NEVF

New England Vegetable and Fruit Conference

2015
New England
Vegetable & Fruit Conference
and Trade Show

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Winter Moth: Detection & Management

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Winter moth is an invasive insect originally from Europe. It was found in Nova Scotia in the 1930s and Cape Cod, MA in the 1990s. Since the 1990s it has spread throughout coastal areas of New England - north into Maine and south through Rhode Island into Connecticut and Long Island, NY. Female winter moths have reduced wings and cannot fly, limiting how quickly winter moths spread. It's unknown at this time whether or not winter moths will stay confined to coastal areas or spread inland throughout New England and New York. During 2015 growing season, winter moths could be found as far west as Worcester, MA and western RI.

Adult winter moths emerge from the ground between Thanksgiving and Christmas. In areas of high winter moth populations hundreds of male moths are attracted at night to porch lights and lighted windows. Small, gray, female moths can be found climbing up tree trunks and buildings. After mating female moths climb trees and deposit eggs singly in crevices of trunks and branches, depositing 150-350 eggs per female. Eggs hatch in early spring and tiny, olive-green caterpillars 'wriggle' into swollen or recently opened buds, such as blueberry flower buds. Inside blueberry buds, caterpillars feed on flower parts, destroying blueberry flowers and inhibiting future pollination. After a couple of weeks, caterpillars can be found feeding on blueberry leaves. Full size caterpillars are bright-green inchworms with pale longitudinal stripes.

Winter moth caterpillars feed on a variety of hosts including oak, maple, apple, birch, elm, ash, crabapple, cherry, and blueberry. Large winter moth populations can defoliate hardwood forests and landscape trees. Generally, the year before winter moths destroy a blueberry crop, leaves of nearby deciduous trees have lacy holes from winter moth caterpillar feeding. An excellent monitoring technique is to scout nearby maple and oak leaves for the characteristic lacy caterpillar feeding damage. Once winter moth damage is found on surrounding trees, control in blueberry bushes is probably needed the following spring. Before winter moths have infested an area no control is needed.

Timing is critical to protect blueberry flowers from winter moth caterpillars. An insecticide must be sprayed in the spring when winter moth eggs begin hatching. Once eggs hatch, tiny larvae move into blueberry buds where they will be protected from insecticides. Experience (not spray trials) has shown that Imidan applied when eggs begin to hatch gives excellent control. For organic production, Entrust is the best insecticide choice. If additional insecticide is needed later, Bacillus thuringiensis (Bt) products can be used. Bt is not effective for the first spray because winter moth caterpillars do not feed as they enter buds and Bt must be ingested to be effective.

Dormant oil applied before eggs hatch may be helpful. Dormant oil can also be mixed with the first insecticide application. For dormant oil to be effective thorough coverage is essential therefore bushes must be well pruned. Dormant oil will not help control winter moth caterpillars that 'balloon' into blueberry bushes from surrounding trees. Ballooning occurs when caterpillars spin a silken thread and are carried by the wind. Oak tree buds are still dormant when winter moth eggs hatch so caterpillars hatching on oak trees are especially prone to ballooning onto nearby blueberries. Through April and May caterpillars can crawl or balloon onto blueberry plants from nearby deciduous trees. Scouting blueberries for winter moth is needed until caterpillars finish feeding late May - early June. At this time winter moth caterpillar's drop to the ground on silken threads, enter the soil to form a cocoon and pupate. Pupae remain in the soil until late November when adult moths emerge again.

To help time sprays for egg hatch in early spring, tree bands can be set up in November. When a climbing female moth encounters a tree band it tends to deposit many eggs below the tree band. These eggs can be monitored in the spring for hatching. Winter moth eggs are first green and then become orange within 2-3 weeks. In the spring, a couple of days before hatching, orange eggs turn light blue. This color change can be monitored using a handlens and allows growers to pinpoint when hatching will take place.

A parasitic fly, *Cyzenis albicans*, has been released at 40 locations in New England since 2005. These flies have been recovered at 17 of the release sites and are believed to be controlling winter moths at one release site so far. The future looks bright for winter moth biological control, but winter moths will not disappear and will need to be monitored and probably controlled in commercial blueberry fields for the foreseeable future.

To be added to my winter moth egg hatching email list please send me an email at hhf@uri.edu.

Finding Revenue in your Blueberry Business

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The Dyson School of Applied Economics and Management at Cornell University has a long history of compiling business summaries for different agricultural sectors in New York with the assistance of Cornell Cooperative Extension. Notable examples of these summaries are the Dairy Farm Business Summary and the Fruit Farm Business Summary (FFBS). Gerald White, Dyson School professor emeritus says that the FFBS "identifies the business and financial information they (growers) need and provides a framework for use in identifying and evaluating the strengths and weaknesses of the farm business." Experience with tree fruit growers using FFBS shows they quickly identify practices that are more costly than state benchmarks and address why their individual costs are higher.

In 2013, Cornell launched a new effort to analyze the financial condition of berry farms in the state through a Berry Farm Business Summary. Led by faculty and staff from the Department of Horticulture, and the Dyson School of Applied Economics and Management, a team of extension educators worked with eight berry farmers across the state to complete farm business summaries. Each farm provided descriptive information on their farm, and income, expense, labor, and capital records.

Eight farms participated in 2013, the first year of the project. Six of the farms had berries as a primary enterprise on the farm, and are smaller farms. Two of the farms primarily grow tree fruit, with berries as an important secondary enterprise. These two farms were larger, making it difficult to draw general conclusions between them and the six smaller farms. One area for further study and possible benchmarking did emerge in the difference between average yields on the farms. For the six farms, average yield of blueberries was 1,985 pounds per acre. When the other two farms are added, the yield increased by 2,312 pounds/acres to 4,297. A more detailed analysis of production practices and management strategies at the enterprise level could show opportunities for higher production rates of berries in New York.

Table 1: Size of Business and Yields

Size of Business	*8 Farms*	*6 Farms*
Bearing Fruit acres	45.60	5.93
Total berry production (lbs.)	41,927.13	15,266.17

Worker equivalent	8.02	2.12
Rates of Production (lbs./acre)		
Blueberries, pounds per bearing acre	4,297.21	1,985.05

In addition to the business summary, an enterprise budget was developed based on input costs and labor costs that were broken down by tasks in a typical high bush blueberry system. Members of the New York State Berry Growers Association then verified the assumptions in the enterprise budgets. Each budget includes cost of production expenses for the pre-plant year, establishment year, and an early production year. Not surprisingly, labor was the most costly component of production expenses, as illustrated by the production year where labor for wholesale or retail berries was 80% of the total expenses. Using information from the business summary, this is also an area that showed differences between the 2 relatively larger farms and the other six farms in the completed analysis. On the 6 farms the average worker could cover 3.44 acres, and when the two other farms are added the average worker handled 4.48 acres. Labor certainly requires careful management for efficiency and maximum profit potential.

Using data from the 2012 NYS Berry Pricing Survey, and the expenses from the enterprise budget, a breakeven analysis was developed based on different yield and price assumptions. Establishment costs were pro-rated over 10 years for the planting. Also, operator labor was included as an expense. In this analysis it showed that farms that are producing 1,876 lbs./acre of blueberries would have to charge $9.00/pound just to cover their costs. On the other hand a farm growing 4,221 lbs./acre would only to need charge $4.00/lbs.

Table 2: Returns to Risk and Management for Wholesale Blueberries, NY 2014

	Yield (lbs./acre)			
Price ($/lb.)	**2,000**	**3,000**	**4,000**	**5,000**
$2.00	$4,000.00	$6,000.00	$8,000.00	$10,000.00
$3.00	$6,000.00	$9,000.00	$12,000.00	$15,000.00
$4.00	$8,000.00	$12,000.00	$16,000.00	**$20,000.00**
$5.00	$10,000.00	$15,000.00	**$20,000.00**	$25,000.00
$6.00	$12,000.00	**$18,000.00**	$24,000.00	$30,000.00
$7.00	$14,000.00	$21,000.00	$28,000.00	$35,000.00
$8.00	$16,000.00	$24,000.00	$32,000.00	$40,000.00
$9.00	**$18,000.00**	$27,000.00	$36,000.00	$45,000.00
Breakeven price	$8.44	$5.63	$4.22	$3.38

For a grower to find additional revenue from their blueberry business, they need to understand their cost of production, pricing, and breakeven yields and prices. Additional production challenges from a changing climate and increasing pest pressure from invasive species can result in higher costs making it even harder to find adequate revenue from blueberries. Growers that have more complete financial information about their business and overall berry economics should be able to better plan to meet their financial goals.

Weed Control and Fertility in Organic Blueberry Production Systems

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Oregon is a leading production region in the U.S. for blueberry and blackberry. While the amount of organic production of these crops on organic farms in the U.S. was relatively small (3%) when last surveyed in 2008, the Pacific Northwest accounted for 40% to 50% of the total area planted to these crops. Our positive research results from long-term certified organic production systems trials (5-year and 9-year trials in blackberry and blueberry, respectively) have had some impact on organic production in our region. In blueberry, certified organic area has increased from an estimated 2% of total planted acreage in 2006 to about 20% in 2015.

Our blueberry trial was designed with input from an advisory committee and included treatments to evaluate the impact of planting method, cultivar, mulch, and fertilizer source and rate. The one-acre research trial was planted in October 2006 and was "transitional" in the establishment years, but was certified organic in the first cropping year (2008) – a typical pattern for commercial growers. The planting was considered mature in the eighth growing season (2014). There were 48 treatment combinations of planting method (raised beds of ~ 1 ft high or flat ground), fertilizer rate and source (a "low" and a "high" rate of either feather meal or fish emulsion), mulch type (sawdust alone; compost topped with sawdust, or weed mat), and cultivar (Duke or Liberty). Plants were spaced 30 inches apart in the row with 10 ft between rows. A grass was grown between rows. The plants were irrigated by drip, and irrigation rate was adjusted to maintain soil water content at similar values across treatments.

The granular feather meal (ranging from 11% to 13% N, depending on product or batch) or fish emulsion (4% to 5% N) fertilizers were applied initially at "low" and "high" rates of 25 and 50 lb N/acre, respectively, during the first few years of establishment (2007–2009) and then increased incrementally as the planting matured to 65 and 125 lb N/acre, respectively, by 2013. In 2007−14, feather meal was broadcast on top of the organic mulches or under the weed mat (around plants from 2007–2010 and opened for application to the in row area from 2011–2014) with half of the total nitrogen (N) applied in March and the other half in May. Fish emulsion was diluted with 10 parts water (v/v) and was applied by hand as a drench around the base of the plants in 2007–2009, side-dressed with a sprayer on each side of the row in 2010, and injected through the drip system (fertigated) in 2011–14 in seven equal applications every 2 weeks from mid-April to early July.

Mulch treatments were: a) Douglas fir sawdust (3" deep to the in-row area); b) yard debris compost (1.5" deep) topped with sawdust (2" deep) ("compost + sawdust"); and c) "weed mat" [black, woven polyethylene ground cover] with sawdust mulch (5 cm) in the 8-inch diameter planting hole. The intent of the compost + sawdust treatment was to have the sawdust mulch act as a barrier to weed seed germination in the more nutrient rich compost layer. The two organic mulches were initially applied just after planting and were then replenished (Jan. 2011 and 2013), as needed, to maintain mulch depth. The solid 1.5-m-wide piece of weed mat, centered over the row, was installed just prior to planting and was replaced with “zippered” weed mat in winter 2010–2011 allowing the weed mat to be opened and granular fertilizers to be applied underneath. Weeds were removed by hand-weeding from plots mulched with sawdust and weed mat (i.e., the planting hole area) and were controlled using OMRI-approved lemon grass oil (Avenger®, Cutting Edge Formulations, Inc., Buford, GA), 20% acetic acid (vinegar) or propane flaming/heat, depending on the year, in addition to hand-weeding in plots mulched with compost + sawdust. Labor and product costs were recorded.

Ripe fruit were harvested by hand approximately every 7 days. In 2011–2014, the planting was sprayed weekly with a spinosad insecticide (“Entrust® SC”; Dow Agro Science, Indianapolis, IN) or a pyrethrin (“PyGanic”®), from when the ‘Liberty’ fruit first turned blue through harvest, to help control Spotted Wing Drosophila [*Drosophila suzukii*]; applications to the early-season ‘Duke’ were not required as insect populations were very low. In 2013–2014, *Bacillus subtilis* (“Serenade® MAX”; AgraQuest, Davis, CA)] was applied in spring for control of botrytis, per label rate and recommendations. No other pesticides were required during the study period. Scare alarms (Bird Gard LLC, Sisters, OR) were used for bird control. To determine the returns per treatment, fruit were sold to a commercial organic berry packer (fresh and processed markets).

While mechanical methods of weed control may be possible in flat ground planting systems, plants grown on raised beds averaged 28% more yield than on flat ground. We only recommend planting on raised beds now. In our long-term study, there has been no effect of mulch type on yield or fruit quality – this is good news for growers.

The between-row, grass cover crop was maintained by mowing and the edges by using vinegar (when planting was young) or a string-trimmer (presently). Drip irrigation (only in the row) reduced grass growth in our dry summers. Weed “pressure” in the row increased as the planting aged. Weeds were fewest in the weed mat mulch (only around “planting hole” area) and greatest in the compost topped with sawdust mulch. Weeds were hand-pulled in all treatments. While Avenger Ag® and vinegar were used as contact herbicides, these products were only effective when weeds were quite small and application was followed by hot, sunny days. Propane heat/flaming was not effective or safe. Hand pulling of weeds was thus needed frequently in the compost + sawdust mulch treatment greatly increasing the weed management costs in this mulch type. While weed mat offered the most economical way to control weeds, plants grown with weed mat required 30 to 50% more irrigation – likely a result of a change in plant architecture and an increase in soil temperature in this treatment. Addition of compost to the mulch layer did provide a source of nutrients to the field (Table 1) and the high pH of the yard debris compost used helped mitigate the decline in soil pH that occurs with fertilization over the planting life. We are continuing to evaluate the impact of these mulches on soil and plant nutrient levels.
We analyzed all of the organic fertilizers used for nutrient content (Table 1). While we applied the products to “hit” a target rate of N based on the percentage of N as stated on the product labels, there was less N in the product and thus lower rates of N were applied. In addition to N, these organic fertilizers also contained high amounts of K (fish emulsion) and Ca (feather meal). The addition of these other nutrients when using organic fertilizer materials or products, even when they are not required by the plants, must be considered in these organic production systems. Available fertilizer sources differ in cost of application and in cost per pound of N. For

example, feather meal was applied as a granular product on top of the organic mulch or under weed mat, whereas fish emulsion was successfully fertigated. Costs averaged $4.50/lb of N for the feather meal and $8.15/lb of N for the fish.

We observed cultivar differences in plant growth and yield response to fertilizer source and rate during establishment and maturation. When plants were establishing, fish emulsion increased growth compared to feather meal, likely because N in the fish was more available to plants when needed. In the later years of the study, when the first application of feather meal was done earlier to improve N availability, there was little effect of fertilizer source and rate in ‘Liberty’, on average, whereas ‘Duke’ had greater yield when fertilized with feather meal than with fish emulsion.

When we began our research, the most common production system used in organic fields was growing blueberry on raised beds, mulching with sawdust and fertilizing with fish emulsion. When we compare cumulative yield in our study to this industry standard, ‘Liberty’ had a greater yield when fertilized with feather meal than with fish when sawdust mulch was used, whereas fertilizer source had little impact when compost + sawdust or weed mat mulch were used. In contrast, fertilizer source had a large impact on yield of ‘Duke’ with little effect of mulch. In ‘Duke’, fertilization with the low rate of fish emulsion led to greater yield than with the high rate of fish.

We have also evaluated the adaptation of eight other cultivars to organic production systems over 9 years. Some varieties have been less adapted to the organic systems trialed, indicating growers need to choose wisely to get good production and returns. We have also tested various additional types of organic fertilizers and can now offer growers specific recommendations, including some others that may be applied through the drip irrigation system. Since our research began, weed mat has become very common in organic as well as conventional blueberry fields in the Pacific Northwest thus reducing costs of herbicides and hand weeding.

I’d like to thank the Research Assistants, Graduate students, scientific colleagues, growers, industry contributors and those who funded the research for all of their support.

Table 1. Nutrients applied to mature blueberry (since 2013) using organic fertilizer sources and mulches.

Fertilizer source	Treatment name	Target rate (lb N/acre)	Nutrients applied based on actual fertilizer content (as analyzed in a lab)										
			Macronutrients (lb/acre)						Micronutrients (oz/acre)				
			N	P	K	Ca	Mg	Na	B	Fe	Mn	Cu	Zn
Feather meal	"low"	65	58	1.5	2.7	3.6	0.3	0.5	0	7	1	0	5
	"high"	125	112	2.9	5.2	7.0	0.5	1.0	0	14	1	1	10
Fish	"low"	65	60	13	18	0.2	5	45	1	5	2	0	6
	"high"	125	115	25	35	0.4	9	87	2	10	4	0	11
Mulch[z]	sawdust	2-3" deep	62	5	20	27	5	-	32	-	16	-	0
	compost	1.5" deep	545	86	305	546	127	-	32	-	385	-	96

[z]Nutrients applied in volume of sawdust alone and the yard debris compost portion of the compost + sawdust mulch treatment. Mulch was replenished over the study; only one application is provided here.

Bernadine Strik evaluating blueberry growth in the certified organic blueberry research planting at Oregon State University's NWREC, Aurora, OR, 2013

Invest in Pollination for Success with Highbush Blueberries

Emily May
Pollinator Conservation Specialist
The Xerces Society for Invertebrate Conservation
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Blueberries require pollination by bees in order to yield a large, marketable crop. Better pollination (e.g., more bees pollinating) = bigger berries. Advance planning for pollination management is essential to maximize blueberry growers' return on investment for their crop. Some of the main takeaway messages from this talk include:

- Both managed bees and wild bees can be important contributors to blueberry pollination.
- Honey bees are key managed pollinators that can be moved into fields for bloom and removed in time for post-bloom pest management. Stocking rates can be adjusted to fit different farm and cultivar requirements. Cultivars vary in how much cross-pollination they need – set stocking rates accordingly.
- Wild bees - some of which are extremely efficient blueberry pollinators – can be plentiful and diverse in landscapes with natural habitat. Their populations can be enhanced in other landscapes by providing food and shelter resources on farm.
- Blueberry flowers are only receptive to pollen for a few days, so it's important to get them pollinated quickly. With variable spring weather, this means it's key to have bees ready to go after rainy or cold days.
- Diversifying your sources of pollination may help manage pollination risk. Bumble bees are excellent blueberry pollinators that fly in colder and rainier weather than honey bees, and may be a good addition to honey bees in areas with variable spring weather. Bumble bees can be purchased from commercial suppliers or can be encouraged on farm by providing flowering resources that bloom throughout the summer.
- Conserve wild bees by setting aside or creating new flowering habitat for their nesting and food after blueberry bloom.
- Minimize pesticide risk: don't spray when bees are active on crop flowers, spray at night or in the early morning, select less toxic chemistries whenever possible, and minimize spray drift onto flowering plants in field margins after crop bloom.

For more information and a variety of resources on growing blueberries, visit http://blueberries.msu.edu/.

Integrated Crop Pollination Project

Different strategies to support pollination of fruit and vegetable crops are currently being monitored on over 100 farms nationwide as part of the Integrated Crop Pollination Project, a multi-year research partnership involving fifteen organizations, including research institutions, federal agencies, and other interdisciplinary stakeholders. Integrated Crop Pollination (ICP) is a concept that combines the use of managed pollinators (such as honey bees, bumble bees, and mason bees) with the restoration of habitat for wild pollinators and the adoption of bee-friendly farm practices to ensure the reliable and economical pollination of crops. For more information, check out the project website at http://www.projecticp.org/.

Emily May is a Pollinator Conservation Specialist for the Xerces Society for Invertebrate Conservation (www.xerces.org), a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. She holds a Master's degree in Entomology from Michigan State University, where she studied bee communities on highbush blueberry farms.

Innovations in Blueberry Product Marketing

Theresa Gaffney
Highland Blueberry Farm
Highland Organics® **"A taste of wild Maine in every blueberry."**
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Stockton Springs, ME 04981
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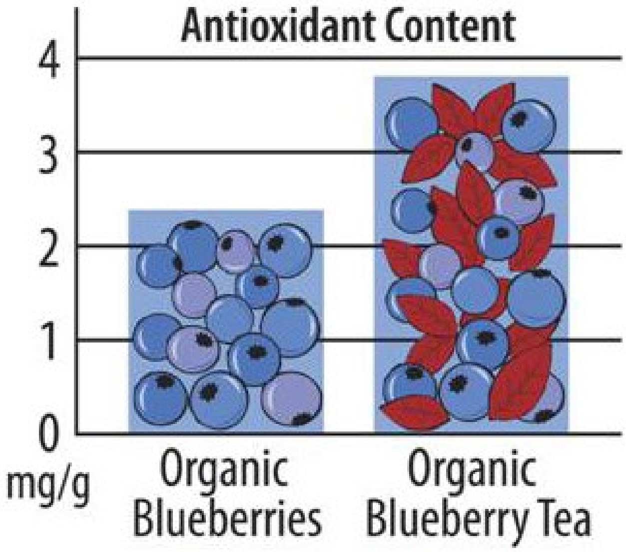
highlandblueberryfarm@gmail.com
www.AtasteofwildMaine.com

Together, Tom Gaffney and I have been stewards of Highland Blueberry Farm since 1989. We began transitioning our farm from conventional practices in 1999 and have been certified organic by the Maine Organic Farmers and Gardeners Association (MOFGA) since 2002. In that time, together with a community of family, friends, and wise advisors, we have been learning how to minimize what man has done to "cultivate" the plant and fruit, while maximizing what God has perfectly created. This principle has guided the care of the fields, the nurturing of pollinators, harvesting and processing, and the care of staff and customers. It is a work that we both have enjoyed.



Testing done by Dr. Crowe for Highland Blueberry Farm™

As a part of **Highland Blueberry Farm, Highland Organics®** was privileged to introduce the first-ever organic whole plant ***Wild Maine Blueberry Tea*** in 2006. Our story began with a question: What value and purpose could the crimson-red blueberry leaves have? On a visit to the farm in 2004, Dr. Kristi Michele Crowe, then doctoral student at the University of Maine, Orono, Food Science and Human Nutrition Department, shared with us that she was looking for a project to do for the National Science Foundation program at a local high school chemistry class, Hampden Academy High School, Hampden, Maine. We posed this question to her and she thought it would make a great hands-on science project for the students. This would in turn benefit our farm with the research we needed to answer this question. Dr. Crowe, teacher Bill Leathem, and students from the high school came to Highland Blueberry Farm, harvested the crimson red blueberry leaves by hand and returned to their lab with their samples. Together scientist, teacher & students, tested the blueberry leaves for anthocyanin levels. This is the first time that this type of research on low-bush wild Maine blueberry leaves had ever been done. To everyone's surprise, the anthocyanin count was higher in the blueberry leaves than they were in the organic blueberries that were tested from Highland Blueberry Farm! What does this mean for you and me? Well, anthocyanins are also known as antioxidants. Antioxidants help to neutralize free radicals, which are unstable molecules that are linked to the development of a number of degenerative diseases and conditions including cancer, cardiovascular disease, cognitive impairment, immune dysfunction, cataracts and macular degeneration. Fruits and vegetables are sources of natural antioxidants and among them blueberries have one of the highest levels of antioxidant activity.

Highland Blueberry Farm received 3 Maine Technology Institute Seed Grants for the research and development of the Organic Whole Plant Wild Maine Blueberry Tea. These grants have helped to develop equipment for harvesting and drying of the blueberry leaves. The first harvest begins in August with the harvest of the organic wild Maine blueberries and the second harvest takes place in September with the organic blueberry leaves, which is considered a waste by-product in the agricultural industry currently. This second harvest has given us the potential to become a year-round farm business, benefiting Maine with this first ever value-added product. The research phase of the grants allowed us the opportunity to work with many people and departments at the University of Maine, such as the Department of Food Science & Human Nutrition and the College of Engineers at the Advanced Manufacturing Center. Our product has undergone testing to determine optimum drying times for the blueberries and the blueberry leaves, while preserving antioxidants in both. In the past, young people from local communities would work with our family to harvest the blueberries. The second harvest of leaves would begin in the fall when the women from a residential discipleship program would come to the farm and harvest blueberry leaves, clean them and preparing them to be packaged with the dried blueberries into this first-ever whole plant blueberry tea. To see pictures and read more visit: http://www.organicblueberrytea.com/pdfs/historyhighland.pdf.

Highland Organics® is committed to utilizing earth-friendly packaging choices. As part of our efforts to minimally impact the environment, our unique Organic Whole Plant Wild Maine Blueberry Tea is sold in containers that we hope will encourage recycling/reusing among our customers. We have also begun switching our labels for our products over to the White Earthfirst labels which are offered by Lightning Label. These labels are made from corn and not petroleum. Our 1 oz. and 2 oz. tea tins, 1.5 oz. and 3 oz. barque labels have already made the switch! Soon all our labels will be Earthfirst.

We use Cellophane bags for packaging some of our gift sets which is a wood byproduct and is biodegradable and recyclable. All our shipping material used in packing product for mailing is packed with recycled materials that we use here on the farm. If it can be shredded or crumpled and it is clean and reusable, we use it. If we use packing peanuts, they are recycled ones that we have received from others or they are made with corn so that water will “melt” them away.

Along with our world famous Organic Whole Plant Blueberry Tea, we also offer our pureed and dehydrated organic blueberries as a snacking treat known as Organic Blueberry Barque. We just introduced to the market this year our organic blueberry barque in a glass sprinkle jar with a shaker top as our Organic Blueberry Sprinkles. We also have large steeping bags of the organic blueberry barque so folks can make a gallon container of our famous organic blueberry cold drink which we sell at our farmers markets’ in the summer, splashed with lemonade! This is a huge hit!

We became famous with our organic whole plant wild Maine blueberry tea as a premium loose leaf tea, but once our blueberry tea became available in tea bags that we hand fill at the farm, we really took off. Which is understandable since tea is the #1 drink in the WORLD! Couple that with being the only ones to offer a whole plant ORGANIC blueberry tea made with only 2 ingredients, and now we are just trying to keep up with the demand. In 2014, we began offering our blueberry tea bags with other flavors, such as our Organic Whole Plant Blueberry Tea and Organic Lemon Verbena; this tea bag makes an excellent cold tea. Our newest flavor, which has not been added to the website yet, is Organic Whole Plant Blueberry Tea, Organic Lemon and Organic Lavender. We started wild harvesting Chaga last year and we now add this to our Organic Whole Plant Blueberry Tea which makes a super antioxidant tea. We love what we do and our fun continues, as ***we*** continue to think outside our box!

Improving Branching of Apple Trees from Nursery to Orchard

Win Cowgill
Rebecca Magron
Jake Peterson
Mike Beese
New Jersey Agricultural Experiment Station, Rutgers, The State University

Wes Autio
Jon Clements
UMASS- Amherst

Terence Robinson
Cornell University

Introduction

With the rapid adoption of the Tall Spindle Apple production system for apple production, growers need to utilize very high quality feathered trees to ensure production in the second leaf and help cover the significant increased costs of establishment. Feathered trees are the critical component of most high-density apple planting systems including the Tall Spindle. As the benefits of highly feathered trees were discovered, it became necessary to develop nursery management techniques to stimulate lateral branch development. (Robinson, Black, Cowgill, 2014) so that apple nurseries can produce the well feathered tree that growers demand for these systems. Promalin was shown to branch apple trees as early as 1983. (Green, 1983)

In the spring of 2009 a new branching chemical, Tiberon, was registered, and was used commercially in the Northwest of the US. Its use significantly improved the quality of apple nursery trees. For Currently the future use of Tiberon is in doubt since Bayer Corp. has withdrawn the product (Robinson, Black, Cowgill, 2014). In 2010-2013 Robinson et al conducted branching experiments in NY, Washington, Chile, with Maxcel and Promalin. Beginning in 2012 Cowgill and Robinson did additional apple branching research at a nursery location in Delaware.

Abstract of Experiments for Branching Apple Trees in the Nursery
Apple tree liners produced in nurseries worldwide typically do not form adequate branches (feathers) in their growth cycle to suit the demand of commercial orchardists utilizing high density production systems of 1100 trees per acre or more. Feathered nursery trees are a critical component of most high-density apple planting systems including the Tall Spindle. Six plant growth regulator research trials were conducted from 2012-2014 in consecutive years at a commercial nursery in the state of Delaware, USA, to identify plant growth regulator (PGR) materials and their application techniques to induce apple tree branching in the nursery. Various rates and timings of Maxcel® (6-Benzyladenine 1.8%) and Promalin® (6-Benzyladenine 1.8%) + Gibberellin A4 and Gibberellin A7) as compared to Tiberon™ (Cyclanilide (2.8%); 1,2-Propanediol were evaluated in 2012. Cultivars treated included Golden Delicious, cv 'Gibson' and Macoun. In 2013 an experiment was conducted on Fuji cv 'Daybreak' and Macoun to evaluate different rates and number of applications of Maxcel® or Promalin®. Our results in these 4 experiments indicate that both 4-5 applications of Maxcel® or Promalin® at 400-500 ppm significantly improve branching over Tiberon™ or the untreated control liners; with 10-17 branches on the Maxcel® and Promalin® liners vs 0-5 branches in the untreated control (UTC) or Tiberon™ liners. In 2014 two additional experiments were conducted to determine the effect of the number of Maxcel® or Promalin® sprays on branching of Fuji cv 'Daybreak' apple nursery liners and to screen wide range of additional varieties (12) for the best treatment, Maxcel® or Promalin®. In the 2014 Fuji experiment both Maxcel® and Promalin® induced a significant increase in the number of feathers with Fuji/M.9 trees compared to the untreated controls. Maxcel® treated trees had an average of 15 feathers while Promalin® treated trees had an average of 13 feathers and the untreated trees had 5 feathers. For the variety screening experiment we selected the best two treatments from our work in 2012 and 2013, Maxcel® @400 ppm and Promalin® @ 400 ppm + Surfactant (Regulaid® @1 pint/100gal). We also added treatment Promalin® @500 ppm + Surfactant. Among varieties, Cripps Pink (Pink Lady) and Enterprise had the highest tree quality ratings when treated with either Maxcel® or Promalin®. Aztec Fuji and Ambrosia had the next highest quality ratings followed by Crimson Crisp, Empire, Gala, Golden Delicious, Honeycrisp and Suncrisp. Royal Cortland, Ruby Mac had the least response to Maxcel® or Promalin®. There was no significant difference in tree quality (number of feathers and height) between those treated with Maxcel® or Promalin® when averaged over all 12 varieties. Standard recommendations for east coast USA nurseries are being developed from this

work for the use of Maxcel® and/or Promalin® to allow for well-feathered apple liners in the nursery.

Branching Experiment at Rutgers Snyder Farm

Following the Delaware ACN nursery treatments in 2012, the trees were dug in November and the experimental trees were planted at Rutgers Snyder Farm. Data was collected annually to track the effect of the branching treatments on the trees in the orchard. **In 2014 Maxcel 500 PPM significantly increased the yield per tree over the other treatments and the untreated control. The yield per acre of all treatments was 413 Bushels per acre in the second leaf on this tall spindle block.**

Table 1 -2014 -Golden Delicious Data for ACNursery trees planted 12/2/12 at Rutgers Snyder Farm, NJ**.** Data includes 2012 # of feathers, 2014 yield per tree, 2014 Return Bloom, 2014 number of fruit per tree and pruning/training times in 2013 and 2014.

Treatment Chemical, PPM, # of Applications	2012 Number of Feathers/Tree		2014 Yield KG/Tree		2014 Return Bloom Clusters/Tree		2014 Number of Fruit/Tree		2013 Time	2014 Time
Maxcel 500 x 2	13	bcd	6.5	ab	334	ab	28	ab	78.2	51.8
Maxcel 500 x 4	17	abc	6.9	ab	284	ab	28	ab	68.2	54.5
Maxcel 500 x 5	21	a	7.9	a	372	a	33	a	63.5	52.5
Promalin 500 x 2	13	cd	5.6	bc	291	ab	23	bc	72.5	38
Promalin 500 x 4	17	abc	6.1	abc	317	ab	25	ab	57.7	44.8
Tiberon 100 x 1	11	d	5.6	bc	288	ab	23	bc	78.2	46.3
Tiberon 500 x 2	10	d	4.4	c	232	b	19	c	60.4	39
UTC	9	d	5.3	bc	245	ab	22	bc	73.8	39.4

Levels not connected by same letter are significantly different.
LS Means Difference Tukey HSD α =.05

2014 Return Bloom was significantly different (p=.05);
2014 Number of Fruit was significantly different (p=.001)
2014 Yield (Kg) was significantly different (p=.0003)

Recommendations for the New England orchards/nurseries

For most varieties my best recommendation is Maxcel @ 500ppm with no added surfactant, 3-4 applications begging at 35 inches of tree height and repeated at 10-14 day intervals (5-6 inches of new growth).

For Macoun Promalin at 500ppm + Regulaid @ 1 pint/100 is the treatment of choice. Make 3-4 applications begging at 35 inches of tree height and repeated at 10-14 day intervals (5-6 inches of new growth).

New England and Cooler Climates- as you move north the temperatures are cooler and the growth rate slower. 3-4 applications may be enough made at 5-6' of growth intervals. The Maxcel 500ppm rate will be more appropiate under cooler conditions. IN NJ and mid-Atlantic we are recommending 5 applications at 5 inches of new growth.

Orchard Recommendations

Even if growers' plant whips, Maxcel can be used in the orchard to induce branching. We have had good results with Maxcel sprayed at 500ppm to the un-branched leader from the tip down the existing branches or to 24 inches above the soil line (on one year old trees) at 10-14 days after bud break, to green tissue (Miranda and Robinson, unpublished).

On older trees in the orchard that need branching, one to three year trees planted in a tall spindle, we have seen good results treating with Maxcel at 200ppm in an airblast sprayer. (Cowgill, un published) targeted at the parts of the tree that need branching. Green at UMASS also has had good results with branching apple in an orchard situation with Maxcel at 200ppm in airblast or a back pack sprayer.

Inducing Branching in the field before bud break with Maxcel or Notching

See the following articles by Clements, Cowgill, Autio:
Using a Heading Cut vs. Notching vs. BA Application
to Induce Branching in 'Non-Feathered' 1st-Leaf Orchard Nursery Trees
http://extension.umass.edu/fruitadvisor/fruit-notes/fruit-notes-summer-2010-vol-75-no-3
https://hrt.msu.edu/glfw/GLFW_2009_Abstracts/2009_28.pdf

The Authors appreciate the financial support of Adams County Nursery, The International Fruit Tree Association, the Northwest Nursery Improvement Institute, Rutgers University, the New Jersey Agricultural Experiment Station. In addition thank you to Mike Beese, Dave Johnson and numerous other Rutgers Master Gardeners who assisted with hundreds of hours of data collection.

Terence L. Robinson, Brent Black, Win Cowgill, 2014. Use of Multiple Applications of maxcel and Promalin to Produce Feathered Trees. Compact Fruit Tree, Volume 47, No.1, 23-28.

Duane W. Green, 1983. Use of Promalin to Increase Branching of Young Trees. Fruit Notes, vol. 48, No. 20-22.

Climate Change Update for New England Tree Fruit Growers

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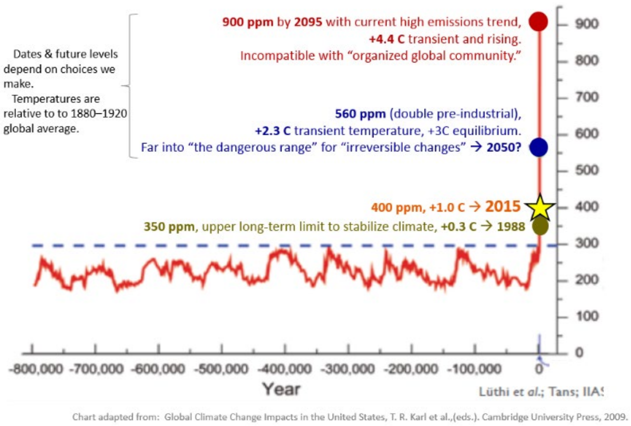
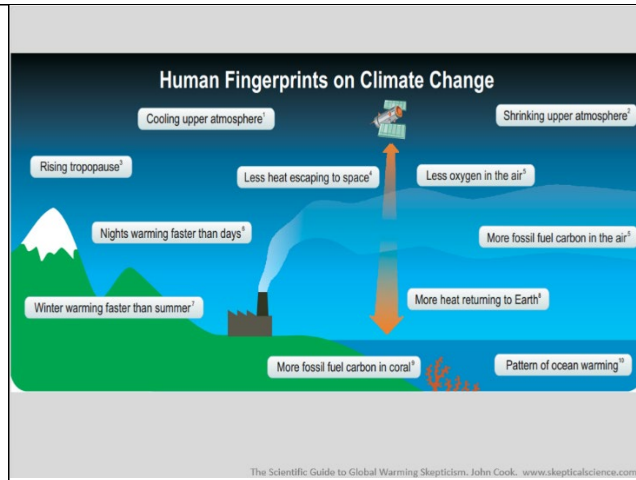
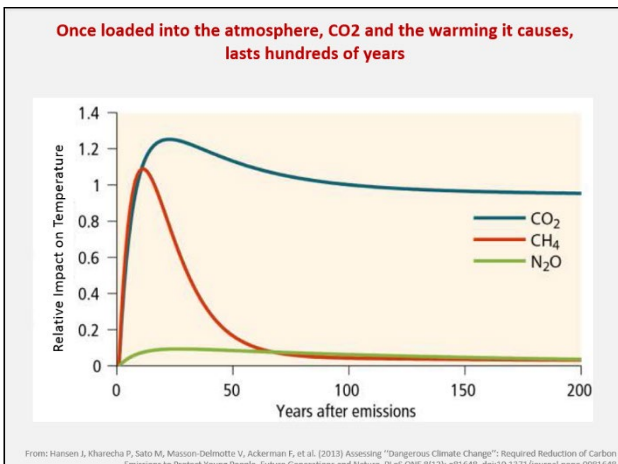
Half the atmosphere
is within 3.3 miles of the surface.
If Earth was the size of an apple …
NASA photo

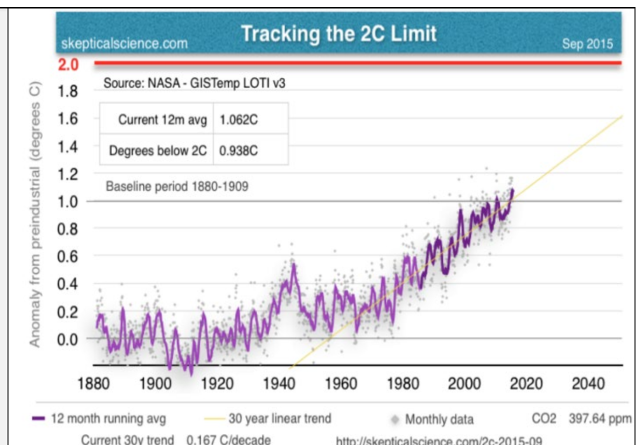

… the atmosphere would be thinner than the skin.
Image by Kevin Van Aelst. http://www.kevinvanaelst.com

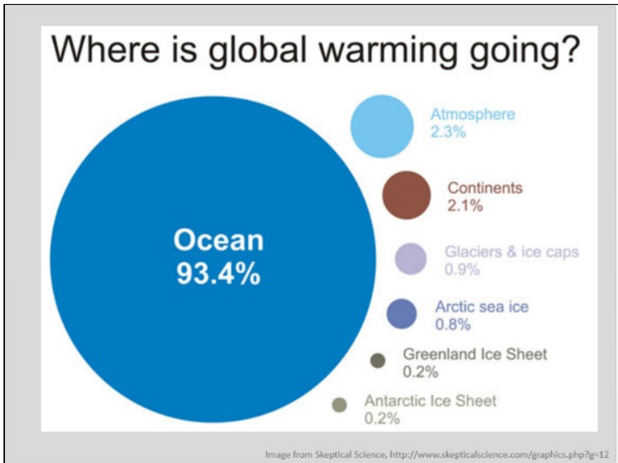


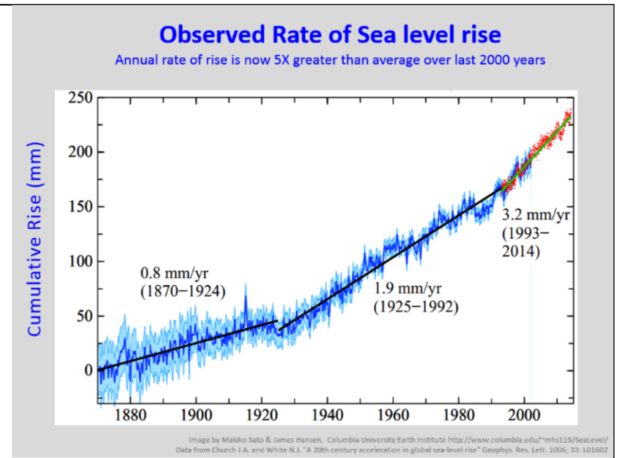


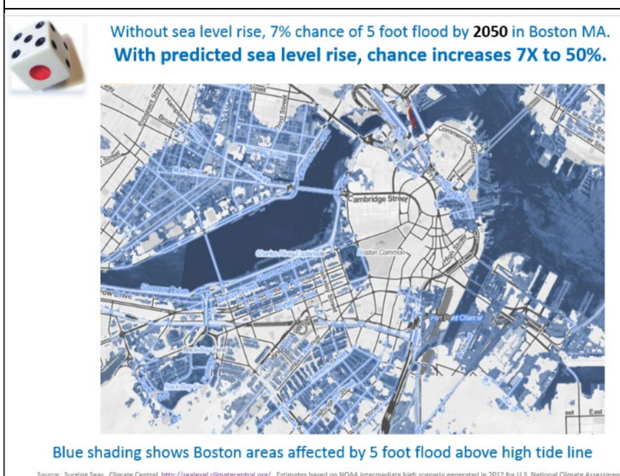
While it is impossible to discuss a topic as complex and multifaceted as global climate change in 25 minutes, this presentation will begin with a quick overview of the key concepts that explain why and how the global climate is changing, and changes that have already been observed in our region that are most relevant to orchard management. For example, between 1948 and 2011 the frequency of "once in 12 month" rain storms increased to "once in 6.5 months." Our flyby of this immense topic will then cover some of the temperature and precipitation changes expected in New England over the next 30 years, and conclude with some thoughts on meeting the challenges, opportunities, and responsibilities that are upon us.

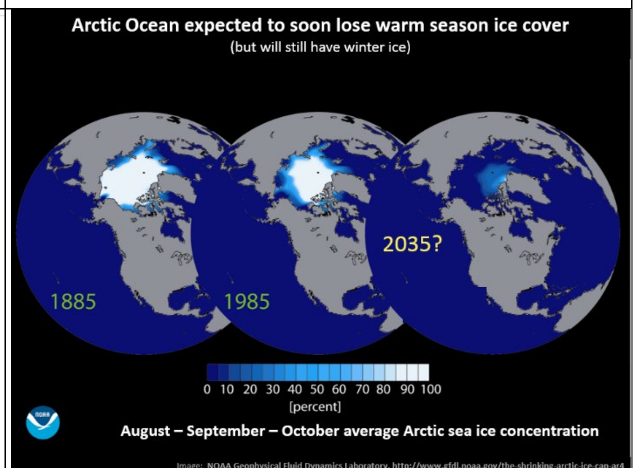


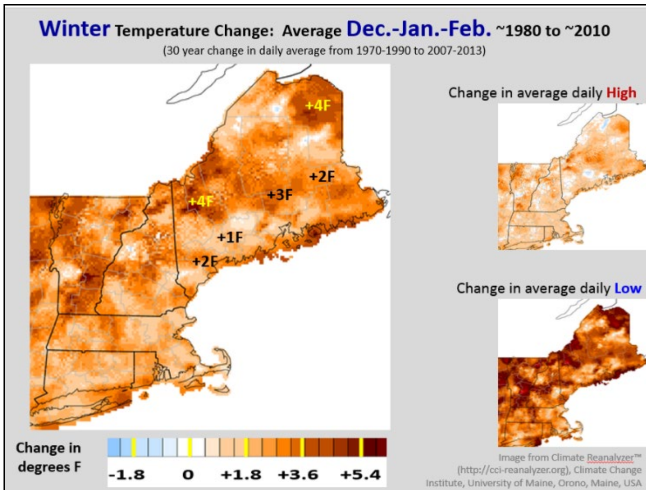


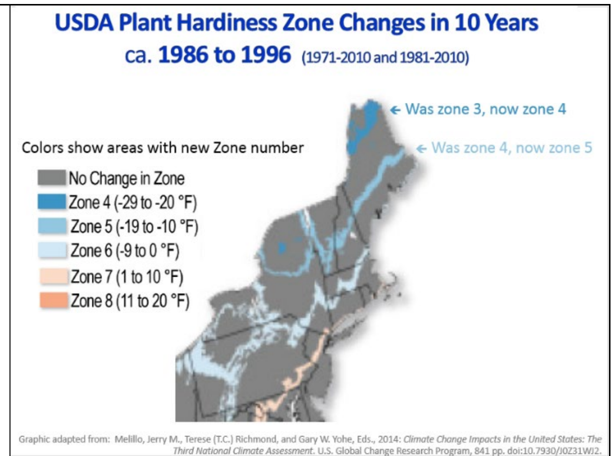

Where is global warming going?
Ocean
93.4%
Atmosphere
2.3%
Continents
2.1%
Glaciers & ice caps
0.9%
Arctic sea ice
0.8%
Greenland Ice Sheet
0.2%
Antarctic Ice Sheet
0.2%
Image from Skeptical Science, http://www.skepticalscience.com/graphics.php?g=12

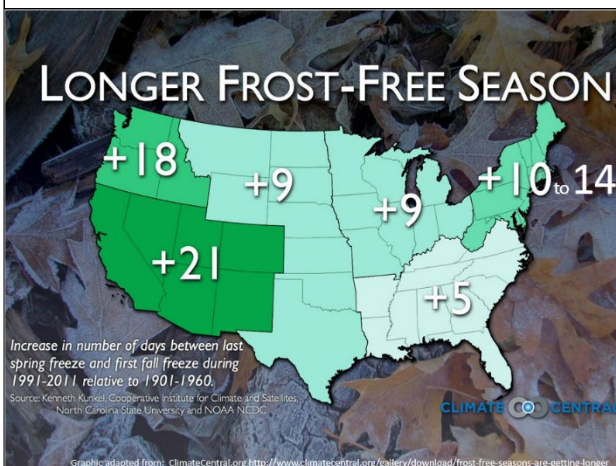

Observed Rate of Sea level rise
Annual rate of rise is now 5X greater than average over last 2000 years
Cumulative Rise (mm)
0.8 mm/yr
(1870–1924)
1.9 mm/yr
(1925–1992)
3.2 mm/yr
(1993–
2014)
0
50
100
150
200
250
1880
1900
1920
1940
1960
1980
2000


Without sea level rise, 7% chance of 5 foot flood by 2050 in Boston MA.
With predicted sea level rise, chance increases 7X to 50%.
Blue shading shows Boston areas affected by 5 foot flood above high tide line


Arctic Ocean expected to soon lose warm season ice cover
(but will still have winter ice)
1885
1985
2035?
0 10 20 30 40 50 60 70 80 90 100
[percent]
August – September – October average Arctic sea ice concentration
Image: NOAA Geophysical Fluid Dynamics Laboratory. http://www.gfdl.noaa.gov/the-shrinking-arctic-ice-cap-ar4







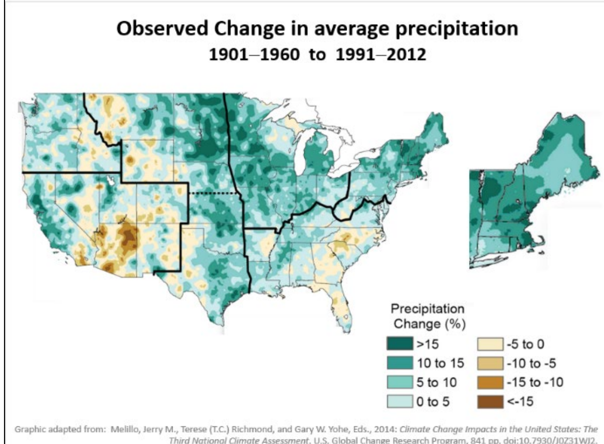


Figure 4: Extreme Storms Are Happening More Frequently Across Much of the United States

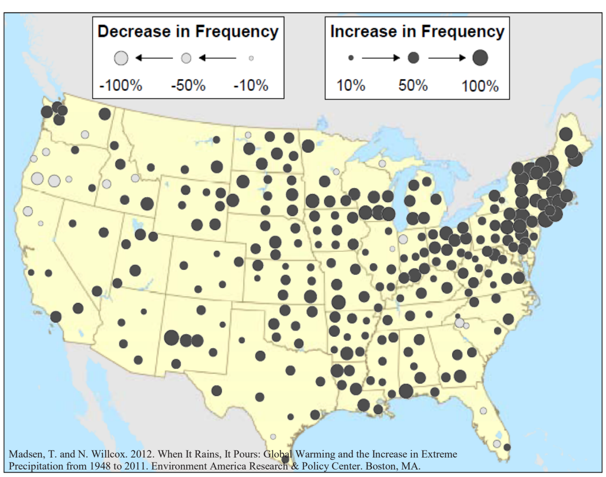
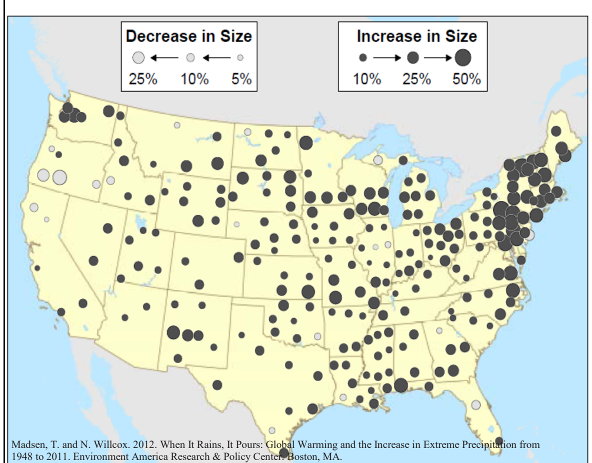
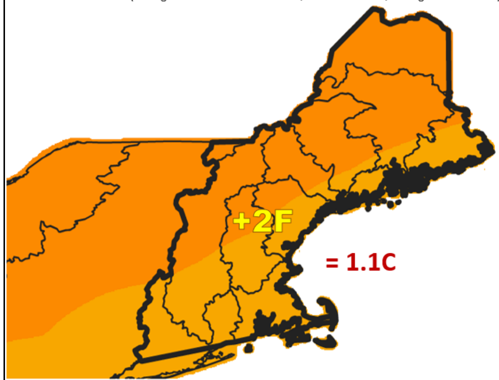


Figure 6: The Largest Annual Storms are Getting Larger Across Much of the United States



Change in annual average maximum Temperature, ca. 2010 to 2040

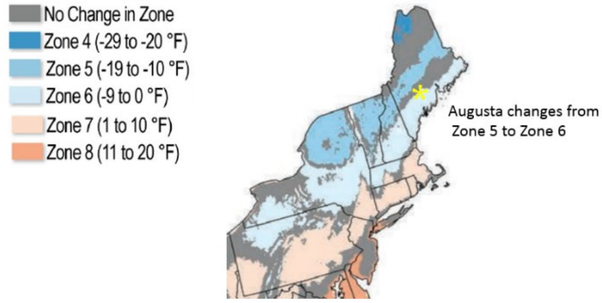
(average 2005-2015 vs. 2035-2045, RCP8.5 scenario, average of 30 models)



From NEX-DCP30 Viewer. J. Alder and S. Hostetler, U.S. Geological Service. http://www.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

Plant Hardiness Zones Changes Expected by 2045

Colors show areas with new Zone number



Graphic adapted from: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Forecast Changes in Growing Season

Prediction for 2045 (30 years from now)

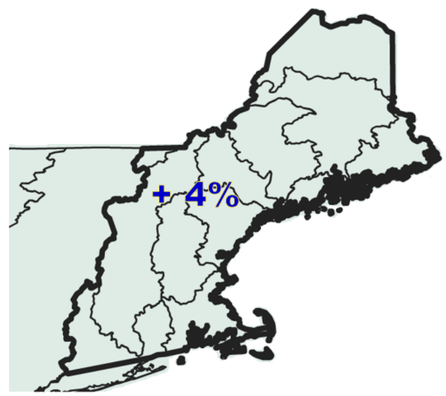
* **Growing season in Northeast expected to add another +10 to +17 days** (primarily because of earlier date of last spring freeze)

* **Apple Bud break and Bloom dates expected to occur earlier by another 3 to 6 days**

Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

Change in annual average Precipitation, ca. 2010 to 2040

(average 2005-2015 vs. 2035-2045, RCP8.5 scenario, average of 30 models)



From NEX-DCP30 Viewer. J. Alder and S. Hostetler, U.S. Geological Service. http://www.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

Risk is not dictated by the environment

Risk is a combination of
Environment,
Vulnerability, &
Resilience.

By reducing Vulnerability and building Resilience, you can reduce Risk.

From IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

Getting the Upper Hand on Fire Blight

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Ask any apple grower and they will tell you the most feared disease is fire blight. Caused by the bacteria *Erwinia amylovora*, fire blight has the ability to devastate an otherwise healthy orchard in one season. The last couple of years have been especially challenging fire blight years in the East, and it is important to understand the disease in order to manage it effectively. The following talk will describe the who, what, why, when, where, how and how much of everything you need to know about fire blight and its management in preparation for the coming season.

Fire blights hosts: obvious and less obvious
Everyone is aware apple, pear, and quince are targets for the fire blight bacteria. Don't underestimate the hosts that linger in the orchard (crabapple), surrounding woods (hawthorn), and in the landscape (cotoneaster, fire thorn, mountain ash, Bradford pear). The host range of the bacteria includes 130 species in 40 genera. These hosts are most likely not being controlled for the disease and can provide additional sources of bacteria to wreak havoc in your orchards if these plants are nearby. In addition, not all apple cultivars and rootstocks are created equal when it comes to susceptibility to the disease. Remember: resistance does not mean immune. If disease pressure is very high even traditionally tolerant cultivars, such as Red Delicious, can become infected.

Where do the bacteria overwinter?
The bacteria overwinter in living tissue surrounding cankers formed at the base of spurs or shoots killed the previous season. Cankers also will form where cuts were made to remove infected shoots during the growing season. Bacterial populations are influenced by temperature and can grow in a range of 50°F to 90°F. Bacteria will begin to multiply at canker margins early

spring, typically between tight cluster and early pink, and begin to ooze, and the ooze contains trillions of bacteria. This is important because this is when the bacteria are first available for dispersal in the orchard.

Bacteria dispersal and colonization

Insects (mostly flies) are attracted to the sweet, sappy bacterial goo oozing from canker sites. These insects will begin to unknowingly disperse the bacteria from tree to tree by leaving colonies of bacteria wherever they walk. Bacteria are capable of surviving and multiplying on plant surfaces several weeks before flowering begins. In addition, the bacteria can also be dispersed by rain (directly or as aerosols), or carried on even modest winds.

Once the first early opening flowers are colonized by bacteria, further dispersal is not only rapid, but specifically directed at open flowers through the activities of honey bees and other pollinators. The five stigmas in the center and top of each blossom have a moist, nutrient rich surface that supports their colonization of the bacteria to high levels even though infection has not yet occurred. One day at 88°F is enough to build a very high bacterial population. As pollinators arrive to collect pollen, the bacteria are picked up on their body hairs and are then subsequently moved to other flowers in the orchard.

Blossom blight phase

Warm weather builds the bacteria population; water/moisture triggers the infection event. Both bacteria and water must be present in the bloom for blossom infection to occur. If rain or dew does not occur during bloom, the pollinated flowers will go ahead and set healthy fruit despite the presence of the bacteria. Unfortunately, bacteria have flexible legs call flagella, which make them very efficient swimmers, and if rain or dew does occur during flowering, the water will move the bacteria from the stigmas to the open nectaries, where over 90% of blossom infections occur. Once inside the plant, the bacteria will move systemically via the plant's vascular system. The younger the tree, the faster the bacteria will move inside the tree. Above 60°F, colonization and infection of the nectaries appear to occur within minutes. Once a blossom infection event does occur, symptom development (black and wilted tissue) can range from 5-6 days under warm conditions to 30 days or more under cool conditions.

Canker blight phase

Canker blight is often a head scratcher and, consequently, grossly underestimated for its ability to cause damage in the orchard. Canker blight develops due to renewed activity by the bacteria at the margins of overwintering cankers from the previous season and occurs regularly every year where the disease is established. In other words, if cankers are left in your trees, you can count on canker blight. The bacteria move systemically from the canker into nearby growing, succulent vegetative tissue. Often times, water sprouts close to active canker sites will develop a distinct yellow to orange color and begin to wilt. Another distinct feature is canker blight "shoot blight" will appear as if the infection is starting from the base of the shoot, as opposed to the shoot tip, which is characteristic of typical shoot blight. In years when blossom infection events do not occur or have been well controlled, active canker sites serve as the primary source of bacteria for a continuing epidemic of secondary shoot blight infections that can lead to major limb, fruit and tree losses.

Shoot blight phase
Shoot tip infections are incited on the youngest 2-3 tender, un-expanded leaves at the tips of vegetative shoots. The significance of these infections are twofold: 1) they tend to progress downward rapidly, often invading and destroying larger supporting limbs; and 2) as bacteria becomes abundant in the orchard, leaf surfaces are colonized by the bacteria (arriving from earlier blossom infections, active cankers or young shoots systemically invaded by bacteria from nearby cankers), but cause no harm so long as they remain on the surface and there is no injury. Unfortunately, injury can easily occur. When potato leafhoppers feed on shoot tips, they will cause damage, thereby creating an entry for the bacteria to enter the plant. A more likely factor for injury is wind, and it does not necessarily need to be high winds associated with storms.

Trauma blight phase
The incidence of severe fire blight associated with damage caused by hail and high wind is well known by experience. Much like shoot blight, leaf surfaces already colonized by the bacteria are severely injured during hail and wind storms so that the bacteria have ready access to internal leaf tissues and the vascular system. When such trauma-inducing events occur, the amount of fire blight that follows appears to be directly related to the amount of foliar colonization by the bacteria in the orchard, being heaviest near good sources of bacteria such as active blossom, canker or shoot blight symptoms or active cankers not previously removed.

Rootstock blight phase
Rootstock blight can be especially damaging where M.26 and M.9 apple rootstocks are used for high density plantings. Bacteria from a single shoot infection can move rapidly down through the otherwise healthy superstructure of branches, limbs and trunk into the rootstock where the bacteria initiate a canker that quickly expands to girdle the tree causing the death of the whole tree. Early fall red coloration of trees in late summer to early autumn is indicative of girdling. Additional trees may show symptoms of decline and die in the early spring.

The How-To Guide to Manage Fire Blight
What to do during dormancy
Dormant pruning of blighted limbs, shoots and cankers must be done every year to reduce the number and distribution of bacterial sources in and around the orchard before the bacteria can be dispersed in the early spring. In addition, remove wild or neglected fruit trees and other susceptible host plants from fencerows and areas nearby.

What to do during green tip/pre-bloom
Be mindful about fertility since excessive amounts of nitrogen make trees more susceptible. A vigorously growing tree will have the nutrients and water (and bacteria if the tree is infected) pumping fast in the vascular system to grow the tree. Also avoid tree stressors, such as poor nutrition, inadequate drainage and nematodes since tree stress results in a tree less capable of resisting the progress of infection. Apply early copper sprays, which will reduce bacteria colonizing bark and bud surfaces. Aim to apply 2 lbs/A of metallic copper at green tip.

What to do during bloom
Blossom sprays protect only flowers that are open and only protect blossoms prior the infection event. Since blossoms do not open all at once, it is necessary to apply several sprays when

infection conditions are frequent during bloom. It is important to be vigilant in monitoring weather conditions: average temperatures >60°F and wetting events (rain, heavy dew).

Options available to protect blossoms and considerations to keep in mind:

- Apply antibiotics as complete sprays and add an adjuvant or surfactant. Antibiotic sprays are most effective when they are applied the day before or the day after an infection event (within 24 hrs!).
- **Streptomycin** is still the best option since it kills the bacteria and has partial systemic activity. Note: the systemic activity does not persist like fungicides and you have about a 48 hour window. Best used when an adjuvant is tank mixed.
- **Kasugamycin** is new to the market in 2015. It is different from streptomycin in that it reduces bacterial growth and reproduction, rather than killing it directly.
- **Oxytetracycline** is an antibiotic that functions similarly to kasugamycin in reducing bacterial growth.
- There is a 4 spray maximum when applying antibiotics and do not apply antibiotics after bloom. This is necessary for resistance management. Please do not think that just because 3 antibiotics are available you are able to apply 12 antibiotic sprays.
- **Blossom Protect** is a live yeast product that colonizes the flower and prevents the bad fire blight bacteria from entering the nectaries. Research on the West Coast indicates this is a very successful product for controlling fire blight. However, this product is not as effective for our conditions on the East Coast at the present time. (Registered in MA, MI, NY, NC, PA,VA.)
- Although applying copper at bloom will kill bacteria, copper can cause fruit russetting and should be used with caution.
- Be mindful of rattail bloom. All blossoms are susceptible to infection if the bacteria and conditions are present.

What to do during post bloom through terminal bud set

As mentioned previously, do not spray antibiotics post petal fall. A hail event is the exception. When making the decision to apply an antibiotic spray after a hail event, take cultivar susceptibility, fire blight history, PHI, and the ability to spray within 24 hrs into consideration if the crop value justifies the cost. Shoot blight will be limited by applying the plant growth regulator, Apogee. The effect of Apogee occurs 10 -14 days after application and can be tank mixed with streptomycin. It is not a streptomycin replacement. Apply during late bloom when active shoot growth is 1 - 3 inches. Apogee will harden off shoots, which will make the shoots not susceptible to shoot blight. Monitor your orchard regularly for infections if there were blossom blight conditions and prune as necessary: symptoms manifest 5 - 30 days post infection and shoot blight infection risk continues until shoot growth ceases. Since insects can cause wounds, which are entry points for the bacteria, be sure to control piercing-sucking insects, such as aphids, leafhoppers, and pear psylla.

Important considerations for cutting out infections

- Do not cut out infections during wet weather since bacteria move via water.
- Cut out active infections early - before necrosis develops (limits the spread of bacteria).
- Pruning is most effective when incidence is low.

- Focus on salvaging tree structure and young high density plantings when incidence is high.
- Avoid excessive cutting since this stimulates secondary shoot growth.
- Bacteria can invade healthy tissue up to ~3 feet in advance of visible symptoms, which makes tool sterilization not effective
- Practice the ugly stub method: cut 6 -12 inches below the margin of visible infection and remove later during winter pruning.
- Bacteria can live very well outside the plant and, to be certain you are getting rid of all sources of bacteria, it best to burn infected tissue that has been removed from the tree.

"Harvista for Precision Harvest Management."

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This presentation will be on the usage of Harvista & PGR's for harvest. Along with our experience's in a hotter southern climate vs. northern climates with the retardation of color. How we prune for return bloom with bud counts aided by the Equilifruit disk. Bud counting under microscopes for flowers to understand what your block looks like before the spring to make pruning adjustments. A brief description of chemical thinning on Honey Crisp using NAA. Rootstocks with Honey Crisp and usage of Apogee during Pink, Bloom & Petal Fall @ 8ozs per/A for Reduction in Bitter Bit. Total elemental amount of calcium @ 28lbs/A needs per season for long term storage needs. How to achieve that with start of 5lbs CaCl2 starting at 20-25mm for first three weeks then switch to 6-8lbs of CaCl2 per week per/A for the rest of the season. Future usage of NAD on biennial bearing fruit to promote return bloom and to set a crop.

How Harvista can help variety change in a rapid changing market place. Also, in addition to different size harvest crews each year which Harvista has excellent PHI & REI's to spray and walk away. Harvista is great dealing with fruit maturity because to don't have to make decision a month away on how you will harvest before you have a harvest crew. Harvista with crop load management and to sway the odds with internal breakdown with optimal harvest time along with stop drop (Macs & Honey Crisp) and stem cracking (Gala). What varieties will return the investment on Harvista vs. ReTain. How to manage harvest with two important varieties at the same time Gala & Honey Crisp in "real time" because Harvista can allow multiple spot picks. "Real Time" because no has a crystal ball in forecasting the weather. What varieties as a packer are hot and what are not. How to over produce valuable varieties. How we are making the change into the future with plantings and grafting (Premier Honey Crisp, Aztec Fuji, Maslin Pink Lady & Cripps Pink Lady).

Some Interesting Discoveries Growing Brussels Sprouts: Choosing Varieties and Deciding Whether or not to Top

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Background & Objectives:
We have conducted experiments at the NH Agricultural Experiment Station to compare Brussels sprout varieties and to research the effects of topping Brussels sprouts. The full research report, with photographs, is available at http://extension.unh.edu/resources/files/Resource003914_Rep5563.pdf.

Cultural Details. Fertilizers were applied based on soil tests. Cultivars were planted in a randomized blocked design with four reps; twelve plants per plot. Plants were spaced 18 inches apart in a single row on 30 inch raised beds covered with black plastic embossed mulch. Plants were seeded in 98-cell plug trays into ProMix BX and transplanted into the field 3-4 weeks later. *Bacillus thuringiensis* (Dipel) was applied throughout both growing seasons to manage caterpillar pests. Cabbage aphids infested plantings in both years, but infestation was earlier and more severe in 2014. Lower leaves were trimmed from all plots once in 2013 and twice in 2014, to improve air circulation.

I. VARIETIES. We evaluated nine (9) cultivars of Brussels sprouts in 2013 and 2014 at Woodman Farm in Durham NH (Zone 5B). Six varieties were included in both years. **In 2013**, plants were seeded on June 3, transplanted into the field on July 8, and harvested on Nov 6. **In 2014**, plants were seeded in May 12, transplanted on June 6, and harvested on Oct 19 and Nov 18. For each plot, we estimated the percentage of total sprouts unmarketable because they were too small (less than 0.75” diameter), too large or loose (over 2” diameter), or due to excessive

Alternaria symptoms. For each plant, we measured **number and weight of marketable sprouts** (0.75-2” diameter).

