can slide out when needed, and slide back and be bunched up out of the way, when not in use. Our blueberry and cherry growers with these systems just cover the bunched up net with black plastic, and store it in place most of the year. This tremendously reduces the labor for annual setup and removal. The support system of posts and wires stays up all year. Blueberry netting and support system might cost $2200-3600/A. That sounds expensive, but if done correctly, it could last 10 or more years. New England research shows bird losses to highbush blueberries can average 41%, equivalent to $4,000/A or more annually.

In New Hampshire, NRCS offers cost-sharing for bird netting. Other states may have similar programs. If you investigate, you might be able to purchase netting at almost no cost to the farm.

A couple of manufacturers are offering netting that can be laid right over strawberry plants. With care, several workers can pick up the edge (as you would with a large row cover) and pile it out of the way, allowing access for pickers. Then it can be put over the crop again, when picking hours end. Two Connecticut River valley growers report great success with this method this year. It may be especially useful for a relatively small planting that is heavily hit by birds…cedar waxwings for example. One product is smartnet's bird/hail/insect netting, but there are others, too.

Noisemakers: All of our bird species become habituated to noises, so it is important to vary them, and use them in combination with other methods. Flocking species are usually more easily scared off than resident pairs. Juvenile birds (under 1 year old) are usually harder to scare off; they haven't learned to be afraid of the noises yet. Noisemakers include 1) pyrotechnics (screamer, banger shells fired from gun or launcher, firecrackers) 2) banging aluminum pans, 3) automated distress calls, 4) propane cannons, 5) critter getter, and others. There is a very wide variety of choices, and a wide range of prices and features. Before buying a very loud device (propane cannon for example), carefully consider the possible severe annoyance to neighbors. In my state, there have been lawsuits (with media coverage) and vandalism associated with cannons.

Shooting: This option has limitations. Federal, State and local laws can affect your ability to legally shoot birds. Some species are off-limits. Shooting can be very annoying to neighbors, customers, and other people. There are also safety concerns. When it is allowed, the main effect is to deter the survivors from more crop feeding, not reduce bird numbers.

Visual scare devices: As with noisemakers, incorporate variability, and use these in combination with other methods. There are hawk and owl effigies. They can be useful if placed realistically, and moved to different locations regularly. Those that incorporate movement can be more effective than those that do not. Predator silhouettes are sometimes used to scare geese away from lawns or turkeys away from feed silos. Various flashing mirrors or tape, or balloons are available. Often their effective range is short…a few yards. There are raptor-shaped kites that can be suspended from balloons in a realistic manner.
Clearly one of the most effective visual scare methods for crows and ravens is to prominently hang up a dead crow. Here, we usually hang a bird by a wing, so the birds clearly recognize what it is. Of course, shooting a victim for display must be done according to local laws. Customers can be deterred by the sight, or the "farmer Rambo" image.

Taste repellents: There are a limited number of situations where taste repellents can be used. Currently, none are legal for use on strawberries, but that may change. Methyl anthranilate is one choice (artificial grape flavor). A new option is anthraquinone. Its label is gradually being expanded to more crops, and might (?) eventually be registered on fruit.

Habitat modification: Some birds really like to have thick roosting cover next to your crop, or perhaps are attracted first by lots of wild berries. If you can eliminate or reduce them, you can reduce some bird problems. For example, shadbush, cherries, mulberry and red cedars are very attractive to cedar waxwings. Studies in the Northwest have shown that providing hawk/owl perches or nest boxes in places where they are limited, will increase the number of raptors hunting there. I have a publication on my website that gives dimensions and other details for target species here.

Falconry: A live, day-active raptor is very effective at reducing bird problems. Birds know what hawks/falcons look like, and if they are abundant, many birds move elsewhere. In some states, there are enough falconers that you might consider asking one to exercise his/her birds at your farm. Perhaps you can offer fruit in exchange?

Here are some brief descriptions of the top small fruit offenders in New England:
Cedar waxwing is arguably the most serious bird pest of New England berries. It is a flocking species with a thin whistle for a call. The bird is gray, 7" long, (smaller than a robin) with a yellow tipped tail. It strongly prefers berries to eat.
Robin: gray with red-brown breast, 10 inches long. **Crow:** 17", all black, distinctive call. **Raven:** 24" all black, with wedge-shaped tail, croaking call. **Gray catbird:** 8.5" long, all gray. Sometimes the brown vent patch is visible. **Mockingbird:** 10", all gray, but with white patches in wings that show when it flies. **Turkey:** 36" or longer. Black with white & brown markings. **Blue jay**: 11", blue, black and white.

More Information:

Much more information than I can cover here is in my recent 20 page publication "Bird Damage Prevention for Northern New England Fruit Growers". If you don't get a copy at the New England Vegetable and Berry Conference, you can download a copy at http://extension.unh.edu/Agric/AGPMP/PMPIPM.htm It includes a long list of suppliers.
Also at UNH Cooperative Extension's website is my shorter publication "Raptors in New Hampshire Orchards. It covers nest boxes to lure certain predator species.
http://extension.unh.edu/Agric/AGPMP/Pubs/Apft5902.pdf
In New Hampshire, NRCS currently has a cost-sharing program on bird netting. Contact your county NRCS office for details. I do not know if the other New England states currently have similar programs. Books on identifying birds are widely available to help you.
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Tunnel Innovation at Kilpatrick Family Farm

Michael Kilpatrick
518-300-4060
Michael@kilpatrickfamilyfarm.com

Kilpatrick Family Farm was started in 2003 and that fall we put up our first hoophouse. As we have grown we have used a multitude of different tunnels for our production. Over the years we have refined, made mistakes, and figured out ways to improve designs, production and efficiencies.

We use 5 different tunnels on the farm. High tunnels, Haygroves, prop house, hoophouses, and mini tunnels. We have specific crops which we prefer in different houses/styles.

High tunnels are a key aspect of our year-round greens production and our high tunnel tomatoes. We do a range of winter greens planted mid-October on and then rip out all greens April 1st for our summer tomatoes. We inter-plant greens with our tomatoes 2 rows either side of the tomato row with 10" between rows and 8" in row. We understand the risk that interplanting entails but find that through careful management and biological controls the risks can be abated. We are using grafted stock for our tomatoes, using the Pellikaan clip system and very happy with it. For air heat, we are using a 100% efficient propane Greengro heater from LB White. Our in-ground heat is powered by a takagi flash hot water heater which we really like. We prefer a 18" to 2' kneewall around our greenhouses to keep cold air from dumping directly onto crops. At least a 6' sidewall is important for winter greens production and allows your walking path to be on the edge of the houses, in the coldest area. One of the big questions is what kind of tillage equipment you are going to be using in your greenhouses and make your doors and ends to suite that.

We love and hate our haygrove. A great 3 season growing space which has it's quirks and tricks. One thing is the plastic, it needs to come off if winds gust over 50 MPH and for any snow over a couple of inches which involves at least biannual removal and re-skinning of the house. Plan on using at least 6-8 people to help skin, 4-5 hours and under 2 MPH wind. it helps to have a bucket/forks tractor at each end to quickly attach the plastic. Although the haygrove is able to be put up on uneven soil we found that with normal vegetable soil disturbance it's best to be mostly level side to side to prevent "losing" the soil out one side of the house. Although it has its downsides, it is a very inexpensive spring/summer/ fall space and we grow a lot of product in it. We love the plastic clip system that haygrove supplies and have adapted it to many diffferent buildings on the farm- (see online resource page).

Our hoophouses are used mainly on our farm now for summer cherry tomatoes, peppers, eggplant and ginger. We do two styles, both movable and semi-permanent- Summer Caterpillar style (8 ft bow spacing) and winter buried plastic style (4-5 ft bow spacing). Our bows are 15 bows from rimol which allows us to have 2 beds of tomatoes or 3 beds of other crops inside. The biggest solution to keeping the plastic on is to keep the ropes very tight and tamp down the soil. We don't run a rope down the spine of the caterpillar but do run one from the end bow to the ground to keep them in position. One of the things that can be done with these hoophouses is setting up a permanent grid of groundposts and anchor points and moving bows and plastic around during the year. (see resource page mentioned at bottom)

We have busted at the seams of our 17X48 transplant house for years now and just haven't gotten around to upgrading. One of the key elements of our house is our heated benches- they are a Delta-T hot water system which we placed over 1" foam insulation to channel the heat up and under ground cloth to keep everything tidy and allow us to slide trays around on the benches. We cover the benches with rowcover during the winter and spring to keep the heat in and prevent us from having to heat the air in the houses. This system has saved us almost 2/3rds on our propane bill. One feature we did put in is a misting system for propagating strawberry tips and allowing us to germinate mid summer greens easier. We have a backup modine heater for emergencies.

We use our mini-tunnels mainly for overwintering greens, onions, and anything else we can dream up. We bought the bender from Johnny's and cover 5' raised(very important) beds made with our buckeye bedformer- we get 10 ft wide plastic, drape it over the hoops and weight it down with LOTS of sandbags. We found that 150' length seems to work best for us.

One thing we have done that has helped us keep weeds down on the edges of our houses is to put 2 ft groundcloth down when we put houses up. We center this on the row of ground posts-one ft on each side and then can mow right up next to the house on the outside and till right up next to it on the inside.

Covered production has been a key to our growth here in the often unpredictable northeast climate. It has its rewards and also its challenges. Please follow the below URL or scan the QR code to access the custom resource page which has much more information including pictures, sketches, dates of planting and harvesting, storage, the presentation slides and other relevant resources.

www.kilpatrickfamilyfarm.com/NEVF

Moveable tunnels: a reality check

Ed Person, Ledgewood Farm 132 Old Mountain Rd, Moultonborough, NH 03254
ed@ledgewoodfarm.com, tel-603-476-8829

The recent interest in moveable tunnels is very easy to understand. A farmer is always trying to cover more crop area with a minimal amount of tunnel square footage. In some cases it makes sense, in other cases I feel that you won't see the benefit of the increased risk.

The situation where a moveable tunnel works best is when you have two crops whose production cycles don't overlap. I can see spring greens, peas, carrots, beets, etc. and then fall raspberries. Neither crop needs to be covered during the time the other crop is vulnerable. In many cases both crops need to be protected at the same time to optimize growth and production. For example, summer tomatoes that will produce until late October and winter greens that need to be covered in September to maximize production. You will have to decide which crop loses.

Rolling poly to the ridge pole. If your main reason for a moveable tunnel is to move the tunnel to expose the soil to the weather, maybe you should consider removing or rolling the poly to the ridge pole for that period of time instead. It is a fairly easy process and only takes an hour or so to complete.

I attach the poly to the ridge pole with short sections of 2"x4" lumber bolted to the ridge. The poly is outside of the lumber and then a piece of 1"x3" board is screwed to the 2"x4" to sandwich the poly between the boards. This keeps the poly from shifting out of position when you roll it up. The next step is to remove your cleats from the hip board and using the roll up pipe roll the sides all the way to the peak. They will be anchored in position with rope tied around the bundles and the ridge. The two handles are tied or wired together so they can't rotate.

Risks with moveable tunnels. The reason that tunnels survive year after year is the ground posts that anchor the tunnel to the ground and provide stability against snow and wind load.

If you remove the ground posts and replace them with a rail or skid you don't have any stability for outward rotation or lift. Lift can be addressed with earth anchors or weights on the skids. You will want to check to see what lifting loads your size frame will experience in various wind conditions. This information is available from a greenhouse engineer. You can reduce lifting forces by making sure the tunnel is completely closed during high wind events including doors and roll up sides. Now the only lift is from suction along the outside of the poly.

Wind and snow loads that push down on the roof of a tunnel transfer that load as an outward force rotating at the curve. The outward force extends down the leg of the bow and if the bow is attached to a track, rail, or skid the leg of the bow will bend outward and allow the roof to cave in to the ground.(classic greenhouse failure even with posts) The only way for a tunnel to survive from wind and snow loads that push down on the roof are with ground posts attached to the tunnel. After the tunnel is moved into position you must drive posts into the ground and bolt or clamp them to the vertical leg of the bows. Depending on the width of the tunnel, you should have a post every other or every third bow. The post will be driven into the ground to a normal post depth of two to three feet. The post should extend above the ground two to three feet and be bolted to the vertical bow with bolts or strong clamps. This will simulate a ground post attachment while still allowing reasonably easy dismantling to move the tunnel.

Bramble Basics: Site, Soil, Planting Systems

David T. Handley, Vegetable and Small Fruits Specialist
University of Maine Cooperative Extension
Highmoor Farm, P.O. Box 179, Monmouth, Maine 04259
david.handley@maine.edu

Choosing a site

Site selection is critical to successful raspberry production. The wrong choice will generate chronic problems which, at the very least, will tax management skills and reduce profits, and may result in a failure of the planting.

A good raspberry site should have an excellent soil. It must be well drained. A site that holds too much water will reduce the vigor of the plants and greatly increase the probability of *Phytophthora* root rot infection. Avoid soils heavy with clay. A sandy loam with acceptable levels of organic matter (2% or higher) will provide the greatest chance of success. The site should receive full sunlight and have good air circulation. This will encourage a dry microclimate within the planting to reduce the incidence of fungal diseases.

Preparing the soil

Have the soil tested to determine what amounts of nutrients need to be added to encourage optimum growth of raspberries. Applications of lime, to adjust the soil pH to 5.8 to 6.5, and fertilizers should be made according to soil test recommendations. Prior to planting, organic matter levels can be increased by incorporating compost, animal manures and/or plowing down cover crops. The use of cover crops prior to planting can also be an effective technique to reduce weeds and improve the nutrient status of the soil. Cover cropping should be carried out for at least two years to effectively reduce weed populations and improve soil conditions.

Raised beds can also be used to improve soil drainage. Beds can be 4 to 10 inches high, depending on the equipment available, and should be 18 to 36 inches wide. Trickle irrigation will be necessary on raised beds to prevent drought, and the chances of winter injury to the plants may be increased.

Planting Raspberries

Raspberry plants are often started from dormant one-year-old canes, however, plants are now also available as tissue-cultured, virus-free plantlets from several nurseries. Although the cost of plants propagated this way is somewhat higher (50-100%) than conventionally propagated plants, the exceptional vigor and uniformity of these plants, in addition to virus indexing, may make them a worthwhile investment for the commercial grower.

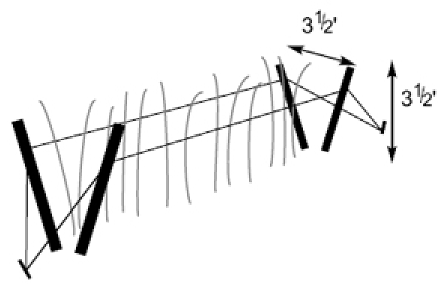
Raspberries are best planted in the early spring, usually from mid-April to early May. Fall plantings are possible, but usually experience higher plant mortality, prolonging the time necessary for the planting to reach its full production potential.

Plants should initially be spaced two to three feet apart within rows, with a minimum of ten feet between rows. Spacing rows too close together is a common mistake. There must be adequate room between the rows to allow equipment through once the planting has reached its full size. Wide row spacing will also encourage air circulation, which will reduce disease problems.

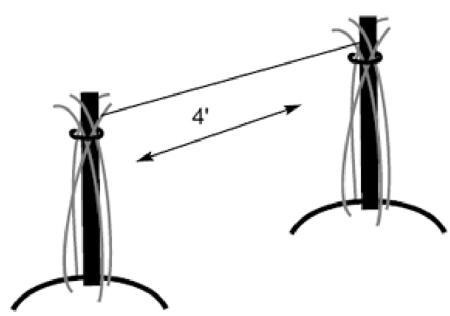
Irrigation and Mulch

Trickle irrigation should be put in place immediately after planting. A well-designed trickle irrigation system will greatly speed the establishment of the planting and encourage consistently good growth and yields. If tissue-cultured plants are used, they should be mulched immediately after planting with a three-inch layer of straw. This will help to conserve soil moisture and reduce the germination of weed seeds in the soil, both critical to a quick establishment of the raspberry plants. The straw should be removed early the next spring to prevent root rot. A more permanent mulch, such as wood chips or shavings can be applied at that time to provide long-term benefits. As the plant rows become established, they should not be allowed to become wider than one and a half feet. Wide rows will not allow adequate light penetration for healthy fruit buds to form in the row centers, and will increase disease problems due to poor air circulation.

Trellis



Summer-bearing raspberries should be trellised. Current research indicates that a "V" type trellis optimizes yields and fruit quality and is relatively simple to manage. The idea is to train the fruiting canes out from the center of the row at approximately a 30-degree angle. This is accomplished by tying fruiting canes to wires supported by posts set in the ground at the appropriate angle. Two strands of wire are run along the posts, one approximately one foot above the ground and the second at three to four feet above the ground, depending on the expected height of the canes. Spreading the fruiting canes out in this manner encourages new cane growth to come up from the center of the row, rather than the edges. Posts should be set approximately every 30 feet in the row and anchored at each end to prevent frost heaving. Spraying, harvesting and pruning are simplified with trellising because the fruiting canes are limited to the outside of the row. Increased light penetration and air circulation within the row as a result of the V trellis may also reduce the incidence of diseases such as gray mold and spur blight.



Purple and black raspberries and blackberries only produce suckers from the base of the crown and will not fill out a hedgerow as red raspberries do. For this reason, they are frequently grown in the hill system. Under the hill system plants are initially set 4-5' apart within rows. A sturdy post is set next to each plant. A wire can be run along all the posts in the row, about 4½ feet above the ground. The fruiting branches of each plant should be spread along the wire, or the canes of each plant can simply be tied to the post next to them.

Consider putting part of your planting into everbearing (primocane fruiting) varieties. These will bear a crop on first year canes in the fall. The canes can then simply be mowed down late in the winter, eliminating the need for selective pruning and a permanent trellis. A temporary trellis made of re-rod or pvc pipe is often used to support the canes when the fruit is set to ease harvest, and is easily removed for mowing. Bear in mind that annual mowing eliminates the summer crop from two-year-old canes.

Bramble Variety Review – Management Considerations

Nate Nourse
Nourse Farms
41 River Road, South Deerfield, MA 01373
413-665-2658
nnourse@noursefarms.com

Before making the decision to purchase a variety, I often ask growers what their goals are. Do you want something for wholesale, retail, or pick your own? Do you want summer production, fall production, or both? Will you produce berries with or with out protected structures and/or trellis? Where are they located, in the cold of zone 3 or the heat of zone 7? These questions will allow me to suggest a variety to fit their situation and should be considered in the selection process.

As a new premise to the selection process, there are several primocane varieties that offer very good summer production with the normal fall season production. These varieties are true everbearers and are the first I recommend for high tunnel production. There are also some varieties sold as summer bearers that produce a late fall harvest. The variety Prelude is a great example.

Trellis systems can boost production by 20-30% and the swing arm trellis can help blackberries grow in more northern climates. Research has shown that planting blackberries in a real greenhouse will help facilitate survival through the winters in zones 3, 4 and 5. High tunnels with trellis can double production potentials for all varieties.

Consequently, just choosing a variety because it tastes good will not always deliver successful results. It is very important to know your soil, starting with a soil test. As with all raspberries, planting in a rich well drained soil with drip irrigation will yield the best results. Too many raspberry growers still plant on flat beds, raised beds are always superior for any variety.

Trellising is not an expense, it is an investment. On average, a good trellis and pruning effort will yield 50% more berries. Like most things in life a little extra effort will yield more successful harvests.

Nourse Farms will offer over 20 varieties of Raspberries for 2012 including Red, Gold, Black, and Purple. We will also offer 8 varieties of blackberries. In the time allotted today, we will explore about half of the selections offered, starting with our top ten sellers

Before beginning I want to be sure everyone understands the following terminology.

Primocane - a perennial raspberry that bears fruit on first year canes. Also known as everbearing, they can produce berries the following summer on canes that survived the winter. While berries are produced, not every variety will yield fresh market quality.

Floricane – a perennial raspberry that bears fruit the second year of cane growth that survives the winter. I will discuss ways to help plants survive the winter in my pruning presentation tomorrow.

Commercial Everbearer – a primocane variety that produces two marketable crops per year.

Prelude is a late producing primocane variety that we treat as a floricane. Many growers have been surprised by its abundant fall harvest especially during a late fall. Some would consider it a commercial everbearer. We top this variety at or below the lowest fruited spur before winter. This variety is a top seller because it is the earliest producing floricane, starting by June 25th for us. I recommend this variety to be planted as 20-30% of a summer raspberry planting.

It finishes before Encore begins. The berry can be soft, especially during high temperatures and if it is not picked every other day. Prelude performs in many climates, it is subject to winter damage in zone 4.

Nova is also a very late primocane that we treat as a floricane. This is the most widely adapted raspberry variety we sell. The start of harvest usually coincides with the first sweet corn harvest (hint to vegetable growers) during the first week of July. Berry production is very good with firm fruit. While I personally prefer Lauren, I plant this variety because I can almost guarantee a harvest every year.

Encore is a late season floricane with great winter hardiness. In the Mid West, growers have struggled with this variety on heavy soils. The fruit is very large, firm and has great flavor. Encore continues to be one of my best producers and is highly recommended.

Octavia is our latest variety that bridges the gap from summer to fall production. This variety has a large berry with good flavor. The final harvest was in the second week of August. While some growers have been discouraged with its winter hardiness, many growers were satisfied. This variety may not be as flavorful as Taylor, but it will out produce it.

Jewel black raspberry leads the pack of black raspberries. Pruning and trellising has helped us achieve yields almost as good as red varieties. We have also seen our biggest berries on shorter laterals. This is a variety that needs to be replaced by the 8th season that means planting replacements the 6th or 7th season. The season is short for this variety, season extension with Bristol and Mac Black is recommended.

Triple Crown is considered the best tasting blackberry variety. Unfortunately, it doesn't like our New England winter low temperatures. Regular harvests occur in zone 6 or higher. I recommend this variety be planted on a swing arm trellis or a small greenhouse. This variety ripens ten days to two weeks before Chester.

Natchez blackberry has indicated similar winter hardiness to Triple Crown and picks 1-2 weeks earlier. This thornless variety is the earliest, biggest berry and has great flavor. A great choice for a swing arm trellis or greenhouse planting. This one will wow all of your customers.

Chester blackberry is the most winter hardy thornless variety. It is very productive and will produce to Labor Day and slightly beyond. The best flavor occurs when fully ripe which is slightly beyond what I would consider wholesale quality.

Anne is the only golden variety we offer, but is capable of fruiting as a Commercial Everbearer. Summer and fall harvests of the largest best tasting golden raspberries will occur with a little extra effort. They are susceptible to botrytis and need regular fungicide applications. On hot days, we try to pick the berries in the morning.

Heritage is a great old variety, but it is the last variety I would recommend for New England growers. Since we switched, our sales increased 20% because other primocane varieties begin ripening 3-4 weeks earlier.

Polana is the earliest primocane we offer. Many growers have struggled to get it to grow taller than 3 or 4 feet. I still recommend that growers apply a double shot of nitrogen through June. We have seen our best results with the combination of fertigation and dry fertilizer with slow release nitrogen. A grower in Washington showed us plants that were over 6 feet tall. The bigger the plant grows, the larger the berry size and yield. I like to prune the rows back in the fall after picking most of the berries off the edges of the rows.

Autumn Britten is one of the most disease resistant raspberry plants. It has always been a favorite for flavor and firmness, its yield is much less than most new primocanes. Many growers consider this variety a Commercial Everbearer. It doesn't like heavier soils.

Caroline picks a week earlier than Heritage and is twice the size. It has great flavor and yield. To reach its full yield potential, it should be planted in zone 6 or higher. If exposed to high summer temperatures and it is not drip irrigated the first few pickings will give crumbly berries. Floricane harvest also tends to be crumbly. While I recommend all raspberries be trellised, this one must be trellised.
Joan J has very yield potentials, but it must be trellised and thinned. The top trellis wire should be at least 50-60 inches high. Our new trellis had the highest yield, the highest of the 4 wires was 72 inches. I would also suggest trying a double T trellis. Joan J's berries are large and flavorful with a very smooth texture. They will get very dark if not picked every other day, this would be of concern for those selling to super markets. As a commercial everbearer it has a lot of potential, I'm not sure it will always overwinter in zone 5 or lower. This variety is a great choice for tunnel production. It is susceptible to late rust.
Polka is one of our newest primocane varieties with great potential. Berries are large and firm with good flavor. It is one I recommend to replace Autumn Britten. In many growing areas, it is a favorite to grow in tunnels. I believe it has the potential to be a Commercial Everbearer. The planting will get too thick and must be thinned to maintain berry size.
Prime Ark® 45 is quickly being recognized to be a high performing primocane blackberry. It is not thorn less, but the spines are modest compared to other thorny varieties. As Prime Ark® 45 ripens later in the season than either Prime Jim or Prime Jan. it is not adapted to as northerly areas, but a excellent candidate for tunnel production. We have publicized the proper tipping procedure for both Jim and Jan. Prime Ark® 45 also needs to be tipped, but the timing and the procedure is different to achieve the best performance. The very large sized berries and great blackberry taste mark Prime Ark® 45 to be a great performer.

Integrated Insect Management I (Brambles), December 2011

Alan T. Eaton Extension Specialist, Entomology
252 Spaulding Hall, 38 Academic Way, University of New Hampshire Durham, NH 03824
alan.eaton@unh.edu

Late this summer, **spotted wing drosophila** (SWD) invaded New England, and drastically changed the insect pest picture for bramble growers. I'll cover SWD, tarnished plant bug (TPB), clipper and mites. I believe Doug Pfeiffer will be covering crown borer, cane borers, and thrips in his session this afternoon.

Brambles seem to be the fruit most heavily attacked by SWD, but strawberries, blueberries, grapes and cherries are also significantly threatened. This insect will survive our New England winters. We hope that the threat will be lower early in the season, and expect it to be a major pest of late season brambles. Monitoring will be important: growers will have to put traps in the fields they wish to protect. The traps are not to control the flies! Trapping should begin before the first fruit ripen, and continue through harvest. Unlike all our other drosophilids, this insect is equipped with a saw-edged egg layer. It lays eggs in ripe and ripening fruit, hastening their decomposition. Once the eggs are inside, we can't stop them with insecticides. I suggest checking traps twice a week, and applying an insecticide if low numbers are detected. Insecticides should knock down the adults, but effects will be short-lasting, thus will need repeating, as trapping results suggest. The insect develops from egg to adult in less than 2 weeks, so there are **many** generations each year. New England fruit entomologists are collaborating to help answer more of our SWD questions before the next harvest. We have many questions about thresholds and insecticide use. Spraying for SWD involves a challenge: we have to do it when fruit are ripe. That limits our choices, and limits efficacy. The perfect insecticide would be long lasting, effective, and safe for people to eat the sprayed fruit! Some treatments have long days-to-harvest intervals, so picking can be interrupted. I'm not going to list pesticides here, because we will have a much better picture in a few months.

Adult males are easy to identify. The black spot on each wing is unique, and can be seen with a hand lens. Females require a microscope to identify. The saw-toothed ovipositor (egg-layer) is unique. None of our 39 other species of drosophilids have these characters. Destroying/preventing over-ripe fruit should really help, but this is impractical in brambles and strawberries. Lightly infested fruit probably can be eaten with no ill effects, but shelf life is shortened. Heavily infested fruit (Sept 6, 2011) turned to "soup" in less than 2 days at room temperature, and was filled with hundreds of tiny maggots. What would your customers say? **If you grow raspberries in New England, you will need to monitor for this insect.** If you grow fall raspberries, give up now if you will not be equipped to monitor and spray. Monitoring will probably have to be fairly frequent, more than once per week. When conditions are ideal, the insect can go from egg to adult stage in eight days. Females can lay up to 200 eggs. Do the math.

Tarnished plant bug attacks a huge number of plants, and prefers flower buds, flowers, and young fruit. It overwinters as an adult, and we have two generations of them in New England. The severity of attack varies greatly with location. If there are many weeds in and around the planting, or lots of early succession vegetation nearby (especially alfalfa or fallow fields with weeds), expect heavy pressure. If your plants are surrounded by woods, you can get very little

TPB pressure. If you have alfalfa nearby, avoid mowing it when brambles are in bloom, or have young green fruit present. That drives them into your crop, just when it is most vulnerable. Check for TPB nymphs by shaking flower trusses (clusters of flower buds) onto a flat white surface, and counting the yellow-green nymphs that are dislodged. Sample 30 clusters across the field. If four or more clusters are infested, we recommend an insecticide treatment. Scout shortly before bloom, when there are flower buds present. If possible, avoid spraying insecticide during bloom. If you must spray during bloom, treat in the evening, to reduce the bee mortality. Pesticide choices keep changing, so see the current New England Small Fruit Pest Management Guide for details. In areas of high pressure, you may need to scout again, after bloom begins.

"Clipper" or **Strawberry bud weevil** also attacks brambles. It has just one generation per year, and adults appear in May or June. The females attack the flower buds, just before the flowers open. After laying an egg in the bud, the female chews at the pedicel, causing the bud to dangle or drop. The tiny grub grows inside that clipped bud, and emerges during the summer. There's only one generation per year, so late summer or fall fruit escapes attack, because they are so late. In new plantings, damage is always worst at the edges, since the insects are invading from the outside. In older beds, the edge effect is less pronounced. Sometimes damage can be severe.

Monitor for clipper when the flower buds appear. We have no established threshold for clipper on brambles. In my state, few plantings show moderate damage. Most show either very little, or lots of clipper damage. Blackberries are sometimes very heavily hit; the weevil has a very short walk from one bud to the next. The New England Small Fruit Management Guide lists insecticide choices. Destroying nearby unmanaged brambles and strawberries may reduce the clipper pressure on your fruit.

I don't see **two-spotted spider mite** (TSSM) problems that often in New Hampshire raspberries. We did have a very serious problem on one farm where the rate of nitrogen fertilizer use was sky-high. Nothing helped until the fertilizer rate was cut down. At two other raspberry plantings with TSSM problems, pesticides had been used which were very rough on predator mites. These included Benlate and Brigade, but there may be others that can do this. I tell growers to concentrate on handling the causes of TSSM problems, rather than just spray for them. TSSM is most common on the undersides of foliage, and most of us need a hand lens to see them. Where populations are high, foliage may be stippled, brownish, or covered with fine webbing. Damage often appears first in drier parts of the field. I expect that the warmer, drier parts of New England are at greater risk from TSSM than the cooler areas.

References:

I think every commercial small fruit grower in New England should have a copy of the latest version of the New England Small Fruit Pest Management Guide. It is full of useful information.

As I write this, we are relying a lot on other regions (with SWD experience) for information on SWD. Here are three sources I found helpful: Mich State U: http://www.ipm.msu.edu/SWD.htm Oregon State Univ: http://swd.hort.oregonstate.edu/ Washington State University : http://ipm.wsu.edu/small/pdf/SWD_Bulletin_Eastern_WA_v1_04.pdf More New England information will be developed soon.

How Raspberries Fit into the Mix at Edgewater Farm

Pooh Sprague

Edgewater Farm 99 River Road, Plainfield, NH 03781

602.298.8391 www.edgewaterfarm.com

Part of the marketing strategy for our farm is to provide our own small fruit for our retail stand, our few wholesale accounts and CSA membership for as much of the growing season as possible. We have 5.5 acres of strawberries, ¾ of an acre of summer brambles, 4 acres of blueberries and 1.25 acres of fall raspberries. This enables us to keep our own small fruit in our product mix from approximately June fifth until frost/closing of the stand which occurs in our area around Oct 15th.

Summer Bearing Varieties: Nova (very hardy) and productive and Laruen (not as), a few Prelude. Yearly favorite seems to be variable in terms of quality due in part to early season temps and nutrition program. Bristol (meager plant maker) and Jewel (more vigorous, so more fruiting "surface." Fall Bearing Varieties: Autumn Britten (wimpy but early), Jaclyn (dependable), Caroline (easy and good quality) and Heritage (older planting).
We will be trialing fruiting fall bearers in a movable greenhouse fall of 2012.

We are not "focused" raspberry growers. We don't know how our yields compare. Much detail work is overlooked. Yet still seem to produce enough for our needs.

Trellising: Summer bearing raspberries on permanent t-trellising with polywire and ½" RAM drip tubing. Pruning done in August to September, with tipping occurring at that time as well, due to problems from snow load on leaves. 3-6 canes "bundled" with baling twine to trellising. Fall bearers trellised annually with a modified San Diego system with 6' x ½ rebar. Fall bearing primocanes are mowed late fall or early spring.

Nutrition: Dairy manure and sulfate or muriate of potash for fall bearers directly on row in early early spring for fall bearers. Manure and vegetable based compost side dressing with row mulcher followed by potash broadcast in summer bearers.

Pest Controls: Devrinol/Princep or Devrinol /Sinbar applications early spring pre-cane emergence and after manuring. Occasional Poast application spot spray late season for annual grass and hand weeding of escaped broadleaves and hardwoods. Number 1, 2, and 3 insect pest problems are Japanese Beetles on fruit and sometimes high pressure on mid summer foliage. Occasionally yellow jackets in a dry year. Botrytis the main disease issue by far. Siting the patch adventitiously is far more efficacious than a spray program.

Harvesting: Summer harvest is done totally by crew. Fall harvest is crew plus PYO.

RASPBERRY ROOT DISEASES

Kerik D. Cox
Assistant Professor
Dept. of Plant Pathology and Plant-Microbe Biology
Cornell University, NYSAES
Geneva, NY 14456
kdc33@cornell.edu

Understanding the root diseases of brambles

Root diseases are particularly devastating and frustrating to manage in small fruit production operations. This is especially the case for established operations because the most effective management practices must be implemented prior to planting. The pathogens causing root diseases are all soilborne and remain protected within the soil. In addition, the most diagnostic symptoms are also below ground, which prevents one from recognizing the problem at a time when action could be taken to save the planting.

In the region, the set of root diseases and disorders affect both raspberry also effects other crops such as strawberry. Hence, identifying the characteristics of these problems will help one understand their role in seasonal plant decline in several small fruit crops. This set of root diseases and disorders include:

1. Winter Injury: Decline from winter injury occurs when plants aren't well insulated against freezing during winter or when young tissue isn't protected against frost in the spring. Plants stressed by disease or abiotic factors prior to dormancy will be more susceptible to winter injury. Winter injury can result in reduced in vigor and productivity, or kill plants outright. Winter injury to the roots can be diagnosed by cutting longitudinally through the crown of dying (not dead) plants. Initially, the cortex of affected roots and crown tissue will appear brown while the vascular tissue remains white and healthy. By contrast, most root diseases will preferentially affect the vascular tissue, and decay in the cortex occurs by secondary pathogens. During the season, winter injured plants will send up new canes that remain healthy through the season. By comparison, a root disease will cause decline of canes throughout the season. Cold injury during spring freezes is more frequently observed in the region and is quite diagnostic. The vascular connections in young floricanes become damaged causing them wilt and die during the spring while hardier primocanes flourish. This causes a planting to appear to have row tops of dead shoots, but healthy crowns and row bottoms.

2. Drought Injury: Periods of drought may injure plants or predispose them to winter injury or diseases. Drought for even a few weeks can cause young leaves to wilt and developing fruit to shrivel. Fine roots may die off and impaired root function may cause the plants to appear as if they are affected by a root disease. In addition, the use of fertilizers, herbicides, and pesticides (e.g. captan) during a drought may result in unexpected injury either from the association of drought conditions with heat, or the excessive need for the plants to uptake the water often used as a carrier in chemical applications. When excavated, a plant suffering from drought will have roots that are dry and sinewy, but still have white vascular tissues and cortex.

3. *Phytophthora* root rot: *Phytophthora* is an aquatic pathogen that prefers cool weather and free moisture (e.g. wet spots in the field). During *Phytophthora* infections, fine/lateral roots will decay first leaving only large primary roots. When the roots and crown are sectioned longitudinally, the affected tissues will be chocolate to reddish brown. As infection progresses and the plant dies, secondary decay fungi will rot the cortex of roots and the crown. Following plant death, infective propagules remain in dead plant tissue and the soil. These are capable of causing infections in later seasons after replanting. In general, red raspberry varieties are more susceptible to *Phytophthora* root rot than purple and black raspberry varieties.

4. *Verticillium* wilt: *Verticllium* wilt has the most distinctive symptoms of the root diseases presented here, and is easiest to diagnose. In raspberries, the youngest canes will wilt first beginning from the base to the tip. On such canes, the petioles will remain attached with the oldest leaves at the base looking scorched and youngest leaves at the tip looking stunted, but often still green. Infected raspberry canes may also have bluish streak-shaped lesions within infected canes. In general, purple and black raspberry varieties are more susceptible to *Phytophthora* root rot than red raspberry varieties.

The role of root diseases in plant decline during 2010 and 2011

In 2010, the early season was warm and dry, but considerable rainfall occurred from late July through September. There were many reports of small fruit plant decline, especially in strawberries and high tunnel raspberries. Unfortunately, the majority of the samples diagnosed by this program had progressed to a stage of decline where it was impossible to confirm root disease as the cause. Some samples provided clear indications of *Verticillium* wilt and signs of *Phytophthora* infected tissues, but others were simply winter injury. In 2011, the early season and late season had considerable rainfall with near flooding in some regions. Between these two periods there was a 1.5 month stretch of drought (i.e. < 1.0” of rain). There were numerous reports of *Phytophthora* root rot, but the majority became manifest in the presence of the drought when root function was most critical. During this period, we received reports and samples of chemical injury from fertilizer and pesticide use on drought stressed plants. In late season, there were more reports of *Phytophthora* root rot likely resulting from overly susceptible plants that had suffered from drought stress.

Preparing for root diseases and decline in 2012

Given the potential for high disease pressure and environmental stress in late 2010 and 2011, there could be considerable root disease in small fruit plantings in 2012. In plantings with severe plant decline in low-lying wet areas, a phosphorous fungicide program may be warranted to prevent additional loss to *Phytophthora*. In addition to diseases, winter injury could be more severe in 2012. Plants with high levels of disease (even foliar diseases like leaf spot) or recovering from drought stress as they enter dormancy may be more susceptible to winter injury in 2012. In order to avoid plant decline in 2012, producers should ensure plant insulation during winter and scout during spring and early summer for the first signs of plant decline (e.g. wilting). If recognized early enough, the extent of losses could be mitigated.

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Organic Sources of Fertility for Fresh Market Broccoli

Ryan Fahey, M.S. candidate, University of Maine
Marianne Sarrantonio, Assoc. Prof. Sustainable Agriculture, University of Maine
University of Maine, 5722 Deering Hall, Orono, ME 04469 ryan.fahey@maine.edu

ABSTRACT:

Field experiments were conducted in 2010 and 2011 to assess the release of plant-available N to broccoli plants from five N-rich soil amendments approve for organic production. Broccoli fresh weight measurements, soil and plant mineral N contents were used to assess potential synchrony between N sources and broccoli N demand during the cool moist spring weather in Maine. Data shows that fish meal supplied an optimal pattern of N for high broccoli yield in both years. Soil analysis in 2010 showed N availability from fish meal differed from other fertility sources, with greater initial NH_4^+ availability and consistently high NO_3^- levels from early to mid-June.

INTRODUCTION:

Growers who rely on commercially-available bagged organic fertilizers have little information on the most efficient and economical choices for vegetable cropping in different seasons. Some of these bagged fertilizers have a relatively high C:N ratio and take time to decompose enough to release nutrients into the soil as a plant available form. This mineralization process is enhanced by warm weather and moist soils, so time of year, soil texture and rainfall can have a huge effect on the efficiency of these fertilizers. Further, organic fertilizers may contain considerable quantities of nutrients other than N, including micronutrients, so their true value should be determined by field evaluation. Late spring-early summer is a key climactic season in Maine, when conditions are cool and moist. The growth cycle of broccoli fits this short growing season and the crop is very responsive to nitrogen. Broccoli yield and growth parameters were used to indicate the synchrony between nitrogen availability and crop demand.

METHODOLOGY:

Trials were located at University of Maine Roger's Research Farm, in 2010 and 2011. Cultivar 'Gypsy' was grown in randomized complete block design of six nitrogen source treatments with four replications. Plants were spaced 84x30 cm apart. Blood meal, fish meal, pelletized poultry manure, soybean meal and Chilean nitrate were supplied at a rate to provide 180 kg ha^{-1} of N to each plot in 2010, and 143 kg N ha^{-1} in 2011. Amendments additionally provided various quantities of other macro and micronutrients (Table 1). Control treatments were not amended with N fertilizer. Phosphorus and potassium were supplied by 112 kg ha^{-1} bone char and 90 kg ha^{-1} SulPoMag, respectively.

Growth and quality of plants were measured weekly until harvest. On two occasions destructive samples were used to measure biomass. Soils sampled were measured to a depth of 22 cm. for NO_3^--N and NH_4^+-N content. Plants were harvested at commercial maturity and evaluated for fresh weight measurements and dry weight nutrient content.

RESULTS AND DISCUSSION:

Biomass and Yield Production:

Trials indicate that source of organic fertility has a significant effect on plant yield, in terms of total biomass, head biomass and diameter. Averages over two years show the biomass of broccoli heads receiving no N fertility to be 6,724.5 kg ha^{-1} and 9,812 kg ha^{-1} for fish meal. All other treatment yields were not significantly higher than the control in 2010, and not significantly different from each other in 2011, averaging 8,292.5 kg ha^{-1}.

Soil Nitrogen Dynamics

Soils amended with fish meal and Chilean nitrate were typically highest in NO_3^- content, although the quantities were not always significantly different from other sources of fertility. Trends of soil N content among treatments were markedly different. Chilean nitrate had high NO_3^- availability from the start of the season, with a striking decline soon afterwards. Fish meal provided fairly consistent, ample levels of available NO_3^- throughout the season, and a generous quantity of NH_4^+ to young transplants. It appeared to be best synchronized with broccoli N needs of all the amendments.

Tables

Nutrient Analysis of Soil Amendments Used:

Material	% N	% Ca	% K	% Mg	% P
Blood meal	13.5	0.885	0.127	0.035	0.095
Fish meal	9.36	8.84	0.629	0.167	4.59
Poultry manure	3.11	1.76	2.39	0.571	1.20
Soybean meal	6.72	0.199	1.80	0.220	0.739

Fertilizer Micronutrients measured as ppm:

Material	Al	B	Cu	Fe	Mn	Zn
Blood meal	205	13.1	3.20	216	7.20	22.1
Fish Meal	61	1.97	0.985	163	14.8	128
Poultry manure	3231	41.7	332	1821	361	442
Soybean meal	58.9	20.3	12.6	211	29.3	49.7

Broccoli Yield According to Organic N Source @ 180 kg/ha N – 2010, @ 143 kg/ha N - 2011

(kg/ha)	Fish	Chilean	Blood	Poultry	Soy	Bare
Total Biomass						
2010	62,791	60,266	58,772	53,856	53,815	47,383
2011	21,829	20,088	17,504	19,116	19,520	12,950
Head Yield						
2010	14,896	11,611	11,749	11,245	12,306	10,450
2011	4,728	5,349	4,993	4,710	4,377	2,999

Expansion of the Eastern Broccoli Industry

Thomas Björkman
Department of Horticulture, Cornell University, Geneva NY 14456 tnb1@cornell.edu

With strong demand for local produce, and expensive transportation for vegetables from the West-Coast salad bowl, there is an opportunity to source much more broccoli from the East. However, current varieties are not sufficiently adapted to the weather during the heart of the Eastern growing season for reliable product quality. Currently northern Maine is the only part of the east with large-scale summer production.

The essential part of the solution is broccoli that will reliably make a top quality product here. Fortunately, several breeders have been working on that issue: Mark Farnham at USDA in Charleston SC, Phillip Griffiths at Cornell, and Jim Myers at Oregon State. There are breeding lines that will stand up to Eastern conditions. With that breakthrough in genetics, it's worth looking at what it will take to make this a viable industry.

We spent a year identifying the barriers to having substantial eastern production, and determining whether those barriers could be overcome. The western industry provides a reliable, high-quality product all year long, and they raise it very efficiently. Buyers who move a lot of volume are already their customers. A new source will have to meet high expectations of quality, consistent supply, volume and price.

One underlying principle is that every business in the chain needs to have reliable suppliers, a reliable market, and needs to make more money on eastern broccoli than what they would do otherwise. This principle applies to the breeders, seed companies, seed distributors, farmers, produce distributors and retailers. By helping advance each of these sectors, we expect to meet the larger goal while maintaining short-term profitability for all participants

A major part of the project is breeding to produce commercially available varieties that are reliable producers for Eastern growers. This work involves breeders from universities, the USDA and several major seed companies. It is an unusual bit of cooperation combined with healthy competition. Having a better set of varieties will be valuable for current growers as well as prospective growers. The first year of the rigorous regional trials have evaluated the best current germplasm, and clearly identified the needs. At the same time the breeders have been busy making crosses and increasing seed for new lines that will be tested in next years trials.

The distribution model favors having several regional production areas that can coordinate post-harvest handling and shipping. These locations need to be good places to grow broccoli, have appropriate infrastructure, and have growers who are willing to work together. We are working on developing those networks so they will be ready to produce as soon as the new varieties are released in several years. The most promising growers will have labor available at harvest time, and rotations where broccoli complements their other crops. In the initial network, its best if each farm has the potential to produce from twenty to a few hundred acres. Smaller farms are good candidates for supplying local markets, either individually or in small networks.

Further information is at www.easternbroccoli.org

Field Production of Leafy Greens/Management of Insect Pests

By Matthew Gifford from Rosaly's Garden
Rt 123 Peterborough NH 03458
603-924-7774 matthewgifford78@gmail.com

At Rosaly's Garden we harvest a variety of leafy greens from April through mid December. We have six high tunnels that are used for bedding plant and tomato production during the summer, that we use for greens production in the spring and fall to extend our season and supplement our income. Nearly 50% of the greens that we produce are marketed wholesale which is in contrast to the rest of our produce of which nearly 90% is marketed directly to our customers through our farmstand. The greens that we produce have become an essential piece of our wholesale marketing, when our greens are suffering so are our sales.

Our field production of greens consists of 19 weekly plantings of head lettuce and our baby greens mix, from mid April (as soon as the soil is workable) through August. We also do an early and late planting of Swiss chard, as well as two later fall brassica plantings that are transplanted to the field in early and mid July. The specific varieties and approximate quantities grown are as follows:

Swiss Chard	**Kale**	**Lettuce**	**Baby Greens**
Improved	Toscano	Green star	Garrison
Rainbow mix	Winterbor	New red fire	Sulu
(2 plantings of	Redbor	Adriana	Defender
600 plants)	(2 plantings	Red cross	Annapolis
	of 600 plants)	Panisse	Green star
		Paradai	Spock
		Claremont	Arugula
		Green forest	Mizuna
		(1,500 plants	Red giant
		per week)	Tatsoi
			(1,400 ft sq/week)

Pre-Plant Considerations

Site selection is essential to a successful planting. As with many crops leafy greens prefer a light well drained soil. Planting in a heavy wet soil can lead to a variety of other problems. The selection of disease resistant varieties such as downy mildew resistant varieties of lettuces is also very important. We only plant resistant varieties for both our head and baby lettuce types. All of our fertility needs are addressed pre-plant using a broadcast spreader. For all of our greens we use a combination of dried chicken manure and potassium sulfate, The rates are determined by annual soil testing.

Planting and Irrigation

Our baby greens are all direct seeded on a fine seedbed using the Johnny's six-row seeder and irrigated with a row of small overhead sprinklers, for one hour twice a day during germination only. All of the transplanted crops are set out using a water wheel transplanter, which is often the only irrigation required due to the good water holding capacity of our soil. The water wheel transplanter also allows us to apply certain insect controls at the time of planting, such as beneficial nematodes to help control Cabbage maggot and Flea beetle larvae.

Pests and Controls

As an organic grower cultural controls are always our first line of defense against any problems. The importance of simple things like crop rotation, controlling weed hosts and the use of floating row covers cannot be understated. Manipulating the timing of plantings can also be a useful tool. For example we no longer plant any spring brassicas because of unmanageable populations of flea beetles for several years, which resulted in unmarketable kale. This simple change has resulted in a much smaller population throughout the entire growing season.

The pests of greens are specific to the type of plant. Swiss chard has relatively few insect pests. I usually only have problems with leafminer, which spinosad is labeled for, but I find to be unnecessary because in most circumstances simply removing damaged leaves from the field gives adequate control.

In most years the lettuces have had few insect pests, mostly caterpillars such as corn earworm later in the summer. The caterpillars are easily controlled with a spray of Bt. This past season however we experienced for the first time severe damage from either crickets or grasshoppers. Over the span of one weekend we lost approximately 4,000 heads of lettuce, from then on a weekly Pyganic application was made which seemed to give good control. Grasshoppers also became an issue on some of our brassicas (broccoli in particular) where again Pyganic seemed to work well.

The brassicas are where we have had the most trouble over the years with insect pests. The two most economically damaging pests for us have been the Crucifer flea beetle and the Imported cabbageworm. Although the cabbageworm is easily controlled with Bt I prefer to apply Entrust as a more expensive alternative because I feel it has some efficacy on the flea beetle as well as excellent cabbageworm control. The other weapon against flea beetles is a rotating spray of Pyganic in between each Entrust application, which as mentioned also helps to control the grasshoppers. These sprays in conjunction with our other controls i.e. weed control, nematodes and only planting late brassicas has produced an outstanding crop now three years running.

Managing Pepper Maggots with OMRI-Approved GF-120 Fruit Fly Bait

T. Jude Boucher, University of Connecticut
24 Hyde Ave., Vernon, CT 06066
Jude.boucher@uconn.edu, 860-875-3331

The pepper maggot (PM), *Zonosemata electa*, is a Tephritid fruit fly native to horsenettle in North America, which first attacked peppers and eggplant in 1921. It has a patchy distribution throughout its range, which includes the eastern United States and Ontario, but also extends west to Kansas and south to Texas and Florida. In New England, it is quite common in the CT River Valley and along the shore in CT, MA and RI, and has been found as far north as Epping, NH.

This pest has a single generation each year. The adult flies emerge from the soil in early to mid-July over a 10- to 14-day period. Males emerge up to 7 days before females. Each female can lay up to 50 eggs, beginning 6 to 7 days after mating. Eggs take 10 to 12 days to hatch. Mating is thought to occur exclusively on the host plant and fruit, where males will fight for territory to win a receptive female. However, the flies spend much of their time feeding in and inhabiting nearby trees, returning to the crop fields during daylight hours for mating and egg laying. Over 94% of egg laying occurs in the first 4 weeks after emergence. The flies may live through mid- to late August if not controlled.

Fully grown maggots emerge from the fruit in late August or early September, and enter the soil to pass the winter as pupae. Adults have been known to migrate at least ½ mile to infest new pepper plantings. Up to 75% of the fruit have been lost in the second year of production on some farms, while other farms go years without experiencing pepper maggot problems. Fruit may be rendered unmarketable by the presence of maggots in the flesh or seed head (pacenta). In late August and early September, fruit may rot when soft rot bacteria enters exit holes left by emerging maggots. The insect survives the winter as a pupa about two inches below the soil surface.

Females lay eggs by inserting their hollow, sword-like ovipositor though the fruit flesh and depositing an egg so that it sticks out into the void on the interior of the pepper pod. In doing so, the female leaves a small, white, round scar on the surface of the fruit, which can be used to monitor for the pest and to time initial insecticide applications. Only 5 to 50% of the egg-laying attempts (or scars) result in an egg being deposited in the fruit. These scars are particularly easy to detect on the glossy surface of cherry pepper pods: a favorite host. The insect will also attack other thick-fleshed, blocky fruit such as bell, cheese and apple pepper varieties and, less frequently, eggplant. Hot cherry peppers (i.e. 'Cherry Bomb') can be used as indicator plants to time insecticide applications, if planted every 50-75 feet in the outer row of peppers along the tree line or in the entire perimeter row of the crop.

Another way to monitor for this pest is to bait a yellow, sticky AM Trap with a vial of 28% ammonium hydroxide solution (Fisher Scientific, Fair Lawn, NJ). We use a common 20 dram drug store vial, stuffed with cotton, with a ¼ -inch hole drilled in the top to dispense the ammonia. Using a paper clip, attach the vial to a hole made in the center of the AM trap. The trap works best 20 feet high in a maple tree beside the pepper field. Lower elevations and other types of trees have proved less reliable. Recent experience has demonstrated that you can eventually trap all the flies out of one tree if that tree is used year after year for monitoring. Simply switching to a nearby tree will allow you to catch more flies.

On IPM farms, pest control involves insecticide sprays with dimethoate or acephate (Orthene) applied within a week of catching the first PM fly or detecting the first stings on fruit. Two or three applications may be needed at 8- to 10-day intervals to cover the entire adult emergence and egg-laying period. Orthene will control both PM and European corn borer, but has a 7 day-to-harvest (dh) restriction. Dimethoate generally has a 0 or 1 dh restriction, but will not control borers.

Pepper maggot can also be controlled using perimeter trap cropping. For example, when planting bell peppers, simply replace the outer perimeter row with a row or two of cherry pepper trap crop plants. You will need to plant a couple of cherry pepper plants at each end of the bell rows too, so that the trap crop completely encircles the cash crop. Within a week of detecting flies or stings, spray just the trap crop with an effective insecticide. For light populations, insecticide applications may not be necessary the first year to stop the flies from reaching the bell peppers. However, maggots that develop in the cherry pepper fruit the first year will produce so many flies the second year that the perimeter will be breached unless the trap crop is sprayed. Perimeter trap cropping has been successfully used to protect eggplant by planting two rows of hot cherry peppers in the perimeter and using a shielded spray to apply insecticide applications only to the trap crop.

Until recently, the only effective management strategy for an organic farm was to cover host crops with a floating row cover throughout the entire flight period (5 to 8 weeks) or to market fruit with maggots inside. The use of row covers often proved impractical, especially during harvest. However, spinosad, which is ineffective when applied as a foliar spray (i.e., as SpinTor or Entrust), has recently been reformulated as a fruit fly bait: GF-120. The new bait formulation allows the fly to ingest more of the active ingredient to provide a higher kill. In research trials, this formulation has been shown to provide 67 to 98% efficacy for related pests, such as apple and blueberry maggots.

The fact that GF-120 is not readily available makes using this product a challenge. Because it is not commonly stocked by local suppliers, GF-120 will have to be ordered prior to the planting season to insure that it arrives on time. For our trial, a representative from Dow AgriSciences provided the product for us to try.

A second challenge is that label directions call for GF-120 to be applied with large orifice nozzles (droplet size 4-6 mm), but as an ultra low volume spray: approximately 1 gallon per acre of finished spray solution. It is also recommended that the material be applied to the underside of leaves “to reduce exposure to sun and rain.” Since large orifices are usually associated with high volumes of finished solution, this essentially meant that we had to travel at approximately 12 mph in an ATV, over rough terrain, while directing the spray up to the underside of the leaf canopy. We accomplished this on an organic farm in CT, both by using perimeter trap cropping to reduce the area requiring spray and by rolling the drive rows early in the season prior to spraying in order to allow high speed travel around a 1-acre block. A high rate of GF-120 was used: 20 fl oz/a in 140 fl oz of finished solution. Originally, based on recommendations from

Dow, we used a SJ3-02 TeeJet fertilizer nozzle with a 50 mesh screen at 20 psi to produce the correct flow rate and droplet size. However, the grower switched back to the nozzles which came with the sprayer for greater spray distance after the first application. The perimeter rows of cherry peppers were sprayed so that applications were directed to the top and underside of the plant canopy in two separate passes. An additional application was directed to the underside of the surrounding tree canopy per label directions. This process was repeated the first three weeks after flies were first detected in traps (starting July 12). The electric sprayer purchased for the ATV application then failed and required repair, which delayed the fourth application for 2.5 weeks or until Mid-August. Additional flies were captured during early August and new stings were detected on the fruit during that time period, which necessitated the final application. The unanticipated delay and heavy August rains may have reduced the efficacy of that final application.

In 2010, pepper maggots were not controlled on this farm and approximately 75% of the fruit were infested and unmarketable. In 2011, using the interrupted GF-120 spray schedule (no spray in early Aug), 60 to 70% of the crop remained maggot-free at harvest. Providing an unsprayed control patch of peppers at the same site to measure the untreated damage level was considered impractical, due to the mobility of the adult fly. The grower was pleased with the results. This grower hedged his bet on the new fruit fly bait by covering a second block of peppers with floating row covers from the first week of July through August. The covered block remained maggot-free through harvest.

Meeting the Postharvest Needs of Vegetables from Field to Market

Lee Stivers, Penn State Extension in Washington County
ljs32@psu.edu; http://extension.psu.edu/washington

Harvested vegetables are living systems that age with time. As a grower, your goal is to slow down the aging process. To do that, you need to understand, and manage, four natural processes: respiration, transpiration, ethylene production, and chilling injury. Proper cooling is the first step, followed by maintaining the optimum temperature and relative humidity (RH) for each vegetable.

Produce a Clean, Mature Product: Quality cannot be improved after harvest; it can only be maintained. So it makes sense to start with the highest quality crop possible at harvest. This means selecting the right varieties, controlling pests during the growing season, managing water and nutrients, and harvesting at the optimal time.

Handle with Tender Loving Care: If produce is injured during harvest, grading or packaging, damage may not be seen until it reaches the retail or consumer levels. Postharvest rots are more prevalent in injured produce. Mechanically damaged fruits and vegetables also lose water more rapidly. Whether you are harvesting and handling cabbages or corn, berries or beans, "treat 'em like eggs!"

Remove the Field Heat: Postharvest cooling lowers the respiration rate of the product, slows water loss, inhibits the growth of molds and bacteria that can cause decay, and reduces the production of the ripening agent ethylene. Cooling methods include room-cooling, forced-air cooling, hydro-cooling and icing.

Sanitize for Food Safety: Using chlorine or other sanitizing agents in wash water and hydro-cooling water helps protect against post-harvest diseases and also helps protect consumers from food-borne illnesses caused by pathogens.

Package Properly: Any packaging should be designed to prevent physical damage to produce and be easy to handle. Packaging can aid in retaining water while still allowing gas exchange.

Know Your Vegetables: Become familiar with the optimum storage temperatures and curing needs of each produce item. Below are specific recommendations for a few important fresh and storage crops grown in New England.

Broccoli:

- Optimum temperature: 32^{o}F reached ASAP after harvest
- 95% RH
- Very high respiration and transpiration rates
- Low ethylene production; extremely sensitive to exposure

Summer Squash:

- Maturity indicated by a variety of characteristics and market demand
- Optimum temperature: 41-50^{o}F
- 95% RH
- Transpiration rates high; water loss shrivels fruit
- Very chilling sensitive when held below 40^{o}F
- Low rates of ethylene production; low to moderately sensitive to ethylene exposure

Winter Squash:

- Maturity indicated by rind hardness, color, and corking of the stem
- Curing helps harden rinds, but not recommended for acorns (10 days, 80-85^{o}F and 80-85% RH)
- Optimum temperature: 55-59^{o}F for most, but 50-55^{o}F for green rind types
- 50-70% RH
- Very chilling sensitive when held below 50^{o}F
- Most store 2-3 months, less for acorns, more for hubbards

Onions:

- Maturity indicated when 10-20% tops down in the field
- Undercutting 1-2 inches accelerates dormancy
- Curing in field when temperatures are over 75^{o}F
- Forced air curing can be rapid (12 hours at 86-105^{o}F) or slower
- Mature for storage when neck scale are completely dry; loss of 5-8%
- Optimum temperature: 32^{o}F but not below
- 75-80% RH for best scale color
- Can store up to 6-9 months; typically 3-6 months
- Exposure to ethylene encourages sprouting

Carrots

- Maturity indicated by a variety of characteristics and market demand
- More mature carrots will store longer than less mature ones
- Optimum temperature: 32^{o}F but not below
- 98-100% RH but avoid free water which speeds decay
- Can store 3-5 months under good conditions
- Low ethylene production; exposure to ethylene results in bitter flavor

Potato

- Maturity indicated when tuber skins are set, vines are dry
- Optimal harvesting temperatures are 45-60^{o}F
- Prevent bruising and injury; treat gently
- Cull and cure before storage. Cure by holding at 50-60^{o}F and 95% RH for 10-14 days.
- Optimum temperature: 38-40^{o}F for tablestock
- 95% RH
- Can store up to 6-9 months; typically 3-6 months
- Exposure to ethylene encourages sprouting

Crop Diversity in Winter Storage at Kilpatrick Family Farm

Michael Kilpatrick
518-300-4060
Michael@kilpatrickfamilyfarm.com

Kilpatrick Family Farm is a year-round mixed vegetable farm. Our main markets are year round Farmer's Markets and CSA. Over the years, we have experimented with pushing the crops we go to see just what can be done. We run 5 distinct different environments for winter crops. This allows us to tailor the environment for the many different crops we grow.

Root cellar (34 degrees, 95% humidity) This is the main storage facility on the farm. A 40' X 8' x9' insulated overseas shipping container with stainless walls and aluminum slated floor, it holds up to 18,000 lbs of crop. We spent around $15,000 buying the container, installing it on a shale pad, and installing refrigeration and electric. To maintain organization in the cooler, we put all crops on pallets, and fill out a grid chart that is shared with all employees. The cooling system is a 3 HP Trenton compressor with 2 evaporation units. If we had know we would have employed a low velocity evaporation unit to reduce moisture loss. Right now our humidity system is "man with hose" but we would like to install a misting system at some time.

Our warm storage area is an unused, insulated garage under our apartment. It has a cement floor that allows us to move stacks of bulk crates of squash and sweet potatoes around with a pallet jack. We regulate the humidity and temperature very unconventionally through opening and closing an inside door or outside window. Our goal is to maintain a temp of 55 in this area.

We store our onions and garlic currently off-farm in a rented 8x14 cooler. It is managed as a low humidity cooler by draining all evaporator drainage into a closed container and limiting visits. We are currently building our own onion storage facility by walling off a section of another insulated shipping container and installing a coolbot.

All of our prepped crops and second vegetable storage is in 2 coolers located in our washing shed. We will also store extra storage greens (greens cut in Nov/Dec and stored for up to 8 wks) in these coolers when we run out of space in our root cellar. We built our main cooler (8X11) out of used cooler panels and a used compressor. We added onto the backside of it 4 years ago for the second cooler (8X8) buying some "second" insulated structural panels from winter panel company out of Brattleburo, VT. They come in 4' widths in varying lengths and at the time ran around $2 a square foot. We cut 2 12" by 6" holes in the shared wall between the coolers and consequently the new cooler runs around 10 degrees warmer than whatever we set the main cooler at. We use the second cooler in the summer for storing tomatoes, peppers, and cukes.

The last area we use to store overwintered crop is directly in the ground. We have successfully over-wintered parsnips, carrots and Jerusalem artichokes this way. Carrots do best with at least 2 layers of rowcover, while JA's and Parsnips are fine with no cover. All of these crops do best when they are on raised beds, out of any danger having saturated soil. Last year, we did have quite the problem with carrot rust fly in our over-wintered carrots and parsnips. We're not sure if it was overwintering that did it, or just the season.

Storing greens was something that we almost discovered by accident. We had several beds of beautiful spinach in the field in December and cut it all to use for the next several markets. We ended up keeping some for 6 weeks. We have found a variety of factors contribute to greens that store well.

A later, high quality planting. This allows for the crop to be in the prime of growth and to want to hunker down and go into hybernation for the winter. They then seem to fill their leaves with sugars, antifreeze, and carbohydrates and thus produce a very sweet, long lasting, durable leaf.

Cutting at a low temperature and immediately getting it into good cold (34) storage. We do find that if spinach has some snow in it, it seems to keep better. We have successfully done this with spinach, lettuce, kale, brussel sprouts, Chinese cabbage, boc choi, hakuri turnips with greens, and mesclun.

We will be trying this with mache, and working to improve our system with the other greens this year. This technique allows us to bunch our greenhouse greens up for the really cold months of January-March and allows us to sell high quality, sweet, relatively inexpensive to produce, greens for the high paced, busy, Holiday markets.

Without the storage facilities we have made the effort to perfect we wouldn't have anywhere close to the diversity that we are able to display at our weekly markets. Please follow the below URL or scan the QR code to access the custom resource page which has much more information on varieties, dates of planting and harvesting, storage, the presentation slides and other relevant resources.

www.kilpatrickfamilyfarm.com/NEVF

PREHARVEST DROP CONTROL WITH RETAIN AND NAA COMBINATIONS

Duane W. Greene, James Krupa, and Maureen Vezina
Department of Plant, Soil, and Insect Sciences
University of Massachusetts
Amherst, MA 01003
dgreene@pssci.umass.edu

Retail sales continue to be an important component in the overall business model for growers in the Northeast. The pick-your-own component of this model is playing an increasingly important role in the overall business. Many varieties, including McIntosh and Macoun, are especially prone to drop. In previous business models, it was sufficient to control preharvest drop for a period of time sufficient for fruit to develop market maturity and to allow a timely harvest. This scenario has changed and we now ask available preharvest drop control compounds to be effective over a much longer period of time. The early weekends in October, especially the extremely busy Columbus Day weekend, are extremely important and growers are now attempting to keep fruit on the tree at least through this holiday weekend. ReTain and NAA are our primary drop control compounds and, by themselves and used as we have done in the past, they do not control drop for this extended period of time. The purpose of this project was to explore strategies using ReTain and NAA to extend the control of drop through the Columbus Day weekend without adversely affecting fruit quality. Both NAA and ReTain have the potential to influence fruit quality, ripening and storage potential.

Materials and Methods

A block of Gatzke McIntosh/M.9 was selected to do this drop control experiment. There were 9 treatments that included an untreated control, trees that received a full rate of ReTain either alone or with one or two applications of NAA at either 10 or 20 ppm and other trees received three half rates of ReTain applied at 2-week intervals that contained 10 or 20 ppm NAA or no NAA. All treatments were replicated 5 times with two trees treated per treatment per replication. One of the treated trees served as the drop tree and no fruit was harvested from this tree. A second tree was designated as the sample tree and all samples for evaluation and storage were harvested from this tree. There were 9 dates when samples for evaluation were taken starting on 26 August and ending on 14 October. Data generally taken on the sample dates included: fruit weight, flesh firmness, soluble solids, red color, internal ethylene and starch rating. A 20 kg sample was harvested on 13 September. Firmness on this sample was taken after 6 and 12 weeks in regular air storage and storage disorders were evaluated after 12 weeks on the remaining fruit in the box. All or a portion of the treatments were applied with a commercial airblast sprayer on 18 August and combination sprays were tank mixed. All fruit that dropped was picked up and discarded and then the number of fruit that subsequently dropped was picked up under each tree and discarded two times per week until 26 October. All remaining fruit were harvested from the drop trees on 26 October, counted and then the cumulative drop calculated over the whole drop period.

Results

Preharvest drop was followed over a 9-week period. Untreated control trees displayed the normal and severe preharvest drop problem associated with McIntosh. By 7 September 25% of the fruit were on the ground and one week later over 50% of the fruit had dropped. All other drop control treatments were effective but there were significant differences among treatments. A full rate of ReTain applied once on 18 August (the industry standard) was effective until the last week in September, when it started to loose its effectiveness. All drop control treatments were statistically better than the ReTain standard. This trend continued through the Columbus Day weekend. NAA when combined with ReTain improved the drop control of the ReTain standard. This was true whether one application of either 10 or 20 ppm NAA was applied with the initial ReTain application or whether two applications of NAA at 10 or 20 ppm were applied at 2 week intervals (one with the initial ReTain and then one alone 2 weeks later). In this experiment the treatment with 3 half rate applications of ReTain at 2 week intervals was superior to the one full rate of ReTain, However, there was no appropriate check (1 application using 1.5 pouches of ReTain) for this treatment so it is unresolved if it is the split application or the total amount of ReTain applied that is the important factor. The treatment involving application of 3 half rates of ReTain where each contained 20 ppm NAA was less effective. Starting as early as 10 September, the drop control of this treatment diminished more than any of the other drop control treatments. It should be noted that this is the only treatment that contains a low rate of ReTain and a high rate of NAA and this may be the major reason. Columbus Day weekend ended on 11 October. On that date the best drop control was achieved where a full rate of ReTain was applied on 18 August with 10 or 20 ppm NAA followed by another 10 or 20 ppm NAA treatment on 10 September. Equally good at this time were the 3 half rates of ReTain and the 3 half rates of ReTain with 10 ppm NAA.

Fruit quality parameters were evaluated and statistically analyzed over the whole sampling period from 26 August to 14. Flesh firmness is an extremely important parameter, not only for fruit quality but also because NAA has the potential to reduce firmness, especially when applied alone. The flesh firmness results were quite unexciting in that there were no substantive differences among treatments. The inescapable conclusion is that ReTain is able to counteract any tendency for NAA to reduce flesh firmness, regardless of time of application. From a flesh firmness standpoint, ReTain makes NAA a much safer compound to use on apples during the harvest period. In general, fruit treated with ReTain had less red color and the addition of NAA with ReTain did not result in an increase in red color. ReTain-treated fruit had slightly lower starch rating and the addition of NAA to the ReTain did not result in any higher starch rating. On 4 October it was noted that the trees that received 3 applications of either 10 or 20 ppm NAA had more cracked fruit. When quantified, it averaged slightly more than 6%. Flesh firmness of fruit following regular air storage for 6 and 12 weeks. A difference among treatments or major trends is absent. The general lack of response seen following storage is similar to results documented at the various harvest dates. The influence of treatments on storage disorders is either nonsignificant or if significant, as with brown core, they are difficult to interpret.

Conclusions

The results of this experiment clearly demonstrate that there is potential benefit of including NAA in a drop control program. The addition of NAA in the initial ReTain application or supplemental applications did enhance the drop control of ReTain. One of the major concerns associated with the use of NAA at harvest time is the potential that it can advance ripening thus adversely affect fruit quality at harvest and following a period of storage. This appears not to be the case. Flesh firmness of fruit held in cold storage for either 6 or 12 weeks showed no differences between ReTain-treated fruit and fruit that received combinations of ReTain and NAA. The multiple applications of 20 ppm NAA with half rates of ReTain raises the question that there may be a ratio between the amount of ReTain applied and the amount of NAA that ReTain is able to negate ripening effects. This must be established in another year, but until this is resolved it seems quite safe to say the one or two applications of NAA at 10 ppm with ReTain is treatment that is likely to enhance overall drop control without resulting in advanced ripening or the shortening of the storage period.

Brown Marmorated Stink Bug: Research and Control

Dr. Tracy Leskey
Research Entomologist
USDA-ARS
Appalachian Fruit Research Station
2217 Wiltshire Road
Kearneysville WV, 25430-2771 USA
TEL: 304-725-3451 x329
EMAIL: tracy.leskey@ars.usda.gov

The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål) is an invasive insect native to China, Taiwan, Korea, and Japan accidently introduced into the United States sometime in the mid- to late 1990s. Over the past several years, BMSB has emerged as a pest of increasing concern to agriculture in the United States. Currently, large populations are now established in PA, NJ, DE, MD, WV, and VA; all of these states have documented severe losses in a number of crops and tremendous nuisance problems for homeowners and businesses. Furthermore, established populations have been detected in CA, CT, IN, KY, NH, NY, OH, OR, and TN, though crop losses have been minimal at this early stage of infestation. Additional states where BMSB has been detected include AL, AZ, FL, GA, IA, IL, MA, ME, MI, MN, MS, NC, NE, RI, SC, TX VT, WA, and WI. In 2011, BMSB was confirmed in Ontario, Canada.

Fig. 1 Adult BMSB on nectarine

In 2010, BMSB populations increased dramatically and attacked many crops in the mid-Atlantic region. Damage in commercial orchard crops reached critical levels with some growers losing entire blocks of stone and pome fruit (Fig. 1, 2, and 3). Severe post-harvest losses from cold storage also were reported for apple throughout the region. In addition, extensive damage and crop losses were reported for peppers, tomatoes, corn, soybeans, and caneberries. Extensive damage to woody and herbaceous ornamentals and to grapes also was reported. In 2011, overwintering survivorship of adults from human-made structures and from wild or natural overwintering sites was substantial. Large populations immigrated into stone fruit orchards in late May-early June to feed on immature fruit. Growers who treated with broad spectrum insecticides at frequent intervals during this primary period of risk had substantially less injury than those that did not. Subsequently, growers have radically altered their management practices to control BMSB, an insect that is now consider the single most important concern in many cropping systems. Tree fruit growers are typically

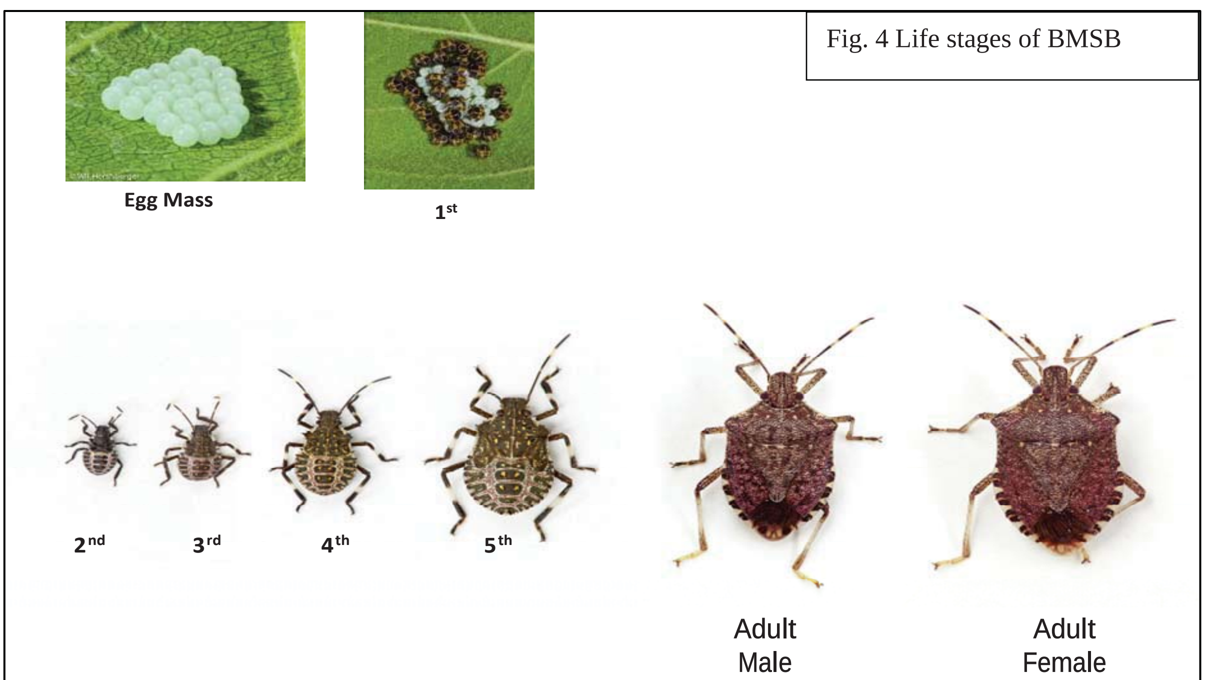
Fig. 2 Early-season BMSB injury on peach

making 2-4x more insecticide applications than in previous years and generally with older, broad-spectrum materials, for example. Those who have maintained a vigilant and very aggressive spray schedule have been able to minimize damage whereas those who did not saw increases in injury. Similarly, chemical treatments have been added to other crops to minimize BMSB injury. A prime example is soybean; growers have made applications in the peripheral areas of soybean fields to combat BMSB. Though growers have been able to reduce injury, these radical departures from previous management regimes have resulted in increased costs (insecticides, fuel, equipment maintenance, and labor) and inputs making this approach unsustainable both economically and environmentally. An obvious casualty of BMSB in agriculture is the devastation to integrated pest management (IPM) programs put into place over the past several decades as well as the tremendous challenges this insect poses for the organic community.

Fig. 3 Late-season BMSB injury on apple

In order to develop effective long-term solutions for managing this invasive species, we must (1) define the basic biology, phenology, and behavior of BMSB in agroecosystems, urban landscapes, and in native, unmanaged habitats; (2) establish the host range and preference of BMSB for both cultivated and wild hosts as well as susceptibility of cultivated hosts; (3) assess and survey BMSB populations to establish geographic distribution, population density and potential spread; (4) develop effective stimulus-based monitoring tools for BMSB to allow growers to make informed management decisions; (5) develop effective behaviorally-based attract-and-kill management strategy for BMSB to reduce insecticide inputs; and ultimately (6) Establish biological control efforts (whether parasitoid, predator, or pathogen) to reduce or eliminate this insect as a pest of agricultural and urban settings.

Fig. 4 Life stages of BMSB



Understanding the Limitations of Newer Apple Fungicides

David A. Rosenberger, Cornell's Hudson Valley Lab
P.O. Box 727, Highland, NY 12528
E-mail: dar22@cornell.edu

DMI fungicides have provided apple growers with a golden era of disease control that is drawing to a close as the appearance of DMI-resistant apple scab gradually reduces the usefulness of this class of fungicides. The DMI fungicides include Rally (formerly sold as Nova), Vintage (formerly sold as Rubigan), Procure, Indar, Inspire Super, Tebuzol, and Topguard. Inspire Super is a package mix of a DMI (difenoconazole) and Vangard, which is in the anilinopyrimidine fungicide class.

The DMI fungicides had advantages that have not yet been duplicated with any other fungicide chemistry. They provided effective control of the three major fungal diseases of apple that occur in spring: apple scab, powdery mildew, and rust diseases. They also provided 96 hr of post-infection or "kick-back" activity, and they suppressed lesion expression and sporulation when applied any time before lesions appeared on leaves. When applied in combinations with captan or mancozeb, the DMIs provided effective disease control when applied at 9 to 12 day intervals as compared to the 7-day spray intervals required for most other fungicides during spring. Because none of the newer fungicides can duplicate the activity of the DMIs, growers will need to carefully consider the limitations of the available fungicides that they will be using to replace the DMIs.

Following is a summary of fungicide classes that are currently available for apple disease control, along with some of the advantages and weaknesses that are common to most of the fungicides within the respective classes.

<u>Contact fungicides</u>: Captan and the mancozeb fungicides (Manzate, Dithane, Penncozeb) were developed more than 50 years ago, but they are still essential for disease control on apples. They are multi-site inhibitors that arrest fungal growth by attacking multiple biochemical pathways simultaneously. As a result, fungi do not develop resistance to these fungicides. Their weakness is that they lack post-infection activity, so they must be applied before germinating spores penetrate leaves. Captan is intrinsically more active against apple scab than are the mancozeb fungicides, but captan does not control rust diseases and is not compatible with oil. Neither captan nor mancozeb control powdery mildew.

<u>Dodine</u> (now sold as Syllit) is an old fungicide that was largely abandoned due to resistance, but it is now regaining consideration as an early-season scab fungicide. Recent work by Kerik Cox and his group at the Geneva Experiment Station has shown that resistance to Syllit is less common than was previously thought. Dodine is an excellent scab fungicide with good retention, redistribution, and anti-sporulant properties. It also provides 48 hr of post-infection activity. However, dodine does not control rust or powdery mildew. Uncertainties about where dodine-resistant strains are lurking dictates that it must always be used in combination with a contact fungicide so as to avert disaster if some dodine-resistant strains are present. A dodine-mancozeb combination can be especially useful for working around early-season oil sprays and may provide better protection during the prebloom period than programs that depend exclusively on captan and mancozeb, especially if prebloom weather generates conditions where protective fungicide coverage may have lapsed between sprays due to heavy rains or weather that precluded

timely applications. However, the maximum label rate of Syllit must be used in combination with captan or mancozeb if the objective is to inactivate visible scab lesions. Using dodine to clean up scab after it appears on leaves will create selection pressure for rapid re-appearance of dodine-resistant scab.

Anilinopyrimidine fungicides include Vangard and Scala. These fungicides work best in cool weather, do not redistribute well, and will not control scab on fruit. Thus, they work best in prebloom sprays. They provide 48 to 72 hr of post-infection activity and can be useful if applied in combinations with captan or mancozeb in prebloom sprays where some post-infection activity is needed, especially if reliability of dodine is uncertain for the orchards in question.

DMI fungicides are still effective against apple scab in many orchards. However, their reliability against scab will always be questionable because the incidence of DMI-resistant scab is gradually increasing in most orchards. Disease control failures can therefore be expected if DMI fungicides are used to arrest established scab lesions (i.e., if they are used for post-infection control of scab) in orchards with high levels of DMI-resistant scab. Even where DMIs no longer control scab, however, they still provide excellent control of rust diseases, especially quince rust, due to their extended post-infection activity against rust diseases. They may also be the best option for controlling powdery mildew, especially if they are used in the petal fall and first cover sprays. Inspire Super is the strongest scab fungicide in this group, but Inspire Super and Indar are weaker than other DMIs against powdery mildew. Rally and Topguard are the best mildewcides. For a variety of reasons, all fungicides in this group should be applied in combination with captan or a mancozeb fungicide. In orchards known to have DMI-resistant scab, the rate of the contact fungicide must be high enough to control scab without assistance from the DMI and spray intervals must be shortened to those that are appropriate for a contact fungicide program.

Strobilurin or QoI fungicides include Flint, Sovran, and Pristine. (Pristine is actually package mix of the strobilurin pyraclostrobin with another product, boscalid, that is a member of the SDHI group). These fungicides should be viewed as "super protectants" in that they work best when applied ahead of rains even though they can provide up to 48 hr of post-infection activity against apple scab. They lack post-infection activity against rust diseases, so they appear weak on rust diseases when compared to DMI fungicides. They also lack the strong post-infection and antisporulant activity that the DMIs exhibit against mildew, so they must be applied before petal fall if they will be used as the primary mildewcide during spring. Apple scab that becomes resistant to this group will show the benomyl-type of resistance where even high doses will not control the pathogen. Such resistant isolates have already been found in many orchards in Michigan and in a few orchards in New York and elsewhere. Fungicides in this group can also be useful for controlling black rot, sooty blotch, and flyspeck during summer. However, all of the product labels restrict use of these fungicides to a total of only four applications per year for any combination of products within the group.

SDHI fungicides are a new class of fungicides, with several products approaching registration. Fontelis (penthiopyrad) is being developed by DuPont. Luna Sensation is a package mix of fluopyram with Flint that will be marketed by Bayer, and BASF will be marketing Merivon, a package mix of fluxapyroxad and pyraclostrobin (the latter being the strobilurin component in Pristine). Other products in the SDHI group are being evaluated by other companies but have not yet been named. In general, the SDHI group provides good control of scab and mildew, but only marginal control of rust diseases. There is some evidence that these products may provide 48 to 60 hr of post-infection activity against apple scab. Their activity against rust diseases may be largely dependent on the protectant activity of the strobilurin or other combination product with which they are mixed. Fontelis may be sold as a stand-alone product, but it has performed best in my trials when mixed with mancozeb. Disappointment awaits anyone who is hoping that the SDHI fungicides will have all of the attributes that we came to associate with DMIs. The best seasonal timing for the SDHI fungicides remains to be determined, but overuse will almost certainly result in rapid development of SDHI-resistant apple scab. This will be especially problematic if Luna Sensation or Merivon, which are package mixes with a strobilurin, are applied in orchards that already contain strobilurin-resistant apple scab. Use of Luna Sensation and Merivon may also be limited by the 4-spray-per-season limitation on any combination of strobilurin sprays since both of these are formulated with a strobilurin fungicide.

Phosphite fungicides are sold under many different brand names such as ProPhyt, Fosphite, K-Phite, Phostrol, and Agri-Fos, as well as numerous others. We have been unable to show that the phosphites provide any advantage when added to captan or mancozeb in springtime sprays. However, when added to captan in summer sprays, that combination will control sooty blotch and flyspeck just as well as a combination of Captan plus Topsin M. Thus, a phosphite-captan combination can be used to fill gaps in summer spray programs where label restrictions on total numbers of sprays or on total lb/A/yr might limit full-summer applications of Topsin M or strobilurin fungicides. However, the phosphite fungicides do NOT enhance activity of captan against black rot and bitter rot fruit decays, so higher rates of captan are required where these pathogens are a concern than would be the case if captan were combined with Topsin M. Crops, diseases, rates, and application intervals vary with product labels, so read the labels carefully.

Fungicides for summer diseases: The combination of captan plus Topsin M has become the standard for controlling summer diseases. Topsin M is usually used at rates of 9 to 16 oz/A, with the higher end of this range required for situations where sooty blotch and flyspeck (SBFS) are especially prevalent. Rates of captan used with Topsin vary from 2 lb/A to 4 lb/A of Captan-80, with the higher rates required where bitter rot is a concern because Topsin M does not control bitter rot. Pristine applied alone is reasonably effective against bitter rot, and bitter rot control can be further enhanced by using a combination of Pristine plus 2 lb/A of Captan-80. Pristine provides the longest residual activity against SBFS and is therefore especially useful as the "last spray" of summer for late-season yellow cultivars such as Golden Delicious and Crispin. However, the residual activity of Pristine will be totally lost after 2.2 to 2.5 inches of rain, so a follow-up spray may be required in September to keep SBFS off of late-season cultivars in southern New England if heavy rains occur in early September and remove the residues of the planned "last spray" that was applied prior to the rains.

Flint initially provided excellent control of SBFS, but we have found in recent years that Flint is no longer controlling some species of sooty blotch when it is applied in late summer.

Inspire Super and Indar both provides good control of SBFS and fair control of fruit decays when applied during summer. However, using Inspire Super or Indar during summer will add selection pressure for DMI-resistant apple scab. Therefore, these fungicides should not be applied after second cover except where DMI activity against apple scab is already totally lost due to DMI-resistance.

Managing Fertility in Bramble Crops

Laura McDermott
Cornell University Cooperative Extension
Capital District Vegetable and Small Fruit Program
415 Lower Main Street
Hudson Falls, NY 12839
518-746-2562
lgm4@cornell.edu

Basic Soil Fertility Concepts

Managing plant and soil fertility in bramble crops is important for optimum production. Nutrient management is not an easy proposition as it varies from farm to farm, and even from site to site on the same farm. Soil variability, along with differences in management practices and weather make it impossible to have a menu driven protocol for farmers to follow. Farmers need to make changes according to specific situations and in order to do that they need to know the basics of nutrient management as it pertains to bramble crops.

The nutrient availability of soils is less understood by farmers than the physical differences between soil types i.e. water and nutrient retention. Soil nutrient tests are used to measure the plant-available nutrients in the soil. They do not measure the total nutrients in the soil, which often is significantly higher than what is available. The type of soil influences how much nutrients are available. If soil particles are small (clay), soil nutrient availability is higher, but those same soils may contain high levels of certain nutrients that block availability of certain nutrients.

Nutrients are available to plants as individual ions with either a positive charge (cation) or a negative charge (anion). The charge impacts how the ion behaves in the soil, for instance ammonium (NH_4^+) is retained by soil adsorption and nitrate (NO_3^-) is often leached despite the fact that both of these forms of N are available to plants. As the plant absorbs the ammonium cation, it excretes one H^+ proton so that there is a neutral charge in the plant. As those positively charged protons accumulate in the soil, the soil pH (a measure of soil acidity) drops and thus alters the availability of other plant nutrients. This is when lime and sulfur come into use. Bramble crops need a soil pH of 6.0 – 6.5, forgiving really, but when even the type of fertilizer one uses could alter the ability of the plant to access nutrients it becomes clear that soil fertility management is a challenging endeavor.

Diagnosing Nutrient Problems

Visual diagnosis is the most common means of detection of fertility problems, but it is the least reliable. Plant symptoms like poor plant vigor, pale leaf color, and distorted fruit are also symptoms of some pest and cultural problems as well as the result of many different nutrient deficiencies or toxicities. Designing a nutrient program by visual symptoms alone will likely be ineffective. Instead, growers should become familiar and comfortable with laboratory analyses. Consistent use of soil tests and foliar analysis can reveal the information necessary for good nutrient management.

- Soil Tests estimate the amount of nutrients available to plants. In order to be effective, soil test samples must be taken correctly. Farmers should be mindful of soil changes within a field and understand that in those cases, two soil tests should be done. Soil tests should be conducted in the fall of the year prior to planting. This allows nutrients and other amendments to be added and incorporated adequately before planting begins. Nitrogen is the exception to this rule. Soil test results from one lab to another cannot be compared because the extraction methods vary. Similarly, the extraction methods used for macronutrients are not appropriate for estimating levels of micronutrients, and often micronutrients cause the most problem in bramble plantings.
- Plant Tissue Testing measures the exact amount of nutrients in the plant part that was submitted at that point in time. Recommendations are based on the levels of these nutrients at specific times of the year. Depending upon the lab that you choose, sufficiency levels for a relatively "minor" crop like brambles may or may not be based on known ranges for raspberries/blackberries. However, if you refer to known sufficiency ranges separate from your lab, you can ensure that you are basing your management on research supported data. See Table 1. for sufficiency ranges.
- Plant sap testing is a new way to track N availability without waiting for results, but this does require time and regularity.

Table 1. Sufficiency ranges for foliar nutrient level in bramble leaves in midsummer (perennial systems).*

Nutrient	Deficient below	Sufficient	Excess
N %	1.9	2.0-3.0	4.0
P %	0.20	0.25-0.40	0.50
K %	1.3	1.5-2.5	3.5
Ca %	0.5	0.6-2.0	2.5
Mg %	0.25	0.6-0.9	1.0
S %	0.35	0.4-0.6	0.8
B (ppm)	23	30-70	90
Fe (ppm)	40	60-250	350
Mn (ppm)	35	50-200	350
Cu (ppm)	3	6-20	30
Zn (ppm)	10	20-50	80

* Raspberry and Blackberry Production Guide: For the Northeast, NRAES-35

A combination of soil testing and tissue analysis along with good visual observation of the crop response to fertilizer is the best approach to assessing nutrient status. Growers should test the soil prior to planting and make amendments according to recommendations. When the plant reaches maturity, conduct a foliar tissue test a minimum of every other year. Conduct soil tests every 3 years. Be alert for problems or changes that occur to the crop during the growing season.

<u>Nutrients Required for Optimum Growth</u>

Nitrogen makes up 2-3% of bramble plant dry matter. According to Table 1, if bramble leaf nitrogen is less than 1.9% N the plant is deficient and likely not very productive. Signs of N deficiency are yellow leaf color and/or tips of older leaves turning red. N toxicity is a problem if the tissue test reveals greater than 3% N resulting in plants that appear too vigorous, with few flower buds.

In newly planted fields, Calcium Nitrate is the fertilizer of choice because it has a readily available form of N that does not volatilize. In established fields ammonium nitrate supplies a quick Nitrate response and a slow release response due to the ammonium. This material has become less available than in the past, due to its explosive characteristics. Urea then is the least expensive N source, but it is subject to volatilization unless incorporated. Foliar urea can only be used in small doses, less than 2 pounds per acre of actual N. For information on N guidelines for berries, refer to Table 2.

Table 2. Nitrogen guidelines for raspberries*

Age of Planting (yrs)	Amount/Timing (actual N)	N source	Comments
Summer-bearing			
0	25-35 lb/A 4 weeks after planting	Calcium nitrate	Avoid touching plants with fertilizer after planting
1	35-55 lb/A May, or split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation
2+	40-80 lb/A May or split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation
Fall bearing			
0	25 lb/A 4 weeks after planting and in August	Calcium nitrate	Avoid touching plants with fertilizer after planting
1	50-80 lb/A split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation
2+	70-100 lb/A split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation. Adjust in response to leaf analysis

*Raspberry and Blackberry Production Guide: For the Northeast, NRAES-35

The other macro nutrients critical to bramble growth and development are Phosphorus (P) and Potassium (K). Uptake of both of these nutrients is primarily through diffusion, so the increased advantage of a large plant root mass will aid uptake.
Berries tend to have a low demand for P relative to other crops, and given that soil pH impacts P availability – pH needs to be close to 6.5 - most fields in the Northeast are not deficient. Too much P however, can interfere with micronutrient uptake. When applying P through a drip system, be aware that many sources of P are incompatible with other fertilizers.

Brambles have a relatively high demand for K and the availability of the K in the soil is very dependent on soil chemistry. Increasing soil organic matter will help to increase the exchange capacity of the soil. Pre-plant incorporation of K is the most effective, while fertigation can be used to supply potassium during the season to established plantings. Potassium levels in leaves tend to fluctuate during the season dropping as crop load increases. Adding K during the season is sometimes necessary. Potassium sulfate or potassium magnesium sulfate are the best sources of potassium for brambles. Muriate of potash is inexpensive, but it has chloride in it that causes problems with brambles.

More specific information about micro nutrients and soil management can be found in the Raspberry and Blackberry Production Guide – NRAES-35.

Cane Borers, Crown Borers, Thrips, Oh My!

Douglas G. Pfeiffer, Dept. of Entomology
Virginia Tech, Blacksburg VA 24061
540-231-4183 dgpfeiff@vt.edu

Rednecked Cane Borer, *Agrilus ruficollis* (F.)

I. Introduction: This buprestid beetle infests wild and cultivated blackberries and raspberries in the eastern states from Canada to the Gulf of Mexico. Adults are about 6-7 mm (1/4 inch) long, with an iridescent coppery pronotum. On galled plants, there is less live vegetative growth and more dead wood. There is often reduced berry size and number, as well as vegetative growth with increasing number of galls per plant. Affected canes may not produce fruit. Canes weakened by galls are more subject to winter injury.

II. Biology: Adults are present from May to August, or late April to early June, depending on the region. Females lay white spherical eggs on the trunk, and produce a yellow viscous material from the ovipositor which is smoothed over into a covering, before fading to white or grey. Larvae exit the egg directly into the plant, never becoming exposed, and so are impervious to sprays. Young larvae are restricted to the cambium, circling the cane 3-4 times in a close spiral, girdling the primocane, and producing gall-like swellings. Larvae winter in the cane, and in March create a pupal chamber. The pupa is formed in late April. The pupal period lasts 20-40 days. When the adult leaves the pupal skin, it remains in the tunnel for about 10 days before chewing a D-shaped emergence hole. Adults feed on foliage for several days before beginning oviposition. They are most easily found on the plants on warm sunny days. There is one generation annually.

III. Control: Chemical control: After leaf fall or during winter pruning, note galls. If more than 10% of the primocanes are infested, or if the number of primocanes expected to be pruned off is exceeded, a spray in justified. Examine primocanes for adults twice weekly, beginning at the beginning of bloom. Damage is minimized when Malathion 8F (2 pt/A) or Brigade 10WSB (8-16 oz/A) is applied at intervals of 7-12 days from the time the first beetles appear (early to mid May) until early June (last emergence). Cultural control: Remove galled canes in dormant season or early spring. This is most effective if nearby wild hosts are eliminated, and also more effective in open settings (wild brambles in nearby woods provide a source of wild beetles). Summer pruning also may provide a substantial reduction in rednecked cane borer infestation, since by the time new shoots appear, they have escaped much of the oviposition period of rednecked cane borer.

Raspberry Cane Borer, *Oberea bimaculata* (Olivier)

I. Introduction: This cerambycid beetle is about 12 mm (1/2 inch) long, and is black except for the pronotum which is bright orange with two black spots. The long antennae easily separate it from the rednecked cane borer.

II. Biology: Raspberry cane borer is distributed from Kansas eastward, and has been reported as being very destructive in Quebec. It infests the young shoots of raspberry, blackberry and sometimes rose. Adults appear in June, and are present until late August. After ovipositing, the female girdles 6 mm above and 6 mm below the egg puncture. Shoot tips wilt in early summer.

IV. Control: Chemical control: Just before blossoms open, either malathion 8F (2 pt/A) or M-Pede (2% solution) may be applied. Cultural control: Wilting canes or those with girdling should be destroyed. If pruning occurs within a few days of the onset of wilting, only a small amount of additional shoot need be removed.

Raspberry Crown Borer, *Pennisetia marginata* (Harris)

I. Introduction: The sesiid moth can be a severe pest to raspberry and blackberry plantings. Its cryptic nature may complicate diagnosis.

II. Biology: Eggs are laid on the undersides of new leaves, with 2-3 eggs per plant. Eggs incubate 3-10 weeks, beginning to hatch in late July (about the first week of September and continuing until early November in the northern part of its range (Canada)). The young larva spins down to the crown, where it overwinters in a hibernaculum. In the spring it tunnels into the cambium. Cracks develop at this site, from which reddish brown frass is produced in April. During the first summer, the larva feeds at the base of new canes, girdling the plant and causing gall formation. Galls are most evident in October. Moths fly from early to mid July through late September (August through September in the north). Females begin to oviposit beginning on the first day after emergence; the female lives 3-11 days, averaging about 103 eggs.

III. Control: Chemical control: Bifenthrin (Brigade 10WSB), may be used as a drench treatment for raspberry crown borer. Apply at either post-harvest (fall) or pre-bloom (spring), as a drench application directed at the crown of plants in a minimum of 50 gal water/A. Do not make a prebloom foliar *and* prebloom drench application. The most effective time of application is between October and early April. Sevin or malathion may be used as foliar sprays. Cultural control: Remove all wilted canes in June and July.

Thrips

I. Introduction: The most common species are the flower thrips, *Frankliniella tritici* (Fitch), and the western flower thrips, *F. occidentalis* (Pergande). The latter species is more damaging, has been expanding it geographic range, and may be more common. WFT infestations appear to be somewhat local and often occur in the proximity of greenhouses with a history of high incidence of WFT.

II. Injury: Thrips feed on plant cells in flowers and young fruit. This injury causes fruit to be abnormally shaped later. Caneberries and strawberries are very susceptible. In caneberries, individual drupelets may be killed. In strawberries, achenes are killed. Adjacent parts of berries do not grow, causing an apparent crowding of the achenes, termed "apical seediness". Thrips are also important vectors of many plant viruses. Thrips populations in brambles therefore pose two, and potentially three, problems. The first relates to feeding injury. Feeding by thrips can injure floral parts and also drupelets after berries are formed. Feeding in fruit may cause individual drupelets to be white. The second problem arises when high populations persist until harvest (not usually the case), and active thrips found in the harvested fruit may be a concern with buyers. The potential third problem relates to virus transmission (see below).

III. Biology: The life cycle of thrips is complex. After the egg stage, there are two feeding instars called larvae. Following these larval stages there are two non-feeding stages, called the prepupa and pupa. These are followed by the adult stage, also a feeding stage. The WFT population built up on weeds, especially clover, in and around orchards throughout the season. In areas with cold winters, thrips may overwinter as pupa in earthen cells, but in warm areas may survive as active forms all year.

IV. Chemical control: There are several chemical alternatives. Because of the tendency of thrips to develop resistance to insecticides, it is important to rotate among differing modes of action. Some pesticide labels recommend an adjuvant to improve efficacy toward thrips.

	Rate /A	Class	REI (h)	PHI (d)	
Assail 30SG	4.5-5.3 0a	4A	12	1	
Aza-Direct	12.5-42.0 fl oz	unknown	4	0	OMRI
Azera	2-3 pt	3A/unknown	12	0	OMRI
Delegate 25WG	3.0-6.0 oz	5	4	1	
Entrust 80WP	80WP	5	4	1	OMRI
Malathion 8F	1.0-4.0 pt	1B	12	1	
Provado 1.6F	8.0 fl oz	4A	12	3	
SucraShield 40	0.8-1.0%	unclass.	48	0	OMRI

The PHI value is of critical importance in caneberries. Thrips are most prevalent during bloom, but there is broad overlap between blossoming and fruit development, including harvest. Not only is proximity to harvest a concern, but bee hazard is an issue as well. Malathion is highly toxic to bees. Entrust is moderately toxic (do not apply to blossoms if bees will forage within 3 hours). Aza-Direct is relatively non-toxic to honey bees.

Pruning Raspberries and Blackberries - Summer Pruning for increased plant health, Fall pruning to prevent winter damage.

Nate Nourse
Nourse Farms
41 River Road
South Deerfield, Ma 01373
413-665-2658
nnourse@noursefarms.com

For over five years, we have reduced winter damage in summer brambles by late fall pruning. Pruning the plant mass reduces the surface area of the plantings, decreasing winter damage due to plant desiccation. I have seen virtually no winter damage in our summer red and black raspberries. Most recommendations suggest it is better to wait until spring and prune off the winter damage in summer bearing brambles. I believe that decreasing the amount of cane the plant has to support, increases the chances it has to survive the winter.

According to Kathy Demchak at Penn State University:

> "In certain situations, such as when cane diseases are an issue, it may be more valuable to remove the floricane along with the disease inoculum on them, and improve air circulation. This is especially important for growers who are growing under low spray, no-spray, or organic systems where cultural controls to manage diseases take on critical value."

At Nourse Farms, we have been very aggressive with our pruning strategy. As soon as summer berry harvest ends, we begin pruning out the old canes. I feel that plant health is the most important consideration, we try to remove all diseased canes. We select the best 6-8 canes per foot of row and attach them to the trellis with clips. We are experimenting with some varieties leaving only 4 canes per foot of row. I would recommend trying several different cane densities to see which is best for you.

Once the raspberry plants have seen a few killing frosts, we begin our fall pruning. The summer red raspberries are topped to 6 inches above the trellis wire. Our top wire is 52-60 inches above the soil for all brambles, the standard used to be 36-40 inches. On black berries and black raspberries, we cut the laterals back to 12 inches. The result has been virtual elimination of winter damage, with temperatures as low as – 15 degrees. Improving plant health and growth contributed to increased yields and profits.

Weed Management in Brambles

Bradley A. Majek
majek@AESOP.Rutgers.edu
Department of Extension Specialists
Rutgers Agricultural Research & Extension Center
121 Northville Road Bridgeton, NJ 08302

Weed control options available to grower include cultural, mechanical, and chemical weed control. Mechanical weed control methods include plowing, disking, and harrowing before planting and disking, mowing, and hand-weeding after planting. Many established perennials weeds can be controlled mechanically by starving the roots. The weed begins to send food to the roots 10 to 14 days after a shoot emerges from the soil. Repeated close mowing or shallow cultivation within 7 to 10 days after any new shoots appear can eventually kill the weed. Many repeated cultivations are usually needed. Three to six months of diligence may be needed to eliminate established perennials. A single late or missed cultivation can "save" the weed. In the short term, cultivation aerates the soil surface, which improves initial water penetration and releases nutrients from oxidized organic matter, but mechanical weed control has disadvantages. Close cultivation can injure the canes, and cultivating too deep prunes roots. Repeated cultivation destroys soil structure and reduces the organic matter content. This reduces the nutrient and water holding capacity of the soil and decreases water penetration. The long term result of constant cultivation is the lowering of the productivity of the land and is not generally recommended for that reason.

Recommended management includes eliminating perennial weeds before planting brambles, maintaining a vegetation free zone in the row, and establishment of a perennial grass sod between the rows. Integration of vegetation management with insect and disease control programs is essential. Maintain the vegetation free zone in the row to prevent competition with the crop. The width of the vegetation free zone should be about forty percent of the distance between the rows. The width may vary, however, depending on soil fertility, water holding capacity and exposure to erosion. Do NOT reduce the width of the vegetation free zone in new plantings. Maintain the full width of the vegetation free zone in new plantings to achieve maximum growth.

Sod between the rows prevents soil erosion, provides traction for equipment, increases soil organic matter, improves soil structure and water permeability, and furnishes shelter for beneficial insects. The sod should not include plants that are an alternate host for insect pests, or diseases and nematodes that attack the crop. In addition, the sod should be easily maintained, tolerant to drought, require little or no fertilization, and compete minimally with the crop.

Tall fescue or hard fescue perennial grass sods are recommended for row middles. Both types of fescue are tolerant to disease, drought, low pH and low fertility. They compete effectively with weeds, do not spread or creep into the row by rhizome or stolen growth, and are semi-dormant during the hot dry summer months. Tall fescue is more vigorous and is more easily established, but requires more frequent mowing. Newly developed "turf type" tall fescue varieties are vigorous, and have a lower mowing requirement than the traditional 'Kentucky 31' tall fescue. Hard fescue grows more slowly and close to the ground, and has a minimal mowing requirement, but is moderately slow and difficult to establish.

The addition of clover or other legumes is not recommended. Although legumes do fix nitrogen, release for plant use unpredictable, and often at the wrong time of year. Legumes may also be alternate hosts for pests, including insects, nematodes, and diseases.

Preparation for sod establishment should begin the year before the crop is planted. Control perennial weeds and nematodes, and correct soil pH and nutrient deficiencies first. Complete primary tillage during the summer months. Consider building gently sloping raised ridges to improve drainage in the future rows **before** sowing grass. Fields planted flat have developed depressions in the row between the strips of sod due to the improving soil structure in the sod compared with the vegetation free strip.

The success of a sod planting will depend on accurate seeding and timing. Sow tall or hard fescue in late summer into a well prepared seedbed. Use 50 to 75 pounds of seed per broadcast acre to establish tall fescue, or 25 to 50 pounds of seed per broadcast acre to establish hard fescue. Blend up to five pounds of perennial ryegrass per one hundred pounds of hard fescue seed to provide a fast thin cover while the hard fescue gets established. The perennial ryegrass will be eliminated from the stand by disease and drought in a few years.

Use a seeder manufactured to sow grass and other similar sized seed that will ensure proper seed placement, a firm seedbed, and good seed and soil contact. Failure to use adequate equipment for seeding frequently results in poor establishment. Do not use a "spinner spreader" to distribute the seed. Fescue seed that lands in the crop rows will establish and may be difficult to control. Seeding should be completed by September first in the northern counties of New Jersey, and by September twentieth in the southern counties. Apply 50 pounds of nitrogen (N) per acre at seeding and repeat in late fall or early spring to encourage rapid establishment.

Excellent results have been obtained by seeding perennial grass in the future crop row as well as between the rows. Use one hundred percent perennial ryegrass in the row rather than fescue. Rapid establishment and growth, and susceptibility to herbicides make perennial ryegrass a better choice. Kill the sod in the row when the crops to be planted and "no-till" the bramble into the dead sod. Use recommended herbicides to control weeds. The sod's roots increase soil organic matter, and improve soil structure and water permeability before it is killed, and acts as a mulch to conserve water and prevent erosion during the establishment year. By fall the dead sod deteriorates and is not attractive to rodents.

Establishment of a dense sod that is competitive with weeds will require fifteen to twenty months. Some additional effort during this period will ensure success. The year before the crop is planted, apply 2,4-D in late fall eight to ten weeks after seeding the grass. Use 0.25 to 0.5 pints of 2,4-D per acre to control seedling annual broadleaf weeds. Apply Gallery 75DF to the sod early the first spring to control large crabgrass and other weeds while the sod establishes. Use Gallery 75DF at 1.0 pound of active ingredient per acre. The Gallery 75DF rate is the same as the rate labeled for use in the row for newly planted nonbearing blackberries and raspberries.

In row weed control the establishment year requires extra care not to injure crop. Surflan 4AS or Devrinol 50 DF plus Gallery is safe and effective after transplanting conventional plants. Planting tissue culture plants, and other planting systems that use plants that are smaller or less vigorous than conventional plants should not be treated with a herbicide until well established. Consider planting into black plastic mulch to aid establishment, and remove the plastic later, but do not use Surflan under plastic mulch.

After establishment, treat brambles with a combination of herbicides to provide residual grass and broadleaf weed control in late fall and/or in early spring, before buds break. Add a postemergence herbicide, if needed to control emerged weeds. Solicam 80DF, Surflan 4AS, or Devrinol 50DF are good residual annual grass herbicides. Solicam will also suppress certain perennial grasses and yellow nutsedge when used at the maximum recommended rate. Princep, Sinbar, and Casoron are residual annual broadleaf weed herbicides. Princep can be applied in late fall or spring. Sinbar leaches more readily, especially in sandy coarse textured soils low in organic matter, and should only be used in the spring before bud break. Casoron is a granular formulation that must be applied in late fall or winter when the crop is dormant, but Casoron controls perennial as well as annual broadleaf weeds.

Gramoxone Extra is a non-selective postemergence herbicide that can be used to control emerged seedling weeds when the crop is dormant. Young growing bramble shoots will be killed or severely injured if sprayed. Poast, Fusilade DX, and Select are postemergence herbicides that control most grasses, but will not injure brambles, or control broadleaf weeds and yellow nutsedge. Select is only for use on non-bearing brambles, but will control tall and hard fescue. Poast and Fusilade DX are labeled for use on bearing brambles, but will not control or even significantly injure tall or hard fescue.

Roundup formulations, Touchdown, and other labeled glyphosate formulations are translocated non-selective postemergence herbicides that should only be used with extreme care in brambles. Application of either of these herbicides to only a few leaves or a small section of green cane may result in death of the plant or severe injury that may persist for more than one year. Apply only as a spot treatment to control difficult perennial weeds.

Effectively Managing Cucurbit Mildews: What You Need to Know

Margaret Tuttle McGrath

Department of Plant Pathology and Plant-Microbe Biology, Cornell University
Long Island Horticultural Research and Extension Center,
3059 Sound Avenue, Riverhead, NY 11901. 631-727-3595. mtm3@cornell.edu

Producing a high-quality cucurbit crop necessitates effectively managing powdery mildew and downy mildew. These two foliar, fungal diseases are common in the northeast because the pathogens produce spores easily dispersed by wind that enable them to spread widely. Crops often are affected by both. While neither pathogen affects fruit directly, they cause leaves to die prematurely which results in fewer fruit and/or fruit of low quality (poor flavor, sunscald, poor storability).

Powdery mildew is managed with resistant varieties and fungicides. An integrated program with both management tools is needed to achieve effective control because the pathogen is adept at evolving new strains resistant to individual tools that thus are not controlled as well by the tool. It is more difficult for new pathogen strains to develop when an integrated program is used, and effective control is more likely. Resistant varieties have not provided as effective control in recent years as before. But they remain an important tool. There are now resistant varieties in most crop groups with new varieties released most years. Select cantaloupes with resistance to pathogen races 1 and 2. Select squash and pumpkins with resistance from both parents (homozygous resistance) when possible. This term is used in a few catalogues (for example Outstanding Seeds) whereas others use terms like ‘high resistance’ and ‘intermediate resistance’ to generally refer to homozygous and heterozygous resistance, respectively. Degree of disease suppression obtained with a variety also depends on modifying genes present. Plant breeders are actively searching for new sources of resistance to powdery mildew.

The most effective fungicide program for powdery mildew is weekly applications of targeted, mobile fungicides tank mixed with a protectant fungicide beginning very early in powdery mildew development. Mobile fungicides are needed for control on the underside of leaves where the pathogen develops best. The action threshold for starting applications is one leaf with symptoms out of 50 older leaves examined. Powdery mildew usually begins to develop around the start of fruit production. Alternate among targeted fungicides and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. Some fungicides are no longer recommended because resistant pathogen strains are sufficiently common to render them ineffective: Topsin M (FRAC code 1; MBC fungicide) and QoI fungicides (Code 11), which include Quadris, Cabrio and Flint. Other fungicide chemistry has remained adequately effective to include in a fungicide program although the pathogen has developed some resistance, in particular the DMI fungicides (Code 3), which include Procure, Rally, Tebuzol, Folicur, and Inspire Super. They remain effective partly because resistance to this group is quantitative, whereas to the Code 1 and 11 fungicides it is qualitative (pathogen is sensitive or resistant), and these DMI fungicides are inherently more active than the first DMI fungicide, Bayleton, which is no longer registered for this use because of control failures due to resistance. Highest label rate is recommended when resistance is quantitative or might be (generally assumed to be until known). Procure applied at its highest label rate provides a higher dose of active ingredient than the other Code 3 fungicides. This fungicide was effective in the yearly fungicide efficacy experiment conducted on Long Island in 2011. Quintec (FRAC Code 13) has been the most consistently effective fungicide in fungicide evaluations, therefore it is recommended as the main mobile fungicide to use on labeled crops (pumpkin, winter squash, gourd, melon) where the crop rotational restriction of 12 months is acceptable. Recent crop additions to the Quintec label have increased the options of what can be planted within 12 months of the last application. The Quintec label specifies no more than two consecutive applications plus a crop maximum of four applications. FRAC Code 7 is the third fungicide chemistry recommended for managing powdery mildew. Boscalid is the only active ingredient in this fungicide group labeled currently for this use. It is in the product Pristine. While highly resistant pathogen strains have been detected, Pristine has continued to provide some control, including in the Long Island 2011 evaluation when it was as effective as Procure.

Prospect looks good for improved control of powdery mildew in the future. There are new mobile fungicides on track for registration soon that are highly effective for powdery mildew. Similar to the targeted, mobile fungicides currently in use, they do have risk of resistance developing because they have single site mode of action. Therefore it will be critical to always use a resistance management program. Hopefully these fungicides will be registered before the pathogen has developed resistance to Quintec so that all can be used together in a fungicide resistance management program. Vivando, which is being developed by BASF, has the novel active ingredient metrafenone. It is a FRAC code U8 fungicide. 'U' designation means it is unknown more of action. It was registered in the US in 2011 with approval for use on grapes. Additional crops including cucurbits are anticipated to be labeled in 2013. Resistance risk is considered medium; elsewhere strains of the wheat powdery mildew pathogen have been detected with reduced sensitivity. Torino, being developed by Gowan, is another product with a unique active ingredient unlike other fungicides. It is cyflufenamid, a FRAC code U6 fungicide. US federal registration is pending and anticipated in spring 2012 for cucurbits, grapes, and strawberries. The cucurbit powdery mildew pathogen has developed resistance elsewhere in the world where already registered. Like Quintec, both of these fungicides are only effective for powdery mildew diseases. Three new fungicides in development have an active ingredient that belongs to the carboxamide class of fungicides (FRAC Code 7), which is the same as boscalid. However, these fungicides have been more effective than Pristine in fungicide evaluations documenting differences in activity. Fontelis (aka LEM17), developed by DuPont, contains penthiopyrad. Federal registration is expected before the end of 2011, thus it will be the first new carboxamide available. The carboxamide ingredient in Merivon is fluxapyroxad. This product also contains pyraclostrobin. It is being developed by BASF. EPA approval is anticipated for the first label with pome/stone fruit in early 2012 and for additional crops including cucurbits in 2013. Bayer Crop Science has the ingredient fluopyram in their Luna series fungicides. Luna Experience is anticipated to be registered before the 2012 growing season but only on watermelon; other cucurbit crops will be added subsequently. Pristine, Merivon, Fontelis, and/or Luna Experience should not be used in alternation because they all have an active ingredient in the same chemical group (Code 7). This chemistry is also effective for gummy stem blight/black rot.

Downy mildew is primarily managed with fungicides. Resistance bred into cucumbers provides some suppression of the pathogen strains present recently, but substantially less that what was achieved against strains present before 2004. However, they are still considered a worthwhile component of an integrated program. Plant breeders are searching for new sources of resistance. As with powdery mildew, fungicide resistance is also a concern with the downy mildew pathogen and therefore the fungicide program recommended for downy mildew is also targeted, mobile fungicides applied in alternation on a weekly schedule and tank mixed with a protectant fungicide beginning very early in disease development. Resistance to mefenoxam and metalaxyl and to strobilurins is sufficiently common that fungicides with these active ingredients (e.g. Ridomil and Cabrio), which use to be highly effective, are no longer recommended.

The full list of mobile fungicides with different modes of action recommended for managing downy mildew includes: Ranman (FRAC Code 21), Forum (40), Revus (40), Presidio (43), Curzate (27), Tanos (27), Gavel (22), and Previcur Flex (28). These have been registered for this use in the US for a few years. Concern about resistance developing to single site mode of action fungicides like these increases with use. Alternating among fungicides in different FRAC Groups (different codes) and tank-mixing them with a protectant fungicide (except for Gavel which contains mancozeb) is recommended for delaying resistance development, minimizing the impact of resistance when it occurs and it is often required to comply with the restrictions on most labels. Curzate and Tanos have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). Presidio has an advantage over Curzate and Previcur Flex of also being effective for Phytophthora blight. Both diseases are often of concern for most cucurbit growers. Presidio has a long rotational interval of 18 months for non-labeled crops, which can be a constraint on production. All cucurbits, fruiting vegetables, tuberous and corm vegetables (except potato), and leafy vegetables are now labeled; carrot, sugar beet, potato and rotational wheat will be labeled soon; and rotational field corn is expected in 2012. All of the mobile fungicides listed above have proven effective in university fungicide efficacy evaluations. Efficacy of Revus has varied among crop types with control being good on pumpkin but poor on cucumber. Based on results from an analysis of all published data from these evaluations, Presidio is the most effective fungicide, followed by Previcur Flex and then Ranman. All of the mobile fungicides are at risk for development of fungicide resistance because of their single site mode of action. And the downy mildew pathogen is considered prone to developing resistance. Resistance to the active ingredient in Tanos and Curzate has been detected in Europe. The analysis of fungicide efficacy data also revealed that combining mobile fungicides with a protectant fungicide improved control; thus there is an additional benefit to this standard practice for managing resistance. None of the downy mildew fungicides are effective for powdery mildew unfortunately.

A new mobile fungicide developed by BASF, Zampro, is anticipated to be registered during the later part of 2012 for use on cucurbits as well as potatoes, grapes, brassicas and fruiting vegetables. It is effective for Phytophthora blight as well as downy mildew. Zampro contains new fungicide chemistry, ametoctradin (FRAC code 45), plus dimethomorph (40), the active ingredient in Forum. Once this fungicide is registered it will be recommended as a component of the fungicide program in place of the code 40 fungicide being used.

Chlorothalonil and mancozeb are the main protectant fungicides for downy mildew. Copper is not as effective. Dithane now has a supplemental label that includes pumpkin, winter squash and gourd.
An important tool for determining when fungicide application is warranted is the forecast web site for this disease at http://cdm.ipmpipe.org. Cucurbit plants are susceptible to downy mildew from emergence; however, this disease usually does not start to develop in the northeast until later in crop development when the pathogen is dispersed by wind into the region. The forecast program monitors where the disease occurs and predicts where the pathogen likely will be successfully spread. The pathogen needs living cucurbit crops to survive, thus it cannot survive where it is cold during winter. The risk of downy mildew occurring throughout the eastern US is forecast and posted three times a week. Forecasts enable timely fungicide applications. Growers can now subscribe to receive customizable alerts by e-mail or text message. Information is also maintained at the forecast web site of cucurbit crop types being affected by downy mildew. This is important because the pathogen exists as pathotypes that differ in their ability to infect the various crops. All pathotypes can infect cucumber; some also can infect melons and squashes are susceptible to others. Success of the forecast system depends on knowledge of where downy mildew is occurring; therefore prompt reporting of outbreaks by growers is critical.

In conclusion, to manage the mildew diseases effectively in cucurbit crops: 1) select resistant varieties, 2) sign up to receive alerts about downy mildew occurrence and routinely check the forecast web site to know where the disease is occurring and what crops are affected, 3) inspect crops routinely for symptoms beginning at the start of crop development for downy mildew and fruit development for powdery mildew, 4) apply protectant fungicides when there is a risk of disease development, and 5) beginning when these diseases start to develop, apply targeted fungicides weekly and alternate amongst available chemistry based on FRAC code. Unfortunately there are no targeted fungicides effective for both mildew diseases because the causal pathogens are biologically very different. Add new fungicides to the program when they become available; substitute new for older product if they are in the same FRAC group.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Note that some products mentioned are not yet registered for use on cucurbits. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

VARIETY SELECTION, CULTURE, AND STORAGE FOR MAXIMIZING EATING QUALITY AND NUTRITION IN SQUASH

J. Brent Loy
Department of Biological Sciences, University of New Hampshire, Durham, NH 03824
Email: jbloy@unh.edu

Three major species of squash are grown worldwide for their mature, edible fruit – *Cucurbita pepo*, *C. maxima*, and *C. moschata*. The species *C. moschata* includes tropical cultigens called calabazas in the Caribbean basin, round to oval to long neck pumpkins grown in parts of North America for processing, and the dumbbell-shaped butternuts, the major fresh market type grown in the Northeast. The species *C. maxima* includes huge show pumpkins, Golden Delicious-type processing squash, Hubbard varieties, and the green to gray, 2 to 3 pound buttercup/kabocha varieties esteemed for their exceptional eating quality. The species *C. pepo* gives us acorn and related varieties such as 'Sweet Dumpling' and 'Delicata' types. Cultural methods for the above species of squash are similar, but for optimum eating quality and nutrition, harvesting schedules and post-harvest handling need to be tailored according to the species and varieties being grown.

What are the key nutrients in winter squash?

Growers can and should identify nutritional benefits of their produce as a marketing tool and service to customers. Carbohydrates in the form of sugars and starch are the major constituents of squash flesh (mesocarp), comprising between 50% to as much as 70% of the dry biomass (solid portion after elimination of water) at harvest (Table 1). Varieties with a high content of dry matter (17-26%) have better eating quality than those with low dry matter content because their high starch content and a low proportion of fibrous cell wall material. Starch contributes to a desirable pasty and sometimes flaky texture of cooked squash, and generates sugars during enzymatic breakdown.

Table 1. Percentage dry weight composition of the edible portion of buttercup and butternut squash at harvest and after 3 months of storage (adapted from T.G. Phillips, 1945).

	Percent of Total	
Component	**Harvest**	**3 Months**
Carbohydrates	62-68	57-62
Starch	52-53	14-19
Sugars	10-15	43
Cell wall (cellulose, pectin)	9-10	13-17
Protein	5-6[z]	6-8[z]
Ash (mineral elements)	5-6[y]	5-6[y]
Other	10-16	8-19

[z]Values overestimated because of high soluble N content.

[y]Data obtained from other sources.

In cooking tests, high sugar content is strongly associated with high ratings for eating quality. The sugar content at harvest can vary from over 20% in some acorn varieties to 10% or less in some kabocha and butternut varieties. The relative sugar content can be estimated using a hand-held refractometer, with values given in % soluble solids (SS). Acceptable eating quality is generally attained when SS values are 11% or higher. If starch levels are sufficiently high, sugar content will progressively increase during storage until most of the starch is consumed. In varieties with low starch content, starch is rapidly depleted in storage, and often sugar content of flesh does not reach acceptable levels. In such varieties, flesh texture deteriorates, becoming more watery and fibrous and less pasty.

Other than providing carbohydrates and dietary fiber, the major nutritional benefit of squash is the high content of carotenoids, the yellow to orange, fat-soluble pigments. Beta-carotene, an abundant carotenoid in several varieties of squash, is an important precursor to vitamin A, an essential vitamin for normal development and eye function. Xanthophyll carotenoids, lutein and zeaxanthin, accumulate in the macular region (central portion of the retina) in the eye, and provide photo-protection. Jennifer Noseworthy, a doctoral student at UNH has been studying carotenoid content and carotenoid profiles in squash and sweet potato. She has found that the carotenoid content in the popular butternut variety 'Waltham,' is comprised of a relatively high proportion of lutein (27 to 37%) and β-carotene (19 to 23%) at harvest. Carotenoid levels were appreciably higher in the kabocha/buttercup varieties analyzed than in butternuts, but over 50% of the carotenoids in kabocha varieties are considered non-beneficial to human health. There may be considerable variability in types of carotenoids in different varieties of squash.

Squash maturity and harvest

The three popular classes of winter squash, kabocha/buttercup, butternut and acorn, differ in their nutritional and eating properties relative to recommended harvest and storage periods. All three classes attain maximum starch content between 30 and 35 days from fruit set (when female flowers open and pollination occurs). Seed development is not completed until about 55 days after fruit set, and so a continuous supply of sugars from leaf photosynthesis or from breakdown of starch in the flesh is needed for the process of seed fill. A general rule of thumb is to wait at least 50 to 60 days after fruit set for removing the fruit from the vine, as long as the vines are healthy.

Butternut varieties will turn tan color about two weeks before the fruit should be harvested. Butternut can be harvested when fruit first turn tan color, but they will have to be stored longer to attain sufficient sugar levels and the flesh quality (% dry matter) often show a more pronounced decrease than if squash were harvested at 55 to 60 days after fruit set. Butternut varieties grown in most regions of New England should be stored for about two months (50 to 60 ^{o}F) to attain sufficient sugar levels. The starch to sugar conversion can be accelerated by storing squash for one to two weeks at 80 to 85 ^{o}F, prior to storing at the recommended lower temperature for long-term storage.

Buttercup varieties harvested at 55 to 60 days after fruit set will sometimes have soluble solids levels of close to 11%; however, it is usually advisable to store the squash for an additional two weeks to acquire higher sugar levels. Moreover, many kabocha squash have excessive dry matter at harvest for good eating quality, and should be stored for a month of more to allow for some loss in dry matter through respiration and for additional sugar accumulation. Because most kabocha varieties have extremely high starch reserves, harvest at 40 days after fruit set is often recommended. The earlier harvest reduces the likelihood for sunburn damage, and studies in New Zealand suggest that kabocha squash are less susceptible to storage rots if harvested early. I usually recommend that kabocha be harvested when the ground-spot on the fruit turns orange; this occurs about 45 to 50 days after fruit set.

Acorn squash are somewhat of enigma in that fruit reach full size and a dark green color within two to three weeks after fruit set, about 4 or 5 weeks before they should be harvested! Consistent quality is difficult to achieve in many acorn varieties. Vining varieties such as Sweet Dumpling and Delicata usually have fairly consistent quality if fruit loads are not too heavy. Most of the semi-bush to bush commercial varieties lack consistent quality and many will never produce fruit with good eating quality under any cultural conditions. The table below shows results from a replicated field study conducted at UNH in 2011, comparing some of the newer commercial acorn varieties with powdery mildew resistance. We compared several acorn varieties with a natural fruit load to those in which fruit set per plant was limited to three fruits Table 2. Although not a recommended practice, we wanted to look at changes in eating quality with reduced fruit loads. Reducing fruit load was expected to improve eating quality because of enhancement of starch levels in plants with smaller fruit load. If 15% flesh DM is considered necessary to have passable quality in acorn squash and 17 to 20% DM and greater than 11% soluble solids is considered necessary for very good to excellent eating quality, it is readily apparent that some of the more popular varieties do not pass muster. Some other relationships are readily apparent from Table 2. Acorn varieties with high dry matter have high sugar content at maturity, and adequate soluble solids (sugar) levels are reached at harvest. Another important relationship evident from Table 2 is that varieties with high dry matter and good eating quality do not produce as high as fresh weight yields as varieties with low dry matter and poor eating quality. It should also be pointed out that even in varieties which are known for superb eating quality, there can be considerable plant to plant variation in eating quality, and variability among fruit from a single plant. When evaluating new hybrid combinations, we always look for consistent quality for whatever traits are being evaluated.

Table 2. Fruit size, fruit yield, % dry matter, and soluble solids levels in six hybrid varieties of squash grown at the Kingman Research Farm in Madbury, NH in 2011 (NH1669 is an experimental hybrid with semi-bush phenotype and powdery mildew resistance).

Hybrid	Ave. Fruit wt. (g)	FW Yield kg/plot	% Dry Wt.	% SS
Unpruned				
Honey Bear	645 A	6.08 A	15.4 D	11.5 D
NH1669	761 B	6.46 A	20.4 E	14.4 E
Table Star	756 B	9.68 BC	11.6 C	8.8 C
Royal Ace	786 BC	8.59 B	9.8 B	8.1 AB
Tip Top	857 C	8.74 B	12.5 C	9.5 C
Autumn Delight	981 D	10.76 C	8.0 A	6.9 A
Pruned				
Honey Bear	602 A	5.13 A	20.6 E	14.4 D
NH1669	757 B	6.81 B	20.4 E	14.9 D
Table Star	791 B	6.74 B	15.4 D	11.6 C
Royal Ace	792 B	7.13 BC	11.4 B	9.0 A
Tip Top	905 C	7.89 BC	13.8 C	10.5 BC
Autumn Delight	995 C	8.47 C	10.4 A	8.7 A

Abbreviations: Ave. Fruit Wt. – average fruit fresh weight; FW Yield = fresh weight total yield per plot in kilograms (1 kg = 2.2 pounds); % Dry Wt. (dry weight); % SS (soluble solids).
Values within a column with a different letter are significantly different at P = 0.05..
Pruned plants were pruned to a maximum of three fruits per plant.

Conclusion

The three major classes of winter squash - acorn, kabocha/buttercup, and butternut – have different attributes associated with maturation and post-harvest changes in eating quality and nutrition. It is important for growers to understand these differences in order to use proper harvesting and post-harvest methods, and also to provide information to customers that will guide them in purchasing and utilizing squash for optimum culinary and nutritional benefits. In addition to species differences in maturation, there are also considerable varietal differences with respect to eating quality and consistency in eating quality. It behooves growers to become more aware of those varieties which exhibit good eating quality so that their customers are satisfied with their purchases, and realize the benefits of purchasing produce at roadside retail markets. Growers should not view squash as just a fill-in vegetable to market in the fall, but as an item they can market as a culinary delight with excellent nutritional benefits.

GROWING SEEDLESS WATERMELONS

Alan Schwartz – Tower Hill Farm
276 Ames Street, Lawrence, MA 01841
(978) 688-2878 alan.schwartz@bostonhousing.org

Watermelons have come a long way since the discovery of their seedy fruits. Through the wonders of science, we now have seedless varieties. How are these seedless watermelon seeds produced? They are created by crossing a tetraploid (seedless) inbred line female parent with a diploid (seeded) inbred line male parent. The resulting varieties are available in various shapes, sizes and colors.

Several factors differentiate seedless from seeded watermelons. First, a pollinator is required. These specially bred melons bloom early, produce large quantities of pollen, and are smaller than the desired melons. Ace and Companion are just two of the pollinators available. Seedless melons also lack the vigor of regular varieties. The seed is expensive and must be handled with great care. It has a greater chance or rotting if certain conditions are not met. A sterile soilless mixture is required. Because the seedlings don't do well if their roots are disturbed, the seed must be planted directly into peat pots. Fill the pots with well moistened, but not wet, soilless starting mixture. Warm the pots to 90 degrees and hold them at that temperature for four days.

It is now time to plant the seedlings. To keep track of the seedlings, make separated plantings of the seedless variety and the pollinator. To insure good fruit set, plant three seedless to one pollinator. Plant the narrow seed, tip down, ½ inch into the soil. Cover the containers with a thin layer of clean sand. This will help maintain soil temperature and moisture.

As soon as the plants emerge, lower the temperature to 75 degrees. Gradually, harden off the seedlings. When the threat of frost is completely gone and the plants have their second set of leaves, plant the pots in raised beds fertilized with 15-15-15 or its organic equivalent at the rate of six pounds per 1,000 feet of row. Black plastic or paper mulch can be applied before planting. Row covers can also be used, but only after the plants have established themselves. Otherwise, the plants will cook. Space the pots with two feet between plants and six feet between rows. To prevent the peat pots from drying out, be sure to cover them with soil. Inter space the triploid with the pollinator. Apply a liquid starter fertilizer.

When the vines begin to run, side dress the plants with nitrogen at the rate of forty pounds per acre. For the rest of the season, watermelons require limited care. They will tolerate drought, but lack the vigor to outgrow weed competition. Beds must be free of weeds. Careful cultivation is required to protect the plants' shallow root system. The use of bees will make for earlier fruit set and increased yields. Two hives per acre are suggested.

If you have followed all these tips and have a bountiful crop, how do you tell when the melons are ripe? There are three signs. First, the bottom of the melon will turn yellow. Second, the tendril closest to the fruit will be brown. Third, when tapped, the melon will make a thumping sound.

The implementation of the tips outlined in this presentation will help you to meet the increasing consumer demand for seedless watermelons.

Choosing the Best Varieties: Zucchini, Summer Squash, and High Tunnel Cucumbers

Becky Sideman, UNH Cooperative Extension
G48 Spaulding Hall, 38 Academic Way, Durham NH 03824 or becky.sideman@unh.edu

The difference between success and failure with a crop often hinges upon variety choice.
In this talk, I will present the results from two years of variety trials conducted in Durham, NH. This will include green and yellow zucchini, summer squash, and high tunnel cucumbers.

Zucchini

In 2010 and 2011, eleven green and five yellow zucchini varieties were evaluated in a replicated field trial. Fruits were harvested every Mon, Wed and Fri from 7/2-8/20 in 2010, and from 7/11-8/19 in 2011. Season-long results from both years are shown below:

Cultivar[a]	Color	Rank Order Yield (no. fruit)[b]		Rank Order Yield (weight)		Rank Order Avg. fruit size	
Green Zucchinis		**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
Cashflow (JSS)	Medium green	3	2	1	1	5	8
Dunja (HM)	Dark green	-	13	-	11	-	5
Midnight Lightning (HM)	Dark green	8	8	9	10	8	9
Partenon (JSS)	Medium green	-	12	-	9	-	4
Payroll (SW)	Medium green	4	4	4	4	4	6
Plato (JSS)	Dark green	5	3	7	5	6	10
Reward (H)	Medium green	1	6	2	8	7	7
Spineless Beauty (H)	Medium green	9	11	5	6	2	2
Spineless Perfection (R)	Dark green	-	10	-	7	-	3
Tigress (H)	Medium green	5	5	3	2	3	1
Zucchini Elite (H)	Medium green	10	-	6	-	1	-
GoldenYellow Zucchinis							
Golden Delight (R)	Bright yellow	-	9	-	13	-	12
Golden Glory (R)	Bright yellow	-	7	-	12	-	11
Golden Rod (H)	Bright yellow	-	1	-	3	-	13
Meteor (JSS)	Bright yellow	2	-	8	-	9	-
Sebring (JSS)	Bright yellow	7	-	10	-	10	-

[a] Seeds provided by or purchased from Harris Seeds (H), High Mowing Seeds (HM), Johnny's Selected Seeds (JSS), Rupp (R) or Seedway Seeds (SW).
[b] Ranks range from 1 = greatest to 10 or 13 = least.

Of the green zucchinis, Reward, Cashflow, Payroll, Tigress and Plato were among the four top yielding varieties in at least one year. Across both years, Cashflow and Payroll consistently had the highest yields (both in terms of number of fruit and weight). Zucchini Elite, Spineless Beauty, Spineless Perfection, Dunja, Partenon and Midnight Lightning were among the lowest yielding varieties; several of these (Zucchini Elite, Spineless Beauty, Spineless Perfection, as well as Tigress) had the largest fruits, which may have reduced fruit set.

In general, the yellow zucchini varieties produced smaller fruits and had lower yields. However, two yellow varieties outperformed most green varieties. In 2010, Meteor had the second highest yields in the trial; and in 2011, Golden Rod had the highest yields (over 25 fruit per plant).

On August 9, 2011 each plot was evaluated for powdery mildew (PM) severity on a 0-5 scale (0 = no visible sporulation, 5 – all leaves and petioles show heavy sporulation). Only two varieties showed consistent tolerance; Dunja (all plots had a rating of 1), and Golden Glory (all plots were rated 2). All other varieties had average ratings of 2.5 or greater.

Yellow Summer Squash

In 2010 and 2011, ten varieties of summer squash were evaluated in a replicated trial along with zucchini cultivars (described above). Season-long results from both years are shown below:

Cultivar[a]	Color	'B' gene[b]	Rank Order Yield (no. fruit)		Rank Order Yield (weight)		Rank Order Avg. fruit size		Comments
			2010	**2011**	**2010**	**2011**	**2010**	**2011**	
Cheetah (H)	Yel	-	-	8	-	5	-	3	Slender, smooth fruit.
Cougar (H)	Yel	B	3	4	2	3	2	2	Rough, teardrop shaped fruit. Spiny plant.
Enterprise (SW)	Yel	-	5	7	4	7	2	4	Smooth, tapered fruit. Extremely spiny plant.
Fortune (SW)	Yel	B	2	1	3	2	6	8	Slightly ridged; teardrop-shaped golden fruit.
Goldprize (R)	Yel	-	-	6	-	4	-	1	Tapered, fairly smooth yellow fruits.
Slick Pik (JSS)	Yel	-	6	3	6	8	5	7	Slender elongated fruit. Smooth stems.
Success PM (HM)	Yel	-	8	5	8	6	4	6	Smooth, teardrop-shaped fruit. Tall plant, not PMR in 2011.
Sunray (H)	Yel	B	4	-	7	-	6	-	Similar to Fortune; but with shorter fruits
Superpik (H)	Yel	B	1	2	1	1	8	5	Long, rough fruit. Extremely spiny plants.
Zephyr (JSS)	Yel/ Grn	-	7	-	5	-	1	-	Smooth, long yellow fruit w/light green tips and pale stripes.

[a] Seeds provided by or purchased from Harris Seeds (H), High Mowing Seeds (HM), Johnny's Selected Seeds (JSS), and Seedway Seeds (SW).
[b] The 'B' or 'precocious' gene causes the stem of the squash to be yellow rather than green. Varieties with this gene do not show symptoms when infected by viruses. These leaves of these varieties may turn bright yellow under certain environmental stresses, as they did in June 2011.

Over both years, Superpik and Fortune produced significantly more fruit per plant (over 29 fruit per plant, on average) than the lowest producing summer squash, Success PM (20.5 fruit per plant, on average). In 2011 each plot was evaluated for PM severity as described above. All summer squash varieties, including the PM tolerant Success PM, were moderately susceptible, with average PM ratings of 2.5 or greater. Fruit appearance and shape, and ease of picking, were highly variable between the varieties we tested.

High Tunnel Cucumbers

In 2010, fourteen varieties of cucumbers were evaluated in a high tunnel in Durham NH. They were trellised and pruned to a single leader. Yields, quality, and susceptibility to powdery mildew and mites were assessed. Season-long results are shown below:

Cultivar[a]	Type	No. fruits per plant	% Not market able	Yield (lbs) per plant	PM[b]	Mite[c]	Comments
Genuine (JSS)	Slicer	27.3	13.3	13.7	1	0	
Green Finger (HM)	Slicer	*9.3*	*31.3*	*8.2*	0	0	Poor fruit set.
Saber (HM)	Slicer	30.5	17.2	12.8	1.3	0	
Tasty Jade (JSS)	Slicer (long)	26.7	21.2	15.4	1.3	0	
Tasty Green (S)	Slicer (long)	*15.8*	*31.5*	*8.6*	0	0.7	Poor fruit set.
Carmen (S)	Oriental	18.2	19.3	9.5	0	3.0	No spines.
Orient Express (H)	Oriental	31.1	16.2	16.7	0.7	0.3	
Orient Express II (S)	Oriental	28.4	18.7	15.9	1.7	0	
Ballerina (SW)	Pickle	37.3	13.5	*9.2*	0	2.5	
Diamant (JSS)	Pickle	27.1	9.2	*8.2*	0.7	2.7	Extremely spiny.
Vertina (JSS)	Pickle	42.8	11.7	10.5	0	2.7	
Diva (H)	Beit alpha	22.1	22.7	9.5	0	0.3	
Katrina (JSS)	Beit alpha	32.8	21.4	11.2	0	5.0	
Socrates (JSS)	Beit alpha	33.3	20.0	13.7	0	3.7	

[a]Seeds provided by or purchased from Harris Seeds (H), High Mowing Seeds (HM), Johnny's Selected Seeds (JSS), Seedway Seeds (SW) and Stokes Seeds (S).
[b]PM (Powdery mildew) was evaluated on a 0-5 scale on 7/26/10, where 0 = no symptoms, 5 = sporulation evidence on entire surface of every leaf.
[c]Mite damage was evaluated on 7/26/10, where 0 = no stippling or webbing evident, 5 = yellowing, stippling, and webbing was observed on all leaves.