Results. For those cultivars grown in both years, performance was generally similar in both years. In 2013, **Gustus, Early Marvel and Nautic** produced the highest marketable yield (all >11 oz per plant). Roodnerf, Catskill and Falstaff produced the lowest yields. In 2014, **Jade Cross E, Octia and Nelson** produced the highest marketable yield (all >16 oz per plant). **Churchill and Nautic** also produced high yields, with >13 oz per plant. Doric and Catskill produced the lowest yields.

In a nutshell. Of the five cultivars grown in both years, **Nautic**, **Diablo** and **Jade Cross E** yielded well (over 8 oz per stalk). While tall and vigorous, Doric was very late to mature, and most sprouts did not reach marketable size. Catskill was also very late, showed considerable variability in growth habit, and yielded poorly in both years.

For those cultivars evaluated in only one year, **Gustus**, **Early Marvel** and **Octia** were promising, with high yields on quality stalks. Nelson and Churchill had high yields but both showed excessive lateral branching and a tendency for bottom sprouts to become oversized. Falstaff and Roodnerf had poor yields, and Falstaff was highly variable with a number of off-type plants.

Prevalence of defects and comments on stalk quality

Cultivar	Reported days to maturity	Relative observed maturity	Too small*	Too large	Alt	Space between sprouts	Comments on stalk quality
Catskill	85	Late	4, 4	0, 0	0, 1	4	Highly variable
Churchill	90	Early	1	1	1	1	Lateral branching
Diablo	110	Mid	2, 3	0, 0	1, 0	2	
Doric	120	Very Late	3, 4	0, 0	0, 0	4	
Early Marvel	85	Mid	2	0	1	3	
Falstaff	98	Late	4	0	0	4	
Gustus	99	Early	1	0	2	1	
Jade Cross E	85	Early	2, 2	1, 1	2, 1	0	
Nautic	105	Mid-Late	2, 2	0, 0	1, 0	3	
Nelson	90	Early	1	2	2	2	Lateral branching
Roodnerf	96	Late	4	0	1	2	Highly variable
Octia	78	Mid-Late	1	1	0	4	

* **Ratings explained:** When two numbers are given, separated by commas, these correspond to ratings in 2013 and, 2014, respectively. Noteworthy ratings are highlighted. **Too small:** 4 = >70%, 3 = 40-70%, 2 = 20-40%, and 1 = <20% sprouts per stalk < 0.75 inch diameter. **Too large:** 2 = >15%, 1 = 5-15%, 0 = <5% sprouts per stalk > 2 inch diameter. **Alt (Alternaria):** 2 = >20%, 1 = 6-20%, 0 = <6% sprouts per stalk unmarketable due to severe symptoms. **Space between sprouts**: 4 = wide spacing between sprouts, 0 = very tightly spaced sprouts

II. TOPPING. Sprouts of Brussels sprouts are axillary buds. Auxins produced by the apical meristem (the top growing point) of the plant inhibit the development of the axillary buds below the top of the plant. Removing the apical meristem causes the axillary buds to expand. Therefore, removing the top of the Brussels sprout plant at the right time has been shown to increase the size of the sprouts at the top of the stalk, improving marketable yields.

Topping Treatments. In each plot, half of the plants (6) were topped when lowest sprouts had started to develop, reaching 0.5-1 inch in diameter; and the other half were left un-topped. Because varieties matured at different dates, topping was performed at different dates, according to the chart below:

2013 Topping Dates		**2014 Topping Dates**	
10 Sept.	Diablo, Early Marvel, Gustus, Jade Cross E	4 Aug.	Jade Cross E
		14 Aug.	Churchill, Nelson
18 Oct.	Catskill, Doric, Falstaff, Nautic, Roodnerf	4 Sept.	Diablo, Nautic, Octia
		23 Sept.	Catskill, Doric

Results. For **some cultivars**, topping had the desired effect, reducing the number of sprouts that were too small, and increasing the marketable number and weight of sprouts. For those varieties that showed a higher tendency for the lower sprouts to become oversized (Nelson, Jade Cross E, Churchill and Octia, for example), topping did not alleviate this problem.

2013. Overall, topping reduced the average percentage of undersized sprouts from 51% (untopped) to 41% (topped), increased the marketable number of sprouts per stalk from 23 to 27, and increased marketable sprout weight from 7.8 to 9.8 oz per stalk. Topping had the greatest positive effect for Diablo, Early Marvel, Gustus and Jade Cross, which were early and mid-season varieties that were ready to be topped by early September. Topping did not affect yields of Catskill, Doric, Falstaff, Nautic or Roodnerf. These varieties had very small sprouts, and were not ready to be topped until mid-October, just 19 days before harvest.

2014. In 2014, the results of topping were mixed. Yields of the early cultivars (Churchill, Jade Cross E and Nelson) were significantly reduced by topping, whereas yields of the mid- and late-season cultivars (Diablo, Doric, Nautic and Octia) were increased by topping.

Topping dates. For all varieties, topping more than 75 days pre-harvest (dph), even if sprouts were already at marketable size, was counterproductive, reducing stalk height and, in may cases, causing the tops to branch. Topping 75 dph was helpful for some varieties. Later topping might also have been beneficial, but we did not include later topping dates.

Conclusions. The practice of topping has the potential to increase yields of Brussels sprouts, assuming a once-over harvest. It can also increase the attractiveness of a full harvested stalk, if growers are marketing entire stalks. However, topping too far in advance of harvest can reduce yields and marketability by causing plants to spend energy growing new stalks.

In California, Brussels sprouts destined for once-over mechanical harvest are typically topped 50-60 days before harvest (National IPM Center Crop Profile, 1999). From our study, it would appear that topping somewhere between 24-75 days before harvest could be beneficial. Topping more than 60-85 days before harvest, even if lower sprouts have reached marketable size, was counterproductive and reduced yields.

In the past, we have suggested that topping should be done based on the physiological development of the plant, for example when the largest sprouts are 0.5-1" diameter, rather than on a specific date. Our current thinking is that topping between 30-60 days before harvest, especially once lower sprouts have begun to reach marketable size, will result in the maximum benefit to marketable yields and appearance of Brussels sprouts. If you do not plan to harvest sprouts for at least 60 days, hold off on topping to allow plants to continue to grow.

For additional information, please contact Becky Sideman (becky.sideman@unh.edu, 603-862-3203) or Olivia Saunders (olivia.saunders@unh.edu).

Growing Ginger in the Northeast

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We have been growing ginger in the Hudson Valley for four seasons (since 2012). This past season, we grew turmeric as well. This presentation will cover how we start and manage our crop of ginger from start to finish, a time frame covering roughly 8 months.

We purchase our ginger from Hawaii Clean Seed (also known as Biker Dude Puna Organics). This past season we purchased 60# of seed and harvested roughly 350# of "number one ginger". We retail at $20.00/lb and wholesale at about $12-$14/lb, which I believe is in the middle of what pricing can be on this crop. We start our ginger in the beginning of March, in 1020 trays of potting soil. We use Vermont compost, Forte V. The ginger is in those trays for approximately 2.5 months before being transplanted out. We can fit about 20-25 pieces in a tray, laying them flat but not touching. We cover with soil lightly.

When we have trayed up all our ginger rhizomes, we put them in a heated germination chamber set to approximately 80 degrees. We convert a small cooler (5' by 12') to the Ginger Sauna. Our electric is solar powered which keeps the price down. We water every 2-3 days in the beginning; just enough to not let things get completely dried out. Ginger does not like to be heavily watered when in trays. It doesn't need light to sprout. It is a rhizome so has most everything it needs to get started in life. Sprouting happens over a period of 2.5 months. We shoot to move the trays into our high tunnels around the 3rd week in May, after the chance of cold weather is largely past.

At the time of the transition to the high tunnel, the ginger has sprouted and needs to get the sunlight it was missing in the dark, heated chamber. Once in the tunnel, the ginger will begin to harden off in the trays. This year, we learned that turmeric is much slower than ginger and is only beginning to sprout. We moved it along into the high tunnels to pace it with the ginger. After a couple of weeks we are ready to plant the ginger into the soil. We use 30” wide raised beds and plant in a single row at 6” spacing. We dig a channel down the middle of the bed with a pickaxe, which naturally forms a bit of a hill on either side of the planting area. We then tease the young ginger plants apart since their roots are somewhat tangled with each other and plant them out. After getting them all set up in the channel we apply some Vermont Compost Plus on top of the ginger rhizome before covering with soil. Ginger is a heavy feeder and likes a lot of organic matter. Our tunnels are between 8-10% organic matter. We then cover and slightly hill the plant at the time of placing the rhizome in the soil.

We generally don’t hill again. (You certainly could.) Throughout the season we make sure the ginger gets regular watering, similar to our tomatoes since they are on the same irrigation set up. We give the ginger a sprinkling of Neptune’s Fish Emulsion mixture, 2-3 times during the growing season for a little boost.

We start to harvest for Labor Day Market and continue to harvest for market and wholesale until mid-October. The ginger really starts to size up in the month of September and by the beginning of October the hands of ginger are quite large. When you start to see the flower buds being produced on the plant it is a nice indication that the ginger root is now starting to gain some weight. There is a good bit of difference in size between the ginger that we harvest in the beginning of September and the ginger we harvest in mid October. It is a little nerve wracking for a farmer who uses the same tunnels for winter growing. Getting the timing of all of your plants coming and going can be quite challenging.

We have developed other added-value products from our ginger, which are nice additions to the ginger line up. We turn our #2 ginger into Ground ginger by slicing it, dehydrating it and then grinding it in a Vitamix blender. We package it in .75 oz jars and sell it for $4.00/jar. We also do a Ginger-Lemon Curd, which is canned, and are in the process of developing ginger, ginger-rhubarb and ginger apple syrups. There are many possibilities with this crop.

Turmeric is widely known for its anti-inflammatory attributes. Turmeric takes a little longer to get going and definitely benefits from the extra growing time in September and October. It is possible to get some very large hands of turmeric as well. Different varieties grow at different rates. We have found the yellow to be the most aggressive and the strongest in flavor. Ginger-turmeric elixirs have become a favorite fall drink.

All parts of the ginger and turmeric plant can be used, both leaves and root. Leaves make a nice tea, using them either fresh or dried. Turmeric leaves are very large and can be used to wrap fish for baking or grilling and thus infusing the flavor in a subtle way.

Harvesting a sizable crop of these tropical plants in the Northeast is quite exciting. Both ginger and turmeric can add some real exotic appeal to your market offerings in early fall.

All About Asparagus & More

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Background

In 2008 Plainville Farm planted their first 4 acres of asparagus. By the end of the 2015 season, we were harvesting 20 acres, 15 of which we grew ourselves. Asparagus is fickle crop that requires time, careful attention and a particular set of conditions. After seven years of maintaining and expanding our asparagus production we feel like we have lessons to share with those looking to grow their own "grass".

Before planting

Before you plant you need to ask yourself three questions:

1. *Can you sell the asparagus your grow?* You need to determine who your customer is going to be and match your volume of asparagus to that outlet. Are you growing for a farm stand? A farmer's market? Wholesale? Asparagus has a short shelf life – have your customers lined up before your put the crowns in the ground.
2. *Do you access to type of labor force you need to harvest asparagus?* Asparagus is labor-intensive crop during harvest. Do you have a crew that will pick seven days a week for six weeks? If not, can you personally harvest what you've planted seven days a week for six weeks?
3. *Do you have the right piece of land to grow your asparagus?* Asparagus does best on well drained sandy soils. And you must choose a piece of land **with no history of**

asparagus. Otherwise you run a high risk of losing anything you grow to *fusarium*, a soil fungus that will cause the crowns to rot. For best results your land should also have high soil organic matter, a high soil pH, good access to sunlight and water and low weed pressure – however through smart site preparation and management most of these factors can be addressed. If your land has high perennial weed pressure consider finding a different site.

Year 0 - Site Preparation

One year prior to planting begin your site preparation. First raise the pH of the soil through liming. Then incorporate organic matter, such as manure, into the soil but be careful to choose a source with no weed seed. Finally knock down weed pressure by killing perennial weeds with herbicide. Remember once you plant the crowns you cannot easily add soil amendments without disturbing the crowns. Take care in preparing your site.

Year One – Planting

Choose a variety of asparagus to match your site. We currently grow two varieties: Jersey supreme (comes in early) and Millennium (high yielding but sensitive to rust). It is best to plant in May when the ground has good soil moisture but temperatures are not too high. Dig trenches 12-14" deep and leave 42" between rows. Then in the trenches put down your fertilizer (we use triple super phosphate); drip tape if using; and then the crowns. Cover with 1.5-2" of dirt. Once the shoots are 6" tall, about 10-14 days after initial planting, begin backfilling in the trench. Slowly continue to backfill the trenches as the shoots grow until the ground is level. At this point you can mechanically cultivate and sidedress as needed until the ferns are 2 feet tall. Then leave them be until the next spring scouting for insects and disease during the summer and fall.

Year 2 - Growing the roots & crown

In late April/early May mow your field low. If you have a lot of weeds you can burn the field to knock down weed pressure. Then apply the first of 2 applications of fertilizer, lightly incorporate (but be careful to minimize damage to the crowns) and spray your herbicide. This all needs to be done prior to the stalks emerging from the ground. Once the stalks emerge you can pick for up to 10 days. Within a week of the last day of picking apply the second fertilizer application and incorporate. The focus of the second year is on root and crown development so continue to scout for disease and pest.

Years 3+ - Harvest

Proceed with field preparation as you did in year 2; burn or mow your field and apply your fertilizer and herbicide. In year 3 you can harvest the asparagus for up to 4 weeks; in years 4 + you can harvest for the full 6-week season. It is important when harvesting asparagus to take care not to harm the crown or the neighboring stalks. Store asparagus cut side down in water around 38 degrees for no more than 48 hours. Each year after harvest to continue to take care of your asparagus field. Apply fertilizer scout regularly and eliminate perennial weeds as you find them through clean cutting of the asparagus or spraying herbicide. Once you finish harvesting the asparagus you begin the important task of taking care of crowns, which are responsible for next year's crop.

Working Smarter, Not Harder with Innovative Tools at Pleasant Valley Farm

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Having efficient systems is as important as efficient tools to running a profitable farm. Labor is a farm's number one expense, so working to keep all employees getting as much done in a day as possible requires the right tools, systems and equipment. We have always run our farm as a business and strived to tweak all areas year after year to get more done in a day with less effort. We have visited farms all over the country and incorporated new pieces of equipment, ideas and gadgets.

Starting with greenhouse production, many techniques and tools can help get the job done quickly and have healthier plants, such as seeding techniques, seeders, tray poppers, specialized labeling, rolling benches, radiant heated benches, and automation.

In the field, transplanting techniques, tips for laying down plastic, and using a bale chopper for mulching will be shown, as well as cultivation techniques with hand tools and a specialized Lely tine-weeder we modified to be like a Williams tool.

Harvesting efficiencies include use of golf carts, home-made wheel barrows, specific crates and techniques to keep the workers earning us the maximum amount per hour possible while they are on the clock, as harvesting is our biggest payroll expense for our farm.

Finally, the newly revised washing station will be reviewed showing the 200-gallon bubbler (milk tank) to wash greens, spinner system, crates on dollies, special switches to operate the barrel washer, hose reels, and other gadgets.

There is no one thing that makes a farm efficient and profitable….all the systems, the tools, how you lead your employees, and what equipment you choose will make the difference.

Cost Effective Ways to Maximize Fertility Options

New England Vegetable & Fruit Conference - Tuesday December 15th
Derek Christianson - Brix Bounty Farm, Dartmouth, MA – www.brixbounty.com

About Brix Bounty Farm: *7 acres of mixed veg in coastal, SE Massachusetts (zone 7a). All crops direct marketed through roadside stand, summer and winter CSA, and one farmers market. Secure leased land, we invest heavily in fertility, we are not certified organic – we don't spray any fungicides, herbicides, or pesticides on the farm (i.e. not even Pyganic or Entrust). Limited investments in irrigation, cold storage, and/or mechanized cultivation. Labor for 2016 growing season – 3 full time farmers (including myself), 1 seasonal, and 3 workshares. ~$140K sales*

Are the minerals in the soil? Do we need importation or increased biological activity or both?
Nutrient Budgets & Full Spectrum Fertility

Takeaways: On Small Acreage Vegetable Farms – Labor Costs are traditionally the greatest cost of production; while systems and mechanization can reduce labor costs at various stages of production, it is critical to examine factors impacting yield. Improving yield (quality and quantity) is essential to increasing profitability. At Brix Bounty Farm we believe that once our production systems are in place, and our cultivation practices are effective, the most critical factor to improving yield (including reducing crop loss due to pests and disease) is fertility.

Fresh Market Onions for Enterprise Analysis – 2016 Production Plans ~1/10th of an Acre

Fresh Onions are marketed before curing – Ailsa Craig, Cabernet, & Sierra Blanca – filling niche between mini-onions and early fall onions – marketed between July 15th and end of August.

Sold by the quart at the stand or market and distributed by the pound through our CSA.
2015 prices $5 per quart (~2.5 pounds) at stand = $2/#, $4 at Market ($1.60/#), and valued at $1.50 per # for our CSA… average marketing price of $1.75 per pound.

4 beds (~1,000 sq. ft. each) – 3 rows per bed, 12'' in row – cluster planted 4 seeds per cell 98's or 128' (final density of ~9 onions per bed foot). For some storage onions and in high fertility fields we've moved to 8'' spacing in row (final density increased to ~13.5 onions per bed foot). This marginally increases transplant production and transplant labor cost, but may provide a hedge against strong root maggot pressure and in good years may increase yield per bed foot...

At Brix our base yield projection for fresh onions is 4# per bed foot or 4,000# for 1/10th acre, good yields ~6# per bed foot, top historical yields achieved >8# per bed foot (fresh weight).

Started in the GH in late Feb/early March, TP out in late April/early May. Drenched in GH as needed (using Hozon injector beginning in 2012)…

Row Cover to increase early season N release, establish strong root systems, and protect from onion maggot. We aren't mechanically cultivating so the use of row cover is quite practical for onions production. While many growers are using plastic and seeing good results, we continue to minimize the use of plasticulture at Brix Bounty Farm. Typically row cover remains on through 1 or 2 cultivations into mid-late May…. all about early season root growth.

Labor Costs: costs below for 4 x 1,000 sq. ft. beds or 4,000 sq. ft. - to calculate per acre x10
Estimated total labor ~55-60 hours for this block or 550-600 hours/per acre equivalent…

<u>Field Prep & Amendment Applications > 2 labor hours</u> (plus 1 hour if "capital" rock picking)

<u>*Extra-Credit" Pre-Plant Fertility ~ 1 labor hour</u> total for 4,000 sq ft. (or ~10 hours per acre)

- Boron Field Spray – simplest way to ensure uniform coverage of Boron for OG growers
- Cobalt, Moly, Selenium Spray – setting the table for soil biology and human health
- "Bio-Builder" Field Spray – liquid fish, sugar (molasses), inoculants, etc.
- Barrel Compost Field Spray – biodynamic inoculant

At Brix Bounty these 4 additional activities require ~60-80 hours of labor in March – April and are traditionally used as a method for introducing the crew to the field spaces on the farm…

Additionally, hand spreading extra N (i.e. alfalfa meal or blood meal/Chilean nitrate in a cool spring) will take just a few minutes per bed or less than 2 hours per acre; we have chosen to hand spread b/c this allows us to pinpoint additional fertility inputs where the return is the greatest – and we don't do this on all of our acreage.

<u>GH Seeding ~4 hours</u> for 30 flats
<u>GH Care ~ 6 hours</u> (to water flats, move, etc for the ~8 weeks they are in the GH)

TP ~4 hours (1 hour per bed which requires ~7 flats)

Cultivation ~16 hours (including 4-5 passes with the hoe and 3 handweeding sessions)
For example – TP 4.25.16, Cult 5.09.16, Cult 5.16.16, Cult + HW 5.23.16, Cult 6.06.16, Cult WT And HW 6.20.16, Final HW for August harvested crop only 7.04.16 – stale bedding an option in a warm spring…

*Sidedressing & Foliar Spraying < 2 hours Foliar Spraying - multi-purpose crop monitoring tool!

Harvesting and "processing" ~20 hours = ~200 pounds per hour to harvest, trim, & spray > box...

Keys to Profitability
Soil fertility and cultivation of course…
Early season growth (strong transplants, sometimes use row cover to push early growth).
Managing pests & diseases – Onions Root Maggot, Thrips, Alternaria, etc…
Full Spectrum Fertility for Fresh Onion Production – Brix Bounty Farm – 2016 … start with field history and soil tests to ascertain nutrient deficiencies and include projected yields in consideration as you develop nutrient budgets. Nitrogen Budget – See Worksheet on next page.

Phosphorous - early season P availability is critical for vigorous early season growth. We typically apply a starter P for onions regardless of soil test P levels – banding is preferred method for starter applications, some OG approved options include

- 5-10 gal. liquid fish (stabilized w/ phosphoric acid –may increase onion maggot pressure)
- 200# bone char (0-16-0) good option if your pH is below 7- will also supply Ca
- 200-400# soft rock phosphate (0-3-0) – will also supply Ca

Potassium – application rates depend on soil test. If soil K is really low we like to balance a heavy K application with Mg & Ca – for example on a low K soil, recommended application rates of K_2O are 150# per acre (note we don't recommend wood ash a K source – too caustic):

- 200# of Potassium Sulfate will supply ~ 100# of Potash, 200# of sul-po-mag will supply 44# of potash while also adding magnesium.

Calcium – calcium is essential for strong cell wall development, cellular nutrition, etc. We don't skimp on calcium anywhere on the farm; key is to increase soil holding capacity and increase Ca levels while maintaining a balance of other minerals. Availability of Ca is key – roots are the best indicator of Ca levels – we like strong pearly white roots… and at Brix we are using Solucal (enhanced hi-cal lime) annually on our fields. Additional sources of Ca as well, gypsum, etc.

Magnesium – in our situation we are cropping soils which have a long history of dolomitic lime applications and as a result have excessive Magnesium levels. Even so we do typically apply just a bit of soluble Mg to ensure availability, see sul-po-mag application above. If your potassium and calcium levels are above optimum than Epsom salts (magnesium sulfate - 50#/ac) is one option for Mg – though not suitable to address large deficiencies because of cost.

Sulfur – sulfur impacts pungency in alliums, if marketing mild types it is best to reduce sulfur application rates. At Brix Bounty we grow full-strength onions – by supplying adequate sulfur to our crops. The potential benefits may also include better protein synthesis in the crop reducing free amino acids (which may attract insects). Broadcast a sulfate form of another major nutrient (e.g. calcium, magnesium, potassium). For onions we like gypsum (calcium sulfate) at 200#-400# per acre or Solucal-S (enhanced gypsum) at 100-200# per acre. Elemental Sulfur is 90% S and a good choice to address large S deficiencies, but its availability is dependent on microbial activity and soil temperature – not a good choice for early season S. Limit 50#/ac. Tiger-90.

Boron, Copper, Iron, Manganese, Zinc… Cobalt, Molybdenum, Selenium, Silicon – as needed… dry forms when appropriate to build up soil levels, pH may impact availability, important to maintain balance and mitigate short-term deficiencies. Foliar sprays may be more cost effective.

Nitrogen Recommendations From 2014-15 NE Veg Guide

Crop	**Nitrogen**
	Lbs/Ac
Basil	115-130
Beans, Snap	50
Beets/Chard	105-130
Cabbage	160
Carrots/Parsnips	110-150
Celery	180
Corn, Sweet	100-130
Cucumbers, Melons	110-130
Eggplant	80-100
Lettuce	80-125
Mesclun	50-80
Onions	130-150
Pea	50-75
Peppers	140
Potatoes	120-180
Pumpkins & Squash	110-140
Radish	50

Rutabaga & Turnip	50
Spinach	90-110
Sweet Potato	50-75
Tomatoes	140-160

Nitrogen Nutrient Budget Worksheet

(December 2015 v.2)

What is the Amount of Nitrogen Needed for Your Crop?

Type of Nitrogen? Nitrate / Ammonium

Anticipated Yields? - Heavy

Length & Timing of Season?

Crop: Fresh Onions (late July > Aug)

Seeding/TP Date: late April or early May

Growing Days: ~84-105 days

Harvest Date: late July - Aug

Cultural Notes: row cover at planting

Total Nitrogen Needed =<u>150 # N</u>

Organic Matter Credits = <u>minus 50#N</u>

(~15# per % OM) we have ~5% OM at Brix

~10# per % OM for non-irrigated conditions

Cover Crop Credits = <u>minus 0#</u>

Crop Residue/Carry Over = <u>minus 0#</u>

Soil Biology Credits = <u>minus 0#</u>

Nitrogen Needed to Import = <u>100#</u>

Pre-Plant – 1,200# Kreher's Sunrise Poultry

(5-4-3) x 1200# = 60#

Alfalfa Meal "Spike" 760# at 2.6%N = 20#

Sidedress #1 760# alfalfa meal = 20#

Sidedress #2 = *avoid late N for onions*

Fertigation (if) = *not in '16 for onions*

Innovative Production and Harvest Systems

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First a little background info about Sisters Hill Farm

I started Sisters Hill Farm for the Sisters of Charity of New York 17 years ago. We began as a CSA with 40 members; today we have grown to 300 members. We farm 5 acres of actual bed area and each year produce approximately 90,000 pounds of mixed organic vegetables on that with no double cropping. The farm crew consists of myself and 3 seasonal apprentices.

Special things about Sisters Hill Farm

Members rank our produce quality as excellent (4.9 out of 5) each season on our surveys. We have an 85% member retention rate. Our average member has been with us for over 6 years and 75 of our members have been with us for over a decade.

- We sell only CSA shares and give 10% to charity.
- We use no plastic mulch, yet have great weed control
- We don't have a transplanter, nor do we have belly mounted seeders.

BRIX BOUNTY FARM
FRESH VEGETABLES & COMMUNITY EDUCATION

- We work 45 hours a week regardless of the season. Less in winter.

Principles by which we operate.

Life is precious and finite. We want work to be fun and productive, so we can enjoy our time at work, but also get home to enjoy our families, hobbies and other passions in life.

Many new small farms and even established large farms that are growing rapidly, have put very little emphasis on efficiency and ergonomics. I decided many years ago to begin with the end in mind; to envision how I wanted my working days to go. How I wanted to streamline processes around the farm to make them more productive, less stressful to my body and those of my crew. Much of what you will see today is a result of that decision and that ongoing process.

So, let’s get right to the principles of production at Sisters Hill Farm

Creating your beds is like pouring the foundation for a home. If the foundation is straight and true and square, all future tasks are straightforward and easy. I work hard to train my apprentices to till and mark accurately. We begin with a 5’ chisel plow, then a 5 foot rototiller. The rototiller creates a nice uniform and flat seed bed. We then use a belly mounted row marker, (I make them for sale) mounted under a cub tractor to mark a grid on the soil. The grid creates 3 rows 15” apart running the length of the bed and makes a cross mark every foot. Using those marks, our crew can quickly and accurately plant up to 15,000 transplants/day by hand. We can also push an old Planet Jr seeder down the rows accurately enough to come back in later and cultivate mechanically. This is the foundation for all future work in those beds, whether it be thinning, weeding, or harvesting. If you are new to farming and are currently planting with no guidance for your seeding or transplanting, having an accurate bed marking system could easily cut your workload in half.

You may wonder, since we are so well established, why we don’t own a transplanter. Years ago I purchased a very sophisticated Mechanical 5000 3 row cup type transplanter. What I discovered was that for our size and scale, it just didn’t make sense. We have a rocky soil which created some misses, moving in creeper gear with a big tractor used burned lots of unnecessary fossil fuel, and the whole process was rather loud and stressful. So we sold it and went back to transplanting by hand. The way we approach it is very fast and efficient but it’s also nice from a social perspective. We always have great conversations while transplanting. There’s a nifty video of our system at this address. https://www.youtube.com/watch?v=TplGzUcsNVw

Weeding

We have 2 IH Cub (cultivating) tractors with the wheels spread to approximately 5 foot centers. The marker I mentioned earlier can be quickly mounted under one of them. The tractor wheels create the walking paths as the bed is marked. Under that same Cub, we can switch out the marker and replace it with sweeps (in a couple different configurations-one for 1 row cultivation-one for 2 or 3 row cultivation) or potato hillers. The second Cub tractor has a Buddhing Basket Weeder mounted under it all of the time. We could probably get by with just one Cub, but it would mean a great deal more switching of implements, which is a hassle. As you know, when things are a hassle, they sometimes go undone; it's better to have 2 tractors and simply hop on one that's ready to roll. Also, much of farming is about taking advantage of narrow windows of opportunity--like that stormy week where you finally have one dry afternoon to make some beds, yet you also have to basket weed some others. At these times, I can have the whole crew on different tractors performing vital operations before the next storm hits.

If you are small scale or just starting and don't have a cultivating tractor, the principle still holds true. For a couple of years we used the same marker, pushing it by hand; we paired it with a wheel hoe with a 12" stirrup blade, and it was a very efficient way to cultivate. (The point is the rows do not wander in and out changing in width requiring you to do two passes where one would suffice.) We still use wheel hoes today when a crop has outgrown the Buddhing.

Harvesting

Simply put, if you are running an efficient diversified organic vegetable farm, harvesting will be the vast majority of your work load. To be profitable and enjoyable one needs to develop systems that make sense for your particular markets and mix of crops.

Being that we are exclusively a CSA and most of our members pick up their shares at the farm, the way we harvest, clean, and package produce can be very efficient. Many crops are simply touched once, going straight into the containers that we will present them to customers in. Others need more processing. All crops are presented in a beautiful way and no crop is ever visibly dirty, except potatoes—we don't clean those at all.

Here are some important harvest principles at Sisters Hill.

- Process things only once. We make bunches in the fields, we clean off yellow and brown leaves while kneeling in the row.
- Be flexible. In the fall we do a lot more thinning of greens than we do in the spring. A good example is Tat-soi. In the spring we clear cut, but in the fall we thin periodically and they eventually become huge, increasing our yields with very little extra work.
- Specialize and batch process. A good example is when we are washing bunches of root crops. We place them around the perimeter of a low mesh bench and pressure wash them. One person lays them out, another follows, pressure washing them; the first person flips them over and they circle around again. The bunches are sparkling clean in 2 or 3 passes this way. One person working alone as a generalist is not 1/2 the speed of 2 specialists working this way.

- Don’t be afraid to thin. Thinning beets is not a waste of time. The increase in yield and quality is well worth the time.
- Ergonomics are vital to the farm’s long term success and workers health and happiness.
    - Match the harvest container size to the crop. Topped root crops go into a container that weighs about 35 pounds when full, greens containers are larger since they are so much lighter. Potatoes, melons, winter squash, and onions get harvested into bulk bins, using the forks on the tractor.
    - Lift things as few times as possible—Use hand trucks, mini pallets, pallet jacks and full size pallets to their full capacity.
    - Create a loading dock at your wash area that makes sense for your size and scale. We use and extended passenger van for both harvest pickup and deliveries, so we have a lower dock than a larger farm would.
    - Pour lots of level concrete areas to take advantage of hand trucks and pallet jacks.
    - A pallet sized scale recessed flush with the slab saves a tremendous amount of time and back breaking effort.
    - Create a height adjustable wash tank. You spend so much time over a wash tank. Why not invest a bit of money in having it be comfortable, making work more fun and avoiding injury.
    - Have a good system set up so everyone always has a sharp knife at hand. We use a belt sander for major blade work, diamond hones for our pockets to touch them up in the field, and a field ready knife rack with a magnetic back that sticks to the side of our harvest van

By the time I present this talk I hope to have numerous videos of many of these tools and topics posted on our YouTube channel. Check it out to find out more… And if you like what you see, click like and subscribe. https://www.youtube.com/user/smallfarmsolutions

Geo-Thermal, Hi Tech Bubble Roof and New Generation Wood Boiler for Greenhouses

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Geo-Thermal Heat

After much research we made the decision to construct a geo-thermal ground source heat pump greenhouse to produce warm season crops all year round at our farm in Minnesota. Tomatoes are the main crop that we raise in this greenhouse, along with some cucumbers and pole beans, mainly for rotational purposes. These crops are planted directly into ground heated with geo-thermal heat tubes.

The greenhouse is a 46' x 126' two bay gutter-connect purchased from Poly Tex built with 90 lb. steel and originally covered with two layer inflated 6 mil plastic. The greenhouse is set on insulated 4' frost walls. Twelve to fourteen inches of soil sit atop 2" rigid insulation. Heat tubes filled with anti-freeze are attached to the insulation at 1' intervals. Soil temperatures at the tube depth are kept at a constant 65 degrees Fahrenheit and the soil temperature at the surface stays around 60 degrees during the winter while warming a little more during the summer months.

The geo-thermal heat pump that we purchased is a 20 ton Econar system manufactured in Minnesota. It consists of two 7 ton heat pumps in the greenhouse, one in each bay that can be regulated separately. A 4 ton pump is located in the pack house for in-floor heating and cold storage. About a year later a 3 ton forced air pump was added to the greenhouse. If all units are running at the same time the system can become overtaxed.

Earth loops feeding the heat pumps are located outside the greenhouse in a field. Twenty-one hundred foot lengths of eight hundred feet of coiled tubing are buried eight feet underground connecting to the heat pumps. These are filled with anti-freeze and bring in the temperature moderated liquid to the pumps. As a perk, when the cold storage is running, heat is transferred back to the earth loops warming the ground up to 65 degrees Fahrenheit in the summer. This is much higher than the 45 to 50 degrees that we would normally begin with in the fall.

Most of the ground above the earth loops is covered in sod surrounded by an earth berm. Waste water from washing produce in the pack house is piped into the bermed area keeping the soil consistently moist which aides in using soil heat more efficiently.

The original plan for backup heat was to install some type of gasification system. Because of cost overruns and difficulty in finding the type of system that we wanted, backup heat for ambient air in the greenhouse was provided by two 300,000 btu propane heaters. These were in use much more than anticipated because we found that while the geo-thermal unit heated the ground nicely, it could not also heat the ambient air up to the temperatures that were needed to get optimum yields from the tomatoes.

Cost for the original geo-thermal system and installation was approx. $60,000 and the addition of the forced air pump added another $8,000. The cost of the greenhouse itself came to approx. $65,000.

Since we don't have the electrical cost of the geo-thermal separated from lighting costs and other electrical needs such as fans, etc., we cannot say for sure how much the geo-thermal costs to run. We can say, however, that our winter electrical costs usually run about $700 a month more than summer.

Sola Wrap Greenhouse Film

After operating the greenhouse for four years the greenhouse film needed to be replaced. Because of the design of our greenhouse, the two layer inflated poly did not stand up to our needs. We are located on a ridge top with a lot of wind and the multi-section design would constantly tear or pull loose, loosing inflation which in turn compromised insulation properties and integrity.

Because of this we looked into different greenhouse coverings. Rigid poly was too expensive so that was not an option. After attending a conference in 2014 and seeing a sample of Sola Wrap greenhouse film we looked closer into bubble wrap film, and chose that option to recover our greenhouse.

Since the Sola Wrap comes in 4', 5', and 6' wide roles, instillation is much different from regular greenhouse film. Replacing the covering on each section of our multi-section greenhouse had to be carefully planned out so a lot of time was spent in the replacement. In the end though, we have a nice, neat tight cover that looks like it will hold up well to the wind. Since this is our first winter with the Sola Wrap have yet to see how it stands up to snow load.

Cost of the Sola Wrap came to about $24,000 with a 10 year guarantee against UV degradation.

The Log Boiler

Since the geo-thermal heat pump did not heat the ambient air as well as we had hoped, the cost of the propane heat was much, much more than anticipated, sometimes $15,000 to $18,000 per year. We again searched for a gasification system and finally found the Log Boiler.

The cost of the Log Boiler was quite high, approx. $64,000, so we applied for and received a Minnesota Department of Ag Bio Fuel grant to help pay for the system. Part of the requirements of this grant is monitoring emissions to be sure that it is a clean burning system.

The Log Boiler consists of a very large fire box that holds up to 1 ¾ cords of wood that are loaded from the top. Logs can be up to 8'long. Burning temperatures are computer controlled to burn gasses at the most optimum temperatures and, depending on the outdoor temperatures, can burn for up to a week without reloading. On the coldest days it should only have to be loaded once every 24 hours.

This unit is rated at 2,500,000 btu's and will be used not only for the geo-thermal greenhouse but two smaller greenhouse as well. This should insure that we have the tomatoes growing at optimum temperatures all winter long.

We do have some wood available on our property, but we estimated that the cost of wood, even if all of it is purchased, would be much less than propane. The cost of the propane could reach up to $18,000 for the year at $1.89 per gallon. We estimate that even using up to 50 cords of wood, our cost would only be about $5,000 at the rate of $100 per cord if purchased by the semi load. This would mean a savings of $10,000 to $13,000 a year.

Human Powered Cultivation

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In recent years there has emerged a worldwide, open source, farmer-driven initiative aimed at the development of new tools and practices for small-scale agriculture. At the same time there is growing awareness of the environmental and human costs of food production, and growing support for alternatives to the overuse of petroleum and chemicals. The challenge for tool makers and engineers is the fact that any new tool or approach will be measured against the performance of current machines and approaches that are based on cheap petroleum. Equally challenging is the instinctive resistance to tools that seem primitive because of the absence of engines or motors. Yet a wide range of engineless machines has existed for centuries, and can be found on farms all over the world, pumping water, threshing grain, washing produce, lifting heavy loads. And these machines are being continuously improved by the people who use them.

Farmers everywhere have to build soil fertility, minimize expenses, and remain healthy in order to stay in business. The work required even on small acreage usually means we have to rely on tractors, which are costly and which take a serious toll on our health: these back-saving machines actually beat up our joints pretty badly over time, even causing many of the health problems usually attributed to the modern sedentary lifestyle. They are essential for soil turning and preparation, and the associated heavy work like manure spreading - but when beds are ready for seeding and cultivation, the power requirement falls sharply. Many seeding and cultivation jobs require hardly any of the horsepower that tractors generate: in fact good cultivation is based on the early-and-often approach, moving little soil per pass but hitting crops frequently with a variety of tools

until they have outgrown their weed competition. And this approach, working no deeper than the top inch of soil, means that a bicycle powered cultivator could do the job just as well if it could match the speed and the swath of a cultivating tractor.
I will be presenting a culticycle along with a basket weeder and star hoe, set up for 3 rows on 48” beds. In the past 8 years I have built 13 of these machines. The first 9 are gone and have given up their parts for the current version, of which 4 models are working on farms in Massachusetts and are still being improved.

Videos of the current version can be found at
https://www.youtube.com/watch?v=Oy3LqlTq4e4&list=UUSzg8G3PqxK8Q9j9DlGCV1g
https://www.youtube.com/watch?v=fVQxlnaFr0s

This is an open source tool, part of a larger effort to renew the traditional culture of manufacturing and problem solving on small farms by sharing knowledge and innovation. It has gained widespread support from organizations and confederations devoted to this larger effort, especially Farmhack (farmhack.net/tools/culticycle) and L’Atelier Paysan (latelierpaysan.org).

48” wide with 3 row basket weeder


48” wide with 3 row star hoe

Presentation: Innovative Ideas on Small Plots

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I have been working in commercial organic vegetable production since 2003, and since 2009 have been the co-owner of Pitchfork Farm, a 12-acre diverse organic vegetable farm on the Intervale in Burlington Vermont. We primarily produce mixed veggies for direct sales to restaurant customers in Burlington (maybe 90% of our revenue), and we operate a small CSA. This last summer we began experimenting with on-farm events—I’m always eager to add new enterprises to the core farm business.

In the off-season over the last ten years I have worked in metal fabrication shops and for industrial design firms. I’ve been fortunate to have had the opportunity to participate in a really diverse array of projects, from welding on industrial cranes, to building art sculpture installations at music festivals, to designing custom lighting fixtures with budgets of tens and even hundreds of thousands of dollars.

Over the last two years I have been turning my attention to growing my own agricultural design and fabrication business, **Upstream Ag**. I’ve done simple projects like wheel hoes and bare-bones three-point hitch toolbars for customers, I’ve welded bent aluminum irrigation pipes, performed lots of repair work, and I've also started doing more complex projects like tractor mounted flame weeders ignited remotely by digital microcontrollers. (Man, that flame weeder was sweet. We don't even have one that nice on my own farm, you can flip the flame on with a switch at the beginning of the bed and flip it off at the end without getting out of the tractor seat.)

I came to farming deliberately—the moment I realized it was an actual thing that you could do, I knew that I wanted to do it—but I came to design a little bit by accident. In 2006 a colleague and myself applied for and were awarded a SARE grant to build and test a pedal powered prone workstation of our own design. The concept was simple enough: Two operators working in the prone position were able to advance over a production bed generating forward momentum using only human power. The operators would be able to hand weed, pick crops, transplant, etc.

It was the first time either of us had encountered a formal design problem, and as we worked through the project we were able to instinctually uncover many of the techniques used by professional designers – carefully attempting to define the problem, prototyping, iterating and refining. We taught ourselves rudimentary metalworking in the process, and in the end we were able to realize a somewhat functional prototype. We had a blast doing it. I was, to say the least, hooked.

A decade later I have remained deeply interested in designing for the small farm. I've become a skilled metalworker (lots of people tell me they want to learn to weld, but let me tell you welding is only one small part of metalworking), and I've learned a lot of other interesting skills along the way. Many of the projects I've been working on this summer for my own farm have required major software components. For example, I coded an application that functions as an add-on to Quickbooks that allows me to print packing labels directly from our invoices. As I'm writing this I'm realizing that doesn't sound very impressive, but the novelty is that the app parses the quantities of each item on each invoice and produces labels for each carton, based on how we actually pack the crops. 48 count of bunched radish is parsed to produce two separate labels stating 24 count radish each and so on. It's saved us an hour and a half of handwriting labels each week, and hundreds of dollars on commercially printed labels each year.

I have been incredibly heartened by the increases in work-flow efficiency, improved profitability, and all-around expansion of pleasure and enjoyment of farm work that can be realized with good design. I have seen it again and again on my own farm, and for the farms I have designed solutions for. In 2013, thinking back to the original SARE grant that got me started in 2006, I decided to design my own take on an electric powered version of the prone workstation. I had seen a handful of examples of this machine, but I didn't think that they were really optimized for small scale organic vegetable production – they were either too big and bulky, making them difficult to move around quickly to different plantings, or they could accommodate only a single operator (my deepest sympathies to anyone who does a lot of hand weeding by themselves for hours at a time). I wanted the machine that I would use on my farm.

After building a couple of prototypes I was totally amazed by the way the prone weeder completely changed the rhythm of the farm. This last winter I brought the machine through the entire design phase to marketable product, and it went into production after my first exhibition at an ag conference.

At this point in my career I would say that I am hell-bent on bringing to life the next generation of appropriate technology for the kind of farming that we have all been working so hard to help take root in the world around us. I have my eye towards technology that will increase the profitability and resiliency of our farm businesses. There are new and powerful tools, materials, and processes available to the designer today that didn't exist ten or even five years ago, and the next generation of tools will follow. I will speak on the panel about my work, how I see design and design skills fitting into agriculture today, and my hope for the future of small farming.

Applied Research for Improved Post-Harvest Produce Washing

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The most recent estimates indicate that there are over 81 million instances of food borne illnesses in the USA annually, with an estimated cost of $152 billion dollars per year (1). Furthermore, the Center for Disease Control (CDC) has estimated that between 1998 and 2008, at least 46% of foodborne illnesses were due to produce (2). Water is one of the attributing sources of contamination on-farm and needs to be managed to reduce food safety risks. The upcoming Produce Rule mandated through the Food Safety Modernization Act of 2011 will include regulations pertaining to agricultural water. However, while proposed food regulations will require increased food safety practices, there is little guidance in complying with these upcoming regulations. UMass Food Science Extension has been working to identify best practices for postharvest produce washing.

Quality Control: The use of sanitizer in produce water has been demonstrated to be effective in reducing water contamination. Research using bench top sampling of model wash water with the presence of *E.coli 0157:H7* with as little as 1.2ppm of chlorine has shown to be effective in reducing microbial loads. We have also conducted evaluations on commercially available quality controls to assess scale approprioate monitoring tools to ensure proper sanitizer concentrations. In one study we evaluated and compared two commercially available portable Oxidative Reduction Potential (ORP in millivolts) meters and a three types of free chlorine test strips as an on farm quality control tool to monitor process wash water sanitation. The quality controls were evaluated using different types of synthetic process wash water (soil, vegetation, and vegetation / soil and challenge water) at varied turbidity concentrations that were inoculated with *E.coli O157:H7.* Results indicate that different types of wash water solutions can influence the free residual chlorine levels. Data suggests ORP range 650-800 RmV and free chlorine test strips used under low turbid wash conditions can be used as a qualitative tool to monitor the free residual chlorine levels for small farm postharvest sanitation management as a best practice for food safety (Table 1).

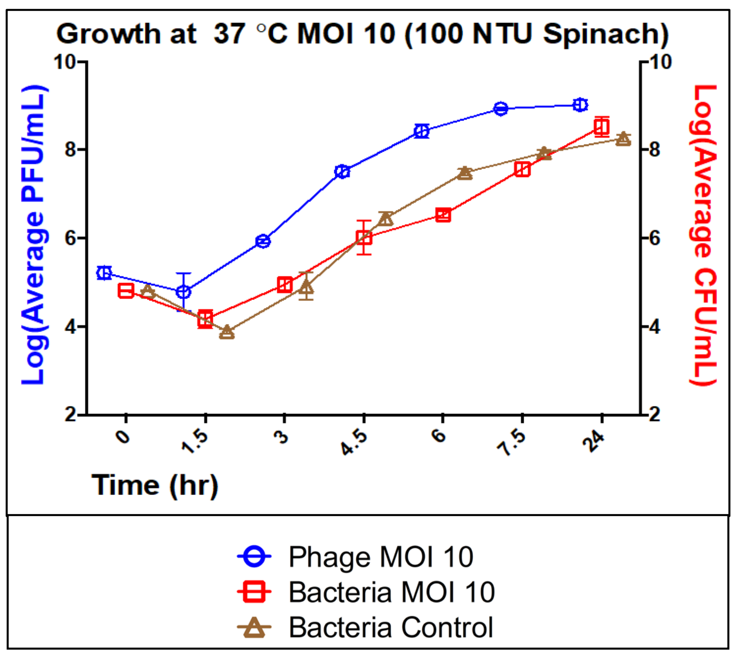
Commercially Available Options: In addition to chlorine based sanitizers, peroxyacetic acid based systems are regulatory compliant and have been shown to be effective. UMass has prepared a fact sheet that outlines some of the current commercially available chlorine and peroxyacetic acid sanitizers, how they compare against others in the market place and where to source them. To learn more you can go to: https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/pssanitizerlawtonkinchlasept15.pdf

New Approaches: There is a variety of research activities presently being conducted at UMass to identify new best practices for produce safety. Examples include:

- Alternative Sanitizers:
  - *Bacteriophage*:

    Bacteriophages are viruses that target infection within bacteria. They have been a used as a natural approach to reduce surface contamination food surfaces in meat production. We recently investigated the use of bacteriophage as a natural alternative sanitizer for produce wash water. Initial analysis indicated that bacteriophage may provide at least a 2 log reduction in *Salmonella* in broth models. However, when experiments were conducted using model wash water with and without the presence of organic load bacteriophage were not an effective sanitizer for salmonella using spinach wash water models at

Figure 1: Bacteriophage are not effective in reducing Salmonella in model wash water solutions.



20°C and 37° C or in broth solutions at 20°C.

- *Organic Acids:* Carvacrol and lauric arginate are examples of organic acids that has been shown to have antimicrobial activity. The food science research group at UMass has developed nano-emulsified organic acids that are highly effective antimicrobials against a range of different microorganisms. Recently research utilized colloidal essential oils containing carvacrol as an antimicrobial treatment for seeds used to grow sprouts. Additional research is being further investigated for use in other produce types.

- Detection: Proposed FSMA Produce Rule will likely include agricultural water sampling on-farm yet most farms do not have the resources to conduct microbial analysis. UMass is researching and developing low cost, easy-to-use and capable of being conducted in low resource settings, such as on-farm. Proof of concept has been able to detect as low as 4 logs. While this technology has not yet been optimized the current progress is promising and relevant to the produce industry.

Table 1: The presence of chlorine will reduce E.coli 0157:H7 by 7 logs.

Wash Solutions	**Sanitizer treatments: NaClO (ppm)**		**Residual Free Cl (Avg HACH)**	Target: 650-800 mV		***E. coli O157:H7* ***
				ORP# 1	**ORP# 2**	
Clean H2O	Water, 0NTU	0 ppm	0 ppm	444.9 ±	455 ± 38	–
	Water, 0 NTU	50 ppm	50 ppm	679.5 ±	705 ± 47	+
Soil + H2O	Soil @ 50 NTU	0 ppm	0 ppm	520.9 ±	490 ± 43	–
	Soil @ 25 NTU	50 ppm	25 ppm	687.0 ±	699 ± 21	+
	Soil @ 50 NTU	50 ppm	50 ppm	708.2 ±	718 ± 20	+
Cucumber + H2O	Cucumber, 50 NTU	0 ppm	0 ppm	344.2 ±	315 ± 26	–
	Cucumber, 25 NTU	50 ppm	11 ppm	822.8 ±	824 ± 21	+
	Cucumber, 50 NTU	50 ppm	1.2 ppm	573.9 ±	556 ± 18	+
Cucumber + Soil	Cucumber/Soil, 50 NTU	0 ppm	0 ppm	375.0 ± 21.6	362 ± 48	–
	Cucumber/Soil, 25 NTU	50 ppm	13 ppm	764.9 ± 13.7	781 ± 18	+
	Cucumber/Soil, 50 NTU	50 ppm	10 ppm	833.1 ± 37.0	816 ± 15	+
Organic Challenge H2O	Challenge water, 0ppm Cl	0 ppm	0 ppm	220.1 ± 17.2	223 ± 24	–
	Challenge water, 50ppm Cl	50 ppm	0 ppm	209.9 ± 25.6	224 ± 31	–
	Challenge water, 200ppm Cl	200 ppm	0 ppm	211.8 ± 1.2	210 ± 1	–

* Indicates survival of ***E. coli O157:H7*** in a sample wash water solution.
(+) Reported > 7 log reduction (CFU/ml), (-) Held a microbial load > 7 (log CFU/ml)

1. Hoffmann, s., Maculloch, B. and Batz, M. Economic Burden of Major Foodborne Illnesses Acquired in the United States, EIB-140. Economic Research Service/USDA, Bulletin Number 140, May 2015. http://www.ers.usda.gov/media/1837791/eib140.pdf

2. Painter JA, Hoekstra RM, Ayers T, Tauxe RV, Braden CR, Angulo FJ, Griffin PM. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998-2008. Emerg Infect Dis. 2013 Mar;19(3):407-15. doi: 10.3201/eid1903.111866.

“Food Safety Considerations for Packing Sheds”

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Packing sheds is where the action is once produce is harvested. Much activity takes place here from simple cleaning to thorough washing to packaging to storage and shipping. There are many places along the way where we need to be conscious of where implementing food safety practices are important.

Food safety practices aren’t just for large facilities. These practices can be used at any scale for any type of facility. Packing sheds can be an actual building, a space in a barn, a garage, under a tree, or under a canopy – four sticks and a lid set up.

It isn’t the size of a facility that matters. The principles are all the same and the practices will match the scale. The important factor is doing what is necessary to minimize microbial risk of contamination so that the produce remains free from food borne disease.

Design is a good place to start. Again, the size of the space where you work in the packing area isn’t important. Having enough space to work, where equipment/tables are located, and how produce flows through is important. Efficiency is critical to save time (which saves money). Incorporating food safety practices does add labor so being efficient is necessary to cover these costs. Having the proper design is one part of this efficiency.

A schematic diagram for basic pack area guidelines can be found at the Cornell Vegetable website. A number of publications are there concerning wash lines, produce washing and handling. Wash table design and various SOPs.
http://cvp.cce.cornell.edu/submission.php?id=119&crumb=food_safety|food_safety

Product Flow
The flow of produce through a wash line area needs to be set up in a manner that allows for separation between unwashed and washed product. (see facility design paper on website).

The design of the wash line needs to allow for a designated area for harvest products coming in from the field to sit prior to emptying harvest containers onto the wash line for rinsing and packing.

The entrance of the wash line should face where field produce comes in. An area for the full containers that are off-loaded from truck or wagon should be made with pallets to keep the bins off of the ground.

Once washed, the produce should move away from the “dirty” side of the facility over to an area where the product can drip dry while awaiting packing.

Pallet(s) should be placed close enough to the wash line to place bins of clean produce. A table for packing/packaging should be nearby.

Finished packed produce then can be moved out to a designated spot on a pallet for moving to storage or packed onto a vehicle for further transport.

An area for cleaning out the produce transport vehicle needs to be designated offering enough space and separation to not allow for tracking in of contamination to the wash line facility.

Tables
A “dirty” table could be in place for containers to be moved to for easy access by the wash crew to reach into the bins or unload them into the wash basins. Pallets could also be used should be close enough to the wash line for easy handling.

If pre-washing is necessary to remove excess mud or dirt, this should be located either right outside of the wash line area or far enough away to avoid splashing onto the wash line.

As the containers are unloaded, the empty harvest bins can be moved over to another pallet beside the “dirty” table where they are stacked. From here they can go back out to the field for more harvesting or moved to another location for storage.

Wash tables or wash lines should be placed in a location where there is easy access to the harvest bins coming in from the field and to the side where the cleaned produce can drip dry, be packed, and moved to either delivery or storage.

Floor
This set up needs to allow for a floor where water does not pool, quickly drains off, and doesn’t create mud. A cement pad that slopes to a floor drain is ideal. This allows for quick drain off, no mud, and easily cleanable. Have the floor drain lead out away from the working area.

Bare ground can work but should be covered with a heavy fastened-down landscape fabric. This will reduce mud. Once the ground becomes compacted, pooling might occur. Having a gravel trench under the wash table or line would greatly reduce the water pooling issue. Design the trench like a French drain with gravel and/or perforated pipe. Slope the trench away from the wash/packing facility. Avoid having the water drain into surface water or streams etc.

Discharge of Used Wash Water
There may be county dept. of health ordinances governing wash water discharge. Used wash water must not be discharged into septic or sewer lines. Used wash water must not

be allowed to drain into surface water ways. Discharged water can be drained off into vegetative buffer strips (in NY). Pipes or gravel lined ditches should be used to reduce erosion. Sludge from drains, pipes, or tanks should be spread out into fields or buffer strips and never into municipal landfills.

Pre-cooling
During hot weather a portable pre-cooler could be set up to remove field heat from box/crates/bins before reaching the wash line.

Wash Line
Have appropriate SOPs in protective clear covers or laminated to keep from getting wet. Have the SOPs placed either in binder in close by spot for easy access or have each SOP hanging in spot by designated area for quick reference.

Workers who are washing produce should have clean clothes or wear a clean apron. They need at least to be able to wash the produce without themselves contaminating it during the process. Workers who are involved with washing and handling clean produce should themselves be clean if they have worked with livestock prior to the handling of produce. This means clean clothes and footwear.

Wash basins, tubs, or sinks, need to be clean at the start of the day's operations. Potable water is to be used. Sanitizer needs to be used in the basins etc. to reduce any microbial contamination that might enter the water. (see Sanitizer SOP for details on using, measuring, and monitoring sanitizer usage). If cleaning and sanitizing of area is done at the end of the day, food contact surfaces should be covered with a clean tarp etc. Before the next wash cycle, inspect the surface areas to make sure pests or anything has contaminated them.

Triple rinse set ups are a good set up for produce with field dirt. The first basin is for getting the heavy soil off. The second is for minor material removal. The third basin is the finish rinse. It is suggested that each tub/basin/container have sanitizer added to the water.

For crops like tomatoes, peppers, melons, and apples, water temperature needs to be within 10 degrees of the pulp temperature of the produce. If the produce is hot from field heat and the water is cold, the water can get "sucked" into the fruit through the cut stem. Without sanitizer, the water could harbor microbes that can pass into the produce. This would contaminate the food. Pre-cooling the fruit or warming the water would be necessary to reduce the chances of the water entering the fruit. Sanitizer is critical in reducing the potential contamination.

For heads of lettuce, greens, or picked leaves/stalks/stems of greens can be dumped into the basins to loosen any field soil from between the leaves. Soaking, agitating, or dunking can help remove the soil and debris.

Another procedure for cleaning heads of lettuce or other greens is to set heads in a rack and use a water hose with spray nozzle to wash out heads rather than dunking them into tanks of water.

Root crops may require hosing first to remove heavy caked on soil. This should be done in an area away from the main wash line so as not to spray soil and water all over. Use of a brush may also be necessary. Keep the brush clean and sanitized before using. Barrel washers can be used though it is suggested that sanitizer be injected through the water line.

As the soil and debris accumulates in the water, the less potent the sanitizer becomes. Chlorine weakens quickest (see SOP on using chlorine bleach). Other sanitizers work well but will need to be monitored (see SOP for monitoring sanitizers). The water will darken as more soil is washed into the water. At some point the water will have to be dumped out and fresh water added. A turbidity Secchi disk test (or dirty water test) can be used (see dirty water SOP). The water can be dumped out into a septic system or approved area that keeps the dirty water from moving into a crop field.

A drip drying area is set just beyond the washing area where the produce can lose much of the water from the washing before it is packed. The dripping water should not be allowed to pool on the floor at all.

From the drying area, produce is packed into preferably new (or extremely clean) containers (depending on buyers' demands). These can be stacked on clean pallets until moved into storage or delivery or go straight into a truck.

Clean-Up

Once wash line and surrounding post-harvest area is set up, keeping it clean and ready to go is important. Cover the tables with a tarp to reduce bird or rodent contamination. Turn basins upside down. Inspect tables, basins, racks, pallets, work surfaces etc. prior to starting a washing batch. Clean and sanitize work areas at the end of a day's use or at least rinse off surfaces and then sanitize prior to start up on another day.

Clean tools and put away in designated area.

Easily washable table set up (R. Hadad) Wash line, packing, and cold storage facility (R. Hadad)

Season Extension Options for Your Farm

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This workshop is geared toward new and beginning farmers and will focus on the use of high tunnels, hoop houses, and other structures to extend the growing season. The basics methods of season extension will be covered as well as management practices to help grow crops for a longer part of the year. Season extension structures will be looked at in terms of design and installation options, and placement and sight considerations. The costs associated with each type of season extension option will be highlighted.

Additionally, an enterprise budget for year round high tunnel production will be shown as an example of the type of financial payback a farmer can expect from investing in a high tunnel. Other season extension resources will be shared so that participants can continue to look into the season extension options for their farms.

Sustainable Pest Management in High Tunnel Winter Greens Production

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Introduction

Many Northeast vegetable growers are looking for ways to extend their season and provide fresh, locally grown produce to winter CSAs and winter farmers markets. High tunnels are proving to be an excellent way to produce 'off-season' greens with little-to-no fossil fuel based heat, contributing to environmental sustainability. These production systems also contribute to economic and social sustainability by creating year-round income and maintaining customer relations during the traditional off-season.

However, pest infestations, such as aphids, mites and cabbage worms restrict the economic potential of these systems. As an experienced grower put it- "Pest management is so much more important in the winter because your losses are so much more". The Cornell Vegetable Program received an award from NESARE to research and promote natural pest management in winter high tunnels over the last 4 seasons. Techniques included early fall releases of parasitoids, winter releases of predators, late fall and winter applications of biorational pesticides, specifically *Beauvaria bassiana*, a commercialized fungal pathogen of aphids (Table 1).

Table 2. Natural Pest Management Tools for Winter Greens Growers

Beneficial Insects:	Type of Control	Pest Target
Aphidius colemani	Parasitoid wasp	Aphids
Aphidius ervi	Parasitoid wasp	Aphids
Lady beetles	Predator	Aphids
Aphelinus abdominalis	Parasitoid wasp	Aphids
Biorational sprays:	Type of Control	Pest Target
Botanigard (conventional)	*Beauveria bassiana* Stain GHA, a fungal pathogen of aphids	Aphids
Neem	Horticultural Oil	Aphids, mites
Mycotrol-O	*Beauveria bassiana* Stain GHA, a fungal pathogen of aphids	Aphids
Bt (i.e. DiPel)	For caterpillars	Caterpillars
Entrust	Iron phosphate (sluggo)	Caterpillars
Iron phosphate	Bait	Slugs

Methods

In this project we found that key pest management steps take place before the winter greens crop is in the ground. Summer tunnel crops (such as tomatoes and peppers) are the single highest source of pests of winter greens. We noted repeatedly in this project that managing a high population of aphids, slugs, cabbage worms, etc. is difficult under cold conditions; biocontrols are too cold sensitive, biopesticides are temperature driven, and periods below freezing make sprays impossible. It is clearer now more than ever that managing pests on the summer crops is key to having marketable winter greens. Fortunately we can use bicontrols in the summer crop successfully as well as appropriate sprays.

Another pre-plant management step is selecting pest/disease resistant varieties. For example Downy Mildew resistance is essential when selecting spinach and lettuce varieties. The cold, damp growing conditions in winter tunnels is perfect for diseases such as Downy Mildew. Growing susceptible varieties is high risk.

Insect resistance is another important trait. At one of our cooperating sites we found aphids were more prevalent in mustard crops, than spinach or other Asian greens (Figure 1).

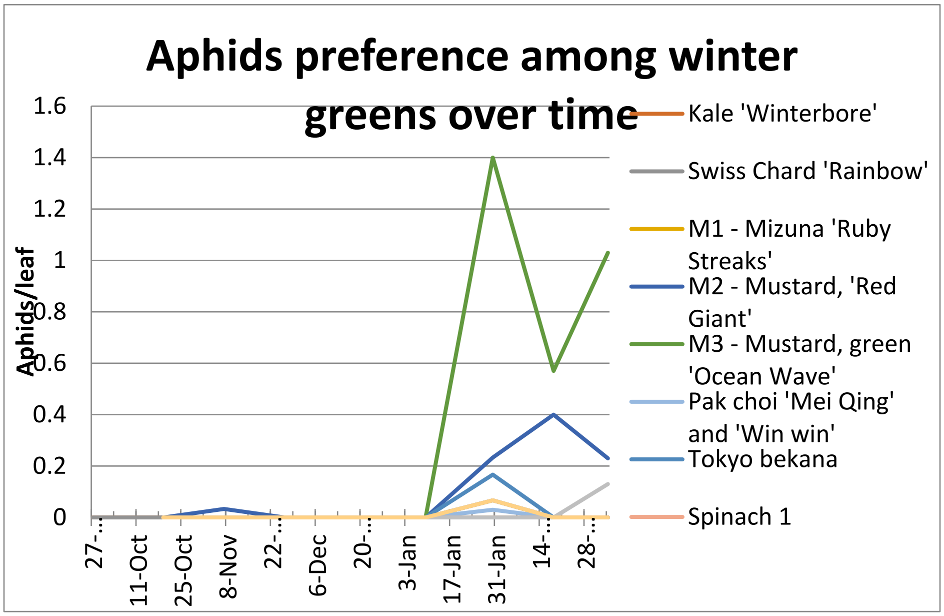

Figure 1. Aphid counts were higher on mustards than other winter greens at one farm.

Appropriate planting density can help with both insect and disease control. High density plantings trap moist air within the canopy which leads to diseases such as Gray Mold and Downy Mildew. The tight canopy also interferes with insect management. For example, aphid materials such as Botanigard or Mycotrol, require contact with the insect. When the greens canopy is closed our sprays cannot effectively reach the target.

As temperatures drop we refrain from the release of biocontrols, with one exception: lady beetles. Under row covers lady beetles have provided excellent control of aphids at some of our cooperating sites. For example one cooperating farm released ladybeetles on November 24. By December 4 the ladybeetles reduced aphid populations by 98.5% in mizuna (Figure 2). This would not be possible with parasitic wasps at this time of year.

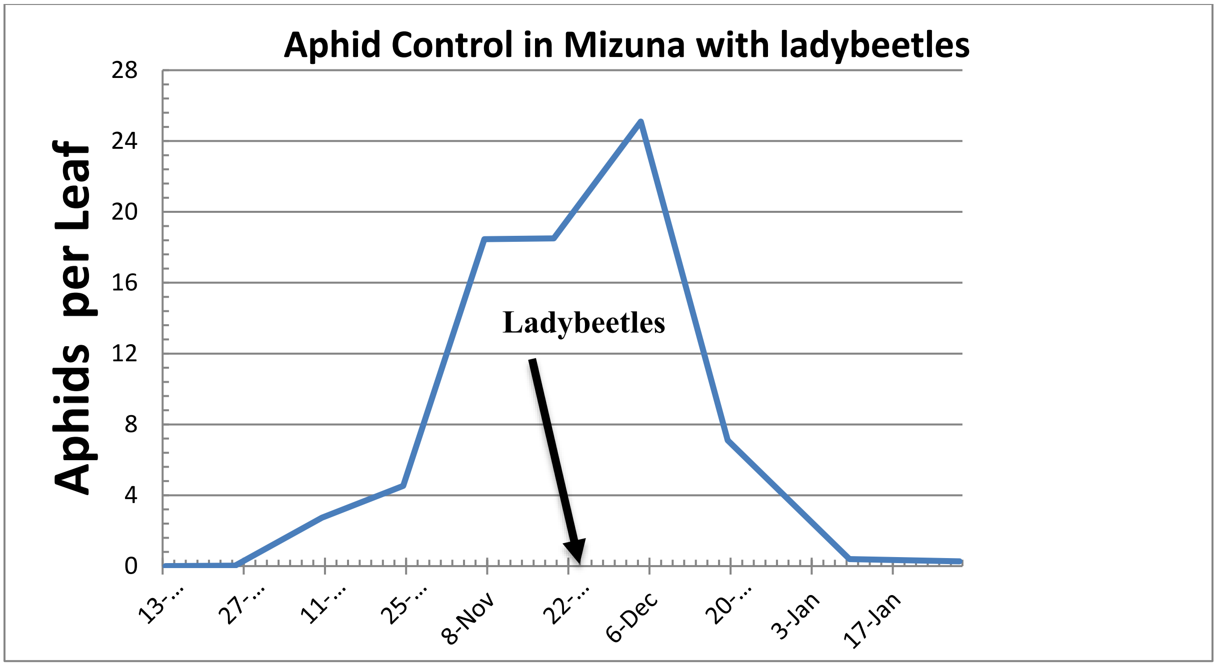

Figure 2. Successful control of aphids with lady beetles in late fall.