Choosing the appropriate TYPE of cucumber for your market is perhaps the most important decision. The Oriental types were excellent for slicing. However, some customers were not sure what they were, because they were unfamiliar to them. Genuine and Saber looked a lot like field slicers, so would be good choices for markets that wanted traditional slicers. Green Finger was a slicer that had poor fruit set (not parthenocarpic) and a lot of unmarketable fruit (scarring). Tasty Green and Tasty Jade were intermediate in type between Asian and typical slicers. Tasty Green had much lower fruit set (and fewer marketable fruit) than Tasty Jade. In general, the picklers yielded the most fruit, and mostly marketable fruit, but were susceptible to mites. Beit alpha types have tender smooth skins, which are susceptible to wounding and scarring. Of this type, Katrina and Socrates had higher yields than Diva, but also more mite damage. This type had the highest percentage unmarketable fruit.

Onion Management: Insects, Diseases, and New Research in Plasticulture

Christine Hoepting, Cornell Cooperative Extension Regional Vegetable Program, 12690 Rte. 31, Albion, NY 14411, 585-798-4265 x 38; cah59@cornell.edu

As a rule of thumb, healthy large onion foliage translants into large onion bulbs. Bulbing is stimulated by the longest day of the year, June 21st. To achieve healthy large foliage, onions should be planted as early as possible in the spring, and anything that will help to push the onion plants along (e.g. optimum nutrients, warm soil, adequate soil moisture, no competition from weeds, etc.) at this early stage should be beneficial. During bulbing, a consistent supply of adequate moisture is best. Ideally, onion foliage should dry down naturally rather than from disease or insect damage or other plant stresses.

Insects:

The most common and problematic insect pest of small-scale onion production is onion thrips (OT). OT feeding reduces the photosynthetic capacity of the onion plant, which can reduce yield and bulb size by 30% or more. Once OT populations exceed 50 OT per plant, they can be very challenging to control. OT generate very quickly and are favored by hot and dry conditions.

Scouting for onion thrips: Start scouting in early- to mid-June. Note that transplants imported from the south may be infested with OT and may need to be sprayed sooner. OT are tiny slender insects. Nymphs are yellow and 0.5 to 1.2 mm in length and adults are brown, up to 2 mm in length. Look deep into the leaf axils to find the first OT of the season. Count the total number of OT and divide by the total number of leaves per plant to get the number of OT per leaf. Insecticide sprays should be started at 1 to 3 OT per leaf, depending on the insecticide used.

Cultural control practices: The first line of defense against OT is insecticides. However, there are cultural practices that are complimentary to an insecticide spray program. In Cornell studies, silver and straw mulches have been shown to delay buildup of OT resulting in delayed onset of the first insecticide spray and increased time interval between sprays. Similarly, kaolin clay has provided only mediocre OT control and may have to be reapplied frequently as it is easily washed off by rain.

Use the best insecticides: Movento (available as a Section 18 in NY) and Radiant are the most highly effective insecticides labeled to control OT. Radiant has excellent residual activity lasting > 7 days. Movento is systemic and has residual activity of > 10 days, but it is not very effective against adult OT. For this reason, Movento is strategically placed during the first half of the season when adult populations are lower than they are late in the season. Agri-Mek (available as a Section 18 in NY) provides good control of OT and has residual activity of 5-7 days. Lannate provides mediocre control of OT, OPs like Penncap-M provide poor control and pyrethroids like Warrior have failed to control OT in Cornell trials. The Cornell recommendations for OT control provide a sequence and strategy that takes into consideration the strengths and weaknesses of the available insecticides and applies them in a responsible manner to avoid the development of resistance in order to provide an effective, sustainable and economical OT management plan.

2011 Cornell spray recommendations for OT:
1) 2 sprays of Movento 5 fl oz, each at 1 OT per leaf*
2) 2 sprays of Agri-Mek 0.15EC 14 fl oz, 7 days apart (note: 30 day PHI)
3) 2 sprays of Lannate 3 pts, 7 days apart
4) 2 sprays of Radiant 6-8 fl oz, each at 3 OT per leaf
*If 3 weeks after the first spray of Movento, the OT population does not reach 1 OT per leaf, skip to Agri-Mek. If after using Movento or Agri-Mek, there are only 2-3 weeks remaining before onions are pulled, skip to Radiant.

For small-scale growers: OT populations may not be resistant to pyrethroids or OPs in these areas as they are in muck areas where large-scale onion production occurs. Start spraying these insecticides at 1 OT per leaf. If after 7 days, OT numbers are higher than 1 OT per leaf, switch to another chemical class.

For organic growers: Entrust is the most effective OMRI-approved insecticide and should be applied at 1 OT per leaf. It should not be applied more than twice before switching to another chemical class. Cultural practices may be incorporated.

Other important points: It is very common to not see a knockdown in OT until after the second consecutive spray of an insecticide. Use the highest rate of penetrating surfactant with Movento, Agri-Mek and Radiant.

Diseases:
The most important diseases of small-scale onion production are purple blotch, downy mildew and bacterial bulb decay.

Purple Blotch: PB usually develops and spreads during July and August as plants begin to mature. PB lesions can girdle onion leaves resulting in leaf dieback and in severe cases, onions can die standing up. When scouting, look for boat-shaped target-spot lesions about 0.5 to 1.0 inch in length on the outer 2-3 leaves of the plant. Lesions can be tan-ish or purplish, sometimes blackish in color, on green leaf tissue. Start spraying for PB in early July or at first sign of disease. In the most recent Cornell fungicide trials (2005-2007), half rate of Scala (9 oz) + half rate of Bravo (1.5 pt), Switch, Rovral and Endura were the top 4 best treatments for control of PB. All of these fungicides also control Botrytis leaf blight, another common leaf disease of onion. Other fungicides that can be used to manage PB include Quadris Top, Pristine, Cabrio and Inspire Super. Note that mancozeb and Bravo are weak against PB. Generally, fungicide sprays for PB need to be continued weekly for the rest of the season.

Downy mildew: DM is sporadic and generally only occurs in cool and wet years or very late in the season. It can be very destructive causing severe leaf dieback and onions often die standing up. Early detection of DM is very tricky. Middle-aged leaves first turn pale, then yellowish, and elongated patches may have grayish-violet fuzzy spores on green leaf tissue. Sporulation is most easily observed when dew is present. In older infections, the initial infection site becomes necrotic and is quickly invaded by PB and secondary pathogens with black spores. Infected leaves will die back very quickly. Once DM is detected, apply Ridomil Gold + mancozeb (Penncozeb, Manzate, Dithane) alternated with a high rate of Quadris Top + mancozeb. Other fungicides labeled for DM in onions include Reason, Revus, Presidio (new), Aliette, Acrobat, Forum, Phostrol/Prophyt. Know that once a plant is infected with DM that it will lose the affected leaves to dieback. The fungicide program is to prevent further spread from the infected plants to healthy ones, so that the whole field is not destroyed. Expect original DM hot spots to worsen, despite fungicide sprays. To assess whether DM is being contained, look for lack of new infections, and lack of spores on old lesions.

Bacterial bulb decay: A complex of several bacterial organisms including from the Geneses *Burkholderia*, *Pantoea* and *Enterobacter* have been found to cause bacterial bulb decay of onion, which are commonly soil borne. Symptoms first appear as leaf blights on the youngest center leaves of the plant and result in yellowing or bleaching and wilting of these leaves. The infection progresses down the leaves and neck, and eventually into the bulb. Affected bulb scales become soft and water-soaked and are yellow-brown in appearance. Cooper bactericides and Oxidate provide mediocre to poor control of bacterial diseases in onion. New research in plasticulture has shown that some very simple and economical adjustments to cultural practices can go a long way towards reducing bacterial diseases of onions.

New Research in Plasticulure:
In small-scale production, onions are typically grown from transplants on 3 foot wide black plastic mulch beds with 2 to 4 rows per bed. Onions are harvested by hand starting in early July and throughout the summer and sold at roadside stands, farmer's markets and produce auctions. Recent Cornell-led studies have demonstrated that narrow plant spacing and alternatives to black plastic mulch can significantly reduce bacterial bulb decay, increase marketable yield and increase profitability of small-scale intensively grown onions.

Narrow plant spacing: Cornell studies showed that when plant spacing was reduced from 6" or 8" to 4" with 3 or 4 rows per 3-foot plastic mulch bed (row spacing: 4 rows = 6"; 3 rows = 8"), this provided 53 to 64% control of bacterial bulb decay at harvest. Marketable yield also increased by 1.4 to 2.4 times, representing an increased net economic return of $43 to $258 per 100 feet of bed, due to increased weight of marketable jumbo-sized bulbs. Wide plant spacing produces big bushy plants with more leaves, thicker necks, delayed maturity and bigger bulbs, which are more prone to rotting. Narrowing plant spacing produces plants with fewer leaves and narrower necks that mature earlier and therefore are less conducive to bacterial bulb decay.

Alternatives to black plastic: Cornell studies showed that silver plastic, biodegradable black plastic and bare ground reduced bacterial bulb decay by 59%, 71% and 75%, respectively. Reflective silver plastic mulch, biodegradable black plastic and bare ground had significantly 1.8 to 2.8 times higher marketable yield than black plastic. Reflective silver and biodegradable black plastics had significantly 3.7 and 3.6 times, respectively, higher jumbo weight than black plastic, which resulted in an increased net return of $96 to $215 per 100 feet of bed compared to black plastic. Despite significantly reduced incidence of bacterial bulb decay, onions grown on bare ground did not yield higher than black plastic due to extreme competition from weeds; for bare ground to be effective, weeds must be adequately controlled. All of the alternatives to black plastic had significantly lower soil temperatures compared to the black plastic; we suspect that the higher temperatures of the black plastic are more favorable for development of bacterial diseases. For more information, visit http://blogs.cce.cornell.edu/cvp/, from the side menu, click on "crops,.." and then "onions", or contact Christy Hoepting.

Detecting and Managing Bloat Nematode in Garlic

Crystal Stewart, Capital District Vegetable and Small Fruit Program, Cornell University Cooperative Extension. cls263@cornell.edu. 518.775.0018

Over the last two years it has been determined that bloat nematode (GBN), *Didylenchus dipsasci*, is widespread on garlic in many parts of the Northeast. As the industry works to control the spread of this nematode to now nematode-free growers, we are simultaneously working to help growers who do have GBN work to eliminate it while preserving their existing crops, if possible. The following steps should be taken by anyone who is unsure if they have GBN.

1) ***Determine if you have bloat nematode.*** Dr. Abawi's lab at the NYSAES can analyze samples of new infestation sites and those in field research trials—please contact Crystal Stewart for updated rates and protocols if you are interested.

2) ***Only plant clean seed.*** Bloat nematode is introduced and perpetuated by planting seed that is infested. ***Do not replant any of your garlic from an infested lot.*** Even if bulbs appear normal (symptomless), low levels of bloat nematodes can increase a thousand fold during one growing season. This means that garlic that showed no symptoms when it was planted could become heavily infested by the time it is harvested the next season. There is currently no NYS certification program for garlic seed, so you will have to work with suppliers to determine how they have ensured their seed is clean. If you or your supplier have not had seed tested, it cannot be guaranteed to be nematode free. Even if seed tests clean, it does not guarantee that bloat nematode does not occur, it just means that it is undetectable. It is recommended to have clean seed re-tested every at least 5 years.

3) ***Do not sell bloat nematode infested garlic for seed.*** Selling quality bulbs infested with bloat nematode for food is acceptable. Garlic festivals may have more detailed rules.

4) ***Plant garlic in a location that has not been cropped to garlic at least 4 years.*** Bloat nematodes can also live in the soil and on alternate hosts. To eliminate and/or to prevent build-up of the nematode populations in the field, rotate away from any *Allium* crops (garlic, onions, leek, chives), celery, parsley, or salsify, and areas with high populations of hairy nightshade weeds. Also, do not plant garlic and control nightshades for at least 4 years in the area where garlic was grown in 2010. Please note, this recommendation may change in the future—preliminary results indicate GBN may not be able to survive winters consistently in the Northeast.

5) ***Plant cover crops after harvesting garlic.*** Mustard, sorghum-sudangrass, and other cover crops have been shown to reduce nematode populations due to their bio-fumigant effect. Thus, they may effectively reduce bloat nematode populations. For information on seeding rates, fertility needs and seeds sources, visit the cover crop website at http://calshort-lamp.cit.cornell.edu/bjorkman/covercrops/fall-mustard.php or contact your vegetable specialist.

6) If possible, ***Keep fields moist***: Bloat nematodes cannot survive for long periods in moist soils, but they do in dry soils.

7) ***Treat infested fields with a conventional fumigant-type nematicide.*** This is an option for conventional growers. Custom applications of Telone-C17 or Vapam are available for use in some states incluing New York as pre-plant treatments and are highly effective against the bloat and other plant-parasitic nematodes, where appropriate and cost-effective.

8) Vydate may also be labeled for control of GBN—please see your state's pesticide guidelines to verify whether this is the case. Hot water treatments are being examined as a treatment option, but are not considered a reliable way to eliminate 100% of the GBN's at this time.

Late blight 2011: biology, resistant varieties, disease forecasting and management.

Bill Fry, Ian Small, Kevin Myers, Giovanna Danies, Laura Joseph. Department of Plant Pathology and Plant-Microbe Biology. Cornell University, Ithaca NY, 14853. wef1@cornell.edu

Biology: As part of an AFRI grant involving more than 20 collaborators from throughout the USA, we received in 2011 more than 120 suspected late blight samples. All but a few were positive for late blight. We received samples from Connecticut, Delaware, Florida, Maine, Minnesota, New Hampshire, North Dakota, Oregon, Pennsylvania, Rhode Island, Virginia, Washington, and Wisconsin. Our major focus was to determine genotype (using microsatellite markers), and convey information as rapidly as possible to extension personnel who submitted the sample. Microsatellite analysis can be done on infected tissue or on sporangia from lesions, so data can be obtained without culturing the pathogen. In many cases, information was returned to the submitter within 24-48 hr of receipt of the sample. The data were uploaded to a national website that reported these various occurrences of late blight.

Preliminary analyses to date (10 October, 2011) indicate that the vast majority of genotypes of *Phytophthora infestans* strains in these samples corresponded to those that had been detected in previous years. These lineages were:
US8 (A2 mating type, resistant to mefenoxam, not aggressive on tomato, very pathogenic to potato, one sample)
US11 (A1 mating type, resistant to mefenoxam, aggressive to tomato and potato, one sample)
US22 (A2 mating type, sensitive to mefenoxam, aggressive on tomatoes, but also pathogenic on potato, > 15 samples (from NY and ME)
US23 (A1 mating type, sensitive to mefenoxam, aggressive on both tomatoes and potatoes, > 50 samples, from many NE states)
US24 (A1 mating type, sensitive to mefenoxam, aggressive mainly on potatoes, >14 samples, from WA, OR, ND, MN, ME, NY)

There were at least ten samples containing genotypes that we had not previously seen. We are currently investigating their mating types, sensitivities to mefenoxam, host preference and relative aggressiveness. There appear to be both A1 and A2 mating types in this group and they also appear to have diverse sensitivities to mefenoxam. We are also investigating their relatedness to other strains.

Phenotypic analyses were conducted in the lab on isolates from the US8, US22, US23 and US24 clonal lineages collected in 2010. Isolates from the US8 and US24 clonal lineages had been obtained almost exclusively from potatoes. We found that sporulation on tomatoes was typically only about 10% that of sporulation on potatoes for each of these two lineages. Thus, it seems that neither US8 nor US24 is likely to cause a sustained epidemic on tomatoes. US8 and US23 appeared to sporulate about equivalently on potato, and more abundantly than did US22 or US24, so US8 and US23 may be the most aggressive potato pathogens. In contrast, US22 and US23 were aggressive to both potato and tomato. Using lesion growth rate and sporulation as criteria, US23 appeared to be somewhat more aggressive on both potato and tomato than was US22.

Resistant varieties. We've investigated also the relative resistances diverse potato and tomato cultivars to late blight. Most of the popular cultivars are susceptible, but some recently available tomato cultivars are immune to the currently dominant strains of *P. infestans*. The relative resistances of many cultivars will be presented. The resistance of potato foliage to *P. infestans* is not necessarily related to the resistance of tubers. Therefore, we are separately obtaining data on the relative resistances of tubers of the most popular cultivars.

Forecasting and Management: Host resistance, weather, pathogen characteristics, and fungicide can be integrated via a Decision Support System (DSS) to achieve efficient late blight suppression. The DSS is currently available on the web at http://blight.eas.cornell.edu/blight/. The system requires a password, but these are readily available. The DSS uses weather data observed at a site chosen by the user. Additionally, the DSS uses weather forecasts (for the next 7 days) that are very specific to the user's location. This enables one to make predictions of late development specific to one's location. The system contains two disease forecasts: Blitecast and Simcast. Simcast incorporates the effects of host resistance and fungicide as well as weather effects. Blitecast incorporates only the effects of weather. This past year, chlorothalonil was the only fungicide in the system, but experiments conducted during the last several years will provide data to include the effects of additional fungicides. In field trials, standard fungicides have been demonstrated to be quite effective to suppress late blight. Even copper is quite effective in suppressing foliar blight. Chlorothalonil was consistently among the most effective at suppressing foliar blight. Unfortunately, we could detect no disease suppressing effect of oxidate. Several fungicides provided significant protection to tubers. These included Gavel, Presidio and Ranman.

The DSS was evaluated in field experiments in 2010 and 2011. Use of the DSS enabled much more efficient use of fungicide compared to standard grower practice –disease suppression equivalent to that of standard grower practice (weekly sprays), but with fewer fungicide applications. Unsprayed plots in the experiments were severely diseased. Sprayed plots were not significantly different from each other, each with a very low level of late blight.

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Growing Small Acreage Potatoes for Profitability

Andre Cantelmo
Heron Pond Farm, South Hampton NH
andre@heronpondfarm.com (603) 591-8720

Growing potatoes for profit may seem like a lost cause. The world uses potatoes as a filler and cheap calorie in many different ways. We have decided not to try to compete with a product that we can not beat. Instead, our potatoes are seen as a local food with unique taste. We grow varieties that you can't find in the store. Someone looking at our Nicolas at market for $1.50 a pound may say “I can get them for .50 cents a pound at the supermarket.” We like being able to say “no, you can't.” We create something that you truly can't get anywhere else. At the same time we have watched many a grower willing to take a major hit in yields per acre to grow spuds at a small scale. This is not necessary. The real money in local potatoes can be made by taking all the great knowledge used by the big boys and scaling down to the size you are. Giving the crop what it needs when it needs it is like printing money. If the same field can give you five times what you planted or twenty times what you planted, which would you take? Of course money can be made by chitting potatoes for early production. We do this, but getting potatoes mid June for early sales is a topic unto itself. The following is a primer that has helped us at least to know when and why we were loosing yield in our main potato crop. After the establishment of a market for your spuds, getting the most per acre is the fastest way to increase profitability.

It is important to start off on the right foot. Good soil prep and the correct conditions will help avoid a lot of problems. Severity of common scab is significantly reduced in soils with pH levels of 5.2 and below, but losses can rapidly increase with small increases in pH above 5.2. Potatoes are commonly grown in soils with a pH of 5.0 to 5.2 for control of common scab. You will have to compensate for poor nutrient up take and the lack of effect of minor elements. Potatoes grow great in 6.5 soil, but it is hard to get around the scab. Legume cover crops should not be grown ahead of potatoes, since this can encourage scab, nor should sod crops, since they may increase wireworm populations. On the other hand, small grains—corn or sorghum-Sudangrass—may benefit a potato crop that follows. In Maine, some growers have used Japanese millet as a cover crop in the year prior to potatoes in an effort to reduce rhizoctonia. We use oats, wheat, or rye. Oats are great for the winter kill and allow the soil to be worked well early.

We chisel plow all our fields, Perfecta harrow. We have very rocky ground, so it takes many passes to get up as many rocks as we can. This leads to a second ground preparation most of the time. We apply our amendments before we go through to fix the ground we compacted. Potatoes love calcium and so putting down gypsum is a good idea when trying not to raise pH. If an organic fertilizer is to be used some of it will need to be put down pre-planting and then incorporated. Our goal is to have 140lbs of nitrogen per acre. Most planters will not be set up to put that much organic material down at planting. Since potatoes should be side dressed only as a last resort, pre-plant incorporation allows for the fertilizer to be below the tubers.

Picking out the best potato variety well ahead of time is key. A standard red, white and gold are important in any potato growing operation. Nevertheless, odd ball, off types, and fingerlings will help set you apart from the supermarket. We know we can't beat the market price so setting ourselves apart is key. We grow reba, chiefton, norland, superior, satina, nicola, Adirondack blue, Adirondack red, peter willcox, la ratt, french fingerling, and Russian banana. By November the year before we know where they are coming from. We get 90% of our potatoes from Bob Chapple, a grower in Vermont to whom we owe much. You need to trust your seed source. What is in their cellar will be in your cellar.

It would be tempting to get your seed, cut it up, and plant it all in the same day. We like to let the seed wake up first. The eyes swell a bit, but do not emerge. Potatoes will regrow their eyes three times, but each time they will be weaker. Best not to let them get to the point where they are damaged at planting. It takes a full day for us to cut our potatoes. We use a line cutter that does a good job of making the piece size. Anything under 1.5 oz is not good and each piece should have at least three eyes. “Blind seed” will cause gaps in the field that give weeds an opportunity and reduce per acre yield. For this reason we love to use “b's” as their size often lends them to being not cut at all. Another benefit of not cutting spuds is it reduces the opportunity for the seed to rot in the field. Seed that must be cut is given a day to heal over before planting out. There are many seed treatments on the market, but we have gotten away from using them as our cultural practice has reduced their need. Cleaning the cutter is important to keeping diseases in check.

We use a John Deer 216 two-row potato planter. You can buy one of these used for about $2,500 and it will transform the way you plant potatoes. This alone may be the biggest increase of yield for some. Each variety has its own needs for fertility, but we have settled on 140 lbs of nitrogen per acre as a base. Potatoes are poor nitrogen scavengers, so all of it should go down at or pre-planting. Side dressing will be less effective. Potatoes need a 1-2-2 N-P-K. Use a good soil text and your agricultural extension to get you where you need to be. We have found that our fertilizer suppliers have been very helpful as well. Fertilizer applied at the time of planting should not be in direct contact with seed pieces. The recommended placement on very low testing soils is in two bands, each band 2 inches to the side and 2 inches below the seed pieces. For our round potatoes we use a spacing of 8.5 inches between seed pieces. Fingerling requires 10-12 inches apart depending on variety. It is important when using a trench planter to maintain the skids below the furrow openers. These skids define the bottom of the trench. Without a good “v” shape seed pieces can roll at panting. This will bunch seed, create gaps, and reduce per acre yields.

We use trench application of pesticides and fungicides to aid in the growing of our spuds. The seed pieces are sprayed as they go down at planting. Admire, Quadis, and Ridomil Gold (see labels) are what we have used, but both organic and conventional growers will benefit from the use of Soil Serenade, designed to protect young plants against soil diseases like Pythium, Rhizoctonia, Fusarium, and Phytophthora. We may replace Ridomil Gold with Serenade because some growers have reported great root growth with the use of this product, in addition to its fungicide effects.

Ground crack occurs just before the leaves and stems push their way out of the soil. Timing is everything at this stage. All the forms of weed control at this point can cause some crop damage, if too much of the crop is up. We have found that you are better off sucking up the crop damage now than letting the weeds get to you. Sencor (see label) can give you a 30-day window and burn down the weeds present at time of application. It can, and will, burn potatoes and will damage colored verities more then whites. Flaming will give you a good week to get to your next cultivation, which may be all you need. Above-ground parts of your spuds will be damaged, but it’s worth it. If you are good with the tool, your ground speed can help you get more weeds and less crop damage. Blind cultivation is a good compromise if you have waited too long. You will get less crop damage, but also control fewer weeds. The weeds controlled, or not controlled, at ground crack will tell you what kind of season you are going to have.

Cultivation and hilling should begin as soon as there is enough plant material above ground that you are not going to bury them. Cross flaming can help with the weeds, but you need to know what you are doing in order not to take down your crop. A benefit of cross flaming is that you will get some bug as you go. You will, however, do nothing to get air down into the root zone of the tubers. We love for our cultivating and hilling season to last about a month. So, week one cultivate, bring soil in between plants, and set up a secondary ridge four to six inches away from plant. This is the beginning of the first hill. Week two, potatoes may be small enough to get in with a second cultivation which is mainly to loosen soil for the first hill. The first hill is done as soon as we are off the field from second cultivation. The first hill cups the plants, it doesn't bury them. After our first hill, our plants look like they are sitting in a trough. By week three, we can't bring in the cultivator without causing crop damage. The potatoes have leafed out and grown to the point that you can't see the cupped hills, but the second hilling takes that soil under the plants and pushes it on top of the lower stems. At the same time more soil is brought in around the plants. Sometimes, week four does not work out for us, mostly because of weather. This last hilling is right on the edge, flirting with damaging the vines. The potatoes are just about ready to close the canopy. This last hilling helps stop greening of spud, and acts as the last cultivation of weeds before the canopy is closed and weeds have a hard time getting started under the crop. A third hilling is so beneficial that we accept a 15% vine damage and still feel we have done the right thing. We use the front tines to lift the vines as we go if need be.

It is important to understand the life cycle of the potato to make the most of the crop that you have in the ground.   Life cycle is broken down into three important parts for us: tuber initiation, bulking, and maturation. Irrigation needs are really the only thing left on the table to look at during each of these stages. Assuming, of course, that we are on top of our disease control, lack of water is the only stress that we need to look out for. Planting as early as we can has already helped us with the best photoperiods.

When the conditions are favorable for tuber initiation, the elongation of the stolon stops, and cells located in the pith and the cortex of the apical region of the stolon, first enlarge and, then, later divide longitudinally. The combination of these processes results in the swelling of the subapical part of the stolon. Induction of tuberization is favored by long nights (short photoperiods), cool temperatures, low rates of nitrogen fertilization, and more advanced "physiological age" of the seed tuber. Tuber initiation begins with the formation of 15-20 tubers. If the plant does not have enough water during this phase only a few tubers will form, decreasing the overall yield.

During tuber bulking, the potatoes increase in size and weight. Between 5 and 10 of the initial tubers actually grow. The rest are either used for nutrition by the plant or absorbed by other potatoes. Moisture stress during this phase results in small potatoes. Stress followed by adequate moisture leads to cracked, misshapen potatoes. A constant rate of increase in tuber size and weight occurs during this stage, unless a growth-limiting factor is present. This stage can last from 60 to over 90 days, depending on the length of the growing season and presence of pathogens. This is critically important: tuber size and quality is closely related to moisture supply in this period. Research has shown that the total yield of potatoes is most sensitive to water stress during mid-bulking. Mid-bulking occurs three to six weeks after tuber initiation. However, water stress any time during this period will have an effect on the total yield. Tuber growth is retarded by moisture stress and does not resume uniformly when moisture again becomes available. New growth and enlargement will take place at the top end while the other portions of the tuber remain stunted. Consequently, especially in some long tuber varieties, constricted areas develop that are directly related to the stage of tuber growth at the time the moisture stress occurred. Other deficiencies in quality such as growth cracks and knobbiness are also related to moisture stress followed by periods of adequate or surplus moisture.
During maturation, the canopy begins to die, water use decreases, and tuber growth slows. When the potatoes are nearly mature, producers typically spray the canopy to kill the plant in preparation for harvest. We have also simply mowed off, being careful of the top of the hills.

Lack of pest and fungal control in the field can take what was a great crop and make it nothing. Growing on long-time potato ground, we have a good population of all the pests you could imagine. Colorado potato beetle is a prime pest. We get 60 days of protection from the Admire, but then we have to be alert for potato beetle outbreaks. We want to use Entrust or Radiant to control late outbreaks. In order to do this, we must be on top of the life cycle of the pest. We get one shot with two sprays to get it. Our missing the correct life stage of the beetle to spray only helps them to become resistant to this powerful tool. As always, please be careful and read the label. No spinosad product controls potato leaf hopper. When you are spraying for CPB, you are not controlling hoppers.

Potato leaf hopper will cause burn down before you get the most out of your crop. Be careful of mowing next to your potato field as you will drive the hoppers into the potatoes. Also, beware of adjacent hay fields being mowed and protect yourself. A combination of pyganic and neem extract seems to do the best job on them. We have used Warrior or some pyrenthins for control as well.

Blight scares us all. Especially after the 2009 scares and crop loss we all had. Ag extension has done a great job of putting out alerts when the spores are present and when conditions are ripe for an outbreak. I highly recommend following their lead for spray timings. We use both copper and Brovo as protectants. If we are in the heat of an outbreak, or have some ourselves, we will start with tank mixes of copper or Brovo with Cruzate or Previcur Flex (see labels). These combinations are effective for both late and early blight, depending on target and rate of application. The Cruzate and copper tank mix can give you a two day reset on late blight and might save a crop.

Many factors effect the timing of your harvest. The ideal harvest temperature is between 50 and 59°F (10° and 15°C). To avoid shatter bruises, do not harvest when the tuber pulp temperature is less than 41°F (5°C). Tubers warmer than 64-68°F (18-20°C) and under drought stress are susceptible to black-spot bruising. Harvesting when tuber pulp temperature exceeds 68°F (20°C) increases the risk of leak and pink rot diseases, which can result in extensive storage decay. You also don't want to leave potatoes in the ground too long because you will start to pick up scerth and rizoctonia. We are trying to time our harvest so we don't import too much heat into our root cellar while at the same time giving the potatoes the correct temperature for curing. We also must give the color potatoes time for their skin to set. We have damaged many a red spud by digging too early or too warm. We try for a minimum two-week wait after mowing, but not to leave them in more then three weeks.

Post-harvest handling and storage can affect pack-out yield as much as anything you do during the growing season. The greatest amount of shrink occurs after harvest and before curing is complete. Harvested potatoes are skinned and there is no barrier to moisture loss until suberin is formed over the wounds. This initial storage period promotes wound healing (suberization) and skin set, and both are critical for long-term storage quality of potatoes. The temperature, relative humidity, and length of the curing period are determined by the condition of the harvested potatoes. High humidity (95%) during the curing period is necessary to prevent excessive shrinkage and to promote wound healing. Mature, healthy potatoes should be cured for about two weeks at 50-60°F (10-15°C) and 95% relative humidity. Good luck with this. We try our best, but come up short all the time. But, the closer you come to this, the better off you will be. We have found that every effort is rewarded at this stage, even if it is not perfect. Long-term storage should be 38 degrees for table stock. Colder temps lead to starch/sugar conversions. This will result in black spots in the cooked potatoes. Potatoes are stored dirty.

Storage and Fresh Market Carrot Production at River Berry Farm.

David Marchant
River Berry Farm, 191 Goose Pond Road, Fairfax, VT 05454
riverberryfarm@comcast.net

We have been growing carrots (certified organic) for fall and winter sales since 1994. We grow two to three acres of carrots that are marketed from October through March and sold primarily to local accounts in the Burlington, VT area.

Production Methods

Pre-Plant Preparation

Carrot fields typically have a cover of winter rye and hairy vetch that is mowed and disked in late May to early June. If there is no cover crop the ground is spread with compost and oats planted in the spring. Oats are then disked in June,

Beds are shaped with a pan bed shaper with chisel plows that are mounted in front of the press pan. The chisels are set where each row is planted so that the soil is friable to a depth of 10 to 12".

Varieties – we primarily plant Bolero (Nantes type carrot) and some Sugar Snax or Navajo (Imperator type). We also plant some specialty carrots (purple haze, solar yellow, rainbow). Bolero is the preferred carrot for flavor, and yields extremely well.

Planting
The beds are prepared one week before planting. The carrots are planted with a stanhay belt seeder and seeded with pelleted seed, 17 in. between rows. Belts are punched with three lines so plant density is approx. 30 seeds per ft. We start planting the last week of June, and plant until approx. July 20th. We plant ½ acre per week. This allows us to keep the hand weeding at a manageable level, as well as giving us time to replant if we have poor emergence. Plantings are overhead irrigated as needed

Weed Control
Approximately 6 days after planting the beds are flamed with a tractor mounted flamer. The carrots are cultivated 3 to 4 times with a budding basket weeder. Carrots are handweeded (on hands and knees) 3 weeks after planting. Depending on weed pressure, carrots will be walked (handweeding) a second time. Once carrots are too tall for basket weeders we use vegetable knives.

Fertilizers – We sidedress with a 5-1-9 custom blended fertilizer from North Country Organics. Rate is 35#/ per 500ft. bed (equivalent of 500#/acre).

Diseases and Pests- We practice good crop rotation with a minimum of three years between crops. Primary field disease is Alternaria on the tops. We have primarily gone with use of resistant varieties. Carrot Rust Fly can be an issue but usually is not a major problem. We attribute this to our later season planting time.

Harvest – We typically start harvesting early October and often will harvest into mid Nov. We want the carrots to be exposed to much cold temperature so as to increase the sugars. Customer demand for our carrots is primarily because of the sweet flavor. This is largely due to late fall harvesting.

We harvest our carrots with an older FMC one –row carrot harvester. We have been using our machine for 17 years now. We rebuilt the conveyor system so it puts the carrots directly into a 20 bushel bulk bin. The most important aspect with using a harvester is growing varieties with strong tops. While the harvester does require a fair bit of maintenance, the time saved in harvesting is unbelievable. A 500ft. row can be harvested by two people in about 2 to 3 minutes

Postharvest Storage – Carrots are stored in bulk bins unwashed. Wooden bins are wrapped with plastic shrink wrap, plastic bins are unwrapped. Tops of bins are covered with either cardboard or grain bags. Coolers are kept near 32 deg. Carrots are regularly misted to keep humidity up. We use greenhouse misters that are mounted on the ceiling of the cooler. Once the temperature of the carrots is brought down, the cooler is set so the evaporator fans only run when the compressor runs. This reduces the drying aspect of the fans.

Packing and Marketing - Carrots are washed in a barrel washer and then packed into perforated polyethylene bags. We have found that they will store up to a month in the bags. We sell in bulk 50#, 25# and cellos of 5# and 1# bags. Juicers (broken carrots) are sold bulk and in 10# bags, at usually half the price. We use Tri Pack tip scales for weighing cellos. Carrots are primarily sold to our local Coops. We shoot for providing carrots through March and sometimes into April.

The Soil Food Web and Pest Management

Mary Barbercheck, Department of Entomology,
501 ASI Building, Penn State University, University Park, PA, 16802
Tel. (814)863-2982 meb34@psu.edu
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Many agricultural production practices affect insect populations. Crop susceptibility to pest damage may be influenced by differences in plant health mediated by soil management. In general, soil management that replenishes and conserves organic matter and enhances the abundance and biodiversity of beneficial organisms creates an environment that promotes plant health. Crop rotation and preservation of beneficial insects through the reduction of insecticide use can reduce pest pressure. Increasingly, research has demonstrated that the ability of a crop plant to resist or tolerate pests is tied to the physical, chemical, and biological properties of soil (Phelan et al., 1995, 1996; Altieri and Nicholls, 2003; Zehnder et al., 2007). Soils with high organic matter and active soil biology generally have both good soil fertility and complex food webs. Soil organisms are involved in many beneficial processes, e.g., decomposition and nutrient cycling, carbon sequestration, maintenance of plant diversity, bioremediation, and biological control. In this paper, I will focus on how two key functions of the soil food web, decomposition/nutrient cycling and biological control, affect pest management in agricultural systems.

The Soil Food Web

All of life can be thought to operate in a food web based trophic groups. Trophic groups are defined by what an organism eats. Food webs are composed of many food chains - depicted as a linear sequence starting from a species that eats no other species, e.g., decomposers and producers (plants), and ends at a species that is eaten by no other species in the chain, e.g., predators. The “structure” of a food web is the composition and relative numbers of organisms in each trophic group. Food web complexity is a characteristic of both the number of species and the number of different species in the soil. The foundation of the soil food web is organic matter. The lower the level of trophic group, the more heavily it relies on its nutrition from soil organic matter. Management practices can alter the diversity and complexity for interactions in the soil through effects on organic matter. For example, crop type, tillage practices, residue management, pesticide use, and irrigation can alter the structure and complexity of the food web.

Bottom-Up Control: Plant Quality from an Insect’s Point of View

From the plant-feeding insect’s point of view – the insect is at the center of the food chain – below it are the food it feeds on - plants - and above it, animals that feed on the insect, – natural enemies. What regulates insect populations to determine whether a plant-feeding insect will reach damaging levels? Characteristics of an insect’s food are considered “bottom-up” factors. Characteristics that influence the natural enemies of insects are considered “top-down” factors because of the position of these factors in relation to the plant-feeding insect in the plant-insect-natural enemy food chain.

Many kinds of insects feed on plants, although not all plant-feeding insects are pests. Even when a known insect pest is present in the environment with a crop, there are many factors that influence whether or not an insect will choose to eat, and potentially damage a plant. Insects use chemical smell and taste cues to help them recognize host plants, and can differentiate plants based on their odors and tastes. The chemistry of the plant determines its appeal to an insect.

Chemical cues from plants that insects use to determine the suitability of the plant as a resource fall into two broad categories: primary and secondary metabolites. Primary metabolites are compounds synthesized by plants for essential functions, such as growth and development. Examples of primary metabolites include carbohydrates, lipids, proteins, and nucleic acids. A key component of proteins and nucleic acids is nitrogen. Secondary metabolites are compounds produced in metabolic pathways other than those directly involved in growth and development and are not considered essential to the plant. Many thousands of secondary metabolites have been isolated from plants, and often contribute to their distinctive colors and flavors. Some secondary metabolites are toxins for insects, and are called plant defense compounds because they can interfere with an insect's metabolism, often by blocking specific biochemical reactions. The higher the concentration of these chemicals in the insect's diet, the less nutrition the insect can gain from eating plant tissues. These defensive chemicals are usually most effective against non-adapted specialists on other plant species and generalist insects that feed across plant types. Plant defensive chemicals include alkaloids, cyanogenic glycosides and glucosinolates, terpenoids, and phenolics.

These defensive chemicals often render a particular plant species unsuitable as a food plant for particular insect species. However, in some cases, insect species have evolved mechanisms to overcome the defensive function of particular secondary metabolites and are be able to exploit them as a food resource.

The Effects of Fertility Source on Plant Quality

Soil organisms play a key role in decomposition and release of plant-available nutrients from soil organic matter, a process called mineralization. As organisms decompose complex materials, or consume other organisms, nutrients are converted from one form to another, and are made available to plants and to other soil organisms.

The way that soil fertility is managed affects insect-plant interactions by altering plant quality as a resource for plant-feeding insects. Soil fertility in agricultural systems is mainly accomplished through applications of synthetic fertilizers, crop rotation, cover cropping, and the application of plant and animal materials. Healthy, vigorous plants that grow quickly are better able to withstand pest damage. However, over-fertilizing crops can increase pest problems through changes in nutrient and chemical composition of crop plants. Specifically, increasing soluble nitrogen levels in plants can decrease their resistance to pests, resulting in higher pest density and crop damage. For example, increased nitrogen fertilizer rates have been associated with increased soluble N in plant tissue and large increases in numbers of mites, aphids, thrips, and other plant feeding insects.

Practices that promote an increase of soil organic matter and a gradual release of plant nutrients through decomposition and mineralization do not generally lead to excessive N levels in plant tissues. Therefore, in theory, do not promote increases in insect pest populations. In general, organic fertilizers such as animal and green manures contain nitrogen sources that are released over a longer time scale than the pulsed and readily-available nitrogen in synthetic fertilizers.

Bottom-Up Control of Insects: Soil fertility and *Brassica* pests

Plants in the *Brassica* (cole crop) family are rich in sulfur containing compounds called glucosinolates. These compounds play a defensive role in *Brassica* – insect relationships and have a negative effect on generalist plant-feeding insects, although some insect species are able to tolerate or detoxify some glucosinolates. Staley et al. (2010) applied organic and synthetic fertilizer treatments at two nitrogen concentrations each to cabbage (*Brassica oleracea* var. *capitata* cv. Derby Day), and measured their effects on the abundance of plant-feeding insects and plant chemistry. The organic treatments included a green manure (white clover, *Trifolium repens* var. Milvus) for the low-nitrogen treatment (approx. 100 kg nitrogen per hectare), while the high- nitrogen treatment included both green and animal manures (organic chicken manure to provide approx. 200 kg nitrogen per hectare in total). The two synthetic fertilizer treatments included a conventional high fertilizer treatment (ammonium nitrate at 200 kg nitrogen per hectare) and a conventional low fertilizer treatment (ammonium nitrate at 100 kg nitro- gen per hectare).

The most common plant-feeding insects found were the cabbage aphid, *Brevicoryne brassicae* (a cole crop specialist), the green peach aphid, *Myzus persicae* (a generalist plant-feeder), and the diamondback moth, *Plutella xylostella* (a cole crop specialist). The cabbage aphid was more abundant on organically fertilized plants, while the green peach aphid had higher populations on synthetically fertilized plants. The diamondback moth was more abundant on synthetically fertilized plants and preferred to oviposit on these plants. Nitrogen concentration was greater for conventionally fertilized than organically fertilized cabbage. Glucosinolate concentrations were up to three times greater on cabbage plants grown in the organic treatments, while foliar nitrogen was maximized on plants under the higher of the synthetic fertilizer treatments. The varying response of insect species to these strong differences in plant chemistry demonstrates that the response of plant-feeding insects to level and source of fertility is complex.

Top-Down Control of Insects: The Soil Food Web and Biological Control

Complex food webs foster populations of beneficial organisms that can help keep pest organisms in check. The exploitation of the predators and parasites, or natural enemies, to control pest insects is called biological control. Natural enemies include predators, such as birds, lady beetles and lacewings, that consume a large number of prey during their whole lifetime; parasitoids whose immature develops on or within a single insect host, ultimately killing it; and pathogens - disease-causing organisms including bacteria, fungi, and viruses that kill their insect host. Many natural enemies can be purchased, but it may be more economical to use a conservation approach – i.e., create conditions through management that attract and retain these beneficial organisms. Some common biological control organisms associated with the soil include ground and rove beetles, spiders and harvestmen, insect-parasitic fungi, and insect-parasitic nematodes.

Biological control of pest insects may be enhanced by reducing disturbance, such as reducing tillage and pesticide use, by creating refuges from these disturbances, and providing alternate food resources for the natural enemies (e.g., nectar and pollen from flowering plants). Crop residue may provide habitat and/or food resources for beneficial arthropods, and diversity and abundance of arthropod predators are greater under no-till in comparison to conventional tillage. Organic cropping practices, and cover cropping, in particular, may conserve and increase the activity of natural enemies.

Managing for Diversity and a Functional Soil Food Web

To exploit the benefits and services of soil organisms, such as bottom-up and top-down control of insect pests, some goals of soil management should be to improve the physical, chemical and biological properties of soil. This is mainly achieved through additions and conservation of soil organic matter, as the base resource for the soil food web

Adding plant diversity to a production system in space and time can help break pest cycles. Plants in the same family tend to have similar pests. Crop rotation, planting a series crops from different plant families in the same space in sequential seasons, helps deter the build up of pests that can occur when one crop species is planted continuously. Crop rotations that include sod, cover crops, and green manure crop provide benefits in addition to providing pest management in annual and perennial crops, including: maintenance or improvement of soil organic matter content; management of plant nutrients; and erosion control. Spatial crop diversity can be achieved through crop rotation and various forms of polyculture, e.g., strip cropping, multiple cropping, or interplanting of plant species or varieties. A general effect of polyculture is a spatial mixing of crops, which can slow the build-up and spread of pests during the growing season.

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Using Compost to Feed the Soil Community and Meet the Nutrient Requirements of Sweet Corn, Is it Realistic?

Mark Hutchinson: Extension Professor, University of Maine mhutch@maine.edu
Dr. David Handley: Small Fruit and Vegetable Specialist, Extension Professor, University of Maine
Dr. Will Brinton: Woods End Laboratory
Tori Lee Jackson: Assistant Extension Professor, University of Maine

Vegetable growers have long been interested in the effect of compost amendments on sweet corn production and soil health. Compost provides a diversity of organic matter from living microbes to stable humus which feeds the soil biological community while building and maintaining high soil quality. The long term investment in soil quality improves the long term production capacity of the soil.

This study evaluated two composts, leaf and yard waste (LY) and biosolids (BS) as soil amendments at three application rates on sweet corn production. The study conducted over two growing seasons. A partial listing of the composts characteristics are shown in Table1.

Table 1: Compost Characteristics

Compost Type	Total Nitrogen %	Bulk Density (lbs/cu yd)	pH	C:N
Leaf and Yard Waste	0.45	956	7.2	15.3
Biosolids	0.61	657	7.9	31.9

Biosolids compost was provided by the Lewiston Auburn Pollution Control Authority (LAPCA). The leaf and yard waste compost was made at the University of Maine Compost Research and Education Facility.

The study was conducted on an Agawam fine sandy loam. Prior to planting in 2010, 80 lbs. of P_2O_5 was broadcasted as recommended by soil tests. No additional conventional or organic fertilizer was added in either year. In both 2010 and 2011, BC 0805 sweet corn (82 days), was planted on 34” rows with a plant population of approximately 28,000 plants per acre. Composts were hand applied at the rates of 0, 10, 20 and 40 tons per acre and incorporated with a Perfecta harrow in replicated plots. A cover crop of oats was planted in August of 2010 after harvest over the entire research area.

In 2011, each plot was split in half. One half received the same treatment as in 2010, 0, 10, 20 and 40 tons/acre. The second half did not receive any additional compost or fertilizer. Conventional herbicide weed control was implemented each year.

In 2010, marketable yield (Figure 1) was greater than the control in all treatments. Biosolid compost (BS) application rates of 20 and 40 tons/acre produce acceptable yields, 1069 and 1263 dozen per acre, respectfully, in 2010 (Figure1). Leaf and yard waste compost (LY) yields were consistently lower then acceptable yield levels of 1000 dozen per acre in 2010.

Preside-dress Soil Nitrate Test (PSNT), data not shown, indicated that soil nitrate levels were above the recommended 25 ppm for only the BS 40 treatment. PSNT values for LY was well below the recommended level which follows the yield. With a PSNT value of 25 ppm you can expect approximately 100 lbs. of N to be plant available during the growing season.

A second year compost application increased yield in all treatments. Yields were significantly higher, 1386 to 1833 dozen per acre for all BS treatments. Leaf and yard waste compost yields were also at or above expected yields. A likely cause is the additional soil organic matter available to microbes for N mineralization. All PSNT values except for BS 40 were above the 25 ppm recommendation. However, the yield increase was greater than a single application which indicates there is an accumulative effect of compost in soils from previous applications.

Plots with no additional compost applications had similar yields as 2010 (Figure1). This indicates that the effects of compost last for at least two years. Compost has a wide diversity of organic matter, from unstable to very stable, therefore mineralization happens over a longer period of time. Under proper soil conditions, stable organic material is mineralized, releasing plant available N.

PSNT data (Figure 2) indicated that soil nitrate levels were below optimal levels without additional compost application but similar to 2010. This supports the idea that compost has a residual effect on the soil and crop productivity. Compost continued to feed the soil microbial population through year two.

Conventional insecticides were not used in either year. There was no marketable yield loss from insect damage.

In conclusion, both types of compost had a positive effect on the yield of sweet corn over a two year period. Compost did provide some plant available nitrogen in both application years. Yield data indicates there was both an accumulative and residual effect of compost applications.

Figure 1. Effect of two compost sources applied pre-planting at three rates on the growth and yield characteristics of sweet corn; Highmoor Farm, 2010 and 2011.

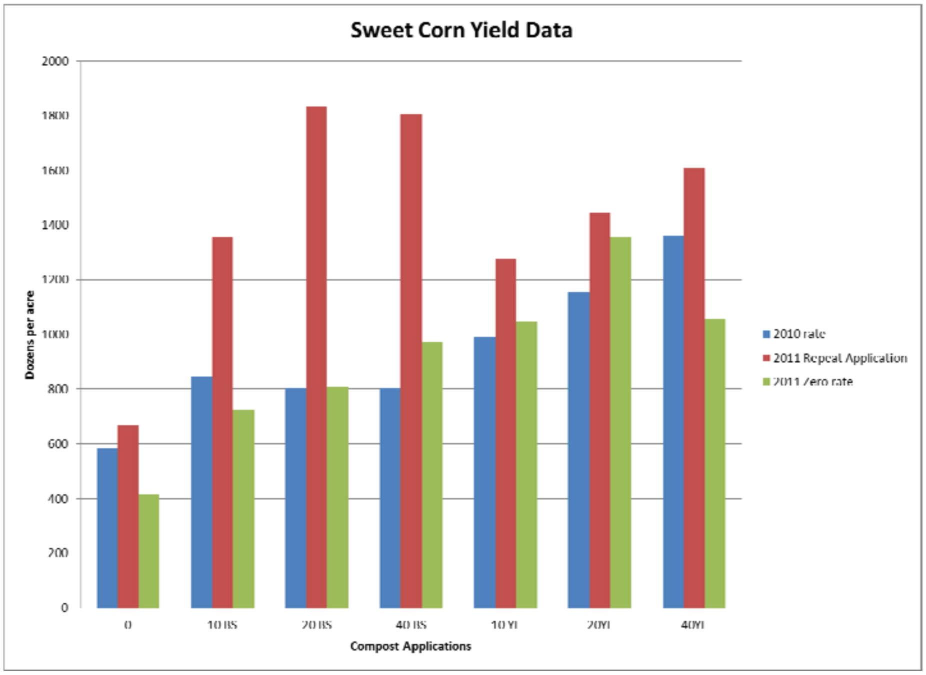
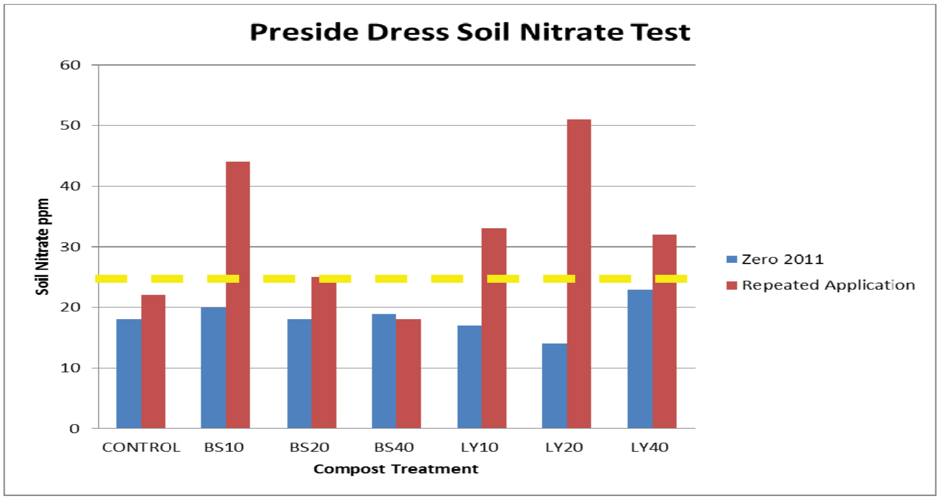


Figure 2. 2011 Preside-dress soil nitrate test from soil amended with compost.



Weed Management in Peppers and Eggplant

Bradley A. Majek
majek@AESOP.Rutgers.edu
Rutgers Agricultural Research & Extension Center
121 Northville Road
Bridgeton, NJ 08302

Good weed control in peppers and eggplant begins the same as any other crop, before the crop is planted. Know the weeds that are a problem in the field. Control established perennials before planning to plant peppers in the field. Use cultural, mechanical, and chemical weed control techniques in a coordinated manor to reduce the risk of interference with the crop. Choose herbicides that control the weeds in the field, apply the proper rate for the soil texture and organic matter in the field, and spray and incorporate herbicides to minimize the risk of crop injury and maximize weed control. Several effective herbicides are registered for use in transplanted peppers. Each a slightly different spectrum of weeds, and has certain disadvantages.

Treflan is labeled for peppers and eggplant, and controls annual grasses, pigweed, common lambsquarter, and a few other weeds. Mechanical incorporation within eight hours of application is necessary to prevent loss by breakdown by sunlight. Yellow nutsedge and many large seeded broadleaf weeds are not controlled by Treflan. Crop injury is a concern when cool and wet conditions prevail after transplanting.

Devrinol is labeled for peppers and eggplant, and controls a similar weed spectrum to Treflan, but crop injury is less of a concern with Devrinol when weather conditions are not favorable after planting. Incorporation is necessary, but can be accomplished with equipment or irrigation, and must occur within two days of application. Yellow nutsedge and many large seeded broadleaf weeds are not controlled by Devrinol. Carryover may affect certain crops such as lettuce up to two years after use.

Command is an extremely effective herbicide with good crop safety in peppers, is not labeled in and should not be used for weed control in eggplant. Care is needed when applying and incorporating is being carried out. Command can drift as spray or after application as vapor and affect adjacent vegetation. Injury symptoms are a distinct whitening of the affected plants, and stunting when the injury is severe. Although recovery usually occurs in several weeks, affected crops may be unmarketable, and injury to ornamental vegetation must be prevented. Command controls most grasses, and many broadleaf weeds. Yellow nutsedge, pigweed, carpetweed, and morninglory species are not controlled.

Good results depend on good incorporation. The herbicide must be mixed thoroughly and uniformly to the depth recommended by the manufacturer. Treflan is usually incorporated two to three inches deep. Devrinol and Command can be incorporated more shallowly, no more than one to two inches deep. Planting on a raised bed or ridge is a good cultural technique used to improve drainage and reduce disease problems, but raised beds and ridges complicate herbicide incorporation. Building the bed or ridge after incorporation increases the herbicide rate and depth of incorporation. The raised bed or ridge must be built first, and the incorporated herbicide mixed to a uniform depth in the irregular field shape. An alternative is to apply the herbicide to the soil surface, plant and incorporate with irrigation.

Prefar 4EC is also labeled for use in peppers and eggplant to control annual grasses and a few broadleaf weeds. Prefar is most commonly used in peppers and eggplant to control weeds under plastic mulch to provide flexibility for the grower. The label for Prefar includes many cucurbit crops, cole crops, lettuce crops, onion crops and others in addition to peppers and eggplant. Note that tomatoes are excluded from the label. Apply 6 quarts per acre in a band immediately prior to laying the plastic. Condensation on the underside of the mulch will activate the herbicide.

In certain states, Dual Magnum has been granted a Special Local Needs 24C label for use on bell peppers. Additional states, including New Jersey, have been granted a Special Local Needs 24C label for use on bell and certain non-bell types of peppers. Due to the concern of the manufacturer, growers must sign an indemnification agreement stating that the grower will not hold the manufacturer responsible for crop damage. Dual Magnum is applied to weed free soil pretransplant, or posttransplant as a spray directed at the base of the pepper plant to control annual grasses, yellow nutsedge, and certain annual broadleaf weeds, including galinsoga. Irrigation is used to “activate” the herbicide.

Grass control can also be accomplished postemergence with Poast. Remember to treat when the grass weeds are small. Never tank-mix Poast with other pesticides unless labeled, or crop injury or poor weed control may result. Poast will not control yellow nutsedge, which is a sedge, not a grass.

When plastic mulch and trickle irrigation are used, weed control becomes more complicated. The area under the plastic and between the rows of mulch must be treated separately. The soil under the plastic mulch should be sprayed separately from the soil between the rows of mulch. Apply herbicides preemergence to preformed beds before laying the plastic mulch, or spray the soil while laying the mulch by adding saddle tanks and a spray nozzle(s) to the plastic layer. Growers producing vegetables on plastic mulch should all have shielded sprayers capable of directing a banded application between rows of plastic mulch. Build a good functional shielded sprayer during the “off season”. Both conventional and organic growers have products that are labeled and approved for use as banded, directed, shielded sprays that are non-residual, non-selective, and able to “burn off” emerged weed seedlings between the rows of mulch. The shielded sprayer should treat only one row of plastic at a time, or no more than the same number of rows that the plastic applicator can lay in one pass. The sprayer and shields should not treat the entire area between two rows of plastic in one pass. Rather, the sprayer should treat the soil on both sides of one piece of plastic about two thirds of the way across to the next row of plastic. This will compensate for small variations in the distance between rows due to driver variability. The slight overlap in the center of the between row soil strip is not important. The boom should be between the front and rear wheels of a high clearance tractor if possible where the applicator has optimum view and control of the boom and shields. The shields should cover the front, back, sides and top of the spray nozzle, have “soft” lower sides so contact with the plastic does not tear the mulch, and not absorb the spray solution. Plastic strips or “plastic” burlap on the bottom of the shield works well. The nozzles should be even flat fans operated at the minimum pressure for adequate performance, 30 PSI or less. A low drift additive should be used, especially when a non-selective herbicide such as Gramoxone Max (conventional growers) or Sharpshooter (organic growers) is being applied. Applications should be made during “zero wind” conditions ONLY!

Under the plastic mulch in peppers, Command at half the rate used without mulch is safe and effective. Devrinol can also be used effectively under plastic mulch in peppers or eggplant. Treflan should never be used under plastic. Dual Magnum, which is only labeled and recommended in peppers, has performed erratically under plastic mulch, probably due to the large volumes of water applied by trickle irrigation in dry years. Between the rows of mulch can be treated like a crop grown without mulch, except growers should recognize that mechanical incorporation of herbicides and cultivation is impossible to accomplish without tearing the edges of the plastic. In addition, Sandea, Prowl H_2O (peppers), Gramoxone Max, and Sharpshooter (organic growers) can be used between rows of plastic mulch.

Sandea 75DF has been labeled for use in peppers and eggplant grown on plastic mulch to control weeds between the strips of mulch. Apply 0.5 go 0.66 ounces of product per acre (0.024 to 0.031 lb ai/a) in a band as a directed and shielded spray between rows of plastic mulch to control yellow nutsedge and certain broadleaf weeds, including smooth pigweed and galinsoga. Do not spray broadcast over the top of plastic mulch. Add nonionic surfactant to be 0.25% of the spray solution. Do not use oil concentrate. The number of broadleaf weeds controlled by Sandea applied postemergence is less than the number controlled by preemergence applications, but yellow nutsedge control is more consistent when treated postemergence. When the target is susceptible broadleaf weeds, apply Sandea at 0.66 ounces of product per acre when the crop has been transplanted at least 14 days and the broadleaf weeds are less than 2 inches in height. Delay the application when yellow nutsedge is the target to allow the perennial sedge more time to develop a leaf canopy to intercept the spray. Use the lower rate, 0.5 ounces of product per acre, and apply Sandea twice when both broadleaf weeds and yellow nutsedge are target weeds.

Prowl H_2O can be used between the rows of plastic mulch in peppers (ONLY) as a banded directed shielded spray. Apply 1 to 3 pints of Prowl H2O per acre and activate with one half inch of rainfall or irrigation to control most annual grasses and certain annual broadleaf weeds. Prowl H2O is chemically related to and similar to Treflan, but is not sensitive to sunlight so applications can be made to the soil surface and activated with moisture. Do NOT apply under plastic mulch, “over the top” of peppers, or to peppers grown on bare soil, or crop injury may result.

Gramoxone Max and Sharpshooter (organic growers) are also registered for use to control weeds between the rows of peppers and eggplant grown on plastic mulch. The herbicide must be applied after weed emergence as a directed shielded spray. Drift on to the crop will cause injury and must be avoided. Always add a nonionic surfactant to Gramoxone Max and a drift control agent. Spray relatively high water volumes at low pressure. Build a good functional shielded sprayer during the “off season”.

Meeting the Postharvest Needs of Vegetables from Field to Market

Lee Stivers, Penn State Extension in Washington County
ljs32@psu.edu; http://extension.psu.edu/washington

Harvested vegetables are living systems that age with time. As a grower, your goal is to slow down the aging process. To do that, you need to understand, and manage, four natural processes: respiration, transpiration, ethylene production, and chilling injury. Proper cooling is the first step, followed by maintaining the optimum temperature and relative humidity (RH) for each vegetable.

Produce a Clean, Mature Product: Quality cannot be improved after harvest; it can only be maintained. So it makes sense to start with the highest quality crop possible at harvest. This means selecting the right varieties, controlling pests during the growing season, managing water and nutrients, and harvesting at the optimal time.

Handle with Tender Loving Care: If produce is injured during harvest, grading or packaging, damage may not be seen until it reaches the retail or consumer levels. Postharvest rots are more prevalent in injured produce. Mechanically damaged fruits and vegetables also lose water more rapidly. Whether you are harvesting and handling cabbages or corn, berries or beans, “treat ‘em like eggs!”

Remove the Field Heat: Postharvest cooling lowers the respiration rate of the product, slows water loss, inhibits the growth of molds and bacteria that can cause decay, and reduces the production of the ripening agent ethylene. Cooling methods include room-cooling, forced-air cooling, hydro-cooling and icing.

Sanitize for Food Safety: Using chlorine or other sanitizing agents in wash water and hydro-cooling water helps protect against post-harvest diseases and also helps protect consumers from food-borne illnesses caused by pathogens.

Package Properly: Any packaging should be designed to prevent physical damage to produce and be easy to handle. Packaging can aid in retaining water while still allowing gas exchange.

Know Your Vegetables: Become familiar with the optimum storage temperatures and curing needs of each produce item. Below are specific recommendations for a few important fresh and storage crops grown in New England.

Broccoli:

- Optimum temperature: 32^{o}F reached ASAP after harvest
- 95% RH
- Very high respiration and transpiration rates
- Low ethylene production; extremely sensitive to exposure

Summer Squash:

- Maturity indicated by a variety of characteristics and market demand
- Optimum temperature: 41-50^{o}F
- 95% RH
- Transpiration rates high; water loss shrivels fruit
- Very chilling sensitive when held below 40^{o}F
- Low rates of ethylene production; low to moderately sensitive to ethylene exposure

Winter Squash:

- Maturity indicated by rind hardness, color, and corking of the stem
- Curing helps harden rinds, but not recommended for acorns (10 days, 80-85^{o}F and 80-85% RH)
- Optimum temperature: 55-59^{o}F for most, but 50-55^{o}F for green rind types
- 50-70% RH
- Very chilling sensitive when held below 50^{o}F
- Most store 2-3 months, less for acorns, more for hubbards

Onions:

- Maturity indicated when 10-20% tops down in the field
- Undercutting 1-2 inches accelerates dormancy
- Curing in field when temperatures are over 75^{o}F
- Forced air curing can be rapid (12 hours at 86-105^{o}F) or slower
- Mature for storage when neck scale are completely dry; loss of 5-8%
- Optimum temperature: 32^{o}F but not below
- 75-80% RH for best scale color
- Can store up to 6-9 months; typically 3-6 months
- Exposure to ethylene encourages sprouting

Carrots

- Maturity indicated by a variety of characteristics and market demand
- More mature carrots will store longer than less mature ones
- Optimum temperature: 32^{o}F but not below
- 98-100% RH but avoid free water which speeds decay
- Can store 3-5 months under good conditions
- Low ethylene production; exposure to ethylene results in bitter flavor

Potato

- Maturity indicated when tuber skins are set, vines are dry
- Optimal harvesting temperatures are 45-60^{o}F
- Prevent bruising and injury; treat gently
- Cull and cure before storage. Cure by holding at 50-60^{o}F and 95% RH for 10-14 days.
- Optimum temperature: 38-40^{o}F for tablestock
- 95% RH
- Can store up to 6-9 months; typically 3-6 months
- Exposure to ethylene encourages sprouting

Crop Diversity in Winter Storage at Kilpatrick Family Farm

Michael Kilpatrick
518-300-4060
Michael@kilpatrickfamilyfarm.com

Kilpatrick Family Farm is a year-round mixed vegetable farm. Our main markets are year round Farmer’s Markets and CSA. Over the years, we have experimented with pushing the crops we go to see just what can be done. We run 5 distinct different environments for winter crops. This allows us to tailor the environment for the many different crops we grow.

Root cellar (34 degrees, 95% humidity) This is the main storage facility on the farm. A 40’ X 8’ x9’ insulated overseas shipping container with stainless walls and aluminum slated floor, it holds up to 18,000 lbs of crop. We spent around $15,000 buying the container, installing it on a shale pad, and installing refrigeration and electric. To maintain organization in the cooler, we put all crops on pallets, and fill out a grid chart that is shared with all employees. The cooling system is a 3 HP Trenton compressor with 2 evaporation units. If we had know we would have employed a low velocity evaporation unit to reduce moisture loss. Right now our humidity system is “man with hose” but we would like to install a misting system at some time.

Our warm storage area is an unused, insulated garage under our apartment. It has a cement floor that allows us to move stacks of bulk crates of squash and sweet potatoes around with a pallet jack. We regulate the humidity and temperature very unconventionally through opening and closing an inside door or outside window. Our goal is to maintain a temp of 55 in this area.

We store our onions and garlic currently off-farm in a rented 8x14 cooler. It is managed as a low humidity cooler by draining all evaporator drainage into a closed container and limiting visits. We are currently building our own onion storage facility by walling off a section of another insulated shipping container and installing a coolbot.

All of our prepped crops and second vegetable storage is in 2 coolers located in our washing shed. We will also store extra storage greens (greens cut in Nov/Dec and stored for up to 8 wks) in these coolers when we run out of space in our root cellar. We built our main cooler (8X11) out of used cooler panels and a used compressor. We added onto the backside of it 4 years ago for the second cooler (8X8) buying some “second” insulated structural panels from winter panel company out of Brattleburo, VT. They come in 4’ widths in varying lengths and at the time ran around $2 a square foot. We cut 2 12” by 6” holes in the shared wall between the coolers and consequently the new cooler runs around 10 degrees warmer than whatever we set the main cooler at. We use the second cooler in the summer for storing tomatoes, peppers, and cukes.

The last area we use to store overwintered crop is directly in the ground. We have successfully over-wintered parsnips, carrots and Jerusalem artichokes this way. Carrots do best with at least 2 layers of rowcover, while JA’s and Parsnips are fine with no cover. All of these crops do best when they are on raised beds, out of any danger having saturated soil. Last year, we did have quite the problem with carrot rust fly in our over-wintered carrots and parsnips. We’re not sure if it was overwintering that did it, or just the season.

Storing greens was something that we almost discovered by accident. We had several beds of beautiful spinach in the field in December and cut it all to use for the next several markets. We ended up keeping some for 6 weeks. We have found a variety of factors contribute to greens that store well.

A later, high quality planting. This allows for the crop to be in the prime of growth and to want to hunker down and go into hybernation for the winter. They then seem to fill their leaves with sugars, antifreeze, and carbohydrates and thus produce a very sweet, long lasting, durable leaf.

Cutting at a low temperature and immediately getting it into good cold (34) storage. We do find that if spinach has some snow in it, it seems to keep better. We have successfully done this with spinach, lettuce, kale, brussel sprouts, Chinese cabbage, boc choi, hakuri turnips with greens, and mesclun.

We will be trying this with mache, and working to improve our system with the other greens this year. This technique allows us to bunch our greenhouse greens up for the really cold months of January-March and allows us to sell high quality, sweet, relatively inexpensive to produce, greens for the high paced, busy, Holiday markets.

Without the storage facilities we have made the effort to perfect we wouldn't have anywhere close to the diversity that we are able to display at our weekly markets. Please follow the below URL or scan the QR code to access the custom resource page which has much more information on varieties, dates of planting and harvesting, storage, the presentation slides and other relevant resources.

www.kilpatrickfamilyfarm.com/NEVF

PREHARVEST DROP CONTROL WITH RETAIN AND NAA COMBINATIONS

Duane W. Greene, James Krupa, and Maureen Vezina
Department of Plant, Soil, and Insect Sciences
University of Massachusetts
Amherst, MA 01003
dgreene@pssci.umass.edu

Retail sales continue to be an important component in the overall business model for growers in the Northeast. The pick-your-own component of this model is playing an increasingly important role in the overall business. Many varieties, including McIntosh and Macoun, are especially prone to drop. In previous business models, it was sufficient to control preharvest drop for a period of time sufficient for fruit to develop market maturity and to allow a timely harvest. This scenario has changed and we now ask available preharvest drop control compounds to be effective over a much longer period of time. The early weekends in October, especially the extremely busy Columbus Day weekend, are extremely important and growers are now attempting to keep fruit on the tree at least through this holiday weekend. ReTain and NAA are our primary drop control compounds and, by themselves and used as we have done in the past, they do not control drop for this extended period of time. The purpose of this project was to explore strategies using ReTain and NAA to extend the control of drop through the Columbus Day weekend without adversely affecting fruit quality. Both NAA and ReTain have the potential to influence fruit quality, ripening and storage potential.

Materials and Methods

A block of Gatzke McIntosh/M.9 was selected to do this drop control experiment. There were 9 treatments that included an untreated control, trees that received a full rate of ReTain either alone or with one or two applications of NAA at either 10 or 20 ppm and other trees received three half rates of ReTain applied at 2-week intervals that contained 10 or 20 ppm NAA or no NAA. All treatments were replicated 5 times with two trees treated per treatment per replication. One of the treated trees served as the drop tree and no fruit was harvested from this tree. A second tree was designated as the sample tree and all samples for evaluation and storage were harvested from this tree. There were 9 dates when samples for evaluation were taken starting on 26 August and ending on 14 October. Data generally taken on the sample dates included: fruit weight, flesh firmness, soluble solids, red color, internal ethylene and starch rating. A 20 kg sample was harvested on 13 September. Firmness on this sample was taken after 6 and 12 weeks in regular air storage and storage disorders were evaluated after 12 weeks on the remaining fruit in the box. All or a portion of the treatments were applied with a commercial airblast sprayer on 18 August and combination sprays were tank mixed. All fruit that dropped was picked up and discarded and then the number of fruit that subsequently dropped was picked up under each tree and discarded two times per week until 26 October. All remaining fruit were harvested from the drop trees on 26 October, counted and then the cumulative drop calculated over the whole drop period.