Conclusions and future work

The opportunity for Northeast vegetable farmers to market winter greens continues to grow. In one of our surveys 75% of respondents had experienced an increase in cool season marketing. Over a 5 year period an average respondent increased revenue by $6,110, over 9.2 weeks of winter.

Participants in this program were able to increase revenue by adopting natural pest management. 24 high tunnel growers adopted natural pest management methods with an average increase in revenue of $2465.13 per farm. An evaluation indicated 61% of increased on-farm revenue was directly attributable to participation in the program. To quote one of the farmers: "Participating in this project has made me take my blinders off. Slowing down enough to emphasize pest management, reprioritizing tasks to get management things done in a timely fashion, helped lead to work environment improvements on my farm.... There is an increased quantity of high quality produce."

However, the project found that certain pests are more difficult to control than others and can cause disproportionate economic losses. One farm lost $1660.00 per season, with at least 75% of that due to Spinach Crown Mite, a pest that is currently without any known effective controls. Disease was as great a cause of an economic loss as insect and mite pests. Combining all seasons and sites, disease accounted for 26.1% of farm losses.

Future work is needed on Spinach Crown Mite, diseases as well as soil and fertility issues surrounding the production of winter greens. The authors express their gratitude to cooperating farmers and NESARE for funding this project.

Frozen Ground Summary from 24 Top Winter Growers in US/Canada

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On August 10-11, 2014 in Fairlee, VT, 24 top growers with experience in winter production, along with ten others representing seed companies, extension programs, and universities, met to discuss the best practices for how to grow greens in colder regions. The idea to pull together such a group came from Eliot Coleman, farmer in Maine, author, and long-time advocate of winter growing, and Sandy Arnold, farmer and owner of Pleasant Valley Farm in Argyle, NY, who has been doing winter growing since 1992 with her husband, Paul. Eliot's daughter, Clara Coleman, also helped organize the gathering, which was named Frozen Ground. The participating growers were from all northern regions of the U.S. as well as some from Canada.

At the cutting edge of the local food movement is the challenge of providing fresh, local food greens in the middle of winter and this group spent two days unraveling what in the past years has worked well, what hasn't, and where we all need to spend more effort researching and experimenting. The group discussed in one huge roundtable setup six major topics for high tunnel production in the winter: Greenhouse design, inner covers, crops, temperature, fertilization, and new developments.

Greenhouse design covered different types and brands of tunnels, which sizes of tunnels were best, orientation (E-W is the preferred for winter), types of external coverings, ground insulation, drainage, moveable tunnels pros and cons, and venting. All agreed that venting is a critical factor in winter production in order to prevent diseases and have healthy crops.

Inner covers session reviewed the types of inside covers folks preferred (Typar, Covertan, and Agri-bon most common but Typar should not be the layer closest to greens), height of covers suspended above crops (the lower the better for heat retention), types of support structures, and the use of plastic on beds. The plastic on beds was shown through the use of data-loggers to increase both the day and night soil temperature, which is critical to growth on the cold days as plants won't grow to any degree with soil temps below 42 degrees. It was agreed that taking covers off as much as possible, especially on sunny days, and 2 to 3 days each week minimum was very beneficial to production.

The crops grown by most growers with success and that showed hardiness include arugula, spinach, Asian Greens (baby and full size), mustards, kale, swiss chard, salad mix, mache, minors lettuce, and parsley, though other greens are certainly out there! Some growers took fresh greenhouse radishes, turnips, carrots, leeks and other hardy crops to winter markets, while others said they preferred growing these in the field in the Fall and cold storing them for winter sales. These growers saved the greenhouses for higher-dollar-value greens. Baby lettuce and head lettuce is less hardy, but with good management, it is possible to grow, especially the Salanova varieties when placed in the center of larger tunnels.

Choosing what to grow and when to seed it is extremely important for winter growing, and requires careful planning. The dates of seedings are variable depending on zone and whether farmers have no heat, ground heat or air heat. Successive sowings of all crops over a 2 to 3-week period gives a better insurance of having success rather than one specific date to seed due to the variability of each winter season's weather. Just as important though is practicing sound greenhouse management during harsh winter weather. Farmers are a creative lot, and every farmer at Frozen Ground seemed to have a unique management approach to the common problems of cold temperature and low light levels.

The Temperature session covered thoughts on differing systems such as temporary heating, ground heating, air heating, geothermal (one farmer from MN), ventilation, and value of HAF fans. The past two winters have been much colder than normal so systems to have some type of heat are one way farmers were combatting the weather to get good yields, but many with no heat still have had reasonable production despite below zero temperatures. The value of winter greens in tunnels were shown to be in the ranges of \$2 to over \$10 per square foot or \$90,000 to \$400,000 per acre. Well worth the time! Hardening off the greens in the fall is critical to having them survive the depths of winter so that there are not extreme fluctuations in temperature.

Fertilization session reviewed soil tests, crop needs for trace minerals, nitrates (and are they a problem?), the use of extra CO_2, as well as winter irrigation systems. Farmers use a range of different methods for irrigation, including overhead and drip, with some being used to reduce salts and nitrates. Nitrates are inorganic ions that occur naturally as part of the nitrogen cycle. When microbes break down animal wastes, ammonia is created, which then oxidizes into nitrates. Nitrates are required for plant growth, but excess nitrates can be a problem for plants. While leaves might be nice and green, root growth is often stunted and leaf edges can become yellow or wilt. Excess nitrogen is famous for inviting pests like aphids. Best practice is to not use animal-based manures and take soil tests regularly to determine any issues.

Maintenance of the crops inside the tunnels include not only fertilization, pest control, and irrigation but also weed control…yes, even in January! Chickweed is by far the worse weed and many systems prove helpful in controlling it, including flame-weeding, "cooking" it with clear plastic, stale-seed bedding in early fall before planting (if the weather is cool enough to have it germinate), use plastic mulch, and use wire-weeders, with a new design of wire-weeder being invented this year. Another new technique that will be shown is steam-sterilizing beds, which has been amazingly effective.

Many New Developments in technology and biology are happening all the time, and there will be some information on a bubble wrap greenhouse plastic that Eliot Coleman put on a tunnel (SolaWrap from Germany), as well as heat storage systems, and breeding for hardier crops.

Winter production is definitely out of its infancy and this Frozen Ground meeting gave a tremendous amount of practical information from the experienced growers that shared their knowledge during the two days of non-stop networking. This information is being used by the experienced growers to tweak their techniques and it will help new growers be able to grow in the winter more productively. However, there is still much to be learned.

For additional resources, many of the power points from this conference, as well as notes taken by the extension folks who attended are posted at:
http://www.uvm.edu/vtvegandberry/WinterGrowingConference2014.html

and many of the farmers would be glad to give more information, including the presenters, Sandy/Paul Arnold (farm tours welcome also) and Michael Kilpatrick.

The Basics of Growing Raspberries

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Choosing a site

Appropriate site selection is critical to the success of a raspberry planting. A poor site will generate chronic problems which, at the very least, will tax management skills and reduce profits, and could result in failure. Well-drained soil is critical. A site that holds too much water will reduce the vigor of the plants and greatly increase the probability of *Phytophthora* root rot. Avoid soils heavy with clay. A sandy loam with acceptable levels of organic matter (4% 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 at least a year before planting to determine what amounts of nutrients need to be added for optimum growth of raspberries. Applications of lime, to adjust the soil pH to 5.8 to 6.5, should be applied the fall before planting. Pre-plant fertilizer applications should be made according to soil test recommendations. Incorporating compost, animal manures cover crops prior to planting, can increase organic matter levels.

Varieties

Select appropriate varieties for your site and market. The most important characteristic in New England is winter hardiness. Relatively few of the varieties available have adequate hardiness to dependably survive our winters. Ripening season, fruit quality, yield potential and disease resistance are other characteristics that should be considered. To extend the harvest season, plant a combination of early, mid and late-season ripening varieties, and perhaps include primocane everbearing varieties to extend the season into the fall. Recommended varieties for New England include: *Early* - Prelude, Boyne, Killarney, Reveille; *Midseason* – Nova, Newburgh, Latham; *Late* – Taylor, Encore; *Everbearing* –Polana, Polka, Joan J, Autumn Bliss, Autumn Britten, Caroline.

Planting Raspberries

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

Plant raspberries in the early spring, as soon as the soil is workable. Plants should initially be spaced about two 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 spread its full size. Wide row spacing will also encourage good light penetration and air circulation, which will reduce disease problems.

Irrigation and Mulch

Trickle irrigation should be put in place at planting. Iirrigation 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 conserve soil moisture and reduce the germination of weed seeds in the soil. The straw should be removed early the next spring to prevent root rot. Permanent mulches, such as wood chips or shavings can be applied at that time to provide long-term benefits. As the plant rows become established, do not allow the base of the plant row to get wider than one and a half feet. Wider plant rows do not allow adequate light penetration for healthy fruit buds to form on canes in the center of the row, 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° 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. 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.

Pruning

Pruning should be given special attention. Every season, regularly prune out any first year canes that emerge outside of the desired one and a half foot row width. This opens up the planting to encourage growth of the other first year canes, which are setting fruit buds for the next season. Dormant pruning should be left until the late winter or early spring. All canes that fruited the previous summer should be pruned out. Any canes that are growing outside of the desired 18 inch row width or showing signs of insect or disease injury should also be pruned out. Only the most vigorous canes, those with the greatest height and basal diameter, should be left in the row. Thinning should continue until the desired cane density of four to five canes per foot of row length is attained. The remaining canes should be attached to the trellis wires. Finally, all of the prunings should be removed from the field. These may harbor diseases and insects that may attack the healthy canes. To view a video on raspberry pruning, visit: http://umaine.edu/highmoor/videos/pruning-raspberries/

Everbearing Raspberries

Everbearing (or primocane fruiting) varieties bear a crop on first year canes in the late summer. All of the canes can then simply be mowed down late in the winter, eliminating the need for selective pruning. Although this practice also eliminates the conventional second year crop from two-year-old canes, many growers prefer this method to reduce labor and risk while still providing profitable yields. Allow plants to become established for at least three years before beginning to mow them. This will allow the plants time to establish a healthy root system and reduce stress caused by mowing. Most everbearing varieties mature their fall crop late in the season, which can be lost to frost. Select varieties that can successfully mature their crop in your area.

Pest Management

It is critical that raspberry growers become familiar with the major pest species that effect their crop, including insects, diseases and weeds, and know what management options are available for each. Weeds and diseases are two of the most common reasons for the failure of raspberry plantings. A grower should be well aware of the pest situation in the planting at all times through frequent and regular monitoring. Information on pest management is available in the New England Small Fruit Pest Management Guide, which can be purchased through your state University Extension or online at http://ag.umass.edu/fruit/publications/new-england-small-fruit-management-guide

Marketing

Demand for raspberries is typically high. However, because the fruit are very perishable and the labor required to harvest them is expensive and often difficult to find, getting good quality berries to market at a price that brings a fair profit is often difficult. While "pick-your-own" marketing can greatly reduce harvest labor, it will probably not suffice as the only marketing channel. Fresh, pre-picked fruit can be sold through stands and farmers markets, as well as to local restaurants, schools, and groceries. However, care must be taken with picked fruit to ensure good post-harvest fruit quality through proper and careful picking, packing, storing and transportation practices.

Nutrient Management in Brambles

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Brambles or "caneberries" (raspberry and blackberry) are important crops in the United States with a reported 11,900 acres of blackberry in 2005 and 16,400 and 1,650 acres of red and black raspberry in 2014, respectively. There were also 495 and 663 acres of organic blackberry and raspberry, respectively, in the United States in 2008.

The unique growth habit of caneberries, where nutrients are accumulated in the primocanes, crown, and roots and are lost in the fruit, floricanes, and leaves (in autumn), makes nutrient management somewhat difficult. In the spring, growth of fruiting laterals and fruit is very dependent upon nutrient reserves stored in the floricanes, crown, and roots and on additional nutrients available from soil or new fertilizer. However, new primocane growth in the spring is most dependent on nutrients available in the soil or from fertilization. Good nutrient management programs are thus important for sustained growth and production.

In order to gain benefits from fertilization, crop management—from selecting certified plants to good irrigation and pest management—must be appropriate and timely. Proper fertilization or excess fertilizer will not compensate for poor growth that is caused by other management problems, or disease, weed, or insect problems. Soil properties such as low pH and/or poor drainage can limit plant growth and yield.

The goal of fertilizing any high-value crop is to supply the plant with ample nutrition in advance of demand, thereby removing nutrient limitations to yield and quality. Important considerations include the economic return from the fertilizer investment, environmental stewardship, and government regulations. A fertilizer application should produce measurable changes in plant growth or nutrient status, or otherwise benefit the crop in a measurable way. The increased fruit yield or quality produces a return on the investment.

Growers, with the assistance of local Extension agents and field representatives, should consider the nutrient needs of each field or type of caneberry (e.g., summer-bearing or primocane-fruiting cultivars). Key questions that need to be answered with regard to any nutrient management program are: How much nutrient should be applied? When is the best time to apply the nutrient? What is the best source of the nutrient for the plant? And what is the best method to apply the nutrient?

Soil and tissue sample analyses help in determining appropriate nutrient applications. Keeping records of weather, yield, disease and insect problems, and nutrient application rates and timing will help in interpreting soil and tissue analysis data over time. Observations of annual growth (visual assessments of cane number, diameter, and height, and fruiting lateral length), leaf color, and fruit quality (amount of rot, drupelet set, and firmness), in addition to yield, will also help in adjusting nutrient management programs as needed.

<u>Soil sampling.</u> Soil testing is important to adjust nutrients prior to planting, if needed. This not only gets the plants off to a good start, but incorporation of nutrients or amendments is very effective for those that are immobile or do not move readily into the rooting zone with a surface application (e.g. lime). Take soil samples well in advance of planting so that pH can be adjusted if needed (e.g. sample in early fall for spring planting) – it takes time for incorporated lime or

sulfur to react and change soil pH. Use the deficiency levels of nutrients in the soil in Table 1 as a guide. A range in deficiency levels is provided, as there is no absolute value and ideal levels may depend on growing region or soil type. If a nutrient is not listed, no standards are available and plant tissue nutrient status should be used to assess nutrient needs after planting. Any needed nutrients should be applied as a broadcast application to the entire field and then incorporated.

Table 1. Suggested nutrient levels for soil in caneberry plantings

Nutrient	Deficient at less than (ppm)
Phosphorus (P; Bray)	20 to 40
Phosphorus (Olsen)	10 to 20
Potassium (K)	150 to 350
Calcium (Ca)	1000
Magnesium (Mg)	120
Manganese (Mn)	20 to 60
Boron (B)	0.5 to 1.0

As soil pH increases, the solubility of Fe, Zn, and Mn decreases. The concentration of Mn and Fe can reach levels that are deficient, causing yellowing of leaves. While the ideal caneberry soil has a pH between about 5.6 and 6.8, commercial production is possible on sites with pH values slightly higher or lower. As soils become alkaline (pH values above 7.0), deficiencies of Fe, Mn, B and Zn can occur.

After planting, periodic soil analyses can be helpful in diagnosing problems, such as low or high soil pH or the presence of excessive salts. Collect soil samples every two to three years to monitor changes in soil nutrient status. In established fields, sample soil at the same time of year, so that years can be more easily compared. Soil pH fluctuates over the season. Do not collect soil samples in spring, right after fertilization has occurred. The irrigation wetting front, fertigation, and band applications of fertilizer affect soil sample results. Collect soil samples in the plant row (where the fertilizer is applied) and, in drip irrigated fields, sample within a few inches of a drip emitter in all sub-sample locations. If mulch is present, remove the mulch layer before taking the soil sample.

<u>Tissue testing.</u> Leaf tissue analysis provides information on the nutrient content of the plant. The results of tissue analysis, when compared with published standards, indicate which elements the tissues contain in adequate, deficient, or excessive amounts. Routine tissue analysis can help in detecting low nutrient concentrations before visible symptoms or yield reduction occur. Tissue analysis is a valuable tool to help diagnose visible plant problems and to evaluate fertilizer programs. Sometimes, even when the soil nutrient content is adequate, the plant is not able to take up the nutrients required (e.g., when soil pH is incorrect; in dry or waterlogged soils; during cool weather; and under certain cultural issues such as with too much or insufficient irrigation). However, using tissue test results to anticipate current-season fertilizer needs does not work well for perennial crops such as caneberries. In part, this is due to the minimal short-term effects of fertilizer on yield. Changes in tissue nutrient concentrations may not be observed for 1 to 2 years after fertilization. In addition, primocanes, which respond to new fertilizer nutrients, do not fruit until the following year in summer-bearing types. Delays in plant uptake are common, particularly when relatively immobile materials, such as phosphorus, potassium, and lime, are topdressed. The only exception is for correction of micronutrient deficiencies (e.g. boron) and N deficiency, where corrections can be made quite quickly. However, in general, leaf testing is more of a tool to assess how the nutrient management program may need to be changed for sustainable growth and production.

In caneberries, primocane leaf tissue nutrient concentration changes throughout the season. The recommended time of sampling leaves for tissue analysis is related to a period of time when the leaf nutrient concentration is most stable. In addition to changing over the growing season, tissue nutrient levels will also change with location or age of the leaf and what type of leaf it is. For example, results from floricane leaves will be different than primocane leaves and older primocane leaves will have different levels of many nutrients than younger leaves. Always sample cultivars separately as they differ in nutrient concentration. Collect leaves that are free of disease or other damage if possible and a sample that represents the entire block/field. In summer-bearing raspberry and blackberry, collect primocane leaves in late-July to early August. In primocane-fruiting blackberry, collect primocane leaf samples during the bloom to green fruit stage of development.

In summer-bearing caneberry cultivars, sample the most-recent, fully expanded leaves from primocanes – about 1 ft from the tip of the cane. In primocane-fruiting cultivars, sample fully-expanded leaves from below the fruiting tip (red raspberry) or from primocane branches (blackberry & black raspberry). Compare primocane tissue samples, taken at the correct time, with published sufficiency levels (Table 2).

If a nutrient is deficient and observations of growth or plant performance indicate fertilizer is needed, apply the correct product (source of nutrient) and at the right time to make the nutrient available for plant uptake.

Table 2. Recommended primocane leaf nutrient sufficiency levels for raspberry and blackberry when sampled in late-July to early-August in Oregon, May to August in California, and the first week of August in northeastern United States. In Oregon, the recommendations are to use whole leaves – petioles included – and to leave them unwashed. In California, there are no specifications for leaf petioles or washing. In the northeast, recommendations include petiole removal and leaf washing.

Nutrient	Oregon[z]	California[y]	Northeastern U.S.[x]
Nitrogen (%)	2.3 to 3.0	2.0 to 3.0	2.0 to 3.0
Phosphorus (%)	0.19 to 0.45	0.25 to 0.40	0.25 to 0.40
Potassium (%)	1.3 to 2.0	1.5 to 2.5	1.5 to 2.5
Calcium (%)	0.6 to 2.0	0.6 to 2.5	0.6 to 2.0
Magnesium (%)	0.3 to 0.6	0.3 to 0.9	0.6 to 0.9
Sulfur (%)	0.1 to 0.2	-	0.4 to 0.6
Manganese (ppm)[w]	50 to 300	50 to 200	50 to 200
Boron (ppm)	30 to 70	30 to 50	30 to 70
Iron (ppm)	60 to 250	50 to 200	60 to 250
Zinc (ppm)	15 to 50	20 to 50	20 to 50
Copper (ppm)	6 to 20	7 to 50	6 to 20

[z]Hart et al. (2006); [y]Bolda et al. (2012); [x]Bushway et al. (2008).

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Trellising Options for Raspberries and Blackberries in Cold Climates

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Several principles involving bramble plant growth and physiology must be understood before one can appreciate the benefits of trellising, and the various ways that brambles can be trellised.

1) The top half of a cane has the potential to produce more fruit than the lower half of a cane.
2) The amount of light intercepted by a bramble plant is somewhat proportional to its yield
3) Brambles can compensate somewhat for the loss of flowers and buds through pruning by increasing bud break and the size of remaining fruit
4) Primocanes can interfere with floricane light interception and harvesting
5) Blackberry primocanes bend when they are young and succulent, whereas raspberry primocanes do not bend.
6) Erect blackberry canes exposed to a typical winter will experience damage to fruiting canes.

Knowing these principles, we can examine various approaches to trellising.

1. No trellis

   This option is obviously less expensive to implement, but unsupported canes often bend over when they have a fruit load and are then difficult to harvest. If canes are topped to prevent bending over, a significant portion of the fruiting potential is lost.

2. I-trellis

   This option holds canes erect and prevents loss from topping. But light interception is poor, and yields do not meet their full potential. Primocanes grow towards the light and can interfere with spraying and harvesting of the floricanes.

3. V-trellis

   This system opens up the canopy by pulling fruiting canes to the outside of the V, and allows primocanes to grow in the middle of the V. Interference with picking is minimized and light interception and penetration are improved. Yields can be improved 30% by converting from and I to a V-trellis, although the trellis is more elaborate and expensive to install.

4. Modified V for a tunnel

   Blackberries in a tunnel grow very vigorously; primocanes of some varieties can grow 20 feet in one season. Standard trellising does not work well in a tunnel as the canopy is too dense and canes are too tall. Vigor can be reduced without a major reduction in yield by horizontally training a limited number of primocanes (2 or 3) to the lower wire of a V-trellis. When the primocane reaches the adjacent plant, it is pinched to promote lateral bud break. These buds are trained upright to one side of the V. Harvesting a one-sided V is much easier than a regularly trained plant (where densely arranged primocanes are shortened to approximately 6 feet). Primocanes are trained to the opposite side of the V in alternating years. This system does not work for raspberries as canes do not bend even when they are young.

5. Rotatable cross-arm trellis

   Primocanes are trained similarly to the previous description of the V-trellis. However, the accommodating trellis has a cross-arm that can rotate into a horizontal position so that canes can be laid against the ground at an appropriate time. The trellis arm with attached canes is

laid on the ground prior to winter, and covered with a row cover to minimize winter injury. The trellis arms are raised after winter, and the buds emerge with significantly less injury. We have documented five-fold differences in yield in cv. Chester between canes laid on the ground and those held erect for winter.
Canes bent and trained along the lower wire twist about 90 degrees when the cross arm is laid in a horizontal position. This small amount of twisting does not damage the canes. However, a vertical cane forced into a prostrate position will snap. Therefore, it is important to train the canes horizontally from the time of their emergence in spring so they will twist and not break when laid horizontally.

Applying these principles to a good trellis design will allow growers to maximize their yield potential in raspberries and blackberries. Installing a trellis requires materials and labor, but the fact that nearly all raspberry and blackberry growers use them, attests to their efficacy.

Primocane-Fruiting Blackberries

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Primocane-fruiting blackberry is a relatively new crop, with the first commercial cultivars, ‘Prime-Jan®’ and ‘Prime-Jim'® (Univ. Arkansas, Fayetteville), released in 2004. Since then, ‘Prime-Ark®45’ (2011), ‘Prime-Ark® Freedom’ (2014) and ‘Prime-Ark® Traveler’ (2015) have been released for commercial production.

The amount of research done on this type of blackberry in addition to grower experience is relatively little compared to the more typical, floricane-fruiting types. Here, I will present a summary of the up-to-date research information (see list at the end of this article), particularly as it relates to crop management, along with some recommendations based on my experience seeing the performance of this crop in various production regions.

Primocane-fruiting, erect blackberries can be grown for a double-crop (floricane in early summer plus primocane in late-summer through autumn) or a single-crop (primocane only). Whether plantings are managed for a double crop depends on the quality and fruiting-season or the potential market of the floricane crop relative to other floricane-fruiting cultivars that are available. Management of the primocane crop, particularly related to modifying the fruiting season (see below), is limited when double-cropping (as the floricanes are present). Also, cost of primocane tipping may be higher when double cropping and yield of the primocane crop may be lower when double cropping than when managing for a primocane crop only.

Primocane crop only

Yield. Primocane yield of the most commonly grown commercial cultivars to date has been limited in many production regions of the USA by their late fruiting season – canes do not have much time to fruit prior to the first frost or heavy rains in autumn. Reported yield in open, field-grown plantings has thus been low in many regions (e.g., 2-3 tons/acre in Oregon; 2-4 tons/acre in Arkansas). Yield can be increased in some of these regions by planting earlier-fruiting cultivars (e.g., ‘PrimeArk® Traveler’ has a primocane harvest date 12 days earlier than ‘PrimeArk® 45’) or by advancing the growth of primocanes using spun-bound polypropylene row covers placed over the row from late winter through early tipping. In Michigan, plants grown only for a primocane crop in a tunnel (plastic sheeted from May through November) still did not produce an economical yield (0.5 to 1.5 tons/acre) from early August to mid-October. Yields in Oregon in a tunnel have ranged from 2 to 8.5 tons/acre depending on pruning method. In these cooler regions, it is clear that yield is limited by the weather – plants have many buds and flowers present on the first frost date. In the central coastal area of California, primocane yield of ‘PrimeArk® 45’ has ranged from 9 to 10 tons/acre when double-tipping.

Pruning. Our early research quickly showed that this type of blackberry has much greater yield on primocanes when they are soft-tipped (removing ~ 2 inches) during the growing season. Soft-tipping primocanes once to about 3 ft tall increased yield 2- to 3-fold compared to untipped canes through increasing branch number per cane and flower number. When we looked at alternative tipping heights of 1.5 ft and 5 ft as compared to 3 ft, we found that yields were similar at the 1.5 and 3 ft soft-tipping height, but tipping later (at 5 ft) reduced branch number, branch length, and yield in our climate. In a tunnel, we showed that double tipping (soft-tipping canes to 1.5 ft and then soft-tipping the branches to 1.5 ft) increased yield compared to a single tip at 1.5 ft and led to a more compact plant growth and uniform presentation of fruit, increasing picking efficiency. Double-tipping did not reduce fruit size – in fact we found larger fruit when compared to a single tip. Also, a single or double tip has had little impact on bloom date or harvest date in our climate – no impact of tipping vs. no tipping and a single tip vs. a double tip.

A single tip quickly became the standard for research and production in other areas, while a double tip was consistently used in the central coast of California. Growers go through a field on several occasions during the growing season to soft-tip primocanes, by hand, to the desired height and, in some cases, to tip the branches (double-tip). It is important to not tip canes or branches that have flower buds present as this will reduce yield. Late-emerging primocanes will not be tipped (and will likely not fruit as they will be too late).

When we compared soft-tipping canes (removing ~5 inches) to hard tipping canes (removing ~ 1.5 ft) to a height of 3 ft, canes that were hard-tipped produced more branches and had more fruit than soft-tipped canes. However, tipping as early as possible was also an important factor for high yield. When canes were hard-tipped early in the season (June 22-27 in Oregon), the number of fruit was increased three-fold compared to soft-tipping canes early. This supported our hypothesis that tipping to older growth and more mature buds improves branching and yield.

We then studied whether mechanical hedging can be used to provide an economic alternative to hand-tipping of primocanes. While hedging shows potential for reducing labor costs, growers must use caution when hedging to ensure that there are not too many canes in the row that have already formed a flower bud and to hedge as early as possible. Performing a hard-hedge early in the season, by cutting canes back to a shorter height than 3 ft, shows promise in this crop for maximizing economic returns.

We have shown that the primocane crop can be delayed one month by re-cutting the primocanes back to ground level once they reach a height of 1.5 ft (then tip/prune as per usual). Of course, this is only an advantage in a warm climate. In a cooler climate (shorter growing season), the primocane crop may be advanced using spun-bound polypropylene row covers placed over the row from late winter through early tipping or by growing plants in a tunnel with plastic on all season.

Double-cropping

The floricanes are most economically pruned in winter by hedging to a height estimated to be below the region of fruit production the prior fall. Yield of the floricane crop is dependent on the cultivar grown, the vigor of the stand (number of floricanes/length of row), how the canes were managed when they were primocanes, winter pruning method, and growing region. The chilling requirement for the recently released cultivars is estimated at 300 hours. Yield in some warmer regions may be limited by insufficient chilling and in colder regions by winter damage, depending on the year. Yield of floricanes was 2 to 3 tons/acre in Oregon, but has been reported as 3 to 11 tons/acre in smaller, research plots and 3 to 4 tons/acre in commercial fields in the coastal region of California. The fruiting season of 'PrimeArk® Traveler' and 'PrimeArk® 45' is similar to 'Natchez'.

The floricanes would either need to be removed by hand from the row after summer fruiting or be left in the row (dead canes) – some growers might do this to reduce labor costs (e.g., rotate between double cropping and single cropping to reduce pruning costs).

In Oregon, producing a floricane crop reduced the number of primocanes per foot of row and thus would be expected to reduce yield relative to a primocane-only crop. One would also expect primocane pruning (tipping once or twice) to be more labor intensive in a double-cropped system. However, double cropping is common in the coastal region of California.

Nutrient management

Current recommendations are to apply N fertilizer in spring and again near primocane bloom (if using a granular) or to fertigate from spring through early fruit set (primocanes). Application of other nutrients should be based on soil fertility and leaf tissue analysis. Our research in Oregon has shown that leaf samples for tissue analysis should be collected at the early green fruit stage (on primocanes), sampling leaves from primocane branches. If leaves are sampled on this crop during the commonly recommended time of late July to early August, the tissue levels for most nutrients are highly variable making interpretation and monitoring changes over the years difficult.

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Post-harvest Care to Enhance Blueberry Crop Value

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Small fruit has garninshed excitement in the US recently, and sales in the berry category have gone up every year, and blueberries of all types are no exception. Blueberries role as a superfood with high levels of antioxidants have pushed consumer sales. Consequently, overproduction is occurring, particularly in the Eastern US. Proper post-harvest care can extend shelf life and marketing window, which can help growers with the increased competition. Fortunately, blueberries are among the hardiest of small fruit, and with proper harvest, cooling, and packing, fresh market berries can store commercially for 2-8 weeks, depending on numerous factors. Rapid cooling using forced-air soon after harvest can cool product much quicker than static cooling and keep berry quality high significantly longer. In addition, for larger volumes of blueberries, modified atmosphere packaging in the form of pallet schrouds can extend the shelf life 4-8 weeks for most varieties.

Forced-air cooling (FAC) is a relatively inexpensive method of removing heat from blueberries quickly. FAC is accomplished by exposing packages of produce in a cooling room to higher air pressure on one side than on the other. This pressure difference forces the cool air through the packages and past the produce, where it picks up heat, greatly increasing the rate of heat transfer. Depending on the temperature, airflow rate, and type of produce being cooled, forced-air cooling can be from 4 to 10 times faster than room cooling. In this talk, a small FAC cooling system will be shown, and resources will be shared to allow growers to build their own FAC system. The use of modified atmosphere packaging will be discussed as well.

Blueberry Varieties for New England Farmers

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To help diversify a 100 acre Apple Orchard my father Mike decided to expand into High Bush Blueberries. In 1981 the first blueberry plants were planted of Bluecrop, Spartan and Jersey. Today we have over 10,000 blueberry plants with 12 varieties over 18 acres. During the 80's and 90's the blueberries were harvested for wholesale with very little being sold through pick your own. Today all of the blueberries are picked by pick your own customers.

The majority of our blueberry fields can be broken into two distinctive planting groups, 1981-'88 and 2006-'12. In the 1980's Bluecrop, Jersey and Elliott's made up the majority of our blueberry production. Our second large planting was from 2004-'09 consisting of Dukes and Patriots. In 2012 we also added Nelson, Bonus and Aurora's.

Listing of our varieties in ripening order.

Duke – Is a great berry, large, sweet and very early. Can be slow to produce new shoots.

Early Blue – Very prolific production, poor color berry.

Hannah's Choice – Test planting, we had hoped it would ripen before Duke. Has questionable winter hardness but is growing and producing well.

Polaris – Very prolific, very sweet berry, medium size

Spartan – Very Large berry, excellent flavor. Can be susceptible winter damage. Older variety that we will be replacing with newer varieties

Patriots – Extended picking window, excellent large berry with great flavor, high yielding.

Blue Crop – Old stable, excellent large berry with great flavor, very high yielding. We have installed trellis to keep branches from bending over.

Nelson – Great berry, sweet large berry, great replacement for Jersey

Jersey – Customer favorite. Low yielding small sweet berries. Produces more wood than berries!

Bonus – Huge sweet berries, great late mid-season variety

Elliott – Great late season, excellent quality, great color and strong flavor. Elliott seems to be the worst for biannual bearing.

Aurora – Even later ripening than Elliott by a few days. Great berry with a great flavor

Improving Spray Deposition in Blueberries

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The optimize deposition of pesticide's active ingredient onto the blueberry bush plant surface is a critical component in the spray application process and control of blueberry pests.

Spray penetration through the blueberry plant canopy is of key importance to the spray deposition, and is necessary for uniform distribution of the spray material inside the canopy to get proper pest control. The blueberry bush canopy characteristics can place a significant limitation on the application and spray deposition. Canopy characteristics like shape, size, and density all play a major role in spray deposition. As the spray droplets penetrate the blueberry bush canopy, even the characteristics of the leaves play an important role in influencing efficient application.

Improving spray deposition in blueberries starts with selecting the right sprayer with proper air movement to optimize deposition of pesticide on and into the blueberry bush. Along with selecting the right sprayer, growers must prune blueberry bushes to optimize spray application. The sprayer must be calibrated and the spray pattern must be adjusted to allow for good spray coverage, minimizing spray drift and off target application. Spray application needs to be applied when weather conditions are conducive to minimizing spray drift.

Accurate application rates and effective pest control can be difficult to maintain with poorly maintained or incorrectly calibrated sprayers. Calibration is an efficiency tool often overlooked and under used by many growers. Over time, all types of nozzles are impacted by wear and tear, and the nozzle orifices get bigger, increasing the desired or calibrated output. Uneven wear can lead to poor spray patterns and uneven control or even crop damage.

Calibrating a sprayer a couple of times a season based on the blueberry bush growth can allow a grower to be more accurate with application rates. Typically a lower rate is used early in the season with an increase in carrier volume as the bushes grow. This results in growers using less chemicals to get the desired pest control. This not only saves the producer money but shows due diligence when it comes to protecting the environment.

Good coverage of active ingredient(s) on the blueberry bush is an essential requirement for effective pest management. Effective penetration of the spray into a dense canopy can be achieved by utilizing proper air movement/air-streams. Installing air deflectors at the air outlets added a slight upward motion to the air-streams and can enhanced spray deposition in the blueberry bush. Use of water-sensitive paper is a useful tool for assessing the spray coverage and penetration. When spray droplets (water) comes in contact with the paper, it turns blue, and spray droplets become visible. The visible pattern can be used as a guide to assess approximate coverage of a spray under field conditions.

Factoring affecting spray deposition:

1. Plant Canopy Characteristics (Growers manipulated by pruning)
    a. Plant density
    b. Plant shape
    c. Plant size
    d. Plant growth
    e. Time of year

2. Weather Condition (Growers determine when to spray)
    a. Wind
    b. Relative humidity
    c. Temperature

3. Pesticide (Growers what to use to spray)
    a. Formulation
    b. Adjuvants

4. Sprayer (Growers select or purchase sprayer)
    a. Droplet sizes
    b. Pressure
    c. Nozzle type
    d. Nozzle tip size
    e. Rate of water/carrier per acre
    f. Type of Air Movement
        i. Air blast
        ii. Air shear
        iii. Hydraulic
    g. Air movement pattern

5. Calibration and spray pattern evaluation(Growers determine how to accomplish)

Superfruit! Understanding the Health Benefits of Blueberries

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The term “Superfruit” means different things to different people. In marketing, it is a term often used when advertising a product that has a high level of antioxidant activity relative to the competition’s product. In nutrition research, the term has little meaning. The reason for this is that measuring the antioxidant activity of a food or beverage in a test tube has very little to do with the actual effects that food or beverage may have in your body, or on your health over the long term.

There are several different methods used to measure antioxidant activity, e.g., ORAC, FRAP, DPPH, etc., and each one may give a different value for the same food or beverage. This is what enables advertisers to rank several similar products, like berries, and choose the method that puts their product on top, i.e., the Superfruit! This term should be used with caution as it may send the wrong message to consumers, implying they should eat less of all other fruits. In order to state that one food is more beneficial with regard to our health, we really need to test the effects of regularly consuming that food in human studies. And that is one area in which blueberries stand out.

Blueberries are often ranked high in antioxidant activity, primarily due to their phytochemical content. Phytochemicals are plant compounds that have biological activities in the body that go beyond their ability to act as antioxidants. For example, they can affect how your blood vessels function, how your cells communicate with one another, and whether certain genes are expressed or not. All of these activities affect how the various organs and systems in your body function and, ultimately, play a role in the development of chronic diseases such as heart disease and cancer.

Phytochemicals are the reason why nearly all plants have some antioxidant activity. However, different types of phytochemicals will have somewhat different effects in the body above and beyond their ability to act as antioxidants. There are thousands of different phytochemicals found in nature, and they are often classified according to their chemical structure. The predominant class of phytochemicals is the phenolics. Among all fruits, blueberries are one of the richest sources of phenolic compounds, including flavonoids, phenolic acids, and stilbenes. The flavonoids are the largest class of phenolics and are often referred to as polyphenols. There are several different types of flavonoids, including the anthocyanins found in berries. Anthocyanins are responsible for the dark red, blue and purple pigments found in these and other similarly colored fruits and vegetables.

We know from studies conducted in cell cultures, in animal models, and in humans that anthocyanins have anti-inflammatory and anti-cancer activities, and may play a role in heart disease prevention, weight management, and in controlling diabetes. Since blueberries are a great source of anthocyanins, we would hope to see similar health effects when we regularly incorporate them into our diet. Given their unique blend of nutrients and phytochemical composition, it is possible that blueberries have additional benefits.

The best way to determine the actual effects of blueberries on human health is to conduct well-designed experiments in human subjects that use the whole food, and not just its isolated components. Previous work conducted by the late USDA/Tufts researcher, Dr. James Joseph, found that blueberries can improve cognition, specifically memory, in aging animals. It is only within the last 5 years that these effects have been studied in human subjects.

In order to inform researchers about the potential health effects of specific foods or nutrients in humans, it is often helpful to begin with an observational study. Observational or epidemiological studies follow the habits of large groups of people over time, and compare these habits with the development of certain chronic diseases. This allows researchers to see if there are any important relationships between the diets of these individuals and specific health outcomes. One such study is the Nurses' Health Study started in 1976 by Harvard researchers and follows the health habits of over 120,000 U.S. nurses. Since that time we have learned many things from this cohort, including the benefits of consuming plant-based foods like berries on a regular basis. In a publication of the data from this study, Devore et al. (2012) observed an important relationship between blueberries and brain function in humans. They found that the nurses who consumed 1 or more servings of blueberries per week scored higher on multiple tests measuring their cognitive function compared with those who consumed less than 1 serving per month.

Other recent human studies have looked at the effects of blueberries on risk factors for heart disease. Both whole blueberries (50 grams or ~ 1/3 cup per day) and freeze-dried blueberry powder (22 gram or the equivalent of 1 cup whole berries per day) have been shown to lower blood pressure after 8 weeks in men and women who are at high risk of developing cardiovascular disease in studies by Basu et al. (2010) and Johnson et al. (2015), respectively. The blueberry powder was also shown to improve arterial stiffness, a measure of damage to the arteries involved in the development of both hypertension and heart disease. Rodriguez-Mateos et al. (2013) reported improved blood vessel function in young healthy men after just a single dose of a blueberry drink made from freeze-dried powder. They were able to demonstrate an even stronger effect with a higher dose of this blueberry drink suggesting an important dose-response effect.

Interestingly, Stull et al. (2015) reported improved blood vessel function but no blood pressure lowering effect in high risk subjects after 6 weeks of drinking two daily smoothies with a total of 45 grams blueberry powder (or ~ 2 cups blueberries) combined with 12 oz of yogurt and skim milk. There is some evidence that combining blueberries with milk reduces their antioxidant activity and the absorption or bioavailability of the phenolic compounds, although there is some controversy about this potential interaction.

Kuntz et al. (2015) found no difference in the absorption of most blueberry anthocyanins among healthy young adults after consuming a serving of an extruded blueberry juice when compared with a smoothie of blueberry puree blended with no milk products, suggesting no interference with the food matrix, i.e., fiber, sugars, etc. In an earlier study, Del Bo' et al. (2012) compared the bioavailability of anthocyanins from two different blueberry purees, one made from raw fresh berries and other from berries that were steam-blanched for 3 minutes, and found no difference in the absorption of these phenolics. Both of these studies have implications for food processors as they suggest some preparation methods, like juicing, blending and subjecting to heat for a short period of time, may be as effective as raw berries in the delivery of blueberry phenolics to humans. Given their versatility and demonstrated health benefits, blueberries may truly be a Superfruit!

Manage Blueberry Fertility through your Trickle System

Trevor M. Hardy
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Brookdale Fruit Farm Inc. is a 7th generation family owned and operated fruit and vegetable farm located in southern NH. Brookdale's primary markets are Wholesale fruit and vegetables, Irrigation and Row crop Supplies division, Retail store locations, and Pick your own fruits and vegetables. Brookdale is the largest diversified fruit and vegetable farm in the state of NH and focuses on growing and distributing many different fruit and vegetable products throughout New England. In recent years Brookdale has become the New England leader in the design, implementation, and utilization of drip and fertigation systems for growing fruit and vegetable crops.

Brookdale has had blueberries in production for pick your own since the early 1980's. We currently operate 7+ acres of high bush blueberries for our pick your own market. These varieties include Blue Ray, Patriot, Bluetta, Blue Crop, and Eliot. The first drip irrigation system was installed on this crop in 1985 and was in continuous yearly use until 2013. At that time the original was replaced due to continued mulching of wood chips over the drip tubing and kinking from bush growth, it was easier to pull new lines than fish out the original working lines. Since that realization as a standard practice after mulching the blueberries we walk each row and pull the tubing back on top of the mulch and to the edge of the bush. This allows for an easy visual check at the beginning of each season for leaks and allows the grower to see the water dripping from the tubing. The primary thing to check when considering feeding plants with fertilizer through a drip system is to make sure your drip system does not have any leaks or breaks.

Our blueberries receive a granular application of ammonium sulfate yearly, and the rest of the nutrients are fed throughout the growing season through our drip system. We typically focus on applying 60 to 75% of required nutrients granularly and depending on weather conditions and timing everything else is fed through the drip system. In some very wet springs where it is impossible to get into the blueberry fields to spread fertilizer early, the drip is turned on for the purpose of applying a starter fertilizer. Fertilization with the drip takes place weekly starting around the end of April to the second week of May and continues strait through with weekly applications till the middle of July. Products used for fertilization is a special berry feed blend created by Plant Marvel Laboratories which is used and distributed throughout the North East by Brookdale Fruit Farm. This unique berry feed blend is a combination of ammoniacal and urea based nitrogen blended with a micro package and a larger sulfur content to help maintain proper PH for blueberries. This fertilizer is water soluble and available in 25 lb bags and applied at varying rates through the season ranging from 20 to 35 pounds to the acre.

Fertigation is a bit of a tricky application to design and implement on a drip irrigation system. The typical method of injection used is conducted through a venturi type injector, also known as a mazzei injector. The injector has to be sized properly to operate within the functional flow rate range of the area of crops to be fertilized. If a square acre plot of high bush blueberries were to be irrigated and fertilized at a plant and spacing of 6 foot between plants and 12 foot between rows approximately 17 rows would be present per acre. 17 rows at 208 feet long give approximate row footage per acre of around 3600 feet of tubing. That tubing typically has drippers built into it with water dripping every 12 inches at a rate of 0.5 gallons per hour per dripper. The math to equate the flow rate of that acre is as follows ((total row footage / dripper spacing per foot) * flow rate in gallons per hour) / 60 in order to get gallons per minute). ((3600/1)*0.5)/60= 30 gallons per minute of water for square acre of blueberries. Brookdale makes it easy with their premade fertilizer injector assembles with accompanied flow rate ranges to size a fertilizer injector for your application. For one acre application either a 2 x 1 inch injector or a 2 x ¾ inch injector will work . The premade injector assemblies contain 3 check valves to meet the EPA guidelines regarding chemical water injection and prevent any possible back siphoning of fertilizer to the water source. For more information on injection tools and applications please contact Trevor Hardy at tractortrv@aol.com

Mazzei fertilizer injector assemblies

	Pipe	Injector Size	Flow GPM	Price
Assembly comes with: camlocks, pressure gauge, gate valve on and off, fertilizer barrel mixing valve on garden hose fitting, injector isolation valves	1"	1/2 inch	2 to 9	**$190.00**
	2"	3/4 inch	9 to 50	**$305.00**
	2"	1 inch	16 to 80	**$350.00**
	3"	1 inch	16 to 180	**$460.00**
	3"	1.5 inch	34 to 350	**$510.00**

Filter Flow capabilities
2" Single   110 GPM
2" Double 220 GPM
3" Double 440 GPM
3" Tripple 660 GPM

Harvest, Handling and Storage at Nature's Route Farm

Kent Coates

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Introduction

History. In 2007 Nature's Route Farm started with 28 CSA members who all got the same "easy to grow" vegetables every week from July until March. In 2015 Nature's Route Farm offered a CSA from July until November for over 300 people and does two farmers' markets all year long. We only sell what we grow ourselves.

In 2012 we decided to focus on storage crops for several reasons:

a. Opportunity. There was limited supply of locally produced crops during the winter and spring months;
b. Sign Up All Year. By maintaining presence at the markets all year long we maintained and grew our customer base and were able to promote our CSA baskets all year long;
c. Carrots. Our regional climate/soil enabled us to grow high quality carrots and customers really like them;
d. Personal Interest. Mechanically inclined and enjoy growing heavy crops; and
e. Winter is Long. There are a lot more weeks during the winter and spring than there are during the growing season!

Winter market sales have grown and February sales ($14,400 in 5 markets) are typically similar to August sales ($14,500 in 5 markets)!!!

Two-Pronged Harvest

Growing Season Harvest. Throughout the season we harvest approximately 3-5 days per week. We cluster our CSA pick-ups on Tuesday and Wednesday to enable us to harvest larger volumes at once and reduce the amount of task changes the crew undergoes throughout the day. We do 3 pick-ups in parking lots of approximately 100 people each. Harvesting during the summer season is mostly done with ship'n'shore fish tote boxes and wheelbarrows. Larger volumes and heavier crops are picked up with a tractor and trailer. Vegetables are prioritized by susceptibility to heat and are harvested as early in the day as possible then hydro-cooled / washed as quickly as we can. Pallet loads of veggies are then placed in the cooler. Refrigerated vehicles will help with this in the future as we will be able to load directly from the wash station.

Storage Crops. We grow a wide variety of storage vegetables and in 2014 we stored over 200,000 lbs of crops for winter and spring sales. Storage crops are harvested by hand. Carrots, beets, parsnips are picked into woven bags (2x5gal bucket per bag). Potatoes, cabbage, kohlrabi and rutabaga are picked into large tote bags (up to 3000lbs). Onions are picked into pallet totes.

Our quest to have the best at storage crops and provide customers with 52 week/per year service led us to expand our cold storage significantly over the last few years.

Infrastructure

2007-2011 – 2 cold rooms in basement with fresh air fan that was turned on during colder nights enabled us to store up to 30,000lbs of mostly carrots and potatoes. Everything was stored in ship'n'shore fish totes, washed with a pressure washer in a tub of water outside all winter long. Very little mechanization. Wheelbarrows and lifting were the main way vegetables were moved around. Vegetables were delivered in a pop-up trailer that we towed with an old VW.

2011 - insulated and installed a coolbot in a 5ftx8ft trailer. This trailer has worked incredibly well and is still used today. Up to 3000lbs of root crops fit into this trailer which was used behind a car for 3 years before upgrading to a sprinter van. We now have a cooled 16ft 3 ton truck too.

2012 – basement cold rooms + 16ft truck box with coolbot. Still washed all winter veggies outside all winter with pressure washer. In the summer of 2012 we built our first dedicated vegetable building. 82x28 ft R30 building with 32ft semi trailer cooler.

2013 – 112ftx44ft R30 building with two 53ft semi trailer coolers. Loader tractor with pallet forks added in spring of 2013 and forklift added in December 2013.

Quality, Quality, Quality

To maintain quality of carrots and potatoes into July and even August (Rutabaga into October of 2015) we control temperature with walk in cooler systems and humidity by using woven 50-80lb polypropylene bags. Larger bulk bags that are vented (built for potatoes) are also used.

Our Buildings:

Both buildings were built with a large vegetable room, one for washing and one for dry handling. There is a smaller room on the end of each building where all of the waste heat is dumped from the coolers. One is the workshop and one is the lunch room. The buildings are built to put greenhouses on the end as well. Currently there is only one greenhouse (27x95ft) on the end of the first building.

Both buildings are built the same way, on a concrete pad with a thickened edge and 6in concrete curb under the walls. 2x6 construction, 17ft tall main room with wet (sticky) cellulose insulation and food grade steel on the inside. Building very rarely freeze and stay between 32degF and 41degF for December until the end of March.

We poured concrete between buildings to enable us to forklift and pallet jack product from one barn to the other.

Things we learned: Concrete contractors will never get the job exactly like you want. Design for this. Make sure man-doors are brought up on top of a curb as they always have water under them in the wash barn and will eventually rot. Build big the first time if you can! Insulate the floor (below concrete) it you can to provide the best flexibility going forward. Know and understand what you want and do as much as you can. Hire the best contractor possible. Remember, you are the one that has to live with the building when it is done, not them.

Why?

1. Walk-in coolers were expensive and once installed limit the use of our farm for prospective buyers.
2. Semi trailers are very modular. We can add or subtract coolers as required. They are cheap, easy to dispose of and do not conduct cold into the floor. Without a footing (just a concrete pad) I wanted to avoid driving the frost into the floor which could be significant during winter if the cooler is being held at zero all year long. T
3. The buildings are built with lots of doors to make moving product easier and provide ultimate flexibility if the buildings are ever repurposed.
4. The buildings are built in dimensions that would be convenient for other uses including as a shop for highway trucks and trailers.
5. Ceiling height was maximized for more space and forklift operation. All doors were made large enough for semi trailers.
6. We installed water cooled walk-in cooling systems on the two larger trailers. This lets us move the heat to wherever we want it and it is tied into the hydronic system which heats the workshop and will (eventually) heat the house. In retrospect, this system is interesting and innovative but is not off the shelf and requires some babysitting.

Semi-Trailer Pros	**Semi-Trailer Cons**
Modular – can add or subtract cooling easily	Loading (requires forklift)
-separates vapours and temperature zones easily	Packing and Access (narrow)
Initial Cost – low purchase cost	Wasted space above and below
Keeps frost out of floor	R Value
Fast and easy set up	
Can fill them before building was completed	
Storage space underneath?	
Mezzanine on top?	
Easy to decommission	

Cost (Cdn $)

Building: 60x28x15 + 22x28x11 R30, finished in steel inside and out including septic waste water system, water, and electricity. $120,000 ($52.25/sqft)

Cooler 32x8ftx8ft - $2500 +$7000 cooling system ($4.64 / cuft)

Building 82x44x17 + 30x44x13 R30, finished inside and out with steel, including 3 phase power, water, drains. $250,000 ($50.75/sqft)

Coolers 2 x (53x8ftx8ft) = $3000+$11,000 cooling system ($4.13 / cuft)

<u>Do It Again</u>? Start with small cooler trailer. Ensure vehicles are cooled to eliminate extra handling. Move to pallets sooner and build BIG the first time.

Vegetable Storage for Winter CSA Sales

Laura Tangerini

Tangerini's Spring St Farm
Millis MA

Tangerini's Farm is located in Millis, Ma. Located about 25 miles southwest of Boston. We currently have 40 acres under cultivation, a display greenhouse, a propagation house, three high tunnels and a low tunnel. We market through our on-site farm stand, farmers' market, co-op and high-end grocery stores. In 2008, we began our CSA with 100 members and today we have 350 members. Today our CSA options run from mid- April to mid March and almost half of our Main Season members continue with us in the winter months.

We have two different winter options. The first option is the winter share. It runs from early November to the end of December. Pick-ups are every other Saturday from 10a.m. to 1:00p.m.. Distribution is held in our display greenhouse and shareholders take a prescribed amount of each item. The second option is our Combo Share. Shareholders continue to pickup every other week until mid March. Pickups for the Combo are held in one of the cold storage units and shareholders can take up to 25 lbs of winter vegetables. Distribution is held Saturday-Tuesday of pickup week. Both the shares have a u-pick greens option that comes with the share.

In 2010, we constructed a three bay, climate controlled cold storage facility primarily for the storage of winter vegetables for our CSA. We felt strongly that having a good winter share would be determined in large part by our ability to store them correctly.

The concrete unit is built into a hill with insulation on the ceiling and floor. It is separated into 3 bays. Each bay (320 sq.ft.) has its own low velocity-cooling unit. All the units are controlled digitally and all have defrosters.

Unit	Crop	Temp.	Humidity
1	Sweet Potato Butternut Acorn	55 degrees	Low
2	Carrots Beets Parsnips Turnips Winter Radish Rutabaga Cabbage Kohlrabi Celery Root	33 degrees	High- greater than 95%
3	Potatoes Onions	38 degrees	Low-80%

The sweet potatoes and squashes in unit 1 are stored unwashed in bins. In this unit there is also a wall-mounted heater that turns on when the thermostat dictates. The wall that divides this unit 1 and 2 is insulated. Prior to insulating this wall it was difficult to control the temperature and the humidity.

In the middle box we keep all our vegetables that need high humidity and low temperatures. Our carrots, beets, parsnips, winter radish and turnips are all washed and bagged into 15” x 30”, 3 mil, vented plastic bags each of which hold about 25 lbs. All the others vegetable in Unit 2 are washed and stored in bins. A wall-mounted electronically controlled mister that sprays a light mist when needed controls the humidity. Data loggers placed in this unit have shown that the temperature remains very constant (31-36 degrees) through the course of the winter even though the outside temperatures ranged from the upper fifties to the single digits.

Unit #3 is for the storage of onions and potatoes. We gradually reduce the temperature to 38 degrees. This year will be the first year we’ll store onions under these conditions but, we are hopeful after speaking with other growers who are doing the same. This is also the home of our Combo Share. All our available produce is crated and displayed in this room. Shareholders enter the room, check off their names and fill their bags with up to 25 pounds of produce. This display is set up on Saturday morning of pick-up week and dismantled on Tuesday evening. Having it set up like this gives the shareholder much more flexibility, so they don’t feel the pressure of getting to pickup when the weather is inclement.

The key to having a good winter share is having good quality, good looking, firm produce. We can’t expect our shareholders to support our efforts if we aren’t making every effort to bring them the best product possible.

Josh Volk
SlowHandFarm.com

Harvest and packing produce are the two biggest labor expenses for most crops on farms so they have the biggest opportunities for cost savings from incremental improvements. I've tried to take key concepts, that are really common sense, and apply them in my thinking about how to streamline harvest and packing while keeping the level of quality, safety and ergonomics high. The 1948 children's book "Cheaper by the Dozen" was my first introduction to the idea of time and motion and efficiency experts, but my father, having worked on factory floors was also quick to point out the potential pitfalls of taking the process too far, as it often has been. In the 1990's the Food Bank Farm folks made an excellent video on their harvest techniques that looked to the efficiencies of large industrial agriculture and scaled down the concepts to systems that fit into a small, diverse farm. Ben Hartman's new "The Lean Farm" talks about a lot of these same concepts, borrowing the language and framework developed by Toyota, which has been applied in factories all over the world on all different scales.

In looking for more efficiency/less waste I find myself focusing on three basic things: thinking through the physical motions of an activity, good communication, and mise en place, or making sure everything has a place, is kept there, and is orderly. These are all parts of creating good systems and having established systems are important to me. Being able to improvise is important, but systems set the foundation.

Field

When I'm harvesting I think about my motions in the field. For example, if I'm harvesting a bed of carrots I start at the far end of the bed and harvest back toward the cart at the beginning of the bed. This way I'm walking the long distance with an empty container, and the short distance with the full container. I also find it works better for me to pick a single row at a time for most crops instead of jumping back and forth between two rows as I move down the bed. If I'm picking two rows I have to move my body twice as far, but my attention and arms aren't constantly jumping back and forth so I ultimately save time and don't unintentionally miss short sections as often.

If you're unsure if one way is actually better than another or if there's dissent on the crew take the Food Bank Farm's approach and have a race, or do a time trial to compare the two methods.

Many of the improvements I'm thinking about don't require any investment in equipment, but I also think about how new tools or improvements to current tools will help, and I make evaluations of what the ROI (return on investment) will be – in dollars, environmental impact and crew morale. The farm carts I've been designing came out of years of working with garden carts and wanting some upgrades to the ergonomics and functionality. Garden carts are great tools, but there were lots of little improvements I wanted: the handle was low to pick up and then caused the cart to tilt back too much when hauling, sometimes tipping tall loads over; the high side walls made loading harvest bins from the side or back difficult, they were too narrow and low to straddle our beds and take into the field for harvest, the frame was a little flexible and didn't always transfer pushing or pulling energy efficiently, the wheels had low quality bearings. My designs worked on making all of those improvements. They have been very successful in improving the ergonomics and usability of the cart on the farm. The improvements aren't necessarily huge, but remember that incremental improvements on something that is used consistently add up over time.

Creating systems for clear, complete communication, especially on a farm where the tasks are highly diverse and there are a lot of transitions, is crucial for limiting transition time and avoiding mistakes and misunderstandings. For field harvest I've developed a standard pick sheet that includes all of the information needed for someone in the field to know exactly what they are harvesting, how and in what quantity. Having the sheet in the field also means they know what the next task is without asking, and there is space for them to communicate and the other folks on the crew what is already complete, and who completed it and how long it took in a quick, concise, and easy to understand way. We also have a standard tape labeling system for harvest totes that minimizes mistakes and helps us keep track of produce as it moves through the farm without having to constantly search for things.

Mise en place is a French term borrowed from kitchens and is similar to the English phrase, "a place for everything and everything in its place." In restaurant kitchens, the same as any production setting, being able to find exactly what you need, when you need it is critical to saving time. The easiest way to do this, both for an individual and especially when multiple people are using the same space is to make sure there is a standard place for everything, that tools and supplies always are put there when they are not being actively used, and generally that all spaces stay tidy and well organized. Factory floors use yellow tape to mark lanes for moving people and products, and it is understood that nothing ever gets left in one of these lanes; there is a pre-designated place for everything, including traffic.

The most common harvest tool, the knife, is one that I prefer everyone have their own, personal version of, and that they keep it on them through the harvest to save time when it is needed. For that reason I personally wear a tool belt and prefer knives that have good sheath options like the Morakniv. I've found that when knives are not personal property they tend to get misplaced more easily, and they rarely stay as sharp. Misplaced knives don't just waste time and money, they are a real safety hazard. I also make everyone brand their knife so we know whose it is if it gets misplaced.

We have clear labeling systems for where harvests are coming from. We also have clearly designated places for all of the supplies for harvest and a waterproof bin that all of the usual supplies sit in that travels out to the field with us on harvest days. The bin keeps picking sheets dry, has tape and markers for labeling totes, twist ties for bunching, and a first aid kit in case of accidents.

Pack Sheds

Similar to the pick sheet for the field, there is a pack sheet for the packing shed, and in the same way when orders are packed a record that the task is started and completed is made to let the other folks who are packing know. There is also a record sheet as everything comes in from the field that helps us keep track of yield information for future planning and cost evaluation.

Having an electronic bench scale sitting right at the entrance of the packing shed is a simple way to check everything in. I use a version rated at 200 pounds, which means it can weigh more than we can lift onto it without getting overloaded. We put it on a custom bench, attached to the wall at the a height that makes it easy to set our harvest totes on without having to bend over, or to lift the totes up high. The display mounts on the wall at eye level which makes it easy to read, and there's a light right there to make it even easier on dim days – all small, but important ergonomic considerations for something that is used regularly.

I designed our washing and sorting tables to be simple, easy to move, and ergonomic. They are sized for one person to work on so they are roughly as wide as someone can reach from side to side. There are little benches on either side of the table for our harvest totes, usually dirty, unsorted product is on one side and it's moving across the table to a clean tote on the other side. The low bench keeps the totes just below the edge of the table so produce can be slid off the side of the table into the tote. A backstop keeps things from sliding off the back. The table top is made from lath which is cheap, easy to build, light, gets smoother with use and doesn't sag (unlike hardware cloth which is commonly used) and gaps between the strips let soil and water through. Scrap metal roofing under the table stiffens the table and directs spray water away from the user's feet keeping them much drier and more comfortable. The tables are very light weight but stable. They are easy to move for cleaning, or reorganizing the space when needed. Typically we use them in the same spot every time though and we have hanging hoses with spray heads over each table location. This means hoses aren't in the way on the floor, and aren't getting dirty, and they're always right there when you need them.

For moving materials around the pack shed I favor hand trucks with simple hand truck pallets. The pallets keep the harvest totes off the ground which improves cooling air flow, and also keeps them away from contact with potential contaminants on the ground. We also use pallet jacks for larger loads, but for the majority of trips we're moving just a few totes at a time so the hand truck pallet is more appropriately sized.

These are just a few examples and with most of these we are still constantly improving so they are not systems or tools that are as good as they can be. These are systems and tools that work well, are better than what we were doing before, and will probably be improved on in the future.

Validation of the MaluSim Carbohydrate Model

Gregory Peck, Ph.D. Assistant Professor of Sustainable Fruit Production Systems

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In commercial apple (*Malus Xdomestica* Borkh.) orchards, farmers remove part of the crop each year in order to reduce biennial bearing and increase fruit quality. This process is referred to as "thinning" and is often accomplished through the use of plant bioregulators and/or caustic chemicals. Due to within- and between-year variability in environmental conditions and the differential response apple trees have to chemical thinners based on cultivar, rootstock, and tree health and age, thinning apple fruit remains one of the most difficult management tasks in an apple orchard. To help overcome this challenging task, researchers at Cornell University have developed MaluSim, a computer-based algorithm that estimates the daily carbohydrate balance for an idealized 'Empire' apple tree using daily high and low temperatures and total daily solar radiation as inputs. In theory, knowing the carbohydrate status of the apple tree at the time of thinning application should allow apple growers to alter products and rates so as to avoid over- or under-thinning. Five years of field trails have been conducted in Winchester, VA in an effort to validate the MaluSim model in the mid-Atlantic region. In these experiments, 6-benzyladenine (MaxCel, Valent BioSciences) and carbaryl (Sevin XLR Plus, Bayer CropScience LP) were applied to 'Bisbee Red Delicious' and 'Crimson Gala' trees on two- to three-day intervals from petal fall to a fruitlet size of approximately 20 mm in diameter. Crop load data was used to assess the effect of thinning from each application treatment. Through the use of cross correlations and the generalized additive model, the MaluSim model provided the most significant response when a six-day running average of the model output was used. Additionally, when the MaluSim model predicted greater carbohydrate levels at the time of thinning, the crop load at harvest was significantly greater. Through these experiments, the MaluSim model was shown to be a useful tool for understanding the impacts of environmental conditions on chemical thinning efficacy.

Adapted from: Peck, G. 2015. Validating the Use of the MaluSim Carbohydrate Model for Apple Fruit Thinning. HortScience 50(9):S112 (Abstr.)

Profits on Small Acreage
$100,000 per Acre on a Small Farm

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During this special 3-hour session, Jean-Martin (JM) will be offering a very interactive presentation with those attending and will also have his popular book (The Market Gardener), which his presentation is based on, for sale at the end of the session.

Farmers can learn how to farm profitably on small acreage using low-tech, high-yields methods of production from one of Canada's most innovative ecological farmers. In this workshop Jean-Martin will provide an overview of how he and his wife generate more than $150,000 of gross sales farming on less then 2 acres of cultivated land. Specifically, he will discuss how to:

- Set-up a micro-farm by designing biologically intensive cropping systems, all with digestible capital outlay
- Adopt a permanent bed system, farm without a tractor all while minimizing fossil fuel inputs through the use of the best hand tools, appropriate machinery and minimum tillage practices.

Designing and Assessing Results of On-Farm Trials

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In the first two presentations in this session, we will de-mystify on-farm experimentation by providing practical guidance to help you design and carry out experiments to test if new practices really offer an improvement over what you normally do.

The fundamentals of on-farm trials

The most important part of designing on-farm trials is to clearly define your research questions and the intended scope of your conclusions. In other words, **what is it you want to learn?** We'll give examples of clear and not-so-clear objectives, and we'll discuss what types of results you can expect from different kinds of research questions.

Designing and conducting an experiment

Using clear examples, we will talk about those aspects of designing an experiment that directly affect how you will analyze the data, what you can learn from the results, and whether or not you have a reasonable chance of successfully answering your question. We'll cover the following:

- Treatment selection
- The use of controls
- Replication (how much is needed?)
- Randomization (how to do it)
- Managing variability

Once you have gone to the effort of designing a trial and carrying it out, how do you know whether you've learned anything? We will discuss the crucial difference between seeing what may look like an improvement and using statistical analysis to test whether such an observed improvement is real. But statistical significance is not everything, for it is also perfectly possible to measure statistically significant differences that are not meaningful in a practical sense.

Even the most carefully designed experiments will not yield good results, however, if you're unable to implement the plan and collect the type and quality of data you need. We will share practical tips for how to choose what to measure, keep track of treatments, and collect data appropriate for analysis.

Statistical analysis and interpretation

Lastly, we'll show examples of statistical analysis, and how to interpret the results. While analysis can be done using spreadsheet programs such as MS Excel, this requires a detailed understanding of statistics. In fact, most researchers use specialized statistical software packages to analyze their data. How, then, to analyze your on-farm data? The best approach is probably to collaborate with your local Extension Specialists and researchers, who are familiar with statistical analysis and who regularly use this software, and ask for their help. We'll show how simple this can be.

Our on Farm Trial to Test a Berry Production System

Sare grant FNE05-553

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In 2005, 2006 and 2007 we tested the establishment of matted row strawberries in a killed rye cover, a winter killed sudex cover crop and in a biodegradable corn based mulch film.