Results

Preharvest drop was followed over a 9-week period. Untreated control trees displayed the normal and severe preharvest drop problem associated with McIntosh. By 7 September 25% of the fruit were on the ground and one week later over 50% of the fruit had dropped. All other drop control treatments were effective but there were significant differences among treatments. A full rate of ReTain applied once on 18 August (the industry standard) was effective until the last week in September, when it started to loose its effectiveness. All drop control treatments were statistically better than the ReTain standard. This trend continued through the Columbus Day weekend. NAA when combined with ReTain improved the drop control of the ReTain standard. This was true whether one application of either 10 or 20 ppm NAA was applied with the initial ReTain application or whether two applications of NAA at 10 or 20 ppm were applied at 2 week intervals (one with the initial ReTain and then one alone 2 weeks later). In this experiment the treatment with 3 half rate applications of ReTain at 2 week intervals was superior to the one full rate of ReTain, However, there was no appropriate check (1 application using 1.5 pouches of ReTain) for this treatment so it is unresolved if it is the split application or the total amount of ReTain applied that is the important factor. The treatment involving application of 3 half rates of ReTain where each contained 20 ppm NAA was less effective. Starting as early as 10 September, the drop control of this treatment diminished more than any of the other drop control treatments. It should be noted that this is the only treatment that contains a low rate of ReTain and a high rate of NAA and this may be the major reason. Columbus Day weekend ended on 11 October. On that date the best drop control was achieved where a full rate of ReTain was applied on 18 August with 10 or 20 ppm NAA followed by another 10 or 20 ppm NAA treatment on 10 September. Equally good at this time were the 3 half rates of ReTain and the 3 half rates of ReTain with 10 ppm NAA.

Fruit quality parameters were evaluated and statistically analyzed over the whole sampling period from 26 August to 14. Flesh firmness is an extremely important parameter, not only for fruit quality but also because NAA has the potential to reduce firmness, especially when applied alone. The flesh firmness results were quite unexciting in that there were no substantive differences among treatments. The inescapable conclusion is that ReTain is able to counteract any tendency for NAA to reduce flesh firmness, regardless of time of application. From a flesh firmness standpoint, ReTain makes NAA a much safer compound to use on apples during the harvest period. In general, fruit treated with ReTain had less red color and the addition of NAA with ReTain did not result in an increase in red color. ReTain-treated fruit had slightly lower starch rating and the addition of NAA to the ReTain did not result in any higher starch rating. On 4 October it was noted that the trees that received 3 applications of either 10 or 20 ppm NAA had more cracked fruit. When quantified, it averaged slightly more than 6%. Flesh firmness of fruit following regular air storage for 6 and 12 weeks. A difference among treatments or major trends is absent. The general lack of response seen following storage is similar to results documented at the various harvest dates. The influence of treatments on storage disorders is either nonsignificant or if significant, as with brown core, they are difficult to interpret.

Conclusions

The results of this experiment clearly demonstrate that there is potential benefit of including NAA in a drop control program. The addition of NAA in the initial ReTain application or supplemental applications did enhance the drop control of ReTain. One of the major concerns associated with the use of NAA at harvest time is the potential that it can advance ripening thus adversely affect fruit quality at harvest and following a period of storage. This appears not to be the case. Flesh firmness of fruit held in cold storage for either 6 or 12 weeks showed no differences between ReTain-treated fruit and fruit that received combinations of ReTain and NAA. The multiple applications of 20 ppm NAA with half rates of ReTain raises the question that there may be a ratio between the amount of ReTain applied and the amount of NAA that ReTain is able to negate ripening effects. This must be established in another year, but until this is resolved it seems quite safe to say the one or two applications of NAA at 10 ppm with ReTain is treatment that is likely to enhance overall drop control without resulting in advanced ripening or the shortening of the storage period.

Brown Marmorated Stink Bug: Research and Control

Dr. Tracy Leskey
Research Entomologist
USDA-ARS
Appalachian Fruit Research Station
2217 Wiltshire Road
Kearneysville WV, 25430-2771 USA
TEL: 304-725-3451 x329
EMAIL: tracy.leskey@ars.usda.gov

The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål) is an invasive insect native to China, Taiwan, Korea, and Japan accidently introduced into the United States sometime in the mid- to late 1990s. Over the past several years, BMSB has emerged as a pest of increasing concern to agriculture in the United States. Currently, large populations are now established in PA, NJ, DE, MD, WV, and VA; all of these states have documented severe losses in a number of crops and tremendous nuisance problems for homeowners and businesses. Furthermore, established populations have been detected in CA, CT, IN, KY, NH, NY, OH, OR, and TN, though crop losses have been minimal at this early stage of infestation. Additional states where BMSB has been detected include AL, AZ, FL, GA, IA, IL, MA, ME, MI, MN, MS, NC, NE, RI, SC, TX VT, WA, and WI. In 2011, BMSB was confirmed in Ontario, Canada.


Fig. 1 Adult BMSB on nectarine

In 2010, BMSB populations increased dramatically and attacked many crops in the mid-Atlantic region. Damage in commercial orchard crops reached critical levels with some growers losing entire blocks of stone and pome fruit (Fig. 1, 2, and 3). Severe post-harvest losses from cold storage also were reported for apple throughout the region. In addition, extensive damage and crop losses were reported for peppers, tomatoes, corn, soybeans, and caneberries. Extensive damage to woody and herbaceous ornamentals and to grapes also was reported. In 2011, overwintering survivorship of adults from human-made structures and from wild or natural overwintering sites was substantial. Large populations immigrated into stone fruit orchards in late May-early June to feed on immature fruit. Growers who treated with broad spectrum insecticides at frequent intervals during this primary period of risk had substantially less injury than those that did not. Subsequently, growers have radically altered their management practices to control BMSB, an insect that is now consider the single most important concern in many cropping systems. Tree fruit growers are typically


Fig. 2 Early-season BMSB injury on peach

making 2-4x more insecticide applications than in previous years and generally with older, broad-spectrum materials, for example. Those who have maintained a vigilant and very aggressive spray schedule have been able to minimize damage whereas those who did not saw increases in injury. Similarly, chemical treatments have been added to other crops to minimize BMSB injury. A prime example is soybean; growers have made applications in the peripheral areas of soybean fields to combat BMSB. Though growers have been able to reduce injury, these radical departures from previous management regimes have resulted in increased costs (insecticides, fuel, equipment maintenance, and labor) and inputs making this approach unsustainable both economically and environmentally. An obvious casualty of BMSB in agriculture is the devastation to integrated pest management (IPM) programs put into place over the past several decades as well as the tremendous challenges this insect poses for the organic community.

Fig. 3 Late-season BMSB injury on apple

In order to develop effective long-term solutions for managing this invasive species, we must (1) define the basic biology, phenology, and behavior of BMSB in agroecosystems, urban landscapes, and in native, unmanaged habitats; (2) establish the host range and preference of BMSB for both cultivated and wild hosts as well as susceptibility of cultivated hosts; (3) assess and survey BMSB populations to establish geographic distribution, population density and potential spread; (4) develop effective stimulus-based monitoring tools for BMSB to allow growers to make informed management decisions; (5) develop effective behaviorally-based attract-and-kill management strategy for BMSB to reduce insecticide inputs; and ultimately (6) Establish biological control efforts (whether parasitoid, predator, or pathogen) to reduce or eliminate this insect as a pest of agricultural and urban settings.

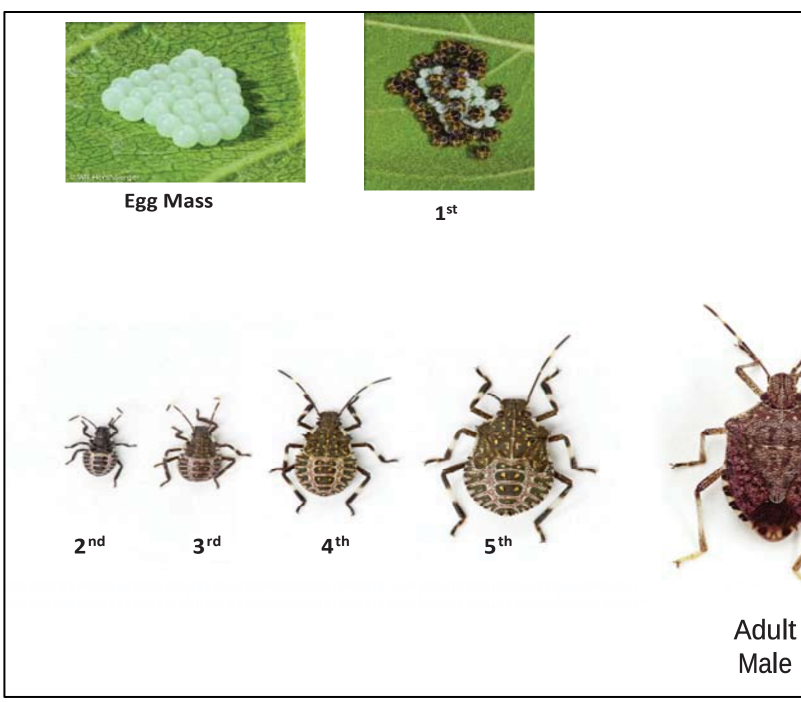


Fig. 4 Life stages of BMSB

Understanding the Limitations of Newer Apple Fungicides

David A. Rosenberger, Cornell's Hudson Valley Lab
P.O. Box 727, Highland, NY 12528
E-mail: dar22@cornell.edu

DMI fungicides have provided apple growers with a golden era of disease control that is drawing to a close as the appearance of DMI-resistant apple scab gradually reduces the usefulness of this class of fungicides. The DMI fungicides include Rally (formerly sold as Nova), Vintage (formerly sold as Rubigan), Procure, Indar, Inspire Super, Tebuzol, and Topguard. Inspire Super is a package mix of a DMI (difenoconazole) and Vangard, which is in the anilinopyrimidine fungicide class.

The DMI fungicides had advantages that have not yet been duplicated with any other fungicide chemistry. They provided effective control of the three major fungal diseases of apple that occur in spring: apple scab, powdery mildew, and rust diseases. They also provided 96 hr of post-infection or "kick-back" activity, and they suppressed lesion expression and sporulation when applied any time before lesions appeared on leaves. When applied in combinations with captan or mancozeb, the DMIs provided effective disease control when applied at 9 to 12 day intervals as compared to the 7-day spray intervals required for most other fungicides during spring. Because none of the newer fungicides can duplicate the activity of the DMIs, growers will need to carefully consider the limitations of the available fungicides that they will be using to replace the DMIs.

Following is a summary of fungicide classes that are currently available for apple disease control, along with some of the advantages and weaknesses that are common to most of the fungicides within the respective classes.

<u>Contact fungicides</u>: Captan and the mancozeb fungicides (Manzate, Dithane, Penncozeb) were developed more than 50 years ago, but they are still essential for disease control on apples. They are multi-site inhibitors that arrest fungal growth by attacking multiple biochemical pathways simultaneously. As a result, fungi do not develop resistance to these fungicides. Their weakness is that they lack post-infection activity, so they must be applied before germinating spores penetrate leaves. Captan is intrinsically more active against apple scab than are the mancozeb fungicides, but captan does not control rust diseases and is not compatible with oil. Neither captan nor mancozeb control powdery mildew.

<u>Dodine</u> (now sold as Syllit) is an old fungicide that was largely abandoned due to resistance, but it is now regaining consideration as an early-season scab fungicide. Recent work by Kerik Cox and his group at the Geneva Experiment Station has shown that resistance to Syllit is less common than was previously thought. Dodine is an excellent scab fungicide with good retention, redistribution, and anti-sporulant properties. It also provides 48 hr of post-infection activity. However, dodine does not control rust or powdery mildew. Uncertainties about where dodine-resistant strains are lurking dictates that it must always be used in combination with a contact fungicide so as to avert disaster if some dodine-resistant strains are present. A dodine-mancozeb combination can be especially useful for working around early-season oil sprays and may provide better protection during the prebloom period than programs that depend exclusively on captan and mancozeb, especially if prebloom weather generates conditions where protective fungicide coverage may have lapsed between sprays due to heavy rains or weather that precluded

timely applications. However, the maximum label rate of Syllit must be used in combination with captan or mancozeb if the objective is to inactivate visible scab lesions. Using dodine to clean up scab after it appears on leaves will create selection pressure for rapid re-appearance of dodine-resistant scab.

Anilinopyrimidine fungicides include Vangard and Scala. These fungicides work best in cool weather, do not redistribute well, and will not control scab on fruit. Thus, they work best in prebloom sprays. They provide 48 to 72 hr of post-infection activity and can be useful if applied in combinations with captan or mancozeb in prebloom sprays where some post-infection activity is needed, especially if reliability of dodine is uncertain for the orchards in question.

DMI fungicides are still effective against apple scab in many orchards. However, their reliability against scab will always be questionable because the incidence of DMI-resistant scab is gradually increasing in most orchards. Disease control failures can therefore be expected if DMI fungicides are used to arrest established scab lesions (i.e., if they are used for post-infection control of scab) in orchards with high levels of DMI-resistant scab. Even where DMIs no longer control scab, however, they still provide excellent control of rust diseases, especially quince rust, due to their extended post-infection activity against rust diseases. They may also be the best option for controlling powdery mildew, especially if they are used in the petal fall and first cover sprays. Inspire Super is the strongest scab fungicide in this group, but Inspire Super and Indar are weaker than other DMIs against powdery mildew. Rally and Topguard are the best mildewcides. For a variety of reasons, all fungicides in this group should be applied in combination with captan or a mancozeb fungicide. In orchards known to have DMI-resistant scab, the rate of the contact fungicide must be high enough to control scab without assistance from the DMI and spray intervals must be shortened to those that are appropriate for a contact fungicide program.

Strobilurin or QoI fungicides include Flint, Sovran, and Pristine. (Pristine is actually package mix of the strobilurin pyraclostrobin with another product, boscalid, that is a member of the SDHI group). These fungicides should be viewed as "super protectants" in that they work best when applied ahead of rains even though they can provide up to 48 hr of post-infection activity against apple scab. They lack post-infection activity against rust diseases, so they appear weak on rust diseases when compared to DMI fungicides. They also lack the strong post-infection and antisporulant activity that the DMIs exhibit against mildew, so they must be applied before petal fall if they will be used as the primary mildewcide during spring. Apple scab that becomes resistant to this group will show the benomyl-type of resistance where even high doses will not control the pathogen. Such resistant isolates have already been found in many orchards in Michigan and in a few orchards in New York and elsewhere. Fungicides in this group can also be useful for controlling black rot, sooty blotch, and flyspeck during summer. However, all of the product labels restrict use of these fungicides to a total of only four applications per year for any combination of products within the group.

SDHI fungicides are a new class of fungicides, with several products approaching registration. Fontelis (penthiopyrad) is being developed by DuPont. Luna Sensation is a package mix of fluopyram with Flint that will be marketed by Bayer, and BASF will be marketing Merivon, a package mix of fluxapyroxad and pyraclostrobin (the latter being the strobilurin component in Pristine). Other products in the SDHI group are being evaluated by other companies but have not yet been named. In general, the SDHI group provides good control of scab and mildew, but only marginal control of rust diseases. There is some evidence that these products may provide 48 to 60 hr of post-infection activity against apple scab. Their activity against rust diseases may be largely dependent on the protectant activity of the strobilurin or other combination product with which they are mixed. Fontelis may be sold as a stand-alone product, but it has performed best in my trials when mixed with mancozeb. Disappointment awaits anyone who is hoping that the SDHI fungicides will have all of the attributes that we came to associate with DMIs. The best seasonal timing for the SDHI fungicides remains to be determined, but overuse will almost certainly result in rapid development of SDHI-resistant apple scab. This will be especially problematic if Luna Sensation or Merivon, which are package mixes with a strobilurin, are applied in orchards that already contain strobilurin-resistant apple scab. Use of Luna Sensation and Merivon may also be limited by the 4-spray-per-season limitation on any combination of strobilurin sprays since both of these are formulated with a strobilurin fungicide.

Phosphite fungicides are sold under many different brand names such as ProPhyt, Fosphite, K-Phite, Phostrol, and Agri-Fos, as well as numerous others. We have been unable to show that the phosphites provide any advantage when added to captan or mancozeb in springtime sprays. However, when added to captan in summer sprays, that combination will control sooty blotch and flyspeck just as well as a combination of Captan plus Topsin M. Thus, a phosphite-captan combination can be used to fill gaps in summer spray programs where label restrictions on total numbers of sprays or on total lb/A/yr might limit full-summer applications of Topsin M or strobilurin fungicides. However, the phosphite fungicides do NOT enhance activity of captan against black rot and bitter rot fruit decays, so higher rates of captan are required where these pathogens are a concern than would be the case if captan were combined with Topsin M. Crops, diseases, rates, and application intervals vary with product labels, so read the labels carefully.

Fungicides for summer diseases: The combination of captan plus Topsin M has become the standard for controlling summer diseases. Topsin M is usually used at rates of 9 to 16 oz/A, with the higher end of this range required for situations where sooty blotch and flyspeck (SBFS) are especially prevalent. Rates of captan used with Topsin vary from 2 lb/A to 4 lb/A of Captan-80, with the higher rates required where bitter rot is a concern because Topsin M does not control bitter rot. Pristine applied alone is reasonably effective against bitter rot, and bitter rot control can be further enhanced by using a combination of Pristine plus 2 lb/A of Captan-80. Pristine provides the longest residual activity against SBFS and is therefore especially useful as the "last spray" of summer for late-season yellow cultivars such as Golden Delicious and Crispin. However, the residual activity of Pristine will be totally lost after 2.2 to 2.5 inches of rain, so a follow-up spray may be required in September to keep SBFS off of late-season cultivars in southern New England if heavy rains occur in early September and remove the residues of the planned "last spray" that was applied prior to the rains.

Flint initially provided excellent control of SBFS, but we have found in recent years that Flint is no longer controlling some species of sooty blotch when it is applied in late summer.

Inspire Super and Indar both provides good control of SBFS and fair control of fruit decays when applied during summer. However, using Inspire Super or Indar during summer will add selection pressure for DMI-resistant apple scab. Therefore, these fungicides should not be applied after second cover except where DMI activity against apple scab is already totally lost due to DMI-resistance.

Managing Fertility in Bramble Crops

Laura McDermott
Cornell University Cooperative Extension
Capital District Vegetable and Small Fruit Program
415 Lower Main Street
Hudson Falls, NY 12839
518-746-2562
lgm4@cornell.edu

Basic Soil Fertility Concepts

Managing plant and soil fertility in bramble crops is important for optimum production. Nutrient management is not an easy proposition as it varies from farm to farm, and even from site to site on the same farm. Soil variability, along with differences in management practices and weather make it impossible to have a menu driven protocol for farmers to follow. Farmers need to make changes according to specific situations and in order to do that they need to know the basics of nutrient management as it pertains to bramble crops.

The nutrient availability of soils is less understood by farmers than the physical differences between soil types i.e. water and nutrient retention. Soil nutrient tests are used to measure the plant-available nutrients in the soil. They do not measure the total nutrients in the soil, which often is significantly higher than what is available. The type of soil influences how much nutrients are available. If soil particles are small (clay), soil nutrient availability is higher, but those same soils may contain high levels of certain nutrients that block availability of certain nutrients.

Nutrients are available to plants as individual ions with either a positive charge (cation) or a negative charge (anion). The charge impacts how the ion behaves in the soil, for instance ammonium ($NH4^+$) is retained by soil adsorption and nitrate ($NO3^-$) is often leached despite the fact that both of these forms of N are available to plants. As the plant absorbs the ammonium cation, it excretes one H^+ proton so that there is a neutral charge in the plant. As those positively charged protons accumulate in the soil, the soil pH (a measure of soil acidity) drops and thus alters the availability of other plant nutrients. This is when lime and sulfur come into use. Bramble crops need a soil pH of 6.0 – 6.5, forgiving really, but when even the type of fertilizer one uses could alter the ability of the plant to access nutrients it becomes clear that soil fertility management is a challenging endeavor.

Diagnosing Nutrient Problems

Visual diagnosis is the most common means of detection of fertility problems, but it is the least reliable. Plant symptoms like poor plant vigor, pale leaf color, and distorted fruit are also symptoms of some pest and cultural problems as well as the result of many different nutrient deficiencies or toxicities. Designing a nutrient program by visual symptoms alone will likely be ineffective. Instead, growers should become familiar and comfortable with laboratory analyses. Consistent use of soil tests and foliar analysis can reveal the information necessary for good nutrient management.

- Soil Tests estimate the amount of nutrients available to plants. In order to be effective, soil test samples must be taken correctly. Farmers should be mindful of soil changes within a field and understand that in those cases, two soil tests should be done. Soil tests should be conducted in the fall of the year prior to planting. This allows nutrients and other amendments to be added and incorporated adequately before planting begins. Nitrogen is the exception to this rule. Soil test results from one lab to another cannot be compared because the extraction methods vary. Similarly, the extraction methods used for macronutrients are not appropriate for estimating levels of micronutrients, and often micronutrients cause the most problem in bramble plantings.
- Plant Tissue Testing measures the exact amount of nutrients in the plant part that was submitted at that point in time. Recommendations are based on the levels of these nutrients at specific times of the year. Depending upon the lab that you choose, sufficiency levels for a relatively "minor" crop like brambles may or may not be based on known ranges for raspberries/blackberries. However, if you refer to known sufficiency ranges separate from your lab, you can ensure that you are basing your management on research supported data. See Table 1. for sufficiency ranges.
- Plant sap testing is a new way to track N availability without waiting for results, but this does require time and regularity.

Table 1. Sufficiency ranges for foliar nutrient level in bramble leaves in midsummer (perennial systems).*

Nutrient	Deficient below	Sufficient	Excess
N %	1.9	2.0-3.0	4.0
P %	0.20	0.25-0.40	0.50
K %	1.3	1.5-2.5	3.5
Ca %	0.5	0.6-2.0	2.5
Mg %	0.25	0.6-0.9	1.0
S %	0.35	0.4-0.6	0.8
B (ppm)	23	30-70	90
Fe (ppm)	40	60-250	350
Mn (ppm)	35	50-200	350
Cu (ppm)	3	6-20	30
Zn (ppm)	10	20-50	80

* Raspberry and Blackberry Production Guide: For the Northeast, NRAES-35

A combination of soil testing and tissue analysis along with good visual observation of the crop response to fertilizer is the best approach to assessing nutrient status. Growers should test the soil prior to planting and make amendments according to recommendations. When the plant reaches maturity, conduct a foliar tissue test a minimum of every other year. Conduct soil tests every 3 years. Be alert for problems or changes that occur to the crop during the growing season.

Nutrients Required for Optimum Growth

Nitrogen makes up 2-3% of bramble plant dry matter. According to Table 1, if bramble leaf nitrogen is less than 1.9% N the plant is deficient and likely not very productive. Signs of N deficiency are yellow leaf color and/or tips of older leaves turning red. N toxicity is a problem if the tissue test reveals greater than 3% N resulting in plants that appear too vigorous, with few flower buds.

In newly planted fields, Calcium Nitrate is the fertilizer of choice because it has a readily available form of N that does not volatilize. In established fields ammonium nitrate supplies a quick Nitrate response and a slow release response due to the ammonium. This material has become less available than in the past, due to its explosive characteristics. Urea then is the least expensive N source, but it is subject to volatilization unless incorporated. Foliar urea can only be used in small doses, less than 2 pounds per acre of actual N. For information on N guidelines for berries, refer to Table 2.

Table 2. Nitrogen guidelines for raspberries*

Age of Planting (yrs)	Amount/Timing (actual N)	N source	Comments
Summer-bearing			
0	25-35 lb/A 4 weeks after planting	Calcium nitrate	Avoid touching plants with fertilizer after planting
1	35-55 lb/A May, or split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation
2+	40-80 lb/A May or split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation
Fall bearing			
0	25 lb/A 4 weeks after planting and in August	Calcium nitrate	Avoid touching plants with fertilizer after planting
1	50-80 lb/A split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation
2+	70-100 lb/A split between May and June	Urea, ammonium nitrate	Use higher amount on sandier soils or if using irrigation. Adjust in response to leaf analysis

*Raspberry and Blackberry Production Guide: For the Northeast, NRAES-35

The other macro nutrients critical to bramble growth and development are Phosphorus (P) and Potassium (K). Uptake of both of these nutrients is primarily through diffusion, so the increased advantage of a large plant root mass will aid uptake.
Berries tend to have a low demand for P relative to other crops, and given that soil pH impacts P availability – pH needs to be close to 6.5 - most fields in the Northeast are not deficient. Too much P however, can interfere with micronutrient uptake. When applying P through a drip system, be aware that many sources of P are incompatible with other fertilizers.

Brambles have a relatively high demand for K and the availability of the K in the soil is very dependent on soil chemistry. Increasing soil organic matter will help to increase the exchange capacity of the soil. Pre-plant incorporation of K is the most effective, while fertigation can be used to supply potassium during the season to established plantings. Potassium levels in leaves tend to fluctuate during the season dropping as crop load increases. Adding K during the season is sometimes necessary. Potassium sulfate or potassium magnesium sulfate are the best sources of potassium for brambles. Muriate of potash is inexpensive, but it has chloride in it that causes problems with brambles.

More specific information about micro nutrients and soil management can be found in the Raspberry and Blackberry Production Guide – NRAES-35.

Cane Borers, Crown Borers, Thrips, Oh My!

Douglas G. Pfeiffer, Dept. of Entomology
Virginia Tech, Blacksburg VA 24061
540-231-4183 dgpfeiff@vt.edu

Rednecked Cane Borer, *Agrilus ruficollis* (F.)

I. Introduction: This buprestid beetle infests wild and cultivated blackberries and raspberries in the eastern states from Canada to the Gulf of Mexico. Adults are about 6-7 mm (1/4 inch) long, with an iridescent coppery pronotum. On galled plants, there is less live vegetative growth and more dead wood. There is often reduced berry size and number, as well as vegetative growth with increasing number of galls per plant. Affected canes may not produce fruit. Canes weakened by galls are more subject to winter injury.

II. Biology: Adults are present from May to August, or late April to early June, depending on the region. Females lay white spherical eggs on the trunk, and produce a yellow viscous material from the ovipositor which is smoothed over into a covering, before fading to white or grey. Larvae exit the egg directly into the plant, never becoming exposed, and so are impervious to sprays. Young larvae are restricted to the cambium, circling the cane 3-4 times in a close spiral, girdling the primocane, and producing gall-like swellings. Larvae winter in the cane, and in March create a pupal chamber. The pupa is formed in late April. The pupal period lasts 20-40 days. When the adult leaves the pupal skin, it remains in the tunnel for about 10 days before chewing a D-shaped emergence hole. Adults feed on foliage for several days before beginning oviposition. They are most easily found on the plants on warm sunny days. There is one generation annually.

III. Control: Chemical control: After leaf fall or during winter pruning, note galls. If more than 10% of the primocanes are infested, or if the number of primocanes expected to be pruned off is exceeded, a spray in justified. Examine primocanes for adults twice weekly, beginning at the beginning of bloom. Damage is minimized when Malathion 8F (2 pt/A) or Brigade 10WSB (8-16 oz/A) is applied at intervals of 7-12 days from the time the first beetles appear (early to mid May) until early June (last emergence). Cultural control: Remove galled canes in dormant season or early spring. This is most effective if nearby wild hosts are eliminated, and also more effective in open settings (wild brambles in nearby woods provide a source of wild beetles). Summer pruning also may provide a substantial reduction in rednecked cane borer infestation, since by the time new shoots appear, they have escaped much of the oviposition period of rednecked cane borer.

Raspberry Cane Borer, *Oberea bimaculata* (Olivier)

I. Introduction: This cerambycid beetle is about 12 mm (1/2 inch) long, and is black except for the pronotum which is bright orange with two black spots. The long antennae easily separate it from the rednecked cane borer.

II. Biology: Raspberry cane borer is distributed from Kansas eastward, and has been reported as being very destructive in Quebec. It infests the young shoots of raspberry, blackberry and sometimes rose. Adults appear in June, and are present until late August. After ovipositing, the female girdles 6 mm above and 6 mm below the egg puncture. Shoot tips wilt in early summer.

IV. Control: Chemical control: Just before blossoms open, either malathion 8F (2 pt/A) or M-Pede (2% solution) may be applied. Cultural control: Wilting canes or those with girdling should be destroyed. If pruning occurs within a few days of the onset of wilting, only a small amount of additional shoot need be removed.

Raspberry Crown Borer, *Pennisetia marginata* (Harris)

I. Introduction: The sesiid moth can be a severe pest to raspberry and blackberry plantings. Its cryptic nature may complicate diagnosis.

II. Biology: Eggs are laid on the undersides of new leaves, with 2-3 eggs per plant. Eggs incubate 3-10 weeks, beginning to hatch in late July (about the first week of September and continuing until early November in the northern part of its range (Canada)). The young larva spins down to the crown, where it overwinters in a hibernaculum. In the spring it tunnels into the cambium. Cracks develop at this site, from which reddish brown frass is produced in April. During the first summer, the larva feeds at the base of new canes, girdling the plant and causing gall formation. Galls are most evident in October. Moths fly from early to mid July through late September (August through September in the north). Females begin to oviposit beginning on the first day after emergence; the female lives 3-11 days, averaging about 103 eggs.

III. Control: Chemical control: Bifenthrin (Brigade 10WSB), may be used as a drench treatment for raspberry crown borer. Apply at either post-harvest (fall) or pre-bloom (spring), as a drench application directed at the crown of plants in a minimum of 50 gal water/A. Do not make a prebloom foliar *and* prebloom drench application. The most effective time of application is between October and early April. Sevin or malathion may be used as foliar sprays. Cultural control: Remove all wilted canes in June and July.

Thrips

I. Introduction: The most common species are the flower thrips, *Frankliniella tritici* (Fitch), and the western flower thrips, *F. occidentalis* (Pergande). The latter species is more damaging, has been expanding it geographic range, and may be more common. WFT infestations appear to be somewhat local and often occur in the proximity of greenhouses with a history of high incidence of WFT.

II. Injury: Thrips feed on plant cells in flowers and young fruit. This injury causes fruit to be abnormally shaped later. Caneberries and strawberries are very susceptible. In caneberries, individual drupelets may be killed. In strawberries, achenes are killed. Adjacent parts of berries do not grow, causing an apparent crowding of the achenes, termed "apical seediness". Thrips are also important vectors of many plant viruses. Thrips populations in brambles therefore pose two, and potentially three, problems. The first relates to feeding injury. Feeding by thrips can injure floral parts and also drupelets after berries are formed. Feeding in fruit may cause individual drupelets to be white. The second problem arises when high populations persist until harvest (not usually the case), and active thrips found in the harvested fruit may be a concern with buyers. The potential third problem relates to virus transmission (see below).

III. Biology: The life cycle of thrips is complex. After the egg stage, there are two feeding instars called larvae. Following these larval stages there are two non-feeding stages, called the prepupa and pupa. These are followed by the adult stage, also a feeding stage. The WFT population built up on weeds, especially clover, in and around orchards throughout the season. In areas with cold winters, thrips may overwinter as pupa in earthen cells, but in warm areas may survive as active forms all year.

IV. Chemical control: There are several chemical alternatives. Because of the tendency of thrips to develop resistance to insecticides, it is important to rotate among differing modes of action. Some pesticide labels recommend an adjuvant to improve efficacy toward thrips.

	Rate /A	Class	REI (h)	PHI (d)	
Assail 30SG	4.5-5.3 0a	4A	12	1	
Aza-Direct	12.5-42.0 fl oz	unknown	4	0	OMRI
Azera	2-3 pt	3A/unknown	12	0	OMRI
Delegate 25WG	3.0-6.0 oz	5	4	1	
Entrust 80WP	80WP	5	4	1	OMRI
Malathion 8F	1.0-4.0 pt	1B	12	1	
Provado 1.6F	8.0 fl oz	4A	12	3	
SucraShield 40	0.8-1.0%	unclass.	48	0	OMRI

The PHI value is of critical importance in caneberries. Thrips are most prevalent during bloom, but there is broad overlap between blossoming and fruit development, including harvest. Not only is proximity to harvest a concern, but bee hazard is an issue as well. Malathion is highly toxic to bees. Entrust is moderately toxic (do not apply to blossoms if bees will forage within 3 hours). Aza-Direct is relatively non-toxic to honey bees.

Pruning Raspberries and Blackberries - Summer Pruning for increased plant health, Fall pruning to prevent winter damage.

Nate Nourse
Nourse Farms
41 River Road
South Deerfield, Ma 01373
413-665-2658
nnourse@noursefarms.com

For over five years, we have reduced winter damage in summer brambles by late fall pruning. Pruning the plant mass reduces the surface area of the plantings, decreasing winter damage due to plant desiccation. I have seen virtually no winter damage in our summer red and black raspberries. Most recommendations suggest it is better to wait until spring and prune off the winter damage in summer bearing brambles. I believe that decreasing the amount of cane the plant has to support, increases the chances it has to survive the winter.

According to Kathy Demchak at Penn State University:

> "In certain situations, such as when cane diseases are an issue, it may be more valuable to remove the floricane along with the disease inoculum on them, and improve air circulation. This is especially important for growers who are growing under low spray, no-spray, or organic systems where cultural controls to manage diseases take on critical value."

At Nourse Farms, we have been very aggressive with our pruning strategy. As soon as summer berry harvest ends, we begin pruning out the old canes. I feel that plant health is the most important consideration, we try to remove all diseased canes. We select the best 6-8 canes per foot of row and attach them to the trellis with clips. We are experimenting with some varieties leaving only 4 canes per foot of row. I would recommend trying several different cane densities to see which is best for you.

Once the raspberry plants have seen a few killing frosts, we begin our fall pruning. The summer red raspberries are topped to 6 inches above the trellis wire. Our top wire is 52-60 inches above the soil for all brambles, the standard used to be 36-40 inches. On black berries and black raspberries, we cut the laterals back to 12 inches. The result has been virtual elimination of winter damage, with temperatures as low as – 15 degrees. Improving plant health and growth contributed to increased yields and profits.

Weed Management in Brambles

Bradley A. Majek
majek@AESOP.Rutgers.edu
Department of Extension Specialists
Rutgers Agricultural Research & Extension Center
121 Northville Road Bridgeton, NJ 08302

Weed control options available to grower include cultural, mechanical, and chemical weed control. Mechanical weed control methods include plowing, disking, and harrowing before planting and disking, mowing, and hand-weeding after planting. Many established perennials weeds can be controlled mechanically by starving the roots. The weed begins to send food to the roots 10 to 14 days after a shoot emerges from the soil. Repeated close mowing or shallow cultivation within 7 to 10 days after any new shoots appear can eventually kill the weed. Many repeated cultivations are usually needed. Three to six months of diligence may be needed to eliminate established perennials. A single late or missed cultivation can "save" the weed. In the short term, cultivation aerates the soil surface, which improves initial water penetration and releases nutrients from oxidized organic matter, but mechanical weed control has disadvantages. Close cultivation can injure the canes, and cultivating too deep prunes roots. Repeated cultivation destroys soil structure and reduces the organic matter content. This reduces the nutrient and water holding capacity of the soil and decreases water penetration. The long term result of constant cultivation is the lowering of the productivity of the land and is not generally recommended for that reason.

Recommended management includes eliminating perennial weeds before planting brambles, maintaining a vegetation free zone in the row, and establishment of a perennial grass sod between the rows. Integration of vegetation management with insect and disease control programs is essential. Maintain the vegetation free zone in the row to prevent competition with the crop. The width of the vegetation free zone should be about forty percent of the distance between the rows. The width may vary, however, depending on soil fertility, water holding capacity and exposure to erosion. Do NOT reduce the width of the vegetation free zone in new plantings. Maintain the full width of the vegetation free zone in new plantings to achieve maximum growth.

Sod between the rows prevents soil erosion, provides traction for equipment, increases soil organic matter, improves soil structure and water permeability, and furnishes shelter for beneficial insects. The sod should not include plants that are an alternate host for insect pests, or diseases and nematodes that attack the crop. In addition, the sod should be easily maintained, tolerant to drought, require little or no fertilization, and compete minimally with the crop.

Tall fescue or hard fescue perennial grass sods are recommended for row middles. Both types of fescue are tolerant to disease, drought, low pH and low fertility. They compete effectively with weeds, do not spread or creep into the row by rhizome or stolen growth, and are semi-dormant during the hot dry summer months. Tall fescue is more vigorous and is more easily established, but requires more frequent mowing. Newly developed "turf type" tall fescue varieties are vigorous, and have a lower mowing requirement than the traditional 'Kentucky 31' tall fescue. Hard fescue grows more slowly and close to the ground, and has a minimal mowing requirement, but is moderately slow and difficult to establish.

The addition of clover or other legumes is not recommended. Although legumes do fix nitrogen, release for plant use unpredictable, and often at the wrong time of year. Legumes may also be alternate hosts for pests, including insects, nematodes, and diseases.

Preparation for sod establishment should begin the year before the crop is planted. Control perennial weeds and nematodes, and correct soil pH and nutrient deficiencies first. Complete primary tillage during the summer months. Consider building gently sloping raised ridges to improve drainage in the future rows **before** sowing grass. Fields planted flat have developed depressions in the row between the strips of sod due to the improving soil structure in the sod compared with the vegetation free strip.

The success of a sod planting will depend on accurate seeding and timing. Sow tall or hard fescue in late summer into a well prepared seedbed. Use 50 to 75 pounds of seed per broadcast acre to establish tall fescue, or 25 to 50 pounds of seed per broadcast acre to establish hard fescue. Blend up to five pounds of perennial ryegrass per one hundred pounds of hard fescue seed to provide a fast thin cover while the hard fescue gets established. The perennial ryegrass will be eliminated from the stand by disease and drought in a few years.

Use a seeder manufactured to sow grass and other similar sized seed that will ensure proper seed placement, a firm seedbed, and good seed and soil contact. Failure to use adequate equipment for seeding frequently results in poor establishment. Do not use a “spinner spreader” to distribute the seed. Fescue seed that lands in the crop rows will establish and may be difficult to control. Seeding should be completed by September first in the northern counties of New Jersey, and by September twentieth in the southern counties. Apply 50 pounds of nitrogen (N) per acre at seeding and repeat in late fall or early spring to encourage rapid establishment.

Excellent results have been obtained by seeding perennial grass in the future crop row as well as between the rows. Use one hundred percent perennial ryegrass in the row rather than fescue. Rapid establishment and growth, and susceptibility to herbicides make perennial ryegrass a better choice. Kill the sod in the row when the crops to be planted and “no-till” the bramble into the dead sod. Use recommended herbicides to control weeds. The sod’s roots increase soil organic matter, and improve soil structure and water permeability before it is killed, and acts as a mulch to conserve water and prevent erosion during the establishment year. By fall the dead sod deteriorates and is not attractive to rodents.

Establishment of a dense sod that is competitive with weeds will require fifteen to twenty months. Some additional effort during this period will ensure success. The year before the crop is planted, apply 2,4-D in late fall eight to ten weeks after seeding the grass. Use 0.25 to 0.5 pints of 2,4-D per acre to control seedling annual broadleaf weeds. Apply Gallery 75DF to the sod early the first spring to control large crabgrass and other weeds while the sod establishes. Use Gallery 75DF at 1.0 pound of active ingredient per acre. The Gallery 75DF rate is the same as the rate labeled for use in the row for newly planted nonbearing blackberries and raspberries.

In row weed control the establishment year requires extra care not to injure crop. Surflan 4AS or Devrinol 50 DF plus Gallery is safe and effective after transplanting conventional plants. Planting tissue culture plants, and other planting systems that use plants that are smaller or less vigorous than conventional plants should not be treated with a herbicide until well established. Consider planting into black plastic mulch to aid establishment, and remove the plastic later, but do not use Surflan under plastic mulch.

After establishment, treat brambles with a combination of herbicides to provide residual grass and broadleaf weed control in late fall and/or in early spring, before buds break. Add a postemergence herbicide, if needed to control emerged weeds. Solicam 80DF, Surflan 4AS, or Devrinol 50DF are good residual annual grass herbicides. Solicam will also suppress certain perennial grasses and yellow nutsedge when used at the maximum recommended rate. Princep, Sinbar, and Casoron are residual annual broadleaf weed herbicides. Princep can be applied in late fall or spring. Sinbar leaches more readily, especially in sandy coarse textured soils low in organic matter, and should only be used in the spring before bud break. Casoron is a granular formulation that must be applied in late fall or winter when the crop is dormant, but Casoron controls perennial as well as annual broadleaf weeds.

Gramoxone Extra is a non-selective postemergence herbicide that can be used to control emerged seedling weeds when the crop is dormant. Young growing bramble shoots will be killed or severely injured if sprayed. Poast, Fusilade DX, and Select are postemergence herbicides that control most grasses, but will not injure brambles, or control broadleaf weeds and yellow nutsedge. Select is only for use on non-bearing brambles, but will control tall and hard fescue. Poast and Fusilade DX are labeled for use on bearing brambles, but will not control or even significantly injure tall or hard fescue.

Roundup formulations, Touchdown, and other labeled glyphosate formulations are translocated non-selective postemergence herbicides that should only be used with extreme care in brambles. Application of either of these herbicides to only a few leaves or a small section of green cane may result in death of the plant or severe injury that may persist for more than one year. Apply only as a spot treatment to control difficult perennial weeds.

Effectively Managing Cucurbit Mildews: What You Need to Know

Margaret Tuttle McGrath

Department of Plant Pathology and Plant-Microbe Biology, Cornell University
Long Island Horticultural Research and Extension Center,
3059 Sound Avenue, Riverhead, NY 11901. 631-727-3595. mtm3@cornell.edu

Producing a high-quality cucurbit crop necessitates effectively managing powdery mildew and downy mildew. These two foliar, fungal diseases are common in the northeast because the pathogens produce spores easily dispersed by wind that enable them to spread widely. Crops often are affected by both. While neither pathogen affects fruit directly, they cause leaves to die prematurely which results in fewer fruit and/or fruit of low quality (poor flavor, sunscald, poor storability).

Powdery mildew is managed with resistant varieties and fungicides. An integrated program with both management tools is needed to achieve effective control because the pathogen is adept at evolving new strains resistant to individual tools that thus are not controlled as well by the tool. It is more difficult for new pathogen strains to develop when an integrated program is used, and effective control is more likely. Resistant varieties have not provided as effective control in recent years as before. But they remain an important tool. There are now resistant varieties in most crop groups with new varieties released most years. Select cantaloupes with resistance to pathogen races 1 and 2. Select squash and pumpkins with resistance from both parents (homozygous resistance) when possible. This term is used in a few catalogues (for example Outstanding Seeds) whereas others use terms like ‘high resistance’ and ‘intermediate resistance’ to generally refer to homozygous and heterozygous resistance, respectively. Degree of disease suppression obtained with a variety also depends on modifying genes present. Plant breeders are actively searching for new sources of resistance to powdery mildew.

The most effective fungicide program for powdery mildew is weekly applications of targeted, mobile fungicides tank mixed with a protectant fungicide beginning very early in powdery mildew development. Mobile fungicides are needed for control on the underside of leaves where the pathogen develops best. The action threshold for starting applications is one leaf with symptoms out of 50 older leaves examined. Powdery mildew usually begins to develop around the start of fruit production. Alternate among targeted fungicides and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. Some fungicides are no longer recommended because resistant pathogen strains are sufficiently common to render them ineffective: Topsin M (FRAC code 1; MBC fungicide) and QoI fungicides (Code 11), which include Quadris, Cabrio and Flint. Other fungicide chemistry has remained adequately effective to include in a fungicide program although the pathogen has developed some resistance, in particular the DMI fungicides (Code 3), which include Procure, Rally, Tebuzol, Folicur, and Inspire Super. They remain effective partly because resistance to this group is quantitative, whereas to the Code 1 and 11 fungicides it is qualitative (pathogen is sensitive or resistant), and these DMI fungicides are inherently more active than the first DMI fungicide, Bayleton, which is no longer registered for this use because of control failures due to resistance. Highest label rate is recommended when resistance is quantitative or might be (generally assumed to be until known). Procure applied at its highest label rate provides a higher dose of active ingredient than the other Code 3 fungicides. This fungicide was effective in the yearly fungicide efficacy experiment conducted on Long Island in 2011. Quintec (FRAC Code 13) has been the most consistently effective fungicide in fungicide evaluations, therefore it is recommended as the main mobile fungicide to use on labeled crops (pumpkin, winter squash, gourd, melon) where the crop rotational restriction of 12 months is acceptable. Recent crop additions to the Quintec label have increased the options of what can be planted within 12 months of the last application. The Quintec label specifies no more than two consecutive applications plus a crop maximum of four applications. FRAC Code 7 is the third fungicide chemistry recommended for managing powdery mildew. Boscalid is the only active ingredient in this fungicide group labeled currently for this use. It is in the product Pristine. While highly resistant pathogen strains have been detected, Pristine has continued to provide some control, including in the Long Island 2011 evaluation when it was as effective as Procure.

Prospect looks good for improved control of powdery mildew in the future. There are new mobile fungicides on track for registration soon that are highly effective for powdery mildew. Similar to the targeted, mobile fungicides currently in use, they do have risk of resistance developing because they have single site mode of action. Therefore it will be critical to always use a resistance management program. Hopefully these fungicides will be registered before the pathogen has developed resistance to Quintec so that all can be used together in a fungicide resistance management program. Vivando, which is being developed by BASF, has the novel active ingredient metrafenone. It is a FRAC code U8 fungicide. 'U' designation means it is unknown more of action. It was registered in the US in 2011 with approval for use on grapes. Additional crops including cucurbits are anticipated to be labeled in 2013. Resistance risk is considered medium; elsewhere strains of the wheat powdery mildew pathogen have been detected with reduced sensitivity. Torino, being developed by Gowan, is another product with a unique active ingredient unlike other fungicides. It is cyflufenamid, a FRAC code U6 fungicide. US federal registration is pending and anticipated in spring 2012 for cucurbits, grapes, and strawberries. The cucurbit powdery mildew pathogen has developed resistance elsewhere in the world where already registered. Like Quintec, both of these fungicides are only effective for powdery mildew diseases. Three new fungicides in development have an active ingredient that belongs to the carboxamide class of fungicides (FRAC Code 7), which is the same as boscalid. However, these fungicides have been more effective than Pristine in fungicide evaluations documenting differences in activity. Fontelis (aka LEM17), developed by DuPont, contains penthiopyrad. Federal registration is expected before the end of 2011, thus it will be the first new carboxamide available. The carboxamide ingredient in Merivon is fluxapyroxad. This product also contains pyraclostrobin. It is being developed by BASF. EPA approval is anticipated for the first label with pome/stone fruit in early 2012 and for additional crops including cucurbits in 2013. Bayer Crop Science has the ingredient fluopyram in their Luna series fungicides. Luna Experience is anticipated to be registered before the 2012 growing season but only on watermelon; other cucurbit crops will be added subsequently. Pristine, Merivon, Fontelis, and/or Luna Experience should not be used in alternation because they all have an active ingredient in the same chemical group (Code 7). This chemistry is also effective for gummy stem blight/black rot.

Downy mildew is primarily managed with fungicides. Resistance bred into cucumbers provides some suppression of the pathogen strains present recently, but substantially less that what was achieved against strains present before 2004. However, they are still considered a worthwhile component of an integrated program. Plant breeders are searching for new sources of resistance. As with powdery mildew, fungicide resistance is also a concern with the downy mildew pathogen and therefore the fungicide program recommended for downy mildew is also targeted, mobile fungicides applied in alternation on a weekly schedule and tank mixed with a protectant fungicide beginning very early in disease development. Resistance to mefenoxam and metalaxyl and to strobilurins is sufficiently common that fungicides with these active ingredients (e.g. Ridomil and Cabrio), which use to be highly effective, are no longer recommended.

The full list of mobile fungicides with different modes of action recommended for managing downy mildew includes: Ranman (FRAC Code 21), Forum (40), Revus (40), Presidio (43), Curzate (27), Tanos (27), Gavel (22), and Previcur Flex (28). These have been registered for this use in the US for a few years. Concern about resistance developing to single site mode of action fungicides like these increases with use. Alternating among fungicides in different FRAC Groups (different codes) and tank-mixing them with a protectant fungicide (except for Gavel which contains mancozeb) is recommended for delaying resistance development, minimizing the impact of resistance when it occurs and it is often required to comply with the restrictions on most labels. Curzate and Tanos have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). Presidio has an advantage over Curzate and Previcur Flex of also being effective for Phytophthora blight. Both diseases are often of concern for most cucurbit growers. Presidio has a long rotational interval of 18 months for non-labeled crops, which can be a constraint on production. All cucurbits, fruiting vegetables, tuberous and corm vegetables (except potato), and leafy vegetables are now labeled; carrot, sugar beet, potato and rotational wheat will be labeled soon; and rotational field corn is expected in 2012. All of the mobile fungicides listed above have proven effective in university fungicide efficacy evaluations. Efficacy of Revus has varied among crop types with control being good on pumpkin but poor on cucumber. Based on results from an analysis of all published data from these evaluations, Presidio is the most effective fungicide, followed by Previcur Flex and then Ranman. All of the mobile fungicides are at risk for development of fungicide resistance because of their single site mode of action. And the downy mildew pathogen is considered prone to developing resistance. Resistance to the active ingredient in Tanos and Curzate has been detected in Europe. The analysis of fungicide efficacy data also revealed that combining mobile fungicides with a protectant fungicide improved control; thus there is an additional benefit to this standard practice for managing resistance. None of the downy mildew fungicides are effective for powdery mildew unfortunately.

A new mobile fungicide developed by BASF, Zampro, is anticipated to be registered during the later part of 2012 for use on cucurbits as well as potatoes, grapes, brassicas and fruiting vegetables. It is effective for Phytophthora blight as well as downy mildew. Zampro contains new fungicide chemistry, ametoctradin (FRAC code 45), plus dimethomorph (40), the active ingredient in Forum. Once this fungicide is registered it will be recommended as a component of the fungicide program in place of the code 40 fungicide being used.

Chlorothalonil and mancozeb are the main protectant fungicides for downy mildew. Copper is not as effective. Dithane now has a supplemental label that includes pumpkin, winter squash and gourd.
An important tool for determining when fungicide application is warranted is the forecast web site for this disease at http://cdm.ipmpipe.org. Cucurbit plants are susceptible to downy mildew from emergence; however, this disease usually does not start to develop in the northeast until later in crop development when the pathogen is dispersed by wind into the region. The forecast program monitors where the disease occurs and predicts where the pathogen likely will be successfully spread. The pathogen needs living cucurbit crops to survive, thus it cannot survive where it is cold during winter. The risk of downy mildew occurring throughout the eastern US is forecast and posted three times a week. Forecasts enable timely fungicide applications. Growers can now subscribe to receive customizable alerts by e-mail or text message. Information is also maintained at the forecast web site of cucurbit crop types being affected by downy mildew. This is important because the pathogen exists as pathotypes that differ in their ability to infect the various crops. All pathotypes can infect cucumber; some also can infect melons and squashes are susceptible to others. Success of the forecast system depends on knowledge of where downy mildew is occurring; therefore prompt reporting of outbreaks by growers is critical.

In conclusion, to manage the mildew diseases effectively in cucurbit crops: 1) select resistant varieties, 2) sign up to receive alerts about downy mildew occurrence and routinely check the forecast web site to know where the disease is occurring and what crops are affected, 3) inspect crops routinely for symptoms beginning at the start of crop development for downy mildew and fruit development for powdery mildew, 4) apply protectant fungicides when there is a risk of disease development, and 5) beginning when these diseases start to develop, apply targeted fungicides weekly and alternate amongst available chemistry based on FRAC code. Unfortunately there are no targeted fungicides effective for both mildew diseases because the causal pathogens are biologically very different. Add new fungicides to the program when they become available; substitute new for older product if they are in the same FRAC group.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Note that some products mentioned are not yet registered for use on cucurbits. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

VARIETY SELECTION, CULTURE, AND STORAGE FOR MAXIMIZING EATING QUALITY AND NUTRITION IN SQUASH

J. Brent Loy
Department of Biological Sciences, University of New Hampshire, Durham, NH 03824
Email: jbloy@unh.edu

Three major species of squash are grown worldwide for their mature, edible fruit – *Cucurbita pepo*, *C. maxima*, and *C. moschata*. The species *C. moschata* includes tropical cultigens called calabazas in the Caribbean basin, round to oval to long neck pumpkins grown in parts of North America for processing, and the dumbbell-shaped butternuts, the major fresh market type grown in the Northeast. The species *C. maxima* includes huge show pumpkins, Golden Delicious-type processing squash, Hubbard varieties, and the green to gray, 2 to 3 pound buttercup/kabocha varieties esteemed for their exceptional eating quality. The species *C. pepo* gives us acorn and related varieties such as 'Sweet Dumpling' and 'Delicata' types. Cultural methods for the above species of squash are similar, but for optimum eating quality and nutrition, harvesting schedules and post-harvest handling need to be tailored according to the species and varieties being grown.

What are the key nutrients in winter squash?

Growers can and should identify nutritional benefits of their produce as a marketing tool and service to customers. Carbohydrates in the form of sugars and starch are the major constituents of squash flesh (mesocarp), comprising between 50% to as much as 70% of the dry biomass (solid portion after elimination of water) at harvest (Table 1). Varieties with a high content of dry matter (17-26%) have better eating quality than those with low dry matter content because their high starch content and a low proportion of fibrous cell wall material. Starch contributes to a desirable pasty and sometimes flaky texture of cooked squash, and generates sugars during enzymatic breakdown.

Table 1. Percentage dry weight composition of the edible portion of buttercup and butternut squash at harvest and after 3 months of storage (adapted from T.G. Phillips, 1945).

	Percent of Total	
Component	**Harvest**	**3 Months**
Carbohydrates	62-68	57-62
Starch	52-53	14-19
Sugars	10-15	43
Cell wall (cellulose, pectin)	9-10	13-17
Protein	5-6[z]	6-8[z]
Ash (mineral elements)	5-6[y]	5-6[y]
Other	10-16	8-19

[z]Values overestimated because of high soluble N content.

[y]Data obtained from other sources.

In cooking tests, high sugar content is strongly associated with high ratings for eating quality. The sugar content at harvest can vary from over 20% in some acorn varieties to 10% or less in some kabocha and butternut varieties. The relative sugar content can be estimated using a hand-held refractometer, with values given in % soluble solids (SS). Acceptable eating quality is generally attained when SS values are 11% or higher. If starch levels are sufficiently high, sugar content will progressively increase during storage until most of the starch is consumed. In varieties with low starch content, starch is rapidly depleted in storage, and often sugar content of flesh does not reach acceptable levels. In such varieties, flesh texture deteriorates, becoming more watery and fibrous and less pasty.

Other than providing carbohydrates and dietary fiber, the major nutritional benefit of squash is the high content of carotenoids, the yellow to orange, fat-soluble pigments. Beta-carotene, an abundant carotenoid in several varieties of squash, is an important precursor to vitamin A, an essential vitamin for normal development and eye function. Xanthophyll carotenoids, lutein and zeaxanthin, accumulate in the macular region (central portion of the retina) in the eye, and provide photo-protection. Jennifer Noseworthy, a doctoral student at UNH has been studying carotenoid content and carotenoid profiles in squash and sweet potato. She has found that the carotenoid content in the popular butternut variety 'Waltham,' is comprised of a relatively high proportion of lutein (27 to 37%) and β-carotene (19 to 23%) at harvest. Carotenoid levels were appreciably higher in the kabocha/buttercup varieties analyzed than in butternuts, but over 50% of the carotenoids in kabocha varieties are considered non-beneficial to human health. There may be considerable variability in types of carotenoids in different varieties of squash.

Squash maturity and harvest

The three popular classes of winter squash, kabocha/buttercup, butternut and acorn, differ in their nutritional and eating properties relative to recommended harvest and storage periods. All three classes attain maximum starch content between 30 and 35 days from fruit set (when female flowers open and pollination occurs). Seed development is not completed until about 55 days after fruit set, and so a continuous supply of sugars from leaf photosynthesis or from breakdown of starch in the flesh is needed for the process of seed fill. A general rule of thumb is to wait at least 50 to 60 days after fruit set for removing the fruit from the vine, as long as the vines are healthy.

Butternut varieties will turn tan color about two weeks before the fruit should be harvested. Butternut can be harvested when fruit first turn tan color, but they will have to be stored longer to attain sufficient sugar levels and the flesh quality (% dry matter) often show a more pronounced decrease than if squash were harvested at 55 to 60 days after fruit set. Butternut varieties grown in most regions of New England should be stored for about two months (50 to 60 ^{o}F) to attain sufficient sugar levels. The starch to sugar conversion can be accelerated by storing squash for one to two weeks at 80 to 85 ^{o}F, prior to storing at the recommended lower temperature for long-term storage.

Buttercup varieties harvested at 55 to 60 days after fruit set will sometimes have soluble solids levels of close to 11%; however, it is usually advisable to store the squash for an additional two weeks to acquire higher sugar levels. Moreover, many kabocha squash have excessive dry matter at harvest for good eating quality, and should be stored for a month of more to allow for some loss in dry matter through respiration and for additional sugar accumulation. Because most kabocha varieties have extremely high starch reserves, harvest at 40 days after fruit set is often recommended. The earlier harvest reduces the likelihood for sunburn damage, and studies in New Zealand suggest that kabocha squash are less susceptible to storage rots if harvested early. I usually recommend that kabocha be harvested when the ground-spot on the fruit turns orange; this occurs about 45 to 50 days after fruit set.

Acorn squash are somewhat of enigma in that fruit reach full size and a dark green color within two to three weeks after fruit set, about 4 or 5 weeks before they should be harvested! Consistent quality is difficult to achieve in many acorn varieties. Vining varieties such as Sweet Dumpling and Delicata usually have fairly consistent quality if fruit loads are not too heavy. Most of the semi-bush to bush commercial varieties lack consistent quality and many will never produce fruit with good eating quality under any cultural conditions. The table below shows results from a replicated field study conducted at UNH in 2011, comparing some of the newer commercial acorn varieties with powdery mildew resistance. We compared several acorn varieties with a natural fruit load to those in which fruit set per plant was limited to three fruits Table 2. Although not a recommended practice, we wanted to look at changes in eating quality with reduced fruit loads. Reducing fruit load was expected to improve eating quality because of enhancement of starch levels in plants with smaller fruit load. If 15% flesh DM is considered necessary to have passable quality in acorn squash and 17 to 20% DM and greater than 11% soluble solids is considered necessary for very good to excellent eating quality, it is readily apparent that some of the more popular varieties do not pass muster. Some other relationships are readily apparent from Table 2. Acorn varieties with high dry matter have high sugar content at maturity, and adequate soluble solids (sugar) levels are reached at harvest. Another important relationship evident from Table 2 is that varieties with high dry matter and good eating quality do not produce as high as fresh weight yields as varieties with low dry matter and poor eating quality. It should also be pointed out that even in varieties which are known for superb eating quality, there can be considerable plant to plant variation in eating quality, and variability among fruit from a single plant. When evaluating new hybrid combinations, we always look for consistent quality for whatever traits are being evaluated.

Table 2. Fruit size, fruit yield, % dry matter, and soluble solids levels in six hybrid varieties of squash grown at the Kingman Research Farm in Madbury, NH in 2011 (NH1669 is an experimental hybrid with semi-bush phenotype and powdery mildew resistance).

Hybrid	Ave. Fruit wt. (g)	FW Yield kg/plot	% Dry Wt.	% SS
Unpruned				
Honey Bear	645 A	6.08 A	15.4 D	11.5 D
NH1669	761 B	6.46 A	20.4 E	14.4 E
Table Star	756 B	9.68 BC	11.6 C	8.8 C
Royal Ace	786 BC	8.59 B	9.8 B	8.1 AB
Tip Top	857 C	8.74 B	12.5 C	9.5 C
Autumn Delight	981 D	10.76 C	8.0 A	6.9 A
Pruned				
Honey Bear	602 A	5.13 A	20.6 E	14.4 D
NH1669	757 B	6.81 B	20.4 E	14.9 D
Table Star	791 B	6.74 B	15.4 D	11.6 C
Royal Ace	792 B	7.13 BC	11.4 B	9.0 A
Tip Top	905 C	7.89 BC	13.8 C	10.5 BC
Autumn Delight	995 C	8.47 C	10.4 A	8.7 A

Abbreviations: Ave. Fruit Wt. – average fruit fresh weight; FW Yield = fresh weight total yield per plot in kilograms (1 kg = 2.2 pounds); % Dry Wt. (dry weight); % SS (soluble solids).
Values within a column with a different letter are significantly different at P = 0.05..
Pruned plants were pruned to a maximum of three fruits per plant.

Conclusion

The three major classes of winter squash - acorn, kabocha/buttercup, and butternut – have different attributes associated with maturation and post-harvest changes in eating quality and nutrition. It is important for growers to understand these differences in order to use proper harvesting and post-harvest methods, and also to provide information to customers that will guide them in purchasing and utilizing squash for optimum culinary and nutritional benefits. In addition to species differences in maturation, there are also considerable varietal differences with respect to eating quality and consistency in eating quality. It behooves growers to become more aware of those varieties which exhibit good eating quality so that their customers are satisfied with their purchases, and realize the benefits of purchasing produce at roadside retail markets. Growers should not view squash as just a fill-in vegetable to market in the fall, but as an item they can market as a culinary delight with excellent nutritional benefits.

GROWING SEEDLESS WATERMELONS

Alan Schwartz – Tower Hill Farm
276 Ames Street, Lawrence, MA 01841
(978) 688-2878 alan.schwartz@bostonhousing.org

Watermelons have come a long way since the discovery of their seedy fruits. Through the wonders of science, we now have seedless varieties. How are these seedless watermelon seeds produced? They are created by crossing a tetraploid (seedless) inbred line female parent with a diploid (seeded) inbred line male parent. The resulting varieties are available in various shapes, sizes and colors.

Several factors differentiate seedless from seeded watermelons. First, a pollinator is required. These specially bred melons bloom early, produce large quantities of pollen, and are smaller than the desired melons. Ace and Companion are just two of the pollinators available. Seedless melons also lack the vigor of regular varieties. The seed is expensive and must be handled with great care. It has a greater chance or rotting if certain conditions are not met. A sterile soilless mixture is required. Because the seedlings don't do well if their roots are disturbed, the seed must be planted directly into peat pots. Fill the pots with well moistened, but not wet, soilless starting mixture. Warm the pots to 90 degrees and hold them at that temperature for four days.

It is now time to plant the seedlings. To keep track of the seedlings, make separated plantings of the seedless variety and the pollinator. To insure good fruit set, plant three seedless to one pollinator. Plant the narrow seed, tip down, ½ inch into the soil. Cover the containers with a thin layer of clean sand. This will help maintain soil temperature and moisture.

As soon as the plants emerge, lower the temperature to 75 degrees. Gradually, harden off the seedlings. When the threat of frost is completely gone and the plants have their second set of leaves, plant the pots in raised beds fertilized with 15-15-15 or its organic equivalent at the rate of six pounds per 1,000 feet of row. Black plastic or paper mulch can be applied before planting. Row covers can also be used, but only after the plants have established themselves. Otherwise, the plants will cook. Space the pots with two feet between plants and six feet between rows. To prevent the peat pots from drying out, be sure to cover them with soil. Inter space the triploid with the pollinator. Apply a liquid starter fertilizer.

When the vines begin to run, side dress the plants with nitrogen at the rate of forty pounds per acre. For the rest of the season, watermelons require limited care. They will tolerate drought, but lack the vigor to outgrow weed competition. Beds must be free of weeds. Careful cultivation is required to protect the plants' shallow root system. The use of bees will make for earlier fruit set and increased yields. Two hives per acre are suggested.

If you have followed all these tips and have a bountiful crop, how do you tell when the melons are ripe? There are three signs. First, the bottom of the melon will turn yellow. Second, the tendril closest to the fruit will be brown. Third, when tapped, the melon will make a thumping sound.

The implementation of the tips outlined in this presentation will help you to meet the increasing consumer demand for seedless watermelons.

Choosing the Best Varieties: Zucchini, Summer Squash, and High Tunnel Cucumbers

Becky Sideman, UNH Cooperative Extension
G48 Spaulding Hall, 38 Academic Way, Durham NH 03824 or becky.sideman@unh.edu

The difference between success and failure with a crop often hinges upon variety choice.
In this talk, I will present the results from two years of variety trials conducted in Durham, NH. This will include green and yellow zucchini, summer squash, and high tunnel cucumbers.

Zucchini

In 2010 and 2011, eleven green and five yellow zucchini varieties were evaluated in a replicated field trial. Fruits were harvested every Mon, Wed and Fri from 7/2-8/20 in 2010, and from 7/11-8/19 in 2011. Season-long results from both years are shown below:

Cultivar[a]	Color	Rank Order Yield (no. fruit)[b]		Rank Order Yield (weight)		Rank Order Avg. fruit size	
Green Zucchinis		**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
Cashflow (JSS)	Medium green	3	2	1	1	5	8
Dunja (HM)	Dark green	-	13	-	11	-	5
Midnight Lightning (HM)	Dark green	8	8	9	10	8	9
Partenon (JSS)	Medium green	-	12	-	9	-	4
Payroll (SW)	Medium green	4	4	4	4	4	6
Plato (JSS)	Dark green	5	3	7	5	6	10
Reward (H)	Medium green	1	6	2	8	7	7
Spineless Beauty (H)	Medium green	9	11	5	6	2	2
Spineless Perfection (R)	Dark green	-	10	-	7	-	3
Tigress (H)	Medium green	5	5	3	2	3	1
Zucchini Elite (H)	Medium green	10	-	6	-	1	-
GoldenYellow Zucchinis							
Golden Delight (R)	Bright yellow	-	9	-	13	-	12
Golden Glory (R)	Bright yellow	-	7	-	12	-	11
Golden Rod (H)	Bright yellow	-	1	-	3	-	13
Meteor (JSS)	Bright yellow	2	-	8	-	9	-
Sebring (JSS)	Bright yellow	7	-	10	-	10	-

[a] Seeds provided by or purchased from Harris Seeds (H), High Mowing Seeds (HM), Johnny's Selected Seeds (JSS), Rupp (R) or Seedway Seeds (SW).
[b] Ranks range from 1 = greatest to 10 or 13 = least.

Of the green zucchinis, Reward, Cashflow, Payroll, Tigress and Plato were among the four top yielding varieties in at least one year. Across both years, Cashflow and Payroll consistently had the highest yields (both in terms of number of fruit and weight). Zucchini Elite, Spineless Beauty, Spineless Perfection, Dunja, Partenon and Midnight Lightning were among the lowest yielding varieties; several of these (Zucchini Elite, Spineless Beauty, Spineless Perfection, as well as Tigress) had the largest fruits, which may have reduced fruit set.

In general, the yellow zucchini varieties produced smaller fruits and had lower yields. However, two yellow varieties outperformed most green varieties. In 2010, Meteor had the second highest yields in the trial; and in 2011, Golden Rod had the highest yields (over 25 fruit per plant).

On August 9, 2011 each plot was evaluated for powdery mildew (PM) severity on a 0-5 scale (0 = no visible sporulation, 5 – all leaves and petioles show heavy sporulation). Only two varieties showed consistent tolerance; Dunja (all plots had a rating of 1), and Golden Glory (all plots were rated 2). All other varieties had average ratings of 2.5 or greater.

Yellow Summer Squash

In 2010 and 2011, ten varieties of summer squash were evaluated in a replicated trial along with zucchini cultivars (described above). Season-long results from both years are shown below:

Cultivar[a]	Color	'B' gene[b]	Rank Order Yield (no. fruit)		Rank Order Yield (weight)		Rank Order Avg. fruit size		Comments
			2010	**2011**	**2010**	**2011**	**2010**	**2011**	
Cheetah (H)	Yel	-	-	8	-	5	-	3	Slender, smooth fruit.
Cougar (H)	Yel	B	3	4	2	3	2	2	Rough, teardrop shaped fruit. Spiny plant.
Enterprise (SW)	Yel	-	5	7	4	7	2	4	Smooth, tapered fruit. Extremely spiny plant.
Fortune (SW)	Yel	B	2	1	3	2	6	8	Slightly ridged; teardrop-shaped golden fruit.
Goldprize (R)	Yel	-	-	6	-	4	-	1	Tapered, fairly smooth yellow fruits.
Slick Pik (JSS)	Yel	-	6	3	6	8	5	7	Slender elongated fruit. Smooth stems.
Success PM (HM)	Yel	-	8	5	8	6	4	6	Smooth, teardrop-shaped fruit. Tall plant, not PMR in 2011.
Sunray (H)	Yel	B	4	-	7	-	6	-	Similar to Fortune; but with shorter fruits
Superpik (H)	Yel	B	1	2	1	1	8	5	Long, rough fruit. Extremely spiny plants.
Zephyr (JSS)	Yel/ Grn	-	7	-	5	-	1	-	Smooth, long yellow fruit w/light green tips and pale stripes.