We obtained a farmer SARE grant to test various ways to establish matted row strawberries as alternatives to bare ground establishment. Our interest in determining a method was to continue with our PYO strawberry operation but to reduce weed control labor during the establishment year without using herbicides. We run a diversified wholesale vegetable operation along with a retail bedding plant operation and pick your own strawberry business. Because of our diverse operation, we find that the strawberries often get overlooked and result in a weedy planting that results in decreased production

The initial primary goals of the project were;

1. To determine if a killed rye cover crop or a winter killed sudex cover crop can provide adequate weed control for matted row strawberries in the establishment year.

2. To test a transplanting technique using an 8' long dibble welded to a wheel that is used on a water wheel transplanter.

Project Activities

We established a winter rye cover crop and a sudex cover crop in late August of 2005. The sudex cover crop winterkilled, and the winter rye was allowed to grow to flowering at which point it was killed either by rolling or flail mowing. After examining the cover crops in the spring of 2006 it was determined to abandon the sudex component of the experiment. The sudex had excellent establishment but it was obvious that after the winter the amount of biomass was inadequate to provide much weed control. This was determined with consultation with our collaborator John Hayden. Six days after rolling and mowing the rye, the bare root strawberries were planted into the killed cover crop. The flail mowing provided more thorough evenly distributed mulch but there was some regrowth of the rye. The rolling method worked to kill the rye, but weeds were able to come up between the bases of the stalks of the killed rye. Both methods gave enough weed control for the dormant strawberry plants to become established (approx. five weeks). At this point the weeds were able to grow through the mulch and easily out compete the strawberry plants. With consultation with our collaborator, we decided to till in the experiment since it was obvious that the strawberries had no chance of establishing a matted row.

Assessment

The results showed that the rye does not suppress weeds long enough for the establishment of matted row strawberries, and at the same time does not breakdown enough to allow for mechanical cultivation of established weeds. The planting of the strawberries through the mulch with the long-spiked dibble proved somewhat successful. While the wheel penetrated well, the hole was a bit difficult to get the bare root plant into because of the narrowness of the hole. The method does work but could be improved with a broader spike. The results suggested that we would like to make a major shift with the experiment. We experimentally used biodegradable corn polymer plastic mulch made by BioTelo for use with winter squash, melons and onions. We are intrigued with using the BioTelo mulch and planting bare root crowns into the mulch in the spring. The material does breakdown at a rate that might allow for the rooting of runner plants produced from the established crowns.

3. Upon consultation with our SARE advisor, Dale Riggs, we redesigned the experiment to evaluate the use of biodegradable mulch films in establishing matted row strawberries. We tested the BioTelo mulch of two different thicknesses (.5 and .6 mil) which are suppose to give 2 to 3 months, and 4 to 5 months of weed control respectively. We also evaluated planting density on the mulch film, degradation of the film during the picking year and tracked weed control labor input. Planting densities tested were single row on 4 ft. mulch with in row spacing of 12 and 18 in., and 2 rows on 4 ft. mulch with 12, 18 and 24 in. in row spacing.

Assessment Biodegradable mulch provided significant savings in labor in establishing matted row strawberries as compared to regular bare ground establishment. Labor was reduced by approximately 50%. The .5 mil provided adequate weed control as compared to the .6 mil, and decomposed at a rate that worked well with the timing of plant runnering. The most successful planting densities were 2 rows spaced at either 18 or 24 in.

Summary

Developing an on farm trial to test a production system was very helpful for our operation. Working with SARE enabled us to get consultation on experimental design and evaluation. The farmer SARE grants were an excellent avenue to explore our ideas on establishing matted row strawberries.

How to Use Plant Growth Regulators; ProGibb and Retain to Reduce Peach Flower Bud Density and Enhance Fruit Firmness for Retail Sales

Win Cowgill
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Wes Autio
Stockbridge School of Agriculture, University of Massachusetts

Introduction

Hand thinning of young peach fruit is an expensive part of peach production. Any technique that could reduce the labor of thinning would be financially beneficial to peach producers. In 2012, we reported on 2 years of work with gibberellic acid (GA) on peaches. GA was applied about 4 weeks before harvest. Work elsewhere suggested that GA applied in this pre-harvest period can reduce flower bud formation. Our results confirmed those with significant reductions in flower bud formation with increasing concentration of GA. Further, GA application increased flesh firmness in the year of application.

In 2013, our goal was to again test the effectiveness of GA application on fruit quality and firmness and to study the potential interacting effects of AVG (Retain®) as an addition to GA to enhance fruit firmness.

Retain has been used labeled for use on peaches since 2004 for stop drop and fruit firmness. It has not been used widely by peach growers but has some specific benefits for PYO and direct market peaches, specifically the ability to manage maturity, fruit firmness, and **stop drop of later maturing peaches. Note:** It is also labeled on plum, pruned and apricot.

ReTain works by retarding the development of ethylene, the chemical that causes ripening. The active ingredient is a natural occurring product aminoethoxyvinylglycine (AVG), which is produced by fermentation. The fermentation process required to produce AVG is very difficult and very expensive. Because of this, Retain should only be used in high value varieties with a large crop of unblemished fruit.

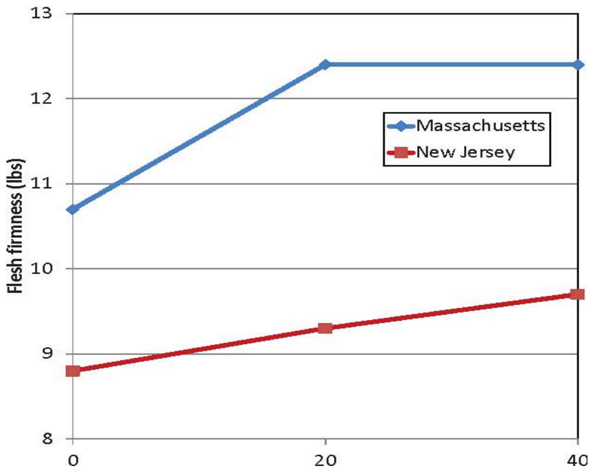
-**More** on recommendations and guidance for the use of Retain later in this article.

GA is labeled for use on stone fruit, it is found on the **Progib 4% label,** section 8, fruit crops.

GA/Retain 2013 Experiment

Materials & Methods In 2013, 78 and 48 trees were selected at the Rutgers Snyder Farm (Pittstown, NJ) and at the UMass Cold Spring Orchard (Belchertown, MA), respectively. Trees were divided randomly among three rates of GA in the form of ProGibb® (0, 20, and 40 g a.i./acre) in all combinations with two rates of AVG in the form of Retain (0 and 50 g a.i./acre). All treatments were applied about 2 weeks before harvest and included 6.4 oz. Sylwet® plus 6 oz. Drexel Defoamer®/100 gallons. Harvest samples were taken on August 15 and 22 in Massachusetts and on August 5, 9, and 14 in New Jersey. At harvest fruit were weighed, flesh firmness was measured with a penetrometer, and the soluble solids concentration of the juice was measured with a hand refractometer. The density of bloom was measured in 2014 by counting the number of flowers on 6 new 1-year-old shoots of similar vigor per tree (reported as the average number of flowers per cm of shoot length).

Figure 1. Effects of GA applied two weeks before harvest on flesh firmness of Jersey peach in Massachusetts and New Jersey.



Results-Retain (AVG) resulted in an increase in flesh firmness in both Massachusetts and New Jersey (0.5-1.0 lbs) but did not impact any other measurement and did not substantially affect the fruit or tree response to GA (data not shown). GA increased flesh firmness by about 1 lb in New Jersey and almost 2 lbs in Massachusetts (Figure 1). In Massachusetts, GA decreased soluble solids concentration, but it did not impact soluble solids in New Jersey Flower bud formation was not affected in New Jersey, but in Massachusetts, the 20g rate of GA reduced 2014 bloom by 38%, and the 40g rate reduced it by 57%

Conclusions-Increased firmness as a result of GA application has been a consistent result from our research, and it appears that AVG, likewise can increase firmness. For flower buds, the GA effect of reduced formation only was measurable in Massachusetts in 2014. This is somewhat inconsistent, but in the two previous studies, was lower and the response to GA was less pronounced in New Jersey than Massachusetts.

We believe that the higher vigor of the New Jersey trees may be affecting their responsiveness to GA applications. In three years of experiments in Massachusetts and two out of three years in New Jersey, GA application 2-4 weeks before harvest significantly reduced flower bud formation and the resulting flower density. GA can therefore significantly impact the need for hand thinning.

We recommend that growers test GA on their farms with trees of different vigor and of different varieties. A rate between 20 and 32 (the maximum label rate) g a.i. per acre and timing of 2 weeks before harvest is a good starting point. We believe that GA, once calibrated for a farm, can be a valuable tool for a peach growers.

Use Retain for Peach Harvest Quality Management

Benefits of Retain on Peach include:
•Stop drop control, specifically for September Maturing varieties prone to drop
•Allow you to let peaches hang on the tree longer, allowing greater color development.
•Allow you to stager harvest of a particular variety if needed, delaying harvest up to four days.
• Increased fruit firmness at harvest across most varieties tested allowing you to pick more mature fruit that is still firm when handled

• Increased fruit firmness in cold storage over several weeks time

Retain works slightly different on each variety; you will need to evaluate it on a variety-by-variety basis. On a few cultivars there is very little effect, Redhaven is the most notable example.

ReTain application is different than apple, it must be applied 7-14 days prior to anticipated harvest to be effective, therefore it is essential growers carefully project ripening dates of each individual block which they plan to use ReTain this season. There is a 7-day PHI on Retain with peaches and nectarines.

Important considerations to follow with ReTain applications on peaches
•Retain has a 7 day (PHI) pre harvest interval.
•Use the full rate of ReTain (1 pouch or 333 grams/Acre of formulated product) for peaches and nectarines
•Apply 7-14 days before normal anticipated harvest. (when harvest would be expected if not treated with Retain)
•For optimal response use Retain with a 100% organosilcone surfactant such as: Silwet L77 at 6.5-13 fluid ounces per 100 gallons, or Sylguard 309 at 6.5-13 fluid ounces per 100 gallons. **Use a final surfactant concentration of 0.05 to 0.10 (v/v) in the spray tank.**
When high temperatures prevail, the lower rate of surfactant is recommended.
•ReTain should be applied with a sufficient amount of water to ensure thorough wetting of the fruit and foliage while avoiding spray run-off. Adjust water volume based on tree size and spacing. No alternate row spraying. 100 gallons per acre at 2x has shown to be effective.
•For optimum results apply during periods of slow drying weather conditions. No rainfall or irrigation should occur within six hours of ReTain application.
•Do not apply ReTain to trees under stress. They may not respond to the benefits of ReTain.
•Tank mix ReTain with other agricultural products has not been fully evaluated. PGR's are usually better applied by themselves

Note: read the label completely to fully understand the use of Retain on stone fruit, there are significant differences in use as compared to apple.

If you have specific questions regarding the use of Retain on peaches do not hesitate to contact me <cowgill@njaes.rutgers.edu>

Bacterial Diseases of Stone Fruit: Spots and Cankers

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The two most problematic bacterial diseases to affect stone fruit orchards are bacterial spot and bacterial canker. Even if you do not have a crop due to hard winters or early spring freezes, both of these diseases still need to be managed during no-crop years. This talk will describe the predisposing factors, symptoms, disease cycle, and management techniques for each disease.

Bacterial spot

Several predisposing factors can favor the occurrence of bacterial spot. Cultivars vary in their susceptibility and those that have early bud break or early fruit ripening are quite susceptible. The soil composition can also play a role: the disease favors sandy and very clay soils. Finally, warm temperatures and high humidity are most favorable to disease development.

Bacterial spot symptoms will manifest on fruit, leaves, and twigs. Early season lesions on fruit will appear as irregularly shaped deep pits extending into the fruit. Late season lesions will be shallow pits, but may coalesce and cause skin cracking, which can create an opening for secondary infections, such as brown rot. Bacterial spot on fruit is often confused with peach scab, which is a fungal disease that infects only the fruit and does not cause foliar symptoms. Peach scab symptoms include circular, dark olive-brown fuzzy lesions that do not cause surface pitting. Bacterial spot symptoms on leaves are always angular lesions and this is due to the lesion being bordered by the leaf's veins. The angular lesions are typically small; however, they can coalesce to form larger lesions. Often times, you will see lesions along the midrib of the leaf; the tip of the leaf; and along the edges (similar to how water runs off of the leaf or settles – this is where the bacteria has the potential to accumulate and cause cell death). There may be a few lesions; there could be many lesions on a leaf. The leaf will eventually turn yellow and fall off the tree. It does not take many lesions on the leaf for the leaf to turn yellow or to fall off. Lesions can occur on older and younger leaves. Copper injury can be confused for bacterial spot. Copper injury is indicative of a lot of round, circular lesions of variable sizes on the leaf. The reason there are a lot of lesions is due to the spray pattern that occurs on the leaf. The appearance of the leaves is reminiscent of "Swiss cheese." The bacteria will also cause infection on twigs and this infection will serve as the overwintering source of the bacteria. Infected twigs will lack vegetative growth, the tip will be blackened, and the bark will be cracked.

Bacterial spot is a polycyclic disease, which favors warm, wet conditions; the disease will slow down during hot, dry weather conditions. Cankers, infected buds, and leaf scars serve as the overwintering source of the bacteria, which will first infect leaves in the spring; throughout the summer, both leaves and fruit are susceptible to infection.

Two main management strategies for bacterial spot are using resistant cultivars and chemical control. Dormant copper sprays are recommended early in the season. Beginning late petal fall to early shuck split, spray for disease management 7 – 14 days according to the weather conditions. Oxytetracycline is the antibiotic to use to manage the disease; however, repeated applications are necessary and oxytet has a 48 hr window of activity. Other chemicals to consider are copper and biological products, such as Serenade Optimum (Bayer CropScience) or

Double Nickel (Certis). To use copper safely in a bacterial spot management program, Dr. Norman Lalancette of Rutgers University recommends using copper at 0.5 oz copper/A. He lists the available coppers and their adjusted rates in an article posted on May 15, 2014 in Rutgers Cooperative Extension's Plant and Pest Advisory: http://plant-pest-advisory.rutgers.edu/copper-bactericides-for-peach-bacterial-spot-management/. Always read the label for all chemicals to be sure you are in compliant with the crop you are treating since apricots and plums are often not included.

Bacterial canker

Several predisposing factors can favor the occurrence of bacterial canker in cherry. The Spanish Bush training system is the most susceptible, whereas Perpendicular V is the least. Cultivars and rootstocks also vary in their susceptibility. Sweetheart and Lapins cultivars are least susceptible; Regina is most susceptible. Gisela rootstocks are highly susceptible to the disease. Sandy and clay soils, as well as soils with high ring nematode populations are favorable to bacterial canker. Trees pruned during the winter are more susceptible to infection and spring freezes favor disease development. This is due to the bacteria having ice nucleation proteins, which allow water to freeze at higher temperatures resulting injury to the plant. The bacteria will then "feed" on the nutrients released by the injured plant tissue.

Bacterial canker symptoms can be seen on fruit, leaves, branches, and trunks. Fruit infection is sporadic and appears as water soaked, brown lesions. Lesions on leaves will occur along the leaf margin and cause a curling effect. On branches and trunks, the bark will be sunken, amber gummosis will be apparent, and limb and tree death can occur.

Bacteria overwinter in buds and cankers, and spring infections are facilitated by cool, wet conditions, as well as frost injury. Blossoms can become infected (blossom blast). During the summer, bacterial populations are at their lowest during hot and dry conditions. Infection is also favored during the fall and bacterial populations can be high due to cool weather favoring the disease.

Managing bacterial canker is very difficult. The goal for management is to reduce the numbers of bacteria before trees enter a susceptible period. Using copper alone has not been effective. However, repeated applications of Bordeaux mixture plus vegetable oil (2.8 qts veg. oil/100 gal) in September, October, and November and repeated again in the spring has shown favorable results to keep the disease in check. Additional information can be found in the September 11, 2012 issue of Rutgers Plant and Pest Advisory (http://njaes.rutgers.edu/pubs/plantandpestadvisory/2012/fr091112.pdf).

When pruning, avoid large dormant cuts; minimize impact of the disease with summer pruning since the bacterial population and activity should be low. Prune 12 inches below the infection and leave and ugly stub, so as to slow the progression of the disease into the main trunk. Other management techniques include planting in well drained soils, maintain nutrients, control weeds, remove wild *Prunus* near orchard, and do not interplant new trees with old trees.

Brown Rot; Best Management Practices and Fungicide Resistance Management

Guido Schnabel

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Brown rot is caused by the fungus *Monilinia fructicola*, the same organism that causes blossom blight during bloom. The fungus overwinters in fruit mummies, blighted blossoms, fruit stems, and cankers. In spring flowers can be infected by spores from fruiting bodies emerging from overwintering mummies on the ground (although I have never seen them in South Carolina) and from conidia produced in mummies on the tree and from cankers. Spores then spread by wind, rain splash and insects to green fruit and may cause latent (invisible) infections that will develop into rot as fruit matures. On mature fruit, the disease can progress very quickly and within days the fruit can be covered with hundreds of thousands of tan spores. When flicked with a finger on a dry day and held against the light, you can see the spores form a dust cloud.

Brown rot of peach

Mummy that should have been removed from tree

Controlling brown rot should be an integrated approach that involves the removal of mummies and cankers during winter pruning, the removal of wild plums in the orchard vicinity, and avoidance of late thinning and dense fruit clusters. But you will still not get around spraying during bloom, fruit maturation, and preharvest season. Bloom sprays may not be required if conditions are dry during bloom. But in general, growers apply at least one fungicide spray at full bloom. Captan sprays after pit hardening do have a significant effect on later season brown rot development and two to three applications of single-site mode of action fungicides are typically applied starting two to three weeks prior to harvest. In South Carolina the rotation of FRAC 3 (DMI) and FRAC 7 (SDHI) and 11 (QoI) fungicides has been very effective during preharvest season. FRAC stands for Fungicide Resistance Action Committee and its coding system puts all active ingredient with the same or similar mode of action into one group (FRAC code). For example, propiconazole and fenbuconazole are both DMI fungicides with the same mode of action and therefore both belong to FRAC 3. The FRAC 3 fungicides have become very popular among growers due to a steep price drop after propiconazole went off patent a few years ago. They have been around since the 1970s and they are still very valuable even though resistance has emerged in several production areas in South Carolina, North Carolina, Georgia, New York, and New Jersey. As opposed to other chemical classes, resistance to FRAC 3s can be overcome when increasing the field rate. That is because resistance is based on an increase of target enzyme in the pathogen; a higher dose of FRAC 3 fungicide can overcome the increased enzyme production. For example, in South Carolina, Georgia and some other states, Indar 2F can be applied up to 12 fl oz/acre (which is necessary to control resistant populations) under a special 24C registration. Check to make sure this exemption is valid for your state.

Although resistance to FRAC 11 fungicides is widespread in many pathogens, our research indicates that it is touch for *Monilinia fructicola* (the fungus causing brown rot) to develop resistance due to an inbuilt genetic barrier for target gene modifications at the most vulnerable location. This means that using FRAC 11 fungicides in mixture with FRAC 7 (such as Pristine and Merivon) a couple of times during preharvest season is a very good call and so far has been a safe bet for success. Many growers are still using Topsin M in combination with captan for brown rot control. But make sure you do not apply captan or phosmet (formulations of both active ingredients contain many inking-inducing minerals) following rainfall too close to harvest to avoid abrasion and inking problems on the fruit finish.

Picture on left: Inking of mature peach fruit.

Also, resistance to Topsin M has been observed in many farms, including farms in Massachusetts. Table 1 is a sample we received from Belchertown, MA and it shows that the ten *M. fructicola* isolates collected from this fruit orchard were viable on non-amended medium (control), resistant to propiconazole (e.g. Tilt), resistant to T Methyl (e.g. Topsin M), but sensitive to azoxystrobin (e.g. Abound), iprodione (e.g. Rovral), and pyraclostrobin+boscalid (Pristine). Knowing your farm specific resistance profile can avoid ineffective sprays and help with the bottom line for fresh market producers and shippers.

Table 1. Peach sample from Belchertown, MA

Isolate	Control	Propiconazole	T Methyl	Azoxystrobin	Iprodione	Pyr+boscalid
1	+++	++	+++	-	-	-
2	+++	+++	+++	-	-	-
3	+++	++	+++	-	-	-
4	+++	+++	+++	-	-	-
5	+++	+++	+++	-	-	-
6	+++	++	+++	-	-	-
7	+++	++	+++	-	-	-
8	+++	++	+++	-	-	-
9	+++	++	+++	-	-	-
10	+++	++	+++	-	-	-

Note: Propiconazole (FRAC 3) is the active ingredient of Tilt, Bumper, and many other generics; T Methyl (FRAC 1) is the active ingredient of Topsin M and other generics; Azoxystrobin (FRAC 11) is the active ingredient of Abound and Azaka; Iprodione is the active ingredient of Rovral and other generics; and Pyr+boscalid are the active ingredients of Pristine. A dash means the fungus was sensitive and a triple plus means the fungus was resistant to the fungicides.

Growing Peaches in Michigan: How We Do It and What Keeps Us Up at Night

Bill Shane, Senior Extension Tree Fruit Specialist,
Michigan State University

Making money producing peaches is difficult because the tree is sensitive to low winter temperatures, blooms relatively early, and the fruit has a short storage life. However, selling good quality peaches is generally easy because of the demand for this queen of fruit. Farm marketers know that peaches draw customers to their fruit stand. I am providing here observations and strategies that I have learned over the years working in Michigan for increasing the productivity of peaches. Although these tips will not eliminate the anxieties associated with growing peaches, I am confident that some of these will help.

Tree longevity anxiety

Temperatures below approximately -13 F in the mid-winter is tough on any peach tree and certainly on peach fruit buds. There are what I call lower tier varieties such as Veteran, Reliance, and Madison, that have the reputation for the best mid-winter hardiness, but their fruit quality and/or appearance are only so-so. 2nd tier peach varieties not quite as hardy as these but with better quality include Harrow Diamond, Starfire, Contender and the flat white fleshed peach Saturn. A third tier of varieties slightly less hardy reliable than these, but still pretty good, and good to excellent quality include Garnet Beauty, Summer Serenade, Redhaven, Allstar, PF17, and Glowingstar.

Since winter damage and tree mortality is a fact of life with peaches, a good strategy is to have an ongoing orchard planting strategy to insure a farm has a range of trees ages, and at least two varieties for each harvest window. A farm with a range of tree ages will have a better chance of surviving a cold winter with some blocks still viable. Winter damage tends to be worse on older trees, but not always.

A careful consideration about the planting site is important to help head off problems. Peach tree do best on sandy loam soils with 3 or more feet thick of topsoil. Tile drainage systems are critical in many orchard sites to handle excess water. In addition to tiles, soils that have more silt or clay than ideal should be shaped into a slight berm so that excess water will drain out of the root zone area. Although peaches do better on sandy sites than other tree fruit, trickle irrigation is invaluable to get an orchard started in good shape during droughty years.

Tree planting depth is particularly important on heavier soils. The traditional approach is to plant peaches so that the graft union is at the soil line. However, if the shank (the part between the graft union and the topmost root) is long (greater than 1 foot), the tree should be planted so that the topmost root is within a few inches of the soil line, which will put the graft union above the soil line. Tree roots that are planted too deep in heavier soils are prone to collar and root rot problems.

For sandy sites a more subtle concern is potential tomato ringspot virus problems. Peach trees with this virus are more prone to reduced productivity and shorter lifespan. This virus is spread from weed to tree and tree to tree by the dagger nematode, a pathogen that prefers sandy sites.

The only two reliable ways to check a site for this problem are to test for the dagger nematode or to test the known weed hosts such as dandelion or the tiny root of the peach tree for the virus. Both tests can only be done by labs with the proper diagnostic kits. Growers who do a good job of keeping broadleaf weeds out of their orchards generally have less problems with this virus. Sites with this virus and nematodes are good candidates for pre plant fumigation or other nematode-fighting techniques such as use of rapeseed, mustards, or other non-host rotations.

Another potential problem is X-disease, caused by a phytoplasm, which is somewhat like a bacterium, but without a cell wall. Trees with X-disease will develop a characteristic red wine colored leaf spot, drop their older leaves, and then decline and die within a few years of infection. This disease is spread by several species of leafhopper, which explains why the disease appears sporadically. The other clue to disease spread and control is the fact that leafhoppers acquire the pathogen from infected chokecherry, tart cherry, and sweet cherry. When X-disease starts showing up in a peach orchard, it usually means that the grower needs to go on a witch hunt for the chokecherries or possibly old tart or sweet cherry trees that are serving as the source of X-disease that the leafhoppers are acquiring —a source that could be a ¼ mile or more away.

Nursery tree anxiety

Nursery tree quality has a big effect on the productivity and useful lifespan of a peach orchard, but is sometimes out of the control of the grower. I have seen cases where nursery trees were exposed to ethylene from apples stored in the same building and the trees would not grow properly. Another occasionally seen problem is trees that grow properly for a few years, but then show trunk splitting and root suckering because the trees had trunk cambium damage due to cold while in the nursery. Diagnosing this requires dissecting a few trees to look for dead cambium tissue in the inner rings of the tree. Another difficult to diagnose problem is trees that have roots dried out somewhere between digging in the nursery and planting. Such trees will be slow to grow in the new planting. I generally recommend that growers plant trees from more than one nursery in a new orchard so that these types of problems are more easily diagnosed.

Tree quality can be particularly important for the success of certain training systems. For example, the Y and quad training systems requires that the nursery tree be headed low at the time of planting. A low vigor tree that pushes out little growth after this heading cut will offer poor options when it comes time to select branches for the scaffold arms. The effort and time spent hunting for the right type of tree is often well spent. I have seen some growers in Michigan preferring June-budded peach trees produced by some nurseries because of their smaller caliper and greater readiness to grow when headed low.

Training system anxiety

Some growers have the knack for growing long-lived orchards. These growers tend to take the time needed for site preparation techniques mentioned above. In addition, they also use tree training techniques that encourage good tree structure. There are many training systems such as 3 to 5 scaffold open center, central leader, Y, palmette, fusetto, quad, and many variations within any one system. The key feature of a long-lived tree is that the scaffold limb arrangement avoids "plumbing" problems. One way to visualize this is to think of a tree as a plumbing project, with tubes (xylem and phloem) running just under the bark. A well-structured tree provides relatively unimpeded flow between the trunk and the scaffolds. A scaffold limb that is "stacked" directly above another scaffold has no clear access to water flow from the roots. Two scaffold limbs that are side by side block "flow" to limbs above them.

Some growers rely on old fashioned wooden clothes pins to help insure good plumbing in their trees. The trees are clothes-pinned when potential new scaffold limbs are 4 to 6 inches long. The clothespin is clamped on the central leader above the new limb such that the tails of the clothespin direct the limb to grow horizontally. This helps to avoid bad crotch angles, poor limb strength, and poor circulation.

Another trick for early years of an orchard is to use 2 or three rounds of pinching and limb breaking in the spring to early summer to encourage growth elsewhere on the tree. This is the so-called "benign neglect" approach to training, a term coined by University of California Extension Specialist Kevin Day. The presence of the broken limbs helps to prevent strong regrowth which happens if the limbs are simply pruned. The tree "gives up" on the broken limbs which are eventually pruned out, but the impact is less harsh than making strong cuts on a young tree.

A third technique to avoid problems in a young tree is to insure that the scaffold ends remain simple in the 2 or 3 years of growth. At the time of bud swell, the excess buds in the first 4 or 5 inches at the scaffold end are removed, leaving the end bud or two intact. This helps eliminate the need for later strong cuts to remove the excess cluster of limbs, a harsh pruning that often leads to disease canker problems. Debudded trees need to have a good spray program for oriental fruit moth to protect the few remaining buds on the scaffold ends.

Stone Fruit, Varieties, Horticultural Practices, and Challenges

Grower Panel (Bill Shane, Michigan State University moderator)

Ben Clark, Clarkdale Fruit Farms, Deerfield, MA
http://www.clarkdalefruitfarms.com/

My father Tom and I grow open-center peach trees, 7.5'x18', pruned to 8' max height. These are on glacial drumlin/till that is very well drained and has modest fertility at best, i.e. a very good peach site. All picking is done from the ground. We grow over 40 varieties of white and yellow-fleshed peaches, some top varieties being Glenglo, Redhaven, White Lady, Brighton, Redskin. We have over 10 acres of stone fruit, largely peach, but also plum, nectarine, cherry, and apricot. We sell almost exclusively retail, out of our farm stand and weekly farmers' market. We start picking cherries at the end of June and finish with plums in mid-October. All of our fruit is tree-ripened, much of it ready to eat when it is sold. We don't offer PYO for stone fruits, due to location of the blocks and high value of the crop. We have been challenged most recently with SWD, and have been forced to pick earlier when the fruit is more firm. Just this August we caught our first BMSB adult, but have not seen crop damage yet. We have achieved excellent control of both OFM and PTB with pheromone disruption ties coupled with targeted sprays. We hope that research addressing control of SWD and BMSB will continue and improve, as these pests represent the greatest challenge to our stone fruit crops.

Andre Tougas, Tougas Family Farm, Northboro MA
http://tougasfamilyfarm.com

Our peach and nectarine acreage over the past thirty years has been reduced from over thirty acres when my parents first purchased the farm in 1981 to about five acres currently. We sell the vast majority of our peach crop Pick-Your-Own starting in mid- to late July with PF-1 and Desiree just after sweet cherries have finished and pick through the summer into the early "fall" season until about Labor Day. Peaches are sold by the box for u-pick at $26 for a peck box that admits up to four people in the orchard and $36 for a 1/2 bushel that admits up to six people into the orchard. When apples are available for picking they can be combined in the box with peaches. We have about a one-quarter acre of flat, “donut” peaches, Saturn, Galaxy, BuenOs, and TangOs for pick-your-own that are harvested over two weekends. All trees are trained to a quad-V with 4 main leaders per tree spaced 16-18 geet between rows and 7-9 feet between trees. The quad-v system allows us to keep the trees to a height of about 8-10' after pruning. We try to reduce labor with the use of an orchard platform for pruning, thinning, and harvest, a hedger for summer and winter pruning, and a Darwin string thinner for mechanical thinning of peaches.

We also grow five acres of sweet cherries on Gisela 5 rootstock trained to Spanish bush and central leader at 6 feet by 12 feet spacing. Cherries present the most challenges of any crop. Bird damage has been solved by bird netting, rain cracking by Haygrove high tunnels and rain cover tarps, but winter bud hardiness and bacterial canker have been major issues that may only be solved by planting hardy and resistant varieties that we have yet to find. Cherries at this point are not a reliable crop but add to our diversification.

Sandie and Gil Barden, Barden Family Orchard, Scituate, RI
http://bardenfamilyorchard.com/

We are a small New England Farm that markets most of our produce directly to consumers at Farmers Markets, at our own Farm Market, and for pick your own. We are partial to some of the sub-acid varieties and some of the star series peaches including Coralstar. Our most recent planting is the quad-v system which we are currently evaluating, planted at 7 foot in row spacing and 17 feet between rows. Our goal with peaches is to sell only the very best varieties well into October. Although it is a harvest management nightmare, we have chosen to grow late season peaches because we have developed a good market. One of our main imperatives is to have peaches picked fresh, that are juicy and of excellent eating quality. As all direct marketers know, quality is the most important aspect of our business.

From our perspective, one of the biggest challenges as a peach grower is to try to determine the best varieties to plant. It is very difficult to decipher true eating quality from the nursery descriptions. What we would like to see are more peach variety trials that result in candid, objective and accurate eating quality information. We believe that all of the New England direct market peach growers want to have varieties that are superior to the shipped in peaches. We think that candid variety evaluations would reduce the amount of trial and error that currently occurs in New England peach orchards.

Win Cowgill, Rutgers Cooperative Extension, Flemington, NJ
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New Jersey is the most northern peach growing state with significant wholesale acreage. While acreage is down somewhat over the last five years, there are still over 5,000 acres of peach and nectarine orchards. Slightly less than 4,000 acres are in wholesale production in southern New Jersey on costal plain soils, the balance is located in north central and northwestern New Jersey on upland soils.

New Jersey fruit growers have gravitated towards the direct market retail sales business over the course of forty years given the high price of land and large close population. New Jersey has close to ten million residents, with ten million more in New York City and two million in Philadelphia putting 22 million people within a two-hour drive of most New Jersey farms.

New Jersey growers have greatly diversified their direct marketing operations. Most have one of more roadside markets, have added extensive PYO acreage and participate in one or more tailgate markets in New Jersey and New York. There are over 75 tailgate farmer markets in New Jersey and the extensive green-market system in New York City.

Growers have added sweet and tart cherries as well to their PYO operations. Sweet cherries are almost exclusively grown under high tunnels (some Haygrove) on dwarfing Gisela 5 and Gisela 6 rootstock. There is also great interest in plantings of tart cherries on dwarfing rootstock for PYO. There are three newer selections of tart cherry, Jubileum, Balaton, Danube and the old standby Montmorency. The new tarts have more sugar and eat better, so they can be eaten fresh or in pies. They have been a big hit for PYO on Gisela 5 rootstock so they can be planted 6-8 feet between trees by 14 feet between rows. Gisela 3 is even more dwarfing and trees could therefore be planted even closer. The new varieties range in bloom and ripening by about two weeks, I would plant all four in PYO block to spread the season, with more trees of Balaton and Montmorency. They do not rain crack and are not nearly as susceptible to bacterial canker as sweet cherries, therefore, they do not need to be grown in tunnels.

Peaches are the mainstay of stone fruit for PYO, ripening in northern New Jersey from early July to late September. Regarding varieties, see “Table 6.1. Comparison Chart of Peach and Nectarine Varieties” on page 60 from our 2015 New Jersey Tree Commercial Tree Fruit production guide, authored by Jerry Frecon, Professor Emeritus, Rutgers (and attached at the end of this article):

https://njaes.rutgers.edu/pubs/publication.asp?pid=e002

For New England, I would recommend only planting the hardiest cultivars on the best sites. For the most part this means do not select California cultivars because they are not particularly cold hardy and they are not selected for bacterial spot resistance.

In NJ for our PYO acreage most growers have stuck with the open center production system, spaced 20 feet between trees by 20-25 feet across the row, keeping the trees 8’ tall (for mostly ground harvest, no ladders) with proper pruning and planted on raised beds.

New Jersey peach production is all about controlling peach insects and diseases too. Brown rot and thrips were an above-average problems in 2015. For bacterial spot Dr. Norman Lalancette has worked out a low rate copper program for each cover spray to control bacterial spot:

http://plant-pest-advisory.rutgers.edu/copper-bactericides-for-peach-bacterial-spot-management/

Of big concern to all peach growers should be the possibility of losing chlorpyrifos (Lorsban and similar) in 2016. All stone fruit growers will likely need to adopt mating disruption for peach tree borers in 2016 and thereafter, as EPA is proposing withdrawing all insecticide registrations with the active ingredient chlorpyrifos:

http://www.growingproduce.com/vegetables/epa-proposes-to-ban-chlorpyrifos/

http://blogs.cornell.edu/jentsch/2015/11/05/trunk-borer-management-update-lorsban-chlorpyrifos-at-risk-of-revoked-tolerances-in-2016/

Table 6.1. Comparison Chart of Peach and Nectarine Varieties

Ripening Date In Southern NJ	Best Peach Cultivars	Best Nectarine Cultivars	Promising Peach Cultivars For Trial	Promising Nectarine Cultivars
June 25 to July 5 - 22 to 32 days before Redhaven (RH)	Flamin' Fury PF5B Desiree NJ 350 Sunbrite Spring Snow (W) Spring Prince Sugar May (W)	Mayfire	Rich May Queencrest Flamin Fury PF 5Big Sugar May (W) Carored Manon (W)	Westbrook
July 6 to July 12 - 15 to 21 days before RH	Harrow Dawn Ruby Prince Sentry	ArcticStar (W)	Early Star Scarlet Pearl (W)	Jade (W)
July 13 to July 19 - 8 to 14 days before RH	Flamin' Fury PF 7 Glenglo Ruby Prince Sentry Summer Serenade	Easternglo Arctic Sweet (W) Arctic Glo (W) Honeyblaze	Vulcan NJ F 18 (FY) Flamin Fury PF 8Ball Snowbrite (W) Galaxy (FW)	Silver Gem (W) Arrington
July 20 to July 26 - 1 to 7 days before RH	Saturn (W) Flavorcrest GaLa Arctic Sweet (W) Flamin Fury PF 11	Flamin' Fury PF11 Harblaze	Country Sweet SnowBrite (W) Vinegold NJF 15 (FY) White Cloud (W) Raritan Rose (W)	Honeykist
July 27 to August 3 With to 7 days after RH	Early Loring Flamin' Fury PF15A Redstar Redhaven John Boy White Lady (W) Starfire Flamin Fury PF Lucky 13 Starfire	Harflame Summer Beaut	Blazing Star TangOs NJF 16 (FY) Blaze Prince Snow Beautyy (W) Flamin Fury PF 9A-007 Salem	Bradley
August 4 to August 10 + 8 to 14 days after RH	Coralstar, Bounty July Prince Flamin' Fury PF17 Harrow Beauty Klondike (W) Loring	Arctic Jay (W) Flavortop Sunglo	Harrow Fair Flamin' Fury PF19-007 Scarlet Prince TangOsII NJ F 17 (FW) Flavrburst Carolina Belle (W)	Emeraude (W)
August 11 to August 18 + 15 to 22 days after RH	Allstar Contender Flamin' Fury PF23 Flamin' Fury PF24-007 Glowing Star	Redgold	Glowingstar Redkist Flamin Fury PF 22-007 Blushingstar (W) Sweet N Up	Arctic Belle (W) Honey Royale
August 19 to August 26 + 23 to 30 day after RH	Cresthaven Flamin' Fury PF Lucky 24B Flamin' Fury PF25 Gloria NJ 351 Messina NJ 352	Fantasia	Early August Prince Sugar Giant (W) Opale (W) Sweet Breeze Benedicte (W)	Arctic Gold (W)
August 27 to September 3 + 31 to 35 days after RH	Flamin Fury PF27A Flamin' Fury PF 28-007 Jerseyqueen, Fayette Redskin		Summerfest Lady Nancy (W) August Prince	Stark Ovation Zephyr (W)
September 3 to September 10 + 36 to 43 days after RH	Laurol Flamin Fury PF 35-007 Fat Lady Flameprince, Laurol		Autumn Star Snow Giant (W) Yukon King (W)	Arctic Pride (W)
September 10 and later 44 days or later after RH	Victoria NJ 353		Big Red (CVN #3)	

See Table 11.1 in "Tree Fruit Pest and Controls" in the New Jersey Tree Fruit Production Guide (E002) for bacterial spot ratings. (W) Indicates White-Flesh, (WF) Indicates White Fleshed Flat Peach, (YF) Indicates Yellow-Fleshed Flat Peach.

Small Scale Cultivation in Diverse Crops

Focusing on sub 10 acre systems I've used on farms

Josh Volk, SlowHandFarm.com

I started working on small organic farms in 1997. The farms I've worked for have ranged from very small, completely hand worked gardens, to 20 plus acre operations with dedicated cultivating tractors. They have all grown a wide variety of vegetables, and some have grown herbs, flowers, fruit and incorporated animals. I've worked in the dessert Southwest, the Northeast, California and Oregon. Over the years I've also had the opportunity to visit many, many farms all over the world, farms at every scale. Whenever I have that opportunity I take to time to learn as much as I can about their systems and the tools they use.

Whether they realize it or not, a lot of times particular tools or weed control practices on specific farms are strongly tied to other parts of the farm system: how beds are prepared and planted, climate and soil, target weed species, available tools and available labor, irrigation techniques, personalities, etc. If a farm is using a technique I'm not, I want to know why, what part of their system makes it a good practice for them, but not fit into my system. Or, should I modify my systems to incorporate their practice, because it's better?

This is the basic system for weed control that I've developed for myself over the past two decades, taking cues from farmers far more experienced than myself.

Rotation

When someone visits one of my farms, the least expensive and least obvious part of my approach is the use of rotation as a tool for dealing with weeds. I realized early on that some crops on the farms I was working on tended to leave the ground relatively weed free for the following crop, salad greens, or lettuce for example. Other crops tended to build up a little weed pressure for the following crop, usually because they were in the ground for a long time and were relatively weed tolerant themselves, leaving little incentive for late weeding, allowing late weeds to go to seed.

In the Northwest we have a very long growing season (nearly 12 months), and our early spring weeds are a completely different set than our summer weeds, which are different from our fall weeds (by Northeast standards we don't really have a winter). A crop that may have built up summer weeds might not be a problem for a subsequent crop planted in the early spring before the summer weed seeds are germinating.

By paying attention to these factors and setting up my crop rotation so that crops that are sensitive to weed pressure and difficult to cultivate go into as clean a field as possible (carrots and alliums, for example) I greatly reduce my weeding costs. Crops that are easy to cultivate, in particular ones that are easy for me to cultivate with the tractor like lettuce and broccoli, can be used to clean up fields that previously had crops like winter squash and sweet corn, crops that, for me, tend to build up some weed pressure.

Clean Bed Preparation

Spending time preparing a bed for planting that is clean of weeds and that will allow you to easily get in with cultivating tools when you need to is a good investment. For me that means giving the cover crop or prior crop residue enough time to decompose and germinating and killing as many weed seeds as possible before planting into the bed. It also means making the bed as straight, flat and even as possible.

In the Northwest it pretty consistently takes four weeks from incorporating flail mowed crop residue to planting time. Within that four weeks, depending on the conditions and weed pressure, I'll surface cultivate the soil at least one more time to kill any weeds that have germinated, and sometimes to speed decomposition of the crop residue. If I need to, I might increase that to two or three times, and this can also help to dry out wet soil, a problem we have only early in the spring.

Weed seeds only germinate from the top 2" of soil so disturbing the soil deeper than 2" will bring up new flushes of weed seeds. Sometimes that's ok, and it may also be necessary to deal with weeds growing back from deep roots (for us that's bind weed, burdock and Canada thistle).

I want the final bed to be flat, straight and weed free, with little to no crop residue or chunks in the top 2". This will make planting easier, and it makes the first passes with cultivating tools easier, allowing me to get as close as possible to the crop without disturbing them, digging up clods or chunks that expose roots, or bury plants, skipping over low spots, or dragging trash with the cultivating tool.

Plant In Even, Straight Rows with Tight Spacing

Choosing crop varieties with good canopies that fill in quickly can help control weeds, especially later weeds. These aren't always the best from a harvest perspective. For example, I choose zucchini varieties with more canopy, which can make it harder to find the fruit and move through the field but prevents weeds from continuing to germinate and thrive after the plant has filled out.

There are a number of factors in choosing good plant spacing. Taking those into account I choose a spacing that lets the crop canopy fill out the entire bed as quickly as possible. I make rows as straight and evenly spaced as possible to speed hoeing and to allow closer tractor cultivation. For weed control reasons I tend to favor closer in line spacing with fewer rows per bed because inter-row cultivation is so much easier than in row cultivation.

Cultivate Early and Often

Timing is key to success in weed management. Weeds are almost always easiest to kill when they have their first seed leaves. Most weeds germinate, or re-sprout in 3-6 days, depending on the time of year. They are typically getting their true leaves 3-6 days later. I think of quickly cultivating every week to keep weeds down but missing a week keeps me in the window. Loosening surface soil by cultivating regularly reduces weed seed germination by breaking soil to seed contact, improves water infiltration from rain and irrigation, improves air movement to roots and soil and releases small doses of nitrogen by increasing biological activity (like turning compost).

Flame weeding can be done pre-emergent on slow germinating seeds after weed seed germination but before crop germination. It is also effective post germination on monocot crops (alliums and corn), but similarly it is not very effective on monocot weeds (grasses) or perennials.

Irrigate to Favor the Crop
In the Northwest we have dry summers so we mostly control when water goes on and where. Drip tape wets less surface and germinates fewer weeds, overhead and natural rainfall evenly wet the surface, but also can cause compaction and germinate more weeds.

Choose Flexible Tools
On small scale, diverse market farms it's hard to have tools dedicated to single crops. Basic sweeps and side knives on a tool bar are good starting tools, essentially basic hoes, and hoes can be used the same way, which is usually faster than the way they are typically used. Carrying a wrench on the tractor makes field adjustments relatively easy. Side knives can be used to move soil away from, or towards the row.

Spring tine rakes in some ways act like lots of little sweeps, with the ability to follow contours and move around hard obstacles like rocks. Individually adjustable tines like the ones on Lely rakes allow quick in the field adjustment for different crops. The small, and spring nature of the tines tend to clog less than knives in wet conditions.

Rolling cultivators tend to clog less in trash and to deal with clods and hard soil better. These are tools like disks, spiders, and baskets.

Limiting variations in rows per bed allows the same tools to work on more crops. Hand tools are most efficiently used in pretty much the same way tractor mounted tools are used and there are close corollaries for most tools.

Killing by Burying, Dragging and Slicing
The above are the three basic ways mechanical tools kill weeds. These tend to be most effective in hot, dry, windy conditions where the weeds will desiccate more quickly, preferably before they can re-establish, but even if they do they will be set back. The smaller the weed, the fewer reserves it has to re-establish.

Set up your beds keeping in mind how soil will move over the course of cultivating through the season. Raised beds may get knocked down, furrows will get filled in.

Know When to Stop
The big trick is judgment, judgment that can only really be learned from careful observation over years: what to do when it's wetter than ideal, how much weed pressure is acceptable, when the crop is established enough to quit weeding. Focus on the pathway and inter-row weeds first, they are easiest to control and will constitute the majority of the weeds in the field. In row weeds are less important than you think.

Mulching and Weed Management

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Mulching is a cornerstone weed management strategy for many diversified vegetable farmers, and its widespread application is testimony to its importance. Many crops are amenable to growing in mulch systems. Mulching is particularly useful for full-season crops, e.g., Aliums, Curcurbits, pepper, tomato, eggplant, cabbage, and cut-flowers, which otherwise would require season-long cultivation and/or hand weeding. Some growers also find benefits from mulching short-season crops, e.g., head lettuce, basil, and broccoli.

Mulching options

Farmers employ a wide array of mulching strategies, each with a suite of potential benefits *and* problems. Organic mulches may be living or dead, the latter grown in-place or added to fields. Common living mulches include ryegrass and Dutch white clover, or various cereals with crimson clover, generally sown in paths between plastic-mulched beds. Competition from the living mulch can be intense, managed somewhat by timely mowing and drip-line irrigation and fertilization, but many growers ultimately prefer a dead organic mulch between beds. Cardboard, newsprint, and rolled paper mulch are sometimes used under other organic mulches in an effort to improve long-term weed control, with variable efficacy. Synthetic mulches include plastic films that are clear, black or colored, or infra-red-transmitting or "IRT," as well as a wide array of woven geotextile or so-called landscaping fabrics. Some growers promote use of heavier silage tarps as a temporary mulch to create a stale seedbed. Specific practices are influenced by soil and site conditions, local availability of organic mulch materials, as well as aesthetic and economic priorities.

Multiple benefits

Tom Roberts, an icon in the Maine organic farming community, tells prospective young farmers: "If you are doing something on the farm for only one reason…STOP!...do something else that solves several problems." Tom is a dedicated mulcher. Each fall, Pittsfield, Maine, community members drop off their bagged leaves at Tom's Snakeroot Farm where he stockpiles them in orderly piles based on their quality. Some are spread into windrows and shredded with a mulching mower to prepare a fine mulch to top garlic or onions, while others are spread intact to create more of a leaf mat to suppress weeds in paths. For Tom, the leaf mulch is helping to manage weeds, it is adding carbon and building soil quality, and helps to conserve soil moisture.

Workload-spreading is a key benefit of mulching for many farmers. Many crops require frequent, timely weeding to maximize yield and quality, e.g., carrot, beet, salad greens, and extensive mulching of other crops ensures that labor can be focused on these particularly sensitive crops. Soil-warming is critical for heat-loving crops grown in northern New England; black plastic, and particularly IRT films, provide soil-warming, conservation of soil moisture and weed control. A benefit unique to organic mulching is their contribution to building soil quality. Some plastic mulching strategies help to deplete the weed seedbank. Specifically, they encourage weeds to germinate, while high temperature or darkness subsequently kills small seedlings. Mulching generally helps to manage plant diseases that are spread by rain/soil splashing, and specific strategies may contribute to the management of particular insect pests, e.g., use of sliver films to help manage aphids. Aesthetics and employee moral are also improved by mulching, leading to a more pleasing and desirable field environment.

Multiple problems

Problems with various mulching practices should be carefully considered. Foremost is the additional expense, both added labor and input cost of purchased mulch hay or straw and any synthetic mulch. Transplanting labor costs are also greater, and there is added expenses associated with the removal and disposal of plastic mulches at the end of the season. Organic mulches may be difficult to obtain locally, and prices for straw or even mulch hay can be relatively high. Organic mulches prevent soil warming, a problem for some crops, they attract slugs and rodents, and thick layers of partially decomposed mulch can be difficult to incorporate into the soil. Purchased hay may contain weed seeds, but forage weeds are generally not a problem in annual vegetable systems. Cereal straw often contains remnant grain seed resulting in volunteer crop plants coming through the mulch. The grain also attracts wild turkeys which can make a mess of plastic-mulched beds and distributed straw. Several of these problems may be overcome by using fresh-cut grass or forages, harvested before weeds set seed, although material handling becomes more difficult. Lastly, some weeds will get through even the best mulch system. Weeds must be removed from the holes in plastic or the edges of plastic-mulched beds. If weed pressure is high, it is likely that any areas where organic mulches are not sufficiently thick will be challenged by underlying weeds with some probability of success. These weeds must be controlled by hand pulling. The mulches largely prevent the use of more efficient weeding tools or flaming.

Mulch or cultivate?

We recently completed field experiments in organic onions managed by cultivation until the crop had a suitable size advantage over weeds, a season-long weed management strategy that completely prevented weed seed rain, and several mulch-based strategies. As we expected, the "zero seed rain" and mulched systems required considerably more labor, and the latter had greater input costs. We considered these to be strategies with a longer-term perspective, reducing the weed seedbank and improving soil quality. Surprisingly, zero seed rain and the mulch-based treatments were the most profitable even in the short term, with the added costs compensated by improved yield. Soil quality parameters, including greater earthworm abundance and water infiltration, reduced compaction, and greater carbon inputs demonstrated further benefits of the mulched systems. For more information on this, and our other weed management research, see: https://gallandt.wordpress.com.

"Mostly Successful Stale Seed Bedding"

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The Take Home Message:
Stale seed bedding is extremely successful if the beds are prepared 4-6 weeks in advance and are weeded using a tine weeder every 5-7 days. Weed pressure is greatly reduced. Hand weeding and hoeing costs are greatly reduced or eliminated altogether. Weeds need to be eliminated in the thread stage before their roots have the opportunity to develop.

The Tools:

1. A 45 inch Williams Spring Tine Rake with guage wheels and a belly mounted Budding Basket Weeder.
2. A 7 foot Lely Weeder with gauge wheels
3. Flame Weeder: We have a small walk behind tool we do not use.

The Crops:
Greens, Root Crops, Peas, Beans, Corn, Winter Squash, Pumpkins,

The Parameters:
It is preferable if the field is stone free, with minimal crop debris and well drained. We prefer oats which winter kill to winter rye in order to get on the field early. Often, we mow the oats in the fall.

The Procedure:

1. Prepare beds immediately in the spring including subsoiling or chisel plowing. Prepare them as far in advance as possible, a minimum of 3 weeks, preferably 6-8 weeks for successive seedings or plantings.
2. Raking the beds every 4-5 days is best, weekly at a minimum. Tractor speeds of 5 mph and higher are preferred.
3. Do not be deterred by rain. Jump on the field as soon as they drain. Ideally, there is a dedicated tractor for this purpose.

Concerns:

1. A prolonged period of rain can result in having to prepare the beds a second time.

2. There is a harvest risk. Namely, the weeds can get ahead of you after seeding. Therefore, we increase the amount we grow to account for losses due to weed issues.

The Results:
Weed pressure varied greatly from field to field and the time of the year. Some beds were virtually weed free, requiring little to no weeding or hoeing. Others did not look much different from our standard routine of preparing beds just before seeding or planting. The critical factor is to keep on a routine of tine weeding every 5-7 days.

What's Bugging My Brassicas?
Managing Cole Crop Pests

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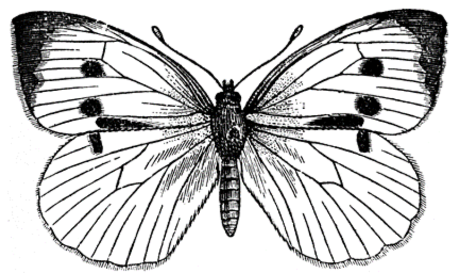

Cabbage, broccoli, cauliflower, Brussels sprouts, kale, collards, arugula, bok choy, radish, broccoli raab are some of the many brassicas popular with consumers – and insects, some of which can quickly destroy seedlings or make even a mature crop unmarketable. Following are some tips on how to plan for and manage the most common insect pests in cole crops.

Caterpillars are among the most common pests of brassicas. Learning to distinguish among them can reduce costs and improve control. **Imported cabbageworm** (ICW), **cabbage looper** (CL), and **diamondback moth** (DBM) are the most common. ICW feeds on cole crops, related weeds and some ornamentals. The dark green caterpillars are somewhat velvety, well-camouflaged on leaves and reach just under 1 ¼". Eggs, laid under leaves, have a bullet shape, turning from almost white to dark yellow or orange with age. The adult is the familiar butterfly seen during the day from mid-spring onwards, white with small, black spots on the forewings. CL caterpillars are medium-green, with whitish stripes along the sides and back that fade in the oldest stage, and a 'looping' or inchworm-like habit when walking unlike caterpillars on brassicas, reaching almost 1 ½" when full-grown. Hosts include brassicas, summer squash, tomatoes, chrysanthemums, lambsquarters, and many others. The grey-brown moth bears a small, silvery figure '8' on the forewing, and is active at night. Eggs are like pinhead-sized white pearls lightly stuck to the leaf underside. CL overwinters in the SE US, migrating north each year. On Long Island CL typically appears around early to mid-July; populations vary considerably from one year to the next. DBM has become a serious world-wide pest due to insecticide resistance. Hosts include most brassicas, especially collards, as well as some related weeds. The caterpillars are pale or gray-green, somewhat segmented, tapering at both ends with hind legs projecting like a forked 'tail'. They reach only about 1/3" full-grown and when disturbed often wriggle rapidly and drop, hanging by a fine thread. Eggs are pale yellow, round, and very small so rarely seen. Adults are small, brownish moths, about 1/3" long, slender with diamond-shaped coalescing paler spots on the back. They are most active during dawn and dusk and often observed when plants are disturbed. There is evidence DBM overwinters at least as far north as Long Island, but also migrates to northern areas annually. Pheromone traps are available for CL and DBM and may be helpful to alert growers to these more difficult-to-control species.

Saltmarsh caterpillar and (in more southern areas) **beet armyworm** are occasional pests of cole crops. The former sometimes is found in groups on one or a few plants causing extensive damage, but rarely a widespread problem in the field. Beet armyworm can be a serious pest where it occurs. The caterpillars will feed directly on the growing point and are known for tolerance to some insecticides.

Many natural controls regulate 'worm' levels in brassicas. Intercropping, trap crops (such as yellow rocket for DBM), hand-collecting, barriers, and removing alternate hosts are among the cultural techniques growers can use. Where insecticides are needed action thresholds help determine when treatment makes sense. On Long Island, fresh-market cabbage, Brussels sprouts, broccoli and cauliflower thresholds used are ≥ 20% plants infested with any species during seedling stage, then 30% infestation from early vegetative to cupping stage. From early head to harvest in cabbage and Brussels sprouts use a 5% threshold. For broccoli and cauliflower, use 15% at curd initiation/cupping, then 5% from curd development to harvest. Adjust these to personal preferences and tolerances. For example, kraut cabbage for processing can tolerate higher levels near harvest as wrapper leaves with holes are generally removed. Growers now have many insecticide options. *Bacillus thuringiensis kurstaki* (DiPel, Deliver, Javelin) or *B.t. aizawai* (Agree) –based materials can work well for all worms in both conventional and organic production but coverage under leaves is essential. Include a wetting agent or sticker where foliage is waxy. For heavy infestations, where loopers are large or if spray coverage under leaves is poor a material with contact or better residual activity may be needed. Entrust (for organic production), Avaunt, chlorantraniliprole (Durivo/soil, Voliam flexi or Xpress/foliar or Coragen soil/foliar), Verimark, Orthene/acephate (Brussels sprouts and cauliflower only), Proclaim, fluendiamide (Belt, Synapse, Vetica), Radiant, Rimon, or Intrepid are options. Pyrethroids (Baythroid XL, Warrior II, Bifenture, Asana XL, etc.) will control ICW and CL but are generally less effective against DBM.

Cabbage maggot (CM) larvae feed on roots of many brassicas and are the bane of many brassica growers, particularly in organic production. Older plants may tolerate some injury but younger ones can be killed. Even light damage to radishes or turnips can render then unmarketable. CM is similar to and slightly smaller than a house fly, sometimes observed resting on or laying eggs near the base of host plants. Many brassicas including canola and weeds (e.g. wild radish) are hosts, but not all cruciferous weeds are suitable. Adult flies emerge in mid-spring in upstate NY, peaking around mid-May with at least four flights per year. Although the first generation is often most damaging, significant damage can occur from successive broods. One study found peak flight times for each generation correlated with peak bloom of various wild plants, useful when scheduling plantings and planning for protection: yellow rocket (winter cress) (1st generation), wild daylily (2nd), Canada thistle or early goldenrod (3rd) and more roughly New England aster (4th) around late September to early October. Cornell's NEWA website also has an updated cabbage maggot model to help growers determine when flights occur based on degree-day accumulations from weather stations (http://newa.cornell.edu - Pest

Forecasts). A pheromone attractant for *Delia* spp. flies (including CM) is available for monitoring fly activity but also attracts seedcorn maggot flies, which can be extremely abundant and a bit difficult to separate from CM.

Some biocontrols feed on CM and populations fluctuate over time, but we have found in most years organic and conventional growers can expect significant damage. Eliminating alternate (weed) hosts such as wild radish may help where practical. We have run many field trials in the past decade or so to evaluate new and alternative treatments (e.g. seed treatment, row covers) with only limited success. Spun-bonded row cover placed over transplants provided nearly 100% control, but ends need to be well-sealed, deer or other animals, which can leave holes, excluded and it is best used on rotated ground. High tunnels may provide similar protection if possible entry points for flies are well-sealed. Lorsban can be applied pre-, at or post-planting and appears in our trials to provide the most consistent and effective control. Diazinon is applied pre-plant broadcast or in transplant water. Capture LFR is labeled for banded application over the seed furrow at planting. Verimark also can be applied to transplants in trays, as a surface spray, or by other methods. In one trial Entrust applied to transplants in flats suggests some benefit but this is not yet a labeled use.

Crucifer and striped flea beetles are familiar to most growers. The adults overwinter, emerging as air temperatures reach 57F and initially appear at field edges, moving deeper into the field as conditions warm. A second generation of adults appears later in summer into fall. Feeding on foliage can kill seedlings and causes shotholing in older leaves. In cabbage, transmission of Alternaria has been associated with flea beetles and late-season populations can significantly damage heads. Flea beetle larvae feed on roots but damage appears to be minor. Yellow sticky traps can be used to monitor activity, placed in or around the crop and just above the canopy. Scout for the beetles when cool and sunny (early morning), taking care to avoid allowing a shadow to fall over the plants. One threshold for cabbage seedlings is 1 beetle per plant; treatment after plants have 6 leaves until early headfill may not be needed, but watch for heavy infestations and later damage to marketable portions. Soil treatment with a systemic (imidacloprid –Admire Pro) can provide long-term control. Foliar applications include pyrethroids (Baythroid XL, Brigade, Warrior II, Mustang Max, etc.) and carbaryl/Sevin. For organic growers, Entrust can suppress infestations or rowcovers placed to exclude beetles while crops are small. Washington State University suggests planting a more attractive trap crop of pac choi, rape or mustard nearby to protect broccoli (see references).

Cabbage aphid (CA) is the most notorious aphid in brassicas in our region. Large numbers of the dusty gray-green insects sometimes cause foliage to curl or just contaminate leaves and heads. Most popular cole crops are hosts. Brussels sprouts are a particular concern as heading starts, since control can be nearly impossible once aphids have entered developing sprouts. CA overwinters as eggs on brassica crop residue or weeds. Infestations in spring are often very spotty or localized, but can become widespread. Some natural enemies help keep CA populations in check but outbreaks still occur. Destroy old crop residue in fall or early spring and monitor fields twice a week – initially check upwind of field borders and along areas with older cole crops. University of California has a sequential sampling plan for Brussels sprouts to assess whether control is needed (see references) using a 40% infestation threshold up to 2 weeks prior to harvest and suggests broccoli and cauliflower can tolerate up to 100 aphids prior to heading, with a nearly zero tolerance after. In cabbage, tolerances during growth are low, 1 – 2% infestation. When treatments are needed, current controls for aphids include Acephate/Orthene (Brussels sprouts and cauliflower), Assail, Verimark (soil), Exirel (foliar), Beleaf, Admire Pro or generic (foliar), Endigo, Fulfill, Movento, Closer, Durivo (soil), Voliam flexi (foliar), and Actara. Organic growers can use M-Pede or a horticultural oil (e.g. SuffOil-X, Sunspray UFO).

A Note on Crop Groupings

Choosing among insecticide products for control of vegetable crop pests can be confusing. Most labels now organize uses by 'crop groupings.' For example, uses for pests on tomatoes, peppers, and eggplant are often listed together on labels under 'fruiting vegetables' (crop group 8). For brassicas the situation is a bit confusing, since different ones fall under various groups. You can find the entire list of crop groups and search where particular crops are listed at http://ir4.rutgers.edu/other/CropGroup.htm. Following is a summary of the groups and respective crops included:

Group 1 - Root and Tuber Vegetables, includes:

Subgroup 1A radish (roots) and horseradish; Subgroup 1B radish (tops)

Group 4 - Leafy Vegetables (except Brassica vegetables)

This actually includes some brassicas in

Subgroup 4A leafy greens – arugula, garden and upland cress

Group 5 - Brassica (Cole) Leafy Vegetables includes:

Subgroup 5A Head and Stem Brassica - Broccoli; broccoli, Chinese; Brussels sprouts; cabbage; cabbage, Chinese (napa); cabbage, Chinese mustard; cauliflower; cavalo broccolo; kohlrabi

Subgroup 5B Leafy Brassica Greens - Broccoli raab; cabbage, Chinese (bok choy); collards; kale; mizuna; mustard greens; mustard spinach; rape greens

Product trade names are used for convenience only. No endorsement of products is intended nor is criticism of unnamed products implied. Information presented is not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

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Exploring Chinese Broccoli Cultivars

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For years I have visited real Chinese markets in Boston and New York and have always been in awe of the varieties, textures and make-up of their greens offerings. What really impresses a person is that the greens section area is often equal to the length of the entire vegetable section of a standard American grocery store. And they do not just have one sample of Bok Choi, but instead about seven different variations that clearly start with the Bok Choi genus.

The next step in my research was to look for these cultivars in your typical seed catalog. The pictures looked similar to what I saw in the Chinese store, but year after year, my attempt to grow them out and achieve similar results was met with many failures. Even calling directly to various catalogs, no one really had any basic knowledge of how these cultivars should be grown and what the main pit falls were. In 2015 our farm took about 14 different Chinese Broccoli varieties and spent a lot of time growing them to know the various cultivars and how they performed in different stages of the growing season.

The first discovery we made was that most of these delicate-stemmed varieties that are topped with broccoli-like immature florets are not grown like you would arugula or Broccoli Raab. Instead, they need a significantly greater space-- more like regular standard heading broccoli. The second most important cultural point is that the plants are treated and behave much like a cut flower. This means that the central growing point should be pinched off at an early stage of the plant's development and that sets the stage for an explosion of branches and side shoots that can keep going for months at a time. The third important point to keep in mind is that one must be constantly vigilant to keep the plant in a "vegetative state" and to avoid letting it deteriorate into the final expression of its "regenerative state." For those not familiar with these two terms: the "Vegetative state" of a plant's development is primarily occurring during its early growth period; this is when the plant is building not only its formal above ground body of early trunk and branches but it is also a time when the roots are developing a nutrient system to deliver the necessary nutrients when the plant starts its (later) "regenerative" or fruiting stage. This was probably the steepest learning curve because with these particular Chinese cultivars, once they have switched to the "regenerative state" there is no reversing the process. Anyone who has tried growing broccoli in the early spring will know what I am speaking about. In April the soil is cool and the plants are growing well; then suddenly you have a small spring heat wave and the broccoli planting suddenly grows florets in two days! And before you know what has happened, your entire planting has gone to flowers, and there is nothing in your power to reverse the process. This is particularly true when working with Chinese broccoli cultivars.

Another important observation we found was that certain varieties had enough similarities culturally, so that we ended up treating one group much differently than the other. Group 1 we called the "dark blue/green" varieties whose leaves were more the color of a typical Arcadia Broccoli. Group 2 we called the "light green/yellow~Pak Choi Type" varieties which were more like Broccoli Raab in color and performance. Some examples of Group 1 dark blue/green varieties would be: Happy Rich (JSS), Guy Long (Seigers), and four varieties: Kailaan, Ryokuho, Suiho and Wan Shen from Kitizawa Seed Company, who was our biggest source of seeds. Finally, from High Mowing Seeds we trialed Te You.
Group 2 light green/yellow Pak Choi varieties included: Yo Choy Sum and Kosaitai.
It took us three seeding cycles before we figured out that the Group 1 variety of plugs acted much like standard broccoli plugs and were quite tolerant of holding in the hardening-off area, waiting for an appropriate day to be put in the fields.

The Group 2 light green/yellow varieties, on the other hand, were like many of the dwarf Bok Choi varieties, in that they did not like staying in a plug cell tray for much more than the third true leaf stage. They often would bolt before we got them to the field to plant! And like the discussion above, once they had made the shift to the regenerative state there was no chance they would be at all productive. Of the Group 2 varieties, we were able to grow out, they were only productive for 2-3 weeks. And during that period of production, we found we had to be vigilant about keeping them well watered and we could see the advantage of multiple foliar feeding programs to keep the delicate balance between the vegetative and the regenerative tendencies manageable! Another observation about the group 2 varieties was that the end of their production cycle was heralded by an increase in the stems lignin production; or more simply, they would get slightly woody and chewy, much like Broccoli Raab will get if you attempt a second cutting.