[a] Seeds provided by or purchased from Harris Seeds (H), High Mowing Seeds (HM), Johnny's Selected Seeds (JSS), and Seedway Seeds (SW).
[b] The 'B' or 'precocious' gene causes the stem of the squash to be yellow rather than green. Varieties with this gene do not show symptoms when infected by viruses. These leaves of these varieties may turn bright yellow under certain environmental stresses, as they did in June 2011.

Over both years, Superpik and Fortune produced significantly more fruit per plant (over 29 fruit per plant, on average) than the lowest producing summer squash, Success PM (20.5 fruit per plant, on average). In 2011 each plot was evaluated for PM severity as described above. All summer squash varieties, including the PM tolerant Success PM, were moderately susceptible, with average PM ratings of 2.5 or greater. Fruit appearance and shape, and ease of picking, were highly variable between the varieties we tested.

High Tunnel Cucumbers

In 2010, fourteen varieties of cucumbers were evaluated in a high tunnel in Durham NH. They were trellised and pruned to a single leader. Yields, quality, and susceptibility to powdery mildew and mites were assessed. Season-long results are shown below:

Cultivar[a]	Type	No. fruits per plant	% Not market able	Yield (lbs) per plant	PM[b]	Mite[c]	Comments
Genuine (JSS)	Slicer	27.3	13.3	13.7	1	0	
Green Finger (HM)	Slicer	*9.3*	*31.3*	*8.2*	0	0	Poor fruit set.
Saber (HM)	Slicer	30.5	17.2	12.8	1.3	0	
Tasty Jade (JSS)	Slicer (long)	26.7	21.2	15.4	1.3	0	
Tasty Green (S)	Slicer (long)	*15.8*	*31.5*	*8.6*	0	0.7	Poor fruit set.
Carmen (S)	Oriental	18.2	19.3	9.5	0	3.0	No spines.
Orient Express (H)	Oriental	31.1	16.2	16.7	0.7	0.3	
Orient Express II (S)	Oriental	28.4	18.7	15.9	1.7	0	
Ballerina (SW)	Pickle	37.3	13.5	*9.2*	0	2.5	
Diamant (JSS)	Pickle	27.1	9.2	*8.2*	0.7	2.7	Extremely spiny.
Vertina (JSS)	Pickle	42.8	11.7	10.5	0	2.7	
Diva (H)	Beit alpha	22.1	22.7	9.5	0	0.3	
Katrina (JSS)	Beit alpha	32.8	21.4	11.2	0	5.0	
Socrates (JSS)	Beit alpha	33.3	20.0	13.7	0	3.7	

[a]Seeds provided by or purchased from Harris Seeds (H), High Mowing Seeds (HM), Johnny's Selected Seeds (JSS), Seedway Seeds (SW) and Stokes Seeds (S).
[b]PM (Powdery mildew) was evaluated on a 0-5 scale on 7/26/10, where 0 = no symptoms, 5 = sporulation evidence on entire surface of every leaf.
[c]Mite damage was evaluated on 7/26/10, where 0 = no stippling or webbing evident, 5 = yellowing, stippling, and webbing was observed on all leaves.

Choosing the appropriate TYPE of cucumber for your market is perhaps the most important decision. The Oriental types were excellent for slicing. However, some customers were not sure what they were, because they were unfamiliar to them. Genuine and Saber looked a lot like field slicers, so would be good choices for markets that wanted traditional slicers. Green Finger was a slicer that had poor fruit set (not parthenocarpic) and a lot of unmarketable fruit (scarring). Tasty Green and Tasty Jade were intermediate in type between Asian and typical slicers. Tasty Green had much lower fruit set (and fewer marketable fruit) than Tasty Jade. In general, the picklers yielded the most fruit, and mostly marketable fruit, but were susceptible to mites. Beit alpha types have tender smooth skins, which are susceptible to wounding and scarring. Of this type, Katrina and Socrates had higher yields than Diva, but also more mite damage. This type had the highest percentage unmarketable fruit.

Onion Management: Insects, Diseases, and New Research in Plasticulture

Christine Hoepting, Cornell Cooperative Extension Regional Vegetable Program,
12690 Rte. 31, Albion, NY 14411, 585-798-4265 x 38; cah59@cornell.edu

As a rule of thumb, healthy large onion foliage translants into large onion bulbs. Bulbing is stimulated by the longest day of the year, June 21st. To achieve healthy large foliage, onions should be planted as early as possible in the spring, and anything that will help to push the onion plants along (e.g. optimum nutrients, warm soil, adequate soil moisture, no competition from weeds, etc.) at this early stage should be beneficial. During bulbing, a consistent supply of adequate moisture is best. Ideally, onion foliage should dry down naturally rather than from disease or insect damage or other plant stresses.

Insects:

The most common and problematic insect pest of small-scale onion production is onion thrips (OT). OT feeding reduces the photosynthetic capacity of the onion plant, which can reduce yield and bulb size by 30% or more. Once OT populations exceed 50 OT per plant, they can be very challenging to control. OT generate very quickly and are favored by hot and dry conditions.

Scouting for onion thrips: Start scouting in early- to mid-June. Note that transplants imported from the south may be infested with OT and may need to be sprayed sooner. OT are tiny slender insects. Nymphs are yellow and 0.5 to 1.2 mm in length and adults are brown, up to 2 mm in length. Look deep into the leaf axils to find the first OT of the season. Count the total number of OT and divide by the total number of leaves per plant to get the number of OT per leaf. Insecticide sprays should be started at 1 to 3 OT per leaf, depending on the insecticide used.

Cultural control practices: The first line of defense against OT is insecticides. However, there are cultural practices that are complimentary to an insecticide spray program. In Cornell studies, silver and straw mulches have been shown to delay buildup of OT resulting in delayed onset of the first insecticide spray and increased time interval between sprays. Similarly, kaolin clay has provided only mediocre OT control and may have to be reapplied frequently as it is easily washed off by rain.

Use the best insecticides: Movento (available as a Section 18 in NY) and Radiant are the most highly effective insecticides labeled to control OT. Radiant has excellent residual activity lasting > 7 days. Movento is systemic and has residual activity of > 10 days, but it is not very effective against adult OT. For this reason, Movento is strategically placed during the first half of the season when adult populations are lower than they are late in the season. Agri-Mek (available as a Section 18 in NY) provides good control of OT and has residual activity of 5-7 days. Lannate provides mediocre control of OT, OPs like Penncap-M provide poor control and pyrethroids like Warrior have failed to control OT in Cornell trials. The Cornell recommendations for OT control provide a sequence and strategy that takes into consideration the strengths and weaknesses of the available insecticides and applies them in a responsible manner to avoid the development of resistance in order to provide an effective, sustainable and economical OT management plan.

2011 Cornell spray recommendations for OT:
1) 2 sprays of Movento 5 fl oz, each at 1 OT per leaf*
2) 2 sprays of Agri-Mek 0.15EC 14 fl oz, 7 days apart (note: 30 day PHI)
3) 2 sprays of Lannate 3 pts, 7 days apart
4) 2 sprays of Radiant 6-8 fl oz, each at 3 OT per leaf
*If 3 weeks after the first spray of Movento, the OT population does not reach 1 OT per leaf, skip to Agri-Mek. If after using Movento or Agri-Mek, there are only 2-3 weeks remaining before onions are pulled, skip to Radiant.

For small-scale growers: OT populations may not be resistant to pyrethroids or OPs in these areas as they are in muck areas where large-scale onion production occurs. Start spraying these insecticides at 1 OT per leaf. If after 7 days, OT numbers are higher than 1 OT per leaf, switch to another chemical class.

For organic growers: Entrust is the most effective OMRI-approved insecticide and should be applied at 1 OT per leaf. It should not be applied more than twice before switching to another chemical class. Cultural practices may be incorporated.

Other important points: It is very common to not see a knockdown in OT until after the second consecutive spray of an insecticide. Use the highest rate of penetrating surfactant with Movento, Agri-Mek and Radiant.

Diseases:
The most important diseases of small-scale onion production are purple blotch, downy mildew and bacterial bulb decay.

Purple Blotch: PB usually develops and spreads during July and August as plants begin to mature. PB lesions can girdle onion leaves resulting in leaf dieback and in severe cases, onions can die standing up. When scouting, look for boat-shaped target-spot lesions about 0.5 to 1.0 inch in length on the outer 2-3 leaves of the plant. Lesions can be tan-ish or purplish, sometimes blackish in color, on green leaf tissue. Start spraying for PB in early July or at first sign of disease. In the most recent Cornell fungicide trials (2005-2007), half rate of Scala (9 oz) + half rate of Bravo (1.5 pt), Switch, Rovral and Endura were the top 4 best treatments for control of PB. All of these fungicides also control Botrytis leaf blight, another common leaf disease of onion. Other fungicides that can be used to manage PB include Quadris Top, Pristine, Cabrio and Inspire Super. Note that mancozeb and Bravo are weak against PB. Generally, fungicide sprays for PB need to be continued weekly for the rest of the season.

Downy mildew: DM is sporadic and generally only occurs in cool and wet years or very late in the season. It can be very destructive causing severe leaf dieback and onions often die standing up. Early detection of DM is very tricky. Middle-aged leaves first turn pale, then yellowish, and elongated patches may have grayish-violet fuzzy spores on green leaf tissue. Sporulation is most easily observed when dew is present. In older infections, the initial infection site becomes necrotic and is quickly invaded by PB and secondary pathogens with black spores. Infected leaves will die back very quickly. Once DM is detected, apply Ridomil Gold + mancozeb (Penncozeb, Manzate, Dithane) alternated with a high rate of Quadris Top + mancozeb. Other fungicides labeled for DM in onions include Reason, Revus, Presidio (new), Aliette, Acrobat, Forum, Phostrol/Prophyt. Know that once a plant is infected with DM that it will lose the affected leaves to dieback. The fungicide program is to prevent further spread from the infected plants to healthy ones, so that the whole field is not destroyed. Expect original DM hot spots to worsen, despite fungicide sprays. To assess whether DM is being contained, look for lack of new infections, and lack of spores on old lesions.

Bacterial bulb decay: A complex of several bacterial organisms including from the Geneses *Burkholderia*, *Pantoea* and *Enterobacter* have been found to cause bacterial bulb decay of onion, which are commonly soil borne. Symptoms first appear as leaf blights on the youngest center leaves of the plant and result in yellowing or bleaching and wilting of these leaves. The infection progresses down the leaves and neck, and eventually into the bulb. Affected bulb scales become soft and water-soaked and are yellow-brown in appearance. Cooper bactericides and Oxidate provide mediocre to poor control of bacterial diseases in onion. New research in plasticulture has shown that some very simple and economical adjustments to cultural practices can go a long way towards reducing bacterial diseases of onions.

New Research in Plasticulure:
In small-scale production, onions are typically grown from transplants on 3 foot wide black plastic mulch beds with 2 to 4 rows per bed. Onions are harvested by hand starting in early July and throughout the summer and sold at roadside stands, farmer's markets and produce auctions. Recent Cornell-led studies have demonstrated that narrow plant spacing and alternatives to black plastic mulch can significantly reduce bacterial bulb decay, increase marketable yield and increase profitability of small-scale intensively grown onions.

Narrow plant spacing: Cornell studies showed that when plant spacing was reduced from 6" or 8" to 4" with 3 or 4 rows per 3-foot plastic mulch bed (row spacing: 4 rows = 6"; 3 rows = 8"), this provided 53 to 64% control of bacterial bulb decay at harvest. Marketable yield also increased by 1.4 to 2.4 times, representing an increased net economic return of $43 to $258 per 100 feet of bed, due to increased weight of marketable jumbo-sized bulbs. Wide plant spacing produces big bushy plants with more leaves, thicker necks, delayed maturity and bigger bulbs, which are more prone to rotting. Narrowing plant spacing produces plants with fewer leaves and narrower necks that mature earlier and therefore are less conducive to bacterial bulb decay.

Alternatives to black plastic: Cornell studies showed that silver plastic, biodegradable black plastic and bare ground reduced bacterial bulb decay by 59%, 71% and 75%, respectively. Reflective silver plastic mulch, biodegradable black plastic and bare ground had significantly 1.8 to 2.8 times higher marketable yield than black plastic. Reflective silver and biodegradable black plastics had significantly 3.7 and 3.6 times, respectively, higher jumbo weight than black plastic, which resulted in an increased net return of $96 to $215 per 100 feet of bed compared to black plastic. Despite significantly reduced incidence of bacterial bulb decay, onions grown on bare ground did not yield higher than black plastic due to extreme competition from weeds; for bare ground to be effective, weeds must be adequately controlled. All of the alternatives to black plastic had significantly lower soil temperatures compared to the black plastic; we suspect that the higher temperatures of the black plastic are more favorable for development of bacterial diseases. For more information, visit http://blogs.cce.cornell.edu/cvp/, from the side menu, click on "crops,.." and then "onions", or contact Christy Hoepting.

Detecting and Managing Bloat Nematode in Garlic

Crystal Stewart, Capital District Vegetable and Small Fruit Program, Cornell University Cooperative Extension. cls263@cornell.edu. 518.775.0018

Over the last two years it has been determined that bloat nematode (GBN), *Didylenchus dipsasci*, is widespread on garlic in many parts of the Northeast. As the industry works to control the spread of this nematode to now nematode-free growers, we are simultaneously working to help growers who do have GBN work to eliminate it while preserving their existing crops, if possible. The following steps should be taken by anyone who is unsure if they have GBN.

1) ***Determine if you have bloat nematode.*** Dr. Abawi's lab at the NYSAES can analyze samples of new infestation sites and those in field research trials—please contact Crystal Stewart for updated rates and protocols if you are interested.

2) ***Only plant clean seed.*** Bloat nematode is introduced and perpetuated by planting seed that is infested. ***Do not replant any of your garlic from an infested lot.*** Even if bulbs appear normal (symptomless), low levels of bloat nematodes can increase a thousand fold during one growing season. This means that garlic that showed no symptoms when it was planted could become heavily infested by the time it is harvested the next season. There is currently no NYS certification program for garlic seed, so you will have to work with suppliers to determine how they have ensured their seed is clean. If you or your supplier have not had seed tested, it cannot be guaranteed to be nematode free. Even if seed tests clean, it does not guarantee that bloat nematode does not occur, it just means that it is undetectable. It is recommended to have clean seed re-tested every at least 5 years.

3) ***Do not sell bloat nematode infested garlic for seed.*** Selling quality bulbs infested with bloat nematode for food is acceptable. Garlic festivals may have more detailed rules.

4) ***Plant garlic in a location that has not been cropped to garlic at least 4 years.*** Bloat nematodes can also live in the soil and on alternate hosts. To eliminate and/or to prevent build-up of the nematode populations in the field, rotate away from any *Allium* crops (garlic, onions, leek, chives), celery, parsley, or salsify, and areas with high populations of hairy nightshade weeds. Also, do not plant garlic and control nightshades for at least 4 years in the area where garlic was grown in 2010. Please note, this recommendation may change in the future—preliminary results indicate GBN may not be able to survive winters consistently in the Northeast.

5) ***Plant cover crops after harvesting garlic.*** Mustard, sorghum-sudangrass, and other cover crops have been shown to reduce nematode populations due to their bio-fumigant effect. Thus, they may effectively reduce bloat nematode populations. For information on seeding rates, fertility needs and seeds sources, visit the cover crop website at http://calshort-lamp.cit.cornell.edu/bjorkman/covercrops/fall-mustard.php or contact your vegetable specialist.

6) If possible, ***Keep fields moist***: Bloat nematodes cannot survive for long periods in moist soils, but they do in dry soils.

7) ***Treat infested fields with a conventional fumigant-type nematicide.*** This is an option for conventional growers. Custom applications of Telone-C17 or Vapam are available for use in some states incluing New York as pre-plant treatments and are highly effective against the bloat and other plant-parasitic nematodes, where appropriate and cost-effective.

8) Vydate may also be labeled for control of GBN—please see your state's pesticide guidelines to verify whether this is the case. Hot water treatments are being examined as a treatment option, but are not considered a reliable way to eliminate 100% of the GBN's at this time.

Late blight 2011: biology, resistant varieties, disease forecasting and management.

Bill Fry, Ian Small, Kevin Myers, Giovanna Danies, Laura Joseph. Department of Plant Pathology and Plant-Microbe Biology. Cornell University, Ithaca NY, 14853. wef1@cornell.edu

Biology: As part of an AFRI grant involving more than 20 collaborators from throughout the USA, we received in 2011 more than 120 suspected late blight samples. All but a few were positive for late blight. We received samples from Connecticut, Delaware, Florida, Maine, Minnesota, New Hampshire, North Dakota, Oregon, Pennsylvania, Rhode Island, Virginia, Washington, and Wisconsin. Our major focus was to determine genotype (using microsatellite markers), and convey information as rapidly as possible to extension personnel who submitted the sample. Microsatellite analysis can be done on infected tissue or on sporangia from lesions, so data can be obtained without culturing the pathogen. In many cases, information was returned to the submitter within 24-48 hr of receipt of the sample. The data were uploaded to a national website that reported these various occurrences of late blight.

Preliminary analyses to date (10 October, 2011) indicate that the vast majority of genotypes of *Phytophthora infestans* strains in these samples corresponded to those that had been detected in previous years. These lineages were:
US8 (A2 mating type, resistant to mefenoxam, not aggressive on tomato, very pathogenic to potato, one sample)
US11 (A1 mating type, resistant to mefenoxam, aggressive to tomato and potato, one sample)
US22 (A2 mating type, sensitive to mefenoxam, aggressive on tomatoes, but also pathogenic on potato, > 15 samples (from NY and ME)
US23 (A1 mating type, sensitive to mefenoxam, aggressive on both tomatoes and potatoes, > 50 samples, from many NE states)
US24 (A1 mating type, sensitive to mefenoxam, aggressive mainly on potatoes, >14 samples, from WA, OR, ND, MN, ME, NY)

There were at least ten samples containing genotypes that we had not previously seen. We are currently investigating their mating types, sensitivities to mefenoxam, host preference and relative aggressiveness. There appear to be both A1 and A2 mating types in this group and they also appear to have diverse sensitivities to mefenoxam. We are also investigating their relatedness to other strains.

Phenotypic analyses were conducted in the lab on isolates from the US8, US22, US23 and US24 clonal lineages collected in 2010. Isolates from the US8 and US24 clonal lineages had been obtained almost exclusively from potatoes. We found that sporulation on tomatoes was typically only about 10% that of sporulation on potatoes for each of these two lineages. Thus, it seems that neither US8 nor US24 is likely to cause a sustained epidemic on tomatoes. US8 and US23 appeared to sporulate about equivalently on potato, and more abundantly than did US22 or US24, so US8 and US23 may be the most aggressive potato pathogens. In contrast, US22 and US23 were aggressive to both potato and tomato. Using lesion growth rate and sporulation as criteria, US23 appeared to be somewhat more aggressive on both potato and tomato than was US22.

Resistant varieties. We've investigated also the relative resistances diverse potato and tomato cultivars to late blight. Most of the popular cultivars are susceptible, but some recently available tomato cultivars are immune to the currently dominant strains of *P. infestans*. The relative resistances of many cultivars will be presented. The resistance of potato foliage to *P. infestans* is not necessarily related to the resistance of tubers. Therefore, we are separately obtaining data on the relative resistances of tubers of the most popular cultivars.

Forecasting and Management: Host resistance, weather, pathogen characteristics, and fungicide can be integrated via a Decision Support System (DSS) to achieve efficient late blight suppression. The DSS is currently available on the web at http://blight.eas.cornell.edu/blight/. The system requires a password, but these are readily available. The DSS uses weather data observed at a site chosen by the user. Additionally, the DSS uses weather forecasts (for the next 7 days) that are very specific to the user's location. This enables one to make predictions of late development specific to one's location. The system contains two disease forecasts: Blitecast and Simcast. Simcast incorporates the effects of host resistance and fungicide as well as weather effects. Blitecast incorporates only the effects of weather. This past year, chlorothalonil was the only fungicide in the system, but experiments conducted during the last several years will provide data to include the effects of additional fungicides. In field trials, standard fungicides have been demonstrated to be quite effective to suppress late blight. Even copper is quite effective in suppressing foliar blight. Chlorothalonil was consistently among the most effective at suppressing foliar blight. Unfortunately, we could detect no disease suppressing effect of oxidate. Several fungicides provided significant protection to tubers. These included Gavel, Presidio and Ranman.

The DSS was evaluated in field experiments in 2010 and 2011. Use of the DSS enabled much more efficient use of fungicide compared to standard grower practice –disease suppression equivalent to that of standard grower practice (weekly sprays), but with fewer fungicide applications. Unsprayed plots in the experiments were severely diseased. Sprayed plots were not significantly different from each other, each with a very low level of late blight.

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Growing Small Acreage Potatoes for Profitability

Andre Cantelmo
Heron Pond Farm, South Hampton NH
andre@heronpondfarm.com (603) 591-8720

Growing potatoes for profit may seem like a lost cause. The world uses potatoes as a filler and cheap calorie in many different ways. We have decided not to try to compete with a product that we can not beat. Instead, our potatoes are seen as a local food with unique taste. We grow varieties that you can't find in the store. Someone looking at our Nicolas at market for $1.50 a pound may say "I can get them for .50 cents a pound at the supermarket." We like being able to say "no, you can't." We create something that you truly can't get anywhere else. At the same time we have watched many a grower willing to take a major hit in yields per acre to grow spuds at a small scale. This is not necessary. The real money in local potatoes can be made by taking all the great knowledge used by the big boys and scaling down to the size you are. Giving the crop what it needs when it needs it is like printing money. If the same field can give you five times what you planted or twenty times what you planted, which would you take? Of course money can be made by chitting potatoes for early production. We do this, but getting potatoes mid June for early sales is a topic unto itself. The following is a primer that has helped us at least to know when and why we were loosing yield in our main potato crop. After the establishment of a market for your spuds, getting the most per acre is the fastest way to increase profitability.

It is important to start off on the right foot. Good soil prep and the correct conditions will help avoid a lot of problems. Severity of common scab is significantly reduced in soils with pH levels of 5.2 and below, but losses can rapidly increase with small increases in pH above 5.2. Potatoes are commonly grown in soils with a pH of 5.0 to 5.2 for control of common scab. You will have to compensate for poor nutrient up take and the lack of effect of minor elements. Potatoes grow great in 6.5 soil, but it is hard to get around the scab. Legume cover crops should not be grown ahead of potatoes, since this can encourage scab, nor should sod crops, since they may increase wireworm populations. On the other hand, small grains—corn or sorghum-Sudangrass—may benefit a potato crop that follows. In Maine, some growers have used Japanese millet as a cover crop in the year prior to potatoes in an effort to reduce rhizoctonia. We use oats, wheat, or rye. Oats are great for the winter kill and allow the soil to be worked well early.

We chisel plow all our fields, Perfecta harrow. We have very rocky ground, so it takes many passes to get up as many rocks as we can. This leads to a second ground preparation most of the time. We apply our amendments before we go through to fix the ground we compacted. Potatoes love calcium and so putting down gypsum is a good idea when trying not to raise pH. If an organic fertilizer is to be used some of it will need to be put down pre-planting and then incorporated. Our goal is to have 140lbs of nitrogen per acre. Most planters will not be set up to put that much organic material down at planting. Since potatoes should be side dressed only as a last resort, pre-plant incorporation allows for the fertilizer to be below the tubers.

Picking out the best potato variety well ahead of time is key. A standard red, white and gold are important in any potato growing operation. Nevertheless, odd ball, off types, and fingerlings will help set you apart from the supermarket. We know we can't beat the market price so setting ourselves apart is key. We grow reba, chiefton, norland, superior, satina, nicola, Adirondack blue, Adirondack red, peter willcox, la ratt, french fingerling, and Russian banana. By November the year before we know where they are coming from. We get 90% of our potatoes from Bob Chapple, a grower in Vermont to whom we owe much. You need to trust your seed source. What is in their cellar will be in your cellar.

It would be tempting to get your seed, cut it up, and plant it all in the same day. We like to let the seed wake up first. The eyes swell a bit, but do not emerge. Potatoes will regrow their eyes three times, but each time they will be weaker. Best not to let them get to the point where they are damaged at planting. It takes a full day for us to cut our potatoes. We use a line cutter that does a good job of making the piece size. Anything under 1.5 oz is not good and each piece should have at least three eyes. “Blind seed” will cause gaps in the field that give weeds an opportunity and reduce per acre yield. For this reason we love to use “b's” as their size often lends them to being not cut at all. Another benefit of not cutting spuds is it reduces the opportunity for the seed to rot in the field. Seed that must be cut is given a day to heal over before planting out. There are many seed treatments on the market, but we have gotten away from using them as our cultural practice has reduced their need. Cleaning the cutter is important to keeping diseases in check.

We use a John Deer 216 two-row potato planter. You can buy one of these used for about $2,500 and it will transform the way you plant potatoes. This alone may be the biggest increase of yield for some. Each variety has its own needs for fertility, but we have settled on 140 lbs of nitrogen per acre as a base. Potatoes are poor nitrogen scavengers, so all of it should go down at or pre-planting. Side dressing will be less effective. Potatoes need a 1-2-2 N-P-K. Use a good soil text and your agricultural extension to get you where you need to be. We have found that our fertilizer suppliers have been very helpful as well. Fertilizer applied at the time of planting should not be in direct contact with seed pieces. The recommended placement on very low testing soils is in two bands, each band 2 inches to the side and 2 inches below the seed pieces. For our round potatoes we use a spacing of 8.5 inches between seed pieces. Fingerling requires 10-12 inches apart depending on variety. It is important when using a trench planter to maintain the skids below the furrow openers. These skids define the bottom of the trench. Without a good “v” shape seed pieces can roll at panting. This will bunch seed, create gaps, and reduce per acre yields.

We use trench application of pesticides and fungicides to aid in the growing of our spuds. The seed pieces are sprayed as they go down at planting. Admire, Quadis, and Ridomil Gold (see labels) are what we have used, but both organic and conventional growers will benefit from the use of Soil Serenade, designed to protect young plants against soil diseases like Pythium, Rhizoctonia, Fusarium, and Phytophthora. We may replace Ridomil Gold with Serenade because some growers have reported great root growth with the use of this product, in addition to its fungicide effects.

Ground crack occurs just before the leaves and stems push their way out of the soil. Timing is everything at this stage. All the forms of weed control at this point can cause some crop damage, if too much of the crop is up. We have found that you are better off sucking up the crop damage now than letting the weeds get to you. Sencor (see label) can give you a 30-day window and burn down the weeds present at time of application. It can, and will, burn potatoes and will damage colored verities more then whites. Flaming will give you a good week to get to your next cultivation, which may be all you need. Above-ground parts of your spuds will be damaged, but it’s worth it. If you are good with the tool, your ground speed can help you get more weeds and less crop damage. Blind cultivation is a good compromise if you have waited too long. You will get less crop damage, but also control fewer weeds. The weeds controlled, or not controlled, at ground crack will tell you what kind of season you are going to have.

Cultivation and hilling should begin as soon as there is enough plant material above ground that you are not going to bury them. Cross flaming can help with the weeds, but you need to know what you are doing in order not to take down your crop. A benefit of cross flaming is that you will get some bug as you go. You will, however, do nothing to get air down into the root zone of the tubers. We love for our cultivating and hilling season to last about a month. So, week one cultivate, bring soil in between plants, and set up a secondary ridge four to six inches away from plant. This is the beginning of the first hill. Week two, potatoes may be small enough to get in with a second cultivation which is mainly to loosen soil for the first hill. The first hill is done as soon as we are off the field from second cultivation. The first hill cups the plants, it doesn't bury them. After our first hill, our plants look like they are sitting in a trough. By week three, we can't bring in the cultivator without causing crop damage. The potatoes have leafed out and grown to the point that you can't see the cupped hills, but the second hilling takes that soil under the plants and pushes it on top of the lower stems. At the same time more soil is brought in around the plants. Sometimes, week four does not work out for us, mostly because of weather. This last hilling is right on the edge, flirting with damaging the vines. The potatoes are just about ready to close the canopy. This last hilling helps stop greening of spud, and acts as the last cultivation of weeds before the canopy is closed and weeds have a hard time getting started under the crop. A third hilling is so beneficial that we accept a 15% vine damage and still feel we have done the right thing. We use the front tines to lift the vines as we go if need be.

It is important to understand the life cycle of the potato to make the most of the crop that you have in the ground.   Life cycle is broken down into three important parts for us: tuber initiation, bulking, and maturation. Irrigation needs are really the only thing left on the table to look at during each of these stages. Assuming, of course, that we are on top of our disease control, lack of water is the only stress that we need to look out for. Planting as early as we can has already helped us with the best photoperiods.

When the conditions are favorable for tuber initiation, the elongation of the stolon stops, and cells located in the pith and the cortex of the apical region of the stolon, first enlarge and, then, later divide longitudinally. The combination of these processes results in the swelling of the subapical part of the stolon. Induction of tuberization is favored by long nights (short photoperiods), cool temperatures, low rates of nitrogen fertilization, and more advanced "physiological age" of the seed tuber. Tuber initiation begins with the formation of 15-20 tubers. If the plant does not have enough water during this phase only a few tubers will form, decreasing the overall yield.

During tuber bulking, the potatoes increase in size and weight. Between 5 and 10 of the initial tubers actually grow. The rest are either used for nutrition by the plant or absorbed by other potatoes. Moisture stress during this phase results in small potatoes. Stress followed by adequate moisture leads to cracked, misshapen potatoes. A constant rate of increase in tuber size and weight occurs during this stage, unless a growth-limiting factor is present. This stage can last from 60 to over 90 days, depending on the length of the growing season and presence of pathogens. This is critically important: tuber size and quality is closely related to moisture supply in this period. Research has shown that the total yield of potatoes is most sensitive to water stress during mid-bulking. Mid-bulking occurs three to six weeks after tuber initiation. However, water stress any time during this period will have an effect on the total yield. Tuber growth is retarded by moisture stress and does not resume uniformly when moisture again becomes available. New growth and enlargement will take place at the top end while the other portions of the tuber remain stunted. Consequently, especially in some long tuber varieties, constricted areas develop that are directly related to the stage of tuber growth at the time the moisture stress occurred. Other deficiencies in quality such as growth cracks and knobbiness are also related to moisture stress followed by periods of adequate or surplus moisture.
During maturation, the canopy begins to die, water use decreases, and tuber growth slows. When the potatoes are nearly mature, producers typically spray the canopy to kill the plant in preparation for harvest. We have also simply mowed off, being careful of the top of the hills.

Lack of pest and fungal control in the field can take what was a great crop and make it nothing. Growing on long-time potato ground, we have a good population of all the pests you could imagine. Colorado potato beetle is a prime pest. We get 60 days of protection from the Admire, but then we have to be alert for potato beetle outbreaks. We want to use Entrust or Radiant to control late outbreaks. In order to do this, we must be on top of the life cycle of the pest. We get one shot with two sprays to get it. Our missing the correct life stage of the beetle to spray only helps them to become resistant to this powerful tool. As always, please be careful and read the label. No spinosad product controls potato leaf hopper. When you are spraying for CPB, you are not controlling hoppers.

Potato leaf hopper will cause burn down before you get the most out of your crop. Be careful of mowing next to your potato field as you will drive the hoppers into the potatoes. Also, beware of adjacent hay fields being mowed and protect yourself. A combination of pyganic and neem extract seems to do the best job on them. We have used Warrior or some pyrenthins for control as well.

Blight scares us all. Especially after the 2009 scares and crop loss we all had. Ag extension has done a great job of putting out alerts when the spores are present and when conditions are ripe for an outbreak. I highly recommend following their lead for spray timings. We use both copper and Brovo as protectants. If we are in the heat of an outbreak, or have some ourselves, we will start with tank mixes of copper or Brovo with Cruzate or Previcur Flex (see labels). These combinations are effective for both late and early blight, depending on target and rate of application. The Cruzate and copper tank mix can give you a two day reset on late blight and might save a crop.

Many factors effect the timing of your harvest. The ideal harvest temperature is between 50 and 59°F (10° and 15°C). To avoid shatter bruises, do not harvest when the tuber pulp temperature is less than 41°F (5°C). Tubers warmer than 64-68°F (18-20°C) and under drought stress are susceptible to black-spot bruising. Harvesting when tuber pulp temperature exceeds 68°F (20°C) increases the risk of leak and pink rot diseases, which can result in extensive storage decay. You also don't want to leave potatoes in the ground too long because you will start to pick up scerth and rizoctonia. We are trying to time our harvest so we don't import too much heat into our root cellar while at the same time giving the potatoes the correct temperature for curing. We also must give the color potatoes time for their skin to set. We have damaged many a red spud by digging too early or too warm. We try for a minimum two-week wait after mowing, but not to leave them in more then three weeks.

Post-harvest handling and storage can affect pack-out yield as much as anything you do during the growing season. The greatest amount of shrink occurs after harvest and before curing is complete. Harvested potatoes are skinned and there is no barrier to moisture loss until suberin is formed over the wounds. This initial storage period promotes wound healing (suberization) and skin set, and both are critical for long-term storage quality of potatoes. The temperature, relative humidity, and length of the curing period are determined by the condition of the harvested potatoes. High humidity (95%) during the curing period is necessary to prevent excessive shrinkage and to promote wound healing. Mature, healthy potatoes should be cured for about two weeks at 50-60°F (10-15°C) and 95% relative humidity. Good luck with this. We try our best, but come up short all the time. But, the closer you come to this, the better off you will be. We have found that every effort is rewarded at this stage, even if it is not perfect. Long-term storage should be 38 degrees for table stock. Colder temps lead to starch/sugar conversions. This will result in black spots in the cooked potatoes. Potatoes are stored dirty.

Storage and Fresh Market Carrot Production at River Berry Farm.

David Marchant
River Berry Farm, 191 Goose Pond Road, Fairfax, VT 05454
riverberryfarm@comcast.net

We have been growing carrots (certified organic) for fall and winter sales since 1994. We grow two to three acres of carrots that are marketed from October through March and sold primarily to local accounts in the Burlington, VT area.

Production Methods

Pre-Plant Preparation

Carrot fields typically have a cover of winter rye and hairy vetch that is mowed and disked in late May to early June. If there is no cover crop the ground is spread with compost and oats planted in the spring. Oats are then disked in June,

Beds are shaped with a pan bed shaper with chisel plows that are mounted in front of the press pan. The chisels are set where each row is planted so that the soil is friable to a depth of 10 to 12".

Varieties – we primarily plant Bolero (Nantes type carrot) and some Sugar Snax or Navajo (Imperator type). We also plant some specialty carrots (purple haze, solar yellow, rainbow). Bolero is the preferred carrot for flavor, and yields extremely well.

Planting
The beds are prepared one week before planting. The carrots are planted with a stanhay belt seeder and seeded with pelleted seed, 17 in. between rows. Belts are punched with three lines so plant density is approx. 30 seeds per ft. We start planting the last week of June, and plant until approx. July 20th. We plant ½ acre per week. This allows us to keep the hand weeding at a manageable level, as well as giving us time to replant if we have poor emergence. Plantings are overhead irrigated as needed

Weed Control
Approximately 6 days after planting the beds are flamed with a tractor mounted flamer. The carrots are cultivated 3 to 4 times with a budding basket weeder. Carrots are handweeded (on hands and knees) 3 weeks after planting. Depending on weed pressure, carrots will be walked (handweeding) a second time. Once carrots are too tall for basket weeders we use vegetable knives.

Fertilizers – We sidedress with a 5-1-9 custom blended fertilizer from North Country Organics. Rate is 35#/ per 500ft. bed (equivalent of 500#/acre).

Diseases and Pests- We practice good crop rotation with a minimum of three years between crops. Primary field disease is Alternaria on the tops. We have primarily gone with use of resistant varieties. Carrot Rust Fly can be an issue but usually is not a major problem. We attribute this to our later season planting time.

Harvest – We typically start harvesting early October and often will harvest into mid Nov. We want the carrots to be exposed to much cold temperature so as to increase the sugars. Customer demand for our carrots is primarily because of the sweet flavor. This is largely due to late fall harvesting.

We harvest our carrots with an older FMC one –row carrot harvester. We have been using our machine for 17 years now. We rebuilt the conveyor system so it puts the carrots directly into a 20 bushel bulk bin. The most important aspect with using a harvester is growing varieties with strong tops. While the harvester does require a fair bit of maintenance, the time saved in harvesting is unbelievable. A 500ft. row can be harvested by two people in about 2 to 3 minutes

Postharvest Storage – Carrots are stored in bulk bins unwashed. Wooden bins are wrapped with plastic shrink wrap, plastic bins are unwrapped. Tops of bins are covered with either cardboard or grain bags. Coolers are kept near 32 deg. Carrots are regularly misted to keep humidity up. We use greenhouse misters that are mounted on the ceiling of the cooler. Once the temperature of the carrots is brought down, the cooler is set so the evaporator fans only run when the compressor runs. This reduces the drying aspect of the fans.

Packing and Marketing - Carrots are washed in a barrel washer and then packed into perforated polyethylene bags. We have found that they will store up to a month in the bags. We sell in bulk 50#, 25# and cellos of 5# and 1# bags. Juicers (broken carrots) are sold bulk and in 10# bags, at usually half the price. We use Tri Pack tip scales for weighing cellos. Carrots are primarily sold to our local Coops. We shoot for providing carrots through March and sometimes into April.

The Soil Food Web and Pest Management

Mary Barbercheck, Department of Entomology,
501 ASI Building, Penn State University, University Park, PA, 16802
Tel. (814)863-2982 meb34@psu.edu
New England Vegetable and Fruit Conference, Manchester, NH December 13-15, 2011

Many agricultural production practices affect insect populations. Crop susceptibility to pest damage may be influenced by differences in plant health mediated by soil management. In general, soil management that replenishes and conserves organic matter and enhances the abundance and biodiversity of beneficial organisms creates an environment that promotes plant health. Crop rotation and preservation of beneficial insects through the reduction of insecticide use can reduce pest pressure. Increasingly, research has demonstrated that the ability of a crop plant to resist or tolerate pests is tied to the physical, chemical, and biological properties of soil (Phelan et al., 1995, 1996; Altieri and Nicholls, 2003; Zehnder et al., 2007). Soils with high organic matter and active soil biology generally have both good soil fertility and complex food webs. Soil organisms are involved in many beneficial processes, e.g., decomposition and nutrient cycling, carbon sequestration, maintenance of plant diversity, bioremediation, and biological control. In this paper, I will focus on how two key functions of the soil food web, decomposition/nutrient cycling and biological control, affect pest management in agricultural systems.

The Soil Food Web

All of life can be thought to operate in a food web based trophic groups. Trophic groups are defined by what an organism eats. Food webs are composed of many food chains - depicted as a linear sequence starting from a species that eats no other species, e.g., decomposers and producers (plants), and ends at a species that is eaten by no other species in the chain, e.g., predators. The "structure" of a food web is the composition and relative numbers of organisms in each trophic group. Food web complexity is a characteristic of both the number of species and the number of different species in the soil. The foundation of the soil food web is organic matter. The lower the level of trophic group, the more heavily it relies on its nutrition from soil organic matter. Management practices can alter the diversity and complexity for interactions in the soil through effects on organic matter. For example, crop type, tillage practices, residue management, pesticide use, and irrigation can alter the structure and complexity of the food web.

Bottom-Up Control: Plant Quality from an Insect's Point of View

From the plant-feeding insect's point of view – the insect is at the center of the food chain – below it are the food it feeds on - plants - and above it, animals that feed on the insect, – natural enemies. What regulates insect populations to determine whether a plant-feeding insect will reach damaging levels? Characteristics of an insect's food are considered "bottom-up" factors. Characteristics that influence the natural enemies of insects are considered "top-down" factors because of the position of these factors in relation to the plant-feeding insect in the plant-insect-natural enemy food chain.

Many kinds of insects feed on plants, although not all plant-feeding insects are pests. Even when a known insect pest is present in the environment with a crop, there are many factors that influence whether or not an insect will choose to eat, and potentially damage a plant. Insects use chemical smell and taste cues to help them recognize host plants, and can differentiate plants based on their odors and tastes. The chemistry of the plant determines its appeal to an insect.

Chemical cues from plants that insects use to determine the suitability of the plant as a resource fall into two broad categories: primary and secondary metabolites. Primary metabolites are compounds synthesized by plants for essential functions, such as growth and development. Examples of primary metabolites include carbohydrates, lipids, proteins, and nucleic acids. A key component of proteins and nucleic acids is nitrogen. Secondary metabolites are compounds produced in metabolic pathways other than those directly involved in growth and development and are not considered essential to the plant. Many thousands of secondary metabolites have been isolated from plants, and often contribute to their distinctive colors and flavors. Some secondary metabolites are toxins for insects, and are called plant defense compounds because they can interfere with an insect's metabolism, often by blocking specific biochemical reactions. The higher the concentration of these chemicals in the insect's diet, the less nutrition the insect can gain from eating plant tissues. These defensive chemicals are usually most effective against non-adapted specialists on other plant species and generalist insects that feed across plant types. Plant defensive chemicals include alkaloids, cyanogenic glycosides and glucosinolates, terpenoids, and phenolics.

These defensive chemicals often render a particular plant species unsuitable as a food plant for particular insect species. However, in some cases, insect species have evolved mechanisms to overcome the defensive function of particular secondary metabolites and are be able to exploit them as a food resource.

The Effects of Fertility Source on Plant Quality

Soil organisms play a key role in decomposition and release of plant-available nutrients from soil organic matter, a process called mineralization. As organisms decompose complex materials, or consume other organisms, nutrients are converted from one form to another, and are made available to plants and to other soil organisms.

The way that soil fertility is managed affects insect-plant interactions by altering plant quality as a resource for plant-feeding insects. Soil fertility in agricultural systems is mainly accomplished through applications of synthetic fertilizers, crop rotation, cover cropping, and the application of plant and animal materials. Healthy, vigorous plants that grow quickly are better able to withstand pest damage. However, over-fertilizing crops can increase pest problems through changes in nutrient and chemical composition of crop plants. Specifically, increasing soluble nitrogen levels in plants can decrease their resistance to pests, resulting in higher pest density and crop damage. For example, increased nitrogen fertilizer rates have been associated with increased soluble N in plant tissue and large increases in numbers of mites, aphids, thrips, and other plant feeding insects.

Practices that promote an increase of soil organic matter and a gradual release of plant nutrients through decomposition and mineralization do not generally lead to excessive N levels in plant tissues. Therefore, in theory, do not promote increases in insect pest populations. In general, organic fertilizers such as animal and green manures contain nitrogen sources that are released over a longer time scale than the pulsed and readily-available nitrogen in synthetic fertilizers.

Bottom-Up Control of Insects: Soil fertility and *Brassica* pests

Plants in the *Brassica* (cole crop) family are rich in sulfur containing compounds called glucosinolates. These compounds play a defensive role in *Brassica* – insect relationships and have a negative effect on generalist plant-feeding insects, although some insect species are able to tolerate or detoxify some glucosinolates. Staley et al. (2010) applied organic and synthetic fertilizer treatments at two nitrogen concentrations each to cabbage (*Brassica oleracea* var. *capitata* cv. Derby Day), and measured their effects on the abundance of plant-feeding insects and plant chemistry. The organic treatments included a green manure (white clover, *Trifolium repens* var. Milvus) for the low-nitrogen treatment (approx. 100 kg nitrogen per hectare), while the high- nitrogen treatment included both green and animal manures (organic chicken manure to provide approx. 200 kg nitrogen per hectare in total). The two synthetic fertilizer treatments included a conventional high fertilizer treatment (ammonium nitrate at 200 kg nitrogen per hectare) and a conventional low fertilizer treatment (ammonium nitrate at 100 kg nitro- gen per hectare).

The most common plant-feeding insects found were the cabbage aphid, *Brevicoryne brassicae* (a cole crop specialist), the green peach aphid, *Myzus persicae* (a generalist plant-feeder), and the diamondback moth, *Plutella xylostella* (a cole crop specialist). The cabbage aphid was more abundant on organically fertilized plants, while the green peach aphid had higher populations on synthetically fertilized plants. The diamondback moth was more abundant on synthetically fertilized plants and preferred to oviposit on these plants. Nitrogen concentration was greater for conventionally fertilized than organically fertilized cabbage. Glucosinolate concentrations were up to three times greater on cabbage plants grown in the organic treatments, while foliar nitrogen was maximized on plants under the higher of the synthetic fertilizer treatments. The varying response of insect species to these strong differences in plant chemistry demonstrates that the response of plant-feeding insects to level and source of fertility is complex.

Top-Down Control of Insects: The Soil Food Web and Biological Control

Complex food webs foster populations of beneficial organisms that can help keep pest organisms in check. The exploitation of the predators and parasites, or natural enemies, to control pest insects is called biological control. Natural enemies include predators, such as birds, lady beetles and lacewings, that consume a large number of prey during their whole lifetime; parasitoids whose immature develops on or within a single insect host, ultimately killing it; and pathogens - disease-causing organisms including bacteria, fungi, and viruses that kill their insect host. Many natural enemies can be purchased, but it may be more economical to use a conservation approach – i.e., create conditions through management that attract and retain these beneficial organisms. Some common biological control organisms associated with the soil include ground and rove beetles, spiders and harvestmen, insect-parasitic fungi, and insect-parasitic nematodes. Biological control of pest insects may be enhanced by reducing disturbance, such as reducing tillage and pesticide use, by creating refuges from these disturbances, and providing alternate food resources for the natural enemies (e.g., nectar and pollen from flowering plants). Crop residue may provide habitat and/or food resources for beneficial arthropods, and diversity and abundance of arthropod predators are greater under no-till in comparison to conventional tillage. Organic cropping practices, and cover cropping, in particular, may conserve and increase the activity of natural enemies.

Managing for Diversity and a Functional Soil Food Web

To exploit the benefits and services of soil organisms, such as bottom-up and top-down control of insect pests, some goals of soil management should be to improve the physical, chemical and biological properties of soil. This is mainly achieved through additions and conservation of soil organic matter, as the base resource for the soil food web

Adding plant diversity to a production system in space and time can help break pest cycles. Plants in the same family tend to have similar pests. Crop rotation, planting a series crops from different plant families in the same space in sequential seasons, helps deter the build up of pests that can occur when one crop species is planted continuously. Crop rotations that include sod, cover crops, and green manure crop provide benefits in addition to providing pest management in annual and perennial crops, including: maintenance or improvement of soil organic matter content; management of plant nutrients; and erosion control. Spatial crop diversity can be achieved through crop rotation and various forms of polyculture, e.g., strip cropping, multiple cropping, or interplanting of plant species or varieties. A general effect of polyculture is a spatial mixing of crops, which can slow the build-up and spread of pests during the growing season.

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Using Compost to Feed the Soil Community and Meet the Nutrient Requirements of Sweet Corn, Is it Realistic?

Mark Hutchinson: Extension Professor, University of Maine mhutch@maine.edu
Dr. David Handley: Small Fruit and Vegetable Specialist, Extension Professor, University of Maine
Dr. Will Brinton: Woods End Laboratory
Tori Lee Jackson: Assistant Extension Professor, University of Maine

Vegetable growers have long been interested in the effect of compost amendments on sweet corn production and soil health. Compost provides a diversity of organic matter from living microbes to stable humus which feeds the soil biological community while building and maintaining high soil quality. The long term investment in soil quality improves the long term production capacity of the soil.

This study evaluated two composts, leaf and yard waste (LY) and biosolids (BS) as soil amendments at three application rates on sweet corn production. The study conducted over two growing seasons. A partial listing of the composts characteristics are shown in Table1.

Table 1: Compost Characteristics

Compost Type	Total Nitrogen %	Bulk Density (lbs/cu yd)	pH	C:N
Leaf and Yard Waste	0.45	956	7.2	15.3
Biosolids	0.61	657	7.9	31.9

Biosolids compost was provided by the Lewiston Auburn Pollution Control Authority (LAPCA). The leaf and yard waste compost was made at the University of Maine Compost Research and Education Facility.

The study was conducted on an Agawam fine sandy loam. Prior to planting in 2010, 80 lbs. of P_2O_5 was broadcasted as recommended by soil tests. No additional conventional or organic fertilizer was added in either year. In both 2010 and 2011, BC 0805 sweet corn (82 days), was planted on 34” rows with a plant population of approximately 28,000 plants per acre. Composts were hand applied at the rates of 0, 10, 20 and 40 tons per acre and incorporated with a Perfecta harrow in replicated plots. A cover crop of oats was planted in August of 2010 after harvest over the entire research area.

In 2011, each plot was split in half. One half received the same treatment as in 2010, 0, 10, 20 and 40 tons/acre. The second half did not receive any additional compost or fertilizer. Conventional herbicide weed control was implemented each year.

In 2010, marketable yield (Figure 1) was greater than the control in all treatments. Biosolid compost (BS) application rates of 20 and 40 tons/acre produce acceptable yields, 1069 and 1263 dozen per acre, respectfully, in 2010 (Figure1). Leaf and yard waste compost (LY) yields were consistently lower then acceptable yield levels of 1000 dozen per acre in 2010.

Preside-dress Soil Nitrate Test (PSNT), data not shown, indicated that soil nitrate levels were above the recommended 25 ppm for only the BS 40 treatment. PSNT values for LY was well below the recommended level which follows the yield. With a PSNT value of 25 ppm you can expect approximately 100 lbs. of N to be plant available during the growing season.

A second year compost application increased yield in all treatments. Yields were significantly higher, 1386 to 1833 dozen per acre for all BS treatments. Leaf and yard waste compost yields were also at or above expected yields. A likely cause is the additional soil organic matter available to microbes for N mineralization. All PSNT values except for BS 40 were above the 25 ppm recommendation. However, the yield increase was greater than a single application which indicates there is an accumulative effect of compost in soils from previous applications.

Plots with no additional compost applications had similar yields as 2010 (Figure1). This indicates that the effects of compost last for at least two years. Compost has a wide diversity of organic matter, from unstable to very stable, therefore mineralization happens over a longer period of time. Under proper soil conditions, stable organic material is mineralized, releasing plant available N.

PSNT data (Figure 2) indicated that soil nitrate levels were below optimal levels without additional compost application but similar to 2010. This supports the idea that compost has a residual effect on the soil and crop productivity. Compost continued to feed the soil microbial population through year two.

Conventional insecticides were not used in either year. There was no marketable yield loss from insect damage.

In conclusion, both types of compost had a positive effect on the yield of sweet corn over a two year period. Compost did provide some plant available nitrogen in both application years. Yield data indicates there was both an accumulative and residual effect of compost applications.

Figure 1. Effect of two compost sources applied pre-planting at three rates on the growth and yield characteristics of sweet corn; Highmoor Farm, 2010 and 2011.

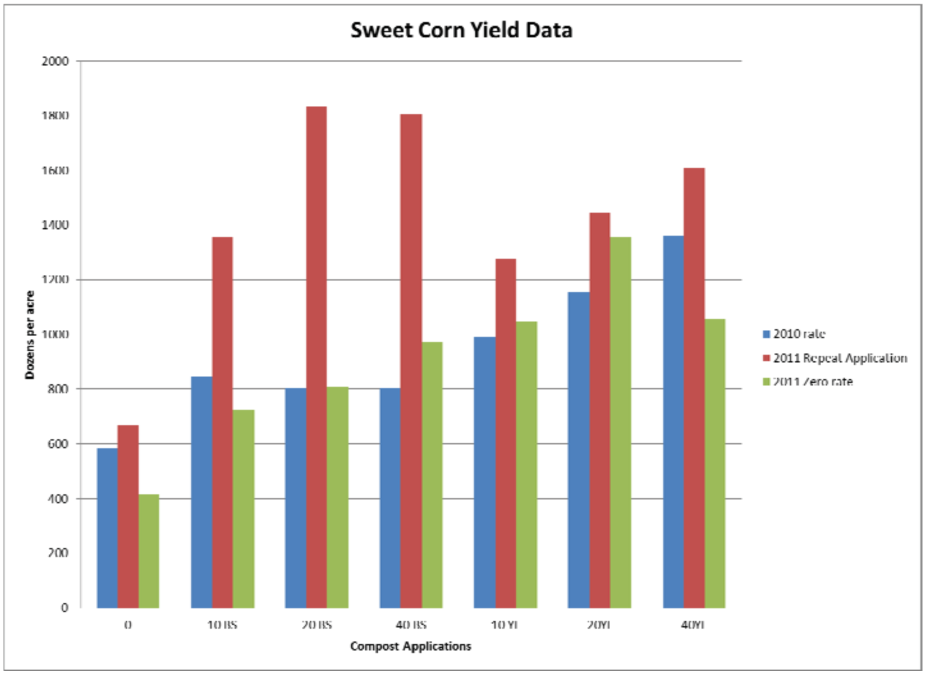
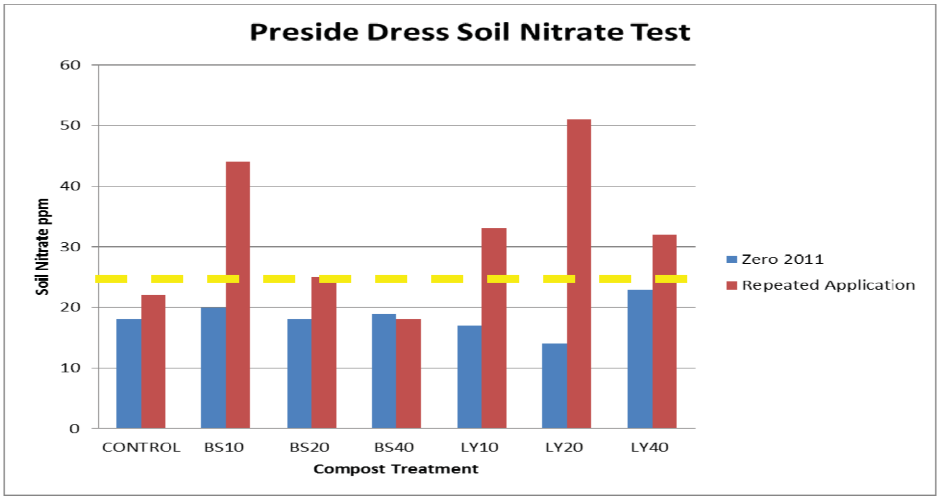


Figure 2. 2011 Preside-dress soil nitrate test from soil amended with compost.



Impact of Cornell Soil Health Program on
Soil Management Practices in New England

Authors: Bianca Moebius-Clune, Harold van Es, Robert Schindelbeck, John Idowu, George Abawi, Dave Wolfe.
Contact Info: Bianca Moebius-Clune, bnm5@cornell.edu , 1001 Bradfield Hall, Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853

Degraded soils in the Northeastern U.S. have become prevalent because management practices usually focus on directly “feeding the crop” with ready nutrients through fertilizers, and less so on “feeding the soil” so that it can feed the crop. Degraded soils become less resilient to more extreme temperatures and precipitation events brought on by climate change. Compaction, disease pressure, lacking resilience to droughts and intense rainfall, loss of organic matter, surface crusting, erosion, increasing inputs with stagnant or declining yields and other problems are common on Northeast farms, and result from ignoring physical and biological soil properties and the need to manage these along with nutrient contents. As agronomically essential soil functions and processes are degraded, this significantly impacts agricultural productivity and the environmental sustainability of agriculture.

Standard chemical soil analysis has been hugely successful in helping growers manage nutrient constraints to cropping, but physical and biological soil constraints that impact crops had been largely ignored by soil testing services until the first version of the Cornell Soil Health Test (CSHT; http://soilhealth.cals.cornell.edu/) became available to the public in 2006. It is available in its current form since 2007, and the team is working on making expanded packages available in the future. This test was developed in NY State (NYS) for use in the Northeast in response to increasing concerns from growers. The CSHT measures, rates and interprets an integrative set of 15 physical, biological, and chemical indicators that represent agronomically important soil processes. Growers receive a color-coded report that provides information about which soil processes are constrained. The grower can then adapt soil management to specifically choose management strategies that promise to alleviate identified constraints.

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)				
Name of Farmer: Willsboro Farm				Sample ID: E128
Location: Sayward Rd. Willsboro NY 12296				Agent: Bob Schindelbeck, Cornell University
Field/Treatment: TILL 3A				Agent's Email: 0
Tillage: 7-9 INCHES				Given Soil Texture: CLAY
Crops Grown: COG/COG/COG				Date Sampled: 4/25/2007
Indicators		Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	12	3	aeration, infiltration, rooting
	Available Water Capacity (m/m)	0.17	43	
	Surface Hardness (psi)	57	91	
	Subsurface Hardness (psi)	200	82	
BIOLOGICAL	Organic Matter (%)	3.3	25	energy storage, C sequestration, water retention
	Active Carbon (ppm) [Permanganate Oxidizable]	559	20	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	4.8	0	N Supply Capacity
	Root Health Rating (1-9)	2.5	88	
CHEMICAL	*pH	6.1	67	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	2.5	44	
	*Extractable Potassium (ppm)	83	100	
	*Minor Elements		100	
OVERALL QUALITY SCORE (OUT OF 100):			55.3	Medium

Figure 1. Cornell Soil Health Test Report (usually in color), showing constraints (Rating < 30, in red) in a long-term moldboard-plowed corn grain field.

The following developments by the Cornell Soil Health Team will be discussed:

1. Interpreting a Cornell Soil Health Report
2. A four-step process to guide management decisions based on a CSHT report
3. Impact in New England thus far
4. Manual, resources

1. Interpreting a Cornell Soil Health Report

The CSHT report (Figure 1.) identifies constraints in agronomically essential soil processes (indicators and rating is explained in our manual). A lower rating means the process is functioning less well. The rating system is as follows: Each measured value receives a rating from 0-100. Ratings of 70 and above indicate optimal functioning (in green), while medium scores (>30, but <70, in yellow) indicate marginal functioning. Ratings below 30 indicate constraints in soil processes that need to be addressed. The constraints column shows what about the soil is not functioning properly when the indicator rating is red.

2. Four-Step Process to Guide Management Decisions Based on a CSHT Report

A key concept in soil health assessment is that indicators measured in the CSHT represent how well agronomically important soil processes are functioning in the soil. For example, when aggregate stability receives a low rating (Fig. 1), this means that soil crumbs fall apart easily in the rain, and this means that problems with aeration, infiltration, shallow rooting, surface crusting and erosion are likely.

The question then is – what can a grower do to alleviate such a problem? It is important to understand that a CSHT report is a guide to management, rather than a prescription (such as nutrient recommendations). Soil health constraints generally require a more integrated and long-term approach, and there are usually many different management approaches that can mitigate the same problem. Also one management practice can affect multiple indicators. What works on one farm is not necessarily feasible or ideal on another, and so report information must be adapted situationally. It is also important to remember that soil health changes slowly over time (on the order of several years to decades).

We have developed a four-step process, to help growers (often in collaboration with their extension educators or consultants) make management decisions that will alleviate identified soil constraints. Fig. 2 shows an example of this process. The grower, in Step 1, lists the constraints identified in the CSHT report (Fig. 1) and then, in Step 2, lists potential management options for those constraints. Examples of

Cornell Soil Health Test Report Field Management Sheet

Step 1. Identify constraints, prioritize **Identified in the Soil Health Report**	*Low aggregate stability (poor soil structure)* *Low organic matter (low energy/C storage, low water retention)* *Low Active C (hungry soil food web)* *Low PMN (low biological activity)*
Step 2. List management options **Some suggestions found in Table 5 (page 52)**	*Add/ grow fresh organic matter* *Add stable organics (composts, biochar)* *Reduce tillage intensity, Rotate with shorter season crop* *Find window for shallow-rooted cover crop*
Step 3. Determine site history/ farm background **Note here any situational opportunities or limitations**	*Far from dairy farm, Short growing season* *Soil "addicted to tillage"* *Diverse inventory of field equipment* *Grower willing to "try anything"*
Step 4. Management Strategy 2010 **The agronomic science of Steps 1 and 2 combine with the grower realities of Step 3 to create Field Management Plan**	*Drill barley/ timothy/ clover mix in spring* *Harvest barley, Mow timothy/ clover as green manure* *Fall mow, rent ripper for strip till for corn 2011* *Learn about strip tillage* *(Build soil for transition to strip till)*

Figure 2. Completed management decision worksheet for the CSHT report in Fig. 2.

such options, such as those listed in Fig 2, Step 2, can be found on page 52 of the Cornell Soil Health Assessment Training Manual (available online, see below). For example adding or growing fresh organic matter and reducing tillage will both improve low aggregate stability and low biological activity. In Step 3, the grower then, considers relevant opportunities (such as having access to diverse equipment, and being willing to try anything) and limitations of the farm and field (such as being far from a dairy farm, and thus having no access to manure, etc). Combining the agronomic science (Steps 1 and 2) with the realities on the ground (Step 3), the grower can then plan short- and/or long-term management strategies that will be feasible on that field.

3. Impact in New England

The soil health lab has received over 700 samples from New England since 2007, most from VT (well over 400), over 200 from NH over the last two years, a few dozen from MA, and several from ME. Use of the Cornell Soil Health Test in New England has increased with almost 300 samples received this year from NH, VT and MA. The NH NRCS has integrated the soil health test in their high tunnel program and is making it available through other cost share programs as well. As part of the high tunnel program, soil health is assessed before the high tunnel is put in place, with the goal to tailor tunnel soil management to preventing degradation and improving identified constraints for sustainable long-term tunnel use. We are currently in the process of assessing the impact of our program on New England soil management practices, and will provide a summary of our findings during the presentation.

4. Manual, Resources

a. Manual – the second Edition of Cornell Soil Health Assessment Training Manual is available on our website **http://soilhealth.cals.cornell.edu**
b. Another good reference is the new edition of the book "Building Soils for Better Crops" by Fred Magdoff and Harold van Es. It can be downloaded for free from the SARE website **http://www.sare.org/publications/soils.htm**

An Update on Storage, Scald Prevention and SmartFresh™ Use

Renae Moran, University of Maine
PO Box 179, Monmouth, ME 04259
rmoran@maine.edu

Much of the information in this paper is a direct result of collaborative research with the NE 1036 project participants in the United States and Canada.

With changes in varieties we grow and with the adoption of new storage tools, the techniques we employ to store apples will also change. Many of us now grow Honeycrisp, and soon the production capacity will be large enough so that storage of this variety will be needed. Another important change is the use of SmartFresh™ which has altered how we treat apples after harvest.

Honeycrisp is quite different in how it tolerates storage conditions compared to McIntosh. Cold temperatures are meant to keep apples crisp and free of decay, but Honeycrisp is chilling sensitive so we recommend a storage temperature of 37 °F. Honeycrisp has good resistance to the other scald – superficial scald, so postharvest drenches not needed, but are useful when Honeycrisp will be placed in for controlled atmosphere (CA) storage. Recent research has shown that Honeycrisp is sensitive to high carbon dioxide and will display internal injury when concentration exceeds a threshold somewhere above 1%. Postharvest drenches that contain diphenylamine give apples protection against high carbon dioxide injury. Not much else is known at this time about its carbon dioxide sensitivity, but it's an ongoing area of research. SmartFresh can worsen carbon dioxide injury so pay close attention to gas concentrations when storing Honeycrisp fruit treated with SmartFresh.

Other varieties that are relatively new are Fuji, Gala and Empire. Although they are not without storage problems, they are easier to store than Honeycrisp, so we have not done any studies on their storage problems in Maine. Other new varieties we are currently evaluating for good storage potential are SnowSweet and Autumn Crisp (NY 674).

Empire and McIntosh Firm Flesh Browning

The occurrence of firm flesh browning is on the rise because of the longer storage durations, particularly with SmartFresh. It is the longer storage duration that directly causes the browning and not SmartFresh. Symptoms are browning in the flesh with no clear cut margin and in severe cases, browning in the core. Empire is more prone than McIntosh, and apples harvested at later dates are more prone to this disorder. Apples from a late harvest are at risk of breakdown when they remain in storage longer than four months. ReTain and CA storage cannot always overcome the adverse effects of a late harvest. With this year's large volume of apples, carefully consider the storage durations and harvest dates. Colder storage temperatures also worsen symptoms of firm flesh browning, so keep temperatures in CA storage around 35 to 36 °F. Warmer temperatures are not recommended for these varieties which can rapidly lose firmness or condition. Keep carbon dioxide below 2% in CA storage and below 1% during the first month. A recent article published in the New York Fruit Quarterly was published on this subject last October (http://www.nyshs.org/fq.php).

Superficial Scald (also called storage scald)

This type of scald is different from soft scald in how it develops and the varieties likely to get it. Fruit picked at early stages of maturity are more prone to scald, and it takes at least three months of cold storage for it to development. Symptoms are well defined patches of brown discoloration in the skin than can be solid or splotchy. Varieties vary in susceptibility with Cortland being extremely susceptible, and Honeycrisp and Gala being resistant. Susceptible fruit that will be stored longer than three months should be treated with a scald inhibitor prior to cold storage.

Diphenylamine (No-Scald) and ethoxyquine are two materials that prevent scald, but SmartFresh has replaced them for most varieties. Drenching bins of fruit with a scald inhibitor is cumbersome, time consuming and requires that a fungicide be added to the drench to prevent decay. Field drenching of bins is replacing the recycling drench, but is still considered experimental. Those of you who are trying the nonrecycling field drench should remember to add only diphenylamine and fungicide, NOT calcium. This technique is currently being researched by Dave Rosenberger at Cornell University.

SmartFresh is effective in preventing scald in most varieties, so fruit that receive a standard application of SmartFresh do not require drenching. Cortland is an exception because SmartFresh will not completely prevent scald in this highly susceptible variety. Empire will also benefit from drenching with diphenylamine because of its susceptibility to carbon dioxide injury when treated with SmartFresh.

Carbon Dioxide Injury

Injury can occur to the skin and flesh of apples in CA storage if the carbon dioxide concentration is too high. Traditionally, the initial concentration was held at or below 3% in the first month or so of the storage period and then allowed to increase up to 5%. Drenching with diphenylamine protects apples from the high carbon dioxide concentrations that occur in CA storage. Where apples are not drenched, carbon dioxide should be kept at 1% or lower, especially in the first month. SmartFresh slows down respiration, so carbon dioxide concentrations should be easier to manage.

Fire Blight Control Strategies

David A. Rosenberger, Cornell's Hudson Valley Lab
P.O. Box 727, Highland, NY 12528
E-mail: dar22@cornell.edu

Fire blight is caused by the bacterium *Erwinia amylovora* and continues to be one of the most unpredictable and devastating diseases of apples and pears. Our ability to control the blossom blight phase of fire blight has been greatly enhanced by the MaryBlyt and Cougar Blight predictive models that can be used to optimize the timing of streptomycin (strep) sprays applied during bloom. However, despite availability of these predictive models, few growers or researchers feel confident about their abilities to consistently control fire blight in pears and susceptible apple cultivars.

Effective control of fire blight requires season-long vigilance and an integrated approach to disease control because no single action or spray program will provide complete and consistent control of fire blight. Following are key considerations and checkpoints for managing fire blight. All of these should be integrated into a seasonal program for fire blight management.

1. New plantings: Regularly examine trees for fire blight during spring and summer after new trees are planted. The fire blight pathogen can be present in symptomless trees that are shipped from reputable nurseries. This is a rare event, but it is of great concern because strep-resistant strains of *E. amylovora* are present in geographic regions around most tree fruit nurseries. If strep-resistant fire blight becomes established in an orchard or region, costs for managing fire blight will double or triple because alternative products are either more costly, less effective, or both. Strep-resistance is stable, so introduction of strep-resistance is probably an irreversible event if the strep resistant bacteria become established in a region after their introduction.

- Newly planted trees that develop symptoms of fire blight should be pulled out immediately to minimize potential spread of disease from these trees.
- Copper (any of the labeled copper products) should be applied at 4 oz/100 gal after newly planted trees begin to grow so as to kill any epiphytic (surface-dwelling) strep-resistant *E. amylovora* that may have come from the nursery. Higher rates of copper products or copper sprays that are applied before the soil settles around newly planted trees may stunt tree growth and therefore are not advised.
- If newly planted trees develop flowers, either remove the flowers by hand at the pink-bud stage or spray the trees with a combination of strep and the low rate of copper (4 oz/100 gal). More than one spray of strep plus copper may be needed during bloom. Use MaryBlyt or Cougar Blight to time these sprays, realizing that they will usually occur several weeks after established plantings have reached petal fall. Hand removal of flowers on young trees should only be done during dry weather because there is a slight possibility that blight could be transmitted on fingers or tools that are used for deblossoming, especially if this work is done while plants are wet.

2. Apply a copper spray at silver tip in orchards that have had active fire blight in either of the past two years. Copper residues on trees sometimes help to suppress levels of *E. amylovora* present during bloom, but the benefit of the copper spray may be minimal if there is more than 3 or 4 inches of rain between the application date and king bloom. Because no one can predict

which years will have heavy rains between silver tip and bloom, the copper spray is always recommended even though it may prove worthless in some years. Applying copper at green tip or quarter-inch green rather than at silver tip may increase the probability that copper residues will still be present on trees at king bloom, but it also increases the risks that the copper spray will cause fruit russetting. Both McIntosh and Empire are highly susceptible to the copper-induced fruit russetting that occurs if there is too much copper residue still present on trees at bloom. Finally, there is no reason to apply copper in orchards with no history of fire blight because these orchards will not have cankers that release bacteria during bloom.

3. <u>Apply streptomycin during bloom</u> using timings suggested by either the MaryBlyt or Cougar Blight models. Strep sprays are the most critical component for effective control of fire blight. Omitting critical strep sprays almost ensures disaster if *E. amylovora* is present in the orchard. Following are additional pointers for effective control of blossom blight:

- Use strep at 8 oz/100 gal of dilute spray or at 1.5 lb/A for mature trees that have a tree-row volume requirement of 300 gal/A. Lower rates of strep may prove ineffective, especially if spray coverage is less than perfect.