The summer 2015 was the worst drought in our thirty-year history! With this as a back drop, we mostly focused on the Group 1 cultivars, which seemed much less needy in terms of our constant assistance and fertility maintenance. In September when the drought finally broke, the Group 1 cultivars did very well, allowing us to get two to four one pound bunches of healthy florets off each plant per week!

We would like to thank Johnny's seed breeders and reps who got equally excited about this project and provided us with timely advice and shared some seeds to experiment with! Especially helpful was John Narvona (their newest in-house seed breeder) who actually got us to expand our horizon into two other similar but different cultivar sidelines to the Chinese Group. Those were A, the European Overwintering Broccolis and B, the more modern cultivars for continuous small head production of "Broccolini" types.

The European Overwintering Broccoli has been around for many years but has fallen out of favor because it involves the extra work of taking the cultivar through a vernalization period or winter. In climates like England where the winters are mild, growers don't have to bother much with hoops and covers, which is not so in New England. However, the intrepid few that do take on this extra work are rewarded with broccoli floret production in March, April and May that has astounding sweet and delicate shoots. We tried several varieties: Santee was Johnny's offering in this sector, "Summer Purple" from Territorial Seeds was recommended for fall but we are going to trial it for as an Overwintering cultivar; De Cicco from High Mowing is another, and from

Fedco Seeds, we are trialing Piracicaba and Purple Peacock Gene Pool; other varieties were from a seed bank in England, which are just numbered varieties. All these varieties were started September 2nd and finally transplanted out into raised plastic beds in late October. We wanted them to build a foundation root mass before we locked them up in hoops and .9 oz remay for their long winter's vernalizing nap.

Our second new focus is on broccoli varieties that are early-to-main season cultivars which are multiple-heading varieties. In an attempt to over-come the vicissitudes of spring broccoli going to seed during the first spring hot spell, we have explored using these "sprouting broccoli varieties." For the last two years, we have planted these varieties on raised black plastic beds with drip irrigation and have had good success. We think that the black plastic helps the roots stay warmer, thus they are better able to not be shocked into "regenerative" explosions of flowers in the event a hot spell occurs. Much like the Chinese cultivars, they seem to keep generating copious amounts of slender stemmed florets with quarter sized tight florets on top. One cultural detail we found useful for initiating the branching and floret expression was to pinch the top leader off about two weeks after transplanting, much like pinching a Zinnia flower to encourage lower level branching and flower development. These summer sprouting broccoli varieties seemed to respond to this redirection of the plant's development. Some of the varieties we liked were: Fedco ~Purple Peacock Gene Pool & Piracicaba, Territorial Seed ~ Apollo and Summer Purple, High Mowing ~ De Cicco, and Johnny's ~ Happy Rich.

In summation, there is a big universe of sprouting, Chinese and other broccolis that can bring in good sales, especially with the new awareness and health benefits of consuming a higher level of greens in the American diet.

Producing Healthy Brassicas Spring Through Fall with Biocontrols & Rotation

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Clear Brook has been in existence since 1994. Over the years, demand for all forms of brassicas has risen so that other than sweet corn it is the family of veg that occupies the most land of any crop on our farm. Our farm is certified organic. We grow about 4 acres of mixed brassicas ranging from broccoli and kale to Brussels Sprouts and napa cabbage.. and everything in between. If we include leafy greens (mesclun, arugula, radish etc) our acreage probably increases another 2 acres. With this proportionally large amount of our land going in to brassica production, the onslaught of bugs and disease is pretty fierce on this crop family. Hence, planning and rotations are key to successful brassica crops throughout the season.

Probably the most advantageous and important part of our brassica strategy lies with us having three separate fields. Our home farm is in the middle and about 3/4-1 mile both north and south we have other substantial fields. This allows us every year to plan our brassica plantings so that one field will get the first 4-6 plantings of brassicas, then another field gets the next 2-3 and the final field gets the last 4 plantings. Our long term brassicas like storage cabbage and Brussels Sprouts go in the field with our last plantings even though they may be transplanted 6-8 weeks before any other brassicas are in that field. This past year due to miscommunication the storage cabbage was planted right next to the early coles, and we payed the price with lots of disease on those late cabbages and basically a un-harvestable crop.

We sell most of our produce retail through our farm stand, farmers market and CSA and so we try to have certain cole crops all season. Brassicas that we aim to have all season long are broccoli, kale, cabbage and then we also try to have cauliflower for all but mid-season. If we throw-in brussels, rutabagas, Gilfeathers, bok choi and napa cabbage we are pretty much seeding some brassica every 7-10 days from late march through July for transplants and through mid-October for leafy greens that are direct seeded. A greenhouse seeding of transplants will have anywhere from 8-18 128 flats (we do Brussels Sprouts in 72s). We generally are able to maintain a consistent supply of coles with this schedule.

Insect threats: Our insect threats can often start in the greenhouse or cold frame where flea beetles have been known to run rampant. Our last 3-4 plantings can sometimes have cabbage moths larvae of one type or other making swiss cheese of brassicas in plug flats! In the field our insect threats consist of flea beetles, various caterpillars and sometimes aphids can get totally out of control. For **flea beetles** on leafy brassicas that are direct seeded we use remay. However, for our brassica transplants we have started relying on a pre plant dip into Surround with a spreader sticker. This often gives us a good week after transplanting out without too much damage. In a bad year we will keep spraying with surround using our boom sprayer. As long as we use a sticker and are on the spraying every 7-10 days Surround does work for us. If things get away from us we occasionally use Pyganic, but it never really seems to work that well for us.

Occasionally we will cover a planting with remay but…. well its the love hate thing as far as remay goes.

Loopers etc: Those larvae things we scout for and generally use Dipel and occasionally Entrust. Though this past summer I am pretty sure we had some Dipel resistance early on and then it seemed to work… maybe bad spray coverage???? **Aphids**… we try botaniguard and pyganic…. never really very effective for us but I know some folks have good luck.

Disease: We have had a lot of problems over the years with alterneria on our brassicas. This is one of the main reasons we started breaking up the year's plantings between our three fields. We used to spray some copper for that, but really did not like using that material more than necessary (tomatoes). So last year we started using Regalia fungicide. Regalia is (if i'm not mistaken) an extract from Japanese Knotweed. It is supposed to boost the immune system of plants and act as a fungicide. This is strictly anecdotal but for the past two years our amount of alterneria which seemed to be getting worse every year, really became "manageable". Our Brussels sprouts are a lot less effected and the same goes with our fall cauliflower. We used to be able to pick maybe the first 2 fall cauli plantings that were pretty clean, but then the later plantings would just get a build up of the disease. Now Cauli can hold in the field for at least an extra 2 weeks per planting before getting spots. We generally spray every 7-10 days (once again using a boom sprayer) until mature. Sometimes we will add Serenade for a "cocktail".

If we really had our wishes, we would have another 20-30 acres an extra 1/2 mile away to make crop rotation of brassicas even more manageable. Nevertheless we do feel fortunate that we have three significant fields scattered about so that we do get some "rotation" both spatially and temporally. We have considered just ***not*** growing mid season brassicas mainly to break up the plantings both spatially and temporally. Still, they are an important attraction to our farm stand. With the advent of seemingly successful organic "fungicides" maybe we can beat the odds more consistently now and have cole crops all season.

Year-round Greens Production at Kilpatrick Family Farm

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Kilpatrick Family Farm was a mixed vegetable, fruit and poultry farm located in Middle Granville, NY, zone 4b, that operated from 2003- 2015.. The majority of our sales were through a 200 member CSA, up to 4 farmers markets in Saratoga Springs and Glens Falls, NY, as well as limited wholesale accounts. The farm was approximately 500 acres of owned, rented and leased land, 50 tillable acres, 100 pastured acres, and the balance woodlot and scrub. We planted between 12-14 acres of vegetables and fruit every year.

Greens have been an important part of what we grew at KFF. They appraised approximately 1/3rd of our total sales and drove our winter markets. People showed up for our greens and bought other crops.

Our rotation for greens was tough because of the amount we grew in relation to our land base. Also, with brassicas being a significant portion of our greens production, it was hard to keep those separated. We ended up using greens, which for us were baby kale, spinach, arugula, lettuce mix, radishes, choi's and Asian greens as one block in our rotation. It ended up working out for us on the timing and soil prep. We tried to give a minimum 4-6 weeks before planting greens in previously cropped areas. That gave us plenty of time for plant residue to break down.

Our field prep for greens was as follows: spread compost, chisel, and rototill the sections about 2-3 weeks before we wanted to plant. About a week later we'd come through and spread fertilizer (Kreher's chicken compost or peanut meal depending on what the soil tests showed) and use our bedmaker/stalebedder to make up beds. A few days before we wanted to seed, we came through again and refreshed the beds, killing more weeds with our bedmaker/stalebedder.

Our field seeding was done with a Jang 5 row seeder, rows set 9" apart. For our winter greenhouse beds, we would double seed the beds, making a second pass so our rows were 4.5 inches apart. For transplanting, our stalebedder/bedformer had a rolling basket in the back which had markers on it. We would then plant based off those lines. Many of our greens were direct seeded due to the density and culture they desire, although we still transplanted lettuce, choi's, and some spinach by hand. A video about how we transplant in our tunnels is here: https://www.youtube.com/watch?v=Bn1Y2HQiwdo

Cultivation was done with a basket weeder and lely tine weeder. We got to the point that we had an employee who every Monday (or next dry day) would cultivate the entire farm. We had a Super C set up with belly baskets and a lely time weeder in the back which we hinged so we could still run our wheel cleaners.

Crop Highlights

Our lettuce production morphed from direct seeded baby leaf to a complete Salanova type mix over our farming career. We found that our customers liked the increased crunch as well as the shelf life being better. We grew our mix 5 rows 9" apart, with 10" between plants in row. Cultivation was done with baskets and lely tine weeder. We harvested each plant twice or more, doing a dome cut to keep the center growing tip alive. We still grew direct seeded baby leaf lettuce in the winter, as the salanova types, while they would survive, didn't give the yield or reliability needed. Our focus on winter and summer varieties was disease resistance and cold hardiness. A favorite winter variety is is Lettony, as the yield, disease resistance, and cold hardiness is hard to beat.

Spinach was always a huge crop for us. We prefered to direct seed, but also transplanted in the spring and into our tunnels when a preceding crop didn't give us enough time to get seeds in the ground. Spinach can be tricky, but we found that consistent watering, raised beds so that it doesn't drown, and silty soils all played a big role in producing a great crop and achieving a good stand. We grew baby, large leaf, and bunching spinach, utilizing different varieties for each. Because of the rapidly changing spinach seed market, it was hard to give varietal recommendations, as varieties sometimes would only be around for a few years. That said, Space and Tyee are great older varieties, and Pigeon (for leaf) and Emperor (for bunching), were two of our new favorites. We felt that even with the increased cost of seed, it was worth planting the newer varieties for baby spinach for increased uniformity, disease resistance, and vigor.

We grew arugula year-round, direct seeding it 5 rows, 9" apart, 30-45 seeds/row ft. We used insect netting and Pyganic to manage flea beetles. Nothing beats a tight rowcover applied soon after seeding. During the summer, we planted once a week, waited 4 days, would blind cultivate lightly with the baskets, and then cover, removing only for harvest. For winter we doubled the rows up to 4.5" apart, planting 3-5 plantings over the winter to keep a good succession. We found that some of the wilder varieties had better cold hardiness, but lack the yield of newer varieties.

Kale and chard were grown very similarly in our system. For outdoor production, we grew on biotello on raised beds with living or straw mulch between. We planted several successions during the summer as well as a large fall planting to store. We also experimented with growing baby kale during the summer with the culture similar to Arugula. It worked, but because it grew so fast under covers, it was hard to keep a good stand for harvesting. We tried to grow both baby and large leaf kale during the winter. Baby kale doesn't grow well during the deep winter, but does okay in the February-March slot, being able to recut the same beds every 10-14 days. Our two favorite varieties in the winter for full size bunched or bagged kale were Western Front and Siberian. For chard, we used Fordhook giant with just enough bright lights to make the bunches pretty.

Asian greens and Boc choi were usually grown only in the fall through spring for us. We transplanted, then 5 rows on the bed, looking to bunch them 2-3 per bunch. During the winter, we interplanted them with chard and kale as they grew faster while the chard and kale need to be established in the fall but wouldn't grow very fast. During the winter, we harvest individual leaves, always leaving a center rosette of leaves to keep the plant growing. As the light changed, and spring approached, they would bolt and be ripped out, leaving the chard and kale to fill out the bed and be harvested.

Specialty Greens

We tried every year to grow a good crop of mache. It's always disappointing until we ate the little that we could grow, what flavor! Our best success was seeding it tight (rows 4" apart) into a late hoophouse and harvesting it in late March, right before it bolts. The financial viability for us is just not there, although it has been our favorite winter green.

We have also tried claytonia, cress, and sorrel. For us, of the three, Sorrel was the only green worth growing in the greenhouse, like kale and chard, it really just sits there all winter and then takes off in early March providing 8-10 weeks of weekly cuttings.

Tips for Overwintered and Storage Greens

We are still learning a lot about overwintering greens. So far, we have successfully overwintered lettuce, spinach, scallions, kale, arugula, asian greens, and onions. Several keys for success:
1. raised, sandy or well-drained beds.
2. proper covers. Most times we were just using row covers but sometimes hoops and mini-tunnels, especially for lettuce.
3. it is key to achieve plants small enough to winter well but with a big enough root system not to heave out of the soil.

To find out about our 2014-15 overwintered spinach trial, go to http://michael-kilpatrick.com/what-we-learned-from-our-overwintering-spinach-trial/ .

For storage greens, we would plant lettuce, spinach, boc choi, chinese cabbage, kale, celery and mache as late as we could and still get full size, healthy plants and then harvest and store them right before the weather turned. Depending on the green, we could get as much as 3 months of storage before they turned yellow or went bad. 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. The whole life cycle and plant physiology slowes. Storing greens allowed us to bunch up our greenhouse greens and therefore have a higher production of greens year round. A big part of achieving long storage life is excellent plant health and no cold damage going into storage. Excellent storage conditions, of course, is key. One of our best units for storage ended up being an old insulated truck box with a little space heater to keep it at 34 degrees. We would throw water on the floor for high humidity. The greens were stored in lidded rubbermaid totes. It is important that the greens are dry going into storage. We had problems with storing in 20 bushel bins (not enough air flow in middle) as well as greens that were too wet going into storage.

Harvest and Packing of Greens

Most of our greens were hand harvested into rubbermaid tubs. For large wholesale orders of spinach, baby kale, and arugula, we would use the quick greens harvester. Greens were brought back to the packing house and submerged in our bubble washer which hydro-cooled, mixed, and cleaned the greens. They were then spun in our spinner, bagged and sent to the cooler. See video about spinning https://youtu.be/vFcbs9p3gqY, and video of full line https://youtu.be/10hgeQWCtkw.

Most of our greens sales are direct to consumer in .35 lb or .26 lb bags. We use a vented liner from Bunzl that costs us about 3 cents each. For a while, when were were selling retail at coops, we used a large clamshell but the cost was prohibitive. We ended up switching those customers to vented ziplock type bags which cost 7 cents each. We used a pre-printed sheet label on those bags for a good marketing presence.

Growing Lettuce, Spinach, and Mustard Greens
(One Farm's Experience)

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This talk will discuss the techniques we use to grow salad greens on our small farm in central Vermont for our CSA, Wholesale, and Farmers' Markets. Annually we sell around 4,500 pounds of greens from early May until the end of December. We use an intensive system, double cropping 1/2 an acre to grow our field greens. We also grow in two 3,000 square foot unheated high tunnels to extend our season in the early spring and into late fall/winter. Over the years, we've developed these systems to grow a diversity of salad greens in a small area so we can provide a continuous supply to meet our markets demands.

<u>We will discuss the following topics</u>:
High tunnels & season extension techniques
Floating row covers
Bed Prep
Seed varieties
Seeding methods
First and last planting dates
Succession planting
Weed control
Pests, disease, & fertility
Harvest
Wash
Storage
Packaging & marketing

Root 5 Farm is a certified organic vegetable farm located on 28 acres in Fairlee, Vermont, along the CT River. The fertile river bottom soils provide a rich environment for growing over140 different varieties of vegetables, herbs, and flowers. Root 5 Farm is owned by Ben Dana and Danielle Allen. The farm has been certified organic by Vermont Organic Farmers (VOF) since 2006. Products from Root 5 Farm are sold through local farmers' markets, CSA memberships, local restaurants and small local grocers.

If you have any questions please feel free to call or email Ben.

Day Neutral Strawberry Fertility and Crop Management Guidelines for Northeast Growers

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There are two opportunities for planting Day Neutral (DN) strawberries – spring planting of fall-dug dormant plants, or late summer planting of plugs. Spring planting remains a priority for many growers as it allows them to take advantage of spring soil moisture. Growers use DN varieties to augment June bearers – primarily to follow the larger matted row production, but also to provide early production the second year.

Pre-plant soil test and site prep should focus on Phosphorus levels. Additionally growers should add 50 lb actual N/acre pre-plant during bed formation usually as a granular blend along with the required P and K. Some growers are prepping fields in the fall to help them get access to fields as soon as possible in the spring. This would mean that some compensation for pre-plant N might be needed. Deer and other critters can also do a number on the plastic mulch, but in many areas it might be worth doing this early especially as they predominately plant the berries by hand. DN strawberries perform best when planted on plastic mulch covered raised beds.

In the spring, flower trusses are removed until the plant reaches a reasonable plant size - 6-8 healthy leaves per crown – which usually translates into sending a crew through twice.

Beginning at heavy bloom to green fruit, soluble fertilizers should be fed through the drip irrigation system at a rate of 3-5 lb actual N/acre/week. Initially the rate starts at 3#, and then it gradually increases until harvest begins. When harvest kicks in, the weekly N rate may actually go up to 7# N/acre/week, or 1# each day.

Alternating weekly fertilizer source between calcium nitrate ($CaNO_3$) and a greenhouse grade potassium nitrate (KNO_3, 13-0-44) to provide necessary calcium and potassium along with nitrogen. Recommended K rate is 15 lb/week. $CaNO_3$ a safe Ca source from a root perspective. Urea can also be used as a N source and later in the season it might be more important as it is less expensive.

Boron is not specifically used, despite the fact that the literature indicates it is very important and most soils in the east are deficient. Many growers are very interested in using foliar nutrients, but the return on investment remains unclear.

DN plantings are mostly annual crops but some growers are holding over the planting for a second season with mixed results. Seascape overwinters well but Albion is quite tricky under northern conditions. The typical overwintering method for Canadian growers is one layer of heavy weight row cover (40 to 50 ml vs. standard 19 ml) with no straw. The heavy cover is more durable, and it lasts at least two years. New York growers still depend on straw.

Most DN fruit is being sold at retail farm stands so yield is important but not as critical as it is for wholesalers as retail growers are receiving a premium price and also need very high quality. The most popular variety is Albion, with a lot of Seascape and San Andreas. San Andreas seems to overwinter better than Albion and has good fruit size, but the first picking may be later than Albion.

Growing Day Neutrals
at Farm to YOU

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In Maine it is possible to have fresh strawberries from late May to late October by growing both summer-bearing and day neutral (DN) strawberries. 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 beds with drip tape buried at time of shaping and laying plastic. Bed size is best determined by equipment available. Option to broadcast dwarf perennial rye grass (living mulch) after the plastic is laid and the ends are dressed. 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. Remove early blossoms prior to mid-June to encourage crown development. Remove runners during growing season (to allow maximum plant development) and enlarge planting hole for better rooting of the branch crowns. Season extension is accomplished with floating row covers or overhead sprinklers as needed. At the end of the harvest season and after the plants go dormant cover the plants with 1.2 oz. floating row cover.

Low Tunnel

Excessive rain storms late summer into the fall will cause a lot of unsaleable fruit that has to be culled out. To address this problem, I constructed a portable modular low tunnel using ¾ in. EMT tubing attached to thirty foot long, two inch diameter, irrigation pipes. Each thirty foot section weighed seventy pounds and was held down by ground augers. Six sections were placed end to end for a one hundred eighty foot low tunnel. Bungee cords were used to keep the plastic taut at all times, even in strong winds and during hot days. For foliar feeding, pesticide application and frost protection, tubing was attached to the ridge pole and drop-down misters were placed every five feet. For venting and harvesting the sides are rolled up. During pollination the plastic must be rolled up outwardly (to protect the pollinators) or inwardly prior to heavy rains. This system will take a lot of wind. However, if strong winds are anticipated, gather up and tie the plastic to the ridge pole.

Renovation

I have been experimenting to get a second year from the life of a DN planting. I find that San Andreas is more winter hardy and out-produces Albion by approximately 50%. Clean debris after the snow melts and cover with floating row cover (for earlier harvest) and remove it at blossom time. This will provide an earlier crop by ten days to two weeks before summer-bearing varieties ripen. There will be a noticeable decline in new blossoms during this harvest time, but plants will re-invigorate after renovation. This is done while the summer-bearing strawberries are producing. The DN strawberries will start to set blossoms immediately and will be harvestable shortly after the summer-bearing season ends. After the plant sets out a few runners, cut these runners and stretch the plastic at the planting hole to promote branch crowns for larger fruit. This crop will peak late August or early September and produce into October.

On May 1, 2013, I planted 2500 San Andreas and Albion strawberry plants on 0.2 acres.

1. Harvest for season 2013:(summer + fall) 2500 quarts
2. Harvest for season 2014: (Spring=1200 quarts)(Fall=1800 quarts) 3000 quarts
3. Harvest for Spring 2015: <u>800 quarts</u>

Strategies for Managing Multiple Pathogens on Pumpkins

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Every year in the northeast, pumpkins (and other cucurbit crops) are potentially affected by more diseases than most other vegetable crops! Powdery mildew always occurs due to the quantity of easily wind-dispersed spores that the pathogen produces and the breadth of conditions under which it can develop (no high moisture requirement). The downy mildew pathogen also can move long distance; its occurrence in the northeast varies yearly, especially on crops other than cucumber. Occurrence of other diseases varies among farms depending on whether the pathogen is in the soil (several including Phytophthora blight), surviving in alternative host plants including weeds (e.g. white mold, viruses), present in insect vectors (e.g. bacterial wilt) or present in/on crop seed (e.g. bacterial leaf spot). Infected crop at a near-by farm can also be a source of pathogens that move short distances such as during a rainstorm (e.g. Plectosporium blight). Most diseases are more severe during a rainy than dry season because wet leaves or soil are favorable conditions for most pathogens (exceptions include powdery mildew, bacterial wilt, and virus diseases). Successful management is based on knowledge of pathogen biology, in particular sources of inoculum and conditions favoring disease development, which is used to identify appropriate cultural management practices. Knowing early symptoms facilitates early detection. It is also important to have current information on fungicides and resistant varieties. Below is information on select diseases followed by an integrated management program. See also: vegetablemdonline.ppath.cornell.edu.

Powdery mildew. An integrated program with both management tools (resistant varieties and fungicides) is recommended to maximize likelihood of effective control. The pathogen has been evolving and becoming less effectively controlled by these. Alternate among targeted, mobile fungicides in the 4 chemical groups below, and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. Note that the main goal is delaying resistance development, not managing resistance. Begin very early in disease development (one older leaf out of 50 with symptoms).

Vivando (FRAC Code U8) is a new fungicide with a new mode of action. Cucurbits are on a supplemental label. It has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. Do not mix with horticultural oils. It can be applied three times per year with no more than two consecutive applications. REI is 12 hr. PHI is 0 days. 365 day plant back restriction for non-labeled crops.

Torino (Code U6) has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. It can only be applied twice to a field in a 12-mo period. Consecutive applications are not recommended. REI is 4 hr. PHI is 0 days.

Quintec (Code 13) has been consistently effective in fungicide evaluations. Activity is limited to powdery mildew. Label specifies no more than two consecutive applications plus a crop maximum of four applications, and no aerial applications. REI is 12 hr. PHI is 3 days.

DMI fungicides (Code 3) include Proline and Procure, which are considered most effective, plus Aprovia Top, Rally, Tebuzol, Folicur, and Inspire Super. Resistance is quantitative. Highest label rate is recommended because the pathogen has become less sensitive to this chemistry. Efficacy has varied in fungicide evaluations. Procure applied at its highest label rate provides a higher dose of active ingredient than the other Code 3 fungicides. Five applications can be made at this rate. REI is 12 hr for these fungicides. PHI is 0 - 7 days. Powdery mildew is the only labeled cucurbit disease for these fungicides, except for Proline, which is labeled for Fusarium, and Aprovia Top and Inspire Super, which contain another active ingredient (Code 7 and 9, respectively) and are labeled for additional diseases.

Carboxamide fungicides (Code 7) could be included in the program used sparingly. Resistant pathogen strains have been detected, and are likely the reason efficacy has varied. Cross resistance was documented between Pristine, Aprovia Top, Fontelis, and

Merivon, the products registered for use on pumpkins, but not with Luna fungicides, which are labeled for use only on watermelon so far. Thus Luna fungicides will be recommended once registered. Carboxamides are labeled for additional diseases. REI is 12 hr. PHI is 1 day.

Resistance continues to be very common to MBC fungicides (FRAC code 1; Topsin M) and QoI fungicides (Code 11; Quadris, Cabrio and Flint); therefore these are not recommended.

There are several protectants for powdery mildew, including chlorothalonil, sulfur, copper, botanical and mineral oils, and several biopesticides.

Phytophthora blight. This destructive disease has more been severe recently in areas where there were intensive rainfall events, which created unusually favorable conditions. A key to successfully managing this disease is managing soil moisture to avoid saturated conditions. Achieving this is difficult when rainfall amounts are large. Another key has been fungicides registered in recent years with targeted activity for pathogens in this biological group (Oomycetes). Information about these follows section on downy mildew. These are considered the reason many growers have been effectively managing Phytophthora blight. A preventive fungicide program is considered essential. Ineffective control with fungicides has been associated with poor application timing in some fields (application missed when rain began before expected) while in others favorability of environmental conditions seemed to have been too great. Development of fungicide resistance is a concern with all targeted fungicides due to single site mode of action; therefore, alternation amongst chemistry is recommended. Resistance to Ranman has been detected in the southeastern US. Protectant fungicides, such as coppers, are not sufficiently effective to be recommended alone for Phytophthora blight; however, they are useful tank-mixed with targeted fungicides to manage resistance. Presidio has a long rotational interval of 18 months for non-labeled crops, which can be a constraint on its utility. Most vegetable crops are now on the primary or supplemental labels. An important notable exception is sweet corn, which is commonly grown in rotation with pumpkins.

Biopesticides There are several products (Actinovate, Double Nickel, Regalia, RootShield, Serenade Soil, SoilGard, Bio-Tam, etc.) that can be applied to soil pre-transplant, at planting, and via drip to manage the blight pathogen, *Phytophthora capsici*, in the root and crown zone and to induce resistance (Regalia). Most of these biopesticides can also be applied to foliage.

Typically Phytophthora blight begins to develop in low areas where water drainage is poor, but symptoms have been found first in sloped areas. This documents the need to look throughout a crop for symptoms and not focus exclusively on low areas. It is better to avoid planting low areas. While crops planted in a field lacking the pathogen (based on crop and disease history) typically will be free of Phytophthora blight, this is not absolute. The pathogen can be moved between farms via water. Two cultural practices that have proved useful are biofumigation and deep zone reduced tillage. Biofumigation can be accomplished by growing a biofumigant mustard cover crop typically in early spring, chopping into small pieces 4-6 weeks after onset of flowering, and immediately incorporating the mustard, then sealing the soil surface with a culti-packer and irrigation. At least 7 days afterwards, lightly disk then plant.

Downy mildew is primarily managed with fungicides. Cucumbers with a new source of resistance are becoming available. Some suppression, albeit variable, can be obtained with varieties bred to be resistant to pathogen strains present before 2004. An integrated program with fungicides applied to resistant varieties is recommend. As with powdery mildew, fungicide resistance is also a concern with the downy mildew pathogen and therefore the fungicide program recommended is also targeted, mobile fungicides applied in alternation based on FRAC Code (see list below) on a weekly schedule and tank mixed with a protectant fungicide (chlorothalonil or mancozeb) beginning very early in disease development.

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 USA is forecast and posted three times a week. Forecasts enable timely fungicide applications. Label directions for some fungicides state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. Growers can 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.

Fungicides for Phytophthora blight (PB) and/or downy mildew (DM):

Presidio (FRAC Code 43). Recommended used early in the season for PB when DM not a concern. No longer effective for DM because of resistance. Apply no more than 4 times in a season with no more than 2 consecutive applications. Must be applied with another fungicide.

Ranman (21). Use organosilicone surfactant when water volumes are less than 60 gallons per acre. REI is 12 hr. PHI is 0 day. Apply no more than 6 times in a season with no more than 3 consecutive applications.

Zing! and Gavel (22). These are the only products that have a targeted fungicide and a protectant fungicide (chlorothalonil or mancozeb). Only Gavel is labeled for PB as well as DM. REI is 12 hr for Zing! and 48 hr for Gavel. PHI is 0 and 5 days, respectively. Apply no more than 8 times in a season with no more than 2 in succession. Limit total use with all products used to 1.6 lb zoxamide and 9.44 lb chlorothalonil per acre per season. The amount of chlorothalonil in an application of Zing! (1.18 lb/A) is less than the highest label rate of chlorothalonil fungicides for downy mildew (1.5 lb/A) and is below the range for other diseases including powdery mildew (1.5-2.25 lb/A). Increasing the amount of chlorothalonil applied is prudent for these diseases. To obtain an application rate of 1.5-2.25 lb/A chlorothalonil, tank mix Bravo WeatherStik at 0.43-1.43 pt/A with Zing!.

Zampro (40, 45) and Revus (40). While in the same fungicide chemical group, there is indication they may have slightly different mode of action, thus there may be benefit to using one for the first application of a product in this group in a fungicide program and then switching to the other product later in the program. REI is 12 hr. PHI is 0 day. Apply no more than 3 times (4 for Revus) in a season with no more than 2 consecutive applications (none with Revus). Revus must be applied with a spreading/penetrating type adjuvant.

Curzate or Tanos (27). These have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). They can be a good choice when it was not possible to apply fungicide at the start of a high risk period when temperature is below 80 F. Apply another targeted fungicide 3-5 days later. Both must be tank-mixed with a protectant. REI is 12 hr. PHI is 3 days. Apply no more than 4 times in a season (6-9 for Curzate depending on rate); no consecutive applications of Tanos are permitted. Curzate is not labeled for PB.

Phosphorous acid fungicides (33). There are numerous products (e.g. Agri-Fos, Fosphite, K-Phite, Phostrol, ProPhyt, Rampart), all effective only for PB. They are recommended used at a low label rate tank mixed with the targeted fungicides listed above for PB.

Previcur Flex (28). Activity is limited to DM. Use sparingly (less than label limit of 5 times in a season). Reduced efficacy recently is thought to be due to fungicide resistance. REI is 12 hr. PHI is 2 days.

Recommended protectant fungicides. Chlorothalonil and mancozeb are the main protectant fungicides for DM and PB. Copper is also good for PB, but isn't as effective for DM.

No longer recommended. Resistance to fluopicolide (active ingredient in Presidio), to mefenoxam and metalaxyl (Ridomil) and to strobilurins (e.g. Cabrio) are sufficiently common that fungicides with these \ ingredients, which use to be highly effective, are now ineffective.

Plectosporium blight. This disease is more common when weather is rainy providing favorable conditions. Rotate, clean equipment between fields, apply chlorothalonil before rain, and incorporate infested debris right after harvest.

Integrated Management Program for Pumpkin Diseases:

Sign up for alerts about downy mildew occurrence at http://cdm.ipmpipe.org before the season starts. Monitor this site during the season for information on outbreaks and crops affected.

Select resistant varieties. See vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm.

Use fungicide-treated seed and/or seed that has been tested for pathogens. FarmMore commercial seed treatment also has an insecticide. Alternaria leaf blight, angular leaf spot, anthracnose, damping-off, Fusarium wilt, gummy stem blight/black rot, scab, Septoria leaf spot.

Rotate land to control diseases caused by pathogens that can survive in soil or on weeds in hedge rows, which include Alternaria leaf blight, anthracnose, angular leaf spot, Fusarium crown and fruit rots, Fusarium wilt, gummy stem blight/black rot, Phytophthora blight, Plectosporium blight, scab, Sclerotinia white mold, Septoria leaf spot, and viruses (which can survive in weeds).

Select a well-drained site to manage damping-off, Phytophthora blight, and scab.

Minimize leaf wetness. Select a site with good air movement and overhead irrigate when leaves will have time to dry before evening dew period to manage foliar diseases.

Physically separate cucurbit plantings.

Avoid moving infested soil into clean fields. Work last in fields where pathogens occur that survive in soil, then clean equipment before working in fields where these diseases haven't occurred (see list under rotate above). Apply pesticides to areas without soil-borne diseases first.

Scout for diseases regularly during the growing season. Focus on older leaves as diseases often start to develop there. Look on both leaf surfaces. It is especially important to scout once plants start to produce fruit. Check low areas for Phytophthora blight. Look for cucumber beetles.

Apply pesticides as needed (fungicides before rain for most diseases except powdery mildew):

Insecticide Admire Pro at planting or transplanting for cucumber beetles, which carry bacteria that cause bacterial wilt. Or use FarMore-treated seed. Planting Blue Hubbard or another cucurbit highly attractive to beetles around the crop to form a perimeter trap is an effective strategy that can result in insecticide only being needed on the trap plants.

Contans before or at planting for white mold.

Ridomil Gold EC (Code 4), Previcur Flex (28) or biopesticides (Actinovate, Bio-Tam, Double Nickel, Regalia, RootShield, Serenade Soil, SoilGard, etc) at planting for damping-off.

Biopesticides (see above) at planting for Phytophthora blight and Fusarium crown rot.

Protectant fungicides (chlorothalonil, mancozeb, and/or copper) before disease onset. A preventive schedule is especially important with copper for angular and bacterial leaf spots.

Where bacterial wilt is a concern, apply insecticide if treatment at planting is no longer killing cucumber beetles early in crop growth, especially prior to canopy closure. Labeled products are Asana, Assail, Baythroid, Brigade, Danitol, Lannate, Pounce, Sevin XLR Plus, Volium Xpress, and Admire applied through drip.

Apply targeted fungicides in alternation based on FRAC code when the following diseases occur starting at first symptom or when risk high, tank-mix with protectant fungicide:

Alternaria leaf spot. Fontelis (7), Inspire Super (3,9), Aprovia Top (3,7), Pristine (7,11), QoI fungicides (11), Reason (11), Tanos (27).
Anthracnose. Aprovia Top (3,7), Inspire Super (3,9), Pristine (7,11), QoI fungicides (11), Tanos (27), and Topsin M (1).
Downy mildew. Powdery mildew, Phytophthora. See sections above.
Gummy stem blight/Black rot. Fontelis (7)*, Aprovia Top (3,7), Inspire Super (3,9), Pristine (7,11)*, Proline (3), Switch (9,12), QoI fungicides (11)*, and Topsin M (1)*.
Plectosporium blight. Aprovia Top (3,7), Inspire Super (3,9), and QoI fungicides (11)*.
Septoria leaf spot. Aprovia Top (3,7) and Inspire Super (3,9).
* Resistance detected in the US.

Hasten decomposition of infested crop debris by chopping debris to break it up and then incorporating with disk, roto-till or plow. Do immediately after harvest.

Please Note: The specific directions on pesticide 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.

Pollination of Pumpkin and Winter Squash - Thanks to Bumble Bees!

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In recent years, there has been concern about the present status and future of crops that require pollination by insects in order to set fruit, due to continuing losses of honey bee colonies. There have been several studies of pollination in pumpkins, which have come to different conclusions about the value of supplementing pollination by bringing in honey bee or bumble bee colonies.

Background: Pumpkin and squash flowers open early in the morning, and most pollination happens early – before 11 am. After that, nearly all the pollen is gone from the male flowers, the remaining pollen is rapidly losing viability, and the flowers start to close. Each flower, male or female, is open for only one morning. Whether a female flower sets fruit depends partly on how much pollen is deposited on the stigma, but also on whether the plant has enough resources to support more fruit. The first fruit set on a plant generally gets priority over later female flowers. Pumpkin and winter squash plants have more female flowers than will survive as fruit, and they have many times more male flowers than female flowers.

The scientific literature (mostly from Dr. Chris Wien at Cornell and his students) says that pumpkins need from 1250 to 2000 pollen grains per stigma for full fruit set. This would require multiple bee visits per female flower – estimates are around 8-12 visits.

Three species of bees are the vast majority of visitors traveling between flowers in pumpkin and squash fields: honey bees (*Apis mellifera*), common eastern bumble bees (*Bombus impatiens*), and squash bees (*Peponapis pruinosa*).

My team has been studying pollination of pumpkin and winter squash in Connecticut for the last four years. Here are some of our studies and findings:

1. We compared naturally pollinated pumpkin flowers with those where we manually added pollen in field studies seven times at experimental farms (Griswold in eastern CT, Lockwood Farm in Hamden, and the Windsor Valley Laboratory). Overall, there was no difference in fruit set, survival of fruit to harvest, size of fruit, or number or weight of seeds in these experiments.
2. At about 20 different pumpkin and/or winter squash fields in Connecticut, each year from 2012 to 2015, we visited the field for one morning, took a variety of samples during pollination, and then collected stigmas from female flowers at the end of the morning. We took the stigmas back to the lab, extracted the pollen from the surface, and counted pollen grains deposited on the stigmas. We sampled a diversity of fields available in Connecticut – organic and IPM, very small up to about 5 acres, mostly in the central and western part of the state. We have done this now 80 times, and only once (Griswold,

2012) did we find that the pollen deposition on average was less than 2000 pollen grains per stigma.

3. We started out doing bee counts in the field – walking a straight line in the field and recording the first 100 flowers we encountered – whether the flower was male or female and how many bees of what species were visiting the flower. Overall, the common eastern bumble bee was the most common visitor, although this varied over the summer and at different sites.
4. However, when we tried to relate overall bee counts to pollen deposited in the female flowers, we found no significant relationship. We found a better statistical relationship of counts of just bumble bees (not honey bees or squash bees) to pollen deposition, and a still better relationship of bumble bee counts on just the female flowers to pollen deposition.
5. As a result, in the last two years, we have focused on more detailed studies of bee behavior on the flowers. We have been making timed observations of bees on just the female flowers – watching each bee come and go. We have set up video cameras on female flowers to record bee behavior on the flowers. Although we are still processing these observations and videos and the data from them, what we have seen so far reinforces the importance of bumble bees as pollinators of pumpkin and winter squash. In comparison with honey bees, they are more frequent visitors, and more likely to make contact with the stigma of the flower. We find that female squash bees rarely visit female flowers – they may be mainly harvesting pollen from the male flowers to feed their offspring. Male squash bees visit female flowers and come in contact with other bees that may be present. They may play a role in getting other bees to move from one flower to another, which is what is required for pollination.

Conclusions: At present, the pollinators on any given sunny summer morning in Connecticut are generally adequate for pumpkin or winter squash pollination. We are depending heavily on a single species, the common eastern bumble bee, for much of our pollination. Fortunately, this is a species of bee that seems to be faring very well in spite of the pathogens, pesticides, and other challenges that are affecting honey bees and several other bumble bee species. However, since this one species is very important for pumpkin and squash growers (and many other crops and native plants, too), it is very important to monitor the health and abundance of this bumble bee.

Calabaza Squash and Personal-sized Watermelons –
Two High Value Specialty Crops

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Four types of watermelons are available in supermarkets. Traditional seeded watermelons that have been a major part of the market since the 1950's and weigh 18-35 pounds. Large seedless watermelons have been available since 1988 and usually weigh 15-25 pounds. Icebox-size melons, generally weighing 7-12 pounds each, have been available for about twenty years. The newest melons on the marketplace are seedless miniature "personal-sized" watermelons, weighing 3-7 pounds each.

Personal-sized watermelons first became available in markets in 2003. They offer an attractive alternative for small families or for consumers that have limited refrigerator space. Consumers are drawn to the product because it is just the right size for a single-meal serving without the storage and bulk issues associated with traditional seedless watermelon. Personal-sized watermelons also reach a group of consumers who seldom purchased watermelon because of its bulkiness. Beside a smaller size, personal-sized watermelons also have a thinner rind which reduces waste and provides more edible flesh. Because the thin rind makes long distance shipping difficult, personal-sized watermelons are an ideal crop for New England's local farmers' markets and roadside stands. In addition, conventional watermelon growers in the South have resisted growing personal-sized watermelons because they require changes in cultural practices and harvesting equipment.

The economic potential of this crop can be very high for growers who sell directly to the consumer. Based on production in our trials, average yield was 10,120 fruit/A. Gross returns, at a retail price of $4.99/fruit, exceeded $50,000/A. With estimated production costs of $13,000/A, net returns would be $37,000/A, providing that the entire crop was harvested and sold. If the cultivar Bravo was grown, the average yield would be 16,139 fruit/A, increasing net returns to over $67,000/A.

Sites and soils. Trials of personal sized watermelons were conducted for three years at the Valley Laboratory, Windsor CT, on Merrimac sandy loam (Entic Haplorthod), an inland sandy terrace soil with somewhat limited moisture holding capacity (Shearin and Hill, 1962); and at Lockwood Farm, Mt. Carmel CT, on Cheshire fine sandy loam (Typic Dystrochrept), a coastal loamy upland soil with moderate moisture holding capacity (Reynolds, 1979).

Cultivars. Eleven cultivars were grown in 2008-2010 at both sites. The cultivars evaluated in 2008 were: Mielhart, Mini Yellow, Valoria, Vanessa, and Wonder. The cultivars evaluated in 2009 were: Big Tasty, Bravo, Extazy, Fantasy, Leopard, Mielhart, Snack Pack, Vanessa, and

Wonder. The cultivars evaluated in 2010 were: Bravo, Extazy, Fantasy, Leopard, Mielhart, Vanessa, and Wonder. The pollinator cultivar for all years was Sidekick.

Culture. The personal sized watermelon cultivars and the pollinator cultivar were seeded on April 25-27. The seedlings were grown in Promix BX (Premier, Red Hill PA) in 3x3x3-inch Jiffystrips and placed in a greenhouse maintained at 75º-90ºF. After germination, plants were thinned to one per pot. Seedlings were moved to a cold frame for hardening before transplanting in the field. Water-soluble 20-20-20 fertilizer (one tbsp/gal) was added to the seedlings before they were transplanted. In mid-June, plants of each cultivar were transplanted 2 feet apart in 50-foot rows. The pollinating cultivar was planted in every third row except in 2007 where the pollinator was planted every other row. One-half (25 feet) of each row was mulched with 1.25 mil black plastic (3 ft wide). Row centers were alternatively 5 and 6 feet apart. In 2005, paired rows, 5 feet apart, were covered with Reemay spun-bonded polyester (10.5 ft x 50 ft). The Reemay was pinned to the soil with 6-inch wide staples that penetrated 5 inches into the soil to prevent loosening in high winds. The Reemay was removed in early July to allow honey bees and other insects to pollinate the first female flowers forming along the vines.

Fertilization. The soils were fertilized at a rate of 1000 lb/A 10-10-10 before planting. After the Reemay was removed or in mid-July, the strips between the black plastic were side-dressed with 240 lb/A calcium nitrate. Total application of nitrogen during the growing season was 140 lb/A. Soil pH was about 6.5 at each site so lime was not applied.

Harvest. Watermelons were harvested in September and each fruit was weighed. Fruits weighing less than 3 pounds were not included in the analysis. Rind thickness was measured on ten random samples and the results averaged. Lycopene content was determined by Dr. Penelope Perkins, USDA/ARS, Oklahoma from samples obtained from the center of each randomly sampled fruit.

Percent soluble solids. Percent soluble solids in fruit is an indicator of percent sugars. The Brix meter is the standard tool for taking this measurement rapidly in the field. Samples were obtained from the center of randomly sampled fruit, the juice squeezed out, and its Brix measured. The 10 Brix readings for each cultivar were averaged.

Results. The average total estimated yield of personal-sized watermelons of all cultivars in 2008-2010 was 10,504 fruit/acre (A) at Windsor compared to 9,737 fruit/A at Mt. Carmel (Maynard 2010). At Windsor, the average number of fruit/plant was 4.6 with an average of 47% of the fruit in the 3-7 pound range. At Mt. Carmel, the average number of fruit/plant was 3.9 with 56% of the fruit in the 3-7 pound range. Compared to plots with no mulch, yields on black plastic mulch increased at both sites in all years by an average of 32%. Mielhart and Bravo had the greatest yields of personal-sized watermelons. Mielhart, Bravo, Fantasy, Leopard, Wonder, and Vanessa produced the largest percentage of melons in the 3-7 pound personal-sized watermelon range. Big Tasty, Mini Yellow, and Snack Pack had significantly thicker rinds, averaging 0.49 of an inch. The varieties producing the thinnest rinds were Bravo, Mielhart, Vanessa, and Valdoria, averaging 0.35 of an inch. Bravo, Mini Yellow, Valdoria, and Wonder had sugar content equal to or greater than 11%.

Calabaza squash, also known as tropical pumpkin, is mostly grown in tropical and semi tropical climates. The shape of its large fruit is round to oblate with deep yellow to orange colored flesh. The fruit are borne on several long runners that branch from the crown and may extend 25-50 feet. Since the growth of the vines is indeterminate, fruit with several stages of maturity may be attached to the same plant. At full maturity, the color of the rind changes from green or green-cream mottled to buff or buff-cream, but the color change only occurs when the vine is still actively growing. Fruit attached to senescent vines may change to buff but remain immature. Because of this, in the marketplace, Calabaza is always sold in sections and wrapped in clear plastic. The buyer must be able to observe the color, texture, and quality of the seeds (which remain intact) to determine if the fruit is mature.

Because excessive vine growth requires abundant space, plant breeders at the University of Florida (Maynard et al. 2002) and the University of Puerto Rico are developing more compact plants with shorter vines (10-18 feet). These short-vine culivars also mature in less than 80 days compared to long-vine cultivars that mature in 100-115 days (Anon 1998). Shorter time to maturity enables them to be planted in more northerly latitudes.

Calabaza is highly prized by Hispanic consumers. It was identified by the Connecticut Department of Agriculture as one of the most sought-after vegetables at Connecticut's farmers' markets. The flesh can be served as a baked or mashed vegetable, or pureed for soups, pie fillings, puddings, and breads. The seeds are often boiled, pureed, and mixed with spices to produce a condiment or roasted for snacking.

The economic potential of this crop is estimated to be very high for growers who sell directly to the consumer. Based on production in our trials, average yield was 37 tons/A. Gross returns, at a retail price of \$0.99/lb, exceeds \$73,000/A. With total production cost estimated to be \$3,400/A, net returns would be almost \$70,000/A provided the harvested crop was completely sold.

Sites and soils. Trials of personal sized watermelons were conducted for three years at the Valley Laboratory, Windsor CT, on Merrimac sandy loam (Entic Haplorthod), an inland sandy terrace soil with somewhat limited moisture holding capacity (Shearin and Hill, 1962); and at Lockwood Farm, Mt. Carmel CT, on Cheshire fine sandy loam (Typic Dystrochrept), a coastal loamy upland soil with moderate moisture holding capacity (Reynolds, 1979).

Cultivars. Five cultivars were grown at both sites 2001-2002. Short-vined varieties included El Dorado, G38-2-22 sem, PR Shortvine, and La Estrella. Also grown was La Primera, a long-vine, open pollinated cultivar for comparison.

Culture. Calabaza seeds were grown in Promix BX (Premier, Red Hill PA) in 3x3x3-inch Jiffystrips in a greenhouse maintained at 75º-90ºF. Seeding occurred in early May for mid-June transplanting. After germination, plants were thinned to one per pot. Seedlings were moved to a cold frame for hardening before transplanting in the field. Water-soluble 20-20-20 fertilizer (one tbsp/gal) was added to the seedlings before they were transplanted. In mid-June, the seedlings of each cultivar were planted 3 feet apart in single 60-foot rows spaced 6 feet apart, equivalent to a planting density of 2420 plants/acre.

Fertilization. The soil at Windsor and Mt. Carmel was fertilized with 10-10-10 at a rate of 1000 lb/acre and 1300 lb/acre, respectively. After 4 weeks at Windsor, when the plants began to form runners, the rows were side-dressed with calcium nitrate at a rate of 240lb/acre. At Windsor, total application of nitrogen for the season was 140 lb/acre, at Mt. Carmel 130 lb/acre.

Harvest. Calabaza fruit was harvested each year in early October following the first light frost. At a spacing of 6 feet between rows, vines from adjacent rows intertwined. Special care was taken to determine the source of each fruit. Individual fruits were weighed and judged for maturity. Immature fruit, generally weighing less than 5 pounds and located at the extremities of the vines, were discarded. Representative samples of fruit from each cultivar were halved to measure the diameters of the fruit and seed cavity.

Vine Length. In 2002, at Mt. Carmel, vine lengths were measured for plants randomly selected in each cultivar row. The distance from the crown to the location of mature fruit along the runner was also measured. Runners shorter than 5 feet were always barren.

Results. The average total estimated yield of calabaza of all cultivars in 2001-2002 was 37.4 tons/acre (A) at Windsor compared to 36.6 tons/A at Mt. Carmel (Hill 2003). Long-vine variety La Primera consistently had the greatest yields (35-48 tons/A) but some plants produced fruit whose shapes were oblate or oblong instead of spherical. Among the short-vine cultivars, El Dorado averaged the greatest yields (32-35 tons/A) compared to PR Shortvine (28-35 tons/A) and La Estrella (21-31 tons/A). La Estrella produced the largest fruit (14 lb/fruit) but its productivity was lowest among all cultivars because it set the fewest fruit/plant (1.6 fruit/plant). El Dorado produced the greatest number of fruit/plant (3.0 fruit/plant). Its fruit were smaller than other cultivars (10 lbs/fruit), but the seed cavities were also small. Average length of runners of short-vine cultivars PR Shortvine and El Dorado was 10.9 feet and 11.8 feet, respectively. The runners of long-vine La Primera had an average length of 24.0 feet while the runners of short-vine La Estrella were of intermediate length (16.2 feet). Average distance to the development of the first mature fruit in PR Shortvine and El Dorado was 6 and 8 feet beyond the crown, respectively. La Estrella and La Primera developed their first mature fruit 10 and 15 feet beyond the crown, respectively.

In 2003, one plant of La Estrella produced mature fruit in only 90 days on 12-foot vines. Early maturing fruit were generally found on the vine within 2 feet of the planting site. Fruit that mature in 90 days is appealing to northern growers because the majority of fruit can mature before frost. Fruit that formed on longer vines does not always reach maturity. We saved the seeds from the fruit planted them at Mt. Carmel and Windsor in 2005. At Windsor, 17% of the plants produced early-maturing fruit (90 days) within 2 feet of the planting site while only 4% produced early fruit at Mt. Carmel. We continued this process of saving the seed from plants that produced mature fruit within 2 feet of the plant and planting them at Mt. Carmel and Windsor for 5 growing seasons. In 2010, 82% of the plants at Windsor produced fruit within 2 feet of the plant compared to 37% of the plants at Mt. Carmel.

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Use of Interspecific Hybrids in Squash for Fresh Market, Processing, and Grafting Rootstocks for Melons

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Introduction

The term 'species' is generally applied to populations of morphologically similar plants which are able to easily hybridize or interbreed. Within the genus *Cucurbita*, the three major domesticated species of squash and pumpkin, *C. pepo* (acorn, gourds, summer squash, pumpkins), *C. maxima* (buttercup, Hubbard, show pumpkins) and *C. moschata* (butternuts, processing squash), generally conform to the usual species concept. Crosses between *C. pepo* and *C. maxima* rarely produce either fruit or seeds. Crosses between *C. pepo* and *C. moschata* will sometimes produce fruit, but rarely filled seeds. However, in some crosses of *C. maxima* (female parent) to *C. moschata* (male parent), both fruit and ample, filled and germinable seeds are produced. The F_1 progeny of the latter crosses are extremely vigorous, but sterile, requiring a pollinator strain of either *C. maxima* or *C. moschata* for setting fruit. Several bush, Golden Delicious-type processing lines were developed in my breeding program at UNH during the 1970s and 1980s, and more recently we have been breeding processing strains of *C. moschata* with support from the NH Agricultural Experiment Station. Because interspecific hybrids have been shown to have vigorous vegetative growth and to be especially resistant to soil borne pathogens, we decided to explore their use for developing processing and fresh market varieties. In addition, as a result of research on compatibility between the two species, *C. maxima and C. moschata*, by a graduate student, Jake Uretsky, we identified a bush processing strain (NH65) which gives good seed yield and well-filled seed in crosses to *C. moschata* strains.

Evaluation of Interspecific Processing Hybrids

In 2011, 2012, and 2013, growth, flowering patterns, and yields were compared among three different NH interspecific hybrids, NH65xLIC (NH1321), NH65xDF, and NH65xSC937 (NH1310) and a Dickinson Field (DF) strain of *C. moschata*, SC936, from Rupp Seeds (Waseon, OH). Growth rates were similar among all of the cultigens; however, branching patterns varied. In particular, NH1310 initiated several lateral branches close to the crown of the plant and leaf petioles were exceedingly elongated. Together with the bush habit of growth, this pattern of development resulted in a rapid, more vertical, and uniform development of the leaf canopy cover, important growth patterns for maximizing photosynthesis. In addition to the vigorous vegetative growth of the interspecific hybrids, they resist predation by vine borer, are less attractive to squash bugs than varieties of *C. maxima*, and have good tolerance to powdery mildew.

As compared to SC936, two of the interspecific hybrids, NH1321 and NH1310, exhibited exceptionally high fresh weight (FW) fruit yields and flesh dry matter (DM) for New England climactic conditions (Table 1). Although FW yields for NH1321 and SC937 were similar, respectively, at 44.8 and 42.1 tons per acre, % dry matter (DM) in NH1321 (10.8%) was almost double that in SC937 (5.8%). The higher DM in NH1321 correlates to about a 5-fold higher starch content than in SC937. High starch content contributes to less water loss during processing and improved consistency and texture of pumpkin puree. The FW fruit yield of NH1310 (63.1 tons/acre) was 39% greater than that of SC936. The percent flesh DW was also higher in NH1310 (8.0%) than SC936, and as a result, the dry weight biomass of the pericarp or fruit flesh (economically important part of the fruit) in NH1310 was more than double that in SC936 (Table 1).

Table 1. Fresh weight (FW) and dry weight (DW) yields in 2012 of interspecific hybrids NH65xLIC (NH1321) and NH65xSC936 (NH1310) compared to SC936, an inbred processing strain of *C. moschata* (Rupp Seeds, Waseon, OH).

Cultigen	Fruit[z] FW (lbs)	Flesh % DW	Fruit No./plot	Fruit FW t/acre	Flesh DW[z] t/ha
SC936	4.3 b[z]	5.8 a[z]	30.5 a[z]	44.8 b[z]	2.3 a[z]
NH1321	3.9 a	10.8 c	31.5 a	42.1 b	4.4 b
NH1310	5.8 c	8.0 b	31.5 a	63.1 c	4.8 c

[z]Numbers within columns preceded by different letters are significantly different, $P \leq 0.05$.

Evaluation of Interspecific Hybrids Fresh Market Squash

With suitable round-fruited, inbred lines of *C. moschata*, it is possible through crosses to bush kabocha/buttercup strains of *C. maxima* to produce interspecific hybrid varieties with a fruit appearance similar similar to kabocha/buttercup varieties, and in addition, have the vigorous semi-bush growth habit and pest resistance described above for the interspecific processing hybrids, as well as tolerant to storage rots. We have produced and evaluated interspecific hybrids with very attractive fruit with both orange and green skin. As with the interspecific processing hybrids, fresh weight yields have been very high. However, we currently have only a few strains of *C. moschata* with the necessary kabocha fruit shape, acceptable eating quality, and compatibility to cross with *C. maxima*. Thus far, we have identified only one hybrid which may have potential for introducing to the seed trade.

Use of Interspecific Hybrids as Rootstocks for Melon Grafting

Interspecific hybrids of *C. maxima* x *C. moschata* have found extensive use worldwide as rootstocks for grafting to melon and watermelon scions. The squash/pumpkin rootstocks have a vigorous root system that affords excellent resistance to soil borne pathogens. Use of these rootstocks is especially prevalent in protected agricultural settings employing greenhouses and high tunnels where plants are grown extensively year after year in the same soil, allowing buildup of pathogens affecting melon growth. The grafting technique may offer unique opportunities for improving field melon production in New England because of enhanced melon growth in stress environments, higher yields, and more consistent fruit quality. Squash roots can withstand cooler soil temperatures than melons, so it may be possible to use earlier spring planting schedules with grafted versus traditional transplants. Janel Martin, a graduate student in Biological Sciences, has embarked on a research project to evaluate squash rootstocks for melon transplants in field melon production. She is using both currently available commercial rootstocks and some developed at UNH from our breeding program.

Experimental results in summer of 2015 were extremely encouraging. Using the UNH-developed cantaloupe variety Halona, Janel grafted melon seedlings to four interspecific rootstocks: Carnivor and Kazako from Syngenta, along with NH1320 and NH1326. Seed germination was poor for Kazako, moderately good with Carnivor and NH1326, and excellent with NH1320. Some cotyledons in seedlings of NH1326, Kazaka, and Carnivor were distorted in growth. The hybrid NH1326 exhibited poor grafting compatibility with Halona; grafting was successful with the other hybrid rootstocks and early seedling growth was normal following union of the grafts in a healing environment. Plants were set out in two separate plots at the Woodman Horticultural Farm and the Kingman Research Farm, the former considered not to have serious soil borne pathogens affecting melons and the plot at the Kingman Farm known to harbor soil borne pathogen(s) causing sudden wilt. Growth in grafted plants of NH1320, Carnivor and Kazako was similar to control (non-grafted) plants for the initial 5 or 6 weeks from transplanting. Non-grafted plants, however, set first fruits about 4 days ahead of grafted plants. As fruit approached maturity, grafted plants began to appear noticeably more vigorous than control plants in both locations. By the time of first harvest, control plants at the Woodman Farm were much less vigorous with less leaf canopy cover than grafted plants. Growth appeared to halt in control plants, but grafted plants continued to grow and set fruit, even with a heavy fruit load. At the Kingman Farm, control plants showed typical symptoms of sudden wilt prior to harvest. The yield results have not yet been completely summarized; however, total fruit weights from plots in the 'healthy field' at the Woodman Horticultural Research Farm were 250 lbs. for control plots (ungrafted), 454 lbs. for Kazako, 642 lbs. for melons grafted to Carnivor, and 667 lbs. for plants grafted to NH1320. Average fruit size was 3.3 lbs. for control plants, 4.2 lbs. for H1320 grafted plants and 4.3 lbs. for Carnovor, and 4.0 for Kazako. Mean soluble solids contents for the treatments were 11.9 (control), 10.9 (NH1320), 10.7 (Carnivor), and 10.7. Soluble solids content correlates to sugar content and sweetness of melons, and a soluble solids content of 11% or greater is required for melons to have acceptable eating quality. Thus, the soluble solids content of many of the grafted melons would be low for good eating quality. These preliminary results suggest that it may be necessary to choose varieties with especially high sugar content for use in grafting.

Next year, Janel Martin's research will focus on different planting dates, testing different melon varieties, and perhaps testing a few more rootstock varieties.

After PYO: Mechanical Harvest Aids

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Fairwinds Farm is a 60 acre farm located in Bowdoinham Maine. Of those 60 acres, 16 of them are planted with strawberries. Approximately 80% of our strawberry sales are made through PYO. The remaining 20% are sold direct to consumer at Farmers' Markets and to wholesale customers.

To get those berries picked in a timely manner for market and wholesale accounts, we hire 30-40 people to come in daily to pick the strawberries. The majority of pickers are high school students; although a few are adults.

Where do we find the pickers? We recruit our pickers through newspaper ads, facebook, help wanted signs at the local stores and word of mouth. We pay "by the quart" meaning pickers are paid for what they pick…we pay them weekly.

How is the picking crew managed? Two to three of our hourly employees are in charge of the picking crew and making sure the berry orders are filled each day. One is designated the Crew Chief. This person oversees the whole picking crew with the help of one or two assistants. He (or she) is given the list of orders for the day; is in charge of quality control; assigns rows to pickers; accepts payment from wholesale customers; and sends berries to market. The Crew Assistants are constantly in the field with the pickers monitoring the quality of berries being picked; they assist the Crew Chief with loading orders for customers; log flats for pickers as they are picked and assist in anyway needed.

The pickers arrive at 6:00 am; our crew arrives 45 minutes to one hour prior to that to get all supplies set up for the day. They set out the number of flats needed to be picked that day (usually 250-300 flats) so there is no concern with either under picking or over picking. If we are picking in more than one field, they set up supplies in each location.

The pickers are each assigned one side of a row; and they pick directly into 8 quart waxed shippers which are already lined with fiber quart containers. The shipper is set into a wooden custom made carrier which has a handle on it. This enables the picker to carrier it easier and also keeps the shipper off the ground. Once the shipper is filled to our specifications, the picker carries it to the truck, where one of the Crew Assistants inspect the berries; marks the picker's initials onto the shipper (for future reference, if needed), records the shipper into the Picker Log, and gives the picker a fresh container so they can go directly back to their assigned aisle to continue picking.

Where do the berries go once they are picked? They go to either one of three places:

1. Into our delivery van to be sent directly to the Farmers' Market.
2. Onto our truck to be held until the customer arrives to pick them up.
3. Onto our truck to be delivered to our cooler for a later pick up or to be frozen for winter sales.

Our goal is to sell fresh berries the same day they are picked…berries are continually being delivered to the market, often within ½ hour of being picked.

How do we know how many berries to pick? We determine how many berries to pick for our Farmers' Market based on past market history (the day of the week, etc); the weather; the time of the season (early on or later in season).

The wholesale customers call us the night before and leave a message with their order.

We also determine any extras we may want to pick to freeze to sell at our winter market.

When things go wrong….how we try to be prepared. We constantly monitor the weather. If rain is predicted for early morning, we will have some of the picking crew come in the evening before and pick some berries to give us a head start on the next day, so we can have a delayed start. If it is predicted to be a complete washout, we will pick some berries the night before, if we are having a market the next day, and will cancel the wholesale orders.

We use waxed carriers (shippers) as they hold up to light rain and heavy dew better. The shippers are loaded directly onto a truck to keep them dry; we give extra dry quart containers to the customers so they can transfer damp berries to them, if needed.

We adjust numbers if the berry picking is going slow….either because there are not enough berries to be picked, or not enough pickers show up.

We plan ahead. If we anticipate that we may need to move from one field to another during the morning pick….we begin the transition prior to actually moving the pickers….so everything is in place, and very little picking time gets lost.

What happens when the pickers are gone for the day? The Crew Chief walks the fields with one of us and we make a determination of where we will have the pickers working the next day. We reevaluate the current day and see where we can make changes or improvements.

When does the season start and end? Our goal is to extend our market season on both ends of the PYO season by planting early and late varieties. We start taking our field berries to market about one week to ten days prior to opening the fields to the public (about Mid June) and will continue at least two weeks after we close the fields to the public (late July).   (We have some berries in a hoop house that we begin picking in Mid May for market sales only). We start picking for wholesale customers about three days prior to opening to the public and will offer wholesale as long as we have an abundance of berries available….usually about two weeks.

Keys to success:

1. Operational Agility. Having the ability to adapt quickly to unanticipated changes; such as an unexpected order called in Mid-Morning; unexpected rain shower; unanticipated demand at the market.
2. Communication. Constant communication must take place in order for the process to be successful. We are in continuous contact with our Crew Chief and our Farmers' Market Crew. The Crew Chief stays in continuous contact with his crew via portable radio communication.
3. Fresh….top quality product. Delivering the berries continuously to market right after they are picked is a strong selling point and earns us many repeat customers.
4. All of this takes place in a window of 4-5 hours, six days per week….so having a plan, and being prepared is a necessity.

Living with Black Root Rot

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Strawberry growers in the Northeast face many difficulties in maintaining healthy strawberry fields, particularly as plantings get older or when berries are planted in the same location as a previous crop. In addition to stress from cold and damp weather, soils often contain pathogens that can increase over time and negatively affect roots under suboptimal conditions. Factors associated with the development unhealthy roots include the age of a planting, the length of time a field has been in berries, the degree of soil compaction, the use of fumigants and herbicides, and planting on flat beds. Typical symptoms of poor root health include a decline in vigor, small leaves, wilting, and blackening roots and lack of root hairs. Symptomatic plants usually occur in patches in the field. The causal organisms seem to vary from one location to another, but generally consist of varying levels of *Phythium, Rhizoctonoa, Phytophthora, Fusarium* pathogens and *Pratylenchus* nematodes. Because of the complex nature of this disease, scientists have named it the Black Root Rot (BRR) complex.

One approach to manage black root rot is to kill the offending organisms. However, there are no products that selectively kill the all of the culprits and leave the many more benign and beneficial organisms unharmed. Certain fungicides have activity against *Phytophthora* and *Pythium*, and can help in situations where these two organisms predominate. Typically, though, growers with severe problems will either avoid planting in those sites again or they will fumigate. Fumigation is effective over the short term, but because the beneficial organisms are also killed, reintroduced pathogens can grow quickly without competitive organisms in the environment, creating a worse environment in a few years. A teaspoon of healthy soil may contain between 600 and 800 million bacteria from 10,000 species; several miles of fungi from 5,000 species; and 1,000 species of protozoa, so specifically targeting three or four pathogenic genera in this complex is beyond the ability of current chemistry.

A second approach is to create conditions that discourage the establishment of harmful levels of BRR pathogens. This approach, while not targeted at specific pathogens, is a more desirable alternative to fumigation because it does not involve the use of synthetic biocides. This holistic approach involves improving the biological, physical and chemical environment of the soil.

Poor internal drainage is the major factor contributing to black root rot in strawberries. This can be addressed by installing tile drainage, decreasing soil compaction, and planting on raised beds. Compaction in isolation has a small negative effect on strawberries, but when combined with standing water, creates conditions very favorable for strawberry root pathogens. Growing certain cover crops with penetrating roots and subsoiling to break up compacted layers are methods to reduce compaction. Excessive cultivation will destroy soil structure and also lead to compaction and poor internal drainage.