- In the first blossom spray, use a good adjuvant such Regulaid (1 pt/100 gal of spray solution) to enhance penetration of streptomycin into the plant tissue. If additional sprays are required during bloom, omit the adjuvant so as to reduce the severity of foliar phytotoxicity (yellowing of leaf margins) that may occur with repeated sprays. However, avoid mixing captan (for scab control) with sprays that include a penetrating adjuvant such as Regulaid because captan applied with a penetrating adjuvant can be phytotoxic.

- Streptomycin does not redistribute after it dries, so sprays will only protect those flowers that are contacted by the spray solution. Thus, good spray coverage is essential.

- Flowers that are not yet open generally will not be fully protected by the strep sprays. Thus, there is an advantage to waiting as long as possible before making the first strep application during the early part of bloom (so as to maximize the number of open flowers), but the application must be completed before a wetting period triggers a blossom blight infection period.

- New high-density plantings often have some late flowers that persist through the time when petal fall insecticides are applied. It may be advantageous to include streptomycin plus Regulaid in the petal fall spray IF no strep was applied during the five days prior to petal fall and IF the orchard has any of the following risk factors:
  - ⇒ The orchard is a pear orchard.
  - ⇒ Trees are less than 7 years old (because young trees are especially susceptible).
  - ⇒ Fire blight was present in the orchard in either of the previous two growing seasons.
  - ⇒ Fire blight was present in nearby blocks (within one-half mile) last year.

  This suggested petal fall application is NOT a substitute for well-timed sprays during bloom as indicated by one of the blossom blight models, but it should help to prevent infections on late flowers.

- Streptomycin is by far the most effective material for preventing blossom blight, and there is absolutely no evidence that repeated sprays during bloom will stimulate development of strep-resistant *E. amylovora*. Therefore, do NOT use alternative products for controlling blossom blight so long as streptomycin is effective.

• Strep sprays may be needed even in relatively blight-resistant cultivars such as McIntosh, Empire, and Red Delicious if high temperatures occur during bloom. Severe blossom blight can occur on these cultivars when the Epiphytic Infection Potential (EIP) in the MaryBlyt model exceeds 300.

4. Apply Apogee where it is horticulturally acceptable and/or when the risk of blossom blight is exceptionally high. Two or three sequential applications of Apogee, with the first application during late bloom, can significantly reduce losses to fire blight in orchards where blossom blight sprays fail to eliminate all blossom blight infections. However, applying Apogee to young trees may reduce their productivity during the early years of orchard establishment. Apogee applications that are delayed until fire blight strikes become evident after bloom will have little or no benefit for controlling fire blight.

5. Monitor orchards for fire blight during June and remove infected shoots ASAP. Quick removal of fire blight strikes can limit secondary spread and is essential for minimizing loss of young trees and of pear trees, but orchards may need to be surveyed two or three times per week if shoot removals are intended to reduce secondary spread.

6. DO NOT APPLY STREPTOMYCIN DURING SUMMER except for cases where hailstorms damage orchards with active fire blight (i.e., visible infections). When hail occurs in orchards with active blight, streptomycin plus Regulaid should be applied as soon as possible and no later than 24 hr after the hail event if an application is allowable within the constraints for preharvest intervals as listed on the streptomycin label. Hailstorms during late summer do not pose a blight risk because trees are not susceptible to fire blight after terminal growth ceases.

Repeated use of streptomycin sprays after petal fall almost guarantees selection that *E. amylovora* will become streptomycin-resistant. This has occurred in Missouri, California, Washington, Oregon and Michigan. There is no reason to believe that it will not occur in New York and New England if we abuse streptomycin by applying it repeatedly during summer.

7. Control potato leafhoppers (PLH) in young plantings. Potato leafhoppers continue to be implicated in spread of fire blight during summer. However, the best evidence suggests that most shoot blight infections that occur during summer are attributable to *E. amylovora* that was disseminated by wind-blown rain and are not attributable to transmission by PLH. Nevertheless, high populations of PLH can stunt young trees, and young trees are also more susceptible to secondary spread of fire blight. Therefore, PLH should be controlled on young trees.

8. Prune out fire blight infections during winter. Removal of blighted shoots is best accomplished during November and December when these shoots can still be identified by the presence of dead leaves that may disappear if removals are delayed until the normal pruning time in February or March. Heavy pruning during late fall or early winter can reduce winter hardiness, especially on young trees, so the pruning required to removed blight shoots may need to be done separately from the normal winter pruning.

Failure to remove blighted wood during winter ensures that abundant inoculum will be available the following year. In the Hudson Valley, we have repeatedly noted that fire blight inoculum can travel at least a half-mile from an inoculum source to previously blight-free orchards. Therefore, a blighted orchard that is not cleaned up during winter can endanger all of the other orchards located within a half-mile radius. Fire blight is a community disease!

The Tall Spindle Apple (TSA) -- critical steps to success

Jon Clements, Extension Educator, University of Massachusetts Amherst
UMass Cold Spring Orchard, 393 Sabin St., Belchertown, MA 01007
clements@umext.umass.edu

First, let me tell you what excites me about the Tall Spindle Apple production system (TSA). It's what Terence Robinson (TR), Cornell University says about it: "The tall spindle system is the path to becoming fabulously wealthy." I believe it, but you must pay attention to details when growing the TSA.

TSA planting system basics

High tree density. TSA is a high planting density system at 1,200 trees per acre, 3 ft. X 12 ft. spacing is the standard. You can go as low as 900 trees per acre (app. 4 ft. X 12 ft.) with more vigorous scion/rootstock combinations.

Fully dwarfing rootstocks are used. These include, for example, Bud. 9, M.9 clones, Geneva 11, 16, and 41. Ottawa 3 and Vineland 3 are options if available.

You should plant high quality, feathered nursery trees. Preferably with 5-10 (or more) feathers (small branches). Trees should be 1/2" minimum caliper, 5/8" even better. Branches should not be too low on the tree (you would have to cut them off!) and trees should have a high graft union. Order trees early (2-3 years ahead of planting year), do your best to obtain and plant high quality trees!

High planting depth. Trees need to be planted with the graft union 4 to 6 inches above the ground. Caution: burr knots can become numerous with this high planting depth and attract dogwood borer.

Minimal pruning at planting. Trees are not headed. Remove low branches (less than knee height) and those breaking the 50% rule (diameter-based pruning) are removed. Leave as many feathers as possible without compromising growth of the leader. This should result in 2nd leaf crop.

Branch bending in first leaf. Remaining branches bent below horizontal at planting. First leaf only. Use wire or string. Very important to bend branches in first leaf to get 2nd leaf yield.

Superior support system. Based on pressure treated (or long-lasting alternative) end and line posts with hi-tensile wire. Use 5-6 inch diameter for end posts, 4-5 inch for line posts, all preferably driven (or alternately, but not as good, augered) 3 feet into the ground. Line posts should be installed every 40 to 45 feet (no farther!). Use 3-4 wires of 12.5 gauge hi-tensile wire down the row spaced 2-3 feet between wires. 'U-Hooks' of the large size (3 inch) are used to attach the trees to the wire. (Purchase from oescoinc.com or peachridge.com.) Trees should be supported ASAP after planting.

Trickle irrigation is a must with dwarf rootstocks assuring good growth during periods of dryness. Netafim 'RAM' tubing (24-inch emitter spacing, 0.4 gallons per hour) is recommended. Add fertigation if possible. It's really not that hard, contact Brookdale Farm in Hollis, NH for irrigation supplies and information.

How much does it cost per acre to establish a TSA planting?

A lot -- count on $10-15,000 per acre depending on tree density and cost. So what does this get you? High early yields! Target yields per acre are:

•2nd leaf = 200 bushels
•3rd leaf = 500 bushels
•4th leaf = 1,000 bushels
•5th leaf = 1,400 bushels

3,100 bushels total! You do the math: 3,100 X $40 retail (for Honeycrisp, at least) = $124,000 gross sales. Hence, as TR says "Fabulous yields in early years!" You CAN make a lot of money growing the TSA.

4 rules of mature TSA tree pruning

Rule 1: Limit tree height to no more than row spacing, preferably a little shorter. Don't cut leader until the tree reaches optimum height (app. 0.9 times row spacing). When the leader has to be cut, prune leader to fruitful side branch.

Rule 2: Remove 2-3 of the largest branches per year. These are typically greater than ¾ inch diameter (quarter-size) or longer than 3 feet. Prune lower branches first, then upper; but don't leave large branches in top of tree. Use bevel cuts (aka 'Dutch cuts') to stimulate new shoot growth/branch replacement. Resist the urge to over-prune, but remember what TR says: "Large branches create large trees."

Rule 3: Simplify remaining branches. No forks ("forks belong on the dinner table"). Branches should be of a single axis (columnar), typically somewhat pendant nature.

Rule 4 (optional, depending on variety): Cut back pendant, weak wood on varieties such as Gala, Fuji that over-crop and have small fruit. Or, remove entirely weak branches. Pencil size (diameter) fruiting wood is ideal. This should help prevent over-cropping and small fruit.

Summary of TSA

In summary, selling points of the TSA include:

. Optimum economic tree density
a. High early production (assuming feathered trees)
b. High light interception (70-75%) as long as tree height = 0.9 X row width (app. 10-11 feet tall trees, no shorter, not taller)
c. Good light distribution with a thin, conical canopy; no permanent branches; and columnar/simple fruiting branches. Result is high fruit quality throughout canopy.
d. Improved labor efficiency -- simplified pruning, potential for partial mechanization of pruning and harvest
e. Bottom line: TSA = happy grower!

What's next?

. Plant one-half to one acre (600 – 1,200 trees)
a. Order trees ahead of time
b. Prepare site
c. Plant early

. Build superior support structure
a. Irrigate/fertilize
b. Pick fruit in following year
c. Make money $$$$$

For more information

http://www.tallspindleapple.com

The Highbush Blueberry Plant and Variety Characteristics

David T. Handley, Vegetable and Small Fruits Specialist
University of Maine Cooperative Extension
Highmoor Farm, P.O. Box 179, Monmouth, Maine 04259
david.handley@maine.edu

Highbush blueberries (*Vaccinium corymbosum*) belong to the same family of plants as cranberries, rhododendrons, and azaleas. They have limited adaptation to the extreme cold winter temperatures of northern New England, but may grow satisfactorily on warmer, protected sites where temperatures do not fall below -25 degrees F. In a good site, the plants can be quite long-lived (50+ years) and produce many good crops.

The roots of a highbush blueberry plant are fibrous and shallow, without strong tap roots or fine root hairs. They extend laterally to about the drip line of the leaves, but can't penetrate heavy, clay soils. Although the roots have a low absorptive capacity, they are usually infected with a beneficial endomycorrhizal fungus, which aids in water and nutrient uptake. Infection and activity of the fungus is enhanced in sandy, organic, nutrient poor soils.

The upright, perennial canes of a blueberry bush can reach six to eight feet in height. New canes emerge from the crown of the plant just below the soil surface each year. These may number very few to many, depending on the variety and the health of the plant. Initial growth of the canes can be quite vigorous, growing three feet or more in just a few weeks. A second flush of growth often follows in the late summer, which may form a few flower buds, but the late, tender growth is often damaged by cold winter temperatures.

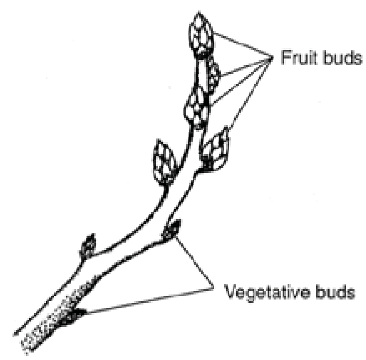


Figure 1. Types of buds on a blueberry shoot

Vegetative buds on the canes develop into shoots or branches during the growing season. The growth usually occurs in two flushes; an initial burst of growth in the spring, followed by a second growth period in the late summer. Fruit buds form at the tips of the shoots during the late summer and fall. On a typical healthy shoot there will be five to ten fruit buds, followed by smaller vegetative buds, which will give rise to new shoots in the spring.

Each tear-dropped shaped fruit bud contains several flower buds. The buds remain dormant on the shoots through the winter until they have met a chilling requirement of 600-1000 hours of temperatures below 45°F. The length of the chilling requirement varies among varieties, but once it is met the plant may break dormancy if the temperatures rise into the 50's or 60's for an extended period of time. This creates a high winter injury risk for plants which have a low chilling requirement, as they may break dormancy when we get a late winter thaw, and are then injured when temperatures fall back below freezing.

Flower buds open in the spring once the chilling requirement is met and the temperatures begin to stabilize well above freezing.   The tear-drop shaped buds swell and open, revealing five to ten flower buds within. The flowers droop downwards and have elongated, white, fused petals known as a corolla. The small opening of the corolla makes pollinating the flowers difficult for honeybees, but both small wild bees and large bumblebees can do a very good job of pollinating. Most blueberry varieties are not very self fertile, and so require a second variety to get good pollination.   The bloom period typically lasts one to two weeks. Blossoms may be susceptible to frost if they emerge too early in the season, so it is best to avoid very early maturing varieties that tend to have early bloom.

Blueberry fruit ripen two to three months after bloom, depending upon variety. Some varieties may ripen too late to be suitable for northern New England. Color is not always a good indicator of ripeness, as fruit may still increase up to 35% in size after they are fully colored. Sugar content can increase significantly after coloring as well, but only if the fruit remains on the plant. It is best to wait several days after full color develops to begin harvesting to assure good fruit quality.

Suggested Varieties

Because of New England's cold winter temperatures and short growing season, you should select blueberry varieties that are described as very hardy and that ripen early or midseason (Table 1). It is usually best to plant more than one variety. Although some blueberries are self-fruitful, cross-pollination among different varieties will improve fruit set and fruit size. In addition, using two or more varieties that ripen at different times will lengthen the harvest season. The varieties listed below have a good track record in New England. For further, locally specific recommendations, contact your State Extension Fruit Specialist.

Table 1. Highbush Blueberry Varieties for Northern New England

Variety	Plant Characteristics	Fruit Qualities	Ripening Season
Patriot	Short, upright, moderate vigor	Medium-large, firm, excellent quality	Early–midseason
Northland	Short, spreading growth habit, vigorous	Medium-small, soft, fair quality, high yields	Early
Bluecrop	Full-sized, upright	Large, firm, good quality	Midseason
Blueray	Full-sized, spreading growth habit	Large, firm, good quality, high yields	Early–midseason
Meader	Full-sized, upright, vigorous	Large, firm, fair quality	Early–midseason
Jersey	Full-sized, upright	Medium-size, firm, fair quality, high yields	Late
Nelson	Full-sized, upright	Large, firm, good quality	Mid–late
Blue Gold	Short, upright, moderate vigor	Medium-sized, good quality	Mid–late
St. Cloud	Short, spreading	Medium-sized, dark, good yields	Midseason
Elliot	Upright, bushy	Small-medium size, good yield, fair quality	Late (too late?)

Site Selection and Preparation for Highbush Blueberries

(*Vaccinium corymbosum*)

Mark Hutchinson: Extension Professor
markh@maine.edu
University of Maine Cooperative Extension

New England Fruit and Vegetable Conference
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Wild highbush blueberries have been growing in New England for hundreds of years. Cultivated Highbush Blueberries (Vaccinium corymbosum) are a relatively new crop for commercial operations in New England. They have limited adaptation to the cold winter temperatures of northern New England, but may grow satisfactorily on warmer, protected sites where the winter temperatures do not fall below -25 degrees F. Select a site that has the proper conditions for **sun, wind, and soil drainage**. Site preparation should begin at **least one year prior** to planting to properly amend the soil and control perennial weeds.

Site Selection: Site selection is an important part of Highbush Blueberry production. Choose a site that meets the following criteria.

Sun: Native Highbush blueberries are usually found as understory plants, however, the lack of sun decreases plant production. Choose a planting site with **full sunlight**. This means at least 6 hrs of direct sunlight. Blueberries can handle more sun if there is water available to support proper growth and fruiting.

Wind: Winter and early spring wind is very hard on fruit buds of blueberries. Blueberries set fruit buds during the previous growing season. If the fruit buds are exposed to extreme cold (below -25 degrees F) or wind, the fruit buds desiccate and die. Winter injury is a common cause of crop loss. Find a protected area or modify the site with a wind break to prevent winter injury.

Soil Drainage: Highbush blueberries prefer well drained soil. They do not like wet feet! Avoid heavy clay soils unless the soil is modified by adding significant organic matter such as peat moss, aged sawdust or compost. A gentle slope will help drain away excessive water and cold air. If possible, plant rows parallel or at an angle with the slope. Low sites are susceptible to poor drainage and early frost.

Site Preparation: Controlling perennial weeds and soil testing are the two most important factors in preparing a site for Highbush Blueberry production.

Weed Control: Perennial weed control is critical to the long term success of Highbush Blueberry production. To control perennial weeds, site preparation should begin at least one year prior to planting. Several strategies can be used to control perennial weeds: removal of the entire plant including the root system, cover crops, crop rotation and fallow periods with cultivation. Many perennial weeds have large root systems it may be necessary to remove a “second generation” of weeds later in the season. Planting a cover crop of oats, annual ryegrass, buckwheat, or rye can help control perennial weeds by increasing competition for resources. Fallow periods will allow annual seeds to germinate. Timely and minimal tillage in fallow periods will reduce the weed seed bank and perennial plants root energy. Perennial weeds are difficult to control in established perennial fruit crops. It is better to be patient and make sure weeds are controlled **BEFORE** planting the main crop.

Soil and Soil Amendments: Soil test, soil test, soil test!

Note: Soil tests are available through your local Cooperative Extension Office.

Have your soil tested to determine the pH and fertility status. Unlike many other garden crops, blueberries require a relatively acid soil for good growth. The soil pH should be within the range of **4.5 to 5.2**. Soils with a higher pH may require additions of finely ground sulfur or aluminum sulfate to lower the pH. Aluminum sulfate is not recommended for continual use. Soil aluminum levels may increase inhibiting the uptake of other plant nutrients. Soil pH changes slowly. It may take up to a year for the sulfur to lower the pH, another good reason to start preparing the soil at least a year prior to planting. Soil type influences the rate of sulfur application. Table 1 provides general recommendations of ground sulfur application rates for different soil types. These are general guidelines. A soil test is highly recommended for more precise application recommendations.

Table 1 – Pounds of ground sulfur/A to lower pH to 4.5
Adapted from the Highbush Blueberry Production Guide: NREAS 1992

pH	Sand	Loam	Clay
5.0	175	530	800
5.5	350	1050	1600
6.0	530	1540	2310
6.5	660	2020	3030
7.0	840	2550	3830

A low pH will also help control some weeds. Ground or prills sulfur is available from agricultural service providers.

Soil Organic Matter (SOM): The soil test will provide information about soil organic matter. Soil organic matter should be maintained at **2-4%** or higher. Growing and incorporating cover crops one or two years prior to planting will add valuable organic matter to the soil. Cover crops will also improve soil health and structure. Compost is also a good source of organic matter. Compost can be applied and incorporated prior to planting. Compost application rates vary widely from 10- 40 tons/acre. Over application of compost can lead to high soil phosphorous levels. Small amounts of compost can be added as a top dress every year. Animal manures may be used as a source of SOM but could introduce weed seeds into the planting.

Site selection and preparation are critical factors in the long term profitability of Highbush Blueberry Production. Soil testing is a major key to success. It is easier to amend the soil prior to planting a perennial crop than afterwards. Careful consideration and planning should be done BEFORE planting.

Resources cited:

Handley, David. 2008. Growing Highbush Blueberries, University of Maine Bulletin# 2253.

NAREAS Publication 2270. 1992. Highbush Blueberry Production Guide. 1992

Highbush Blueberries - Planting, Early Care, and Nutrition

Cathy Heidenreich, Cornell University, Department of Horticulture, NYSAES-Cornell University, 630 West North Street, Geneva, NY 14456, mcm4@cornell.edu

Commercial blueberry plantings are most successfully established when careful attention is paid to site selection and preparation, planting, early care and nutrition.

Planting

Where - By way of review, highbush blueberry sites should be those that offer full sun, excellent air and soil drainage, proper soil pH (optimum 4.5 to 5.0, range 3.8 to 5.5), soil organic matter content of 3% or higher, and soil calcium content of less than 2,000 lb./A.
Selected sites should be well-prepared in terms of pre-plant weed management, pH modification and soil amendment prior to planting. Amendments should be incorporated to a soil depth of 8”.

When - Planting may be done in early spring as soon as soil can be worked, and after danger of severe freeze/frost damage is past. Alternatively, plants may be established in fall on lighter soils with good drainage, provided plants are mulched after planting. Fall planting may be problematic however, on soils prone to frost heaving.

How – The blueberry root system is a shallow dense mat, thus planting holes should be wider than deep! Bare root plants should be set so the root/shoot juncture is at or slightly below (0.5”) the soil surface. Make a slight mound of soil in the center of the planting hole. Set plant on top, spreading roots out in all directions. Soil should be firmed over the roots to prevent desiccation/exposure.
Containerized plants should be set with the root ball mass slightly below the soil surface level (0.5”). Loosen roots from root ball gently, spreading them in all directions. If plants are root bound, cut 4 upward slits in root ball base with sharp knife, then gently spread root ball out in 4 directions. Note: Failure to do this with pot bound plants may result in plant death in subsequent years when above ground foliage can no longer be sustained by a root mass that has not grown out beyond the original root mass. These plants may collapse and die under water stress conditions. Be sure the root ball surface is well-covered to prevent potting medium from being exposed/drying out.
Replace half the original soil excavated with supplemental organic matter when backfilling the planting hole. Alternatively, supplemental organic matter may be incorporated into the top 6 to 8 inches of soil prior to planting (i.e. a 2” layer of sawdust). Supplemental organic matter improves soil moisture, nutrient holding capacity and soil texture as well as facilitating root penetration. Organic material options include peat moss, composted sawdust, cranberry leaves, and wood chips. Mushroom compost should be avoided as it is not pH compatible with blueberries (very alkaline). Peat moss should be incorporated at the rate of 1 gallon *well-moistened* peat per plant. Peat bales are purchased dry to avoid excessive weight. They should be placed at regular intervals between planting rows in the field prior to planting. Slit the tops and saturate bales with water several days before planting.
Soil should be firmed around the plant to maximize root-soil contact. Plants should be irrigated immediately with 1” water to further settle soil around roots and prevent desiccation.

Early Care
Irrigation - Plants should leaf out and show a second flush of growth approx. 2 weeks after planting. At this point it is important to remember blueberries have the bulk of their root systems in top 18”of soil and are subject to drought stress. They require 1.0” to 1.5” water per week in form of precipitation or irrigation. The quality of irrigation water provided is also important. It should both low in total dissolved solids (<0.1%) and pH (<6.0).

Weed Management – Manage weeds to reduce competition for nutrients and water during the establishment period. In-row weed management is especially critical at this stage. Keep a 3 ft. area around young plants weed free through the summer. This may be accomplished using various methods: a mulched strip, hand weeding, herbicides. A mulched strip should be 4 feet in width. A layer of landscape fabric or water penetrable weed barrier may be applied under the mulch. Cover the 4 ft strip with 3 to 5” of mulch such as wood chips, bark, sawdust, straw, or chopped corn stalks. Between-row weed management techniques include frequent shallow mechanical cultivation, mulch, or row middle cover crops. Remember if cultivation is used to manage between row weeds that care must be taken to avoid any disruption of the root zone. Row middle cover crops are another option for between row weed management (Table1). Research at the Pennsylvania State University indicates hard fescues are an excellent choice for this purpose. They perform extremely well as permanent sod covers as they are slow growing (= less mowing), relatively non-competitive (non-spreading), and tough enough to withstand traffic. Hard fescues are best established in fall vs. spring.

Table 1: Characteristics of Row Middle Cover Crops

Cover Crop	**Water Use**	**Establish-ment**	**Vigor**	**Dura-bility[a]**	**Seeding rate (lb/A)**	**Seeding time (month)**	**Requirements[d] N-P-K lbs/A & pH**
Creeping red fescue	M[c]	VG[b]	L[c]	VG[b]	70	Apr-May or Aug-Sept	60-80-40 & 6-7
Chewing fescues	M	G	L	VG	75	Apr-May or Aug-Sept	60-80-40 & 6-7
Hard fescues*	M	F	L	E	80	Apr-May or Aug-Sept	60-80-40 & 6-7
White (ladino) clover	H	F	M	F	15	Apr-May	10-80-60 & 6-7
Tall fescue	MH	G	H	E	75	Apr-May or Aug-Sept	50-60-40 & 5-7
Sudangrass hybrids	H	VG	VH	P	80	June-Aug	80-40-40 & 5-7
Kentucky bluegrass	M	G	M	G	75	Apr-May or Aug-Sept	60-80-40 & 6-7
Perennial ryegrass	M	G	M	G	85	Apr-May or Aug-Sept	60-80-40 & 6-7
Annual ryegrass	M	G	M	P	60	Apr-May or Aug-Sept	60-80-40 & 6-7
Rye (*S. cereale*)	H	VG	H	P	110	May-Sept	30-60-30 & 5-7
Buckwheat	H	VG	H	P	75	May-Aug	30-40-30 & 5-7
Oats	H	VG	H	P	100	April or Aug	30-60-30 & 6-7

[a] tolerance to foot traffic or equipment operations [b] E = excellent; VG = very good; G = good; F = fair; P = poor. [c] VH = very high; H = high; MH = moderately high; M = moderate; L = low. [d] Nutrient requirements may be met by some soils without amendments. Consult soil test before applying fertilizers. Avoid balanced fertilizers high in chloride. *(Source: Mid-Atlantic Berry Guide for Commercial Growers 2010-2011)*

De-flowering - Gently rub off flower buds on newly set plants as they appear. This may be done by closing the palms of your hands over the flower clusters and gently rubbing them together. This practice will keep plants vegetative during the first season after planting to hasten establishment. This practice may be continued into year 2 if necessary for good establishment.

Nutrition
Pre-plant soil analysis and soil amendment based on test results is critical to successful blueberry planting establishment. Blueberry nutrition does not stop there however.

pH adjustment - If soil pH is under adjustment monitor pH semi-annually using a field pH test kit (DIY, $10). Collect 10 or more separate top soil samples (to 8" depth) at various locations across the planting for a better understanding of the soil acidification process underway: Apply 200 lb/A sulfur spring and fall until the desired pH is reached.

Soil analysis after planting- Periodic soil testing (every 2 to 3 years or as needed) is advisable for blueberry plantings. These tests estimate the available phosphorus, potassium, calcium and magnesium in soil. Soil test results and pH are used in conjunction with leaf analysis to check for possible deficiencies or excesses and develop the best fertilization strategy for the planting.

Leaf analysis – Annual leaf analysis is recommended for optimizing blueberry plant nutrition. It's a means of accurately identifying nutritional problems difficult to diagnose by soil testing or observation of bush appearance (plants can be deficient without showing visible symptoms in the field). Leaf analysis helps identify and correct potential nutrient deficiencies before growth and/or yield is impacted by providing estimates of nitrogen availability along with other macro and micro nutrient content in leaves.

The recommended procedure for leaf analysis is as follows: Collect 1 leaf sample per every 10 acres of planting. Each sample should be composed of 30 to 50 leaves collected from different bushes in sampling area. Collect middle leaves on current season shoots just before or during harvest. Leaves from different varieties or the same varieties on different soil types should not be combined; do not combine leaves from plants of different ages. Avoid including leaves from abnormal, weak or unhealthy plants; these should be sampled and analyzed separately.
Wash leaves by swirling in dilute detergent solution for several seconds then rinse with distilled water. Air dry leaves completely on a table top or counter. Pack dried leaves in brown paper bags for shipping to the lab for analysis.

Plantings with results below a deficiency level are likely to respond to nutrient applications. Those with results slightly below the sufficient range would not be expected to respond to nutrient applications but should continue to be monitored (Table 2). Results showing one or more of the deficiencies boron, copper, iron, manganese and/or zinc may indicate problems with soil pH. For information on fertilizer sources of major nutrients and suggested micronutrient sources see Chapter 11 - Nutrient Management in: *NRAES-55 Highbush Blueberry Production Guide.*

Table 2: Deficient, sufficient, and excessive nutrient concentrations in blueberry leaves.

Nutrient		Deficient below	Sufficient	Excessive above
N	(%)*	1.70	1.7 – 2.1	2.3
P	(%)	0.08	0.1 – 0.4	0.6
K	(%)	0.35	0.4 – 0.65	0.9
Ca	(%)	0.13	0.3 – 0.8	1.0
Mg	(%)	0.10	0.15 – 0.3	0.4
S	(%)	--	0.12 – 0.2	--
B	(ppm)*	20	30 – 70	200
Cu	(ppm)	5	5 – 70	--
Fe	(ppm)	60	60 – 200	400
Mn	(ppm)	25	50 – 350	450
Zn	(ppm)	8	8 - 30	80

*(%) = percent dry weight of blueberry leaf; (ppm) = parts per million. (*Source: NRAES-55 Highbush Blueberry Production Guide*)

Blueberry plantings generally need nitrogen applications on an annual basis. Unlike other plants, blueberries are sensitive to applications of nitrate nitrogen forms (No 10-10-10!). The ammonium form of nitrogen such as ammonium sulfate, ammonium nitrate, urea or other organic sources are preferable. If soil pH is not under adjustment, urea is the recommended ammonium nitrogen form for blueberries. It is high in nitrogen (46%) and generally less expensive per unit N. It also provides some control of mummyberry disease when applied in spring. Urea should be applied during cool, wet weather or immediately be followed by irrigation to reduce loss due to volatilization. If pH is still under adjustment, ammonium sulfate is the best choice as it provides some added measure of soil acidification.

Table 3: Recommended annual rates of nitrogen (lb/A) in typical Northeastern or Midwestern blueberry plantings.

Planting Age (years)	Actual Nitrogen (lb/A)	Urea (lb/A)	Ammonium Sulfate (lb/A)
Planting year	--	--	--
2	15	35	75
3	20	45	95
4	27	60	130
5	35	80	170
6	45	100	215
7	55	120	260
8	65	145	310

(*Source: NRAES-55 Highbush Blueberry Production Guide*)

Pruning Blueberry Bushes Young & Old

David T. Handley, Vegetable and Small Fruits Specialist
University of Maine Cooperative Extension
Highmoor Farm, P.O. Box 179, Monmouth, Maine 04259
david.handley@maine.edu

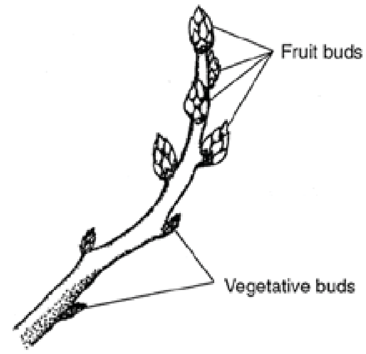


Figure 1. Types of buds on a blueberry shoot

Blueberry bushes should be pruned every year to produce high yields of good quality fruit. Prune the plants when they are fully dormant during the late winter or early spring (January through March).

For the first two years after planting, simply remove any dead branches and all weak, spindly growth. Do not over prune young bushes. During the early stages of plant development you want a good root system and plant crown to become established; heavy pruning of young plants can delay this process. A productive, well-managed blueberry plant should have 5-10 healthy, vigorous, upright canes which range in age from one to six years old. To achieve this follow the steps below for all plants that have been established for three years or more.

1. Prune out any weak, low-growing or diseased canes.
2. Prune out any canes that are more than six years old (these are usually the thickest canes, which are gray in color with peeling bark). Blueberry canes tend to be less productive once they are more than six years old and should be pruned out in favor of younger, more productive canes. Cut the old canes back to ground level unless new cane growth has been sparse; in which case, leave a four- to eight-inch stub above the ground. New canes may sprout from these stubs.
3. Thin the remaining canes, leaving those with the most vigorous shoot growth (long, thick branches with good fruit buds). Leave six to seven vigorous two- to five-year-old canes and two or three one-year-old canes per bush. A mature blueberry plant should have six to ten healthy canes varying in age from one to six years old.
4. Remove any weak fruiting branches on the remaining canes, especially those less than six inches in length. Most fruit is produced on vigorous one-year-old shoots on healthy two- to five-year-old canes. The fruit buds on these shoots are large and teardrop-shaped. Each bud will produce a cluster of five to eight flowers. The shoots also have smaller, pointed vegetative buds that will produce leaves (Figure 1).

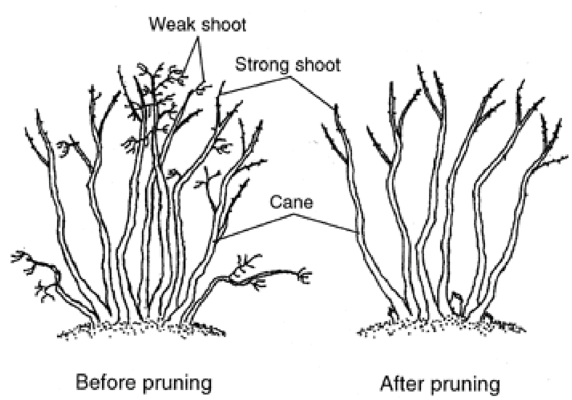


Figure 2. Dormant blueberry pruning

Old, neglected bushes that have not been pruned for years can be renovated by pruning out ¼ to 1/3 of the oldest canes (tallest, thickest) per year during the dormant season, for each of the next three to four years. In this way, by the end of four years, all of the old canes will have been removed while new canes have now had four years to become established and productive, resulting in no loss of yield over the renovation, and improved yield and fruit quality by the end of the process.

Insect and Disease Management Basics

Sonia Schloemann
UMass Extension
sgs@umext.umass.edu

Basic insect and disease management in highbush blueberries starts with good monitoring methods to determine if and when a problem is occurring at a level where action is needed to suppress it. For insects, this usually means some sort of trapping system that provides the grower with information about when a pest arrives or emerges and how many are present. This information combined with knowing the stage of the crop (i.e., if it's at a vulnerable stage for damage) helps growers make decisions about spraying or other interventions.

For diseases, monitoring for the presence of diseases before they cause damage is too difficult because spores are too small to see. Instead growers monitor for environmental conditions that are suitable for disease to infect the crop; that is, an infection period. This has mostly to do with surface wetness from rain or other wetting events combined with temperature over a period of time. This monitoring is done with some type of weather monitoring equipment. This equipment can be as simple as a recording thermometer and a rain gage. Or, it can be a fully equipped weather station with many sensors. More sophisticated weather monitoring can be done that provides the ability to forecast infection risk using modeling programs. Insect pest development can also be monitored this way using growing degree-day (GDD) accumulations, which helps focus scouting efforts on the right period of time, thereby saving scouting costs.

For both insect and disease threats, growers need to know what they're looking for and when to look for it. This requires a good working knowledge of what key insects and diseases look like, how to monitor for them and something about their life cycles. For less common problems, it requires having a fast reliable way to identify the cause of a problem coupled with access to recommendations for control.

Below are some examples of key insect and disease problems common in New England. They include a description of the insect or pest, a bit about their life cycle, the damage they cause, how to monitor for them and some cultural/biological and chemical control strategies. The presentation will cover these and additional insects and diseases of blueberries. At the end of this article you'll see a listing of resources that you can use to look further into the details of blueberry insect and disease problems.

INSECTS

Blueberry Maggot

ID/Life Cycle: The adult fly, similar in size to a house fly, is black in color, with a pattern of dark and clear bands on its wings. The maggots are small, white, legless, and are found inside infested fruit.

This insect overwinters as pupae in the soil beneath the blueberry bushes. Emergence of overwintering adults coincides with the ripening of blueberry fruit and spans several weeks, which extends their period of activity in the field. Females lay their eggs singly beneath the surface of a ripening berry. The emerging larva feeds inside the berries for a two-week period. When full grown, the larva drops to the ground, if the berry has not already fallen. It pupates in the soil, where it will remain for the winter. There is one generation per year.

Damage: Flies lay eggs under the fruit skin just as the fruit begins to turn blue and larvae feed within the fruit. Maggots are later found in ripening and harvested fruit. Maggots feeding within developing fruits render fruit unmarketable. Berries become soft and mushy. Undetected infested berries contaminate pack-out.

Management

Monitoring: Yellow sticky rectangle traps can be used to monitor blueberry maggot populations in the planting. Traps are placed in the upper third of 4-8 bushes around the perimeter of the planting and another 2-4 traps on interior bushes. Bushes with traps should be marked with flagging tape so they can be easily found. Traps should be set out prior to any fruit ripening (approximately 900 GDD (Base 50˚F) from 3/1) and checked every few days to determine when Blueberry Maggot flies are becoming active. Sustained catch of the blueberry maggot fly in traps indicates that it is an optimal time to make an insecticide treatment; sustained catch means not just the first one or two flies, but consistent catch of several flies per week.

Control strategies

Cultural/Biological:

- Eliminate wild *Vaccinium* in the vicinity of cultivated blueberries.
- Preserve natural enemies whenever possible by selecting spray materials that are less toxic to beneficials.
- Prune to achieve small, open bushes with good sunlight penetration through the canopy, reducing shading on the soil surface to generate a less favorable habitat for build-up of this pest.
- Set out a high density of traps (1 trap per bush) in small plantings to trap-out this insect.

Chemical:

- Apply recommended insecticides when trap catches indicate a sustained population.
- If repeat applications are needed, rotate insecticides from different IRAC groups to reduce the chance of resistance development in the pest.
- Be aware of pre-harvest intervals for materials applied close to harvest.

Cranberry/ Cherry Fruitworm

ID/Life Cycle: Both Cranberry Fruitworm and Cherry Fruitworm are native to North America, as are the blueberries they infest. The adult forms of these fruitworms are small brownish-gray or grayish-black moths. Eggs are laid near the calyx of green fruit and are pale creamy color. Larvae found within blueberry fruit in June are small and pale yellowish green in color.

Fruitworms overwinter as larvae and pupate in the spring, emerging as adult moths after the start of bloom and usually before early fruit set. Once mated, moths move into blueberry plantings when fruit is small and green to lay eggs directly on the fruit. Larvae then tunnel into the fruit and begin feeding. Infested fruit turn prematurely blue making them easy to identify when scouting. Larvae will consume from 3-6 berries, filling them with brown frass, and web together fruit with silk. Upon reaching maturity, larvae leave the berries and move to over-wintering sites in nearby woods or hedgerows. There is one generation per year.

Damage: Larvae feed on ripening fruit. Feeding reduces the crop and spoils marketability of the berries.

Management

Monitoring: Pheromone traps can be used to monitor male populations of this pest and helps to identify the initial flight into a blueberry planting. Traps should be placed immediately after bloom or at approximately 350-400 GDD base 50˚F from 3/1. Monitor trap catches twice weekly and remove trap catches in order to identify a peak flight or follow GDD until 85 GDD after the date of first sustained moth catch (biofix), showing the date egglaying starts. Egglaying continues for 400 GDD from that point. Secondary scouting can be done for egg laying by inspecting green fruit with a hand lens. Scout the periphery of the planting especially near woods and hedgerows. Finally, scout for infested fruit by looking for prematurely pigmented berries.

Control strategies

Cultural/Biological:

- Eliminate wild *Vaccinium* in the vicinity of cultivated blueberries.
- Eliminate weeds and trash around plants to cut down on overwintering protection for larvae.
- Clean cultivate between rows to disrupt pupation sites and reduce the population of this pest.
- Hand pick and destroy infested fruit in small plantings.
- Preserve natural enemies whenever possible by selecting spray materials that are less toxic to beneficials.

Chemical:

- Apply recommended insecticides beginning one week after peak trap catches which usually coincide with berry-touch or when 85 GDD from biofix have elapsed. Repeat applications as needed for duration of the egg laying period (400 GDD).
- Rotate insecticides from different IRAC groups to reduce the chance of resistance development in the pest.
- Use pesticides that are less toxic to predators (e.g., insect growth regulators or B.t. products) to promote populations of natural enemies.

DISEASES

Mummy Berry

ID/Disease Cycle: The first symptom of this disease is browning along the major leaf veins on newly emerging leaf clusters. The leaves wilt quickly and bend to resemble a shepherd's crook. A light gray powdery layer of spores develops at the leaf base. These spores go on to infect flowers and fruit. Infected green berries appear healthy but cutting them open reveals a white fungal growth inside. When berries start to ripen, infected berries appear pinkish tan and slightly ridged. They feel rubbery and contain a gray to black fungal mass inside. Infected berries eventually become faded, shrivel up, and fall to the ground. After the fruit skin has weathered off, the berries look like tiny black pumpkins.

The fungus overwinters in the mummified fruit on the ground. In early spring, trumpet-shaped mushroom cups produced on the mummies eject windborne spore that infect young shoots. Frost may increase susceptibility of blueberry shoots to infection. Spores are produced on blighted shoots and are carried to flowers by wind, rain, and insects (bees), resulting in fruit infections. Mummies that fall to the ground provide inoculum for the disease in the following year.

Damage: The fungus infects and invades the developing fruit rendering it unmarketable.

Management

Monitoring: Consult scouting records from previous years to determine if build-up of this disease is indicated. Monitor weather conditions to identify likely infection periods. Scout fields beginning at budbreak for symptomatic tissue.

Control strategies

Cultural/Biological:

- Plant resistant varieties whenever possible.
- Prune bushes to open the canopy to light, air, and spray penetration.

- Cultivate beneath plants in fall and again in early spring to disrupt overwintering inoculum.
- Apply a 3-4" layer of mulch material over the soil surface in early spring before mushroom cups emerge to create a physical barrier to spore release.

Chemical:

- Apply recommended fungicides at budbreak if scouting and weather monitoring indicate risk of infection.
- Time fungicide applications closely to frost/freeze events that predispose tissue to infection.
- Repeat fungicide applications at recommended intervals if weather conditions are conducive to infection.
- Rotate fungicide materials from different FRAC groups to avoid promoting the development of resistant strains of this disease.

<u>Botrytis Blight/Gray Mold</u>

ID/Disease Cycle: Rotted berries are typically covered with a gray fuzz of the mycelium and spores, which gives the disease its name. Infection occurs during bloom on flowers and tender green tissue. Moderate temperatures (60˚F – 68˚F) and frequent rain favors disease development. The fungus survives the winter on dead twigs and in soil organic matter. It is present every year, but only causes severe damage during cool, wet periods several days in duration. The most critical period for infection is during bloom.

Damage: Damage is to fruit production, quality and storage life. The fungus can cause stem blight as well.

<u>Management</u>

Monitoring: Consult scouting records from previous years to determine if build-up of this disease is indicated. Monitor weather conditions to identify likely infection periods. Scout fields beginning at bloom for symptomatic tissue.

<u>Control strategies</u>

Cultural/Biological:

- Prune bushes to open the canopy to light, air, and spray penetration.
- Avoid overhead irrigation that wets plant surfaces.
- Avoid excessive nitrogen fertilization that can result in a dense canopy.
- Harvest frequently to limit the amount of overripe fruit present in the field.
- Refrigerate harvested fruit as soon as possible after harvest.

Chemical:

- Apply recommended fungicides at bloom if scouting and weather monitoring indicate risk of infection.
- Repeat fungicide applications at recommended intervals if weather conditions are conducive to infection.
- Rotate fungicide materials from different FRAC groups to avoid promoting the development of resistant strains of this disease.

<u>Resources:</u>

New England Small Fruit Pest Management Guide: www.umass.edu/fruitadvisor/pdf/2010NESmallFruitGuide.pdf
New York (Cornell) Blueberry IPM: http://www.fruit.cornell.edu/berry/ipm/blueberryipm.html
Michigan Blueberry IPM Facts: http://blueberries.msu.edu/
Michigan State Enviro-Weather pest modeling site: http://www.enviroweather.msu.edu/

From Field to Vase: Postharvest Care of Fresh Cut Flowers

Presented by Dr. Lois Berg Stack
Extension Specialist, Ornamental Horticulture, University of Maine Cooperative Extension
Email: lois.stack@maine.edu Telephone: 207-581-2949

Postharvest care of fresh cut flowers should be a consideration at every step of production: (1) selection of flower species and cultivars, (2) selection and preparation of the production site, (3) crop scheduling, (4) field production, and (5) actions taken after harvest to maintain high quality. This paper includes specific recommendations for that fifth step: how to harvest, process and store cut flowers to maintain high quality.

Stage of development for harvest varies by type of cut flower, and by marketing strategy. See web-based references on the next page for species-by-species recommendations. Consider what your customers want: for direct sales, harvest slightly more mature flowers than for wholesale sales. For longest vase life, cut most flowers in bud, as they start to show color, except for daisy-type flowers (cut when open and just starting to show pollen), and spike flowers (cut when the one-to-two lowest flowers are open).

Time of day for harvest requires some compromise. Flowers have their highest water content early in the morning, but their highest level of sugars at the end of the day. Cut most flowers in the morning, when they are cool and turgid, and when you have enough light to do the job. Cut after the dew dries, to avoid gray mold. Avoid cutting during the heat of midday. If you must cut late in the day for next-day sales, cool the flowers as soon as possible after cutting.

Temperature is important, because flowers age faster when warm. Harvest in morning when both air and plants are cool. Remove field heat as needed, before packing or bunching. Transfer cut flower to a cooler (see web-based references on the next page for information about cold storage facilities. If no cold storage is available, put cut flowers in the shade or a ventilated shed. If possible, maintain high relative humidity to reduce water loss from cut flowers.

Water must be provided, immediately to fully hydrate cut stems. Take a bucket of cold water into the field when you harvest. To open buds faster, use warm water (100-110F). To rehydrate wilted stems, use eight-inch-deep warm water. If any flower types tend to wilt, recut their stems under water to eliminate air bubbles. Buckets and water must be clean and bacteria-free. Acidify water to pH 3.5 for best uptake by stems … always test your water before trying to change it.

Ethylene causing plant tissues to age. It is produced by aging and damaged tissue. Do not harvest stems with diseased or badly damaged tissue. Remove lower leaves and damaged leaves. Use clean buckets. Cool flowers quickly to slow ethylene production. Ventilate your holding area if possible to remove ethylene from the area. Do not store cut flowers and fruits together; many fruits produce a burst of ethylene as they mature.

Postharvest solutions can greatly extend vase life. Rehydrate cut stems in the field; take a bucket of water (pH 3.5 is desirable) to the field when you harvest. Grade and bunch, and then pulse stems by placing them in a 1.5-2.0% sugar solution (add 13 ounces sucrose to 10 gallons water for a 1% solution). Use acid water and a bactericide to control bacteria. Commercial floral preservatives contain sugar, acid and bactericide. Sugar provides energy for plant processes, acid helps water enter stems, and bactericide helps reduce organisms that clog water-uptake tissues. BUT … the most important component of cut flower solutions is clean water, changed daily.

Web-based Cut Flower References With an Emphasis on Postharvest Care

http://www.ascfg.org/
Website of the Association of Specialty Cut Flower Growers

http://www.oznet.ksu.edu/library/hort2/mf2261.pdf
Site of publication: "Postharvest Handling of Fresh Cut Flowers and Plant Material"; includes information on handling, grading, precooling, storage, temperature, storage life and vase life.

http://www.oznet.ksu.edu/library/hort2/mf2323.pdf
Information for retail florists, on care and handling of over 40 kinds of fresh flowers.

http://www.oznet.ksu.edu/library/hort2/MF1174.PDF
Site of publication: *Cold Storage for Specialty Cut Flowers and Plant Material*.

http://www.uvm.edu/pss/ppp/coh29ph.htm
Good introduction to the factors that affect cut flower longevity.

Websites that address postharvest care of specific cut flowers:

http://www.oznet.ksu.edu/library/hort2/srp840.pdf
Covers helenium, cosmos, sunflowers, beebalm and others.

http://www.oznet.ksu.edu/library/hort2/MF1034.pdf
33-page publication: *Specialty Cut Flowers: a Commercial Growers Guide*.

http://www.oznet.ksu.edu/library/hort2/srp805.pdf
Addresses care of autumn sedum, cardinal flower, sunflowers and others.

http://www.oznet.ksu.edu/library/hort2/SRP751.PDF
Addresses care of sunflowers.

http://extension.umass.edu/floriculture/fact-sheets/crops
Website from which you can access fact sheets that cover:
1-Postharvest care of spring flowering bulbs;
2-Postharvest care of astilbe, gladiolus, helianthus, liatris, lilies, zinnia; and
3-sugar and acidity in preservative solutions for cut flowers.

http://www.ncsu.edu/project/cutflowers/postharvest/index.htm
Extensive list of field trials and postharvest trials of specific cut flower cultivars.

http://nesare.org/
Website of the USDA-SARE (Sustainable Agriculture Research and Education) program. Do you have an idea for an applied research project, to investigate postharvest care of cut flowers (or any other aspect of cut flower production)? SARE provides research funding to innovative growers.

GROWING SPECIALTY CUT FLOWERS IN NEW ENGLAND

Nancy Stedman
Little River Flower Farm
160 Turkey Lane
Buxton, Maine 04093
Email: Lrff@sacoriver.net

I have been growing cut flowers for 19 years and have developed some favorite annuals that create a "wow" factor in my bouquets and arrangements that I will share with you.

LISIANTHUS is a stunning annual that I describe as a look alike between a rose and a tulip. You can dress it up or dress it down so it fits well in all types of bouquets. I have been growing them for 9 years and they have never failed me. Since they take about a month to germinate and are extremely slow growers, I buy them in as 125 or 210 plug trays. They are grown in raised beds in my greenhouse starting mid-March.
They don't start blooming till late July but continue thru September, and there are always a few straggles I get cuts off of in October. I tried to winter them over using a lot of mulch during one mild season but found they had fungal disease problems in the spring. The two series I like the best for Maine growing are Mariachi and Echo and my favorite colors are yellow, purple, lavender and green. They come in other colors like white, lite pink to a darker one called carmine and also come in interesting bi-color series called picotee and misty. I only grow the double petal ones.
I grow them in well-drained soil with a little fresh compost mixed in every year.
They don't like to be dried out and as they reach maturity between 18- 30 inches, more water is needed. Staking is necessary even in the greenhouse.
Lisianthus lasts a good 3 weeks in a vase after being cut. I use them in my wedding bouquets, corsages and boutonnieres and sell them to florists.

DAHLIAS are another stunning annual I grow from either tubers or stem cuttings that I buy every year. They come in different sizes, colors, and petal shapes. I grow the Karma and decorative series. They are grown in black crates in the greenhouse in early April then in May transferred to a hoop house for the rest of the growing cycle. I plant 5 tubers per crate in about 8 inches of soil, which is a mix of organic potting soil w/ a shovelful of compost mixed in. Thoroughly water them after planting but not much more till you see growth appearing. When the stems are about 5" tall, I pinch the tips to create side branches.
Dahlias start blooming for me, around mid-July but definitely peak in August and September. As Long as I cover them during a hard frost, I still can get some blooms in October. After cutting them, condition them in warm water because they are hollow stemmed. I usually expect them to last 4-7 days once cut. I use them in wedding bouquet work but avoid using them in arrangements requiring oasis because they don't hold up as well.

SNAPDRAGONS are a staple in our bouquets. They are the earliest annuals on the farm to bloom so we usually grow between 250 & 300 plants. We grow three varieties, which include rocket series, greenhouse forcing, and azalea.

Rocket series is one of the standard choices for field grown snaps. It comes in a mix of 10 colors. In June and early July, we get hundreds of blooms and as long as you give them lots of water, they will produce well throughout the summer into fall. If you don't hydrate them well, they will produce very little in August and can give you a small to medium reblooming in the fall as the cooler weather sets in. Water, water, water is the key to continual flowering. We plant our snaps as early as May 1 depending on the weather. We use drip irrigation, black plastic and cover them with row cover.

If you sell to florists or need tall snaps for your arrangements, grow greenhouse-forcing snaps. They come in single color choices and we grow dark orange, red, yellow and pink. Stem length varies from 24-32". We use snaps mostly in our weekly bouquets and wedding centerpiece work. We have only found azalea type snaps in two colors, pink and peach. They are a shorter version, closer to the size of rockets or shorter. Blossoms are larger and slightly ruffed and make a fun addition to any bouquet.

KISS-ME-OVER-THE-GARDEN-GATE (Polygonum orientale) is a fun annual that makes our arrangements stand out. It is a hot pink color. It is challenging to germinate but once you grow it, it happily reseeds for you. It needs a pre-chill period of about 3 weeks in the refrigerator, and then it is helpful to nick the seed coat before planting. Germination ranges from 2 weeks to 2 months.

It grows in any kind of soil reaching a height of 4 to 8 feet. We wait till the flowers mature before cutting so they don't wilt. It branches out well so one plant can give you quite a few stems. We use it in our weekly bouquets.

CRASPEDIA, Drumstick Flower, is a unique golden yellow globe shape annual. It can be used fresh or dried. It has a long growing period so we seed it up in late February or early March.

It likes to be grown on the dry side in the seedling stage. It can tolerate heat and dry conditions grown outside.

The one-inch balls, often referred to as billy balls, makes for a unique addition in any bouquet.

Managing Insects and Mites in Field-Grown Cut Flowers

Tina Smith, UMass Extension, Greenhouse Crops and Floriculture Program
tsmith@umext.umass.edu

Scouting and Early Detection. Regular and careful observation of the plants will help detect pest problems as they are just beginning. A 10x handlens or magnifying glass is useful for detecting small insects. In greenhouses and high tunnels, yellow sticky traps may serve as a useful tool for whitefly, thrips and fungus gnats and outdoors for detecting migrating leafhoppers. Place traps among the flower crops checking them weekly to determine what pests may be present and as an indicator for the effectiveness of treatments. Plant foliage may be tapped over a white sheet of paper to look for mites and thrips. A sweep-net is used to capture plant bugs and leafhoppers.

Insect Management. The best approach insect management begins with good sanitation and soil management. Keep the field free of weeds and plant debris. Adjust soil fertility and pH based on soil tests and space plants to allow sufficient air circulation within plantings.

Most damaging pests are likely to attack a wide variety of plant types while a few are specific to a limited number of hosts. In any case, it is important to be able to recognize the damage that results from the feeding of particular insects so that management strategies can be applied before the damage becomes extensive, or preventative steps can be taken.

Protecting Pollinators from Insecticides. To avoid killing bees, avoid applying pesticides that are hazardous to bees during the blooming period. Pesticides should be applied when there is no wind and when bees are not visiting plants in the area. The time and intensity of bee visitation to a crop depends on the abundance and attractiveness of the bloom. In general, evening or early night applications are the least harmful to bees. Dust formulations and microencapsulated pesticides are usually more hazardous to bees than sprays. Wettable powders often have a longer residual effect than emulsifiable concentrates.

Pesticides for Cut flowers: http://extension.umass.edu/floriculture/fact-sheets/pest-management

Insects Causing Damage by Chewing. Pests with chewing mouthparts feed on all parts of the plant, tearing or cutting, then chewing and swallowing bits of tissue leaving a ragged leaf or flower margin in the process. In severe cases, most of the leaf may be eaten, in other cases, the insect may not be able to chew completely through the leaf surface and the result is a lacy appearance to the damaged leaf.

Caterpillars are the larvae of moths and butterflies. Damaging caterpillars include cutworm larvae, (newly planted annual flowers); beet armyworms which may bore into flower buds and defoliate plants; painted lady butterfly larvae; yellow woolybear; greenhouse leaftier; checkerspot butterfly; orange tortrix; verbena bud moth; diamondback moth; columbine skipper; corn earworm; and redbanded leafroller.

Flies (maggots) and midges. Maggots are the immature stage of some flies. The sunflower maggot infests the stems of Helichrysum causing the stem to collapse. Chrysanthemum gall midge bores into the leaves, stems or buds which creating the formation of cone-shaped galls where they develop. As a result buds become distorted and stems and leaves twisted.

Beetles. Adult Japanese beetles feed during the day on a large number of flowering plants. Adults emerge from the soil in June and July and feed on foliage for about 30-45 days. Other beetles that cause damage include Asiatic garden beetle, various species of snout beetles, spotted and striped cucumber beetles, larvae of click beetles (wireworms), blister beetles, golden tortoise beetle, flea beetles, rose chafer, and June beetles.
Miscellaneous chewing pests include sawfly larvae, grasshoppers, slugs and snails.

Insects Causing Damage by Piercing-sucking. Insects with piercing-sucking mouthparts do not chew plant tissue. They pierce the leaf, flower, roots or stem with sharp, needle-like structures and pump liquid such as sap into its stomach. At the same time a salivary liquid is pumped into the plant to facilitate food withdrawal. In some cases the saliva may cause a toxic reaction in the plant. This process of feeding can result in insects with piercing-sucking mouthparts to transmit viruses and mycoplasm- like organisms to healthy plants.

Damage may show up as small specks or chlorotic spots where the plant or flower was punctured. Other damage appears as twisted, curled or deformed plant or flower growth, due to the introduction of the toxic saliva. Systemic, translaminar and contact pesticides may work best. Insecticidal soaps have contact activity but must be come in contact with the pest because they have no residual activity.

Leafhoppers. The aster leafhopper (six-spotted leafhopper) is the primary vector of aster yellows disease. It does not overwinter here, but migrates from more southern regions each season. The amount of aster yellows is related to the disease incidence occurring in the southern United States at the time if migration and levels can vary from year to year.

Aster yellow symptoms may appear as distorted leaves and flowers, flowers that fail to form, and/or foliar yellowing. The disease affects many cut flowers such as Annual statice, Gomphrena and Asters. The best method for disease management is to monitor for and control leafhoppers as soon as they appear.

Thrips are very tiny, (about the size and shape of a grass seed), cream to dark colored insects that prefer to feed in opening leaf and flower buds. Some species will feed on leaf tissue where they produce silvery depressed areas that frequently contain black specks. Thrips will attack many cut flowers. Feeding damage appears as a dull discoloration. Flowers can be streaked, mottled or flecked with off-color areas. New growth may become misshapen and deformed, or buds may fail to open. Thrips also transmit impatiens necrotic spot virus (INSV), a serious disease in greenhouses. Since thrips prefer to feed in tight, protected places such as expanding flower buds, multiple applications of insecticides are often necessary for adequate management.

Aphids. Aphids can occur in large numbers very quickly. Most aphids are about 1/16-1/8 inch long, rounded or almond shaped with two "tailpipes" cornicles at the rear of the abdomen. Aphids damage plants by removing plant juices, and also are effective vectors of many virus diseases. Plants can generally cope with small numbers of aphids.

Plant bugs. Fourlined and tarnished plant bugs attack a large number of different cut flowers. Plant bugs cause spotting on the upper leaf surface and deformed blossom heads as a result of feeding. In some instances the injury resembles fungal spotting.

Mites. Two spotted spider mite, cyclamen mites and broad mites. Two spotted mites are most active on the underside of the leaves, their presence being apparent by the fine stippling caused by their feeding and seen on the upper surface of the leaves. Fine webbing is produced by the mites. Leaves turn yellow or bronze, and many drop.
Cyclamen mites and broad mites are invisible to the naked eye but cause a great deal of damage, particularly to Delphiniums, Aconitum, Dahlia, Chrysanthemum, and Verbena. Mite feeding causes the leaves to curl, twist, and become brittle and scabby. Flower buds may dry up and die. Light infestations may result in discolored or dark-flecked flowers. On Delphinium, leaves cup or curl and are blackened. Flower spikes are stunted and blackened. Cyclamen mites are most active during high relative humidity and cool temperatures, while broad mites are most active during high temperatures.

Whiteflies. The greenhouse whitefly and sweet potato whitefly can be important pests on greenhouse-grown transplants or when outdoor temperatures become favorable and they leave the greenhouse to infest suitable hosts outdoors.

Mining Insects
Leafminers. Females deposit eggs on the underside of leaves and the maggots burrow between the upper and lower leaf surfaces and feed. Many leaves may have light green or white winding trails that eventually turn brown and die. The mature larva emerges through a slit in the leaf surface and enters a resting stage where it passes as a pupa in the soil. There are many species and lifecycles may vary a bit. Susceptible plants include Chrysanthemum, Dahlia, Dianthus, Salvia, Verbena, Delphinium, Gypsophila and Aconitum. Elimination of alternate weed hosts also helps reduce populations of leafminers in the field.

Boring Insects. The larval stage of some moths and beetles cause damage by boring into stems and other parts of plants. There are many borers that attack cut flowers. Stalk borers, burdock borer, iris borer, and European corn borer are common borers found in cut flowers. Flowers such as Aster, Dahlia, Iris, Monarda, Centaurea, Chrysanthemum, Delphinium, Rudbeckia, Alcea, Phlox and Salvia are all susceptible to borers. To help reduce borer populations, it is advisable to destroy old leaves and other debris in the fall or before hatching of the eggs in the spring.

Resources

http://extension.umass.edu/vegetable/soil-crop-pest-management/insects
http://extension.umass.edu/floriculture/fact-sheets/pest-management
2011 Cornell Guide for the Integrated Management of Greenhouse Floral Crops
http://ipmguidelines.org/greenhouse/
2011 Cornell Pest Management Guide for Production and Maintenance of Herbaceous Perennials
http://ipmguidelines.org/HerbaceousPerennials/
2011-2012 New England Greenhouse Floriculture Guide
http://extension.umass.edu/floriculture/pest-management/new-england-pest-management-guide

FENCING OPTIONS FOR WILDLIFE CONTROL

By David Kennard
Wellscroft Fence Systems, LLC
167 Sunset Hill, Harrisville, NH 03450
1-855-FARMFENCE Fax: 603-827-2999
info@wellscroft.com

Since 1978 when Wellscroft Fence Systems started, wildlife pressure on crops has increased as much as tenfold in certain areas. This is due not only to the rise in deer population, but also to the urbanization that has caused increased pressure on open spaces for forage. In addition raccoons, woodchucks, rabbits and even coyotes have caused significant damage to both perennial and annual crops. Fences that were developed in the 1980's, such as the Penn State five-wire vertical electric deer fence, were very effective in the beginning but cannot withstand these new escalated pressures. Consequently, many initially effective fences have had to be retrofitted to accommodate new pressure. The following describes what Wellscroft believes are viable options for deterring and excluding wildlife in the northeast. When protecting perennials such as fruit trees in the winter, many considerations must be taken into account due to the ice and snow loads in this region. Below is an outline of twelve different types of anti-wildlife fence that we have used with growers and state agencies over the last thirty years. There are also many other non-fence techniques for dissuading wildlife which may be used in conjunction with fencing for even more effectiveness. These items include such things as chemical repellants, natural repellants, noisemakers, guard dogs and of course, hunting.

In choosing a wildlife fence for your crop protection, there are several questions one must ask. First, what is the type of wildlife to be excluded? Do you need both a psychological (electric) and/or physical (woven wire)? Second, is this a temporary or permanent fence? Does it need to be taken down annually or moved? Is it on rented land and for how long is the lease? Third, what is the degree of pressure? Are there other sources of food in the area for the wildlife? Fourth, what degree of exclusion as it relates to fence expense does the grower wish to achieve? Is 95% exclusion good enough or must it be 100%? What is the cost of the fence in relation to the value of the crop damage incurred? We have growers who are very happy with the effectiveness of a 40-cents-per-foot portable electric fence versus those who need a $5.50-a-foot, 100% exclusion year round fence. Fifth, is the crop to be protected an annual or perennial? Does it need to be protected in the winter or are the nine growing months sufficient? A winter fence needs to be much more substantial due to snow, ice and the insulating properties of dry frozen ground when considering electric fence. Finally, are there aesthetic factors, which for some situations growers will need a fence that is pleasing to the eye and not too formidable?

The following reviews the options for both electric (psychological) and non-electric (physical) wildlife fences. Keep in mind that electric fences require more maintenance but have portability and economic advantages. The non-electric fence must be very strong as there is no deterrent to keep the critters from working the fence and trying to push through, under or over it. They have the advantage of requiring the least maintenance and being the most effective. Over the years, many studies have been done of these various options and there is no doubt that the eight-foot ***Fixed Knot*** hi-tensile fence is the **most effective and economical** in the long run for deer. However, it is unquestionably more labor intensive to erect. Many growers have said that they paid for the fence in the first two years in crop savings. Wellscroft has hundreds of these fence systems working in the northeast and can supply you with names of growers near you who have experienced similar problems.

ELECTRIC FENCE OPTIONS FOR WILDLIFE CONTROL

1. **1-3 tapes or ropes at 20”, 40” and 60”.**
    - Good only for annual vegetables, flowers, fruits, etc. (April-October in moist soil conditions.)
    - Easily taken down and moved for crop rotation or rented land. The ½” tape is easier to move; rope should be used in more semi-permanent situations.
    - Good for rented land.
    - Needs to be faithfully baited (aluminum foil pouch w/peanut butter inside or scent caps).
    - Note: lower wires may be added at 5” and 10” for raccoons, woodchucks, etc.
    - Least expensive - $.30 to $.60 per foot.
    - Longevity: 5-10 years.
2. **1-2 tapes or ropes in conjunction with 3-4 maxi-shock galvanized cables**.
    - Good for both annuals or perennials (not too effective in the winter, unless polarity is switched)
    - Needs to be baited (aluminum foil pouch with peanut butter inside or scent caps).
    - May be removed with more work than option #1
    - More conductive in situations of heavier vegetation.
    - More expensive - $.50 to $.90 per foot.
    - Longevity: 10-15 years.
3. **Three dimensional tape or rope fence**
    - Two fences 4’ apart; one conductor at 30” on outside, two to three at 20” and 40-60” on inside.
    - Very effective but uses more wire, posts, land and is more difficult to maintain. Deer have a hard time jumping through this double fence.
    - To be used when option #1 starts to fail.
    - Needs to be baited.
    - More expensive - $.40 to $.80 per foot.
    - Longevity: 5-10 years.
4. **Electric netting**
    - Easy to install and remove; comes complete with posts every 12’. Available in 82’ or 164’ lengths; 20”, 30”, 42”, 48”, or 68” heights. Comes in white/black, or dark green.
    - Good for scenic, small areas. Homeowner gardens.
    - Vegetation needs to be maintained under the net.
    - Very easily moved.
    - Works well for woodchucks, raccoons, rabbits, pets.
    - May be set up positive/negative.
    - Not recommended for winter use.
    - More expensive - $.55 to $2.60 per foot.
    - Longevity: 10 years.

5. **Vertical High Tensile Electric Fence, 8-wire 6'**
    - Very permanent, not easily moved.
    - Good for low to medium deer pressure.
    - May be set up bipolar for winter or dry summer conditions.
    - Requires strong corners and ends.
    - Requires a visibility lane on the outside (6'-10').
    - Should be faithfully baited.
    - Cost effective in larger areas with straight runs, few gates.
    - Cost - $1.00 to $1.55 per foot.
    - Longevity – 20 years.
6. **Electrified offset wires for 91" Tenax type plastic anti-deer mesh**
    - Least visible for residential plantings and landscaping.
    - Easily installed; must be baited.
    - Less effective in winter.
    - May be subject to damage from ice and heavy snow.
    - Cost - $1.20 to $1.55 per foot.
    - Longevity – mesh – 10 years.
7. **2x4 Woven wire, 4-6' high with 1 electric top wire and 1 electric offset 12" up**
    - Very effective for small and large wildlife
    - Low maintenance
    - Year round protection
    - Cost- $1.70 to $2.90 per foot.
    - Longevity—25 years

SIX RULES FOR AN EFFECTIVE ELECTRIC ANTI-WILDLIFE FENCE:

1. While erecting fence, energize the wires at the end of every workday because the wildlife's first encounter with the fence is very important.
2. **Always keep the fence energized** and properly grounded.
3. Keep a clear lane on the outside of the fence so it is visible to the wildlife. It should be at least 6-feet from the edge of the woods.
4. Keep the vegetation off the fence line.
5. **Bait the fence** with scent caps or peanut butter wrapped in tinfoil and stapled around the fence wire, or smeared directly onto the tape.
6. Maintain the voltage (at least 3500 volts; use a fence tester). Use a Fence Alert

NON ELECTRIC FENCE OPTIONS FOR WILDLIFE CONTROL

8. **Smart Net-Anti-Deer fence 8' x 100' rolls**
    - Easy to install and move
    - Has its own polyester support line built in (post needed every 15-25')
    - Needs braced corners and must be stretched
    - Black net disappears
    - Cost - $1.60 to $2.40 per foot
    - Longevity—15 years

9. **91" Tenax – C-Flex anti-deer mesh**
    - Least visible.
    - Easily installed (post every 25'). Hangs on 8 g. polywire or 12 g. steel wire.
    - Good for light pressure but may be penetrated if not electrified (see #6 above).
    - Not good for small wildlife which will chew through it.
    - Cost - $1.10 to $1.35 per foot.
    - Longevity – 10 years.
10. **Woven Wire 2 x 4 6' high**
    - Good for small areas with light deer pressure and small critters
    - Needs braced corners and must be stretched.
    - Post every 15'.
    - Cost - $1.30 - $2.25 per foot.
    - Longevity – 20 years.
11. **Woven wire Fixed Knot 6', 8', or 10' high**
    The most cost effective and permanent method in the long run for deer.
    - One-piece vertical resists snow and ice loads, deer penetration.
    - Available in black as well as galvanized steel, 14 or 12 ½ gauge.
    - Least amount of maintenance.
    - Must be braced, recommend PT or locust posts, with wood, pipe or galvanized T-posts in between.
    - Cost - $2.25 - $4.25 per foot.
    - Longevity – 25-30 year fence minimum.
12. **Smart Net Overhead and Side Netting System for Birds**
    - Fully protects crops from birds
    - Extremely effective
    - Pays for itself in the first year of crop savings
    - Netting is permanently attached to side support wires and at the end of the growing season is pulled back and stored at one end.
    - Netting is supported on lines of high tensile wire 8-9' in the air.
    - Cost – Approximately $1900.00 per acre for top and side nets, posts and wire extra.
    - Longevity—10 years

If the fence needs to deter both deer and smaller critters such as woodchucks, raccoons, rabbits, etc., an additional baited electrical offset wire is essential as those predators will just climb over or dig under a physical fence. In terms of aerial predation from birds, Wellscroft highly recommends the Smart Net System of overhead netting which is suspended on grid of high tensile wires nine feet in the air.