Organic matter is the food source for the biological component of the soil. Soils high in organic matter tend to harbor a more diverse set of microorganisms which, in turn, seem to suppress the establishment of pathogens. Organic carbon pools in soil are important not only for increasing the cation exchange capacity of the soil, but also for N cycling. Some microbes are also able to fix N_2 gas from the air, providing another source of plant available N. The presence of microorganisms in the soil also increases soil aggregation through bacterial mucigel and fungal hyphae. Aggregation improves water infiltration, aeration, and reduces erosion. Without soil C these important microbial populations would decline and the benefits would decrease.

Methods of increasing organic matter include cover cropping and composting. Certain cover crop sequences suppress soil pathogens better than others, and work almost as well as fumigation. However, too much compost can excessively increase water holding capacity and create favorable conditions for soil pathogens. Also, we have evidence that too much straw can be detrimental to strawberry plant growth. For these reasons, it is difficult to develop hard and fast rules for managing soils.

An example of this difficulty involves the use of straw mulch for protecting strawberries for winter. A survey of strawberry farms in NYS indicated that almost all have low levels of biological soil health which may reflect low levels of beneficial microorganisms and less competition for disease organisms. This may partially explain the long term decrease in yield per acre in NYS reported by the National Agricultural Statistics Service, and the increasing incidence of BRR that growers report. One difference between berry fields with low biological soil health and adjacent fields of vegetables with higher values is that strawberry growers use a large amount of straw for winter protection each year. One might expect that large additions of organic matter would enhance soil health, but it is possible that this large annual influx of straw might actually reduce microbiological activity, increase soil moisture in already wet soils, and make plants more vulnerable to BRR. We are studying various soil amendments/mulches and depth of tillage to determine how they affect biological soil health, and if so, what is the nature of those amendments that deplete, rather than enhance, soil health.

Until more is known, growers should try to prevent the establishment of BRR by ensuring that internal drainage is adequate, avoiding compacting soils, and ensuring that organic matter is high. Rotations of various cover crops between plantings of strawberries will suppress pathogens that otherwise would carry over into the new planting. Cornell University has a soil health test that determines where a soil falls on indicators of physical, biological and chemical health, and recommends adjustments in practices that can be made to improve these indicators.

Healthy soil will lead to healthy plants. While one can also obtain healthy plants in sterile soil, this is impractical to achieve in perennial cropping systems.

Considerable information on soil health is contained in a free 175 page publication: Berry Soil and Nutrient Management: A Guide for Educators and Growers

http://fruit.cornell.edu/berry/production/soilnutrientmgmt/pdfs/BerrySoilandNutrientManagementGuide.pdf

Also, Cornell has archived a series of 14 webinars specifically about soil management. These can be found at:

http://fruit.cornell.edu/berry/webinar/archive.html#Soil

Strawberry Viruses: Why Worry?

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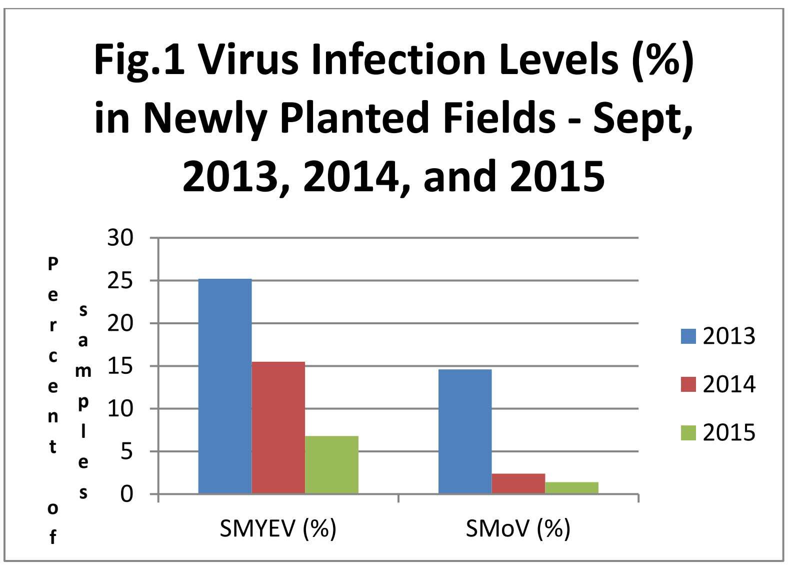
An outbreak of two aphid vectored viruses in Nova Scotia strawberry fields in 2012-2013 caused significant losses to both nursery and commercial fruiting operations. The overall loss to the sector was nearly 50% of the combined $19 million crop value. Recovery efforts focused on three strategies: 1) inoculum reduction facilitated by a federal/provincial disaster assistance "replant" program, 2) production of clean nursery stock facilitated by third party virus testing, and 3) optimum vector management facilitated by a province wide aphid monitoring program. More than half of the commercial fruit crop was lost in 2013 and about 25% in 2014 due to the effects of the viruses. However, the 2015 crop was a bumper one and most growers attribute this to declining virus levels (Figure 1).



The two problem viruses, strawberry mild yellow edge virus (SMYEV) and strawberry mottle virus (SMoV), are among the most common viruses to be found in strawberries and are reported around the world. Individually, they do not appear to cause problems for strawberries but in mixed infections can cause decline symptoms and severe yield reduction. A third previously unknown virus, named strawberry polerovirus 1 (SPV1), was discovered in symptomatic plants collected in 2013 and may also add to the synergistic effects of the primary viruses identified above.

SMYEV and SMoV are both spread primarily by the strawberry aphid, *Chaetosiphon fragaefolii*, so monitoring and management of this aphid is critical for controlling the spread and impact of the decline phenomena observed in Nova Scotia in 2012/2013. In Nova Scotia, this aphid species overwinters as shiny black, football shaped eggs on the underside of old leaves lying close to the ground. Monitoring should begin immediately after mulch removal in the spring with the assumption that the majority of eggs found are of the strawberry aphid. If significant numbers are found, plans should be made to apply a control shortly after hatch which will be within 2 weeks of mulch removal. Newly hatched strawberry aphid nymphs prefer young succulent leaves so monitoring is facilitated by collecting 60 random immature trifoliate leaves on a weekly basis from each field block and examining for nymphs on the underside of the leaves. The strawberry aphid nymphs are wingless and easy to identify although growers will require either trained scouting services or magnifying equipment greater than 20x for verification. No thresholds for treatment have been established but our experience in Nova Scotia has shown that even low numbers of nymphs will increase rapidly and a treatment should be applied when monitoring counts exceed 15 nymphs per 60 leaf sample.

Fig.2 "Wingless" strawberry aphid

Left untreated, strawberry aphid colonies will eventually become crowded and adult aphids will quickly grow wings to allow dispersal to new areas. This marks the beginning of the high-risk flight period where winged strawberry aphids can spread viruses from infected plants throughout a field and potentially downwind to a neighbor's fields. Monitoring for the initiation of the strawberry aphid flight period is critical for minimizing virus spread and we are using yellow sticky traps for this purpose. Ten traps per field block are deployed at canopy height in mid to late May in Nova Scotia and examined on a weekly basis to establish the beginning of the flight period and upon first catch in a given area growers are informed by a “virus alert” email. Once again, no thresholds for treatment have been established for winged aphid catches but it is important to know that the yellow sticky traps are extremely conservative and even with zero counts in a field, there can be new infections. As such, in the midst of an epidemic such as experienced in Nova Scotia in 2012-2013, it is advisable to guide your spray decisions based on the overall monitoring report (eg. virus alert) rather than your individual field counts. In contrast, a threshold of 1 winged strawberry aphid per 10 trap set is likely a satisfactory threshold to warrant a spray in a low virus pressure situation.

Fig.3 “Winged” strawberry aphid

The strawberry aphid flight period lasts 6-8 weeks in Nova Scotia and upon completion growers may breathe a sigh of relief; however, fields should be monitored by leaf sampling in mid-fall to assess the need for a clean-up spray to minimize egg laying.

Strawberry viruses are a very real threat that caused a serious crop failure in Nova Scotia in 2012-2013. These viruses and others causing decline symptoms in northeastern North America in recent years have been primarily aphid vectored and effective control can be achieved by timely removal of fields, replanting with virus tested stock, and effective monitoring and management of the strawberry aphid.

Managing Persistent Weed Problems in Strawberries

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Weed management is one of the greatest challenges a strawberry grower faces. The most common reason for plowing down a strawberry bed is weeds. A critical first step in managing weeds is to plant where the weed pressure is low, e.g. a site that has had well managed cover crops and/or cash crops that either smothered weeds or allowed effective cultivation.

Late planting is another strategy can help to manage weeds in a new strawberry bed. The ground is prepared in the fall or in the early spring, and the first flush of spring weeds is allowed to germinate before planting. These are killed by light cultivation, contact herbicide or flaming. Eliminating the first flush of weeds and planting into a warmer, drier soil, reduces the need for early cultivation and hand weeding. However, delaying planting by four to six weeks can also reduce the quality and performance of your stored strawberry plants, so you should work with your nursery to have the plants stored and shipped appropriately.

Strip or zone tillage is another strategy for managing weeds in the planting year. A thick cover crop of oats or winter rye is grown the year prior to planting, and killed in the spring, leaving the plant residue undisturbed on the soil surface except for narrow (8-12") strips or zones tilled for the strawberry plants. Leaving most of the soil surface covered with a heavy plant residue prevents weed seeds from germinating. Zone tillage requires specialized equipment to make planting strips, which is expensive and heavy, requiring a fair amount of horsepower. As the residue breaks down over the season, weeds once again become an issue, and additional control measures will be needed.

For weed management following harvest, growers have developed renovation schemes for that reduce the typical flush of weeds that follows renovation by eliminating tillage from the scheme. Much of the weed pressure following renovation is due to tillage bringing buried weed seed up to the soil surface. Rather than tilling to narrow plant rows after harvest, contact herbicides or flaming are used. The sprayer or flamer must be adequately shielded to prevent burning the plants in the center of the rows (they should be narrowed to about 8 to 12 inches). Repeated burning will be necessary to manage weeds between the rows through the summer, and regular hand weeding within the rows will also be necessary, but by not tilling the soil, growers are finding that weed pressure in the second year is significantly reduced. Yields tend to be lower and fruit size smaller in the second harvest year with this practice.

The one harvest year rotation is probably still the best option for most organic growers (plant year one, harvest year two, plow down and plant to rotation crops) to manage weed problems in strawberry beds. However, some of the new strategies being developed may allow growers to extend the productive life of strawberry beds and thus improve their profitability.

Herbicides can offer good control of many weeds in strawberries if applied under the appropriate conditions. However, the use of herbicides alone rarely gives complete weed control. Other strategies should always be in combination with herbicides to get the best control of all weed problems. Herbicides registered for strawberries and their applications are listed below.

1. DCPA (Dacthal®): A pre-emergent herbicide used in the early spring, late fall or after renovation. It offers good, short-term control of some annual broadleaf weeds and grasses. It is weak on ragweed, galinsoga, smartweed, shepherd's purse and mustard. Its action will be improved if worked into the soil by irrigation or light cultivation, and it tends to work best in lighter, warmer soils. This may be used as an alternative to terbacil or napropamide when there is a high risk of plant injury from those products.

2. Napropamide (Devrinol®): A pre-emergent herbicide that provides good control of annual grasses, volunteer grains and some broadleaf weeds. It is typically applied just before mulching in the fall. Split applications have become popular due to the loss of other pre-emergent herbicides, e.g. half maximum rate application after renovation or in late summer after desired daughter plants have rooted, and a second half rate application once the strawberry plants are dormant. Napropamide should be worked in by irrigation, rainfall or light cultivation within 24 hours of application.

3. Terbacil (Sinbar®): A pre-emergent herbicide with some post-emergent activity, which should be applied at renovation time – after mowing and tilling the beds, but before new growth begins. A second application can be made in late fall, after the plants are dormant. No more than 6 oz. may be applied in a single application, and no more than 8 oz. may be applied in one season. An example of one season's use could be 5 oz. applied at renovation and 3 oz. applied in the late fall, the latter in addition to napropamide or DCPA. Terbacil can cause plant injury. It is important to determine appropriate rates for each location.

4. Clopyralid (Spur®): One application is permitted per crop per year following harvest to emerged weeds. Apply uniformly in a minimum of 10 gallons of water per acre. Do not tank mix with other herbicides. Clopyralid offers control of clover, dandelion and thistle.

5. Sethoxydim (Poast®): A post-emergent herbicide for control of actively growing grasses. It will not control broadleaf weeds. It should not be applied when grasses are under stress, e.g. drought, or on unusually hot, humid days. Do not use sethoxydim within 6 weeks of terbacil (Sinbar®) applications, to avoid leaf injury. Sethoxydim should be used in combination with a crop oil concentrate. Do not tank mix with 2, 4-D.

6. Clethodim (Arrow®, Prism®, Select®): A post-emergent herbicide, similar in activity to Poast®, for control of actively growing grasses. It will not control broadleaf weeds. It should not be applied when grasses are under stress, e.g. drought, or on unusually hot, humid days. Clethodim should be used in combination with a crop oil concentrate.

7. Paraquat (Gramoxone Inteon®): A contact herbicide for post-emergent control of most annual weeds and suppression of many perennial weeds. Paraquat will injure or kill strawberries, so applications are made between rows only, with a sprayer shielded to protect

the strawberries. It should be used in combination with a nonionic surfactant. Paraquat should not be applied within 21 days of harvest or more than three times in one season.

8. Pelargonic Acid (Scythe®): A contact herbicide for post-emergent control of most annual weeds and suppression of many perennial weeds. Scythe® will injure or kill strawberries, so applications are made between rows only, with a sprayer shielded to protect the strawberries. This product has a relatively low toxicity and no residual soil activity. It has a strong, unpleasant odor.

9. 2,4-D Amine (Formula 40®, Amine 4): A post-emergent herbicide effective on most broadleaf perennial weeds. It will not control grasses, nor offer any pre-emergent control. 2,4-D should be applied immediately after harvest is complete if emerged broadleaf weeds are a problem. After application, the bed should be left undisturbed for three to five days, before mowing the leaves off the plants. This allows time for the material to be taken in by the weeds. This material can also be used when the plants are dormant (late fall or early spring) to control winter annuals and biennials. Fall applications may result in injury to the strawberries if the plants are not completely dormant. Do not tank mix 2,4-D with sethoxydim (Poast®).

10. Flumloxazin (Chateau®): A pre-emergent herbicide for control of broadleaf weeds, including dandelion and shepherd's purse. For use in the fall when plants are dormant for control of weeds the following spring. If small boadleaf weeds are emerged, also apply a crop oil concentrate at 1% or a non-ionic surfactant at ¼% by volume. Chateau will control emerged chickweed, field pansy, and oxalis if sufficient contact is made with the weeds. Chateau can also be applied with a hood or shield to row middles of non-dormant strawberries prior to fruit set.

11. Pendimethalin (Prowl H20®): A pre-emergent herbicide that may be applied to the soil surface prior to planting. It may also be applied as a band with a shielded sprayer between the rows of strawberries up to 35 days before harvest. No weed control will be provided within the plant rows, and contact of this product on the strawberry plants will cause injury. Prowl provides excellent control of many annual grasses and several broadleaf species.

Always read and follow all product label information and precautions. 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. Users of these products assume all associated risks.

Supplying Nitrogen from Organic Sources: New Tools for an Old Challenge

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Nitrogen management is a challenge because nitrogen occurs in several different forms, some of which are easily lost from soil. Organic nitrogen from soil organic matter, or from added compost or manure, must be transformed to inorganic nitrogen (nitrate, NO_3^-, and ammonium, NH_4^+) before it is available for plant uptake. This microbial transformation of nitrogen, mineralization, can be fast at warmer soil temperatures and optimal moisture contents. The process is slower at cooler temperatures and in soils that are too wet or too dry, making predicting nitrogen supply to plants during the growing season difficult for growers and scientists. It is important to be able to predict nitrogen mineralization during the growing season so that nitrogen is not under-applied, leading to lower than expected yields, or over-applied, leading to wasted resources and money, as well as environmental damage. Human activities, including agriculture, have increased soluble inorganic nitrogen in the environment significantly, resulting in damage to lakes and coastal waters, among other environmental concerns.

There are many possible sources of organic nitrogen in agricultural soils including soil organic matter, plant roots and aboveground plant residues from the previous crop, green manure crops, compost, and non-composted waste, such as leaves, straw, etc. Soil microbes decompose soil organic matter and transform organic nitrogen to inorganic nitrogen. This naturally-occuring process produces about 15-65 lb per acre per year. Soils typically contain 0.5-5% organic matter, and soils with higher levels of organic matter have more potential to supply nitrogen to crops due to mineralization. Tracking levels of organic matter in soils through traditional soil testing is important.

When residuals such as composts are used as soil amendments, testing the material to be used is important due to variability in feedstocks and processes. A study of 4 commercially-available composts was conducted at Highmoor Farm, Monmouth, ME in 2013 and 2014. Composts (applied at a rate of 300 kg total N ha^{-1}) and inorganic nitrogen fertilizer (applied at a rate of 110 kg N ha^{-1}) were added to soil in high tunnels, and tomatoes were grown. Poultry manure compost contained the greatest percentage of inorganic nitrogen both years (Table 1). In both years tomato yield and plant nitrogen uptake were similar in plant grown in soils amended with poultry manure compost and inorganic nitrogen fertilizer (Table 2). In 2013 Beef manure compost also had high inorganic nitrogen, and plants grown in soils amended with Beef manure compost had high yield and nitrogen uptake. In 2014 inorganic nitrogen levels in Beef manure compost were lower and so was yield and nitrogen uptake. Soil nutrient levels at the 2014 site were lower than at the 2013 site, and yields were generally lower in 2014. In this study, and a related laboratory incubation study, the mineralization of organic nitrogen from the compost was relatively low. The composts that boosted yield added significant amounts of inorganic nitrogen to the soils initially, not through later decomposition. We saw no evidence that the relatively warm temperatures and optimal moisture conditions in high tunnels resulted in higher than expected rates of nitrogen mineralization in the first season after compost addition.

Table 1. Selected properties of four composts used in high tunnel tomato cultivation at Highmoor Farm, Monmouth, ME

	N	C:N	NH_4^+-	NNO_3^{-}N	Inorg N	Appl Rate
2013	(%)		---------(mg kg^{-1}) --------		(%)	(ton ha^{-1})
Beef Compost	2.4	15	295	2880	13	44
Food Compost	1.7	15	4	321	2	47
Dairy Compost	1.3	18	64	364	3	64
Poultry Compost	1.8	14	3850	1220	29	36
2014						
Beef Compost	2.4	13	18	381	2	41
Food Compost	1.7	20	58	416	3	56
Dairy Compost	1.5	17	74	306	3	63
Poultry Compost	2.312	2470314	17	27		

Table 2. Tomato plant nitrogen uptake and total marketable yield in high tunnel tomato cultivation at Highmoor Farm, Monmouth, ME

Treatment	**N uptake**	**Marketable Yield**
2013	(g plant^{-1})	(t ha^{-1})
Beef Compost	19.7ab	124a
Food Compost	15.8b	104b
Dairy Compost	15.3b	98b
Poultry Compost	23.8a	124a
Inorganic N fert	18.9ab	123a
No amendment	17.4b	101b
2014		
Beef Compost	5.9b	66b
Food Compost	7.0b	68b
Dairy Compost	5.5b	63b
Poultry Compost	9.7a	96a
Inorganic N fert	11.7a	109a
No amendment	5.2b	40c

Values followed by the same letter in a column are not significantly different from each other.

In addition to environmental conditions, such as temperature and moisture, amendment characteristics influence the rate of nitrogen release from organic materials. Perhaps the most useful parameter is the ratio of carbon to nitrogen (C:N) in the material. Organic materials with a C:N ratio less than 10 are likely to supply ~50% of total N over 8-12 weeks. Purchased organic fertilizers such as blood meal or feather meal, can have C:N of ~5. Composts are often in the 12-20 range for C:N, and may supply only 2-10% of their organic nitrogen in the first growing season. Some composts contain significant amounts of inorganic nitrogen, and this fraction is available for plant uptake immediately. Testing composts and other residuals is important, especially to determine % total N, % of total N in the inorganic form, and C:N ratio.

Because the rate of nitrogen mineralization depends on soil temperature and moisture conditions, the challenge of predicting nitrogen availability from organic sources is likely to be even greater in the future due to weather variability and changing climate. Maine, for example, is predicted to grow warmer and wetter in the coming decades. High tunnels may become more popular as a way to moderate weather extremes. Use of tools to monitor and track soil temperature and soil moisture levels may become more common. A variety of commercial and free tools and data streams can be found on-line. The USDA has established 'Climate Hubs' for each region of the U.S., and the NE Climate Hub is compiling a variety of relevant information. The Climate Hubs Tool Shed (http://climatehubs.oce.usda.gov/content/agriculture-tools-0) lists a variety of on-line tools, including those relevant to nitrogen management, such as Adapt-N. This site also lists costs, if any, and the developer of the tool.

For nitrogen, the research base involves mostly inorganic nitrogen and commodity crops, i.e. corn, wheat, switchgrass. There is a need for more information and studies involving organic N sources, diversified vegetable and fruit production systems, and New England climatic conditions.

Cover Crop Research at the University of Rhode Island

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Cover crops provide many important services as part of a vegetable production system, including reducing runoff and soil erosion, capturing nutrients within the root zone, fixing nitrogen, building soil organic matter, and suppressing weed growth. Much of the research on cover crops has focused on winter cover crops or on crops that remain in place for one or more growing seasons. Rotation with long term forage or grain crops maximizes the benefits of cover crops, but is frequently economically unfeasible for peri-urban farms where high land costs combine with limited infrastructure for harvesting, storing, and marketing forage and grain crops. Winter cover crops are of limited utility when farmers are using season extension practices to plant vegetables as early as possible in the spring, and prolong harvest as late as possible in the fall. These limitations have led to cereal rye being the cover crop of choice for winter, and buckwheat being the most widely used summer cover crop.

Both cereal rye and buckwheat provide benefits. Rye is extremely winter hardy, and can be planted as late as early November in Rhode Island. It is effective at reducing runoff and soil erosion and capturing nutrients within the root zone. While rye can provide large amounts of organic matter, realizing this benefit requires letting the rye grow until late spring which delays planting of the vegetable crop. In practice, rye is often incorporated in early spring and contributes minimal organic matter. Buckwheat germinates and grows very quickly in warm soil, effectively suppressing many annual and perennial weeds. It is an excellent phosphorous scavenger. The biomass is easily incorporated and breaks down quickly without being allelopathic. The flowers are attractive to pollinators and beneficial insects. However, buckwheat matures very quickly in the heat of summer, and if termination of the cover crop is delayed it will self-seed, becoming a weed in the following crop. Buckwheat residue degrades quickly, contributing little to the soil organic matter levels.

The vegetable production team at the University of Rhode Island has been investigating alternatives to buckwheat for short-season summer cover crops, seeking crops that suppress weeds effectively but also contribute significant organic matter to the subsequent crop or fix nitrogen. This report presents the results of the first year of a two year study funded by an NRCS Conservation Innovation Grant.

Alternatives to Buckwheat

The objective of this portion of the study was to evaluate some of the newer summer cover crop species to identify crops which mature in the same 6-8 week period as buckwheat, but would provide different benefits and decreased likelihood of self-seeding. We tested teff (*Eragrostis teff* cv. Dessie), Japanese millet (*Echinochloa esculenta* VNS), sunn hemp (*Crotalaria juncea* cv. Tillage Sunn), and chickling vetch (*Lathyrus sativus* cv. AC Greenfix). Teff and Japanese millet

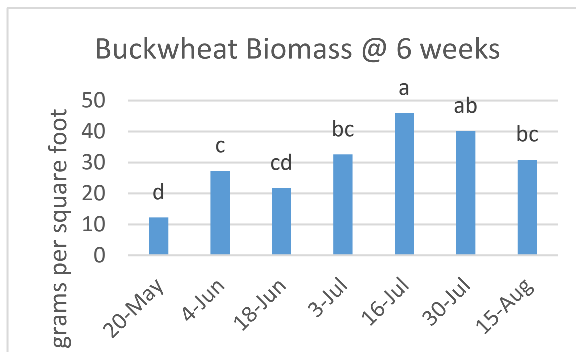
Table 1. Standard seeding rates

Crop	Target rate
Buckwheat	50 lbs/acre
Teff	9 lbs/acre
Japanese Millet	20 lbs/acre
Sunn Hemp	50 lbs/acre
Chickling Vetch	80 lbs/acre

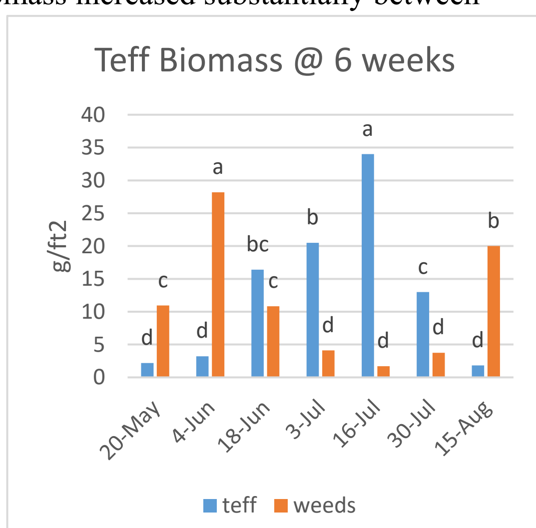
are warm-season annual grasses, able to produce abundant biomass under warm, dry conditions. Sunn hemp and chickling vetch are annual legumes with the potential to fix 60-100 pounds of nitrogen per acre within 6-8 weeks of seeding. Sorghum and sorghum-sudangrass (Sudex) were not included in this study because under our conditions they require 10 weeks or longer to fulfill their potential.

Buckwheat, sunn hemp, teff, and Japanese millet were seeded at the standard rate (Table 1) every two weeks from May 20 to August 15, while chickling vetch was seeded from July 15 to August 16. Data were collected on seedling emergence, crop biomass, and weed biomass at 6 weeks after seeding, and crop biomass at 8 weeks after seeding. Biomass samples were cut at one inch above the soil surface and dried to constant moisture before weighing. We also tested alternate seeding rates for teff, sunn hemp, and Japanese millet, planting each crop at four rates on June 18. Sunn hemp, buckwheat, and chickling vetch were seeded with a standard grain drill, while teff and Japanese millet were seeded with a Brillion cultipacker. Plots were 1500 square feet, with data collected from six randomly placed 1 square foot quadrats within each plot. Legume seeds were inoculated with compatible rhizobia bacteria prior to seeding. Grass plots were fertilized at seeding with Nature's Turf 8-1-9 organic fertilizer at 40 lb N/acre.

Effects of Seeding Date



Dry biomass production for buckwheat six weeks after planting ranged from 12 g/ft^2 to 46 g/ft^2 with the May 20 seeding producing the least biomass, and the July 16 seeding producing the most. July 16 and 30 were the best seeding dates, followed by July 3 and August 15. Weed biomass was low with no significant differences between seeding dates. Biomass increased substantially between weeks 6 and 8 the for the June 4 and July 3 seedings, but not other dates.



Dry biomass for Japanese millet ranged from 3 g/ft^2 to 39 g/ft^2 at 6 weeks after planting, and from 4 g/ft^2 to 70 g/ft ^{2}at 8 weeks after planting. Biomass production was significantly greater for the July 16 seeding than any other date. Japanese millet biomass production was highly variable within individual plots, suggesting that this species is sensitive to small differences in soil quality.

Teff biomass production also peaked in the July 16 seeding, with 34 g/ft ^{2} at 6 weeks and 50 g/ft ^{2} at 8 weeks. Teff was effective at suppressing weeds in seedings between June 18 and July 30, but not in earlier or later seedings.

Sunn hemp performed poorly on all seeding dates, with biomass at 8 weeks ranging from 1 g/ft ^{2} to 17 g/ft ^{2}. Weed biomass exceeded sunn hemp biomass on all dates except July 16, when sunn hemp 6 week biomass peaked at 8 g/ft ^{2}.

Chickling vetch was seeded on only 3 dates out of concern that as a cool season legume it would perform poorly in mid-summer. The species has the potential to produce over 1 ton of biomass per acre, but the best of our yields was only 1100 lbs/ac. Biomass at eight weeks ranged from 8 to 12 g/ft ^{2}with the highest production from the July 30 seeding. Chickling vetch out-performed sunn hemp on all three dates that both crops were seeded. Weed biomass greatly exceeded chickling vetch biomass six weeks after the July 16 seeding, but the other planting dates were much less weedy.

Effects of Seeding Rate

Sunn hemp, teff, and Japanese millet are less commonly used cover crops than buckwheat and ideal seeding rates have not been established for southern New England. Teff was seeded at 7, 8.5, 12, and 18 lbs/acre. Japanese millet was seeded at 11, 22, 33, and 44 lbs/acre. Sunn hemp was seeded at 12.5, 20, 25, and 33 lbs per acre. Crop biomass was measured at 10 weeks after seeding as well as at 6 and 8 weeks, and weed biomass was measured on all three dates.

Seeding rate did not significantly affect biomass production for teff at 6 or 10 weeks, and only slightly affected biomass at 8 weeks. All seeding rates were able to out-compete the weeds. Japanese millet biomass increased with seeding rate, but differences were mostly not significant due to high variability. The 33 lb rate produced the most biomass overall, with 82 g/ft ^{2} at 10 weeks. The second highest biomass production was with the 44 lb rate, which produced 75 g/ft ^{2} of biomass at 8 weeks. Biomass production increased between weeks 8 and 10 for all rates except the 44 lb rate. Increasing the seeding rate of Japanese millet significantly reduced weed biomass at 6, 8 and 10 weeks, with the 44 lb rate consistently having the least weeds, and the 11 lb rate having the most. Seeding rate did not have any effect on sunn hemp biomass production.

Conclusions

Teff seeded at 7-9 pounds per acre is effective if seeded from mid June through July. Teff's ability to suppress weeds is comparable to buckwheat, with the added advantage that teff can be mowed or grazed at any time after establishment. In addition teff will not mature seed under New England conditions, so will not become a weed. While a 50 lb bag of teff seed costs significantly more than a 50 lb bag of buckwheat seed, the much lower seeding rate for teff means that the cost per acre is much less. Japanese millet has the potential to be a valuable high biomass cover crop, but it needs to be seeded at a minimum of 33 lbs per acre, and higher rates would further improve weed suppression. Sunn hemp does not appear to be a viable option under Rhode Island conditions due to our relatively cool summers. It may be useful in more inland areas of New England where summers are hotter. Chickling vetch may be a useful summer legume, but it needs to be tested at a greater range of seeding dates.

Impacts of Farm Management Upon Arbuscular Mycorrhizal Fungi and Production and Utilization of Inoculum

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Introduction to arbuscular mycorrhizal fungi

Arbuscular mycorrhizal [AM] fungi are naturally-occurring soil fungi that form a mutualistic symbiosis with the roots of most crop plants. The plant benefits through increased: nutrient uptake from the soil, disease resistance, and water stress resistance. Other benefits to crop production and agricultural sustainability arising from the symbiosis include increased stability of soil aggregates and increased sequestration of carbon in the soil due to the actions and secretions of the fungi. The fungi benefit through receipt of sugar from the host plant's roots. AM fungi are totally dependent on this source of sugar ("fixed carbon") and are unable to complete their life cycle or grow independently without colonizing a root.

The primary benefit to plant growth arising from the formation of the mycorrhiza (a root colonized by AM fungi) is enhanced uptake of phosphorus. Phosphorus [P] is categorized as a nutrient that is immobile in the soil solution. Roots that are not colonized by AM fungi can take up P only from the volume of soil explored by the root hairs- only 1 mm or so out from the root surface. Roots that are colonized by AM fungi have the "extraradical" hyphae of the fungus (the strands of the fungi that extend out from the root) growing out to upward of 15 cm from the root surface. These hyphae explore a much greater volume of soil, taking up P and transporting it back to "intraradical" structures of the fungi for release to the root cells. This aspect of the symbiosis explains the frequent observation that positive responses of plant growth to inoculation with AM fungi are more likely in low nutrient, especially P, soils. In high nutrient soils, or horticultural situations with frequent nutrient additions, roots may find all the nutrients the plant needs within the root hair zone.

Management and utilization of AM fungi

Given the above-mentioned benefits of the AM symbiosis, optimal utilization of AM fungi is essential for the long term sustainability of agricultural systems. Farmers have two basic options in this regard:

1) better utilize the AM fungus community indigenous to their soils, and
2) inoculate with effective strains of AM fungi.

These two options also basically divide farmers into two groups. Row crop farmers and others that sow seeds of crops in the field are better off managing and utilizing their indigenous AM fungi. Ways that this can be done will be given below. Vegetable and horticulture crop farmers who grow seedlings in a greenhouse prior to outplanting can efficiently use inoculum of AM fungi. This division is readily explained by both practical and biological reasons. Inoculation of field crops, such as corn, requires sufficient inoculum to effectively supplement/compete with the native population. This can become economically infeasible especially considering the low value of each plant. On the other hand, vegetable growers who produce seedlings for outplanting can readily and economically mix AM fungus inoculum into the horticultural potting media for growth of the seedlings.

1. Management of the native population of AM fungi

Many agricultural practices developed to enhance sustainability also have beneficial effects upon AM fungi. Often these could have been predicted with a little prior knowledge of the biology of AM fungi.

a) Use of overwintering cover crops. Inclusion of overwintering cover crops in a crop rotation has been shown to increase the population of AM fungi in the soil. Though this management practice was developed to retard soil erosion, replenish/retain soil nutrients (especially N), control weeds, and add to soil organic matter, it also provides host plants for the AM fungi to colonize and from which to receive sugar for growth and reproduction. Just one cycle of an overwintering cover crop of hairy vetch was shown to increase the AM fungus population in the soil. *Brassica* cover crops, however, are not hosts for AM fungi and although there are other good reasons for using them at times, they will not have this beneficial effect.

b) Reducing tillage. By the time of crop senescence and harvest, a substantial network of extraradical hyphae (the fine threads of the fungi, extending out from the colonized roots) has developed. Subsequent tillage in preparation for sowing the next crop disrupts this network. Broken pieces of AM fungus hyphae are very poor propagules, and are largely incapable of colonizing roots of the next crop plant. No-till is encouraged to retard soil erosion and build soil organic matter, but it also leaves the AM fungus hyphal network intact, allowing for more rapid colonization of the next crop.

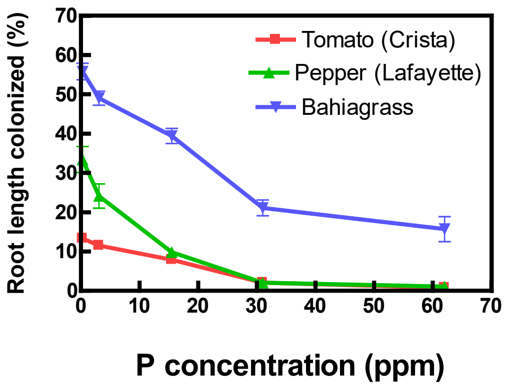
c) Crop rotation. The AM fungus community in an agricultural soil can contain several dozen species, and those that reproduce best on a particular crop are not necessarily those that enhance its growth. This means AM fungi can contribute to the reduced yields characteristic of continuous monocultures. Crop rotations were developed for disease management and their impact upon yield, but they also serve to guard against buildup of populations of ineffective AM fungi.

2. Inoculation with effective isolates of AM fungi

The goal of the use of AM fungus inoculum in the greenhouse is to produce seedlings with established AM fungus colonization, ready to take advantage of the symbiosis upon outplanting, rather than have to wait 1-2 weeks for colonization by the indigenous fungi in the field. Inocula are available commercially either in concentrated form or already incorporated into potting media. Inoculum of the AM fungus community indigenous to the farm can be produced on-farm. Independent of which inocula you use, certain considerations or precautions apply.

a) Inoculate only plants that are susceptible to AM fungus colonization. There are plant families, notably the Brassicas and Amaranthaceae, eg. broccoli and sugar beet, which do not become mycorrhizal ("nonmycotrophic").

b) Adjust your greenhouse nutrient regime. Plants respond to high levels of nutrients, notably P, by inhibiting colonization by AM fungi. The P level at which this occurs varies by plant, but usually is greater than 10 ppm (see figure). Lower the P and keep other nutrients the same. Growth will likely be about the same.



On-farm production of AM fungus inoculum

Inoculum of AM fungi can be produced on-farm in mixtures of compost and vermiculite with bahiagrass (*Paspalum notatum* Flugge) as the nurse host plant (see resource A(3), below). Briefly, after the threat of frost has passed, plastic bags (7 Gallon "Grow Bags", Worm's Way, Bloomington, IN 47404) are three fourths filled with a 1:4 [volume basis] mixture of screened compost and vermiculite, respectively. One to two hundred cm^3 (approx. 0.5 to 1 cup) of sieved soil (the "starter inoculum"), collected from the surface 10 cm (4 in.) of a field with a diverse plant community, is then added and mixed into the bag. Five *P. notatum* seedlings then are transplanted into the bags. Bags are weeded and watered as needed throughout the growing season, with no supplemental fertilization needed. The roots become colonized and proliferate throughout the bag, as do the AM fungi originally present in the soil. The *P. notatum* host plants are winter killed, and the AM fungi over winter outdoors in the growth medium. The following spring, the compost and vermiculite mixtures, now containing propagules of AM fungi, are thoroughly mixed into horticultural potting media at a rate typically of 1:9 inoculum to potting media (volume basis). Demonstration of this method at cooperating farms has produced an average of 300 propagules cm^{-3} over 40 site years (see resource C, below).

So far, inocula produced by this method have been shown to increase the yield of strawberries, potatoes, peppers, leeks, and sweet potatoes (see resource B, below).

Resources:

A. On the Rodale Institute website:
http://newfarm.rodaleinstitute.org/depts/NFfield_trials/0903/factsheet_mycorrhiza.shtml
http://newfarm.rodaleinstitute.org/depts/NFfield_trials/0604/factsheet.shtml
http://rodaleinstitute.org/2010/a-complete-how-to-on-farm-am-fungus-inoculum-production

B. To find reprints of the research papers that give more details on what was presented, search the ERRC Publications page (accessible on the Internet, does not require VPN): http://wyndmoor.errc.ars.usda.gov/pubs/ and type "Douds" into the author box. (or just contact me directly)

C. See also our article in the Journal of the National Assoc. of County Agriculture Agents: On-farm production of arbuscular mycorrhizal fungus inoculum in compost and vermiculite mixtures: results of on-farm demonstrations and impact of compost microbiological quality. Vol 7, issue 2, Dec 2014.

Building Better Soils Through Soil Health Management

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Soil health, or the capacity of the soil to function, is critical to human survival. Soil health constraints beyond nutrient limitations and excesses currently limit agroecosystem productivity and sustainability, resilience to drought and extreme rainfall, and progress in soil and water conservation. With mounting pressure to produce food, feed, fiber, and even fuel for an increasing population, soil health is gaining national and international attention. Research on both assessment and management of soil health, and farmers' innovations in soil health management approaches have matured over the decades. Multiple regional, national, and global efforts are now leveraging that work to reach new stakeholder audiences, so that soil health management is expanding into mainstream agriculture. Public recognition of the critical importance of maintaining and rebuilding healthy soils for long term sustainable agricultural production is growing. But while much progress has been made, there is much more to be done.

Each grower is generally faced with a unique situation in the choice of management options to address soil health constraints and each system affords its own set of opportunities or limitations to soil management. A more comprehensive understanding of soil health status can better guide farmers' soil management decisions. Until recently however, there has not been a formalized decision making process for implementing a soil health management system that alleviates field-specific constrains identified through standard measurements and then maintains improved soil health. To that end, we created a framework for developing Soil Health Management Plans (SHMP) for a farm operation.

This framework includes:

- Six general steps for the planning and implementation process.
- Within the six steps, a Comprehensive Assessment of Soil Health report that explicitly provides initial interpretation, prioritization, and management suggestions, from which a SHMP can be developed (Figure 1).
- A detailed listing of management suggestions specific to each indicator showing constrained soil functioning, and relevant NRCS cost-shared practices that could be applied to address the resource concerns identified through a soil health assessment.
- A pilot SHMP template for such plans that includes purpose, site information, assessment results and interpretation, and planned practices via a multi-year management calendar outlining a specific plan for each field.

Our Comprehensive Assessment of Soil Health report is an integral part of the Cornell Soil Health Management Planning and Implementation Framework. The Assessment is available to the public on a fee-for-service basis, and measures indicators of agronomically and environmentally important soil processes that then uses scoring functions to interpret measured results in the context of soil conditions and management options (http://soilhealth.cals.cornell.edu/). The process is designed to alleviate field-specific constraints identified through the Assessment, and then maintain improved soil health over time. The process links specific constraints (e.g., low aggregate stability) to management solutions (e.g., cover cropping, organic matter additions, reduced tillage) through a farmer-centered decision process. Constraints identified in the assessment are then prioritized and specific management strategies are developed to address quantified soil health constraints. This step is critical to creating workable management plans. Land managers can monitor changes over time through further assessment, and adapt management practices to achieve chosen goals. In essence, the Assessment expands a well understood approach that has been foundational to high agricultural productivity. Just as standard soil testing has informed nutrient management based on identified deficiencies and excesses since the 1900s, the Assessment developed here, similarly, identifies constraints to biological and physical soil functioning.

The current (2015) version of the Comprehensive Assessment of Soil Health and its interpretive scoring was developed for the Northeastern United States. However, the concepts, framework and indicators for the Assessment and management planning can be expanded and adapted for national and global applications. The most relevant components of the framework are 1) measurement of indicators that represent critical soil processes, 2) scoring of measured values that allows for interpretation, and 3) linkage of identified constraints with management practices. The main benefit of this approach is that the identification of physical, biological and chemical constraints prompts farmers to seek improved - more sustainable - soil and crop management practices. We hope that this framework will evolve and be used widely to measure and monitor soil health status, so that better understanding can lead to better, regenerative, and sustainable management of soils through holistic, adaptive, and data-driven approaches.

Links:

Soil Health Testing

Cornell Comprehensive Assessment of Soil Health:
http://soilhealth.cals.cornell.edu/extension/test.htm

Soil Health Management

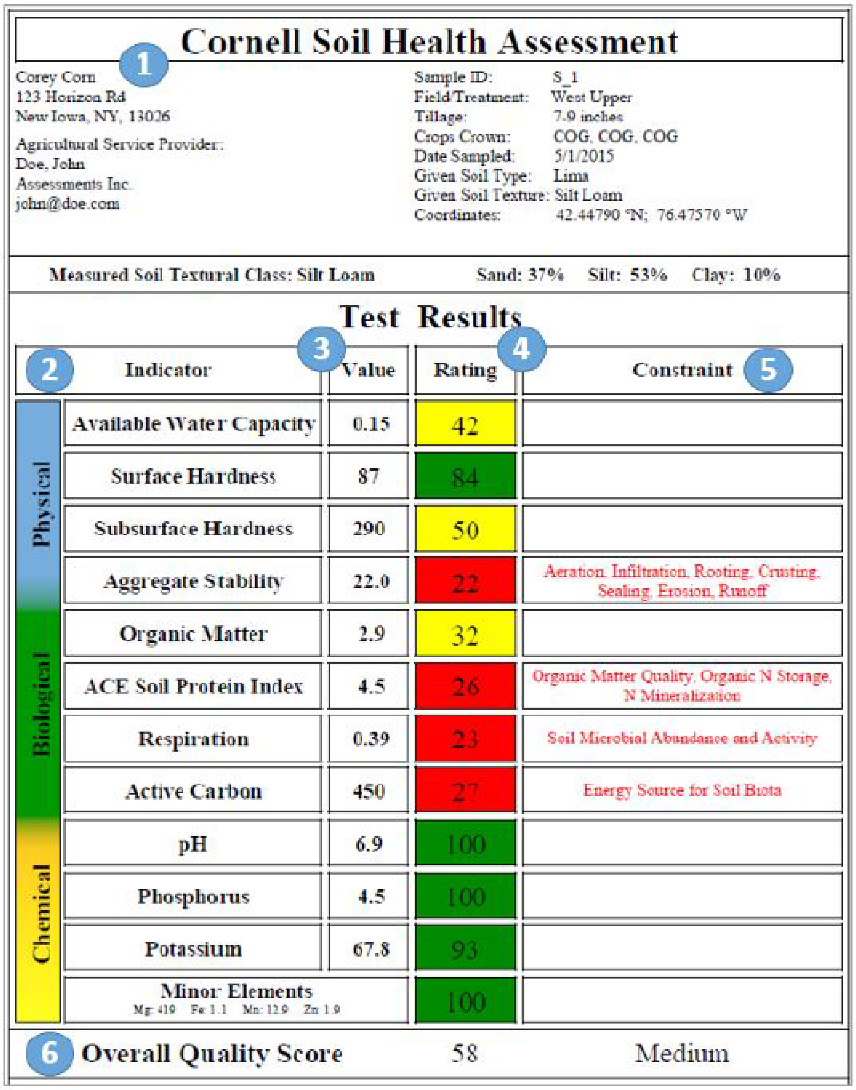
Comprehensive Assessment of Soil Health – The Cornell Framework Manual:
http://soilhealth.cals.cornell.edu/extension/manual.htm

Soil Health Text Book:
http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition

Berry Soil and Nutrient Management:
http://www.sare.org/content/download/74320/1253195/BerrySoilandNutrientManagementGuide.pdf

Soil Heavy Metal Contaminants Testing Factsheets:

http://cwmi.css.cornell.edu/sourcesandimpacts.pdf
http://cwmi.css.cornell.edu/guidetosoil.pdf
http://cwmi.css.cornell.edu/Soil_Contaminants.pdf



Cornell Soil Health Assessment

Corey Corn
123 Horizon Rd
New Iowa, NY, 13026

Agricultural Service Provider:
Doe, John
Assessments Inc.
john@doe.com

Sample ID: S_1
Field/Treatment: West Upper
Tillage: 7-9 inches
Crops Grown: COG, COG, COG
Date Sampled: 5/1/2015
Given Soil Type: Lima
Given Soil Texture: Silt Loam
Coordinates: 42.44790 °N; 76.47570 °W

Measured Soil Textural Class: Silt Loam   Sand: 37%   Silt: 53%   Clay: 10%

Test Results

	Indicator	Value	Rating	Constraint
Physical	Available Water Capacity	0.15	42	
Physical	Surface Hardness	87	84	
Physical	Subsurface Hardness	290	50	
Physical	Aggregate Stability	22.0	22	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
Biological	Organic Matter	2.9	32	
Biological	ACE Soil Protein Index	4.5	26	Organic Matter Quality, Organic N Storage, N Mineralization
Biological	Respiration	0.39	23	Soil Microbial Abundance and Activity
Biological	Active Carbon	450	27	Energy Source for Soil Biota
Chemical	pH	6.9	100	
Chemical	Phosphorus	4.5	100	
Chemical	Potassium	67.8	93	
Chemical	Minor Elements (Mg: 419 Fe: 1.1 Mn: 12.9 Zn: 1.9)		100	
	Overall Quality Score		58	Medium

Figure 2. Sample Comprehensive Assessment of Soil Health Report with (1) Background info. (2) Measured indicators, (3) Indicator value, (4) Rating, (5) Constraints and (6) Overall quality score.

The Comprehensive Assessment of Soil Health Report

Measured values, interpretive ratings, and constraints identified by soil health indicators are synthesized in an auto-generated and grower-friendly report to present information to growers and agricultural service providers. Background information about sample location and management history from the submission form are combined with the raw data from the individual indicator tests. The information is presented in a summary page, above, followed by a short narrative description of each indicator's importance, status and suggestions for targeted management (not shown).

Building a Bigger Orchard – An Overview of the US Hard Cider Market

Jon London
Angry Orchard Hard Cider

This discussion will focus on the state of the US Hard Cider market. We will discuss the growth of the category and the reasons behind it. We will look at how the category has evolved, its relative size vs. other beer categories, and how big it may potentially become. We'll review hard cider trends across the country and specifically what geographies overindex the most in terms of cider development. We'll review who is drinking hard cider, what they're trading out as they increase their consumption of cider, and what some of the threats to cider are. We'll also discuss why hard cider has such strong appeal.

Bittersweet Fruit & English Cider-Making

Neil Macdonald
Orchard Park Farms
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www.orchardparkfarms.com

Over the past decade few agricultural enterprises have seen growth to match that of the UK cider industry. In 2006 cider was 1.2% of UK total alcohol sales; by 2012 it had risen to 9.4% and has since remained stable. Furthermore, in 2012 over 70% of all global cider was made and consumed in the UK; in 2015 it was less than 43%, demonstrating the huge growth in the global popularity of cider.

Global consumption of cider is predicted to grow by around 5% a year, from a 2015 level of 2.4bn litres to more than 3bn litres by 2020, with some 70% of the extra consumption expected to come from the US, Australia and South Africa. In the US the forecast is for growth of 12% per year up to 2020.

If the popularity of cider in both the UK and the rest of the world continues then it will require an increase in raw ingredients. The global consumer is recognising that cider apples are a key ingredient of the popularity of the product. There is currently an undersupply globally.

- How can modern methods of apple production be applied to meet this global demand?
- What apples do the cider-makers want, and why?
- What are the economic and environmental issues of growing cider apples?

In the UK, although a lot of cider is made without cider apples, the categories in growth are those using a percentage of bittersweet fruit. Tradition and culture are important to cider, but why is bittersweet fruit important to cider? And if the economics of growing cider apples are not great what are the varieties, the methods and the processes by which we have combated this in the UK?

We will be discussing orchard size, apple varieties, growing methods, treatments, mechanisation, plant & equipment and organisational structure. We will review the place of concentrate in the development of the industry in the US and the opportunities offered by strategic partnerships and cooperative ventures.

Neil Macdonald is a current Nuffield Agricultural Scholar whose scholarship travels have taken him to Australasia, America and Europe to research his topic. This presentation offers some insights into his findings on the state of the industry globally.

Considerations in Designing & Establishing a Cider Orchard

Gregory Peck, Ph.D. Assistant Professor of Sustainable Fruit Production Systems
Cornell University, Horticulture Section, gmp32@cornell.edu

The U.S. Alcohol and Tobacco Tax and Trade Bureau reported that in 2014 over 54 million gallons of hard cider were sold in the U.S. A substantial, but unknown amount of this cider was produced using apples grown in the U.S. This volume of cider would require approximately 6.1 million bushels (256 million pounds) of apples, equivalent to 2.7% of the U.S. apple crop. If the recent 75% per annum growth in cider production continues, the cider industry could be using an equivalent of nearly 10% of all apples currently produced in the U.S by 2018. The potential value of these apples is $332 million. Currently, there are 55 cider producers in New England (by state: ME=9, NH=6, VT=16, RI=1, and MA=23) (www.cydermarket.com). Increased cider production could create new opportunities for New England's apple growers, allowing for orchard expansion and diversification, as well as increased profitability. A 2012 survey conducted in Virginia found that one-third of the Virginia cider makers were willing to pay 20% more and two-thirds were willing to pay 50% more for European cider apples than the average price they were paying for culinary apples. Anecdotally, apple growers in the Finger Lakes region of New York are reportedly selling European cider apples for upwards of $40 per bushel.

However, many of the specialized European cider cultivars that are desired by cider producers have been selected for their fruit and juice quality more so than their horticultural performance, and thus present production challenges to commercial apple growers. Some of the known issues with European cider varieties include biennial bearing, susceptibility to fireblight, susceptibility to powdery mildew, pre-mature fruit drop, overly vigorous growth, and production of extensive blind wood (shoots with few or no flower buds).

So, what kind of planting system is best for growing cider apples? In many apple production regions of the U.S., there has been a dramatic shift towards growing fresh market varieties in high-density orchards using dwarfing rootstock with trellis systems. The benefits of these intensive apple production systems are clear: greater precocity, better fruit quality, less biennial bearing, better spray coverage, and greater labor efficiency. These factors all lead to greater profitability. Will the benefits that have been found for growing culinary apples in high-density orchards convey to cider apples? I suggest that the answer is most likely yes. In fact, many cider apple growers in Europe now use high-density systems. However, installation costs of $15,000 to $25,000 per acre mean that cider apple growers need to carefully consider the pros and cons of using high-density orchard systems.

While the consumption of hard cider has grown astronomically in recent years, and major marketing firms predict a continued growth for the next decade, there is no guarantee that these consumer trends will continue. An orchard is a 20-25 year investment and growers will have to weigh the risk of planting varieties that have not been widely grown or objectively evaluated in New England. Additionally, apple growers will have to weight the potential lost opportunity costs if cider consumption trends falter.

Some general recommendations:

- Plant orchards in horticulturally desirable sites
  - Meaning sites with excellent sun exposure, air drainage, well-drained soils, etc.
  - At $15K+ per acre for installation, all but the best sites are going to give less than desirable results
- Use precocious rootstocks that are disease resistant
  - There are several Geneva stocks that will have a mature tree size between M.9 and M.26, but have greater resistance to soil-borne diseases, replant disease, and fireblight
- Use varieties that are going to produce annually and have some level of disease resistance
  - European? American? Traditional New England?
  - Talk to your customers to understand their needs
  - See some suggestions in the below resources
- Use plant growth regulators for:
  - Thinning, increasing return bloom, minimizing pre-harvest drop, and, if harvesting from the ground, fruit loosening
- What's most important to you (if you're producing your own cider) and/or your buyer (if you're selling fruit to a cidery)?
  - Fruit with high tannin content? High yields? Labor efficiency? Organic?
- Do your homework, an orchard is a 25-year-long investment

Resources

General Information

Miles, C., Moulton, G., King, J., & Foren A. (2008). WSU fruit horticulture program. Retrieved from: http://maritimefruit.wsu.edu/.

Peck, G. (2012). *Hard cider production in Virginia*. Retrieved from: http://www.arec.vaes.vt.edu/alson-h-smith/treefruit/horticulture/hard-cider/.

Peck, G., Miles, C., King, J., Bradshaw, T., Rothwell, N., & Merwin, I. (2014). An introduction to hard cider in the U.S. *eXtension*. Retrieved from: http://www.extension.org/pages/70601/an-introduction-to-hard-cider-in-the-us#.U438Wibn-Ul.

Cost of Producing Cider Apples

Farris, J., Peck, G., & Groover, G. (2013). *Assessing the economic feasibility of growing specialized apple cultivars for sale to commercial hard cider producers.* Virginia Cooperative Extension publication AREC-46-P. 15 p.

Galinato, S.P., Gallardo, K., & Miles, C. (2014). *Cost estimates of establishing a cider orchard in western Washington*. Washington State University Extension publication FS141E, 6 p.

Cider Apple Variety Information

Miles, C., King, J., & Peck, G. (2015). Commonly Grown Cider Apples In the U.S. Washington State University CIDER Report #2. Retrieved from: www.wsu.edu/maritimefruit/hard-cider/.

Merwin, I.A. (2015). Growing Apples for Craft Ciders. New York Fruit Quarterly 23(1):5-9. Retrieved from: http://www.nyshs.org/fq.php.

National Hard Cider Conference: www.ciderconference.com

U.S. Association of Cider Makers (USACM): www.ciderassociation.org

Cider Apple Research in Vermont

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(Hard) cider production has increased rapidly in the U.S., with an annualized growth rate of about 50% between 2009 and 2014. This growth has been experienced at all scales, from the large national and international brands to smaller regional and local products. In order to meet growing demand for their products, cideries are thirsty for fruit, which represents a significant market expansion opportunity for New England apple growers. The diversity of scales and product offerings from cideries has translated into demand for several different categories of fruit. Until recently, growers and technical support providers have worked diligently to *avoid* growing cider apples, because the traditional outlet for lower-grade fruit was to (non-fermented) juice processors and relatively low prices paid for those fruit did not support growing specifically for that market. Given changes in the marketplace for hard cider apples, research supporting cider apple production recently began in Vermont and other cooperating states. Given the long-term nature of apple production, this field of study is expected to yield results over the years and decades to come. The information contained herein represents early findings and directions for current and future research.

Apple cultivars

Cider may be made from a wide variety of apple cultivars with finished products presented at differing price points. Three main categories of apple cultivars are purchased by cideries:

1) Traditional dessert cultivars (e.g. 'McIntosh', 'Cortland') from packing house culls, orchard-run hail or otherwise damaged fruit, or intentionally managed (reduced-input) cider orchards. These fruit are widely available but prices are the lowest at $4.00-7.50 per bushel as reported in a 2014 survey of Vermont orchards and cideries.
2) Specialty cider apples, often of European descent (e.g. 'Dabinett', 'Yarlington Mill') or North American crabapple types (e.g. 'Wickson', 'Hewes'), that have unique flavor, acid, and phenolic characteristics suited for making high-quality ciders. These fruit command the highest price of $15-25 per bushel but are planted in limited quantities. Horticultural management and cultivar adaptation to the local soils and climate are not fully understood for these cultivars, which presents an area for long-term evaluation. Because these fruit typically have low eating, storing, and/or processing (other than cider) qualities, there may be market risk in planting them if a suitable cider market cannot be found or if local supply begins to outpace demand.
3) Dual-purpose cultivars that have suitable juice quality characteristics (e.g. 'Northern Spy', 'Golden Russet') and which may be sold to both fresh and cider markets depending on quality and market access. Local markets for these fruit may be saturated or require development in many areas, and horticultural parameters such as low precocity, biennialism, and low yield may limit their suitability in New England orchards.

Planting systems

Much debate has occurred in Europe over decades on the topic of large (standard) vs small (semidwarf) rootstocks and training intensity for cider apples. The concept of planting at lower tree densities is at odds with the direction of the New England dessert apple market toward high density, intensively managed orchards. Some New England growers are planting high-value European cider apples in high density planting systems in order to achieve early production and capture strong fruit prices; others are planting lower-density cider orchards to reduce installation costs and potentially improve juice quality. The prospect of mechanical harvest is important to consider when planting cider orchards. At present, essentially no mechanical harvest systems are used in the U.S. as they are in Europe, and differing training systems would require different harvest machines, each at considerable cost to the grower. Questions remain about what planting systems are ideal for cider production in New England. Because of the lack of replicated trees represented in each orchard in New England, research will continue for a decade or more to answer those questions.

Pest management

If apples are being grown for processing into cider, the cosmetic quality of the fruit is of less concern, which presents opportunities to reduce pest management inputs and production costs. We have begun to evaluate pest management programs on scab-resistant cultivars in order to produce fruit with desired cider qualities that may be grown at in low-input systems. Reduction of pest sprays may be an important management tool to reduce production costs and meet lower price points for dessert cultivars grown in cider orchards compared to the fresh market. This may be a tempting strategy for growers, but purchase agreements should be in-hand at the beginning of the season to prevent growing unmarketable fruit in the event that a cider buyer is not found or prices paid are too low to justify change in management.

Economics

Evaluating the costs and returns for producing cider apples is critical to frame production methods, management, cultivar and rootstock choices. Results from a 2014 survey of Vermont apple growers and cideries include:

•Vermont growers see opportunity in the growth in popularity of hard cider; but receiving adequate prices was identified as a key threat. On average, the prices they receive are below target prices for all markets.

•Cideries see opportunity in the growth of hard cider's popularity, and increase in quality. Maintaining adequate fruit supply was identified as a major risk. Cideries pay an average price above the growers' mean target price for specialty cider apples but lower than the growers' target price for dessert apples.

•Cideries and apples growers have both expressed interest in dual purpose cultivars for cider making. Apple growers have expressed limited interest in growing specialty cider cultivars even while cider makers have expressed strong interest in purchasing those fruit. Planting new apple cultivars is a long-term investment and commitment that apple growers most likely will not do unless they have the assurance that cideries will buy the apples when the trees start producing. This might imply entering into more formal agreements such as long-term contracts that are not commonly used at present.

Cost of production assessments will be completed this winter with participating growers and data used to model market opportunities and potential profitability.

Juice quality

All cider apple research within our program is correlated to juice quality, and each cultivar, planting system, and pest management program is being evaluated for effects on potential cider making characteristics. A database of cultivar juice characteristics is being developed in order to evaluate those parameters and their effects on cider quality over multiple seasons. In addition, sample fermentations are being conducted of select cultivars each year in order to evaluate final effects on cider quality.

Sample 2014 juice lab data

Cultivar	Soluble solids (°brix)	pH	Malic acid (mg/l)	Total polyphenols (%)	YAN
Ashmead's Kernel	17.6	3.25	10.40	0.075	262.4
Cortland	11.2	3.43	4.74	0.047	45.1
Dabinet	13.1	4.13	1.88	0.109	60.6
Esopus Spitzenburg	15.3	3.48	7.10	0.035	113.4
Honeycrisp	12.6	3.52	4.97	0.027	85.0
Idared	10.8	3.29	5.98	0.017	15.5
Jonagold	12.3	3.40	5.12	0.021	38.6
Liberty	11.5	3.45	5.72	0.018	56.7
Macoun	11.7	3.47	4.17	0.021	65.1
McIntosh	11.7	3.25	5.48	0.036	30.1
PaulaRed	11.0	3.40	4.45	0.050	30.4
Topaz	12.4	3.35	9.86	0.056	16.1
Wickson	13.9	3.40	11.94	0.018	53.3

Values represent sample data collected from multiple Vermont Orchards in 2014. YAN = yeast assimilable nitrogen.

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Innovations in Mechanical Harvest for Cider Apples

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Cider, also referred to as 'hard cider,' is fermented apple juice and is the fastest growing segment of the liquor industry in the U.S. today. There was a 65% increase in production each year from 2008 to 2014; in 2008, 2.3 million liters of cider were produced and this increased 30-fold to 69.3 million liters in 2014. There is a need to develop cost effective, efficient, and high yielding orchard systems to supply fruit for the expanding cider market in the U.S.

The cost of hand harvest of cider apples accounted for 30% of the total annual orcharding costs in a study in western Washington. This result indicates that reducing harvest costs could improve profitability of cider orchards in the U.S. In this two-year study (2011 and 2012) we compared a mechanical over-the-row 'shake and catch' small fruit harvester to hand harvest for cider variety 'Brown Snout' grafted onto Malling 27 (M.27) and East Malling/Long Ashton 9 (EMLA9) grown on a low trellis. We compared weight of harvested fruit, labor hours for harvest, tree and fruit damage, and fruit and juice quality characteristics for machine and hand harvest.

Methods

The orchard for this study was established in 2002 at Washington State University Northwestern Washington Research and Extension Center (WSU NWREC) at Mount Vernon. 'Brown Snout' cider apple was planted at 16-ft between-row and 4-ft in-row spacing. Orchard planting density was 680 trees per acre. Between-row spacing was wider than commonly used in commercial orchards to accommodate potential unknown needs for mechanical harvest. Trees were trained to a three-wire trellis system with post height of 6.5 ft. The lowest wire was 2 ft above the soil surface to accommodate the catch plate of the mechanical harvester. In 2011, tree limbs were attached tightly to the trellis wires and were pruned to maintain a narrow canopy, whereas in 2012 limb attachment to the trellis wires was loosened and pruning was adjusted to widen the canopy so that the harvester shaker bars could more readily shake the fruit off the trees.

Fruit was harvested when fully ripe, on 25 Oct. in 2011 and 17 Oct. in 2012. Hand harvest was done by four unskilled agricultural workers who were not specialized in apple picking. Machine harvest was done with an over-the-row small fruit harvester (model OR0012; Littau Harvester, Lyndon, WA) operated by an experienced harvester driver. In addition, two unskilled agricultural workers moved fruit from the machine harvest belt into totes on top of the harvester. Hand harvest plots were picked first, then respective plots were picked with the machine harvester.

All ground falls were first removed from the orchard. For hand harvest plots, fruit were picked from trees and any fruit that fell to the ground during picking were picked up and included in the total yield, following common grower practices as groundfalls can be used to make cider. For machine harvest plots, fruit was harvested with the over-the-row harvester, and the fruit weight was recorded. All fruit remaining on trees following machine harvest as well as fruit that fell to the ground during harvest were picked and weighed together, and were considered to be clean-up fruit weight. The number of labor-hours required to pick each plot was recorded, and the cost of labor per acre was calculated based on wage rates paid by local growers for similar work: $18 per hour for hand harvest and fruit handling on the mechanical harvester, and $22 per hour for driving the harvester (both rates included applicable taxes and benefits).

Both years, one box of fruit per plot was assessed immediately after harvest. For stored fruit, one box per plot was assessed after 3 weeks of storage in 2011, while in 2012, one box per plot was assessed after 2 weeks of storage and one box per plot was assessed after 4 weeks of storage. Fruit were stored in the same facility both years at 32 ºF. Each box of fruit was milled and pressed in a basket cider press. A 500 mL sample was collected from the juice of each plot, placed in a plastic bottle, and frozen (5 ºF) until all samples had been pressed. Juice samples were then thawed to room temperature (74 ºF) and assayed for soluble solid content (measured by Brix), pH, specific gravity, titratable acidity, and tannins.

Results and Discussion

There were significant differences between years for most of the parameters measured, however there were no significant differences due to rootstock or interactions between year and rootstock for any of the parameters measured. On average, harvest weight was 11,319 lb per acre for hand harvest and 7,812 lb per acre for machine harvest, a mechanical harvest efficiency of 70%. When weight of fruit that was left on trees or fallen to the ground after machine harvest (clean-up fruit weight) was added, mechanical harvest weight increased to 9,998 lb per acre overall, and harvest efficiency increased to 88%. A training system more like a fruiting wall may optimize fruit yield with an over-the-row 'shake and catch' harvester. Netting could be added to the front and back of the harvester to prevent fruit from bouncing out after it drops onto the catchplate. Yield of 'Brown Snout' was reduced because tree density in this study (680 trees per acre) was 38% lower than the recommended density for a similar training style (1100 trees per acre). Additionally, tree height was low (6.5 ft) to allow the machine harvester to pass over the row, and this further limited yield. An over-the-row machine harvester for trees that are 10-12 ft tall would be a better option to optimize apple yield.

The number of labor-hours per acre for hand harvest was eight times greater than for machine harvest in 2011 and was two times greater in 2012. Hand harvest labor-hours were three times greater in 2011 than in 2012 due to heavier fruit set and higher yields in 2011. On average for the 2 years, hand harvest required 23 labor-hours per acre while machine harvest required 5 labor-hours per acre. Generally, the 2-year average cost per acre for harvest labor was four times greater for hand harvest ($417) than for machine harvest ($93). In this study, harvest was done by general orchard workers and not by experienced fruit pickers. The number of labor hours for hand harvest with an experienced apple picking crew would likely be less than the number measured in this study, while the number of labor hours for machine harvest would likely be similar.