Note: All price estimates are per foot of materials except anti-bird netting and **do not include installation labor**.

BACKPACK SPRAYERS FOR SMALL-SCALE FARMERS – ADDRESSING THE DISCONNECT

John Grande
Rutgers Snyder Research Farm
140 Locust Grove Road, Pittstown, NJ 08867
grande@aesop.rutgers.edu

Small-scale farmers utilize backpack sprayers in many parts of the world. Backpack sprayers are inexpensive and simple in design making them a cost-effective device for small-scale farmers. Unfortunately, there is a disconnect that exists in the utilization of these sprayers. This disconnect refers to the issue that farmers need to acquire information from multiple sources to effectively use backpack sprayers in many instances. The company's manufacturing backpack sprayers generally produce a very limited array of sprayer accessories. There are, however, companies producing a multitude of sprayer accessories allowing farmers to more effectively apply spray materials. Adapting these accessories to the many different styles of sprayers manufactured in various parts of the world is problematic for the farmer. In addition, many crop spray products for farmers have limited directions for use. These products can vary substantially in viscosity and consistency making applications problematic.

- Farmers would benefit from a more turnkey approach to the application of liquid spray products through backpack sprayers. This information is not generally available from agricultural educators. This project was conceived and intended to address this disconnect.

- Many advances in backpack sprayers have been realized over the last 15 years. As noted above, accessories are difficult to obtain and evaluate in a systems approach due to the fragmented nature of the business.

- Our project provides deployable technical resources providing farmers with information regarding types of backpack sprayers and simple modifications to allow accurate, cost-effective application of spray products to small-scale horticultural crops.

- 19 models of backpack sprayers were evaluated objectively [such as pump performance] and subjectively utilizing farmers to evaluate sprayers under field conditions for efficiency and ease-of-use.

- In summary large discrepancies were noted among sprayers evaluated under field conditions regarding parameters such as pumping fatigue, spray efficiency and overall comfort. The cost of the sprayer did not relate to the overall performance.

- All sprayers were retrofitted with an identical spray handle. This provided a readily available array of spray application accessories such as nozzles, pressure regulators, and strainers to accomplish a multitude of crop application tasks including banding herbicides, foliar application of fungicides and insecticides requiring various spray parameters.

- In summary the best performing sprayers evaluated both objectively and subjectively were neither the highest priced nor the most readily available. The use of the Internet to find and purchase backpack sprayers simplified this task.

Project Funded by NESARE

TOOLS FOR EFFICIENT POST HARVEST HANDLING AT CEDAR CIRCLE FARM

Megan Baxter
Cedar Circle Farm
225 Pavillion Road
East Thetford, VT 05043
802-785-4737
megan@cedarcirclefarm.org

At Cedar Circle Farm our post harvesting tools have evolved as we have expanded and diversified our crops and markets. Ten years ago we washed out of a large plastic tub outside of one of our greenhouses and packed directly into wax produce boxes. At this time our harvests and markets were minimal and this system met our needs. Today we supply 140 families with a CSA share, maintain a seasonally open farm stand, attend 3 farmer's markets and sell to a variety of wholesale outlets, ranging from school cafeterias to high-end restaurants. Our tools for post harvest handling have evolved as well. Our processing area includes 3, 3 bay stainless steel sinks, stainless counters and overhead high pressure hoses. Produce is stored in 3 walk-in coolers, as well as in 2 temperature controlled storage rooms in our barn, primarily used for roots crops, onions and winter squash.

On a physical level our tools for efficient post harvest handling include simple things like waterproof gloves so our staff can work in all weather, spray nozzles, handcarts, wax boxes and storage bags. We harvest into containers, or "totes" and pack into black plastic "crates" which are kept clean and out of the field. We have enough vehicles to move product from place to place, 2 farm trucks, 2 golf carts and a market van, as well as hand-held radios for communication between staff and management.

These physical tools are easy to purchase in farm tech. catalogs or at a local hard wear store and they help only so long as an efficient system is in place. Our harvest and post harvest system center on a "pick sheet", essentially an order form that our farm stand staff fills out at closing. In the morning our production manager adds orders for the CSA, farmer's markets, wholesale and our commercial kitchen to the pick sheet, totals the quantities and then writes up the harvesting plan on a whiteboard located in our processing area. Each crop is assigned to a certain staff member or group. The white board is the central point of our production crew's day. Our processing lead then directs produce as it comes in from the harvest using the pick sheet. We are a small enough operation that systems of training, record keeping and operating procedures and far more important then physical tools.

Most of our staff is seasonal and comes in at the busiest time of the harvest-year. Key members return for several years and these people help with training and quality control. We have written procedures for harvesting and processing every crop we grow, as well as procedures for storing and displaying that crop (which gives each item a longer shelf-life either in the stand or at farmer's markets). Improvement on these systems is encouraged; their fluidity allows staff to take ownership of their position on a daily basis and has created some excellent additions to our procedures over the years. Signs are posted outside of each of our walk-ins and storage rooms with a list of crops stored there. Communication between different areas of the farm, especially between our production staff and retail staff is improved by the use of several white boards that describe what crops we have in and in what quantities, crops that are arriving and crops that are going out of season. Our most efficient tools in post-harvest handling are training, operating systems and an expanded processing area and storage units.

Of course there is always room for improvements and a wish list for new tools but our goal is to sell everything we pick and if we can't sell it then direct it to non-profits or staff. Record keeping allows us to track spoilage and to plan next years seed charts so that we are growing in pace with our markets.

If you are interested in our standard operating procedures for harvesting, processing and storage or our food safety policies please email me: megan@cedarcirclefarm.org – we love to share and receive feedback.

High Tunnel Tomatoes at Edgewater Farm

Pooh Sprague

Edgewater Farm 99 River Road, Plainfield, NH 03781

602.298.8391 www.edgewaterfarm.com

We are a small diversified farm in the Upper Connecticut Valley. Our marketing strategy incorporates CSA, wholesale and our farmstand. Tomatoes are our single most important vegetable crop to all facets. Historically we started out in the 70's as field growers of tomatoes. Today with the exception of cherry, grape and roma tomatoes,   all of our tomatoes are grown in greenhouse environs. We grow 60% in heated tunnels, 40% in the traditional high tunnels….old school. Why?: Extra low budget technology still yields better fruit, less inputs by creating a moderated environment.

Tunnels: Ledgewood Farm 21x96 with 5' sides. No electricity available so poly gets rolled down in season and collected in a bundle at the peak in the off season. Poly gal gable end coverings a recent upgrade for increased light transmission. 5 Row system, nominally spaced 14-16 " in single row. Double drip lines for each row, irrigated by pond water that is tested annually for e coli. Trellising is single poly strand tied off at the purlins for each plant. Somewhat spacious, but helps with air movement in July and August in a passive environment without HAF.
Soil: Agawam sandy loam. SME tested annually. Organic amendments use for fertility. Peanut or feather meal, sulfate of potash, a little bone char for P plus compost amendment in spring because of off season leaching of fall and winter rains and snows.

Plants: All grafted plants, as we are in our 8th year with the newest of the houses. Mix of heirlooms, romas and beefsteak, Geronimo is now our backbone, Trust and Abrason. All grafted on Maxifort rootstock. Tried Emperador from JSS, will continue to experiment with them.

Culture: Planting seeds late February and early march for early may planting. Plants will be 8-10" ideally and well rooted in 4.5" pot. Beds are made with a rotary plow so they can be 6-8" high, covered with biotelo. Plants are set in with no started charge. Frost protection is supplied by a propane pot burner. Fruiting begins early-mid July depending on weather, and sunlight. Culturally we sucker and clip, but only partially successful in truss pruning and putting in truss supports. Usually spray once for hornworm, but 2009 late blight has us now keep a battery or fungicides from different frac groups on hand. Fulvia has been an occasional problem, we hope for some low humidity breezes and steer away from varieties that are prone to it ,like Big Beef and Massada. We do not lower vines, but let them drape and use the "older" houses for #2 fruit and canners. We harvest all #1 into 17 lb single level nesting poly trays. Usually harvest 5- 6 good trusses of fruit depending on variety before plants are topped or begin draping, fruit quality diminishes beyond that.

Summary: High tunnels, in their elementary form have certain advantages over more sophisticated capital intensive tomato growing systems.   At our farm we like simple. A simple system gives you the biggest bang for your buck. Simpletons can fix simple systems. When the flood hits, it's a much simpler fix.

Tips from Ten Years of Grafting Tomatoes

Skip Paul skippaul13@gmail.com
Wishing Stone Farm
25 Shaw Road, Little Compton, RI 02837

Many greenhouse growers started grafting tomatoes because they were running into production problems, which were mainly the result of repeatedly growing tomatoes in the same greenhouses year after year. The issues were many and varied between growers but “corky root rot”, “high salinity” and other issues were driving down our production and, equally as bad, the above ground problems seemed to be increasing and hastening the demise of the tomato plants productive months. The first generation of root stocks had good disease resistance but lacked in their level of vigor to continue to push production. The next generation, e.g., “Maxiforte”, which we use today has both good disease resistance but also an extraordinary level of vigor.

Anyone who has watched a good house painter will observe that it is the hours/days of prepping the houses surface that makes the paint job go easy and turn out well. Similarly, grafting tomatoes is all about preparation of the plants weeks before hand and their care immediately after grafting. The actual “act” of doing the graft is rather perfunctory and the skill level needed only average. The slogan; “the devil is in the details” is very much true when it comes to grafting tomatoes. The following is a list of do’s and don’t we aspire to. I have very good fellow tomato grafters who do things much differently than us and they get great results; it is truly more art than science. But as one veteran grafter once admitted; the details that work in January may not deliver the same results in April. Light intensity, greenhouse temperature and humidity levels are much different and your lists of parameters will change. The following is a check list of points to keep in mind and adjust as your season progresses.

We start with fresh seed for our earliest seedings. It is January 14th and there is no room for error. By February 14th, I am more lenient about using old seed and I am more tolerant of skips because our production by then is so high. The first seedlings we plant are our bottom tomatoes or root stock (Maxiforte). It is a wild hybrid tomato from Thailand and consistently has always had some delayed soil emergence issues. Two days later we plant our tops or scions on the tomato you want to produce. (Sixty percent of our tomato production uses Geronimo.) If we are doing a 98 tray of Maxiforte we will plant a quarter of a 98 tray the Geronimos and another quarter tray everyday thereafter till it is full. Since we are “top grafters” (as opposed to side grafters) it is very important, come the day to graft, that all our rootstock and scions match width-wise. Since we are doing hundreds of grafts at a time, this process of staggered seedings works well for having the right sized plants when you need them. For this reason we over plant by 15% just to be sure we have an ample amount of sizes to make our quotas.

Point #1: Stagger Plantings to get good sizes choices

Point #2: Do not over nourish your plants; a bit purple-ish and light green is good.
We use Vermont Compost Co. “Forte lite” as our soil. We never feed the plants anything but water and rely on the innate fertility inherent in the soil mix to see them through the entire grafting process. We also use Root Shield and other plant/seed protectants.

Point #3: Provide bottom heat (never over 73 degrees) and a bit of artificial light.
Bottom heat is essential but double check you mats for hot spots etc... too much heat can be worse than slightly cool (lower than 70 degrees). Over heating is dangerous because it starts a stretching tendency in the plant that is hard to arrest. This year we finally built a boiler which gives us very even heat. We also box in our heat tables to take night time drafts out of the equation. We built mini-greenhouses out of five or so 1/2" electrical conduit bent over the table and some cheap clear plastic. Make sure you have mini roll-up sides so you don't overheat during daylight hours.

Point #4: Use larger top graft clips and larger (thicker) plants. Remember, if one has to be fatter than the other "always" have the top scion bigger than the bottom root stock.
Though you can buy 1.2 and 1.5 grafting clips, we only use 2.0 and up... There are many reasons but "1.2mm clips = too small = too young".

Point #5: Do not cut too much of an angle; the Japanese cut them completely flat. So use your judgment. We try for a 45 degree angle.

Point #6: Choose your plants the day before grafting and place them in a two lane tray. From now on bottom water only. The day before grafting, we choose the root stock tomatoes and place them in a 98 cell tray that has been cut so that it has two long lanes of cells. This holds the plants upright and stable during grafting and also (most important) allows us to work down the line of plants without disturbing the previously grafted plants. From now on no more top watering. Only bottom watering. We have found keeping the stems and leaves free of any liquids keeps impurities out of the equation. Oxidate your bottom watering tray liquid and keep it at 400:1. This water "must" be kept germ-free and pure.

Point #7: Immediately after grafting put the special cut 98 cell strip into a solid 10X20 tray and put a "high dome" over it that has been misted on the inside to create ample humidity. Place the domed tray and plants in the ACU or darkened heated area. You want a stable 78 degrees and about 95% humidity. Most important of all is an extremely low light level. This can't be emphasized enough; it must be close to 85% reduction. Keep your mister at the ready all day and once more late at night. It is important to mist the "inside" of the dome and "not" the plants. Be sure the temp doesn't spike. Again, too much heat will only stress the plants healing process. Our source of "high domes" is Growers Solution: 2212 Isaacs Pl.; Cookeville, TN 38506 Tel: 931-528-3398

Point #8: Do most of your grafting after 2PM especially on sunny days. It is less stressful to the plants. You will get better and quicker takes if you wait till afternoon. There must be some scientific plant physiologically reason; suffice it to say, it works for us.

Point #9: Be attentive to moisture, heat and light for the next three days. The scion may droop a little but just be patient. If just before grafting, you see that the scions plants have oversized leaves or too many leaves, it's advisable to remove some or even cut the leaves in half. "Be careful" there is a fine line between lessening the leaf load on the plant but then again having enough leaves that it creates a need in the plant to suck up nutrients from the rootstock and urge the tissues to reconnect and heal.

Point #10: After 3-5 days move the grafted plants into “recovery area #2”. It should still have shady \ diminished light and we also keep the domes on but now start slightly opening them. As the days go by evaluate your grafts and slowly acclimate them to your greenhouse environment. Be very aware of a sudden change in the sunlight during these last days of readjustment. If you pull your plants out of the first recovery room at the beginning of three days of clouds and rain, be very cautious about the effect the sunlight will have when it finally returns. I have seen beautiful healthy plants roll over and die from too sudden a change in light or acclimation to the dry hot air of a greenhouse on a sunny day in March.

Point #11: Leave the clips on till they pop off on their own.

Point #12: Purchase Mike Collins’ video showing his techniques. Mike knows more than anyone I know about this delicate process. It is available from UVM video/DVD store.

Point #13: Keep sanitation awareness and execution upper-most on your list. We use Oxidate and other disinfectants at all stages of our operation. Use new 98 cell trays.
New 2.0mm clips. We sanitize our razor blade we graft with after every ten cuts. As mentioned earlier if you respect the details needed, the devil will have a hard time thwarting your best efforts.

HOW WE USE TOMATO IPM AT FURMANO FOODS INC

Ken Martin
770 Cannery Road, Northumberland PA 17857
ken.martin@furmanos.com 570-412-0691 (cell) 570-473-4474 Ext 596 (office)

- Furmano Foods Inc is a tomato, snap bean (green and yellow] and dry bean processor in the central part of Pennsylvania. We process most of our products in both institutional-[food service] and retail cans along with a food service plastic pouch for tomato sauces and just started putting dry beans in a pouch for the food service business.
- We are the only whole peeled tomato processor on the east coast and one of only two left on the east coast. California processes 96.4 percent of the tomatoes in the US with the Midwest at about 3 percent. So you can see where we fall on the scale of processing tomatoes. Our production is split about half dry beans and half tomatoes with a small portion in snap beans.
- Since 2006 we have been required by one of our largest food service vendors, SYSCO, to write an IPM Sustainable program for the products that we sell to them, at that point tomatoes and snap beans. Along with writing the program there is also an audit to measure progress in the program which requires a minimum passing percentage to continue to partner with them. As with any audit there are portions that we struggle with, the portion that deals with social questions pertaining to how we and our growers treat our employee's for instance or how we address things like recycling and others.
- This included not only Furman Farms but all our contract growers also. As we worked at becoming IPM certified along with our growers we realized that we as growers had been practicing IPM and managing our crop with IPM principles, we just had not been documenting what we were doing.
- SYSCO built the IPM Sustainable audit with the input of the IPM Institute's Tom Green along with an advisory panel of growers and processors and academia people. They also looked at what other certifiers were out there and a good one for tomato was the University of Massachusetts IPM worksheet. Very up to date and really spot on when it came to cultural practices, pest and soil management and disease and insect management. I include that work sheet in my manual as a checklist and points ranking to see how we are doing. Also things like sprayer calibration, pesticide reporting and spray drift are in the audit along with GAP's concerning soil health. And having a good scouting program for monitoring for disease and pest. We have to document our nutritional additives N-P-K along with manure.
- Certification- do we receive a premium for this requirement? No and we also have to pay for the audit which can be fairly expensive.
- Some tools we have in our toolbox to achieve a good and robust IPM program. **TAKE A SOIL TEST** the very first thing to help you know what is in your soil and what to add for optimum growth in you crops. Keep looking for good information on current crop protection materials. Keep looking for "softer" materials that still do a good job. Making

sure we are scouting or hire a scout [share a scout] to identify and verify problems that might be out there.

- Update your sprayer. Maintain your sprayer, with calibration and replacing tips. Many times this exercise has turned into a savings when you find tips that are not functioning both too much and not enough of material.
- We use GPS on our planter and cultivation along with harvesting
- Drip irrigation along with moisture sensors to help us see where moisture levels are in the soil
- Build a high tunnel. Great way to reduce crop protection material and increase production. Limitations would be crop rotations and cost.
- Read and attend meetings that keep you abreast of new ideas and technologies. Find the GAP’s that you need to do to keep your farm sustainable and viable for the next generation.
- Look around and see what other growers are doing even some who might not share your thoughts on cultural practices

Bacterial Disease Management in Tomato

Christine Smart, Holly Lange, Maryann Herman, and Lisa Jones
Department of Plant Pathology and Plant-Microbe Biology
Cornell University, Geneva, NY 14456
cds14@cornell.edu

A combination of cultural practices and copper-based pesticides are the standard control strategy for bacterial pathogens of vegetable crops. The three common bacterial diseases of tomato in New England are bacterial speck, caused by *Pseudomonas syringae* pv. *tomato*; bacterial spot, caused by several species of *Xanthomonas*; and bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis*. Cultural practices including utilization of disease-free seed, sanitation of greenhouse transplant production areas, cleansing of trellising stakes, and working with plants only when the leaves are dry are critical to prevent the spread of bacterial diseases. While copper is effective in slowing the spread of disease, we wanted to determine the efficacy of several newly developed compounds available for control of bacterial pathogens. We have tested plant activators and bacteriaphage as potential control strategies for bacterial pathogens of tomato, and compared them to standard copper-based control strategies. Activators were tested in the field against bacterial speck, while bacteriaphage were tested in the greenhouse against bacterial canker. Additionally, we are now testing surface irrigation water for the presence of plant pathogens, to help growers prevent the spread of tomato pathogens while irrigating.

Compounds that can activate plant defense responses are known as plant activators, plant defense activators or systemic acquired resistance (SAR) inducers and are frequently termed biopesticides. Additionally, many of these compounds are said to increase plant health and yield, and are expected to be environmentally friendly, having no direct effect upon the pathogen. Some activators are certified for organic use, and thus they could also fit into organic production systems. There are two types of plant activators, and one example of each was included in our study. The first type consists of living microbes that colonize plant roots and activate a resistance mechanism known as induced systemic resistance (ISR). These products are frequently plant growth-promoting rhizobacteria (PGPR), or yield-enhancement biologicals, which are thought to increase yield while reducing pathogen problems. PGPR are living bacteria (many are *Bacillus* spp.) which can be mixed in with soil just prior to sowing seed.

A specific plant defense pathway known as systemic acquired resistance (SAR) is induced by the second type of activator. Acibenzolar-*S*-methyl (ASM) is the SAR activator included in this study, which is a salicylic acid analog that is applied to the foliage. In contrast to ISR, there have been several reports of yield decreases following application of an SAR-inducing compound. This is thought to occur from the systemic activation of SAR, which diverts resources away from other areas of the plant, such as growth. While both ISR and SAR induce the plant's natural defense mechanisms, they are not the same and it is unknown which mechanism will have greater efficacy against tomato pathogens in the Northeast. In addition, it is unknown if usage of the two products together could act synergistically to enhance both yield and disease control.

We found that the ASM treatments reduced the number of leaf lesions in each of the three field seasons tested. Additionally, there were no significant differences in yield between any of the treatments. These results are encouraging for growers. In contrast to previous studies, we did not find any decrease in yield relative to the untreated control when ASM was applied to plants. ASM treatments provided the best control of bacterial speck, although they were not statistically different from the copper treatments. This provides evidence that ASM can be a weapon used to compliment a copper spray program. The PGPR product did provide disease control significantly greater than the untreated control, but did not have an impact on yield in our study.

Additionally we have tested bacteriaphage (also known as phage), which are naturally occurring bacterial viruses. There is a company that identifies and produces large quantities of phage that are specific to a bacterial pathogen. These phage can then be sprayed onto plants to kill the bacteria. They are used commercially in Florida and Georgia to control bacterial spot on tomato, and are also used in large greenhouse tomato production to control bacterial canker. In our greenhouse trials testing phage against bacterial canker, we did not see statistical differences between treated and untreated plants, however there did appear to be a reduction in the number of bacteria on plants.

During the growing seasons of 2010 and 2011, monthly sampling of irrigation water from about 20 vegetable farms located throughout the state of New York began. Water samples were analyzed for multiple pathogens including those that are known to be found in irrigation water and are a significant problem on vegetables. Hundreds of potential pathogen isolates have been cultured from irrigation water and are currently being identified. Along with plant pathogens, we are working with colleagues in food science to test for indicator organisms for the potential human pathogens *Escherichia coli* and *Salmonella enterica*. The presence and spread of human pathogens in irrigation water is a growing food safety concern.

An ultraviolet (UV) treatment system will also be evaluated as a potential means to treat water found to be infested with the pathogens. A commercial UV processing unit used for unfiltered cider that is capable of continually adjusting for dissolved and suspended solids will be used to carry out the treatment. There are high hopes for this UV system to treat irrigation water because of the similar qualities of unfiltered juices and irrigation water, qualities such as high turbidity, color and the presence of particulate matter. The system will be tested with multiple surface irrigation water sources and in the presence of multiple pathogens.

Vineyard Establishment

Peter D. Oldak, MD
Jewell Towne Vineyards, South Hampton, NH
jewelvin@rcn.com

Owning a vineyard and a winery is a dream of many, including doctors, lawyers, movie stars and athletes. For many the opportunity to withdraw from the complexities of corporate America and to return to the simpler life of farming and ownership of one's own business is irresistible. Owning a winery has become the poster child of retirement as presented by one investment company. In my case, it was as my wife describes it "a hobby run amuck".

Most individuals contemplating establishing a vineyard in New England already own the land. They may have bought the land some years back and are considering putting in a vineyard as a career change or a retirement project. The land may have been in the family for a generation or more as a farm, and in the interest in keeping the property in agriculture, consideration is given to converting it to a value added agriculture product such as wine. In any case the decision to install a vineyard is made after the land is owned. The question is; is the land appropriate for a vineyard, and if so, what varieties should be planted and how should it be established? If not, what can be done to mitigate the situation?

There are a number of issues which need to be addressed in establishing a vineyard in New England. These include the microclimate of the site, the aspect of the vineyard and the soil.

The climate of the location determines what varieties of grape can be grown. It is important to know the average winter low temperature, the usual dates of the last spring frost and the first fall frost and, if known, the number of degree days (base 50) for that location. The United States Department of Agriculture publishes a temperature map which delineates zones of average winter low temperature throughout the country. For instance, Zone 6 covers areas ranging from -10 to 0° F. Zone 5 covers -20 to -10 °F. Zone 4 covers -30 to -20 °F. As a very broad generalization, with many exceptions, Zone 6 will support some vinifera, and almost all French-American and Cornell hybrids. Zone 5 will support most French-American and Cornell hybrids as well as many American varieties. Zone 4 and below will support primarily the Minnesota hybrids.

Grapes need both good air and good water drainage. Locations with slopes, up to 8° incline, promote good drainage of air. Low spots or areas with blocked air movement create frost pockets which will adversely affect winter vine and bud survival as well as pose a risk for spring bud injury and early fall frost damage.

The nature of the land determines the appropriateness of the site for planting grapes. Land with big boulders and shallow ledge is not appropriate for a vineyard. Nor is land that is wet for a major portion of the summer. It is said "grapes do not ripen with wet feet". However, flat land with poor drainage or land with heavy clay near the surface may be farmable if the drainage problem is improved with tiling.

Grapes need full sun for as much of the day as possible. Sites which are surrounded by tall trees not only limit the sun exposure, but also are an invitation to hungry birds and other wild life to steal the crop.

The ideal soil for a vineyard is somewhat gravelly, with the potential for good water drainage. It should not be overly fertile since fertility can lead to excessive foliage growth with associated shading.

Establishing the Vineyard

The year prior to planting, a soil test should be obtained from your local agriculture extension. One of the most important values is the pH. The preferred pH for vinifera varieties is about 6.5, for French-American and Cornell hybrids is 6.0-6.5, and for American and Minnesota hybrids is around 5.5 to 6,0. If indicated, amendments for deficiencies of potassium, phosphorus, calcium and magnesium should be considered.

Grapes are a perennial crop. Established perennial weeds will be a real challenge to the newly planted vines. It is strongly recommended that in this pre-plant year, the prospective vineyard be plowed and harrowed, or rototilled. All stumps and large rocks should be removed. PH and nutrient amendments should be made at this time, and a crop such as winter rye be planted. This will suppress the perennial weeds, and when plowed in will provide a “green manure”. This should be done several times during the pre-plant season. Finally, vines for the following season should be ordered from a commercial nursery in the fall prior to planting.

The following spring, as soon as the land can be worked, the field for the vineyard should be rototilled for the last time. The vineyard can now be laid out. For safety reasons, rows are best laid out running directly up and down slopes. If a slope is gentle, rows can run across the slope. Rows which run North and South theoretically get 10 % more sun. Rows that run East and West have the advantage of the prevailing wind for drying. The lay of the land should determine the row alignment.

The distance between rows and vines is determined by the type of trellis, the training system, and the type of mechanical equipment to be used. Row spacing for vineyards in the East is usually a minimum of eight feet, and frequently nine or ten feet apart, especially if a divided curtain training system is used or if mechanical harvesting is anticipated. Vine spacing is determined by the variety of grape and the training system. In general, vinifera are trained to a cordon system and spaced at 4 to 7 foot intervals. Hybrids are frequently trained, either cane or cordon, to a vertical shoot positioning system (VSP) and spaced at 6 to 8 foot intervals. American varieties with a drooping habit are best trained to a Geneva Double Curtain system (GDC) and spaced at 6 to 8 foot intervals. A vineyard with 8X8 spacing will contain 680 vines per acre.

Vines ordered from a commercial nursery the previous fall will be sent to you as bare rooted vines in a dormant state, at about the proper time for planting. Vines are usually planted using a tree planter of a post-hole digger. If using a post-hole digger, the roots are spread at the bottom of the hole and then it is back-filled with soil. Care should be taken that the crown is 1-2” above the ground so that when the soil settles the vine crown will be flush with the soil surface. A stake should be inserted close to the vine on the North side and the newly planted vine should be cut back to 4 nodes. The vines are usually not fertilized the first year, but should be watered as needed. The trellis should be installed during the first year or at the latest, the beginning of the second year. Grow tubes are used by some growers to accelerate growth during the first year and to protect against herbicide injury. When used care should be taken to spray to prevent damage from Japanese beetles.

Mid rows are usually planted with a cover crop or a slow growing grass. The area under the trellis is usually kept clear with herbicides. It is especially important to control weeds during the first year for newly planted vines. Alternatively for those who prefer not to use herbicides, a weed badger or grape hoe may achieve the same goal.

Variety selection, trellis construction, pruning and training to a trellis system are subjects for another session.

Cultivar Selection for Cold Climates

John R. Thull, Vineyard Manager
University of Minnesota
Horticultural Research Center
Excelsior, MN 55331
jthull@umn.edu

Many grapevine cultivars can be grown successfully with winter protection practices in cold climates. Ripening those cultivars is sometimes another issue. When looking to grow vines, however, that will survive your local cold weather conditions and reliably ripen their fruit, your choices of varieties that fit the criteria become narrower. Fortunately for those of us who are adventurous enough (or just crazy enough) to push the limits of grape growing northward, there have been some great developments in “winter hardy” varieties in the last fifty years.

Winter hardiness is a relative term. It is not only determined by a cultivar’s particular genetics, but is also influenced by the environment in which the cultivar grows. The environment can be thought of as the soil type that the vine is growing in as well as the current weather conditions it is experiencing. Together the soil and weather will affect the vine’s growth over the course of the season. When it comes time to enter dormancy, all that the vine experienced throughout the season will weigh in on how well equipped it will be to handle the upcoming winter. Think of it as the vine having a memory. Another component to winter hardiness besides genetics and environment is cultural practices. The relative hardiness of the vine can largely be affected by pruning, training, shoot thinning, shoot positioning, crop adjustment, fertilizing, spraying, irrigation, and so on. These practices must be constantly adjusted as new information is acquired. For example, if the season is drier than average we would want to alleviate the stress on the vines by possibly dropping fruit and irrigating more. If the season is wetter, we know that there is more fungal pressure in the vineyard as well as more luscious shoot growth which means more time will be required for exposing fruit clusters and spraying. The one practice that seems to set the tone for the whole growing season is pruning. Developing a pruning strategy that fits well with your cultivar and site will go a long way toward helping your vines reach their maximum winter hardiness.

One tool that we can use to measure our vines’ hardiness is bud dissection. It is a useful practice that helps guide our pruning according to how well the buds survived along potential fruitful canes. In the case of mature vines, we prune off 85-90% of the last season’s growth, so we are able to sacrifice a few canes for bud dissection. The following table shows “Primary Bud Survival” data collected over the course of four years at the University of Minnesota’s Horticultural Research Center in Excelsior, Minnesota. It is meant to convey that “hardiness” is in fact “relative” from one year to the next and also provide some comparative options when determining which cultivar to plant. The “other varieties considered hardy” are just that with no bud dissection data available at this time. Remember that a cultivar’s commercial viability can change dramatically over time. Checking on local market demands will help with your cultivar selection process. Good Luck!

Primary Bud Survival of Dissected Buds of Grapevine Canes

	2011	2010	2009	2008
Baltica	100%	N/A	N/A	N/A
Castel	71%	44%	7%	56%
Edelweiss	75%	77%	69%	92%
Frontenac	94%	98%	84%	86%
Frontenac Gris	96%	100%	93%	81%
La Crescent	100%	96%	80%	94%
La Crosse	83%	79%	67%	6%
Leon Milllot	69%	83%	84%	58%
Lousie Swenson	73%	77%	91%	83%
Marechal Foch	90%	96%	98%	86%
Marquette	98%	98%	87%	78%
Prairie Star	83%	98%	78%	81%
Sabrevois	69%	83%	84%	58%
St. Croix	73%	83%	89%	86%
St. Pepin	90%	96%	78%	53%
Swenson Red	60%	81%	20%	N/A
Swenson White	88%	65%	60%	N/A
Valiant	92%	90%	89%	N/A
Vandal-Cliché	N/A	98%	N/A	N/A
	6 Canes 8 Buds	6 Canes 8 Buds	5 Canes 9 Buds	4 Canes 9 Buds
Total amt buds	48	48	45	36

Other Varieties Considered Hardy

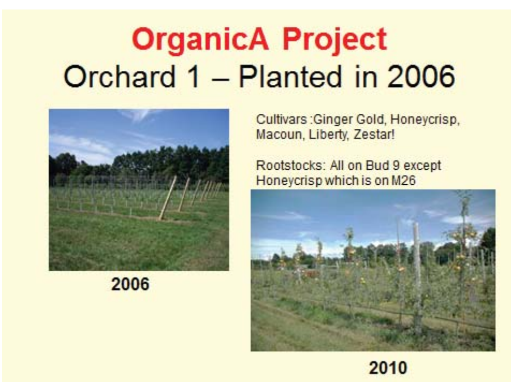
Briana	Petite Amie	Somerset Seedless
Concord	Petite Jewel	Zilga
Frontenac	Petite Pearl	
King of the North	Seyval	

Workshop on the Challenges and Opportunities of Organic Apple Production with Five Apple Cultivars: Six years of research results from the OrganicA Project

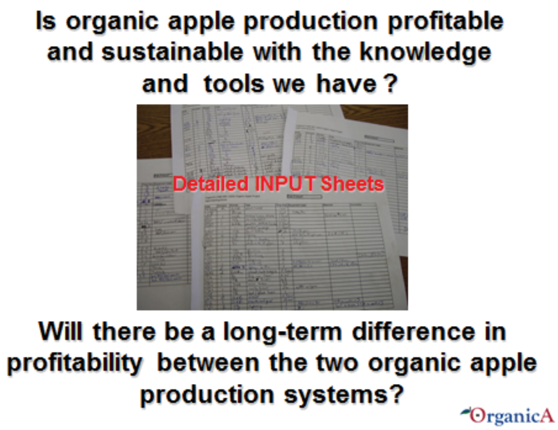
Berkett, L., Moran, R., Garcia, E., Darby, H., Parsons, R., Bradshaw, T.,
Kingsley-Richards, S. and M. Griffith
University of Vermont
University of Maine
University of Arkansas
Email: Lorraine.Berkett@uvm.edu

Introduction:

In 2006, after extensive grower input, we proposed to examine organic apple production systems that reflected consumer preferences for newer cultivars and organically grown food, and grower desires for sustainability and profitability. We initiated a transdisciplinary, multi-state research project to determine the opportunities and challenges of organic apple production within the two major production systems growers were using to change to new cultivars and with five of the top apple cultivars that growers identified as important to the future of the industry. The orchard systems are: (i) a new orchard planted with young trees purchased from a nursery and (ii) a "top-grafted" orchard, i.e., an established, older orchard onto which new cultivars are grafted. The cultivars being studied in replicated plots in each orchard system are: Zestar!, Ginger Gold, Honeycrisp, Macoun, and Liberty, a scab-resistant cultivar. Phase 1 (2006-2009) of the long-term project covered the orchard establishment period; a summary of progress during the first phase is on the OrganicA website at http://www.uvm.edu/organica/OrganicAProject/2009ProgressReport/progress.html . We are currently in Phase 2 – the early bearing years of the two orchard systems under investigation.



We are collecting an extensive amount of data in the two orchards to answer the following basic questions:



Workshop Presentations: Project personnel will discuss results and insights in the following presentations - (look for summaries of these presentations on the OrganicA Project website)

- *The OrganicA Project - Research Objectives and Project Overview*
  Dr. Lorraine Berkett, University of Vermont
- *Horticultural Challenges and Opportunities in Two Organic Apple Orchard Systems with Ginger Gold, Honeycrisp, Liberty, Macoun, and Zestar!*
  Dr. Elena Garcia, University of Arkansas
- *IPM Challenges and Opportunities in Two Organic Apple Orchard Systems containing Ginger Gold, Honeycrisp, Liberty, Macoun, and Zestar!*
  Terence Bradshaw, University of Vermont
- *Ground Cover Management Trials in an Organic Apple Orchard in Maine*
  Dr. Renae Moran, University of Maine
- *Further Discussion on Economics, Soil Health, and Viewpoints of Organic Apple Growers.*

Resources:
The OrganicA Project website: http://www.uvm.edu/organica/

Organic Orchard Observations.
http://www.uvm.edu/organica/ListservesBlogs/listservesblogs.html

OrganicA Project: Research Update, 2009 -2010.
http://www.uvm.edu/organica/OrganicA_Feb082011_VTFGApresentation.ppt

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Vermont Tree Fruit Growers' Association

Marketing Tips for Farm Business Success

James C. McConnon, Jr., Extension Specialist and Professor of Economics
University of Maine
101A Libby Hall, Orono, ME 04469
mcconnon@maine.edu

SEMINAR ABSTRACT

Customers are the most important part of any farm business and how you communicate with them will determine how many you have. Marketing is the pathway through which you communicate with your customers; through your products, packaging, pricing, branding, and promotional techniques. That's why marketing is such an important aspect of growing a profitable and sustainable small fruit or vegetable business.

The purpose of this seminar is to share with you some practical and proven tips that will strengthen your marketing efforts and improve your bottom line. Effective marketing tips that have helped farm operators improve their profitability will be presented and discussed.

Marketing Tips for Success

While there is no "cookbook formula" for success, here are ten proven tips that have helped farm businesses strengthen their marketing efforts and improve their bottom lines.

Tip #1: Research Your Market

The success of your farm business depends on your ability to effectively compete in a changing marketplace and profitably meet the changing wants and needs of your customers. Market research can be as simple as asking your customers a few questions or reading about the latest industry trends. The intent is to learn as much as you can about the market so you can grow and sustain your farm business.

Tip #2: Target Your Market

Your target market includes all of those customers you are trying to attract. It's important to remember that while everyone out there is a potential customer, there are some who have a greater need or ability to buy your products than others. So, focusing your limited resources on those customers with the greatest likelihood of buying your products is an important strategy for success.

Tip #3: Educate Your Customers

While it's important for you as the farm business operator to learn as much as you can about your customers, it's equally important for you to help your customers learn about you, your farm business and the products you produce and services you provide.

Tip #4: Price Your Products for Profit

Pricing is an art, not a science. You need to know your costs, your customers, and your competition, and you need to be flexible in the prices you charge. The key to pricing is to set the price high enough to cover your costs and ensure a profit, yet low enough to encourage people in your target market to buy your products.

Tip #5: Diversify Your Marketing Strategies

A common feature among successful farm businesses is that they use a number of different strategies to market their products. Many small producers both wholesale and retail their products. Some growers sell their products to restaurants and through their local farmer's market. It's important to recognize that for many small farm businesses, diversifying their marketing is a good method of managing risk and increasing profitability.

Tip #6: Market for Quality

Many farms in New England have a difficult time competing in the high-volume commodity markets. They have to focus on quality not quantity. One way for New England farmers to compete is to focus on offering the highest quality products possible. In most cases, high quality and profits go hand in hand.

Tip #7: Practice Excellent Customer Service

Customers **are** the most important part of any business. Research shows that 60% of customer defections are a result of poor customer service. Practicing good customer service will help satisfy existing customers and bring in new customers.

Tip #8: Communicate with Your Customers Through the Web

An increasing number of people are using social media to communicate with one another. If your customers are part of this growing group of consumers, you should consider using web-based and/or mobile technologies to reach and interact with them.

Tip #9: Create a Brand for Your Business and Products

Creating a brand name or local identity for your farm business and products may improve the demand for the products, the prices you receive, and farm profitability. Developing an image and logo are important first steps in establishing an effective brand for your farm business.

Tip #10: Develop a Marketing Plan

A marketing plan is a written document that communicates your farm's marketing goals and objectives and how you plan to achieve them. A marketing plan will help you prioritize your marketing efforts and help to ensure that you are communicating with your target market as efficiently and effectively as possible.

Making Your Market Fit Your Product and Your Product Fit Your Market

Keena Tracy, Little Ridge Farm
101 Gould Rd. Lisbon Falls, ME 04252
LittleRidge@gwi.net

Starting a new farm is challenging. One of the greatest challenges is narrowing down what type of products your farm will offer and how they will be marketed. Farmers can market their product through several avenues: farm stands, CSA, farmer's markets, wholesale, senior farm shares. And within each of those markets lie a myriad of ways one can present their product. And in recent years with one-stop shopping on everyone's mind and the new wave of growing food all year round, the temptation to "do it all" is hard not to fall prey to.

I run a 112 family (75 full share) summer CSA and a 40 family Holiday and Winter CSA. Yearly I raise 50 turkeys, 10 beef cows and 8-10 pigs. The shareholders have access to PYO strawberries and raspberries and a free PYO flower and herb garden. I sell select products wholesale in the fall/winter. I have 5 workshares who work 2 hours a week for 18 weeks during the summer and a husband who works full time off the farm but likes to drive the tractor on the weekends and grow the PYO flowers. This past year I decided to hire a person to work 6-12 hours a week. Other than that I run most of the farm's ins and outs on my own.

At the beginning I sat down and created a set of goals that expanded over 3 years; from prefarm through the first year as a full time farmer with customers. I made conscious decisions about how I wanted the farm to look and run and fully thought about what I thought I could handle, what the population would be interested in buying and what I would enjoy doing. I believe farmer health is as important as soil health.

- What products do you like to grow?
- Do you like to work with the public?
- Do you have parking for the public?
- Do you like packing vegetables or putting things into bunches?
- Do you want to or have the time to make deliveries?
- Do you want employees or apprentices?
- Would you mind going to a farmer's market every week for most of the year?
- Do you live close to your clientele?
- How much and what type of land do you have?
- What can make you the most amount of money with the least amount of work?

Every entity of the farm has its own budget: PYO fruits, the livestock, jams…. It has to make money* and it has to be fun.

*Money: My monetary goal for the farm is to be self sustaining (i.e., not to use "personal" money to make the farm run) and to make $30,000 profit yearly. I want to be able to run the farm and still keep my house/land if something happened to my husband's job—not necessarily *support* the entire household.

CSA:

Summer Share:
It is a free choice, market style approach. Members come once a week May/June-October, Tuesday or Friday from 3:00-7:00p.m. I set out all of the produce and folks choose what they want up to a given weekly amount. Yearly average: Half shares 6lbs/week and full shares 11lbs.

Holiday Shares:
Free choice, 30lbs of produce plus items such as homemade rolls and apples. One pick-up just before Thanksgiving and another just before the December holiday.

Winter Shares:
Free choice, 15lbs of storage crops and extras like a bag of hoophouse greens, dry beans or frozen berries. Pick-ups are once a month January-April

Meat:
All animals are sold in bulk in the fall. Priced per lb hanging weight.

PYO raspberries and strawberries:
Priced per lb. Everything on my farm is self-serve and bring-your-own container.

Wholesale:
4000lbs of Carrots and Winter radish. I chose these specifically so that my packaging is simple, the crop is not “delicate”, I can wash them in a root washer, and all of the harvest/deliveries are done in a couple of months rather than spread throughout the season.

Basically I’ve tried to create a business that would allow me to farm as much as possible, get to know my community and still have personal space with my husband. Consciously I did this. Again I create a set list of goals and stick to them.

Every single person is unique: interests, situation, soil, farm infrastructure and location.

What Beans Reveal about Ozone Impact on Plants in the Northeast

Margaret Tuttle McGrath

Department of Plant Pathology and Plant-Microbe Biology, Cornell University
Long Island Horticultural Research and Extension Center,
3059 Sound Avenue, Riverhead, NY 11901. 631-727-3595. mtm3@cornell.edu

Every summer on Long Island, NY, ozone reaches high enough concentrations to cause visible foliar injury in sensitive plants. While regulations have resulted in a reduction in vehicular emissions, which are an important source of precursors for the formation of ozone by the action of uv radiation, there has been an increase in the number of vehicles. Ozone is more toxic to plants than other common air pollutants. Plants generally are more sensitive to ozone than people. Injury includes stippling and bronzing, which can lead to leaf death. Leaves without acute injury may also die prematurely because ozone induces accelerated senescence of leaves that involves many of the genes involved in natural senescence.

Presumably injury and senescence induced by ambient ozone affects the productivity of plants; however, determining this impact is challenging. Assessing impact necessitates having plants not affected by ozone to compare with plants that are affected. The main method that has been used entails growing plants outdoors in specialized chambers with charcoal-filtered air next to plants grown in similar chambers with non-filtered air. A disadvantage of this system, aside from the cost, is the fact that the environment inside is different from that outside the chamber where the plants normally grow and this could have a confounding effect.

An alternative method for investigating ozone impact has been identified that entails comparing two lines or clones of a plant that differ in sensitivity to elevated ozone but have similar productivity when ozone levels are low. A system with snap bean was developed for assessing ozone impact. The two bean clones are grown outdoors in the ground. Both fresh market and mature yield are measured by removing pods from some plants every week as they reach size for fresh market consumption and removing pods once they have dried from the other plants. Since beans reach maturity in just 12 weeks, two to three successive planting times are needed to cover the entire summer growing period.

Ambient ozone on Long Island has been demonstrated to have an impact on plant productivity using the bean system at Cornell University's research facility in Riverhead. This work has been on going for several years. During growth periods when ozone levels measured at this location were low, which was sometimes in the spring and other years during fall, the ozone-sensitive and tolerant plants did not differ significantly in the number or weight of bean pods produced. This documents these pairs do produce similarly when ozone is low, providing validity to the system. Leaves of the sensitive bean have exhibited bronzing, which often has been sufficiently severe to result in the leaves drying up and dropping off the plant. Images of the injury are posted at http://www.longislandhort.cornell.edu/vegpath/photos/ozone_beans.htm. Impact of episodes of high ozone on productivity of bean has been extremely high. Weight of beans harvested immature for fresh market was reduced as much as 62%. There were up to 56% fewer bean seeds in mature pods. And the average weight of those seeds was up to 42% lower.

A simple relationship has not been found between ozone concentrations that plants were exposed to and the subsequent impact measured. This partly reflects the fact the dose of ozone that gets inside of plants depends on stomatal conductance and other aspects of flux. If plants are water stressed when ozone is high, stomates will be closed, and thus ozone dose will be lower than for well-watered plants. Sometimes an acute exposure (several days of very high ozone concentrations) can result in severe leaf injury that is more detrimental to plant productivity than moderate high ozone levels on all the other days during the growth period. For example, ozone exceeded 80 ppb on 6 of 7 days during 15 – 21 July 2007 with hourly average reaching 120 -128 ppb three times. Very severe ozone injury was observed on 25 July, which was 6 days before the first harvest of fresh market pods in the second planting that year. High ozone events in Riverhead have varied from year to year since 1996. The yearly highest 1-hour ozone concentration recorded has ranged from 104 ppb to 168 ppb. The date that this has occurred has varied from 7 June to 9 August. Ozone has been at least 80 ppb for as few as 40 hours on 8 days during a growing season and as many as 184 hours on 31 days. This research continues to further document the impact of ground level ozone on plant productivity and to elucidate the relationship between ozone exposure and impact.

Ozone injury has been observed in vegetable crops growing on Long Island, in particular pumpkin and potato. Premature senescence of leaves may also be occurring. Consequently these crops may also be sustaining yield reduction due to ozone. Images of injury are posted at http://www.longislandhort.cornell.edu/vegpath/photos/index.htm.

Ozone also reaches high levels in New England; consequently, plant productivity may also be affected there. For example, during 2006 – 2011, while the 1-hr highest ozone concentration in Riverhead ranged from 90 to 167 ppb, it was 96 to 129 ppb in New Haven, CT, 89 to 146 ppb in East Hartford, CT, 109 to 144 ppb in Danbury, CT, 86 to 106 ppb in East Providence, RI, 66 to 81 ppb in Boston, MA, 87 to 119 ppb in Adams, MA, 83 to 128 ppb in Truro, MA, 83 to 136 ppb in North Amherst, MA, 73 to 92 ppb in Manchester, NH, 71 to 84 ppb in Bennington, VT, 78 to 120 ppb in Portland, ME, 80 to 99 ppb in Kennebunkport, ME, 55 to 76 ppb in Presque Isle, ME. Concentrations above 40 ppb are considered potentially injurious to sensitive plants. Ozone concentrations can be high far from major urban areas due to air currents moving the ozone and additionally, ozone concentrations tend to decline more quickly in urban areas because vehicles and other sources of precursors for ozone formation are also sources of compounds involved in breaking down ozone. There is concern that ozone pollution could increase in the future as a result of deep natural gas well drilling using hydraulic fracturing (aka fracking) as a means of natural gas extraction.

Pea and Bean Crop Rotations with Buckwheat

Thomas Björkman
Department of Horticulture, Cornell University, Geneva NY 14456 tnb1@cornell.edu

Growers interested in maintaining soil health can benefit from a once-common practice: following early peas or beans with buckwheat.

We have worked out the parameters that maximize the value of buckwheat while minimizing the effort required at that busy time of year. Many pea and bean fields are left open after harvest until farm operations slow down a little. Planting buckwheat is an easy alternative with a payback in better-working soil and a smaller weed seedbank. Peas and beans have a narrow harvest window, so it is not unusual to harvest when the soil is wet enough to cause compaction. Buckwheat can also be helpful in rectifying that damage. A number of growers have made buckwheat planting a routine post-harvest operation, and are happy with the result.

The rule of thumb for planting after a previous crop is to allow two weeks for the incorporated residue to break down. The pea-to-buckwheat sequence seemed likely to allow less time since the residue is high in nitrogen, soil microbes are already active in mid-summer, and buckwheat does not require much nitrogen.

We found that the best results came when waiting about a week. Planting immediately reduced the stand too much, waiting 10 days allowed weeds to get started. Incorporating crop residue was essential, not just to speed decomposition and killing pathogens, but also to loosen the soil and kill weeds and thereby get buckwheat off to a good head start.

The buckwheat can be used in several ways. First, it can be used strictly as a cover crop to improve tilth and suppress weeds, then followed by a fall-planted crop. Second, it can be raised for commercial grain harvest and sold to processors. Finally, it can be raised for cover crop seed and sold locally.

A cover crop is killed just as it comes into full bloom, typically 35-40 days after planting. If compaction is a serious issue, it can be followed by cover-crop radishes in the fall.

Rotating buckwheat for grain after early legumes can make good sense for certain growers. Buckwheat can provide revenue. The price of buckwheat grain has risen substantially in recent years. In the Northeast, demand exceeds supply. Wholesale buckwheat grain will be the best fit for growers who have a large land base (rotating tens of acres), and access to drills and combines for small grains. Buckwheat does not require additional farm labor, or cash besides seed cost.

Buckwheat for cover crop seed makes sense for growers with a few acres who can meet the exacting standards of high-vigor weed-free seed and are able to direct market to their local grower community. Elizabeth Dyck (www.ogrin.org) has been developing marketing strategies that strengthen the organic economy, and can be used in New England as well. Vegetable and berry growers who find buckwheat cover crops useful will welcome a local supply as cost-effective.

Keys to success: Fast start. No Gaps. Kill on time.

Further information is at www.covercrop.net

Effective Use of Pea and Bean Transplants for Earlier and Greater Yields

Paul & Sandy Arnold; Pleasant Valley Farm, 118 South Valley Rd; Argyle, NY 12809
(518) 638-6501 arnold.pvf@gmail.com

We have a small, diversified, family farm which we have grown vegetables on with organic methods for 23 years in upstate New York, zone 4. We raise over 40 types of vegetables and fruits which we sell year-round at farmers' markets, and this diversity gives us our stable income. Every year, some crops fail or don't do well, and over the years, we have looked to find techniques to improve the production of many, including peas and beans.

As we managed our soils over the years and increased their organic matter percentage, the earthworm population increased as well, and we soon discovered that the pea seeds we direct planted in the early spring were being eaten by all these wonderful worms! We could only grow the peas on the newly acquired fields where there were not so many earthworms, but the rotations became challenging. We had been transplanting beans already, and discovered the system worked well for peas also. In determining if the extra time to transplant them was profitable, we had to analyze the crop.

Some of our management decisions to decide what to grow or systems to use for individual crops are made by a "hunch", but many are based on the records that we keep on our farm. Record keeping is very valuable for running a farm business. Maintaining very simple records works well in our farming system and it requires minimal time outlay. We keep field seeding records in a notebook and what is listed are: date of seeding or transplanting, variety, row footage, and spacing. From these few numbers, the square footage of each crop grown can be calculated. For example, many of our crops are planted in beds which have 4 rows planted 14" apart and are 100 feet long and have two feet between beds; each of these beds is therefore 550 square feet. We also use a simple spreadsheet in a notebook in the washing station that is filled in each harvest day showing the product, quantity packed for the market (bunches, heads, pounds, etc), and the quantity that returns from the market. From those few numbers, a total quantity sold of each product can be determined at the end of the year, and therefore its total approximate value.

These simple records help us utilize an important rule that we employ in our management. The rule is what we call the "$20,000 per acre rule." What that means is that each crop is expected to have a minimum gross value of $20,000 per acre **if extrapolated out**. This calculation is determined by using our records that show the square footage of each crop that is grown on and the actual dollar value that each crop produced for the entire year. The extrapolation is necessary because we do not grow an acre of most crops and we need to have a system to compare them evenly. Planting most crops intensively in rows 14 inch on center is important to utilizing small acreage to its fullest extent on our farm. If a particular crop is not making us $20,000 per acre, then we must once again make a management decision on that crop to raise its value. Some of the options to accomplish this are by: improving our production and harvesting techniques; changing the variety; packaging or displaying it differently; increasing the price; or extending its growing season. Another option is to discontinue growing the crop, which we rarely do because that would reduce our diversity.

To give an example of how this rule has worked for us, we will examine pea production. In an average year (or an average over several years), our records showed the following:

SUGAR SNAP PEAS:
Income = 538 pints @$3/pt =$1,614
Field space = 2,700 square feet
Since 1 acre = 43,560 square feet, the actual acreage planted is 2,700/43,560 = .062 acre
Then to extrapolate to show the value of the crop for one acre: $2,152/.062 acre = $34,710 per acre

Using these same formulas and our records, the values of the other peas were:
SHELL PEAS: $13,700 per acre (at $4.00 per quart)
SNOW PEAS: $64,100 per acre (at $4.00 per pint)

We could see that sugar snap and snow peas had a good value (when they had high germinations), so they were worth the effort to transplant to get the production back up. We seed 2 seeds per cells in a 200 cell seedling tray, making sure they are pushed down in well under the soil mix. We grow them in the greenhouse for about 2 weeks until they have just enough roots to hold together when pulled out. Leaving them too long in the trays can be a real problem as they grow fast and can get stressed. Over the past 4 years, we have experimented with Biotello, a cornstarch based plastic that can be rototilled in at the end of the season. Our farm has never used any regular plastic. Our system of transplanting into the Biotello and having chopped straw or hay (clean) between the rows of Biotello has given us great advantages, not only for weed control, but also enabling us to transplant out on a better schedule since the Biotello can be laid ahead of time when the weather permits. The pea plants are hand transplanted into the 4' wide Biotello in 2 rows with the plants spaced about 3" apart in-row, packing them in as close as possible. If the variety is a climbing type (Sugar Snap), the 2 rows are planted about 12 inches apart, then the Hortinova fencing can be put between them and the peas climb up from both sides. If they are bush types, we spread the 2 rows out to the 2 edges of the Biotello to increase air circulation and make harvesting easier.

We start the peas when we know we will be able to get on the field and lay the Biotello within 2 weeks (hopefully late March or the first week of April), then we will rowcover them after transplanting. We typically do 3 successive sowings of Sugar Ann snap pea and Oregon Giant snow pea, our favorite varieties, and one planting of Sugar Snap, which is trellised and produces longer. These seedings are spaced 7 to 10 days apart. We also do a few shell peas, but they are grown mostly for us to freeze and enjoy; their value is not as high per square foot so production is kept limited and the other varieties are maxed out to increase profitability.

Similarly, we start some of our beans in the greenhouse, then transplant them outside or into our high tunnels. The first beans are started in late April in 50 or 72 cell Winstrip trays, 2 seeds per cell, with Jade and Provider typically the varieties we use. After about 3 to 4 weeks, these first ones are transplanted into our high tunnel in rows 12" apart and plants 3 to 4" apart in row. By transplanting, the previous winter/spring crop can produce an extra 3 to 4 weeks while the plants grow in the greenhouse, thereby increasing productivity in the tunnel. This also gives us very uniform stands of beans and earlier production. Rowcovers are used on all the early spring crops, like beans and peas. If greenhouse space permits, successive sowings can we started for transplanting out to the fields, with our standard bed format of 4 rows 14" apart being used and the transplants being placed about 3 to 4" apart. The water-wheel transplanter is not used on the beans as 6" is the closest setting we have, and we do a limited number of beans every other week. Transplanting also has the advantage of getting a jump on the weeds; a few timed cultivations with the Lely tine-weeder does a great job and the crop comes and goes before weeds have a chance. An inoculum is used on all pea and bean seeds at planting time, mixing a few drops of water onto the seeds, then having them dipped in the inoculum.

Transplanting of the peas and beans has helped increase our yields consistently each year due to finally getting uniform, full sections of the plants. Their production is also earlier as seeding in the greenhouse doesn't have all the restrictions that direct seeding does waiting for the soil to be in good condition to plant, and the Biotello for the peas also gives some extra heat to the soil in April/May. Finally, it saves us lots of money by not having repeated re-seedings due to the earthworms and lack of germination due to cold, wet soils and rotting peas.

Herbicide Update and Weed Management in Peas and Beans

Dr. Bradley A. Majek
majek@AESOP.Rutgers.edu
Department of Plant Science
Rutgers Agricultural Research & Extension Center
121 Northville Road
Bridgeton, NJ 08302

A good weed control program considers the weed species that need to be controlled, crop safety, not only under optimum growing conditions but also when conditions are adverse, and herbicide carryover and options available for following crops. Since peas and snap beans mature quickly, and peas are planted very early, follow crop options are more important than in full season crops.

The herbicides recommended in the mid Atlantic states for controlling weeds in peas are Pursuit (imazethapyr), Dual Magnum 7.62EC (s-metolachlor), Command 3ME, Poast 1.5EC (sethoxydim), Select 2EC/SelectMax 0.97EC (clethodim), AssureII (quizalofop), and Basagran 4SC (bentazon),

The herbicides recommended in the mid Atlantic states for controlling weeds in snap beans are Treflan 4EC (trifluralin), Eptam 7EC (EPTC), Dual Magnum 7.62EC (s-metolachlor), Command 3ME, Dacthal 6F (DCPA), Poast 1.5EC (sethoxydim), Select 2EC/SelectMax 0.97EC (clethodim), Basagran 4SC (bentazon), Sandea 75DF (halosulfuron), and Reflex 2SC (fomesafen).

Treflan 4EC is recommended for use in snap beans, and is labeled but not recommended for peas due to the potential for crop injury, especially when conditions after planting are cold and wet. Treflan 4EC controls annual grasses and suppresses or controls a few broadleaf weeds, but use alone may result in annual grass control and broadleaf weed problems. The label requires applications to be made preplant incorporated. Research has indicated that incorporation can be accomplished with a finishing disk or field cultivator with sweeps, and that two passes at right angles to achieve the good results. A single slow pass with PTO driven tillage equipment provides the best mixing of the herbicide and soil. The plantback restriction for most unlabeled crops is 5 months, but longer for beets and spinach. Follow crop options are available due to the large number of vegetables on the label.

Eptam 7EC is only labeled and recommended for use in snap beans. Eptam 7EC controls annual grasses and suppresses or controls a certain broadleaf weeds, but use alone may result in escapes that result in broadleaf weed problems. Eptam is volatile, so the label requires applications to be preplant incorporated immediately after application. A delay in incorporation of 20 minutes can result in the loss of a significant amount of herbicide by evaporation and reduced weed control. Incorporate using the same methods as Treflan. Eptam does not have plantback restrictions after snap bean harvest.

Pursuit is only recommended for use in peas. Pursuit controls many annual broadleaf weeds and certain annual grasses, but use is limited by the long 48 month plantback restriction for most vegetable crops. Pursuit is not labeled for peas in New England.

Dual Magnum 7.62EC is recommended for use in peas and snap beans. Dual Magnum 7.62EC controls annual grasses and suppresses or controls a certain broadleaf weeds, including nightshade, but use alone may result in annual grass control and broadleaf weed problems. Common lambsquarter is a frequent problem in fields treated with Dual Magnum. The label allows applications to be made preplant incorporated or preemergence. Preplant incorporation improves control of yellow nutsedge. Preemergence applications are more effective for the control of small seeded annual broadleaf weeds such as nightshade species when rainfall or irrigation can activate the herbicide before weed emergence. Follow crop options are available due to the large number of vegetables on the label.

Command 3ME is recommended for use in peas and snap beans, but snap beans are less tolerant to Command than some other labeled crops. Recommended rate for peas is 0.188 to 0.38 pounds of active ingredient per acre and for snap beans between 0.125 and 0.25 pounds of active ingredient per acre. Some early injury may be observed as a whitening of the edges of some of the leaves after emergence. Excellent control of annual grasses and many broadleaf weeds can be obtained with Command, but pigweed and carpetweed frequently escape and can cause serious problems. Preemergence applications cause less crop injury, and provide better weed control, but vapor drift of Command 3ME, although less than the old 4EC formulation, can still affect vegetation in adjacent fields. An alternative application technique is a preemergence application that is incorporated immediately after application about one quarter of an inch deep between the rows with rolling basket cultivators, a rotary hoe or with irrigation. Follow crop options are available due to the number of vegetables on the label.

Dacthal 6F is only labeled and recommended for use in snap beans. Dacthal 6F applied preemergence controls annual grasses and suppresses or controls certain broadleaf weeds, including common lambsquarter and common purslane, but use alone may result in annual grass control and other broadleaf weed problems. Nightshade and galinsoga are frequent problems in fields treated with only Dacthal. Preemergence applications are more effective when rainfall or irrigation can activate the herbicide before weed emergence. Follow crop options are available due to the large number of vegetables on the label.

Poast 1.5EC, Select/SelectMax, and Assure II/Targa 0.88EC are labeled and recommended for use in peas and snap beans to control annual and perennial grasses postemergence. Add oil concentrate to Poast, Select, or AssureII/Targa to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or nonionic surfactant to SelectMax to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with other pesticides unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. . Follow crop options are available due to the large number of vegetables on the label.

Basagran 4SC is recommended for use in peas and snap beans. Peas should be treated after they have more than 3 pairs of true leaves, but before bloom. Snap Beans should be treated when the beans have 1 to 3 fully expanded first trifoliate leaves. Earlier application will result in an increased risk of crop injury. Later application may split the pod set. Use lower rate to control common cocklebur, mustards, and jimsonweed and the higher rate to control yellow nutsedge, common ragweed, and Canada thistle. Common lambsquarter and smooth pigweed control may not be acceptable. Temporary, pronounced crop injury may be observed that can result in delayed maturity. The use of oil concentrate may increase the risk and severity of crop injury. To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when weeds are small and soil moisture is adequate. Do not spray when temperatures are over 90^{o}F (32.2^{o}C). Basagran does not have plantback restrictions after harvest.

Sandea 75WDG is recommended for use in snap beans to control broadleaf weeds and yellow nutsedge. Sandea may be applied preemergence or postemergence, depending on the target weeds, to suppress or control many broadleaf weeds and yellow nutsedge.

Apply preemergence after seeding to control the largest number of annual broadleaf weed species. Irrigate to activate the herbicide if rainfall is not imminent after application. Weed control failures may occur if activating moisture is not provided. Sandea will not control grasses, and may not control or only suppress common lambsquarter and certain other broadleaf weeds, especially if moisture for herbicide activation is delayed. Tank-mix with another herbicide to control annual grasses and broadleaf weeds known to be present in the field and are not controlled by Sandea.

Apply postemergence to control certain broadleaf weeds, including smooth pigweed and galinsoga, and to control yellow nutsedge. Add nonionic surfactant to be 0.25% of the spray solution. Do not use oil concentrate. The number of broadleaf weeds controlled by Sandea applied postemergence is less than the number controlled by preemergence applications, but yellow nutsedge control is more consistent when treated postemergence. Apply Sandea when the crop has 2 to 3 trifoliate leaves. Target broadleaf weeds should be less than 2 inches in height. Delay the application when yellow nutsedge is the target, to allow the perennial sedge time to emerge and develop a leaf canopy to intercept the spray, but treat before the crop has more than 3 trifoliate leaves.

Extensive testing at Rutgers and other mid Atlantic universities has established that the margin of crop safety for Sandea is good when it is used to control weeds in snap beans. Some temporary crop injury has been observed when postemergence treatments are applied to a rapidly growing crop and “soft” growing conditions prevail. The injury appears about 5 to 7 days after treatment, and is seen as a light green or yellow color in the new growth. The color of the shoot tips recovers quickly and appears normal within a week with no affect on yield. Applications after the crop has more than 2 to 3 trifoliate leaves should be avoided due to the increased possibility of splitting the pod set. Follow crop options are available due to the number of vegetables on the label.

Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Observe a thirty (30) day preharvest interval (PHI). Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Reflex 2SC is recommended in the mid Atlantic states for use postemergence in snap beans. Apply Reflex 2SC when snap beans have one to two fully expanded trifoliate leaves to control many annual broadleaf weeds. The recommended rate is lower than the labeled rate to reduce the risk of crop injury. Use the lower recommended rate when weeds are small or when plentiful soil moisture, high humidity, and warm cloudy weather cause “soft” growing conditions. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray). Tank-mix with bentazon (Basagran) to improve the control of common lambsquarter. Observe labeled plantback restrictions. Do NOT apply to any field more than once every two years. Use of Reflex is limited by the long plantback restriction for most vegetable crops.

The most commonly recommended herbicide program for weed control in peas is Command or Dual Magnum. preemergence, or a tank-mix of Command and Dual Magnum. Basagran is most often recommended postemergence. The choice between Command and Dual Magnum is made based on weeds anticipated in the field and the following crop to be planted after pea harvest.

The most commonly recommended program for weed control in snap beans is Dual Magnum preemergence followed by Reflex postemergence for large growers that rotate snap beans with field crops. Small direct market growers often cannot adjust to the long follow crop restrictions on the Reflex label. These growers use Dual magnum plus Dacthal preemergence and Basagran postemergence if it is needed. Sandea is also used by both groups, most commonly for yellow nutedge control.

Aronia: A New/Old Berry Crop for the Northeast

Dr. Eldon Everhart,
Everhart Horticulture Consulting, 1208 Chestnut Street, Atlantic, IA 50022-2236, 712-254-4035,
eldoneverhart@gmail.com www.hortconsulting.com

Aronia melanocarpa is a woody, perennial shrub that is native to northeastern United States and southeastern Canada. It grows in full sun and along woodland edges. Aronia is cold hardy to at least USDA Zone 3. Its late blooms usually avoid spring frosts. The plants grow best in well-drained soils with a slightly acid to neutral pH.

Early in the 20th century, aronia was introduced to Eastern Europe, Scandinavia, and Russia where high quality, large fruited cultivars were selected. In recent years, these improved cultivars have been reintroduced to the Unites States.

A common name for *Aronia melanocarpa* is chokeberry. It is often confused with chokecherry, which is the common name for *Prunus virginiana*. About the only thing that chokeberry and chokecherry have in common are their sound-alike common names. To avoid confusion, aronia rather than chokeberry is the common name most often used for *Aronia melanocarpa*.

Without pruning to restrict their size, aronia plants of cultivars selected for fruit production grow eight feet or taller with 40 or more basal shoots at maturity. Pruning is used to renew the plants and manage their height by heading back to a height of three feet or to ground level at three to five year intervals or by yearly or every other year selective pruning of the tallest shoots.

Minimal or no major disease or insect pests have been reported on aronia plantings in the United States. “My plants have never suffered from any disease and I’ve never seen any pest on the foliage or fruit,” said Jan Riggenbach, syndicated columnist who has grown aronia plants in her trial garden in southwest Iowa for more than 30 years (Riggenbach 2008). Japanese beetles also leave her aronia plants alone (Riggenbach, personal communication, September 5, 2008). In contrast, Japanese beetles have caused minor damage in commercial aronia plantings in Illinois (Teresa Santiago, personal communication, August 11, 2009). Deer can be a problem. Birds usually do not eat the newly ripened fruit but, if not harvested, the fruit will be eaten by birds during the winter (Hardin 1973).

Two years after planting, aronia plants produce about two to ten pounds of berries per bush. By the third year, production is about 15 to 20 pounds per bush. Yields levels off at 30 to 40 pounds per plant by the fourth or fifth year (Eldon Everhart personal observations 2006-2011). The violet-black berries are firm, one-quarter inch in diameter, and produced in pendulous, loose clusters of 10 to 15 berries at the ends of shoots. Fruit is harvested in late August or early September by hand or with mechanical harvesters (Trinklein 2007).

Aronia berries are high in tannins which puckers you mouth with a dry sensation. They are also high in sugar (21 to 22 brix) with a pH of 4.5 to 5. They can be eaten fresh or preserved by freezing or drying. Fresh or frozen berries can be used in baked goods or used like any other berry. Many products are made from the berries including aronia wine, juice, tea, syrup, and candy, or they can be used to flavor and color yogurt, sorbet, ice cream, milk, and other products.

Aronia berries are high in vitamins, minerals, and folic acids. They are one of the richest plant sources of proanthocyanins and anthocyanins (Oszmiański and Wojdylo 2005). Aronia berries have higher antioxidant content than blackberries, blueberries, cranberries, elderberries, grapes, and raspberries, as well as imports such as the goji and acai. Medical research has documented many health benefits of aronia berries. Currently, there is no data in the literature about any unwanted effects of aronia fruits, juice, or extracts (Kulling and Rawel 2008 and 2006).