There were no significant differences due to harvest method for Brix, pH, specific gravity, titratable acidity, or tannins of fruit pressed immediately after harvest or after 2 to 4 weeks storage. When fruit was pressed after storage (3 weeks in 2011, 2 and 4 weeks in 2012), Brix and specific gravity of juice increased as compared to juice pressed immediately after harvest both years. For fruit that were stored, pH of juice tended to decline both years (0.01 pH units in 2011, 0.06-0.12 pH units in 2012), however this difference was significant only in 2012. Changes in juice sugar content and pH with storage followed expected trends, as starch breaks down into sugars, sugars become more concentrated due to dehydration, and fruit acidity increases due to respiration during storage. Machine harvested fruit were bruised and some fruit were also sliced and cut. Where fruit is stored outside or in open barns for up to 1 month before pressing ('sweating'), cut and sliced fruit are more prone to rot which causes off-flavors in the pressed juice. A current study is underway to assess fruit quality when mechanically harvested fruit are stored under ambient barn conditions.

The cost of an over-the-row harvester varies depending on manufacturer, year, model, wear-and-tear (if used or refurbished), and location. In general, cost ranges from $70,000 for used, refurbished models in good working order to $225,000 for a new custom built model. More information is needed to determine economic feasibility of over-the-row mechanical harvest of cider apples.

Farm Decisions: Scaling Up, or Not
"Understanding Economy of Scale - Honing In & Finding Your Place"

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I will share my experiences from a personal perspective through my story of what many call quick growth of a small farm. Through this context I will focus on the perspectives I have gained in growing our farm quickly. We have experienced several stages of scale and had it rear its ugly head numerous times. As a diversified organic vegetable operation with a limit on land availability and a strong market we have had a range of challenges. I will dig deep in my experiences that are fairly personal and my analysis of the profound conclusions I have come to. All of which were outside the realm of conventional wisdom and where I thought I was going with this career choice. I can focus on the aspects that really came about as my business grew quickly and the moves I couldn't for see as I moved up in scale.

I started my farm with market garden experience. We went from $48,000/year in sales to $515,000/year in the first five years. We had 10 full time employees, had 3 children in three of those years along the way, ~500 CSA members, a full farm store with over 100 SKU's including some value added. We started at nothing and grew to having a full farm operation quickly. All in all I still consider my business a small farm but have a very different point of view on growth then I did a few short seasons ago.

We started incorporating agro tourism & really pushing onsite retail through a farm store, some pick your own, and season extension. We quickly became a staple in our community. We grew rapidly and never slept. As our kids grew my wife's involvement became less and less. My monthly payroll costs were more than I had ever made in one year prior to my career in farming. Management became a monster, and wearing all the hats became overwhelming as owner operator.

In 2015 I made huge changes and honed in on what was really working in the business and what was not. I was up against everyone from staff, family, and customers; everyone thought I was crazy for making such drastic changes. We had a better bottom line profitability, and a new trajectory that wasn't at a constant tipping point. This is where we honed in. This is largely the context of my discussion; how I realized I have to slow down in order to speed up, what led to those decisions, what they were, and the experiences that followed.

Identifying who you are as a person, determining and understanding your logistics, taking your hard work ethic to your smart work ethic, understanding and working with capacities, changing yourself as your business changes, managing growth are all parts of the discussion.

Although all farms are unique to each situation many of the hurdles, and successes on our farm are common on most vegetable farms today. From growing rows of organic crops to farmers markets, farm stands, CSA's, labor, equipment, striving for net profits and quality of life.

Farms today exist in a variety of sizes. What one farmer calls a large operation another farmer may think is small. The details surrounding size are vast. The particular circumstances, available markets and resources, have everything to do with scale. As we make important decisions about growing our businesses often many variables surrounding management and actual logistics are overlooked due to our lack of experience. For some being a small farm doesn't make sense or vice versa. We may have pre dispositions as we thought we wanted to be this size or that size of a farm. Your economics and what you can do with your particular variables to make a profit determine that.

From equipment, to labor logistics, systems and procedures, often what you thought was smart is no longer the case as you scale up. Many concepts that flourish at a smaller scale are often illusive and misleading as we move up in size. More often than not a small issue can become very drastic at a slightly increased scale. So how do you make the move without the experience and survive the learning curve? I can share my trials and tribulations of just that.

It takes time and exploration to find out what works for your particular circumstance. There is no bulletproof rule to the ratios involved with scaling up. Some large general rules of thumb are available, but it is the unforeseeable details that really make it work or not. The economy of scale with in your farm is all about how you settle into it and make the most out of what you have and can actually accomplish.

I have always been seeking answers that only experience can give. Although growth was challenging it has been extremely rewarding in many areas of my life. It goes way beyond producing great healthy vegetables, and it is only partially about the money. My farm has been an interpersonal journey with expectations all over the place. Some have been met and exceeded beyond belief while others have been a big let down and created hurdles I never imagined. I was operating many economies of scale in different areas of my farm and not seeing the interconnectedness of it. I will share these experiences and what I had to do.

Everyone asks - To scale up or not?

This is not a question anyone can answer; there are so many variables that come into play. A decision of this magnitude can only be answered through deep evaluation of your logistics and circumstances that are unique to you as a person and your operation. I can tell you about my experience with no business background, no college education, and having little farming experience. I am a first generation farmer, and grew up in the city. I had an idealistic concept of growing healthy food and living the dream… ha…

We exploded and stepped confidently into many marketing areas that lead to a larger business than anticipated. Maintaining semblance as an operation internally was the meat of the matter.

For years I farmed year to year. All season the M.O. was “just get through the season we will figure it all out in winter”. Each year we took on more and more, we never had a break to figure it all out.

Some people invite change and flourish within it. Other’s find change so difficult and battle it all throughout its evolution. My story is a little bit of both.

Growth can be deceiving and hard to keep up with. Where to find balance points, where and when to evaluate them and dig deeply has everything to do with the health of your business.

Farming presents many challenges and is a job that is never done. We had to determine cut off points with what we were going to go after. It took time to push capacities to their max to realize I don’t want to do that. I went through an intense period of feeling very alone as my business grew faster than my people could keep up with. I had to change my management style and sometimes my personality in order to keep the business on track.

At the end of the day, regardless of your accomplishments, your farm is a business and must have profit.

For the first time in 2015 I was operating my business at its capacity of what it could produce while everything from systems, procedures, facilities and employees were not constantly pushed to the edge. I’m nowhere near out of the weeds; I’m still working just as hard, but getting smarter. This season was the light I’ve been looking for and it had nothing to do with weather. It’s fairly easy to be aggressive, think big and go all in. But pulling through without getting hurt and having a future is where it counts.

Nutrient Content, Availability, and Release Rates from Natural Fertilizers

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Organic farmers can supply nutrients to growing plants from a variety of sources: soil organic matter, animal manures, compost, cover crops, and a bewildering variety of purchased supplements such as blood meal, soy meal, alfalfa meal, and blended natural fertilizers. Most of these sources must go through microbial degradation to release nutrients in a plant-available form. Because of its biological nature, release rates are highly dependent on the complexity of the organic form, soil temperature, and to some extent soil moisture. Nitrogen is especially difficult to manage. Weather-dependent release rates and multiple loss pathways cause the overall complexity of nitrogen management from year to year. A number of laboratory studies have been conducted on natural/organic N sources. Limited work has been done on P and K release rates from natural fertilizers.

Most long-season crop plants take in the bulk of their total seasonal N requirement relatively early in the growth cycle. There is some crop to crop variability, but generally nitrogen uptake increases dramatically starting 3 – 4 weeks after planting. This concentrated uptake period will last for another 3 - 4 weeks, corresponding to the period of rapid height and foliar growth. It is imperative that there be an ample supply of plant-available N (PAN) during this 4 week uptake "window".

A number of studies looking at N mineralization from natural fertilizers have been conducted over the past 5 – 10 years in MI, CA, OR, and VT. These studies either looked at a very limited number of materials, or emphasized short-term release, or documented release rates at relatively warm soil temperature. In 2013, a nitrogen mineralization study was conducted at the University of Maine using a wide variety of locally-available natural N fertilizers, at low soil temperature, for an entire growing season. A field-moist soil was blended with feather meal, blood meal, soy meal, alfalfa meal, fish meal, corn gluten, broiler manure (Nutriwave), and blended natural fertilizers from North Country Organics, NatureSafe, Bradfield Organics, and Espoma. These were compared to 2 chemical N sources: urea and ammonium sulfate. All materials were mixed with soil to supply 100 ppm total N (200 lb/A) and incubated at 15 C (60 F) for 16 weeks. Plant available NO_3-N was measured at 1, 2, 4, 8, 12, and 16 weeks, to document N release rates for an entire growing season at the cooler soil temperatures common in the Northeast.

Chemical sources released the majority of PAN in only 2 – 4 weeks. N release from natural sources maximized at 4 – 8 weeks, better matching the crop uptake window for N. The early release of PAN from chemical sources, prior to crop uptake demand, leaves PAN much more susceptible to major losses from heavy rainfall events. The majority of natural materials studied had nearly identical release rates to blood meal, including feather and soy, traditionally considered to be slow release materials (Figure 1).

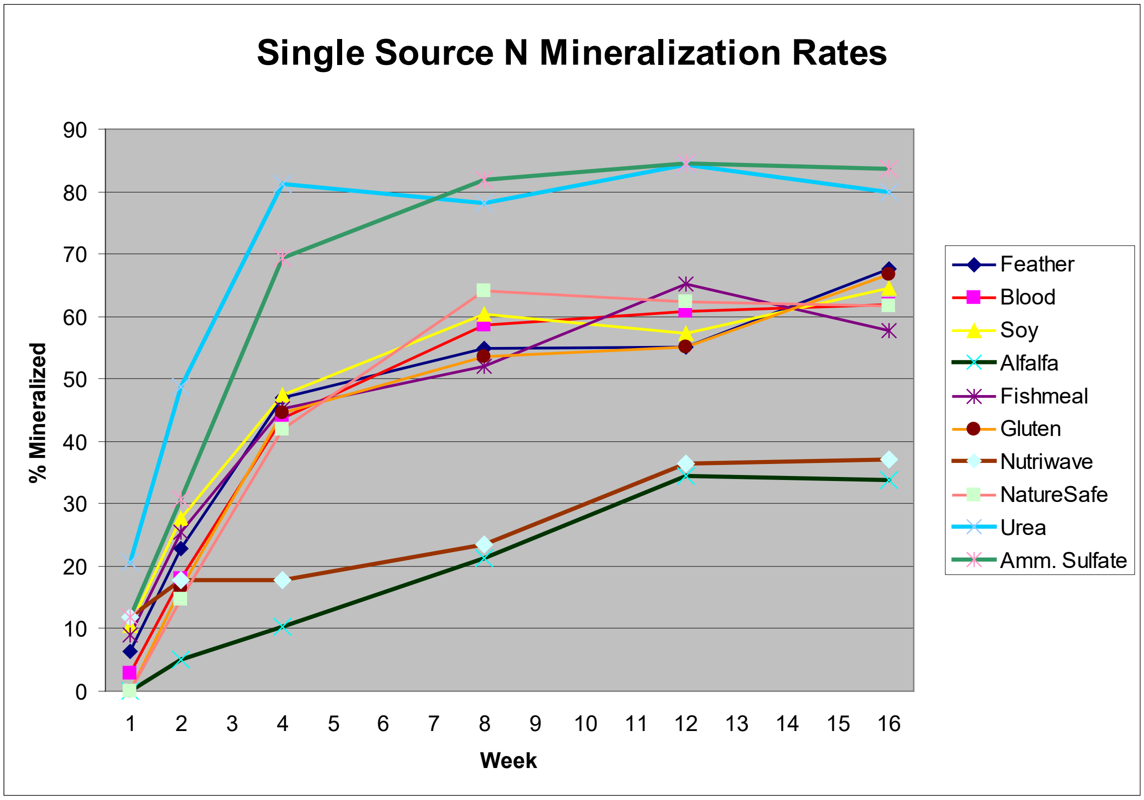

Figure 1. Nitrogen mineralization rates at 60 F soil temp. University of Maine, 2013.

Broiler manure and alfalfa meal exhibited a much slower N release rate than other single source materials. This can be attributed to the higher Carbon to Nitrogen (C:N) ratio of these materials. This effect was also documented by Heather Darby in a 2012 N-release study in VT. In both ME and VT studies, materials with a C:N ratio below 10:1 released relatively rapidly while those above 10:1 released more slowly. This was also observed in a very early (1942!) study at Rutgers. Blended fertilizers in the ME study exhibited N release rates between the rapid and slow rate groups, since they contain a variety of N sources meant to provide some rapid release and some slow release nitrogen.

N release from common materials used in ME, MI, OR, CA, and NJ all agreed very well. However, ME release rates in 8 weeks at 60 F were matched by the OR study in only 4 weeks at 72 F. In effect OR doubled ME N-mineralization rates by increasing soil temp by 12 F (7 C). This emphasizes the effect of soil temperature on N release from non-chemical sources. N release in warm soil later in the season will be much more rapid than in cool soil in spring. Likewise, N release will be more rapid in high tunnel production, with higher soil temperature, than in open field production.

N release from manures is also biologically mediated and is also affected by C:N ratio and soil temperature. Most manure sources have a significant portion of the total N content in the ammonium form, with the remainder being organic N. The ammonium-N will be converted to nitrate relatively quickly, usually in 2 – 4 weeks, and is considered to be immediately available. N release from the remaining organic fraction will be more gradual, generally about 50 % mineralized in 4 – 8 weeks depending on soil temp and C:N ratio. There is a well documented N

release from manure the second and even third year after application, though at a much diminished rate. Manure organic N release rates are from 25 – 55 % the first year, 10 – 12 % the second year, and 4 – 5 % the third year.
N in cover crops (green manures) is almost exclusively in the organic form. Crop residues release nitrogen generally between 2 - 6 weeks after incorporation. However, this will be delayed with higher C:N residue or at lower soil temperatures.

Compost and native soil organic matter have already been partially broken down and so release PA N at a much reduced rate, regardless of C:N ratio. In a compost incubation study at UMaine in 2013, 4 sources of compost were mixed with soil to supply 320 ppm total N (640 lb/A) and incubated at 68 F (20C) for 8 weeks. From all 4 sources, only 5 % of the organic N content was fully mineralized to PAN in 8 weeks. Two of the sources had a substantial portion of total N in plant available form at the start of the incubation, but even these released only an additional 5 % of the organic N during incubation. Compost is a <u>very</u> slow release source of PAN. As with manure, there can be a greatly diminished release of PAN in the subsequent 1-2 years after application.

P and K release from natural sources has not been extensively studied or characterized. The chemistry of plant available K (and especially P) greatly complicates the study of release rates for these nutrients. Available potassium can be lost or temporarily tied up in soil clays. Studies have documented 15 – 20 % loss of applied K to unavailable forms. P is highly reactive, forming stable and often unavailable compounds and complexes with Al and Fe at low soil pH and with Ca and Mg at high soil pH. Studies have documented 70 – 90 % loss of applied chemical P to unavailable forms.

The remaining mixed material from the UMaine natural fertilizer study, not used for N mineralization, was allowed to incubate in unsealed plastic bags for 16 weeks at ambient room temperature. Samples dried slowly and were rewet to original moisture content each month. For those N fertilizers that also contained significant P content, only 5 – 10 % of applied P was plant available after 16 weeks. For those N fertilizers that also had significant K content, 50 – 85 % of applied K was plant available after 16 weeks. P and K recovery (fertilizer efficiency values) from natural sources were therefore comparable to those found using chemical sources.

Plant and animal meals, natural minerals, compost, manure, and cover crops have much more complex nutrient contents than do chemical fertilizers. Trace elements and micronutrients in natural fertilizers are an added benefit not typically found in purified chemical fertilizer salts. Secondary and trace element content from natural fertilizers is highly variable, depending on the source material. Materials derived from or originating in marine environments are especially good sources of a broad spectrum of trace elements, including boron. Kelp meal and Greensand (a marine deposit) are two of the best natural sources of boron. More concentrated sources, such as Borax, are not usually recommended since they must be applied with <u>extreme</u> care to avoid toxicity. A listing of secondary and micronutrient (total content) in a variety of natural fertilizers can be found on the Lab website (anlab.umesci.maine.edu) under the “Understanding Recommendations” tab.

How We Manage Soil Fertility at Clear Brook Farm

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Our farm has been growing veggies and fruits at the present location since 1995. We started with 1 acre and now have around 45 acres under cultivation. Of that, 25-30 acres are in veggies every year and the remainder is cover cropped/fallow… we do take about 4-6 acres of those acres specifically for straw production too. Our home farm has about 7 acres of cropland (plus almost 20,000+ sqft for in ground greenhouse growing and 15,000 sqft for bedding plant and field start production) We lease 15 acres of cropland and own another 25 acres that we bought about 6 years ago and farmed for the 4 before that. We did not have all this land enter production at once, but rather as our business grew we added more and more land under cultivation.

Pretty much all the fields that we brought under cultivation were either very neglected or recently under very poor conventional production. One observation i've made over the years is that no matter what fertility scheme we might have employed as we started farming a particular piece of land, it seemed to take until the 7th season for a piece of land to "kick-in" to being productive in a consistent way, year to year. I imagine it takes a bit for the microbes to get going and the nutrient levels to be such that they are readily available to plants no matter the weather.

As far as greenhouse fertility we take soil tests most years before planting tomatoes, I send the results to Vern Grubinger or use his online paper to help me figure out needs. Most years it seems we need to build organic matter, lower PH (our irrigation water is high buffer and PH), add a little K and N and things seem to work. So we often use soy or alfalfa meal for N sulfate of potash for K and peat for PH and organic matter.

In the field we have not been as rigorous in testing our soils, but this year we are participating in a study and so have had a number of our soils tested for us, and seeing how easy it was for the person doing the test with a soil probe, we will be purchasing one of those at some point soon. In any case when we initially start farming a field we do a soil test to get the PH corrected and then will often start with a year or two of cover crops and fallow to get rid of the quack grass. We will mostly use rye over the first winter plow that under; use a fallow period discing every 2 weeks to kill weeds and then either plant a pea/oat mix or vetch/oat mix for that winter to build up some N. Also if we are in a compost "phase" we might spread either in the late summer after the fallow or the following spring.

For ease of discussion I will break our fertility management into two categories: cover crops and compost/fertilizer. I will first cover our use of cover crops. The first area of cover cropping is the main winter cover time. What we plant for a winter cover is often determined by the next year's use. So if a piece of land is going to be used early for spring crops we will plant a winter killed cover. The last few years pea/oats has been the "go-to" for this. We plant these any time after August 10 and until early September. Generally we plant around 200Lb of mixed seed per acre. We used to inoculate the peas, but I think we have so much innouculent in the soil now that we rarely use it. Most years these plantings put on a lot of growth. Sometimes we will lay plastic for our garlic planting and then seed over it with this mix and so have a nice cover between the beds that dies down over winter…it can grow so much it is hard to see the plastic to plant!

Now with winter growing eating up some acreage it can be hard to cover crop some land in the fall. If this is the case, in the spring we will often plant pea/oat mix to turn under in June and plant mid and late summer plantings after that. Another spring cover crop we have come to favor is intercropping annual rye between rows of plastic or in roadways between blocks of crops. These plantings do require mowing periodically through the summer but I think it really benefits the soil to have a cover on it and not just be bare ground having to get disced or tilled every 2 weeks. The annual rye easily out-competes weeds. **A couple tips for planting:** we have an old McCormick #10 box seeder a friend gave us. IT looks like it should be in a museum but does a great job seeding roadways. For between plastic, we use a Scotts drop grass seeder, and then lightly run some tines over it. In order to make it easier to pull that plastic we have some hilling discs pointed out from the plastic and run along the edges.

On the compost and fertilizer end of things, we started growing by just using aged manure back in the 90s. As regulations made using those materials more cumbersome time wise with harvest windows we moved to both a wet chicken manure compost (Giroux's) and then when we realized how far we were trucking all that "water", we switched to pelletized chicken compost (Krehers). We have been using Krehers pretty exclusively the last 6 years, but have recently started back with spreading fall compost. However after talking with Vern G. about phosphorous regulations coming down the pike we are being a bit hesitant about that.

Our Krehers use looks like this: We broadcast 1 ton/acre over most fields about a week of more before we plant (sometimes just 1 day if we are busy). For certain crops such as sweet potatoes and carrots we may mix in some sulfate of potash at a 150-200Lb/acre. On heavy feeding crops or crops in the ground a long time we may side or top-dress a field. For side-dressing we a **Clampco side dresser (**a great piece of equipment for side dressing pelleted chicken). On most of our corn we will side-dress and mix in some Chilean Nitrate at about 150Lb/acre. WE find our corn really responds well to the Chilean. Other crops we side-dress such as some brassicas and winter squash we only side dress with Krehers. Our side dresser is set up to drop 400# of Krehers/downspout/acre. This really seems to help a lot with those crops.

AS stated above, it really has taken us a good 7 years of growing on a piece of land for it to "bank" the nutrients and microbes needed for sustained veggie growth year to year. One other observation is that after turning in a nice, lush cover crop whether a fall seeded hairy vetch or a spring seeded pea/oat the following crops always look dynamite. I think this is more so than when we just "pump" the chicken compost. The mix of both a nice cover and some Krehers seems to be really effective in growing crops for us in southwest VT.

Lettuce Production Using Plastic Mulch and an Update on the Status of Biodegradable Plastic Mulch for Organic Systems

Comparing two baby-leaf lettuce production systems

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Over the last two decades, annual supermarket sales of ready-to-eat salad mix have increased more than five-fold in the U.S., from $197 million in 1993 to $2.7 billion in 2012. While baby-leaf salad mixes are composed of lettuce, spinach, arugula, pac choi, kale, Asian and Indian mustards, and raddichio, consumer demand is especially high for baby-leaf lettuce. The primary barrier to baby-leaf salad production for organic growers is weed pressure because the crop is produced in densely seeded beds and the only practical post-emergence weed management method is hand weeding before harvest, and manual removal of weeds from the crop after harvest. Both of these practices are very labor and time-intensive and greatly increase production costs.

One method to produce baby-leaf lettuce while minimizing weeds is to use plastic mulch to grow head lettuce varieties that are designed for salad mix production, such as Salanova™ from Johnny's Selected Seeds. At the mature head stage, the individual leaves of these cultivars remain short (approximately 3 in.) and the head will develop an average of 200 leaves as opposed to the 60 leaves that are typical of conventional head lettuce. One drawback to growing Salanova™ lettuce is substantially higher cost per seed. Additionally, little information is available on yield.

Two separate but adjacent studies were conducted in Spring 2014 at the Washington State University Northwest Washington Research and Extension Center in Mount Vernon, WA in a field that was in its third year of transition to organic. One trial was of traditional baby-leaf lettuce with the romaine cultivar Flashy Trout's Back planted twice, two weeks apart. The crop was seeded in six rows spaced 4 in. apart within the bed, and spacing within each row was 1/2 in. The second trial was of Salanova™ lettuce with eight cultivars, Red and Green Oakleaf, Red and Green Butterhead, Red and Green Sweet Crisp, and Red and Green Incised. Transplants were spaced 8 in. center-to-center with three rows per bed, and beds were covered with 1 mil black embossed plastic mulch. Both studies were drip irrigated at a rate of 1 in. per week accounting for precipitation.

The traditional baby-leaf lettuce planting was harvested when leaves were 4-in. length, which was 48 days after seeding. In this study the planting was only harvested once, and yield was multiplied to estimate the yield for one and two reharvests. The second and third harvest would have been 10 days apart such that the third harvest would be 68 days after seeding. Salanova™ cultivars were harvested when heads reached 8 in. diameter, 75 days after seeding and 52 days after transplanting.

Mean yield of traditional baby-leaf lettuce did not differ due to planting date. For Salanova™, yield was measured for cored heads and there was no significant difference among cultivars, but green Salanova™ cultivars (2.7 lb per bed-foot) had a higher yield than red cultivars (1.7 lb per bed-foot). For a 100-ft bed of baby-leaf lettuce from the traditional planting the yield was 32.6 lb. for a single harvest with a value of $67 wholesale ($2.04 per lb.) and $268 retail ($8.22 per lb.), 65.0 lb. for a double harvest with a value of $145 wholesale and $539 retail, and 97.7 for a triple harvest with a value of $199 wholesale and $801 retail. Yield of Salanova™ lettuce was 155 lb. per 100-foot bed, with a value of $317 wholesale and $1275 retail. Yield of Salanova™ lettuce was 1.6 to 4.7 greater and value was 0.6 to 3.8 times greater than for traditional baby-leaf lettuce.

A 100-ft bed of traditional baby-leaf lettuce requires approximately 14,400 seeds at an average cost of $0.0006 per seed and a total cost of $8.64. A 100-ft bed of Salanova™ lettuce with three rows requires 300 seeds at an average cost of $0.064 per seed and a total cost of $19.20. The cost per seed is 100 times greater for a Salanova™ cultivar than for a common leaf lettuce cultivar, while the cost of seeding a 100-foot bed is two times greater for Salanova™ than for a common leaf lettuce. The difference in cost of seed for Salanova™ lettuce was insignificant considering its increased yield.

The yield advantage of salad mix head lettuce combined with the weed management advantages of growing such varieties on plastic-covered beds shows promise for baby-leaf lettuce production. Thus a complete economic comparison of the two production systems is warranted.

Biodegradable mulch films: their constituents and suitability for organic agriculture

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Today there are many agricultural mulches that are marketed as "biodegradable." The goal for a biodegradable mulch is that it will retain a relatively high level of intactness during the growing season, so that it meets the functionality expectations of growers (e.g., weed control, moisture retention), and at the end of the growing season it can then be incorporated into the field where it will biodegrade fully over a relatively short period of time (i.e., within 2 years). Being able to till the mulch into the soil after the crop harvest eliminates removal and disposal costs for growers and reduces landfill waste for communities.

The USDA National Organic Standards Board (NOSB) passed a final rule on October 30, 2014 which added 'biodegradable biobased mulch film' to their list of allowed substances for organic crop production ["7 Code of Federal Regulations (CFR) section 205", available at http://www.regulations.gov/#!documentDetail;D=AMS-NOP-13-0011-0125]. To be considered biodegradable and biobased, a mulch film MUST:

- Achieve at least 90% biodegradation in the soil within two years, in accordance with the ISO 17556 or ASTM D5988 testing methods
- Be biobased, with biobased content measured using ASTM D6866
- Meet compostability specifications of one of the following standards: ASTM D6400, ASTM D6868, EN 13432, EN 14995, or ISO 17088 (*Section 205.2*)
- Be produced without organisms or feedstock derived from excluded methods [*Section 205.601(b)(2)(iii)*]
- Be produced without the use of synthetic (non-biobased) polymers; minor additives such as colorants and processing aids are not required to be biobased (*NOP Policy Memo 15-1*)

It is important to note that while biodegradable paper mulch is allowable in certified organic production systems, **currently, none of the biodegradable mulch films have been approved for use in the U.S. because, so far, none meet the requirement of using only biobased feedstock**. To be considered 'biobased' the feedstocks used to make the mulch must be derived from a renewable resource (plant and/or animal mass derived from carbon dioxide recently fixed via photosynthesis). The feedstock must be made using biological processes and may not be derived from, or using, GMO organisms. Biodegradable mulch films currently on the market contain only 10 – 20% biobased content and the remaining content includes polymers derived from fossil fuels (petroleum or natural gas) as well as dyes, minerals, and in some cases heavy metals (OMRI report to USDA-NOP, June 5 2015).

The most common biobased materials used to make biodegradable mulch films are starch, polylactic acid (PLA), and polyhydroxyalkanoate (PHA). Each of these three biopolymers is most commonly blended with non-biobased polymers and minerals, and then processed using synthetic procedures. Starch starts as a natural polysaccharide but is typically processed into a thermoplastic material by extruding with water and organic alcohols (usually glycerol, a biobased co-product from biodiesel manufacture), or it may be esterified chemically. Corn starch sourced from the U.S. is most likely derived from a genetically modified organism (GMO); however, there are no cost-effective assays for determining GMO status. PLA is derived from starch and oxidized by yeasts or other microorganisms to produce lactic acid, which is subsequently polymerized synthetically through a series of reaction steps. PHAs are biopolymers that are biosynthesized through fermentation by bacterial enzymes. PLA and PHA are most commonly produced using GMOs.

Under the NOP rule, the grower is responsible for ensuring that the mulch reaches 90% biodegradation within the 2 year period. All the biodegradable testing procedures cited by the NOP are laboratory procedures that utilize controlled conditions including temperature, moisture, and organic matter substrates; and the material being tested is ground into a fine powder. In the field, there is variability in environmental conditions: heat, UV light, wind, soil type, pH, microbes, irrigation, aeration of the soil, and other production practices. Environmental conditions during the period of time when the mulch is being used on the soil surface may also affect biodegradation. For example, PBAT (a constituent of several biodegradable mulch films) can undergo photochemical reactions that form cross-links, and the cross-links reduce the extent of biodegradation that can be achieved. If the mulch does not adequately biodegrade in the soil, the grower may be in non-compliance.

In 2009, the USDA-Specialty Crop Research Initiative (SCRI) funded project *Biodegradable Mulches for Specialty Crops Produced Under Protective Covers* (Ref. No: 2009-02484) followed four biodegradable mulches (BioAgri, BioTelo, PLA Experimental, WeedGuard) in the soil for 2 years at three locations in the U.S. (Knoxville TN, Lubbock TX, Mount Vernon WA) post-incorporation using a mesh-bag protocol. Results from this study showed that WeedGuard biodegraded at all locations, BioAgri and BioTelo (very similar products) biodegraded at different rates at each location, and the PLA mulch did not biodegrade at any location. A new 5-year field study initiated in 2015 (USDA-SCRI Ref. No. 2014-51181-22382) *Performance and Adoptability of Biodegradable Plastic Mulch for Sustainable Specialty Crop Production* at Washington State University Northwest Washington Research and Extension Center and the University of Tennessee–Knoxville is testing 5 biodegradable mulch products, WeedGuard, BioAgri, Naturecycle, Organix, and an experimental PLA/PHA-based mulch film. Evaluation includes mulch impacts on crop production and soil micro-organisms, and mulch biodegradation in the soil over 4 years of repeated applications. Soil sampling methods will be developed to enable growers, certifying agencies and scientists to determine how much mulch is remaining in the soil post-incorporation. For more information about this research project, see www.biodegradablemulch.org.

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Horticulture and Disease Management of Cold Climate Grapes in Vermont

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Winegrape production is relatively new to New England, especially in colder regions away from the coast, due to the breeding of cold-hardy cultivars that has enabled this industry to be successful. In the great wine regions of the world, cultivar adaptation to sites evolved over decades if not centuries. The comparatively young New England winegrape industry must likewise adapt cultivar choice and management to ensure profitable production of high-quality wines that consumers want and purchase.

Evaluation of winegrape cultivar performance has been conducted at the UVM Horticulture Research and Education Center in South Burlington, VT (USDA hardiness zone 5a) since 2007. The farm is located on Windsor-Adams loamy sand soil with low organic matter and good soil drainage. Eight winegrape cultivars were planted in a randomized complete block design of six blocks with four-vine plots of each cultivar per block: ‘Corot Noir’, ‘Frontenac’, ‘La Crescent’, ‘Marquette’, ‘Prairie Star’, ‘St. Croix’, ‘Traminette’, and ‘Vignoles’. Vines were trained from two trunks per vine to a five-foot high-wire bilateral cordon system at a density of 726 vines/acre.

Assessed horticultural parameters included: vine vigor (pruning weight); indirect cold hardiness measurements (primary winter bud survival, cordon length); yield, and juice quality parameters. In addition, incidence of disease on fruit and foliage was evaluated. ‘Frontenac’, ‘La Crescent’, ‘Marquette’, ‘Prairie Star, and ‘St Croix’ rated well for measurements of cold hardiness and vine vigor. Those cultivars also had among the highest crop yield in most years, except ‘Prairie Star’ which rated among the lowest in all years. ‘Corot Noir’ had among the best crop yield through 2013, but suffered from substantial winter damage in the cold 2013-2014 and 2014-2015 winters. ‘Frontenac’, ‘La Crescent’, ‘Marquette’, and 'Vignoles' generally produced juice with higher titratable acidity (TA) and soluble solids than other cultivars, and ‘Corot Noir’ and ‘St Croix’ juices ranked lower for those variables. ‘Traminette’ and ‘Vignoles’ performed poorly in most measures of cold hardiness, vine vigor and crop yield compared to other cultivars in this trial, and were removed from the planting after 2011.

Diseases that were assessed included: powdery mildew; downy mildew; black rot; Phomopsis leaf spot and fruit rot; angular leaf scorch; and anthracnose (data not shown). Complete assessment was conducted in 2010-2012. Later assessments have been conducted as the vines have matured but data were not analyzed by the time of this publication. Powdery mildew was the most prevalent disease and was observed on the foliage of all cultivars in each year. 'Frontenac' or 'Prairie Star' ranked the highest numerically in percent leaves infected but were not significantly different from some of the other cultivars. No powdery mildew was observed on any fruit in any year. Downy mildew was also observed only on foliage and not on any fruit over the three years of the study. In 2010 and 2011, the highest foliar incidence was observed on 'Vignoles'; in 2012, the highest foliar incidence was observed on 'La Crescent' vines after 'Vignoles' vines (and 'Traminette' vines) were removed from the planting after 2011. Phomopsis foliar symptoms were not observed in any year but fruit rot symptoms were observed in 2010 and 2012. In 2012, 'Frontenac' had the highest incidence and severity, followed by 'Marquette'. Black rot, angular leaf scorch and anthracnose were either not observed or at very low incidence during the three growing seasons. In summary, differences in disease incidence and severity among the cultivars were observed for some diseases. Future research which allows for comparison of multiple fungicide programs during a growing season is needed to determine the innate disease resistance/susceptibility of these cultivars and how best to incorporate this knowledge into effective disease management programs that address economic, health, and environmental concerns.

Acknowledgements
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UVM NE-1020 Winegrape Evaluation Vineyard: Harvested crop yield tons/acre.

Cultivar	Cumulative	2009	2010	2011	2012	2013	2014	2015
Corot Noir	28.80a[z]	1.87ab	3.75abc	9.20a	5.16a	5.61	1.72c	1.49c
Frontenac	29.97a	2.29a	3.84ab	6.33a	4.10ab	6.00	4.06a	3.34ab
La Crescent	24.81a	1.80ab	4.69ab	6.46a	2.75bc	5.31	2.57bc	1.21c
Marquette	26.67a	1.17abc	4.79ab	6.24a	2.51c	6.91	2.89abc	2.34abc
Prairie Star	21.06a	1.45abc	2.68bc	2.66b	1.77c	5.28	3.74ab	3.47a
St Croix	29.30a	1.93a	5.79a	7.91a	2.59c	5.65	3.39ab	2.04bc
Traminette[y]	5.01*	0.26c	2.14bc	2.62b	.	.	.	.
Vignoles[y]	1.59*	0.66bc	0.92c	.	.	.	.	.

Mean performance parameters 2009-2015

Cultivar	Cordon length (m)	Pruning weight (kg)[w]	% Live nodes in spring	Cluster weight (g)	°Brix[x]	pH[x]	TA[x]
Corot Noir	1.61ab	0.45bc	65.5b	133.3a	16.5d	3.14b	0.89d
Frontenac	1.72a	0.68ab	86.0ab	107.2b	23.5ab	3.16b	1.64a
La Crescent	1.72a	0.69ab	87.2ab	92.1bc	21.8bc	3.05bc	1.52ab
Marquette	1.61ab	0.72ab	83.9ab	87.9bc	24.4bc	3.08b	1.39ab
Prairie Star	1.65ab	0.56b	73.9b	77.2c	20.8b	3.32a	1.10c
St Croix	1.71ab	0.80a	88.9a	97.5c	18.7c	3.13b	0.88d
Traminette	1.63ab	0.39bc	64.7b	73.2c	21.5bc	2.86c	1.15c
Vignoles	1.50b	0.23c	63.4b	53.8c	22.0bc	2.95c	1.53a

[z] Values represent the mean from 6 replicate four-vine plots per cultivar of 20 leaves or 10 clusters per plot. Means followed by the same letters within columns are not significantly different according to Tukey's Studentized Range (HSD) Test ($p \leq 0.05$).

[y] Traminette and Vignoles were removed after the 2011 season due to poor cold hardiness, yield, and disease sensitivity.

[x] Parameters measured on extracted juice samples.

[w] Pruning weight represents mean weight of canewood removed per vine each year.

Relative Disease Ratings for Wine Grape Varieties Grown in Vermont
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http://www.uvm.edu/~fruit/grapes/gr_ipm/RelativeRatingsOfDiseaseMay2011.pdf

	Black Rot	Powdery Mildew	Downy Mildew	Botrytis	Angular Leaf Scorch	Phomopsis	Anthracnose
Baco Noir	+++	++	+	+++	++	+	?
Cayuga White	+	+	++	+	++	+	?
Frontenac	+++	+++	+	++	++	+	+
Frontenac Gris	++	+++	+	++	?	+	+
La Crescent	+++	+++	+++	+	++	+	+++
La Crosse	+++	++	+++	+++	?	++	+
Leon Millot	+	+++	+++	+	+	+	+
Louise Swenson	+	+	+	+	++	?	++
Marechal Foch	++	++	+	+	+	+	++
Marquette	+++	+++	+	+	+	?	+++
Prairie Star	++	+	+++	+++	++	?	++
Riesling	+++	+++	+++	+++	+	++	?
Sabrevois	+	+	+	+	?	?	?
St. Croix	+++	++	++	++	++	?	+
St. Pepin	+	+++	++	++	+	?	?
Seyval	++	+++	++	+++	++	++	?
Swenson Red	+	++	+++	++	++	?	?
Swenson White	+	++	++	+	+++	+	+++
Traminette	++	+	+++	+	+	?	+
Vidal	++	+++	+++	+	+	+	+++
Vignoles	+	+++	+++	+++	++	++	+++

*Resources: Midwest Grape Production Guide, Bulletin 919, OSU, 2005; New York and Pennsylvania Pest Management Guidelines for Grapes: 2006; "Characteristics of Cold Hardy Grape Cultivars", Dr. Paul Domoto, Iowa State University, 2007; and observations from Vermont vineyards. Note: Where there were differing ratings, the more susceptible rating was used.

Ratings: *+ slightly susceptible; ++ moderately susceptible; +++ highly susceptible*

Site and Soil Considerations for Northern Grape Production

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The most fundamental and irreversible decision in the life of a vineyard is the choice of site. Growers invest anywhere from $12 to 16,000 /acre to establish a vineyard – and site characteristics can determine the overall productivity and profitability over the life of the vineyard.

Cold-hardy 'Northern Grape' cultivars have expanded the range of sites suitable for grape production to those with winter low temperatures down to -20 to -30 °F. But surviving winter low temperatures is only one facet of site suitability. In all other respects, Northern, cold-hardy cultivars require the same things other grape varieties require to thrive in the vineyard.

What is Required of a Vineyard Site?

Grapevines need:

- A **growing season** of sufficient length The growing season is by the number of days between the last 28°F in spring and the first fall occurrence. The season at a particular site must be long enough to allow both the fruit and the vegetative parts of the vine to mature. It must provide enough heat energy to ripen the fruit and vegetation.
- There must be adequate **sunlight hours** to ensure a sufficient supply of carbohydrates are produced by photosynthesis to mature the fruit and vine and to maintain future productive potential.
- The supply and the availability of essential **mineral elements** in the rooting zone must neither be inadequate nor excessive. Mineral elements which are not essential may also be problematic if they are toxic to grapevines or consumers.
- There must be a steady and sufficient **supply of wate**r to allow the vine to function properly. However, soil water must not be in excess or grapevine roots will suffer. Often in cool or cold climate production regions the vines are not irrigated. In that case the soil must retain enough water in the root zone to provide vine needs between rains.
- The site should neither **receive nor retain excessive moisture**, and it **should allow cold, dense air to drain away** from the vineyard. Otherwise cold injury or water logging may occur. However, surface water and air drainage should not be obtained at the cost of increased **soil erosion** or limitations on the ability to **operate machinery safely**.

Climate: Climate sets the limit on how specific grapevine varieties perform, on two levels:

- **Macro climate:** Regional climate sets overall limits on what grapevines will survive and be productive. In a cool climate with cold winters, winter low temperatures (Table 1) are a prime determinant of what varieties will survive the winter with minimal bud and trunk injury. Frost-free dates (which determine the length of the growing season) and heat unit accumulations are also important macroclimate considerations.

Table 1. Mid-winter Low Temperature Risks for Grapevines

If low temperature is higher than	Injury hazard is	Suitable Varieties
0°F	very low	almost any
-5°F	low	most northern vinifera
-10°F	moderate	hardy vinifera/moderately hardy hybrids
-15°F	high	hardy hybrids/most American
<-15°F	very high	hardy American varieties
<-18°F	Extreme	Cold-climate (Minnesota & Swenson) hybrids

- **Mesoclimate:** Local climate within a region is modified by elevation, slope, aspect (slope direction) and presence of barriers to air flow. **Sites with poor air drainage have significantly lower temperatures during radiation frosts, which greatly increases the risk of spring and fall frost injury, and sometimes mid-winter injury.** Spring frost can particularly affect cold-hardy 'Minnesota' and 'Swenson' varieties, which tend to have significantly earlier budburst than classic *vinifera* or other standard hybrid varieties.

Figure 1 illustrates 3 relevant measures, based on Min/Max temperature readings: 1) Frost-free days: Number of days between last spring and first fall temperature below 29° F. 2) Growing degree-days: Summation of daily average temperature above 50° F, and 3) Winter low temperatures.

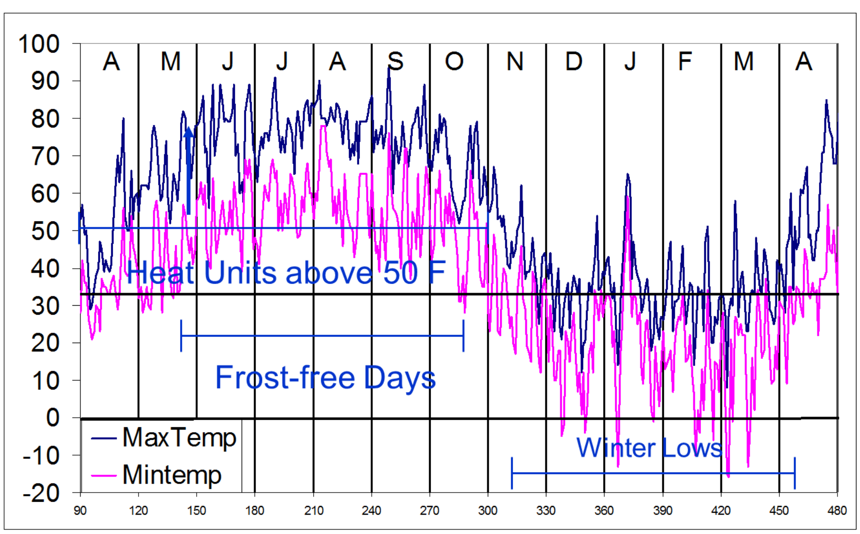

Figure 1: Minimum maximum temperatures and climate parameters.

Climate and mesoclimate are the most important site characteristics to consider in choosing a site. Choose a site with good air and water drainage, a southerly (or SW to SE) aspect, and at an appropriate elevation (mid-slope in hilly regions).
Soils: Grapes are adaptable to many types of soils, but the best vineyard soils tend to be light-medium textured, (e.g. gravelly loams, silty loams, sandy silt-loams) with excellent internal soil drainage, and a lack of hardpans that limit soil rooting depth. Northern grapes prefer moderately acidic (6.0-6.5) soil pH.

Soil characteristics can be modified prior to planting to dramatically improve vine performance. Thousands of acres of *vinifera* grapes are grown on heavy clay soils in Canada's Niagara peninsula, with the installation of dense (every row) drainage tile lines. Soil preparation preplant can adjust the supply and balance of mineral nutrients, and soil pH. Preplant cover crops can add organic matter to deficient soils, and some are reported to suppress plant pathogenic nematodes.

Complete references on soils, climate, and site selection considerations are available online and in production guides. I recommend:

Wolf et al. 2011. Wine Grape Production Guide for Eastern North America, NRAES 145, PALS Publishing, Cornell University Ithaca NY. Online: http://palspublishing.cals.cornell.edu/nra_winegrapecontent.html

Lakso A. and T. Martinson, 2010. The basics of site evaluation and selection. Posted at: www.nyvineyardsite.org

Sforza and Wolf 2014. Eastern U.S. Web-Based GIS Tool for vineyard site evaluation. Map-based web tool for site specific climate and soils information. Posted at: http://www.arec.vaes.vt.edu/alson-h-smith/grapes/viticulture/research/scri-index.html

Economics: Choosing the best possible site has long-term consequences. Over the 25 year expected lifespan of a vineyard, raising average production by each 0.1 Ton per acre adds $900 net present value at planting time. In other words, you can afford to pay $900 per acre more for a vineyard site if you expect only 0.1 T /acre per year extra over the life of the vineyard. It also follows that any pre-plant investment (deep ripping, tiling, soil pH) you make prior to planting that raises productivity of the site is likely to pay off in a more profitable vineyard.

The takehome message is this: Pay now or pay later. You can pay up front for superior sites and improvements or you will pay later in poor growth, lower production, and poor vine performance.

Using Under-vine Cover Crops to Replace Herbicides Application in Northeast Vineyards

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Reasons to substitute herbicide with under-vine cover crops:
Herbicide resistance, soil runoff, nutrient leaching, and environmental contamination can result from extended use of herbicides in vineyards. Under-vine cover crops are known to benefit long-term soil health and could provide competition for water and nutrients, helping to alleviate the problem of excessive vine vigor.

Effect of under-vine cover crop on soil and vine:
Six multi-year, replicated field experiments have been conducted to investigate the impact of under-vine cover crops in vigorous *vinifera* vineyards in the Finger Lakes region of New York State. Under-vine cover crops of buckwheat and annual rye grass resulted in few consistent differences in vine vegetative growth, yield, vine nutrient status at veraison, or midday water status. Chicory, white clover, and native vegetation as under-vine cover crops reduced pruning weight, vine yield, and vine nitrogen level. Soil microbial respiration was greater in native vegetation and white clover cover crop treatments compared to glyphosate plots, while organic matter loss were greater in glyphosate plots compared to cover crops. Less nitrogen leached from native vegetation plots compared to glyphosate and white clover plots. Impact of under-vine cover crops on must composition was inconsistent.

Effect of under-vine cover crop on wine sensory property:
When subjected to wine sensory analyses, under-vine cover crops impacted the perceived aromatic properties of Riesling but not the aromatic and gustatory properties of Cabernet franc.

Economic analysis:
Economic analyses suggest the cost of planting and maintaining an under-vine cover crop is considerably lower than maintaining an herbicide strip. However the more competitive cover crops can reduce vine yield resulting in less fruit or wine available for sale; partial budget analysis of treatments in a Cabernet franc study with young vines revealed that under-vine cover crops reduced revenue by more than $2,000 per acre when yield was reduced by approximately 50%.

Conclusion:

The potential of under-vine cover crops to reduce vine size, maintain soil quality, and decrease the leaching of nutrients in comparison to herbicide use have been demonstrated in these experiments, however the impacts of different cover crop treatments on aromatic properties of the resulting wines requires further investigation. Under-vine cover crop maintenance is cheaper than an herbicide strip and can be adopted in vineyards when maximal yield is not desired.

Vineyard Nutrition for Cold Climate Grapes

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Developing an appropriate fertility program should be the first step towards growing quality cold hardy grapes. Grapevine nutrition is important not only to growth and yield, but, influences disease and insect susceptibility, storage life, and grape quality. Over the last several years, five states have been involved in nutritional profiling of cold climate grape cultivars as part of the Northern Grapes Project. With this multi-state collaborative effort, we have increased production of cold hardy grapes (*Vitis vinifera*-based hybrids) and consumer acceptance, and we continue to make strides to understanding cold hardy grape cultivar performance.

To assess grapevine nutrition, we sampled soil and plant tissue across multiple locations in Iowa. By profiling soil and tissue nutrition, we can tailor fertilizer recommendations for cold climate grapes instead of relying on information developed for *V. vinifera* and *V. labrusca*. In this study, soil and tissue samples were used to correlate yield, vine, and fruit parameters for Marquette, La Crescent, and Frontenac. Commercial sites were selected in Iowa to represent different soil types and textures: Behrens vineyard, Carroll, IA (Loam), Blackwing Vineyards, Glenwood, IA (Loam; Silt Loam), Park Farms, Bankston, IA (Loam; Silt Loam), Snus Hill Winery and Vineyard, Madrid, IA (Sandy Loam), and Tassel Ridge Vineyard and Winery, Oskaloosa, IA (Silty Clay Loam; Clay Loam). Soil samples were collected at the beginning of the season. Samples were obtained by following general soil testing guidelines: 9 core samples per replication. Tissue samples were collected at bloom, 4 weeks after bloom, and at veraison. Plots within cultivar were divided into three replications with at least 15 mature vines per replication. All soil and tissue samples were sent to a commercial lab for analysis.

“Weaving vs Stringing Tomatoes, Which is More Profitable?”

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The Take Home Message:
It depends! It depends upon a number of factors. Or should I say, upon reflection, one is not necessarily more profitable than another. It is more about the farmer’s goals.

1. If the house is an inexpensive hoop house with low sides, then weaving is an excellent, choice. If the house is an expensive, wide, gothic style houses, then stringing is the best growing method.
2. If your work force is very skilled and adept at pruning, clipping etc., then stringing is the best choice. If the work force is inexperienced, then weaving is an alternative to consider.
3. If the goal of production is to get as many first clusters at one foot spacing, then stringing is the choice. If a goal of production is to limit the number of tomatoes necessary to grow and graft, then weaving is a possible choice.
4. If the goal of production is to grow lots of excellent tomatoes with the least amount of effort, then weaving is an excellent choice. If the goal of production is to grow the most tomatoes over the longest period of time, then stringing is the only choice.

Conclusion:
The decision to weave or string is dependent upon the farmer’s goal. But if the farmer wants the most inexpensive way to grow tomatoes weaving is the method. It is quicker. There is little to no suckering, truss pruning, clipping, and fiddling with truss supports. The plants grow themselves.

Fifty Shades of Gray Mold-Managing Tomato Diseases in High Tunnels

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Specific and current pesticide recommendations can be found https://nevegetable.org/

Early season issues: Most early season problems are abiotic (non-living and non-infectious).

- **Root diseases (several different soil borne fungi). Symptoms-wilting, poor vigor, brown scorching around leaf edges**

Rotation is a cornerstone of IPM and helps keep root and foliar diseases to a minimum, yet growers are reluctant to replace tomatoes in high tunnels with a less lucrative crop. Although the several soil borne fungi that cause root rots can build up in soils, the widespread use of vigorous rootstocks has helped eliminate most root rot issues in soils planted with tomatoes for several years. Planting when soils are too cold or wet, however, can still result in root rots and should be avoided.

- **Ethylene damage (Abiotic). Symptoms-curling and twisting or downward bending of foliage (epinasty), flower abortion**

Tomatoes are **very** sensitive to ethylene damage. Ethylene is a naturally occurring plant hormone but can be produced when heaters are not functioning properly or venting is inadequate. Other sources include: leaky gas lines, propane heaters and exhaust from combustion engines. The damage is typically seen in late winter or early spring when temperatures drop and the heat is turned on. Once the source of the leak is fixed, the plants will grow out of the disorder although sometimes the damage can be so severe, the plants never fully recover. The damage occurs very fast and can be present on all the tomatoes in the house or it may be worst on plants nearest the heater. If you suspect ethylene injury or any other abiotic damage (cold, heat, over-fertilization, etc.) check the newest growth on the tomatoes after a day or two to see if it looks symptom-free. If so, then the damage was typically an abiotic (non-living) disorder and the plants should recover. Proper heating system maintenance before the heating season is critical.

- **Cold temperature damage/transplant shock (Abiotic). Symptoms-Overall purpling of foliage or browning/flecking on affected leaves, often limited to leaves that were emerging at the time of the event.**

Tomato foliage can look really bad early in the season and most of the damage is caused by cold temperatures (resulting in slow transport of nutrients) or transplant shock. Symptoms include “purplish leaves”, browning of leaf edges and brown spotting on foliage. Often affects only one age of leaves-the ones that were most vulnerable at the time of the damage. Check new growth. Don't worry about the bad looking older leaves as long as new growth looks good and vigorous.

- **Edema (Abiotic). Symptoms-Bubbling, corkiness on leaf undersides, often along veins**

Tomatoes can be susceptible to this abiotic disorder. It typically occurs in late winter/spring when temperatures are cool. Plants get watered and don't transpire the water due to cloudy cold conditions. The water builds up in the cells and then bursts. Plants will grow out of edema. Adjust watering and watch weather conditions. Check newest growth to make sure it looks good and symptom-free.

- **Tomato pith necrosis (several soil borne *Pseudomonas* species). Symptoms-Yellowing of young leaves, wilt in tops, split, collapsed or swollen stems often hollow with a ladder or chambered appearance when split in half, often accompanied by lots of adventitious roots. Can resemble bacterial canker. Rule out bacterial canker with a diagnostic lab to be sure.**

This disease is random in the greenhouse and is usually limited to a few plants. Occurs with cool nights, cloudy weather, high humidity and excessive N. Plants often grow out of it as temperatures become warmer.

Midseason/late season issues-These are typically infectious diseases and can spread.

Minimizing leaf diseases in high tunnels is all about moisture management. Although sometimes common field fungal diseases (*Septoria* and *Alternaria*/early blight) are found in outer rows exposed to driving rain, these diseases are rare in high tunnels since leaf wetness can be minimized. Although growers avoid some of the field diseases that require leaf wetness, several diseases can become an issue **when humidity is over 85%,** such as gray mold (*Botrytis*), leaf mold (*Fulvia*), powdery mildew (*Oidium*) and late blight, (*Phytophthora*). These fungal diseases are fairly easy to identify:

- **Gray mold (*Botrytis cinerea*) symptoms-Look for brownish/grayish spores covering any part of the plant including leaves, dying flower blossoms or stems. Should be easy to see with the naked eye. On fruit look for white circles called "ghost spots.' Can also cause cankers on stems when there is prolonged high humidity and lots of inoculum (spores).**

Gray mold is typically a weak pathogen that attacks dead or dying tissue. This pathogen is ALWAYS present in a high tunnel and can become aggressive if humidity is high and air circulation is poor. Manage by decreasing humidity through venting, opening end walls, rolling up sides, using fans and if necessary, by heating and venting to reduce humidity and condensation at night. Remove infected tissue from the greenhouse. With lower humidity, fungicides should not be necessary and should not be substituted for managing humidity.

- **Leaf mold (*Fulvia fulva*) symptoms-Looks like yellow polka dots on the upper side of the leaf with gray/purplish spores on the leaf undersides. Does not affect fruit.**

This disease typically starts low in the plant where air circulation is poorest. Choose resistant cultivars, prune off lower foliage and remove from the greenhouse and decrease humidity through venting, opening end walls, rolling up sides, fans and if necessary, by heating and venting to reduce humidity. With lower humidity, fungicides should not be necessary as long as the cultivar is not extremely susceptible to the disease.

- **Powdery mildew (*Oidium neolycopersici*). Symptoms-White coating of spores in patches on leaves. Can also cover stems.**

PM is becoming a more important greenhouse tomato disease. Favored by low light and high humidity. Decrease humidity through venting, opening end walls, rolling up sides, fans and if necessary, by heating and venting to reduce humidity. There is one resistant cultivar, Grace, from DeRuiter's seeds. Fungicides may be necessary to help manage the disease.

- **Late Blight (*Phytophthora infestans*). Symptoms starts as a water-soaked spot, usually higher in the plant. When humidity is high, there will be a white band of spores around the outer edge of the spot on the underside of the leaf. Can attack stems and fruit.**

Very aggressive. Keep humidity low through venting, opening end walls, rolling up sides, fans and if necessary by heating and venting to reduce humidity. When the disease is known to be in the area, fungicides and thorough coverage are necessary to protect crops. Choose resistant varieties. Destroy infected crops.

- **Blossom end rot (Abiotic). Symptoms-Dry brown rot at the blossom end of the fruit**

Caused by insufficient uptake and translocation of calcium to the fruit. Maintain uniform soil moisture.

Canker Diseases-Symptoms-if you notice a wilting plant in the greenhouse or scorching (browning on leaf edges) on foliage or on one side of the plant, eliminate the possibility of root rots and look for cankers (dead areas on the stem) that would interrupt the flow of water upwards in the plant.

- **Bacterial canker (*Clavibactor*)-Typically shows up once there is a fruit load on the plant as wilting or scorching on half a leaf or one side of plant. Look for dark streaking in the vascular system. Contact Diagnostic Lab for confirmation.**

Very destructive, can be easily moved around by pruning, tools. Destroy plants. Buy or hot water treat seeds to kill the bacteria at 122 F for 25 minutes.

- **White mold (*Sclerotinia*)-Fluffy white mold or brown woody dry cankers on stem. Black hardened sclerotia (overwintering structures-looks like mouse droppings) are present when stems are split open.**

May be more likely in wetter spots in greenhouse. Usually very hit or miss in a greenhouse. Cut stem off at soil line and remove and destroy plants so sclerotia are not allowed to drop into the soil.

- **Other canker problems-**Gray mold **(***Botrytis)* can cause stem cankers when relative humidity and inoculum is high. Late blight (*Phytophthora*) can cause stem cankers.

Growing Great Tomatoes All Winter in Minnesota

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When we decided to build our geo-thermal greenhouse, we chose to grow tomatoes because of the high value of the crop. We also chose to grow these tomatoes in the ground to aid in as much flavor and nutrition as possible. Growing tomatoes in the ground in the winter is not easy and we were warned away from this decision, but chose to do so anyway. It has been an adventure to say the least!

Our greenhouse is a 46' x 126' gutter-connect. The ground is heated with a geo-thermal ground source heat pump system and up until this winter ambient air was heated with two 300,000 btu propane heaters. This year we have in place a Log Boiler which is a very large gasification unit. Because it supplies up to 2,500,000 btu's it not only heats the geo-thermal house, but two smaller greenhouses as well.

Each bay consists of 4 beds 108' long, each containing 2 rows of tomatoes (or cucumbers, beans, etc) 18" apart. Tomatoes are also planted 18" apart in row. Beds are approx. 3' apart. The wide spacing of the tomato plants aids in air flow.

Plants are trained up tomato twine held on tomahooks. We usually wind at least 30' of twine per hook because the plants are in place for up to 10 months and will use all of that length. Tomahooks are hooked onto cable held at a height of 9'. Tomatoes are pruned and clipped weekly and usually hooks are unwound and tomatoes dropped every two weeks, or whenever they reach the cable.

Our original plan was to plant the tomatoes in August and hopefully harvest tomatoes by Thanksgiving. This rarely happened because of heating and light issues. This year we planted the tomatoes in July and they have been producing steady since September.

The beds were prepared with the addition of 1 inch of compost, Sustain fertilizer and dry kelp. Sheets of white ground fabric were placed over the entire bay with holes cut every 18" down the double rows on the beds. Tomatoes were planted directly into the ground through the holes and 1 gallon pots with the bottoms cut out were place around the tomato plants. These pots are later filled with more compost and fertilizer as the plants grow and serve to hold the stems off the floor as they are dropped during the year.

Fertilizer, either Sustain or Midwest Bio Ag Veggie Sol, along with kelp, some molasses and Soil Set will be added approx. every six weeks.

We monitor closely for disease and pest issues. We didn't have the roof panels in place right away during part of this last summer so the plants got rained on and developed some septoria. After closing in the greenhouse and with careful pruning we have mostly eliminated that threat. Pests were not much of a problem during the warm months but as cold set in we did have some mildew problems. This we treated with spraying sulfur potash and Serenade.

The biggest pest issue that we normally have are thrips and aphids. We have used in the past, and will use again, biological controls such as beneficial mites, pirate bugs, midges and parasitic wasps.

We also have additional lighting in place. Each bed has 18-400 watt HID lights. Lights are on automatic timers, one bay turning on at 4 o clock in the morning and turning off again at about 8 o clock. The other bay turns on at 4 o clock in the afternoon and off again at 9 pm. Lights are manually turned on all day when days are dark and cloudy.

Water is set up with orchard tubing and spikes. These ensure even water pressure all the way to the end of the rows. An automatic timer is used on individual rows, usually set at one hour giving about a half-gallon of water to each plant.

After trialing many different varieties of tomatoes, we have settled on a couple of favorites as well as continuing to trial more. Our main slicing tomato is Rebelski purchased from Johnnys Selected Seeds. For cherry tomatoes we like Favorita and Sun Peach, also from Johnnys. Currently we are also growing Bigdena and Frederik, both from Johnnys, and Caiman from High Mowing Seeds.

Since we have not been able to use the greenhouse up to its full potential until this year, yields have been spotty and low. This year, with better heating and greenhouse film in place, we anticipate yields up to or surpassing original projections.

This is the projected production for the 2015/2016 season (September to June). This year we planted only 5 of the 8 double rows in tomatoes. Cucumbers were planted in 2 of the beds and pole beans in one of the beds for the first planting in July. Another planting of cucumbers was planted in one of the beds and beans in another in November, as well as a bed of San Marzano tomatoes in the third. We do not have an estimate on production for the San Marzanos cucumbers or beans. If the entire greenhouse was planted to tomatoes the numbers below could be extrapolated out accordingly.

Cherry tomatoes, 1 ½ beds: 2700 pints @ average $2.50 per pint = $ 6750.00
Slicing tomatoes, 3 ½ beds: 12,960 lbs @ average $2.50 per lb = <u>$32400.00</u>
Total $39150.00

Root Crop Variety Trials

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Growers throughout the Northeast are constantly searching for the next root crop variety that will yield abundant, high quality roots and disease-free tops. Three trials located in Eastern NY examined these qualities in 31 carrots, 18 beets, and 8 parsnips during the 2015 growing season.

Background information: All three trials were hosted by the Hudson Valley Farm Hub in Hurley, NY. This farm has fine sandy loam soils. Trials were all grown organically and with optimum fertility. Carrots were grown on ridges, while beets and parsnips were grown on flat ground (raised beds would have been preferred, but the farm did not have a raised bed maker). Crops were all seeded using two vacuum seeders; a MS4100 MaterMacc vacuum precision planter for the parsnips and beets and an Olimpia Gaspardo vacuum precision planter for the carrots.

Beet methods and results: Beets were seeded on June 26th for an anticipated harvest date of September 25th. At harvest, two 20-foot sections were hand-harvested from random sites along 350-foot rows. Beets were graded into three classes: Small marketable (3/4 inch to two inch diameter), large marketable (two inches or more diameter), and culls (physical damage such as cracking or mouse damage, or smaller than 3/4 inch diameter). The results of this harvest are presented in the table below. No extrapolations have been done with these numbers to yield per 100 feet or yield per acre because we were not able to harvest a third subsample, and extrapolations may yield misleading numbers. Yields shown are based on actual harvests from 40 row-feet of each variety.

Variety	Small Marketable Count	Small Marketable Weight (lb)	Large Marketable Count	Large Marketable Weight	Unmarketable Count	Unmarketable Weight	Total Weight	% Marketable
Avalanche	177	15.4	97	20.4	140	7.9	43.7	82%
Boldor	133	11.4	47	11.2	106	4.6	27.2	83%
Boro	204	20.1	180	52.7	54	2.9	75.7	96%
Chioggia Guardsmark	244	27.9	80	17	138	7.6	52.5	86%
Detroit Supreme	159	13.9	87	23.5	44	1.1	38.5	97%
Eagle	147	14.6	143	29.4	60	1.2	45.2	97%
Falcon	20	1.8	98	46.7	2	0.9	49.4	98%
HV Brilliant	24	1.5	84	26.2	14	0.4	28.1	99%
Merlin	197	17.3	82	19.2	118	3.6	40.1	91%
Pablo	206	17	161	32.1	69	1.8	50.9	96%
Red Ace	168	17.5	137	35.3	82	2.9	55.7	95%
Red Cloud	**140**	**13.9**	**162**	**50.5**	**48**	**3.4**	**67.8**	**95%**
Ruby Queen	112	8.2	176	46.2	60	1.4	55.8	97%
Rhonda	173	14.8	117	27.2	159	4.4	46.4	91%
Robin	12	0.9	56	23	10	2.6	26.5	90%
Subeto (60 ft)	175	17.3	165	29.9	52	1.5	48.7	97%
Touchstone Gold	99	9.8	106	30.8	45	3.1	43.7	93%
Vulture	140	15.7	64	26.3	91	3.4	45.4	93%

The size distribution of these beets was based on a relatively heavy seeding rate and no thinning. If a grower were to thin the crop, an initial crop of baby beets followed by a crop of normal sized beets could be expected, likely with a higher total yield. Our results were impacted by crowding.

Carrot methods and results:

Carrots were also seeded on June 26th for a September 25th harvest. Carrot germination was quite uniform and three subsamples were harvested per variety, allowing for more confident extrapolation of numbers.