"Aronia berries top the list of… foods that have been scientifically tested for antioxidant capacity," said Dr. Xianli Wu, a researcher at the Arkansas Children's Nutrition Center. "Researchers have looked at how aronia affects cardiovascular disease, colon and breast cancers, liver failure, and obesity," said Dr. Wu. "I believe aronia berries have a huge potential as a healthy food." (Sagario 2008) The interest in "eating healthy" has led to the phenomenal worldwide growth in the popularity of aronia berries and products made from them. This in turn is leading to the planting of aronia as a cash crop in the United States (Trinklein 2007).

Aronia is not a new crop. Commercial aronia plantings started in the Soviet Union in the late 1940s, and reached 43,984 acres in 1984 (Kask 1987). It has been grown in Eastern European since the 1950s. According to the Polish Ministry of Agriculture, in 2004 there were 11,119 acres in Poland. A year later the number had grown to 12,355 acres. One Polish company alone sold 40,000 tons of aronia juice (Kampuse and Kampuss 2006). In Europe, new business start-ups, that use aronia berries as an ingredient, have increased from two launches in 1997 to 108 in 2007 (McNally 2008). There is an estimated 200 to 300 acres of aronia berries in the US in 2011 (Eldon Everhart client contact records). "Public interest in eating healthy, antioxidants, and organic products is driving the interest in aronia…." said Charlie Caldwell, an aronia grower in Iowa. He sees the market increasing, as more people learn about the fruit (Sagario 2008).

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Aronia Berry Production: A Promising Crop for Northeast Growers

Dr. Mark Brand, University of Connecticut (mark.brand@uconn.edu)
Dr. Lois Berg Stack, University of Maine Cooperative Extension (lois.stack@maine.edu)

Black chokeberry (*Aronia melanocarpa*), a native Northeast shrub, shows promise as a nutraceutical crop for small fruit producers. The market for functional foods is on the rise. *Aronia* is the focus of our research and outreach project, "Aronia Berries: a Profitable Nutraceutical Crop for the Northeast," supported by a grant from Northeast SARE. This project encourages development of a Northeast aronia industry through these three efforts:

1. WEBSITE: http://umaine.edu/agriculture/home/aronia/
Our website provides a place where we can communicate with growers, share research results, and announce field days and other events about aronia. Log on and click on the link to complete our online form; we'll send you project updates, and information about our 2012 field days in Connecticut and Maine. And, we'll consult one-on-one if you're interested in growing aronia.

2. GROWER COLLABORATORS:
In late summer 2010, one-acre plots of aronia were installed at two locations:
Maple Lane Farms, Preston, CT, where Allyn Brown grows 100 acres of black currants; and Western Maine Nurseries, Fryeburg, ME, where Rick Eastman grows tree seedlings and liners. These plantings provide places where cultural procedures are being verified for New England conditions, and where potential growers can attend field days and become familiar with the crop.

3. RESEARCH:
Dr. Mark Brand is researching aronia to more clearly characterize its genetics, and identify which aronias are best for Northeast production. His results to date include the following:

- A replicated evaluation planting of over 150 accessions of black, red and purple aronia has been established. Accessions have been collected from AL, CT, CE, FL, IN, MA, MD, ME, MI, NY, NC, NH, OH, PA, TN, TX, VA, VT, WI, WV and Canada.
- Many of the accessions have been shared with the National Plant Germplasm System of USDA, since *Aronia* is one of their priority genera.
- All red chokeberries appear to be tetraploids. Purple chokeberries are mostly tetraploid, and are rarely triploids. Black chokeberries in New England are diploid or tetraploid, while those from the Midwest and Appalachian Mountains are only tetraploid.
- Aronia plant habit can be highly variable with plants ranging from ground covers to tall and leggy shrubs up to 20' in height.
- Wild chokeberries vary considerably in fruit size, color, ripening date and flavor.
- Biochemical analysis has found considerable variation in antioxidant and phenolic composition of wild black chokeberry.
- Exactly what differentiates the red, purple and black species remains unclear and must be confirmed with genetic analysis that is underway now.
- Polyploid aronias all appear to reproduce from unfertilized (apomictic) seeds.
- Genetic testing of the popular aronia cultivars 'Viking' and 'Nero' indicates that they are probably hybrids between *Aronia melanocarpa* and *Sorbus aucuparia* (Mountain Ash).

Elderberry Production in Missouri

Patrick Byers, Regional Horticulture Specialist,
University of Missouri Extension-Greene County
2400 S. Scenic, Springfield, MO 65708; 417-881-8909
Byerspl@missouri.edu

Cultivars

Several elderberry cultivars are available commercially, including Adams 1, Adams 2, York, Nova, Scotia, Kent, and Johns. Of these, in our trials Adams 2 has consistently outperformed all others. Recommendations from other regions include all these cultivars. A large portion of the commercial fruit crop, especially in the Midwest, is harvested from wild plants. Two selections from the Midwest, Wyldewood and Bob Gordon, were released in 2010-11 and are available from several sources.

Propagation

Elderberries are easy to propagate. Root cuttings (pencil diameter or slightly smaller, 4-6 inches long) may be dug in early March before growth begins. The cuttings are placed horizontally in a flat or pot, covered with .75 to 1 inch of a light soil or soilless medium, and kept warm and moist. Often a single root cutting will produce 2-3 plants. Dormant hardwood cuttings root easily. Collect 3-4 node cuttings before growth begins in the spring, and place the basal 2 nodes below the surface of a well drained soil or medium. Be sure that the cutting wood is not cold damaged. A dip of the basal end of the cutting in an IBA rooting powder may increase rooting. Sprouted hardwood cuttings and softwood cuttings are also easily rooted, provided provision is made to maintain high humidity around the cuttings until rooted. An intermittent mist system works well. A rooting hormone dip may be beneficial. Cuttings of 2-3 nodes root well. Remove a portion of the foliage from softwood cuttings (we usually leave only the 2 basal leaflets of each leaf). Softwood cuttings typically root well until about July 1; rooting percentage drops as the summer progresses.

Establishment

Elderberries tolerate a range of soils, but do best in a moist, well drained soil. Choose a site that is in full sun. Bare root 1 year plants dug from a nursery work well for planting establishment. Recently propagated container-grown plants may be used to establish plantings during the same season. Plantings may be established from dormant cuttings stuck directly in place in the orchard, but rooting percentage may vary. Berming may benefit plant performance. Plants are spaced 4 feet apart in the planting row, with 10-12 feet between rows.

Pruning

American elderberries produce fruit on shoots older than one year, and also produce suckers from the crown or root system which will bear fruit the first year. Plants may be pruned selectively, leaving a mix of young and older shoots. However, with many cultivars we have learned that the average size of panicles when shoots are renewed annually is significantly larger, suggesting that current season suckers produce larger though fewer panicles. Most of the panicles on these plants were harvested in two harvests, over a period of two weeks.

Fertilization and irrigation

We apply nitrogen annually to the elderberry plantings. Mature plantings receive 60-80 pounds of nitrogen, applied at budbreak in late March – early April. We apply other nutrients every second year if needed based on a soil test (using blackberry recommendations), using a complete fertilizer as the nitrogen source. Elderberries are not drought tolerant, and we irrigate the plantings during dry periods. We use trickle irrigation. The plantings are also mulched, to help conserve soil moisture.

Elderberry pests

While elderberries are relatively pest resistant, we have noted several potential problems in our plantings. An unidentified stem borer causes wilting and dieback of new shoots in April and May. Japanese beetle adults feed on foliage. The adult elder borer, also known as the elderberry longhorned beetle, has been collected from plantings in Missouri. The larva of this beetle bores into the woody parts of the plant. Stink bugs are routinely noted on ripe panicles, but the amount of damage is unknown. A potentially damaging pest is the eriophyid mite, present across Missouri. This mite causes a cupping and crinkling of the foliage, and can cause abortion of florets and young fruit. The economic impact can be severe. Fall webworms were also noted in the Mount Vernon planting. An unidentified leaf spot disease, which usually is noted in midsummer, can cause premature leaf drop and occasionally defoliation. Birds of several species will feed on elderberry fruit; those selections with pendulous panicles appear to be less attractive to birds.

Elderberry harvest, yields, and juice parameters

Elderberry harvest takes place in late July, August, and early September. Entire panicles are clipped and harvested when all berries are fully colored. The panicles on current season's shoots ripen later than panicles on older wood. A bush with shoots of mixed age will ripen fruit over a 3 week period. We harvest plants at weekly intervals. Berries may be removed from the panicle by freezing the entire panicle and shaking off the fruit. The berries may be refrozen and processed as needed. Several studies suggest that average yields are around 1200 lb/acre in the first year and 8500 lb/acre in the second and succeeding years. We do not know how long a planting will remain productive; our oldest plantings have produced into year 7.

Uses and markets for elderberry fruit and flowers

At present, most of the elderberries grown in the Midwest are harvested for processing markets. Several wineries produce elderberry wines from the fruit, and the flower panicles are used to flavor wines or drinks. Dried blossoms are used in teas. Jelly and jam are produced from elderberry juice or blends of elderberry and other fruits. Elderberries contain high levels of antioxidants, and elderberry juice and concentrate are marketed as nutraceuticals. The pigments in elderberry juice are suitable for colorant use. Fresh or dried fruit are used in baking and energy bars.

Additional information on elderberry, including yields, juice qualities, and results of research projects, is available from the author.

Hops Production in New England

Dr. Heather Darby, UVM Extension Agronomist
278 S. Main St, St. Albans, VT 05478
(802) 524-6501 ext 437 heather.darby@uvm.edu

Hops were a major crop in the Northeast in the early 1800s, before disease pressure and the appeal of the Pacific Northwestern climate drew the hops industry to the other side of the county. Currently, New England is home to over 175 high quality microbreweries. Public interest in sourcing local foods is also extending into beverages, and the current demand for local and organic brewing ingredients is quickly increasing. Sourcing local beer making ingredients is difficult and there are only a handful of examples to draw from in the area. The breweries in New England want locally grown hops to create niche brews for local markets. This demand has created a niche market potential for many farmers. Brewers and cicerones (the beer equivalent of wine's *sommeliers*) state that like grapes, hops are influenced by climate and *terroir*, with different regions producing different characteristics of the same variety based on soil type and micro, meso, and macro climatic factors. With this in mind, the potential of a specialty Northeastern, completely local brew is very exciting, especially under consideration of the exploding *localvore* movement. In 2009, UVM Extension was awarded a USDA Organic Agriculture Research and Extension Initiative grant in partnership with Washington State University, Colorado State University, and Michigan State University. The goal of this grant is to develop agronomic recommendations for organic hops production for the Northeast. Much has changed since hops were last grown in this area in the 1800s, with many new disease resistant varieties available and a better understanding of pest lifecycles. With this in mind, in August of 2010, UVM Extension planted a hops variety trial at Borderview Farm in Alburgh, VT. The UVM Extension hopyard is evaluating 19 widely available hop varieties. One goal of this project is to determine hop varieties that demonstrate disease and pest resistance in combination with high yields, and also present desirable characteristics to brewers. Another goal of the project is to develop outreach materials that will assist new growers with successfully growing hops. These materials include information on how to construct and maintain a hopyard, how to properly fertilize, and how to identify and manage pests of hops. All materials can be found at www.uvm.edu/extension/cropsoil/hops/. The results presented below are from the first year of production.

Item	Amount	Cost
5/16 cable	6750 ft	$ 1,850
Poles	65	$ 2,098
Turnbuckle, 3/4" x 12"	37	$ 589
4' ground anchors	40	$ 560
Haven Grips cable pullers	2	$ 166
Cable cutter	1	$ 66
Cable clamps	300	$ 197
Stone (to secure posts)	10 yards	$ 460
Total material costs		$ 5,985
Hydraulic post hole digger rental		$ 339
Labor	65 man hours	
Tractor and lift	32 hours	
Tractor and loader to set poles	13 hours	
Tractor and auger to set anchors	3 hours	

MATERIALS AND METHODS

The replicated research plots were located at Borderview Farm in Alburgh, VT on a Benson rocky silt loam. The hopyard was constructed in the spring of 2010, with a finished height of 16 feet using 20’ x 6” larch, tamarack and cedar posts. Aircraft cable (5/16”) was used for trellis wires. A complete list of materials and videos on the construction of the UVM Extension hopyard can be found at www.uvm.edu/extension/cropsoil/hops. The materials and cost for the ¾ acre hopyard are listed in the table.

The prior crop was an alfalfa/grass crop. The hop beds were prepared by first moldboard plowing only the area where the hops were to be planted. The area was then rototilled to further break up the soil to prepare for planting. This left a strip of grass/alfalfa between the rows of hops. The tillage was implemented prior to construction of the hopyard. Once the hopyard was constructed there were two vegetative hop cuttings planted per hill on August 4th, 2010. The experimental design was a randomized complete block with three replicates; treatments were varieties. Hills of hops were planted 7 feet apart, and rows were spaced at 10 feet. Each plot consisted of five consecutive hills. From planting to harvest, plants were watered with drip irrigation as needed. In-row rototilling and hand weeding was used to control weeds, and as the weeds were brought under control, rows were trained with two strings of coir (coconut fibre) per hill, fertilized, and mulched with hardwood mulch. Pro-Gro® 5-3-4 and Probooster® 10-0-0 (North Country Organics) were applied to give 50 lbs plant available N, 40 lbs P, and 80 lbs K per acre. Boron was also applied at a rate of 10 lbs/acre. As the previous crop had been plowed-down legume/alfalfa we calculated 25 lbs of additional N credit. On June 6 and 7, Chilean nitrate was sidedressed at the rate of 50 lbs N.

On June 13, 2011, downy mildew (*Pseudoperonospora humuli*) was identified, and Regalia (Marrone Bio Innovations, EPA Reg. No. 84059-3), an extract of *Reynoutria sachalinensis*, was sprayed three days later using a Fimco 45 gallon trailer sprayer equipped with a hand gun and pulled by a John Deere 20 hp riding lawn mower. Regalia® is labeled for use on hops against both powdery mildew (*Podosphaera macularis*) and downy mildew, and is a plant extract that is used to help bolster a plant’s natural defense mechanisms. It was applied as per label specifications. Starting on June 29, 2011, three leaves per hill and two hills per plot were scouted weekly for presence of insect pests, diseases, and beneficial insects. Potato leafhoppers (*Empoasca fabae*) and two-spotted spider mites (*Tetranychus urticae Koch*) were identified in the hopyard and determined to be above economic threshold. Economic thresholds for potato leafhoppers in hops has not been documented, but with an in-depth literature review, it was determined that two leafhoppers per leaf was economically damaging to organically grown hops. Economic thresholds for two-spotted spider mites has been determined in the Pacific Northwest to be 1-2 spider mites per leaf in June, or 5-10 per leaf in July. Regalia was again sprayed as a preventative measure against downy mildew, and was tank-mixed with Pyganic (McLaughlin Gormley King Company, EPA Reg. No. 1021-1771) and Aza-Direct (Gowan, EPA Reg. No. 71908-1-10163). All are OMRI-approved for use in organic systems, and were applied at rates specified by their labels. Hop harvest was targeted for when cones were between 20 and 25% dry matter. Hop bines were cut in the field and brought to the barn to be handpicked on a table. Harvest date by variety can be found in Table 1. Hop cones from each plot were sent to Alpha Analytics in Yakima, WA where they were analyzed for alpha and beta acids. Yields are presented at harvest moisture and at 8% moisture on a per hill and per acre basis. Per acre calculations were performed using the spacing in the UVM Extension hopyard of 70 ft^2 per hill, 622 hills/acre. In all tables, the top performing variety can be found in bold. Varieties that were not significantly lower in performance than the highest variety in a particular column are indicated with an asterisk.

RESULTS

Harvest was targeted for when hop cones were between 20 and 25% dry matter (Table 1). Cluster outperformed all other varieties, averaging 3.58 lbs/hill at harvest moisture, and 0.74 lbs/hill at 8% moisture, or 2,228 lbs/acre at harvest and 459 lbs/acre at 8% moisture (Table 2). Liberty was the worst performing variety, although statistically not different from Centennial, Crystal, Fuggle, Glacier, Liberty, Mt. Hood, Perle, Saaz, Santiam, Sterling, Tettnang, and Vanguard (Table 2).

Table 1. Dry matter by harvest date and variety.

Variety	Date harvested	Dry matter %
Cascade	24-Aug-11	22.0
Cascade	26-Aug-11	22.6
Centennial	2-Sep-11	23.7
Chinook	2-Sep-11	23.3
Chinook	6-Sep-11	23.5
Cluster	11-Aug-11	19.1
Cluster	12-Aug-11	18.9
Crystal	12-Sep-11	21.2
Crystal	14-Sep-11	21.4
Fuggle	24-Aug-11	23.6
Fuggle	6-Sep-11	22.0
Galena	31-Aug-11	24.0
Glacier	6-Sep-11	22.1
Glacier	8-Sep-11	23.1
Glacier	14-Sep-11	25.8
Liberty	2-Sep-11	*
Mt. Hood	2-Sep-11	21.4
Newport	14-Sep-11	25.1
Nugget	6-Sep-11	22.7
Perle	2-Sep-11	25.3
Saaz	24-Aug-11	23.7
Santiam	6-Sep-11	19.2
Santiam	14-Sep-11	22.5
Sterling	13-Sep-11	21.4
Sterling	14-Sep-11	23.6
Tettnang	31-Aug-11	24.3
Tettnang	2-Sep-11	23.2
Vanguard	31-Aug-11	26.5
Vanguard	2-Sep-11	21.9
Willamette	31-Aug-11	25.6

*indicates not enough sample available.

Table 2. Yields at harvest moisture and at 8% moisture by variety.

Variety	Yield at harvest moisture		Yield at 8 % moisture	
	lbs/hill	lbs/ac	lbs/hill	lbs/ac
Cascade	1.71	1060	0.41	254
Centennial	0.44	273	0.11	70.0
Chinook	1.20	747	0.30	189
Cluster	**3.58***	**2230***	**0.74***	**459***
Crystal	0.37	232	0.09	53.8
Fuggle	0.13	77.8	0.03	19.3
Galena	1.87	1170	0.49	303
Glacier	0.87	539	0.22	138
Liberty	0.02	12.3	0.00	0.0
Mt. Hood	0.53	329	0.12	76.7
Newport	1.54	959	0.41	257
Nugget	1.40	870	0.35	217
Perle	0.07	43.2	0.02	12.0
Saaz	0.05	28.4	0.01	7.3
Santiam	0.31	193	0.06	40.4
Sterling	0.05	31.9	0.01	7.9
Tettnang	0.08	48.9	0.02	12.6
Vanguard	0.37	227	0.09	58.8
Willamette	1.60	993	0.41	256
Mean	0.84	526	0.20	127

Brewing values for select varieties are presented in Table 5. Some varieties did not yield enough sample to be tested for brewing values. Alpha acid percentages for Cluster, Cascade, Galena, and Vanguard fell within industry averages. Nugget and Willamette exceeded industry alpha acid averages (Figure 1). Beta acid levels for Centennial, Cluster, Crystal, Mt. Hood, Newport, Nugget, and Santiam all fell within the industry averages. Cascade, Chinook, Fuggle, and Willamette all had beta acid levels higher than industry averages (Figure 2).

DISCUSSION

The UVM Extension hopyard was planted in August of 2010, putting the yard a stage of maturity between one and two year old plants. According to Jason Perrault, a fourth generation hop grower who presented at the UVM Extension 2010 Winter Hops Conference, first-year yields are generally assumed to be approximately 50% of a mature yard's yields, although some varieties perform better in the first and second year. Some varieties, such as Cluster and Galena, yielded well for first year-plants. Other varieties, namely Santiam, Fuggle, Tettnang, Perle, Sterling, Saaz, and Liberty, did not thrive nor yield well. Hops, like grapes, have *terroir*: their brewing characteristics and oil content are reflective of their microclimate. Hops grown on the East Coast, even though genetically the exact same, will not be like hops in the Pacific Northwest due to different soils and different climates. Hops grown in the Northeast will present unique brewing characteristics. It is important to evaluate hops in different localities to develop geographically specific profiles for varieties that grow well in those regions.

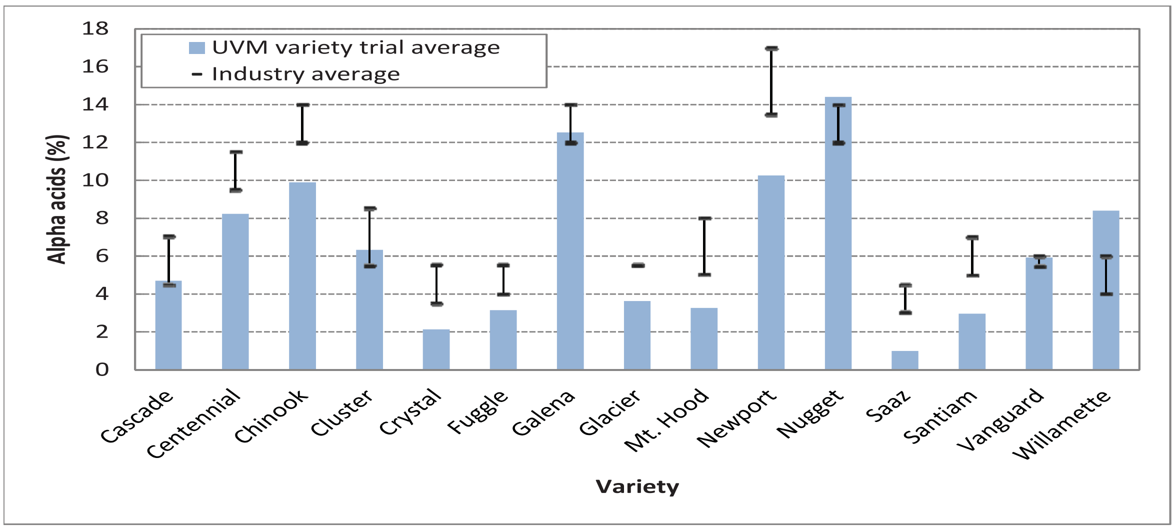


Figure 1. Alpha acid levels from the UVM Extension hopyard compared to industry averages calculated from values presented by Hopunion CBS, LLC and Yakima Chief, Inc.

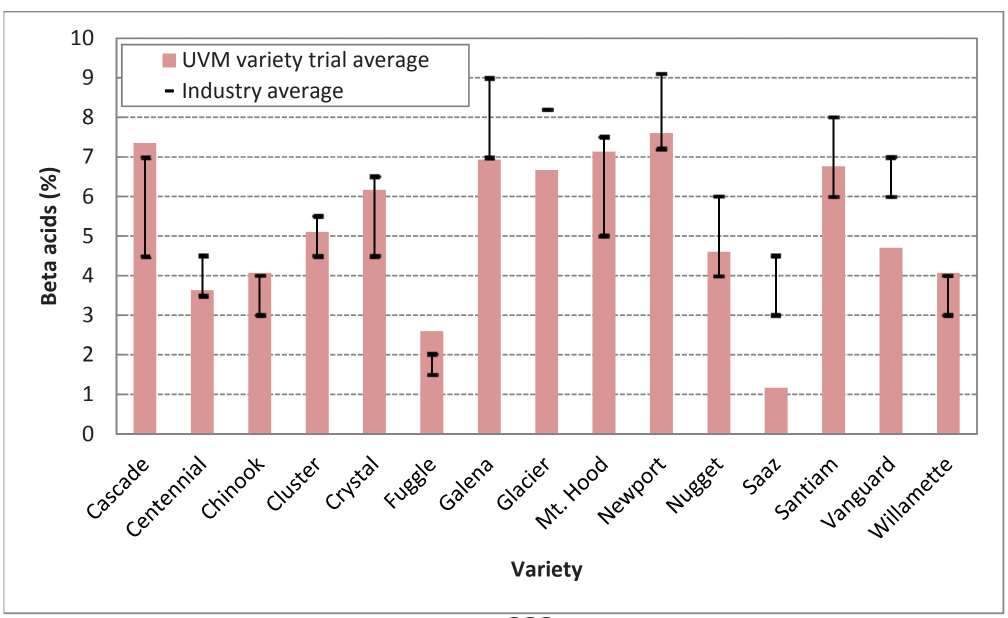


Figure 2. Beta acid levels from the UVM Extension hopyard compared to industry averages calculated from values presented by Hopunion CBS, LLC and Yakima Chief, Inc.

CURRANT AND GOOSEBERRY PRODUCTION

Steven A. McKay, Extension Educator
Cornell Cooperative Extension
479 Route 66
Hudson, NY 12534
(518) 828-3346 sam44@cornell.edu

Introduction: *Ribes* is the genus name of currants, gooseberries, and crosses of the two. Currants and gooseberries were once grown extensively on a commercial basis in the US. At the beginning of the century, the largest collection of currants and gooseberries in the country was in Geneva, NY, and the state ranked number one in red currant production in the 1930's. There are over 150 species of gooseberries in the world, and hundreds of currants and selected and hybridized cultivars. One British nurseryman told me in 1999 that he refers to a variety publication from earlier this century that lists over 1,500 varieties of gooseberries alone, and some researchers report that about 4,000 have been reported over the years (possibly a number are duplicates). Many cultivars have been lost, or are very rare, and there is an international effort to save as many of these as possible.

Even though currants and gooseberries are in the same family, they appear quite different. The crosses may look like either parent, some like currants and others like gooseberries. The variety in shapes, colors, texture, and flavor make *Ribes* a good candidate for development in gourmet and specialty markets. Fresh fruit can decorate plates, salads, and desserts. Cooked or processed fruit makes delicious sauces, pastry, wine, vinegar, and preserves. The juices have great flavor and health benefits that make them appropriate for popularizing as common breakfast or snack drinks. A comprehensive cookbook is currently available for *Ribes,* and recipes can be found in old cookbooks, cooking magazines.

Description: **Gooseberries** grow on a bush approximately 3 to 6 feet tall and about 3 to 4 feet wide. Most gooseberries have spines or thorns at each of the leaf nodes. The spines may be single, double, or triple, and they may be large, (10 to 15 mm) to small (l to 5 mm). The habit of the plant may vary from low spreading to upright and tall. Berry color may vary from green to yellow/green, to yellow; or white, to pink, to red, to dark red or purple. The size of the berries varies from about 1.5 grams to more than 12 grams. The average is about 3 to 6 grams. The berries are usually borne in ones, twos, or threes, and hang under the branches. The taste ranges from very tart to very sweet. In the US, gooseberries ripen starting about mid-June and the latest are ripe about mid-August. The seasons may vary a week or more either way, depending on the weather and your location.

Gooseberries are generally classified as dessert berries, those that are used raw, and culinary, or ‘cookers’ that are used primarily for processing or cooking. There are some that fall into both categories depending on the stage of ripeness when picked. Generally the dessert berries are larger and used when completely ripe. The culinary berries are generally smaller, very tart and used before they are fully ripe. Some growers use some of the dessert type berries while still unripe as cookers and as a means of thinning and using the crop. The remaining berries become larger and are used as they ripen.

Some of the cultivars used as dessert berries in North America are:
Achilles, Captivator, Early Sulphur, Hoenings Earliest, Invicta, Hinnomaki Red, Hinnomaki Yellow, and Whinham's Industry.

Some of the culinary cultivars are:
Careless (dual use), Oregon Champion, Poorman, and Red Jacket, (Pixwell less recommended).

There are many other cultivars available in varying supplies that could be used in plantings for berries for sale at farmer's markets or roadside markets.
Currants grow on a bush that is generally larger than a gooseberry bush with thicker wood. There are no thorns or spines, and bushes can be spreading or upright. There are two major different types of currants, black currants (R. *nigrum)* and red currants (R. *rubrum).* The red currants also include the pink, white, and yellow currants, which are color phases of the red.

Almost all **black currants** are processed into juice or other products such as syrup, jam, jelly, tea, yogurt, pie fillings, candy, nutraceuticals, and wine. There has been an increase in consumption of black currant flavored beverages, and fresh consumption is growing, although demand remains relatively low because berries have a strong pungent flavor. The flavor is great for those who are accustomed to it, either fresh, or for cooking.

Some available black currant cultivars that may be used:
Black Currants: Ben Sarek, Ben Lomond, Ben Alder, Titania, (Ben Nevis, Consort....less recommended).

Red currants are used both fresh and processed. They grow in bunches similar to grapes called strigs and may have from 10 to 35 berries. Fruits are often made into juice which can be consumed as a beverage, or used for preserves or other products. Currant jelly is an ingredient in many recipes to produce a tart flavor or to glaze. Red currants are used in sauces for meats, poultry or fish as well as a dessert topping on ice cream, cake, puddings, and creams.

Some currant cultivars that may be used:
Red Currants: Red Lake, Jonkeer Van Tets, Redstart, Rovada, and Tatran.
White Currants: Primus, Blanka, White Imperial, Pink Champagne, and White Versailles.

There are **other hybrids** and species of *Ribes* that don't fit into the above classifications. One of these is Crandall. It is often grouped with black currants, but is actually another species, *R . odoratum,* and looks like a black currant, but has a milder flavor and is often eaten as fresh, raw fruit. It is quite large, and late for a black currant. Josta berries, and selections called ORUS are actually hybrids of gooseberry and black currant.

Deciding Whether to *Grow Ribes:* *Ribes* crops definitely have a place in a grower's diversification formula. Local consumption by gourmet enthusiasts, small scale processors, and ethnic markets should be one's first target. Know what your market is before planting. Remember that larger scale production is more risky. As an example, the production of red currants as of 2009 has grown so much that it is a challenge to sell them all during the season. However, CA storage could be considered as a way to extend season and increase prices.

One should be conscious of any regulations that restrict *Ribes* production in the local area. Consider proximity to white pines, and the information about white pine blister rust. Labor or proximity to a harvester is also a critical factor.**Considerations in Choosing a Variety:** As with other crops, no ideal varieties of *Ribes* crops have been developed. Certain varieties are better suited to certain geographical locations, Fruit quality on a given variety might be excellent, while lack of disease resistance or poor plant growth habit could be a flaw. When you consider varieties for commercial production, consider the following factors: availability of plant material, ease of propagation, plant patents, local laws, market audience final use of fruit, yield, ease of picking (length of strig), fruit color, size and quality, plant: thorns, growth habit/size, disease resistance.

Culture: Spacing - Planting rates for gooseberries and currants that are being used in pick-your-own operations should be about 3-4 feet in the row and in rows about 6-8 feet apart, depending on your training system and equipment. It is very important to know about the growth habit of your selected varieties and the space requirements of equipment, especially if you plan to mechanically harvest. Field spacing can be planned according to the defined parameters. For example, the black currant Ben Lomond would be planted a little closer in row, while Titania could be spaced wider, due to size differences of plants. Mechanically harvested plants are spaced closer in the row, at about 18", with alleys spaced wider so that equipment can pass. One grower in England advocates planting at 12" in-row spacing, insisting that a tight hedgerow is critical for success in mechanical harvesting.

Mechanical harvesting is also possible for gooseberries (and red currants). Gooseberries that are planted for processing are planted closer in row, and are 'stripped' of berries while still fairly green (un-ripe) and hard. Gooseberries picked for fresh market are often planted about 3.5 feet in the row unless trained to vertical cordons. Fresh market berries are generally hand-picked.

Both red currants and gooseberries are most efficiently trained to cordons if they are to be used for fresh fruit production. Please contact my office for a detailed article on this training system.

Soil and Water - *Ribes* are best grown in good soil with at least 3-5% organic matter content and a pH of about 6.5, (however they can tolerate lower readings). High nitrogen should be avoided as this produces too much vegetative growth and may predispose plants to more mildew problems. A British rule of thumb is to add 50 kg per hectare each of N and K (actual) for crops producing 10 metric tons per hectare. (A 10 m t/ h crop will extract the following kg of actual nutrient per hectare: N 20, P 5, K 44, Ca 8, Mg 3, S 4.) *Ribes* need about 0.6-1 inch of water per week during the fruiting season. Drip irrigation and mulching with straw, chips, or plastic is beneficial.

Pruning and Training - The best fruit is borne on 2 and 3 year old wood, and wood should be pruned out after 4 years. Many training systems have been developed over the years, and continue to be developed. One alternative for black currant is to prune plants to the ground every other year, and to harvest alternate years. The crop is essentially grown as a "field crop" with as little as 15 hours of labor per year per acre. The Dutch have developed a mechanical pruning system that removes 1/3 of the bush per year on rotation. Systems will vary by use of fruit, harvest method, and other factors.

Pest Control - The lack of registered chemicals has been a problem from time to time for *Ribes* producers. (Check with your local extension office for the latest recommendations.)
1. Mildew tends to be the major disease problem, but trials are showing that it can be controlled by stylet oil. Gooseberry fruits are blemished and deformed by the disease. Shoot tips are deformed. The disease was once the limiting factor preventing success with European cultivars in North America.
2. Leaf spot has been a serious a problem on all *Ribes* crops. Leaf yellowing and premature defoliation weakens the plant and affects yield. Copper sprays and weed control help to control the disease.
3. White pine blister rust has been the cause of *Ribes* restrictions in the Northeast which are being reconsidered for modification. Immune cultivars are advisable especially near white pine stands. Gooseberry and red currant are resistant to the disease.
4. The British are controlling cane borers with pheromone mating disruption. They are sometimes a problem in the Northeast.
5. Aphids sometimes cause a red deformation on red currant leaves.
6. Reversion virus is common in black currant in Europe, but not found in the US. It can reduce the useful life of a black currant planting to as few as eight years. Quarantine has kept the disease out so far. The disease is spread by big bud mites.
7. Currant Cane Blight, a fungus disease that was a problem in the past (when ribes were previously cultivated in large acreage), has become a problem again. It is caused by *Botryosphaeria ribis*, and causes branches to yellow, wilt, and die.
8. Imported currant worm, is a green larva that can defoliate a plant in a matter of days. They are easily controlled with insecticide, but control measures must be taken quickly, because they can defoliate a plant in a couple of days.
Recommendations for pest control can be found in the *Cornell Small Fruit Crop Pest Management Recommendations* or other local extension publications.

Harvest/Postharvest: As with all berries, harvest and post harvest care of fruit can extend the shelf life of fruit. Some varieties hang longer on the plant than others. Generally speaking, red and black currants will sweeten as they hang, and fresh eating quality improves. Most people have a tendency to pick these fruits on the green side. Gooseberries will ripen off the plant. They ripen slowly in cold storage. Gooseberries lose their distinct veination as they ripen and become overripe. They develop a stronger, mustier flavor, lose acid, and can become mealy. Gooseberries and red currants can be kept a number of months (up to seven) with palletized CA storage.

Hand Harvesting: At harvest, one should avoid pricking gooseberries on thorns, and leave the blossom and stem end of the berry intact. Avoid bruising fruit. Red currants are left on strigs, and should be picked carefully to avoid smashing berries closest to the plant. Cultivars with long strigs, not heavily clustered are easier to hand pick. Black currants would follow the same generalizations as the red currants. Often harvest of black currants is best started as the first ripe berries in the top of the plant are beginning to fall off. In all *Ribes*, free moisture should be avoided, and berries should be shaded in the field and chilled as rapidly as possible. Fruit of all three types can be held at 36-40 F for two to three weeks. I have held fruit at 33F for as long as six weeks. CA storage methods are being developed for these fruits.

Machine Harvest: Proper adjustment of shakers is critical so that a thorough job of harvesting is done and the bushes are not badly beaten. Some machines are gentle enough to harvest gooseberry and black currant fruit suitable for fresh market. Red currants are more desirable intact on strigs for fresh market, and this is not possible with machine.

Useful Resource:

Currants, Gooseberries, And Jostaberries: A Guide For Growers, Marketers, And Researchers In North America by Danny L., Ph.D. Barney and Kim E. Hummer

GROWING SWEET CORN FOR WHOLESALE MARKETS

John H Gill
Gill Corn Farms, Inc.
1875 Hurley Mt. Rd.
PO Box 225
Hurley, NY 12443
845-331-1187 office
John@gillfarms.com

With the ever increasing cost of inputs to grow a crop of sweet corn for the wholesale market place, making it a profitable business is a challenge.

First off, this year you had to deal with the price of fuel and fertilizer doubling, the cost of seed and crop protectants up 20-30%, the cost of labor, and the cost of maintaining Good Ag Practice (GAP) certification. On top of all this, weather and insect pressure are variable and have to be dealt with. All this needs to be managed while meeting the USDA standards for a fancy box of corn.

Upon the completion of growing a corn crop, harvesting, packing, and shipping are the next items to be dealt with. We mechanically harvest our corn. To do this we have two Pixall corn pullers and two Byron harvesters to use in case of down corn. All the corn is within a four mile radius of our packinghouse and transported to it with tractors and wagons. Once it enters the packing house we grade it to meet the USDA requirements for a US Fancy box of corn. As the crates of corn come off the packing line they are stacked 35 boxes to a pallet.

Once the corn is palletized we then run it through a Hydro-cooler for 45 minutes in 38degree water to bring the pulp temperature down to 42 degrees. It is then stacked up to 42 boxes to a pallet and either loaded on a truck or stored in our cold room at 38 degrees. After a truck is loaded, we then put 2500 to 3000 pounds of top ice on it. The ice is meant to melt at a slow rate to keep the corn wet. The trucks are refrigerated and kept at 38 degrees.

Growing conditions can play a role in selling your crop. Too dry or too wet growing conditions can make the quality of your crop suffer. Poor quality results in a lower price for your product. Insect pressure can lead to problems too. When you are on a close spray schedule and it rains a lot, you can miss a spray. This can lead to pests such as corn borer and earworm larvae in your crop and all the problems associated with them.

We market our corn up and down the east coast, as far west as Texas and export to Puerto Rico and England. To do this we have two salesmen on our farm from July to the first of October. We supply many chain stores, the major terminal markets and distribution houses around the country. This can be a challenge for many different reasons. At the time of year that we have corn, so does most of the country. If all the growing regions have a good crop, the market tends to be weak. If one or more regions have a short crop, marketing opportunities become available and generally the price goes up.

The changing face of today's agricultural community is another aspect that has impacted the profitability of our farm. Being a "large farm in a small community" has its challenges. As a larger farm we have a large investment in equipment, buildings, refrigeration, crop specific packaging, storage, handling equipment, and costly investments in food safety requirements in order to be GAP certified. These are required by most chain stores, distribution centers, and other customers in order to sell our corn to them. The recent onset of the "buy local" campaign has affected the way our clients do business with-in the farming community. In the past, stores would pull product from a central warehouse supplied by larger farms such as ourselves. Individual stores may buy local produce through the back door from smaller local growers, who are not necessarily burdened with the certifications and overhead costs of a large scale grower. This has cut down on the amount of product the stores take from their warehouse. Because of this trend, the amount of corn we send to the chains is less than it has been in the past.

To combat this trend we have had to find new markets for our corn. One way we have changed our customer base is to sell a greater share of our crop to the western states. Another is an increase in export business to other countries.

2011 Sweet Corn Variety Trials, University of Maine, Highmoor Farm

David Handley (david.handley@maine.edu) and Mark Hutton (mark.hutton@maine.edu)
University of Maine
Highmoor Farm, Monmouth ME

Supersweet (Sh_2) and Augmented Supersweet Corn Variety Trial, University of Maine, Highmoor Farm

Cultivar	Picking Ease[2]	Tip Cover (inches)	Ear Length (inches)	Rows/Ear
2873	2.7	1.8	7.3	16.2
4012	2.7	2.7	7.4	16.9
7112	2.7	3.2	7.6	16.3
2573 XTRA	3.0	2.1	7.8	16.9
2876 XTRA	2.7	2.6	7.6	17.3
7002R	2.7	2.1	7.4	17.1
ACX 7905MR	2.7	2.4	7.5	16.9
BSS0982	2.0	3.0	7.5	15.4
BSS5419	2.5	2.5	7.6	17.6
BSS8040	2.3	3.0	7.7	17.2
EX08767143	2.7	2.6	7.6	17.8
Legion	2.3	2.2	7.7	17.1
Mirai 302	2.7	2.3	7.6	17.3
Mirai 336	3.0	2.8	7.5	15.6
Mirai 350	2.3	2.3	7.5	16.5
Primus	2.0	3.8	7.8	15.5
Stellar	2.0	2.5	7.4	17.2
XT 2170	2.7	2.8	7.6	15.8
XT 274A	2.3	2.6	7.7	16.7
XT 278A	3.0	2.8	7.6	16.6
Tukey's HSD 0.05	ns	ns	ns	ns

Planted in 6 row plots, 40' long, 10" between seeds, 36" between rows, hand-planted: 4 replicates, randomized complete block design. Ear characteristics based on 8 ear sample per plot.

[1]Tukey's HSD test: differences between values within a column must be greater than this to be considered significant.

[2]Picking ease rated on a scale of 1-3 with 3 being the easiest or best.

Supersweet (Se) and Augmented Supersweet Corn Variety Trial, University of Maine, Highmoor Farm

Cultivar	Stand plants/row	Yield ears/row	Plant Ht. (inches)	Ear Ht. (inches)	Picking Ease[2]	Tip Cover (inches)	Ear Length (inches)	Rows/Ear
1102	19.8	14.8	81.2	25.7	2.0	3.2	7.2	15.5
Cameo	23.3	20.3	84.1	34.6	2.7	2.5	7.4	16.4
Expresson	24.0	24.0	73.8	16.4	2.7	2.3	8.0	15.6
Harris 1001	19.2	21.2	80.2	18.3	3.0	2.3	7.0	15.5
Kristine	20.7	20.0	68.1	14.3	3.0	2.9	7.2	15.7
Luscious	19.7	17.7	81.3	25.4	2.7	2.9	7.1	16.8
Monomoy	21.3	20.7	65.1	17.2	2.8	3.2	7.2	14.1
PowWow	22.3	22.3	94.0	30.9	2.8	2.1	7.0	17.8
Reflection	20.3	18.3	71.2	21.4	2.8	2.5	6.6	16.2
Renaissance	22.0	22.7	83.5	20.0	2.8	2.3	7.5	12.3
SEB6RH1080	24.0	22.0	65.3	14.8	2.5	3.1	7.2	16.1
Sparkler	24.0	23.7	76.7	20.6	2.4	2.8	7.5	16.8
Synergy	24.7	21.0	64.3	16.0	2.7	2.6	6.9	16.6
Temptation	22.3	21.2	76.5	20.7	2.5	2.4	7.1	15.6
Vitality	24.3	28.0	71.3	15.8	3.0	1.5	6.9	14.0
Tukey's HSD[1] 0.05	ns	3.2	3.4	1.6	ns	0.4	0.2	0.5

Planted in 6 row plots, 40' long, 10" between seeds, 36" between rows, hand-planted: 4 replicates, randomized complete block design. Ear characteristics based on 8 ear sample per plot.

[1]Tukey's HSD test: differences between values within a column must be greater than this to be considered significant.

[2]Picking ease rated on a scale of 1-3 with 3 being the easiest or best.

More information and photos can be seen at the Highmoor farm website (http://umaine.edu/highmoor/research/).

Adapt-N: A New Nitrogen Management Tool for Sweet Corn?

Authors: Bianca Moebius-Clune, Harold van Es, Jeff Melkonian, Laura Joseph.
Contact Info: Bianca Moebius-Clune, bnm5@cornell.edu , 1001 Bradfield Hall, Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853

Try Adapt-N

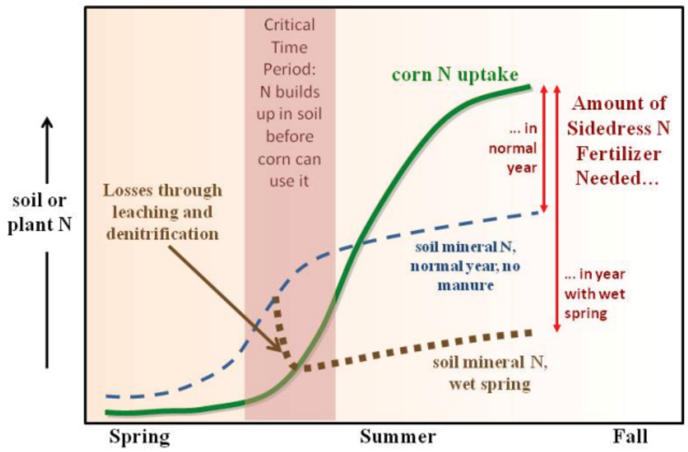
Adapt-N is an online decision support tool (http://adapt-n.cals.cornell.edu) that we are currently beta-testing in on-farm trials in New York and Iowa. The tool was designed to help precisely manage N inputs for grain, silage, as well as sweet corn. It uses a well-calibrated computer model and incorporates high resolution weather information to develop recommendations that are specific to your farm. It was designed to help you do the following:

- Predict corn N needs more precisely based on field-specific conditions
- Adjust N applications based on weather on your farm
- Reduce fertilizer rates, costs and losses in the long-term, while maintaining yield
- Fine-tune sidedress N rates
- Determine whether manured fields need additional fertilizer N
- Determine whether you need rescue N after heavy spring rains
- After the growing season – is there excess N?
- Explore this learning tool and evaluate alternatives: "What if I had…?"
- Use it on your smartphone, iPad, or tablet computer – Adapt-N is mobile enabled.

Our website has detailed information about why (environmentally and economically) adaptive N management is important, how it relates to climate change, how to get an Adapt-N account, how to use the Adapt-N tool and how it works. We also have a blog you can sign up for, and a long list of factsheets, articles, and peer-reviewed publications with more in-depth information about the model that's at the core of the tool.

Background

Nitrogen management is of key importance in corn production systems because of the relatively large N inputs that are used inefficiently (N recovery in the plant is usually lower than 50%), the high cost of N fertilizer, weather impacts on available N, and public concerns over N pollution of the environment. Our studies have shown that early season weather, particularly rainfall, contributes to the well-documented variability in economic optimum corn N rates. In other words, it's because of weather variability that the amount of fertilizer N needs in one year could differ by about 100 lb N from what is needed in another year! Why? … In warm weather nitrogen mineralizes faster from the organic matter in the soil to become available to the crop, but this occurs slower in colder weather. In a normal or dry spring, nitrogen mineralizes to nitrate form and remains in the root zone where the crop can take it up later, when it needs it (see the green vs. blue line in the graph). However, in a wet spring (see the brown dotted line in



the graph), nitrogen can be leached out of the crop's reach or denitrified during the "Critical Time Period" when nitrates build up but have not been used by the crop yet.

This means that it is not possible to accurately determine how much N fertilizer will be needed at the beginning of the growing season. Therefore, many growers currently pay for "insurance fertilizer" – they apply in excess of what is needed in most years, and still come up short in some years. This reduces farm profits and causes potentially high environmental losses to both surface and ground water and to the atmosphere. Nitrate leaching to water bodies can cause excessive nitrate levels in estuaries such as the Great Bay, Chesapeake Bay and the Gulf of Mexico, resulting in algae build-up, dead zones and fish kills. Also, denitrification of nitrate to N_2O, which is a potent greenhouse gas with a warming potential about 300 times greater than CO_2, is contributing the largest chunk to agricultural greenhouse gas emissions. For reference, agricultural N_2O emissions make a larger yearly contribution than all of U.S. aviation.

Adaptive N Management: Benefits of Incorporating the Weather Component

The Adapt-N tool encourages lower N application at planting, and then, at sidedress time, provides more precise N recommendations for corn, based on site-specific management and weather-related dynamics. *Economic and logistical benefits:* More accurately estimating N needs will allow you to spend less money on fertilizer in the average year (about 3 out of 4 years) by adjusting fertilizer rates downward based on weather conditions in the spring, but will allow you to maintain yields in wet years by applying additional N as needed. Using the tool saves time, as there is no need for in-season soil sampling or waiting for test results. There is currently no cost for using this online tool, and you will receive the N-recommendation instantaneously. *Environmental benefits:* 1) Less nitrate leaching and denitrification because less nitrate is subject to losses in the Critical Time Period and in the fall when soils tend to be wetter. There is a win-win opportunity here: it has been shown that leaching and denitrification losses increase exponentially when over-fertilizing above corn N demand. So farmer profits and environment are satisfied by the same goal – applying as much N as is needed and not more. Remember: N lost to the environment is N you paid for (or got "for free" from your organic matter), that your crop cannot use.

How does Adapt-N work?

Adapt-N is accessed through a web interface (http://adapt-n.cals.cornell.edu) 'wrapped' around the Precision Nitrogen Management (PNM) model. This interface allows users to input crop, soil, and N management information to get a nitrogen recommendation. There are three key components of this model-based N management decision support tool:

1) Well-calibrated and tested dynamic simulation model: composed of a corn growth and N uptake model, linked to a soil process model. It simulates 1) water and N transport, 2) chemical and biological N transformations in the soil and 3) N uptake, growth and yield of the corn crop. All these processes are heavily impacted by rainfall and temperature. The model has been extensively tested for experimental applications in the Northeast, and is currently being beta-tested for on-farm use in New York and Iowa. We will make this season's results available on our webpage this winter.!

2) Model access to weather data: at the appropriate scale for farm-level applications. Weather is a key driver of soil/crop processes: The conventional weather station network is not sufficiently dense to pick up local variation in temperature and precipitation. The Northeast Regional Climate Center (NRCC) and the Cornell University Center for Advanced Computing

(CAC) have collaborated to produce and distribute near real-time daily high resolution temperature data and precipitation data (3 x 3 mile gridded) for the Northeast U.S. These data are updated daily and can be automatically accessed by Adapt-N through the web.

3) A user-friendly interface: Adapt-N is designed for easy data entry, and uses information that is part of routine record keeping. Generating a nitrogen recommendation generally requires only several minutes once the needed information (see our manual online) has been gathered, and requires less time with repeated use and experience. N recommendations can be generated at any time and the tool therefore allows for continuous monitoring of N availability as the crop progresses in the growing season. We are planning on an email alert service for next spring. Adapt-N also provides a large, valuable set of information, including graphs of the location's precipitation and temperature, mineralization of N from OM, soil inorganic N content, a graph showing daily PSNT values, and leaching losses, among others, on a daily time step.

How do I begin using the tool?

To register to access Adapt-N, please contact Jeff Melkonian (jjm11@cornell.edu) for your user ID and password. Then, go to the Adapt-N website at http://adapt-n.cals.cornell.edu/, read the directions provided in the manual section, and click on the 'Adapt-N Sign in' button. You will be able to enter any number of fields, and receive weather- and input-adjusted information about N dynamics, including an in-season nitrogen recommendation. You can even test scenarios: for example – what if you had applied the same amount of N at sidedress instead of at planting in 2011?

What info do I need to run a field in Adapt-N?

- Latitude and longitude for the field location (link provided online, if needed).
- Soils: coarse, medium, or fine texture, field slope, % organic matter
- Tillage: fall plowing, spring plowing (date and depth), or conservation tillage (25, 50, 75, or 100% residue cover)
- Manure applications for current and past two growing seasons: date, rate, N content (dry matter, lbs ammonium-N and organic-N/1000 gals), surface applied or incorporated.
- Sod in last 3 years: % legume in the sod, surface kill or incorporation date
- Rotating out of soybean?
- Starter/additional N fertilizer: type, date of application, depth and rate of each application
- Crop: planting date, cultivar (silage/grain/sweet corn and maturity class), expected harvest population, expected yield in that field that year.

What's the current status of beta-testing the Adapt-N tool?

The model is well calibrated through about 20 years of experimental work. With funding from a National Conservation Innovation Grant from the NRCS and a grant from New York Farm Viability Institute we are beta testing it with replicated strip trials on over 40 farms. We are comparing each collaborating grower's standard practice with the Adapt-N recommendation. This year, Adapt-N recommendations in NY trials were between 15 and 130lb N lower than what growers are currently applying. We will be analyzing this year's yields, plant N uptake and soils data, and adjusting the tool.

Winemaking in Cool Climates

Dr. Dave Miller
Owner / Winemaker White Pine Winery and Vineyards LLC
Visiting Professor
Department of Food Science and Human Nutrition
Michigan State University, East Lansing, MI 48823
dm49065@gmail.com

Winemaking Principles:

Making wine in cool climates is essentially the same as making wine anywhere else: it requires attention to the fundamentals of sound wine production. That begins with clean, ripe fruit from the vineyard and is followed by the use of clean and sanitary process equipment that handles fruit gently. The resulting juice must be analyzed for sugar, acid and nutrients and corrected where necessary when it is racked to the fermentation vessel. A small amount of SO_2 added to the must is good protection against growth of unwanted yeast and bacteria that may create off odors and flavors in the wine. Yeast inoculum must be prepared with adequate nutrients and acclimated to the must before adding. The fermentation itself has to be monitored and controlled. White wine fermentations should be conducted under relatively cool conditions (i.e. 60 – 65°F) while red fermentations are conducted at warmer temperatures of 80 – 85°F. Allowing white fermentations to get too warm causes a loss of varietal aromas. Allowing any fermentation to get above 90°F can lead to yeast death and a stuck fermentation. Stuck fermentations are particularly problematic as the must can spoil quickly at elevated temperature. Twice – daily monitoring of Brix decline and temperature enables the winemaker to intervene before a problem occurs.

Cool climate musts are typically high in natural grape acids and often require deacidification prior to fermentation. Laboratory trials of deacidification procedures should be done before treating an entire batch of must in the cellar. The double salt deacidification process is the most common approach used and winemakers in cool climates should be familiar with the procedure. Color extraction and stability are often problematic in cool climate red wines. The use of oak and / or oak extracts in red fermentors to aid in color stabilization is common in many parts of the world and is gaining wider acceptance in the eastern US. SO_2 is often added at the end of malolactic fermentation to protect the wine but has the undesirable side effect of bleaching pigments and reducing color. Thus a judicious use of SO_2 is required in order to protect the wine from spoilage without bleaching pigments. Micro oxygenation of wines following fermentation is becoming more common in eastern wineries to aid in pigment polymerization and stabilization. Once pigment polymers form they are more resistant to SO_2 bleaching and result in more deeply colored wines. The production of high quality, deeply colored red wines relies on clean fruit and sanitary winery practices.

Wine Quality Assurance:

Once fermentations are complete, wines should be racked into full tanks, clarified and stabilized. If tanks cannot be filled then headspace must be sparged with an inert gas. Argon is preferred since it is heavier than air and will blanket wine in a partially filled tank. Monthly sampling of wines for volatile acidity (VA) and free SO_2 (FSO_2) will insure that any problems are detected early and can be controlled before the wine spoils.

Pre-bottling Quality Assurance:
Before bottling wines should be checked for heat and cold stability, alcohol content, TA, VA, pH, TSO_2 and FSO_2. Instabilities not corrected before bottling may lead to precipitates or haze in the bottle. Wines bottled with residual sugar should always have potassium sorbate added as a preservative along with adequate FSO_2 for 0.8ppm molecular SO_2 at the pH of the wine. All wines with residual sugar should be filtered through a 0.45 micron membrane into the bottle filler to insure yeast counts are as low as possible in the bottle. One of the biggest problems in small wineries is the re-fermentation of sweet wines in the bottle. This problem can be prevented by following the proper steps in preparing the wine for bottling.

Winemaker groups:
In southwest Michigan where I make wine we have formed an informal group of winemakers who get together monthly during the winter to taste one another's wines. These tastings have proved invaluable in helping solve problems in winemaking and sharing experiences so we can all learn more quickly. The tastings are educational and fun. We all learn something from others experiences and we have become better acquainted so it's easier to pick up the phone and call someone if we have questions, need help or supplies during harvest. I highly recommend forming groups of local winemakers to make everyone's wines better and raise the quality and status of the wines in your area.

Vine Balance

Dr. David Miller
Owner / Winemaker White Pine Winery and Vineyards LLC
Visiting Professor
Department of Food Science and Human Nutrition
Michigan State University, East Lansing, MI 48823
dm49065@gmail.com

Vine Balance Principles:

The term "vine balance" refers to the balance between a grapevines vegetative and reproductive growth. Too much vegetation leads to shaded canopies and unripe / poor quality fruit; too much fruit leads to unripe fruit and a weakened vine. Understanding the principle of vine balance and how to use vineyard management practices to achieve and maintain vine balance are some of the most important factors in producing high quality wines.

The concept of vine balance was first conceived by Newton Partridge. Nelson Shaulis later expanded on the concept and better defined what was meant by "balance". Shaulis showed that opening the canopies of Concord grapevines created more fruitful buds the following season. Additionally, he showed that vigorous vines could carry more crop, and better mature that crop, when vines were balanced and canopy density reduced so fruit was exposed to sunlight. A Key concept – part of vine "balance" has to do with canopy density or the number of shoots per unit row length and number of leaf layers.
Winkler et al. discuss at some length the relationship between vine vegetative growth and yield and suggest the goal of the grower is to achieve a "proper balance" between the two in order to maximize both yield and fruit quality.

Richard Smart (a student under Shaulis) went to first-growth vineyards in Bordeaux and Burgundy and measured vine canopy metrics: leaf layer number, leaf size, shoots per unit row length, shoot length, percent fruit exposure and canopy gaps. He also measured vines in vineyards that were not rated first growth. He demonstrated that the best vineyards had vine metrics that were indicative of balanced vines – short internodes, small leaves, few laterals, 4 to 5 shoots or less per foot row length, shoots 1.5 meters in length or less, a high percentage of exposed fruit, gaps in the canopy, a fruit yield to pruning weight ratio of 5 to 10 and l.5 leaf layers or less. Vines in vineyards that produced fruit of lower quality had longer shoots, larger leaves, fewer canopy gaps, more leaf layers and less-exposed fruit or fruit that was shaded in the vine canopy interior.

Based on these and other data, Smart developed a manual of vineyard Quality Assurance practices that he published as "Sunlight Into Wine". It is still the foundation for Vineyard Best Practices used today. Every viticulturist should either own the book or understand the concepts outlined by Smart and how to use them in vineyard management.
In order to grow balanced vines one must first evaluate the growth potential of a given vineyard site. Macro climate effects describe the general growing region: growing season length, heat

accumulation, rainfall amount, frequency and distribution, day length and sunlight intensity combine to determine the growth potential of a region. Meso-climate factors describe those variables which affect a particular vineyard site. Slope, aspect, soil type, water holding capacity, cation exchange potential effect vine growth directly. A careful evaluation of macro and meso-climate variables will guide the decision making process for choice of rootstock, vine spacing and trellis type. Correct vine spacing and trellising in a given environment will produce vine canopy micro-climates conducive to the production of high quality fruit.

Row spacing and trellis type ultimately determine the exposed leaf surface area of the vineyard which determines crop potential. A properly designed vineyard will produce balanced vines that require less canopy management intervention and relatively good yields of high quality fruit. The key is in the design – variety choice for the macro-climate, rootstock, vine spacing and a careful and honest assessment of exposed leaf area based on trellis type will guide decisions in crop adjustment.

A grapevine idiotype is a description of a hypothetical "perfect" vine in terms of shoot length, leaf size, percent exposed fruit, number of laterals, shoots per unit row length, cane prunings per unit row length, buds per unit pruning weight and other metrics. We will discuss a grapevine idiotype, how to monitor your vineyard and steps that can be taken to manage vine canopies. Shoot thinning, hedging and leaf removal are widely used tools to produce a grapevine canopy environment where fruit is exposed along with sufficient leaf area to mature the crop.

References:

Winkler, A.J., J.A. Cook, W.M. Kliewer, L.A. Lider. General Viticulture. 1974. 710 pp. University of California Press.

Grapevine Nutrition 101

Kevin W. Ker, PhD, P.Ag
CCOVI Brock University
KCMS Applied Research and Consulting
kker@kcms.ca or kker@brocku.ca

To develop a good vineyard nutrient management plan requires one to do a self check to establish what is happening, why and what can be done to change things.

1. Goals and Objectives

What are your goals for the vineyard?

a) Better yields - overall or per vine
b) Better fruit quality at harvest - Brix, TA, pH, fruit colour, flavours???
c) Better efficiency in production – reduce inputs or improve labour efficiency
d) Improve vine health – winter survival, better cane selection, reduce pest impact
e) Responding to vine signs or symptoms of problems starting or progressing

To answer the above questions requires some self assessment of the vineyard health and productivity. This may require the collection some additional information, however in many cases much of the information is already in your possession. What type of information do I already have on hand?

Vineyard Facts - Cultivar, rootstock, spacing, training system, pruning practices; Awareness of areas of missing vines (this impacts on efficiency and economics);Topography; Climatic variables; Soil management; Signs or Symptoms of problems or areas of excellent vine health/productivity

Vineyard performance - Historical yields; Fruit quality at harvest; Within vineyard variables; Current nutrient program; Costs of inputs

Grapevine nutrition needs to look at the vines as individuals but also as part the bigger group (kind of like cows in a herd). The productivity of each vine impacts on the overall yield but you cannot spend an excessive amount of time or money on a few individual vines at the expense of the entire vineyard. What is needed is to achieve the best fit or a program that works for the majority and is viable instead of spending extra money on a treatment of the whole block just to improve the few vines that are not performing up to standards. In many cases, underperforming vines may be a result of poor pruning, or poor soil attributes or they may just be poor vine. Before applying any extra sprays or nutrients you need to be sure what is the real problem causing the signs or symptoms you are seeing.

From a nutrition standpoint you need to understand:

- What are the critical nutrient elements necessary for premium production?
- What do I have right now at my site?
- How can I assess what I need or do not need?

2. Critical or Essential elements

- **Nitrogen** - Most essential element of plants; Part of chlorophyll molecule to allow for photosynthesis – Sunlight into Wine!; Part of genetic building blocks; Part of enzymes regulating vine growth rates and functions
- **Phosphorus** - Stimulates flowering and fruiting; Stimulates root development; Fruit composition and wine quality; Resistance to disease; Uptake of other nutrients; Part of plant enzymes and proteins; Important part of reproductive growth – part of genetic memory of the vine; Involved in formation and translocation of sugars and starches; Part of seed maturation – important for fruit ripening!
- **Potassium -** Water uptake from roots; Water retention in the plant; Movement of carbohydrates (sugars) throughout the plant (berry accumulation); Carbohydrate metabolism; Nitrogen uptake, cell growth and structure; Vine Hardiness
- **Calcium** - Key component in cell walls; May influence berry skin durability; Allows for cell division and elongation (berry size increase!); Involved with seed formation; Component of vine structural strength
- **Magnesium** - Essential part of chlorophyll molecule; Aids in formation of sugars and flavour compounds; Helps with enzyme activity; Part of protein formation

Assessing What is There

For most growers, observing the plant growth and fruiting characteristics is the most common method of first identifying if there are issues in the vineyard. Most people respond to signs or signals of poor vine performance and look immediately to correct them with some form of supplemental application or treatment.

You should be aware of the impacts of the " unseen" factors that can significantly impact vine health and nutrient uptake . These include: soil pH, soil texture, soil moisture, organic matter levels and rooting depth. Before doing anything, it is vital to understand that nutrient availability and plant response is a dynamic situation not a stationary or static position. Over the season the plant is going through a substantial number of changes and demands depending on where it is in the growth cycle.

There are two perspectives to looking at vine nutrition;

1. What is available for the vine to take up (the soil or "buffet table")?
2. What is the vine actually getting (the tissue or "patient blood test")?

Soil and Tissue sampling can help in the decision making process. They can provide data to:

- Establish base levels of nutrients
- Diagnose problem areas
- Monitor nutrient levels
- Assist in establishing fertilizer and lime requirements

Being aware of the ever changing demands of the vine is important as is the awareness of how each element acts or reacts in the soil system and the mobility of the element within the vine after it has been taken up by the root system.

What can soil tests do for me?

- General composition of the soil
- Soil pH at time of sampling
- Assist in planning fertilization program for the future

However there are limitations – they do not take into account nitrogen content fluctuation over season. They can only provide a relative amount and availability of nutrients but do NOT tell us what the vine is actually taking up and they cannot fully reflect what perennial crops such as vines may take out of the soil for permanent plant structure (roots, trunks etc) .

What about Tissue Testing?

Tissue tests are like blood tests for people. They can be very helpful but also have limitations. They provide:

- General concentration in tissue at the time of sampling
- Results will be **variable with tissue selected and time of season selected**
- Nitrogen content will fluctuate over season
- Plant stresses not taken into consideration – e.g. drought, excessive crop level, recent pruning, shading
- Does NOT tell you what is available in the soil

Tissue tests can be very helpful in diagnosing or providing confirmation of deficiencies observed and assist in the development of plans to match soil programs with plant responses. Remember plant demands vary over the season and many times short term deficiencies rectify themselves without any intervention!

Now I Have Some Numbers Now What ?

There are many different "ranges" in the literature cited as being deficient or adequate or excessive. These values are averages developed over time from any samples from specific regions or locations and are meant as guides. The most useful set of numbers are those that you develop for your own location. I highly recommend that a plan of sampling be developed that is systematic and occurs over a number of years. It is also requires sampling from the best locations and the best vines on your farm. It is from these "best producers or sites that you can develop your own set of target numbers for tissue and soil tests for your vineyards.

Basic rules to remember

1. Make a **good site map** for you and others to follow
2. Collect **data for your site** – no two locations are the same
3. **Compare your onsite values** – good balanced growth versus poor areas
4. **Be consistent –** same time each year and general locations for sampling
5. Match the application to **real need** not "suspected" need
6. Nutrient applications are **not cheap –**especially when blending in micronutrients
7. Foliar fertilizers are okay when really needed but a **luxury expense** when not really necessary
8. All purpose foliar mixtures can be expensive band aid treatments (buying lots of **things you likely do not really need** or want)
9. Read, think and ask questions – trust what you already know and have seen!

SEED HEAT - TREATMENT AS PART OF AN INTEGRATED MANAGEMENT PLAN FOR CONTROLLING DISEASES CAUSED BY SEED-BORNE PATHOGENS

Kristian E. Holmstrom
Rutgers Cooperative Extension Vegetable IPM Program

C. Andrew Wyenandt, Ph.D.
Rutgers Cooperative Extension Specialist in Vegetable Pathology

Margaret Tuttle McGrath, Ph.D.
Department of Plant Pathology and Plant-Microbe Biology, Cornell University

Seed contaminated with a bacterial or fungal pathogen can be an important source of inoculum for diseases. Surface treatment with fungicide or hypochloride solution is effective for pathogens located on the seed surface. But some pathogens, notably bacteria, can be inside the seed.

Bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis* (*Cmm*), bacterial speck (*Pseudomonas syringae* pv. *tomato*), and bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*) are serious pathogens of tomatoes wherever they are grown. These diseases have been increasing in occurrence and severity in the northeastern United States. For many New Jersey tomato growers, bacterial canker is presently the most serious disease in the production system. A severe canker infection can result in complete loss of production, although losses when speck or spot are present in a tomato planting generally vary from none (minimal foliar injury) to total yield loss, and are dependent on source of the infection, weather conditions and cultural practices. To be effective, a management plan for bacterial diseases must integrate cultural and sanitary practices with chemical use. Seed heat-treatment is one cultural practice that prevents infected seed from resulting in losses to bacterial disease in the field.

Pathogen Survival and Spread

Infected seed is commonly named as the source of bacterial infections, and while the speck and spot pathogens can be present on the seed coat, plants that are infected with bacterial canker will produce seed that may contain the bacteria both on and within the seed coat. Bacterial pathogens have been detected on living and dead plant material in infected fields, and *Cmm* cells are reported to survive on tomato debris (including seed) for up to 5 years if the debris is undecomposed. Survival is influenced by the depth to which the inoculum is buried, and the degree to which infested debris breaks down. Cells of all three pathogens will survive for relatively short periods of time in soil without solid debris.

Bacterial pathogens can survive for up to a year on infested tomato stakes, and presumably on greenhouse benches and plant debris within the greenhouse. Perennial solanaceous weeds like horsenettle may serve as overwintering hosts, and *Cmm* has been isolated from roots of this weed growing in fields without tomatoes for up to 2 years. Debris from annual solanaceous weeds like our nightshades may harbor *Cmm* through the winter as well. Additionally, solanaceous weeds serve as asymptomatic hosts on which the pathogen can multiply during the course of a growing season.

A common and serious means of dissemination is through transplant production. In this case, even low numbers of infected seed can result in widespread infections, as seedlings are in close proximity to one another and are handled frequently. Seedlings are also at risk for infection if tools, benches, etc. have not been cleaned properly, or there are potentially infected weed hosts or debris present in the greenhouse. Infected seedlings then are put into the field, where the infection becomes severe. In-field infections can originate from infected tomato plants, infected weeds, or infested debris and stakes. Once individual or groups of plants are infected, dissemination through the field is aided by cultural practices that injure the plants including tying, pruning, and harvesting as well as wind driven rain. Even injury as slight as breaking of the hairs (trichomes) on leaves and stems has been implicated in disease spread. Infections are difficult to contain once they appear in a planting. The extent of the damage is largely related to the timing and method of initial of infection.

Management Strategies

Starting with pathogen free seed

Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments for the elimination of seed-borne pathogens. Heat treatment has the additional benefit of killing pathogens such as the bacterial canker organism of tomatoes that may be found within the seed coat. Heat treatment is particularly useful for tomatoes and other crops that are prone to seed-borne bacterial infections, including peppers and brassica crops. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heat cycle is for 10 minutes at 100ºF (37ºC) followed by the effective temperature cycle. The following (from Dr. S.A. Miller of the Ohio State Univ.) are effective temperature protocols for several important crop groups:

Seed	Water temperature		Minutes
	°F	**°C**	
Brussels sprouts, eggplant, spinach, cabbage, tomato	122	50	25
Broccoli, cauliflower, carrot, collard, kale, kohlrabi, rutabaga, turnip	122	50	20
Pepper	125	51	30

Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper, and may be re-dusted with fungicide if desired. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current season.

Heat treatment of seeds will be demonstrated in this workshop, and other management strategies for bacterial pathogens including those for transplant greenhouses and field production will be discussed.