Variety	Marketable Count	Marketable weight	Un-marketable count	Total count	Unmarket-able weight	% Marketable	Total yield (lb)	Yield/100'	Yield per acre at 17200 row feet/acre
Baltimore	153	33.45	136	289	15.2	69%	48.65	81.1	13946
Bejo 2976	129	18.1	161	290	13.3	58%	31.4	52.3	9001
Belgrado	282	51.55	297	579	28.5	64%	80.05	133.4	22948
Berlin	146	44.2	117	263	22.9	66%	67.1	111.8	19235
Carson	170	53.6	155	325	18.3	75%	71.9	119.8	20611
Coreless Amsterdam	115	18.5	198	313	23.4	44%	41.9	69.8	12011
Crofton	249	23.5	196	445	11.8	67%	35.3	58.8	10119
Cupal	226	51.3	130	356	14.4	78%	65.7	109.5	18834
Envy	299	78.05	135	434	21.6	**78%**	99.65	**166.1**	28566
Goldfinger	323	61.1	169	492	17.6	**78%**	78.7	131.2	22561
Ingot	222	42.1	285	507	27.6	60%	69.7	116.2	19981
Juliana	125	39.8	158	283	29.75	57%	69.55	115.9	19938
Magnum	390	58.3	329	**719**	25.2	70%	83.5	139.2	23937
Miami	168	45.2	99	267	18.2	71%	63.4	105.7	18175
Mokum	167	27	160	327	17.9	60%	44.9	74.8	12871
Napoli	181	46.4	163	344	28.85	62%	75.25	125.4	21572
Naval	245	52.8	171	416	27.5	66%	80.3	133.8	23019
Navarino	222	44.9	116	338	17.8	72%	62.7	104.5	17974
Nayarit	109	25.5	165	**274**	25.6	50%	51.1	85.2	14649
Nelson	212	41.2	117	329	15.4	73%	56.6	94.3	16225
Nelson	204	48.4	121	325	20.7	70%	69.1	115.2	19809
Nerja	175	28.65	159	334	20.05	59%	48.7	81.2	13961
Nevis	140	15.5	94	**234**	16.5	48%	32	53.3	9173
Newhall	104	24.4	135	239	22.6	52%	47	78.3	13473
Norwalk	149	22.35	150	299	12.05	65%	34.4	57.3	9861
Rainbow	129	35.6	90	**219**	18	66%	53.6	89.3	15365
Romance	250	56.3	137	387	21.2	73%	77.5	129.2	22217
Scarlett Nantes	391	10.8	270	661	17	**39%**	27.8	**46.3**	7969
Siroco	137	19.15	162	299	13.25	59%	32.4	54.0	9288
SV2384DL	206	46.3	165	371	28.41	62%	74.71	124.5	21417
Vitana	348	55.9	231	579	20.1	74%	76	126.7	21787
White Satin	130	35.1	146	276	28.5	55%	63.6	106.0	18232

Notably, the carrots were quite dry during July, and experienced a few heavy rainfalls in late August and September. This variability in precipitation helped show clear winners and losers in cracking susceptibility. It is also worth noting that new cultivation equipment was not quite dialed in this season, resulting in soil being removed from ridge tops rather than a light hilling. This led to higher than average levels of greening, which was overlooked during the ratings. If the trial is repeated under ideal conditions, greening will be rated.

During a grower field meeting held on September 29th, samples of each variety were provided for tasting. The standouts for flavor from the trial were Baltimore, followed by Envy.

Additional information about the root crop trials, including pictures of each variety, are available on the Eastern NY Commercial Horticulture Website: http://enych.cce.cornell.edu/

Growing and Marketing Root Crops at Tangerini's Spring Street Farm

Laura Tangerini

Although our 67 acre farm has been around since the early 1800's it was established as Tangerini's Spring Street Farm in 1995. Located in Millis, Ma. We currently have 40 acres under cultivation, a display greenhouse, a propagation house, three high tunnels and a low tunnel. In 2010, we construction a three bay, climate controlled cold storage facility primarily for the storage of winter vegetables for our CSA. The farm's diverse operations include the growing and selling of a wide variety of vegetables and fruits using organic methods on all our crops with the exception of apples and sweet corn. Our fresh-picked produce is sold through our farm stand, our 325 member CSA that distributes from mid-April to mid-March, two local farmers' markets and a few wholesale accounts. The farm supports other local growers and producers as well as local fisherman by making their products available at the farm. Our family farm is a treasured piece of open space and a profitable agricultural operation whose doors are open to people in the Metro-West area. Over the years, Tangerini's Spring Street Farm has become a model for the preservation of open space for landowners who want to see their land remain productive while sharing it with future generations.

We grow a number of different root crops including carrots, beets, parsnips, rutabaga, turnip, winter radish and daikon. But for the purpose of this presentation, I would like to talk about growing carrots for winter storage. Of all the vegetables we grow, carrots are a mainstay for 99% of our customers. It's a vegetable enjoyed by people of all ages and it's an absolute must for winter and Deep Winter CSAs. Many people signup for our Winter CSA because of the carrots. The cold temperatures associate with the late season harvest, makes carrots a standout in the CSA share. Most carrots in the grocery stores come from much milder climates and the carrots don't sugar like carrots grown throughout New England. That's why it's important to grow and store them well.

When we started our winter share we knew we were going to have to raise more root crops, particularly carrots. We spent hours on our hands and knees tending to carrot seedlings only to save half of them. While we were spending our afternoons on carrots, other crops were getting neglected. After a couple seasons of struggling with trying to keep up with the weeding of carrots we developed a plan that works for our farm. Not only were the carrots much easier to grow, but we also freed up man-hours that could be spent on producing other crops.

We begin by performing a soil test. Two to three weeks prior to planting date, which is somewhere between July 15th and July 25th we start preparing the field. We till in the previous crop, subsoil or chisel plow the field, add our compost and the necessary amendments and prepare a nice seedbed using our 8' rototiller.

It is important to get as many weeds to germinate as possible prior to planting. If we are not getting adequate rainfall we will irrigate the field several times. By the time the field is ready to seed, our first flush of weeds will have germinated and it's time to flame the whole field. We use a Flame Engineering flamer that is connected to the three-point hitch of our JD5095MH. We run over the beds with the flamer with a tractor speed of 2-4 mph depending on weed pressure and soil moisture. The flamer uses liquid propane and emits about 1,000,000 BTUs. The flamer does a good job on annual weeds and sets the grasses back too. Immediately after flaming we seed the field with pelletized Bolero seed using a Mater Macc 4 row vacuum seeder. We drop 15 seeds to the foot. Only 80% of the carrots seeds will germinate so we a will get a stand of about 12 carrots to the foot. If necessary we will irrigate the field. When the carrots are just seeded we irrigate with Netafim Meganet. It put down even moisture without disturbing the seedbed. Five days after seeding we flame again for the last time. During the summer months our carrots can emerge in 6 to 7 days so it important to set the alarm on your phone to remind yourself. The last flaming will save you hours of weeding. When the carrots emerge our fields are clean of all weeds with the exception of some grasses here and there. With a July 25th seeding date we are able to mechanically cultivate carrot seedling by August 15th with our 4-row Fobro weeder. In total, one of our fields that has about 7000 linear feet of carrots required less than 6 man hour of hand weeding after using the Fobro weeder.

Carrots are harvested with the tops on all during the month of October. Harvesting for storage begins during the 3rd week of October. Carrots are lifted during a modified plastic lifter. The crew removes the tops while they are picking and crate them. By the end of the day any carrots that have been picked that day are washed in the barrel washer and packed in 15" x 30" vented plastic bags and put in bins that are eventually stacked three high our in a high moisture, low temperature storage unit along with our beets, parsnips, winter radishes, rutabaga, turnips, celery root and cabbage. Not only do we have carrots available all winter long but, they will be available for our farmers' markets in May.

We prepare the soil for parsnips as far in advance as we can which is often difficult in the spring. Parsnips are done in the same way carrots are except they take much longer to germinate so we wait about 2 ½ weeks for the last flaming of the field. We still use pelletized seed mostly because if there is an issue when seeding you notices it right away. Parsnips are one of the last roots we harvest. Harvesting in mid-November ensures that they are nice a sweet. We again wash them the day of harvest and pack them in vented plastic bags.

Beets are a little different because they emerge from the soil so quickly during the summer months, you can flame them a second time. Fortunately, they grow a little faster allowing us to mechanically cultivate earlier. To get good sized beets thin them to about 2-3" apart. For winter storage it is important to thin them while they are young. Trying to thin beets that are 6" high is difficult.
Winter radish, rutabaga and turnips are treated similarly. The seed bed is created just we do for carrots but flaming only takes place once, just before seeding.

Root crops are a must for many diversified farms and they can be profitable to grow if you take the time to develop a system that minimizes hand weeding.

Getting Ready to Store Root Crops: What You Need to Know

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To store or not to store, that is the question. Stored crops must start with minimal problems. Marketing can affect the length of storage as well as other issues. Storage can range from days to months. Root cellars, cool bots, and refrigerated rooms are different approaches to crop storage. Each has increasing cost inputs but result in increased storage length.

Refrigeration lowers the temperature of harvested crops and extends storage life. The amount of refrigeration required is a function of crop type and quantity, the difference in temperature from the harvested crop and the target temperature, cooling rate, among others.

For example, cooling potatoes from 70°F to 40°F in 15 days is a 30°F temperature difference with a cooling rate of 2°F per day. Using the specific heat of potato as 0.84 BTU/lb./hour. Cooling 20 hundredweight or 2,000 pounds of potatoes 2°F per day requires 3,360 BTU/day or 140 BTU/hour. Potatoes respire and give off heat which also must be taken into account. Using the heat of respiration as 0.42 BTU/lb./hour, 2,000 pounds of potatoes require 84 BTU/hour to cool the heat from respiration or a total of 224 BTU/hour to cool 2,000 lbs. of potatoes 2°F per day. Adding 20% for defrost cycles and a 10% overload brings the total to 296 BTU/hour. This does not take into account cooling efficiency or cooling loss.

Cabbige: A Price Optimization Tool for Small Farms

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The complexity of farm businesses demand the development and use of technologies that manage inventory, monitor market trends, inform pricing, and identify crop profitability to assist in crop-planning. Tracking the day-to-day details for 50+ crops and varieties in a way that is searchable, allows for meaningful analysis, and is actionable is nearly impossible using pen and paper, and only slightly less so using programs like Excel and Google Docs.

Bio-diverse farms need software that is designed specifically for their business that simplifies the manual tracking of data and, at the same time, delivers actionable analysis and insights that farms can use to continually improve their business. Cabbige was developed with these objectives in mine – to be the comprehensive business management tool designed for bio-diverse growers.

Cabbige began simply as a pricing tool – a bit of software designed to find the optimal price for a crop throughout the season by monitoring and measuring yield production and sales performance. The pricing tool is nothing more than a machine that is doing a lot of math behind the scenes, the same amount that would take most people hours, in a matter of seconds. And, the benefit of optimized pricing is clear: farms that piloted Cabbige in 2014 saw an average 9.6% increase in revenue. Identifying crops, markets, and points in time that would benefit from a price adjustment can have a demonstrable impact on a farm's overall revenue and profits.

The key to identifying the optimal price for crops is determining and monitoring a crop's sell-through rate – the percentage sold relative to the harvested inventory. For example, if 500 bunches of carrots have been harvested and 400 are sold, the current sell-through rate is 80%.

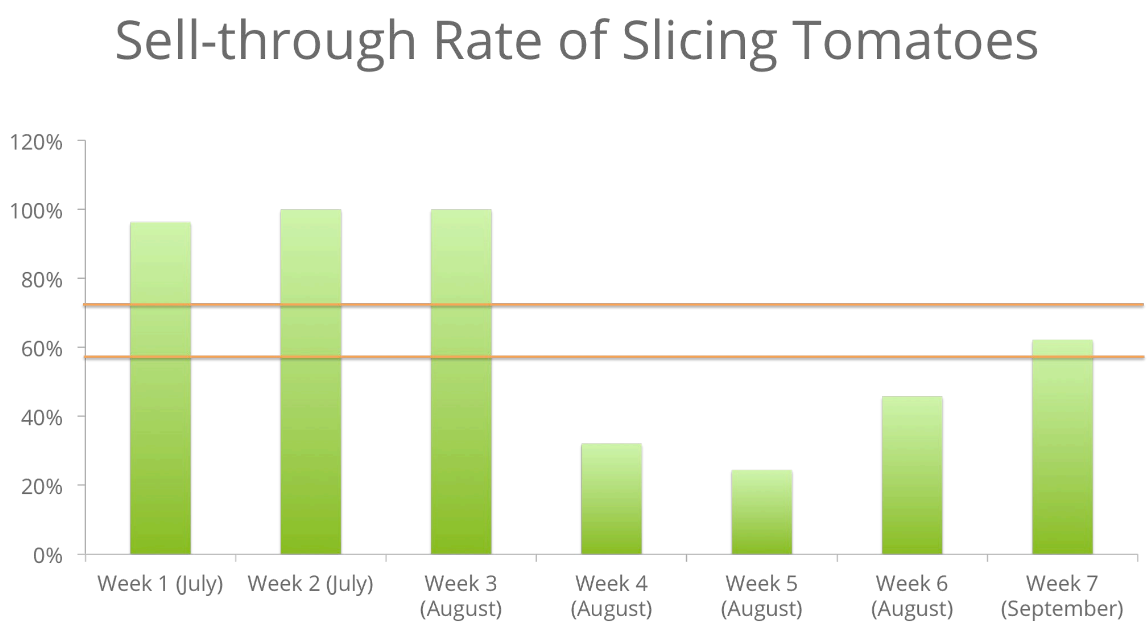
400 bunches sold / 500 bunches harvested = 80% sell-through rate

From there, we want to determine the *eRPU* or *effective Revenue per Unit*, which takes the price, amount sold, and volume harvested into consideration. If the carrot bunches sell for $3.00/bunch, the total revenue is $1200.00 and the *eRPU* is $2.40.

$1200 Revenue / 500 bunches harvested = $2.40 per unit revenue

The next step is to determine if dropping the price to $2.75 would yield more than $1200 revenue – would the farm be able to sell more than 436 bunches, the amount needed to exceed the $1200 revenue benchmark. Or, would the farm earn more revenue by raising the price to $3.25, in which case, only 369 units would need to be sold? Or, should the price remain constant at $3.00? Cabbige analyzes past sales performance to inform the final price recommendation, which is updated daily, in a way that growers would do, if they had many hours to dedicate to these exercises.

A real world example of the need to optimize prices throughout the season is slicing tomatoes. In this case, we tracked the sell-through rate of slicing tomatoes from the start of the season in July through September.



The market dynamics are quite clear: consumer demand is high at the start of the season and would support a premium price; as inventory increases and consumer demand wanes, the sell-through rate falls dramatically and begins to recover towards the end of the season. This is an ideal use case for price optimization, to ensure that revenue is maximized, even as market conditions change. Cabbige does the monitoring and calculations in seconds, allowing farms to benefit from the analysis without the manual calculations.

The salient point to remember, and what will be discussed in further detail during the session, is that software has the ability to dramatically improve farm businesses by taking on the burden of these calculations and analysis, executing in seconds what would take many hours of manual calculation. Leveraging software tools will be the key to building the next generation of farm businesses.

Apps for Pest Management

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Smart phones and tablets are becoming much more common place today on the farm. There are practical applications for these phones aside from taking selfies and posting them on Facebook or Instagram. Numerous applications (apps) are available to assist farmers with their pesticide management. Apps are available for mixing and loading, sprayer calibration, pesticide recordkeeping and selecting the appropriate sprayer tips. There are also apps for pest identification, agricultural news and weather. Other useful apps include a flashlight, calculator, notes, voice memos, camera, timer and reminders.

One simple way I use my phone is when I am filling my 300 gallon produce sprayer I set my timer on my phone for 30 minutes. I know it takes about 40 minutes to fill it, so in case I get distracted and forget the alarm will sound and remind me. More than one once I was reminded by my phone I need to go back and check the sprayer before it over flowed.

More apps are being developed all the time and more are out there than I have listed. This is list of some free apps that I have found to be the most user friendly and potentially helpful for farmers.

Tank Mix Calculator for iPhone + Android

Build pesticide tank mixes for your fields. Build a spray recipe from our database of 11,000+ pesticides by simply entering area, tank size, total spray volume per acre and choose pesticides. Tank Mix Calculator generates a Bill of Goods, calculates each individual load and number of loads required to cover acreage.
http://www.farmlogic.com/farmlogic_products/tank-mix-calculator/

TankMix App for iPhone only

The DuPont TankMix Calculator Application lets you quickly and easily calculate how much product and water you need for effective applications based on your acreage or spray tank size. Choose from a wide selection of units of measure and work in either numerals or fractions.

Calibrate My Sprayer for iPhone + Android

Improperly calibrated pesticide spraying equipment may cause either too little or too much pesticide to be applied. This free mobile app was created to aid in the proper calibration of spraying equipment. Simply select the type of sprayer you want to calibrate (Broadcast or Banded), insert values in each input box, select what you want the app to calculate (Volume/Area or Catch/Nozzle), and tap 'Calculate'. Each input's units can be customized by

tapping the units. Sprayers can be saved with user-defined names.
http://www.clemson.edu/extension/mobile-apps/

Mix Tank for iPhone + Android
Very similar app for Growmark Products called **FS Adjuvants**

Mix Tank is designed to assist agricultural applicators with the proper tank mixing sequence of crop protection products. Mix Tank also captures product use rates and application information with Mix Sheets and conveniently maintains accurate Spray Logs for easy record keeping.
http://www.mixtankapp.com/

TeeJet Technologies (Spray Select)

The TeeJet Technologies SpraySelect App allows you to quickly and easily choose the proper tip or nozzle for your application. Just enter speed, spacing and your target rate, Select your drop size category and you have a list of tips that will work for your application. The right nozzle is just a few seconds away.http://www.teejet.com/english/home/products/spray-products/sprayselect-tip-selection-app.aspx

Other Useful Apps

Ag Weed ID for iPhone + Android

Ag Weed ID is an in-hand tool to help producers identify weeds during scouting in 6 major row crops (corn, cotton, rice, sorghum, soybeans, and wheat), from the experts at Penton Farm Progress Group. Our database includes information and images for about 75 of the most common weeds, and enables you to narrow your search by crop, season, and location so that you can compare weeds that might be relevant to you right now.

ID Weeds for iPhone + Android

ID Weeds is produced by the University of Missouri's College of Agriculture, Food and Natural Resources' Division of Plant Science.

AgWeb for iPhone + Android

Get the latest agribusiness news and advice. Read ag management news, farm business blogs and articles from one trusted source | AGWEB.com

DTN/The Progressive Farmer for iPhone + Android

This app meets your information needs with access to award-winning agriculture news, commodity market data, and industry-specific weather intelligence.

Lancaster Farming for iPhone + Android

Weather Underground for iPhone + Android

This weather app I like most for the radar. I also like the ability to look up personal online weather stations and see rainfall amounts in real time.

SoilWeb for iPhone and Android

This application uses the GPS built into the smartphone to acquire your current location, and then submits an HTTP request to a server via the SoilWeb API. A graphical summary of the soils mapped at your current location is presented on screen, with links to details through an online soil survey, or via the USDA-Natural Resources Conservation Service official series description archive.

GAP Certified

The GAP Certified app provides on-the-go data entry to help farmers meet the requirements for GAP certification. Designed for users of GAP Certified, this app allows you to enter data on your phone or tablet that will then sync with your account. From recording wildlife sightings to tracking storage temperatures, you can enter the details you'll need for the reports that are required during your annual GAP audit. The app is free but requires a subscription of$29/month or $319/year. However it may be beneficial for someone required to be GAP Certified. http://www.gapcertified.com/

Andrew Frankenfield is an Extension Educator in Montgomery County on the Field Crops and Forages Team with Penn State Extension. In addition to working with field crop farmers he also works with vegetable producers in the area as a result of his vegetable knowledge since he also is a vegetable producer himself. He has his B.S. degree in Agribusiness and his M.B.A in Food and Agribusiness both from Delaware Valley College. He lives in Souderton on the family farm with his wife Tanya and three children Delaney, Tanner and Sage.

My IPM, a New Smartphone App for Strawberry and Peach Disease Management

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Abstract
We developed a new smartphone application, MyIPM, to promote Integrated Disease Management for sustained peach and strawberry production in the southern United States. *The app is available in the Google Play Store and Apple Store*. It features about a dozen of the most important diseases and disorders of the two fruit crops. For each disease/disorder there are pictures of signs and symptoms, descriptions of the causal agent, and a 2-min audio from the regional specialist. The app features chemical and biological control options, including a list of registered active ingredients for each disease that are sortable by FRAC codes and southeastern spray guide-published efficacy. The app also features field EIQ values as published by the Cornell IPM Program. The active ingredients are linked to registered trade names. MyIPM also features some audio recordings from regional specialists on peach and strawberry IPM issues. Our vision is that this app provides a valuable tool for growers and specialists alike that supplements current spray guides. The unique display of active ingredients, color-coded by chemical classes, provides a useful tool to promote resistance management. MyIPM is fed by an external database that can be updated through an authoring tool and is free of charge. It is expandable to more crops and could, with minor programming modifications, also be useful for entomologists. MyIPM provides Integrated Pest Management (IPM) information to conventional and organic producers of strawberries and peaches in the Southeastern United States. The target audience includes commercial growers, farm advisors, and specialists, but homeowners will also find useful information.

Specific Features
The welcome screen lets the user choose either strawberries or peaches. On the main page he may slide through pictures of diseases from left to right or right to left or pick a disease from the dropdown menu. For strawberries the app features Angular Leaf Spot, Anthracnose Crown Rot, Anthracnose Fruit Rot, Botrytis Crown Rot, Charcoal Rot, Gray Mold, Leaf Blight/Spots/Scorch, Leather Rot, Phytophthora Crown Rot, Powdery Mildew, Red Stele, and Verticillium Wilt. For peaches the app features Alternaria Fruit Rot, Anthracnose Fruit Rot, Armillaria Root Rot, Bacterial Spot, Blossom Blight, Brown Rot, Constriction Canker, Gummosis, Leaf Curl, Peach Scab, Peach Tree Short Life, Rhizopus/Gilbertella Rot, and Rusty Spot. Tapping ‘Summary/Gallery/More' opens the Summary page, which provides an overview and a short two to four minute audio from a regional expert. The GALLERY features up to six pictures of disease signs, disease symptoms, schematics, or photographs of management options. The user can zoom in on each picture by tapping and spreading with two fingers. In the MORE section, the user finds information about the disease and its causal organism (including Symptoms and Signs and Disease Cycle), Chemical Control information, Fungicide Resistance in the eastern U.S., and Non-Chemical Control information (including Biological Control Options, Cultural Control Options, and Resistant Varieties).

Back on the main page, underneath ‘Summary/Gallery/More are links to Active Ingredients and Trade Names for the featured disease. For example, on the page displaying Strawberry/Angular Leaf Spot, when tapping Active Ingredients the user can choose between Conventional (Acibenzolar-S-Methyl) and Organic (Bacillus amyloliquefaciens, various coppers, hydrogen dioxide, and neem oil) materials. Active ingredients are color-coded according to FRAC Code. Efficacy values from the regional spray guide as well as Field EIQ (Toxicity values) Cornell IPM Program are also listed and can be obtained by sliding the right half of the table. FRAC Codes, Efficacy and Toxicity values are sortable. When tapping an active ingredient in the left column, a new table appears listing the registered Trade Names that contain that active ingredient. Back on the main page, tapping Trade Names displays all available products for this specific disease for conventional and organic production separately. Also featured in the sliding table are the Active Ingredient, Rate/Acre, PHI, REI, and Toxicity values. Again, all components in the sliding table are sortable. In order to quickly display Active Ingredients and Trade Names for a specific disease, the user can choose a different disease from the dropdown menu on the top right. For example, starting from strawberry/Angular Leaf Spot/Active Ingredient, the user can select on the drop down menu the next disease (Anthracnose Crown Rot). Different Active Ingredients are displayed that are registered for Anthracnose Crown Rot management (displayed in active ingredient column are: azoxystrobin in green, boscalid;pyraclostrobin in red and green, captan in black, and more). Note: For some diseases (Charcoal Rot or Verticillium Wilt) no active ingredients are registered and only the empty table is displayed. Back on the main page, under General/Fungicide Resistance are three choices: FAQs, Guidelines for collecting and mailing your samples, and Situation in the Eastern U.S. Under FAQ are questions and corresponding answers; 'Guidelines for collecting…' lists text and pictures; and 'Situation in the …' lists one paragraph of text. Back on the main page, About MyIPM features more information about who made the app, the sources for Active Ingredient and Trade Name tables and links to the sources. Back on the main page, the Feedback button allows users to contact the main author of the app. Upon tapping this link, an email message in the outbox is prepared.

Future Developments

Work is in progress to add blueberry diseases to MyIPM. We are also working on a pest version of MyIPM (MyIPMpests) to feature first blueberry pests and later peach and strawberry pests.

Pros and Cons of UAV's in Agriculture

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Everyday there is new information on UAV's, UAS's, or Drones in the news and in Agriculture. Everyday there is someone on YouTube with a UAV Video. The current "theme" is to keep learning, stay in touch with the Regulations and don't be stupid. I will provide the pro's and con's of UAV's, help producers understand why they might want to look at this technology, give them examples and provide questions on if they are really suitable to use this technology.

I suggest following these sites for continuing updates and technology information. (No Endorsements are intended)

FAA: http://www.faa.gov/uas/

http://knowbeforeyoufly.org/

Search the FAA Sect 333 List (Nov 2015 - 2215 granted)
https://www.faa.gov/uas/legislative_programs/section_333/

Public Discussions:

Search and Join and Discuss with groups on Facebook and Twitter

Chad Colby : http://www.agtechtalk.net/

Rory Blog : http://aerialfarmer.blogspot.com/

Small UAV Coalition : http://www.smalluavcoalition.org/

Company Discussions:

DJI : http://www.dji.com/

Drone Deploy : https://www.dronedeploy.com/ag

Flying Ag : http://flyingag.com/

Ag Eagle : https://www.facebook.com/AgEagleLLC

University discussions:

eXtension: https://learn.extension.org/ Search UAS

Facebook: https://www.facebook.com/learnuasag/

Twitter: http://twitter.com/learnuasag

Website: http://www.learnuasag.org/

Sweet Corn Genetics: Where We Are and Where We Are Going

Blake Myers
Independent Consultant
Siegers Seed Company, Holland MI

Genetic Ancestry
Corn has apparently been cultivated for thousands of year. Its exact origins may date back as far as 10,000 years, but corn's exact history becomes cloudy from the lack of accurate records. Myth and folklore also obscure its origins. It is possible, but not absolutely certain, that corn arose from teosinte. Corn is surely one of our most important cereal crops and is the most widely grown feed grain in the U.S.A. Completely dependent on mankind, it doesn't exist in nature without our nurture.

Breeding
For millennia corn was open pollinated (O.P.), bred by selecting the most desirable ears from the most desirable plants. Favorite strains or varieties became available. Around the late 1800's to the early 1900's breeders began crossing pure line varieties and the resulting crosses were our earliest hybrids.

Around the end of the great depression, roughly 1940, the use of hybridized varieties exploded and today, the vast majority of corn acres are covered with hybrids. Hybrids are characterized by stability, improved disease tolerance and "hybrid vigor." Hybrids also give breeding companies the incentive to pour resources into the development of new varieties.

Genetic Engineering, for traits such as insect tolerance and herbicide tolerance, arrived on the commercial scene in the mid to late 1990's in sweet corn. New varieties are being developed with improved insect and herbicide tolerances as well as draught tolerance.

Gene Types (Mutations)
Simply put, corn wouldn't exist without mutations and sweet corn wouldn't be "sweet corn" had it not mutated from hard corns.

Much of today's breeding has been built on a platform of 3 major modifier gene mutations: Sugary (su-1), sugary enhancer (se) and shrunken-2 (sh-2). These are random mutations that occurred in nature.

There are also several other major modifiers including brittle and brittle-2 genes. A few of today's synergistic varieties utilize the brittle-2 modifier. The brittle-2 mutation behaves similar to the sh-2 gene, so for most growers, it is not necessary to make the distinction. All of these major modifier mutations are naturally occurring and were recognized by breeders and utilized in conventional breeding practices.

More recently, breeding has focused on double and triple mutants. Remember, to be sweet corn, it needs a double recessive gene from at least one of the major modifiers listed above. However, there's no reason why it cannot have genes from more than one of those genetic mutations. Double and triple mutants include the <u>synergistic</u> and <u>augmented</u> supersweet classes. Among the progressive roadside and commercial growers, those two classes dominate today's market. With these advances, pericarps are tenderer, sugar levels have increased, and quality has improved. Conventional synergistic and augmented varieties are developed using traditional breeding practices.

Vigor – Seed and Plant

Stand establishment is essential for yield. Seed production companies learned that they needed to handle the harvest, milling and treatments of these varieties differently than the starchy varieties of the past. Many growers have also adapted better practices, realizing that the conditions on the initial planting day has a significant outcome on the final crop.

Variety vigor is talked about as if it is a single, solitary characteristic. Simple observation of your sweet corn emergence should have you thinking differently about vigor. "Seed" vigor is that vigor which begins the moment that the seed imbibes, and facilitates the growth of the embryo the first several weeks. Somewhere around the 2 to 5 leaf stage, the "plant" vigor begins to overshadow, but not correct for, seed vigor.

A low starch content in the endosperm of today's highly mutated, high quality sweet corn seed can often be related to low seed vigor. So generally, there becomes a negative correlation between modern high sugar varieties and vigor.

SuperSeedWare®

Through traditional breeding practices, Abbott and Cobb, developed a patented trait referred to as SuperSeedWare®. Although the seed that you plant in the field is well filled out (not of a shrunken appearance), they have managed to breed high quality hybrids that retain a long field or shelf life. These varieties hold the promise of improved cool season emergence, stronger root systems and even trimming a few days off of the maturity. A&C is in the process of rapidly converting their popular and promising hybrids to SuperSeedWare®. Abbott and Cobb already offer a number of varieties with SSW®.

sh2-i Gene

Crookham, and likely other breeding and production companies, are improving their seed quality using a conventionally bred trait called the sh2-i gene (a.k.a. shrunken-i gene). In the <u>seed</u> production fields, the endosperm is converted to starch, yielding vigorous, easy to plant seed with improved cold soil emergence over similar high quality varieties without the sh2-i gene. However in the hybrid sweet corn field, the grower's ears are sweet and tender. Several varieties are already commercially available.

Kernel Color

Look for improvement in kernel color, especially white kernels. Fresh, bright looking kernels are key to an attractive ears. Even in bicolor corns, attractive contrast is achieved by having a brilliant white kernel instead of a dark yellow kernel. Through traditional breeding practices A & C has developed their HiGlowMS® varieties with improved kernel color. Work is also taking place to release a "dominate" white kernel, instead of the recessive white kernel used in today's hybrids. A grower would no long need to worry about yellow kernels crossing into his white fields. It would also make other color combinations possible, such as bicolor corns with a higher percentage of white kernels and possibly even tricolor corns, if an eye appealing third color is developed.

Quality

Quality is still improving also. High quality varieties of just 10 or 15 years ago are now marginal, as many more varieties achieve super high quality status. This year I was fortunate enough to sample varieties with improved pericarp, texture, and flavor combined with 21% brix!

Disease Tolerance

Northern corn leaf blight is showing up earlier and more virulent than in the past. Varieties that had exhibited at least a moderate level of tolerance are sometimes showing full susceptibility. New strains of NCLB are probably appearing, and work is being done for a broader range of tolerance.

New strains of rust are also appearing. Illinois Foundation Seed has done an excellent job of breeding tolerance to these strains and often their new hybrid names are followed by the designation "XR" for the new rust resistance or "MXR" for maize dwarf mosaic virus tolerance and tolerance to the new races of rust. Conventional breeding was used for these resistances.

Summary

Today's choices of sweet corn varieties are probably more varied than at any time in history. From the plethora varieties in seed catalogs or on the internet, growers can choose from an abundance of heirloom (O.P.) varieties, conventional hybrids or genetic engineered varieties. Choices come in a range of colors, maturities and gene types. The future holds the promise of improved yield through better vigor and disease tolerances. Additionally, expect potentially more eye-appealing varieties with improved kernel color and longer retention of a fresh husk appearance. Tenderness, texture, sugars and flavor continue to improve.

Producing the World's Best Popcorn at Hurricane Flats Farm

Geo Honigford
Hurricane Flats Farm
South Royalton VT

If you can grow sweet corn, you can grow popcorn, so I'll spend most of my time talking about harvesting, drying, shelling, cleaning and marketing popcorn. I grow two acres in a two row system. My spacing is a bit tighter then normal with two rows in a 48" bed, but my yields are the same that they are getting in the Midwest. I fertilize with either chicken manure or soy meal, I keep it very clean from weeds, and never side dress. I plant in early May, as the popcorn is a hardy seed and the plants can take a frost.

I pick when you can press into the kernel with your thumb and not leave a mark, usually in early November. I use a one row corn picker that also husks it and drops it in a gravity wagon. The husking bed only husks, 85% of the ears, I think this is largely because the bed is designed for the larger diameter dent corn. The unhusked ears do not inhibit drying, but do add more trash that needs to be cleaned out of the corn.

Now the real challenge starts, drying. Popcorn will pop at 15.5% moisture content, but will mold if put into long term storage. It will also not pop below 12.5%. My range is between 13 – 14.5% moisture content. Popcorn of different moisture levels will even out the moisture content if placed into the same storage container. If you apply too much heat (above 100 degrees) the kernels can crack and then will not pop, it is also hard on the kernels to shell them if they are too wet. Most popcorn is dried on the ear and shelled when it reaches the correct moisture level.

In the Midwest, they are picking popcorn out of the field at around 15-18%. We are picking it here at 23%. However, we do have the advantage of a having cold dry winters, which prevents the molding of the wet popcorn. You have so many degree days to dry it down from the time you pick it to when it starts to mold. You can crib it, but it can take a long time to dry and you have a slight risk it not being dry enough to shell. I've seen popcorn gain 2% points through a single rain event, so it will reabsorb moisture from the atmosphere very rapidly. One year we were shelling in June, which is dangerously close to July and August when the humidity climbs and it becomes difficult to dry popcorn.

We have built a drying bin, as there is no commercial dryer built for growers of our size. It is a plywood box 8' x 4' x 8' with a grain drying floor and a plenum below that. I holds 2000 pounds of ear popcorn, but it drys more evenly when we load it with around 1400 lbs. We blow heated air into the plenum, with the whole system set to a humidstat. If the atmospheric humidity gets to high, we are no longer drying rather adding humidity. The humidstat shuts down system if the air becomes too wet.

When it is dry, we conveyor it out into a pto sheller. These are no longer made as they are built into combines. We can shell about 70 pounds in two minutes, which is lightspeed over the shellers that do one ear at a time. The only draw back is that the sheller is so aggressive it chews up the cobs and adds more trash to clean out of the popcorn. We pour it in food grade barrels that hold from 120 to 440 pounds of popcorn. At the right moisture content, it will store for years in the barn.

We clean it using a clipper 2-b. These are easier to find then pto shellers, but you might have to make a drive to the Midwest to grab one. Because the high amount of trash I have rigged up a bouncy house fan to the cleaner to blow more particles out of the system. It does a fair job of cleaning it, but we do end up with some "wings" in the corn and some pieces of cob that are the same size as the popcorn. This bothers me some, but in the 6 years I've been growing 5-7,000 pounds of popcorn, I've heard zero complaints.

We sell some in bulk, but most of it goes in 1.5 pound preprinted zip lock bags. We bag it using a bulk food bin (like the coops use to sell grains) with the sliding door. We need a faster bagging option, but the next step up is rather expense. I've got a few ideas to speed up the process, but no time to develop them as yet. We sell it direct to our customers and through three stores. We control the supply to ensure that customers can get it year around at these places. People love it as we are not even close to meeting demand. More stores want it then we can supply.

It costs us $1.53 a pound to grow, process and bag popcorn. Our average price is 2.08 a pound. Thus, we are making .55 cents profit on every pound of popcorn we sell. As typical of a report of this nature, I'm only writing a small fraction of what I've learned.

Managing Bird Problems in New England Sweet Corn

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Bird problems in sweet corn can be very frustrating. Most problems occur at two growth stages. One is the seedling stage, and the other is the milk stage, just as harvest is imminent. The species that cause problems vary greatly from farm to farm. Most birds that give us problems in sweet corn are flocking species. They tend to be easier to scare off than resident pairs, which establish and defend territories.

Seedling stage problems

In New England, the most common offenders are crows and ravens. They walk down the rows, pull up the plants one after another, and eat the seeds that are attached. These are intelligent birds, capable of learning from their experiences, and remembering feeding opportunities from the past. They are protected by international treaty (Canada/US/Mexico), also federal laws, state laws, and sometimes local laws. Actually, there are two species of crow here (fish crow and common crow), but the visual differences between the two are so subtle, most people cannot distinguish them except by voice. I suspect common crow is the main offender. Ravens are rare in southern New England, and common in Maine and the northern halves of Vermont and New Hampshire.

Taste repellant: In Vermont, New Hampshire and Maine a chemical taste repellant (9,10-anthraquinone or Avipel) is registered to deter birds from pulling up sweet/field corn seedlings. I believe they are all 24c (state and local needs) registrations. New Hampshire's expires in July of 2016; Maine's is good through June 30th, 2017; Vermont's expires in December 2016. The material can be very effective. The registrant is Arkion Life Sciences LLC. The product is available in dry and liquid forms, and is applied to the seed at planting time.

An East Hartford, CT grower reported success in constructing what I'd call barriers. Other CT growers found it worked as well. They lay out a zig-zag pattern of tomato stakes lengthwise through a block of emerging corn and attach fishing line that runs from stake to stake the length of the field. The crows quickly learn that it is an unsafe place to land. When the corn is over 6-8" tall the growers move the stakes and line and move it to the next emerging planting.

Some New Hampshire growers have had success planting into standing stubble. That makes the seedlings less visible for the vulnerable period. Once the plants grow enough to be well rooted, the birds have difficulty pulling them, and damage stops. Auditory or visual scare devices might work, but might be a lot of work to set up. For seedling problems, protection is required for a relatively short time.

Milk stage problems

Many bird species can peck the ears, but the most common seem to be crows, ravens, starlings, and redwinged blackbirds. One large flock can peck into many ears in just a few minutes.

Managing milk stage bird problems can involve various techniques. In general, <u>combining</u> scare techniques yields greater success than relying on just one method. Also, changing methods over time really helps. If the same old method is employed day after day, the birds quickly learn it isn't a threat. Crows and ravens are particularly quick learners with long memories. **Visual scare devices** include air crow, silhouettes, scare eye balloons, and flashing tape. Air crows are relatively new. They consist of a fabric sleeve with head and arms, attached to a blower. Turn the blower on, and the fabric sleeve jumps up and dances until the blower is turned off. The air crow and blower cost about $200. You'll probably get better visibility by raising it up a bit on a platform, especially if it is in a tall crop like sweet corn. If you don't have electricity at a site, you might consider a portable generator. Coyote silhouettes and owl effigies are examples of visual devices that do not incorporate movement (usually) and therefor often have lower success than something that moves and/or provides sound. An additional problem with silhouettes is that they are not visible from some angles, including above. Scare-eye balloons are often tethered on tall stakes, to make them visible above the crop. By themselves they have limited effectiveness, but combined with other devices (noisemakers for example) they can be effective in sweet corn. One static visual technique that is very effective on crows and ravens is to suspend a dead crow by the leg (with a wing loose & dangling) in the field. The appearance can be distasteful to customers, so might not be appropriate in some spots. Some growers in my state shoot one or two crows during the legal season for them (Aug 15 to Nov 30 in NH this year), and then double bag them in plastic, and store in the freezer until needed.

Auditory scare devices include cannons, screamers, bangers, firecrackers, and electronic distress calls. The ones that can vary the timing and type of noise are generally more effective than those that do not. Propane cannons are still used in some situations, but are VERY ANNOYING to workers, customers and neighbors. They have been the cause of some serious lawsuits. Birds quickly get used to them, but people do not. Screamers and bangers are examples of pyrotechnic devices that are fired either from a launcher or sometimes from a shotgun. Aim them at a group of birds in your crop. Screamers make a loud scream starting when they leave the launcher, lasting two or three seconds. Bangers create a mild report when fired, and then they sail out over the flock and explode 20 to 50 yards away from the launcher. Both are fairly expensive per shot, and often require permits to obtain and use. They are most useful to move out a flock that has landed in your fields.

Taste repellants: A product [Avian Control, by Avian Enterprises LLC, Jupiter, FL] containing methyl anthranilate is registered in several New England states, on a wide variety of crops. Methyl anthranilate is artificial grape flavor. The product can be sprayed or fogged, and some users report better success with fogging. One NH grower used it to prevent pecking on sweet corn ears in both 2014 and 2015. He had some success with it in 2014, and suggested it should be started before pecking begins. It is expensive. He also reported honeybee kill associated with spraying Avian Control and an insecticide at the same time.

Natural repellants: A live, active aerial raptor (hawk for example) is an extremely effective deterrent. In a few New England towns, falconers are available, and might be able to scare off flocking birds. Various state laws affect if, where and when this can be done. If you are lucky enough to have nesting hawks on your farm, leave them undisturbed and they'll work for free.

Lethal control generally means shooting, but very rarely wildlife authorities give permission to utilize poisons. The main effect of shooting is scaring off the survivors, rather than reducing pest numbers. It is regulated by laws and statutes which differ greatly region to region. Also, many growers would be harmed by the "farmer Rambo" image that shooting might create, if it was viewed by customers or neighbors, especially those who like to post things on social media. Shooting protected species could land a person in serious trouble, so ask before you shoot.

Genetics/varietal characteristics can be employed. Sweet corn varieties that have the tips of the ears exposed or poorly covered by husks often suffer more pecking than those that have good tip coverage. Sometimes vegetable specialists and seed companies list this characteristic, when reporting on varietal performance. Another characteristic is less frequently reported: the angle between the ear and stalk. Varieties with less upright ears provide handy landing spots (the ears) for birds. Those with lower angles have smaller perching/landing spots.

"Topping" is a practice that is not often used in my state, but may work for you, especially if you have a site where corn is regularly attacked by birds. After the ears have been pollinated, cut off the stalks above the ears and haul them away. It requires a bit of labor, but reduces bird pecking (perhaps because birds feel exposed). It is reported to make picking faster as well.

References/More Help

USDA/APHIS/Wildlife Services has offices throughout New England. In addition to excellent help, they also have the authority to offer some control options that are regulated (lethal controls for example). For Massachusetts, Connecticut or Rhode Island growers, the office is in Amherst, Massachusetts: 413-253-2403. For Vermont and New Hampshire, the office is in Concord NH: 603-223-6832. For Maine it is in Augusta: 207-629-5181.

A publication on UNH Cooperative Extension's website, to be downloaded for free, is Bird Damage Prevention for Northern New England Fruit Growers
http://extension.unh.edu/Agric/AGPMP/PMPIPM.htm

My older publication describing how to attract hawks & owls to nest is also on our website. The title is Raptors in New Hampshire Orchards
https://extension.unh.edu/resources/files/Resource000014_Rep14.pdf

Labels for bird control sprays are sometimes hard to find. A few are on the www.cdms.net website. The most reliable sources for labels are the manufacturers' websites, which is why I listed manufacturers in the article.

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Grape Pests and IPM Practices for Cold Climate Cultivars

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The Cold Climate (wine) grape industry is a new and rapidly growing industry in northeastern and upper Midwestern states, based on cold hardy, *Vitis riparia* hybrids. Despite the innate disease resistance of many of these cultivars, insect and disease management is one of the biggest viticultural challenges in the Northeast, partly due to the extremely humid climate. An Integrated Pest Management (IPM) strategy can be used to successfully manage vineyard pests, while minimizing negative impacts such as chemical inputs and pesticide resistance.

What is IPM?

Integrated pest management (IPM) is a sustainable approach to pest management that *combines* cultural, mechanical, biological, and chemical tactics, while *minimizing* economic, human health, and environmental risks. Management decisions are made utilizing all information available including weather, pest pressure, etc. The goal of IPM is to *manage* pest populations and damage within an acceptable level, rather than eliminate them completely. Insects and diseases are carefully monitored, and thresholds are set for unacceptable damage levels. Control measures are employed when it is determined that the thresholds may be breached.

In some cases, pests (especially diseases) may reach the threshold before we can detect them: i.e. spores may be discharged during rain events, spreading inoculum around the vineyard, but symptoms of disease will not be present until much later. In these cases, educated management decisions are made based on other information, such as pressure in previous seasons and weather conditions.

IPM Practices

Cultural

- **Vineyard Site:** Good soil conditions, air drainage, and sun exposure are all things to consider when choosing where to plant. Excellent conditions are the first step to growing healthy vines, which will be less susceptible to many pests.
- **Plant material:** Choose cultivars with pest resistance, suitable for your area. A resistant plant will require less work and few inputs to keep them healthy. Vines with the appropriate hardiness for your site will sustain less winter damage and making them less susceptible to many diseases.

Mechanical

- **Canopy Management:** Most grape diseases thrive in moist, slow drying conditions. Managing the canopy to increase airflow will reduce disease. Canopy management also increases sunlight penetration. The UV radiation is effective at killing many diseases.

- **Sanitation:** Many vineyard diseases overwinter on dried stems or berries from the previous season. Therefore, it is very important to remove as much dead plant material as possible and mow the vineyard floor to chop up debris during the dormant season.
- **Protection:** Vertebrate pests (deer, voles, turkeys) are a serious threat to grape vines. Protecting your valuable investment with fencing is almost a necessity in the northeast. Grow tubes can also be used on new vines to protect from deer browsing.
- **Weed control:** Maintaining good weed control will reduce habitat for insects and diseases. Weeds also act as an ideal food source and habitat for rodents in the winter time; voles and mice will tunnel under the snow to feed on weeds and then girdle vines.

Chemical

Chemical pesticides are an essential part of effective insect and disease control in our area. For the most successful pest control, appropriate materials should be used to target specific diseases at critical life stages. Whenever you are spraying ANY pesticides remember:

- **The label is the law.** Read it before mixing your tank and applying. Only apply as directed, including the site/crop, rates, and personal protective equipment specified.
- **Rotate groups.** Using the same material over and over can lead to resistance. This means the insects and diseases will build up a tolerance to those materials, and you'll have to eliminate them as control options. So use more than one product. Look for the FRAC or IRAC group number and rotate these groups between consecutive applications.

Grape disease overview

Disease pests are one of the biggest challenges of cold climate vineyards in the northeast. Diseases are usually active before symptoms are present, therefore it is important to be proactive (i.e. preventive, instead of reactionary). In the table on the following page is a description of the most economically significant disease pests of vineyards, their biology, and effective control measures.

Resources for Cold Climate Vineyard IPM:

Cornell IPM Fact Sheets for Grapes
http://nysipm.cornell.edu/factsheets/grapes/default.asp

New York and Pennsylvania Pest Management Guidelines for Grapes (published annually)
http://store.cornell.edu/p-189430-2015-new-york-and-pennsylvania-pest-management-guidelines-for-grapes.aspx

Grape Disease Control, 2015. Dr. Wayne Wilcox (published annually)
http://rvpadmin.cce.cornell.edu/uploads/doc_308.pdf

Cornell Vineyard Spraying Website
http://web.entomology.cornell.edu/landers/pestapp/grape.htm

Integrated Pest Management Strategy for Cold Climate Winegrape Growers. Lorraine Berkett
http://www.uvm.edu/~fruit/grapes/gr_ipm/AnInitialIPMStrategy.pdf

Economically significant diseases of cold climate vineyards

Disease	Biology	Control*
Phomopsis	- Persists (years) on infected wood - Spores produced early, spread by rain-splashing to a couple feet	- Prune out dead wood - Critical spray time: when clusters first appear, 3-5” shoot growth
Anthracnose	- Overwinters primarily in cane lesions on the vine - Spores produced in spring, dispersed by splashing raindrops - Likes it warm (70’s and 80’s) but infects at colder temps if wet - Young shoots, leaves and stems, and berries are susceptible.	- Remove infected tissue from the vineyard, tilling/mulc diseased berries on ground - Critical Spray Time: ‘delayed dormant’ Lime-sulfur; early season broad-spectrum fungicides targeting phomopsis will also be effective against anthracnose.
Downy Mildew	- First infections come from spores in soil or on fallen leaves - Specific weather conditions required: prefers warm, humid nights (64-72°F) and rain (>0.1”)	- Improve air circulation to speed drying time of leaves - Critical Spray Time: apply a protectant 2-3 weeks before bloom, then every 7-10 days
Powdery Mildew	- Does NOT require free water (rain or dew) for infection - Warmer temperatures speed sporulation (mid 60s-80s) - Sensitive to direct sunlight (UV)	- Canopy management to improve air circulation and sun exposure - Critical Spray Timing: starting at 3-5” shoot growth and depending on weather conditions. Protection of bloom through pea-sized berries is CRITICAL
Black Rot	- Fungus overwinters in mummies, infects during rain	- Sanitation: Remove mummies from vines and trellis - Critical Spray Time: start of bloom through +4 weeks
Botrytis	- Many fungus sources, especially old cluster stems - Infection can occur during bloom and remain latent until berries begin to ripen	- Improve air circulation through site selection, canopy management, and loosening clusters - Critical Spray Time: varies by season and is weather-dependent

*Specific recommendations for chemical insecticides can be found in the *New York and Pennsylvania Pest Management Guidelines for Grapes.* (Link to this book is listed above)

Grapevine Fungal Vascular Diseases.

Elsa Petit, Stockbridge School of Agriculture, University of Massachusetts Amherst, epetit@umass.edu

Grapevine fungal trunk diseases, from esca to dead arm, are very destructive worldwide. Vascular diseases are less obvious than foliar and fruit diseases but they can infect the perennial wood, grow unchecked and become worse as a vineyard ages, resulting in significant dieback and decline over the years. There is a strong demand for novel disease management strategies. In order to improve control of grapevine trunk diseases, we need to better understand them.

1- What are fungal vascular diseases of grapevine?

Eutypa dieback is the best known of the vascular fungal diseases in Northeastern American viticulture. It is diagnosed by the characteristic wedge-shaped area of dead tissue when cutting part of the permanent woody structure of the grapevine. However, there are many unrelated fungi that can cause vascular diseases on grapes (Bettiga, 2013): (1) Species in the Diatrypaceae family including *Eutypa lata* the causal agent of Eutypa dieback ; (2) 21 species in the Botryosphaeriaceae family causing Botryosphaeria dieback and comprised in the genera *Botryosphaeria, Diplodia, Dothiorella, Guignardia, Lasiodiploidia, Neofusicoccum, Phaeobotryosphaeria,* and *Spencermartinsia*, have been isolated from grapevine dieback symptoms, some of which cause a wedge-shaped canker indistinguishable from Eutypa dieback; (3) Species in the genus *Phaeoacremonium* and *Phaeomoniella*, the causal agents of esca or black measles and Petri disease; (4) Species in the genus *Cylindrocarpon*, the causal agent of black foot disease, a root and trunk disease. This list of fungi is absolutely not exhaustive as additional species are frequently being isolated from wood cankers and branch dieback worldwide. Each fungus has its own biology and therefore should theoretically be managed differently.

2- Do you have a fungal vascular diseases in your vineyard?

- On perennial parts:
  - Wedged-shaped perennial cankers could be an indication of either Eutypa dieback or Botryosphaeria dieback.
  - Vascular streaking could be indicative of esca, Petri disease, Botryosphaeria dieback or black foot disease.

- On fruits: One of the most noticeable symptoms of esca occurs on the fruits and inspired the common name "black measles". Superficial dark spots develop on the berry epidermis between fruit set and ripening. If the spots appear early in the season, the dark spots coalesce, causing berries to shrivel and entire clusters to dry on the vine.

- On leaves: Leaf symptoms of esca usually develop on cane with symptomatic fruits. Leaves show interveinal discoloration and dark-colored cultivars display red-margin around the dead interveinal areas.

- On shoots:
  - Flag shoot: For esca, during the active seasons, the first symptom to appear would be a shoot tip dieback where the entire tip appears blighted.

- Stunted shoots: Shoot symptoms of vines help separate Botryosphaeria from Eutypa diseases. In the case of Eutypa, shoots have short internodes and show stunted spring growth with leaves small cupped and chlorotic. In the case of Botryosphaeria, a given cordon could show a total absence of spring growth and normal healthy development of shoots.

3- Preventing and managing fungal vascular diseases of grapevine.

Prevention:
Plant material should be inspected before planting and young vines should be properly handled during their establishment. Abiotic stress (water-stress…) could be a predisposing factor.

Fungal vascular diseases infect primarily through pruning wounds. In young vineyards (< 5 years old), prevention starts by avoiding infections of new pruning wounds. This can be done by either not pruning during a season when pruning wounds could get infected or by practicing double pruning (i.e. pruning when there is a chance of infection and pruning later on when infection are less likely to remove the part of the trunk that might have been exposed to trunk pathogens). Pruning wounds can also be protected with either fungicides that are labelled for the dormant season or non-fungicide materials that create a physical barrier against infection.

Many grape growers in cool climate viticulture have renewals such as double trunk. This practice could be useful in a case where a canker would have expanded significantly low in the perennial wood in one of the trunk and removal of that trunk is necessary.

Eradication:
Preventative measures reduce the chance of new infections but do not eradicate diseases. If a vine is infected, one should prune any perennial part with cankers 4 or 5 inches below the visible canker and destroy the wood by burying or burning. Because the fruiting bodies of fungal canker pathogens can be found on dead wood, it is essential to destroy it. Sanitation creates large wounds; therefore it is recommended to apply a pruning-wound protectant if conditions are conducive to disease when pruning (i.e. rain) or one expects the inoculum to be present. In New-York state, a concentrated solution of Topsin-M 70 WSB (3.2 oz/gallon of water) can be applied to pruning wounds where extensive cuts have been made due to the presence of a canker and therefore potential surrounding inoculum is expected (Wilcox, Wayne, 2015).

References cited:

Bettiga, L. J. (Ed.). 2013. *Grape pest management*. Oakland, California: University of California, Agriculture and Natural Resources.

Wilcox, Wayne. 2015. *Grape disease control*.

The Effect of Vine Architechture in New England Vineyards
Gouveia Vineyard
Wallingford, CT

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Background and Rationale: Most inland Connecticut growers continue to depend on French-American hybrids or other cold-hardy cultivars for the bulk of their production. These hybrids can be very productive and are relatively resistant to freeze damage. Many have growth habits quite different from those of *Vitis vinifera*, however, and may have the potential for greater production and higher fruit quality when grown on high training systems and divided canopies. Some Connecticut growers with newer plantings are employing wider vine spacing and divided canopies, but no efforts at within-vineyard comparisons have been made.

Treatments: Four training systems were followed:

- Geneva Double Curtain (GDC)
  - Horizontally divided canopy, top-wire trained.
  - Combed
- Hudson River Umbrella (HRU)
  - Top-wire trained
  - Combed
- Smart-Dyson (SD)
  - Vertically divided canopy, mid-wire trained.
  - Catch wires above and below
- Vertical Shoot Positioning (VSP)
  - Mid-wire trained
  - Catch wires above
  - Hedged

Each of these training methods was either cane or spur pruned. Plant spacing was 6 feet for the cane pruned plants and either 6 or 8 feet for the spur pruned plants. Thus there were a total of 12 treatments replicated 4 times within the experimental plot with at least 4 plants per replicate.

Spur pruned Hudson River Umbrella.

Methods: Vines were planted in 2008. Training and pruning were performed from early-March to mid-April each year. It took 3-4 years to establish the high wire cordons for the GDC and HRU spur pruned vines. By 2012 all training systems were incorporated into the plot. In that year two late frosts in the first week of May occurred after bud break and there was little or no fruit produced. In 2015, there was an 8 hour period (15 February 15 12AM- 8AM) during which temperature remained below 0 F. The result was considerable bud mortality (> 60 %).

Smart-Dyson cane pruned at 6 foot spacing

Results: Judicious pruning (leaving 3-4 buds per spur) on the spur trained vines partially compensated for the bud loss and spur pruned vines still produced a reasonable crop. However, this was not possible on cane pruned vines resulting in less fruiting canes and clusters per foot of row. Thus, cane pruned vines tended to have less yield (Table 1). The productivity of the SD trained spur pruned vines was reduced by winter kill despite the extra buds per spur (Table 1).

Table 1. Yield components for St. Croix Trial at Wallingford CT in 2015.

Training	Pruning	Spacing	Clusters /cordon	Yield kg/cordon
GDC	Cane	6	35.7	2.06
	Spur	6	75.7	4.02
		8	86.9	4.51
HRU	Cane	6	34.1	2.15
	Spur	6	89.0	4.49
		8	86.8	5.06
SD	Cane	6	39.6	2.26
	Spur	6	60.3	2.85
		8	78.6	3.87
VSP	Cane	6	40.7	2.16
	Spur	6	77.3	4.10
		8	96.1	4.95

What the results mean:

- Fruit chemistry and berry size was remarkably constant irrespective of training and pruning treatments, as well as plant spacing.

Short summary:

Crop yield for St. Croix in Connecticut was relatively independent of training methods. Winter bud kill had a much larger impact on cane pruned vines.

Table Grape Varieties for New England

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Seedless Table Grape Cultivar Evaluation 2010-2015

Farmers and growers that sell agricultural crops directly to the consumers are looking for new crops to expand their marketing opportunities. The purpose of this project was to look at seedless table grape varieties to see which varieties are adaptable to southern New Hampshire growing condition during the first three to four years after planting.

Fifteen different seedless table grape varieties were planted in the spring of 2010 and the sixteenth variety was planted in spring of 2011. Ten vines of each variety were planted, eight feet between vines and eight feet between rows. The trellis was constructed in 2010 and constructed for training the grape vines in the Vertical Shoot Positioned (VSP) system. The VSP has the grapes at the bottom of the canopy and then the shoots grow towards the sky, vertically. Shoots are held upright by using catch wires that keep the shoots close to the trellis system. During the first four years, all varieties were adaptive to the VSP system, however, there are concerns that some of the varieties may be too vigorous in the future.

During winter months daily temperatures were recorded. Then each spring the seedless table grape variety was reviewed for survival in winter conditions, the amount of winter die-back and winter bud survival. Two varieties did not survive the New Hampshire conditions (Einset and Suffolk Red). Three other varieties were slow or weak growing in their first three or four years (Canadice, Vanessa, and Summerset Seedless), however all three cultivars are very good to excellent in flavor.

The date of harvest, pounds of fruit harvested, and soluble solids (sugar brix) were recorded on those varieties that started to produce marketable fruit during the first four years. Four varieties surfaced to be productive during the fourth and fifth year after planting (Reliance, Marquis, Thomcord, and Concord Seedless). However, this is based just on the beginning of the productive life to grape vines and needs to be continually evaluated over the next five or more years for a realistic evaluation. Finally, we will evaluate which grape varieties customers preferred and found very little to no difference in customer choice with a limited number of varieties.

This Seedless Table Grape Cultivar Evaluation Grown on Vertical Shoot Positioned (VSP) Training System project was supported by a Farmer/Rancher Project grant from the Northeast SARE. Also, the New England Vegetable and Berry Growers Association support the project with a 2010 Research Grant.

Seedless Table Grape Cultivar Evaluation									
Merrimack, New Hampshire									
George Hamilton, Extension Field Specialist, UNH Cooperative Extension									
Cultivars	**Cluster Weight**		**Berry Weight**		**Soluble Solids**			**Production per Vine**	
Cultivars Name (color/year planted)	**grams**	**grams**	**grams**	**grams**	**brixs**	**brixs**	**brixs**	**pounds**	**pounds**
	2013	2014	2013	2014	2013	2014	2015	2013	2015
	1-Sep	8-Sep	1-Sep	8-Sep	1-Sep	8-Sep	10-Sep	Sep	Sep
Red:									
Canadice (Red 2010)	130	153	1.8	1.5	18.7	17.2	21.0	2.8	3.3
Einset (Red 2010)	-	-	-	-	-	-	-	-	-
Reliance (Red 2010)	191	198	2.3	2.1	20.7	18.8	22.0	9.2	11.7
Somerset Seedless (Red 2011)	-	86	-	1.5	-	20.0	22.0	-	7.0
Suffolk Red (Red 2010)	-	81	-	2.1	-	21.5	-	-	1.0
Vanessa (Red 2010)	66	159	1.5	2.9	17.3	17.4	18.0	1.1	2.2
Blue/Black:									
Concord Seedless (Blue/Black 2010)	105	138	1.4	2.3	22.8	17.5	17.0	4.6	8.2
Glenora (Blue/Black 2010)	71	66	2.0	2.1	-	18.4	18.4	0.6	-
Jupiter (Blue/Black 2010)	129	243	4.2	4.1	18.0	14.5	18.0	2.3	6.8
Mars (Blue/Black 2010)	107	236	3.7	3.4	15.0	15.2	20.0	2.4	12.9
Thomcord (Blue/Black 2010)	124	257	2.4	2.5	15.0	16.5	19.0	5.5	10.7
Venus (Blue/Black 2010)	60	256	3.3	2.3	22.7	19.0	19.0	0.2	1.9
White:									
Himrod (White 2010)	70	83	2.4	1.7	16.0	18.6	20.0	1.1	7.1
Interlaken (White 2010)	115	154	2.5	1.9	18.0	20.2	20.0	0.5	2.3
Lakemont (White 2010)	89	192	1.5	2.1	14.7	17.5	20.0	0.5	1.1
Marquis (White 2010)	192	187	2.5	4.0	15.7	18.5	21.0	9.1	11.1

227 grams per 1/2 pound

No total harvest yields were recorded in 2014.

Growing and Marketing Seedless Table Grapes at Kimball Fruit Farm

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Kimball Fruit Farm straddles the border of N.H. and Mass. We own 200 acres and farm 140 acres. Originally we were an 80 acre apple farm with a small roadside stand. But with the downturn of the apple industry in the 1980's we needed to grow in a different direction. Over the next 10 years my father watched with tears in his eyes as we took 50 acres of apples out and slowly changed to a much diversified farm. We turned the land into other tree fruits, small fruits and a wide variety of vegetables. We also replaced the remaining 30 acres of apples with newer trees and varieties. We also expanded our farm stand to make it easier to market the new crops. There is a lot of competition in our area with farm stands and we needed to find more avenues for selling all the crops we were growing. In 1989 we started going to farmers markets that were just becoming popular in the Boston area. Attending these markets gave us an opportunity to see other farmers' crops and expanded our thinking of what to grow.

I also follow the local university's ideas of crops to grow. I believe it was UMass that had an article on growing seedless grapes. I kept that idea on the backburner of my mind as I hadn't seen any grapes at the farmer's markets we were attending. My wife and I attended a meeting at the Cornell Hudson Valley location, a 2 day event, called "Do you want a farm winery ". After hearing about state and federal oversight we ran back to New Hampshire as fast as we could with the winery idea left behind. After a meeting about grapes, one year, Double A Nurseries from New York gave a talk .They have an extremely useful website with links to trellis construction and variety descriptions. I bought 50 vines each of Vanessa, Marquise, and Mars, based on cold tolerance, disease tolerance, production, and flavor. Next came the trellis which I found the most difficult part as there aren't many vineyards in my area. Thanks to the internet I flew over

California with Google Earth and went down to street view where I had seen rows going to the street. It was cool as I could see how they designed there trellis. A few days later my 70 something retired neighbor wanted to help me on the farm as he needed something to do. I flashed the idea of helping with a trellis and he was thrilled. Now he owned a printing company and did a lot of work for Harvard so he was meticulous in whatever he did. Two years later he finished the trellis! Three sets of 2 wires starting at 32” and the top wire at 72”. We use VSM (vertical shoot positioning) for our training and pruning. Each trunk cluster putting 4 pencil thin shoots with 10 buds on the bottom wires. We use a taper to attach vines to wires. As the shoots grow from the 10 buds we feed them up through the next two sets of wires. Our fruiting zone is between the bottom and the top wires. Suckers from the base of the trunk cluster are ripped off easily when they are young .Failure to do this makes the vines more difficult to manage as the season goes on, trust me on this! Later in the season starting at the beginning of August we pull shoots and leaves from the fruiting zone to expose the fruit to sunlight and also for good spray penetration .This is very important as SWD will be around .

Having been an apple grower my whole life made understanding pest control easier. I followed the universities “Small Fruit Management Guide “in making pest control decisions. Also I have been fortunate to have an SWD traps, in my various fruit crops, with help from George Hamilton’s (UNH) grant project .Black Rot and Mildews are the most prevalent diseases.SWD and Japanese Beatles are the most aggressive insects. Danitol, Mustang Max, and Delegate, in rotation, are what I have found to control SWD, based on trap captures.

We use an instrument to measure sugar to determine harvest time as well as color. This is usually around August 20 and continues to October 15. This wide window of harvesting works well for us in sales. About 90% of our harvest went through our retail outlets and the rest went wholesale through a broker in Boston, restaurants that we are already selling other crops to, and other farm stands. For our retail outlets we package grapes in wooden quart boxes and pack, 20 to a tray, on bread trays. Prices this year were $5 per quart for retail, and $3.50 for wholesale. The last 2 years we have picked just over 3000 quarts on the 300 vines. The biggest challenge we have is time. Peaches, apples, corn, tomatoes, raspberries , and all the other crops are in full swing. I have found myself doing all the picking keeping my crew busy on other crops. Being a little over an acre it has been a good choice for our mix of crops and we have great response from customers who now look forward to grape season to come.

Hops Production in New England

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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. 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. However there is very little information on how to grow hops in our region. Hops are primarily grown in the Pacific Northwest a climate that is far different than ours. Since 2009, UVM Extension has been working to develop regionally relevant production and processing information on hops.

Construction of a Hopyard

Hops are grown on vertical trellis systems that are built to heights of 22 feet. A complete list of materials and videos on the construction of the UVM Extension hop yard can be found at www.uvm.edu/extension/cropsoil/hops. Low trellis systems are possible but require specific varieties that produce cones at lower growing heights. Hops require substantial quantities of water throughout the growing season and irrigation is a necessity to produce high yields. Drip irrigation is the most common system implemented in hopyards in the Northeast. Costs for implementing an irrigation system and a YouTube video on how to set up irrigation in your hopyard can be found at http://bit.ly/poHHoy.

Selecting Hop Varieties

Proper variety selection is essential to producing high yielding hops in the region. Publicly available varieties can be secured from a number sources located throughout the U.S. Hops can be purchased as rhizomes, rooted cuttings, or plants. Rhizomes are the cheapest source of hop material but may also be laden with diseases including downy mildew and various viruses and viroids. Purchasing plants or rooted cuttings that have been confirmed to be “disease-free” will get your hop operation off to a good start! Selecting varieties that have some disease and insect tolerance will also be important as pests can reduce hop yields significantly. Lastly understanding what types of hops brewers are interested in purchasing can further guide the varieties that you might select for production. UVM has conducted research to identify varieties that perform well in our region. After four years of research, the most successful varieties were clear. Several varieties did not survive pest pressure or lacked winter hardiness. Table 4 indicates varieties that performed well and those that did not.

Table 4. *High and low performing hop varieties after four years of evaluation.*

High Performance Cultivars	Low Performance Cultivars
Centennial	Liberty
Chinook	Crystal
Newport	Saaz
Cascade	Sterling
Nugget	Cluster

Fertility Management

Hop plants prefer to grow in a soil with a pH ranging from 6.0 to 6.5. For the lime to react quickly, it is best to mix it in with the soil. In some cases the ph maybe too high. A pH over 7.5 should be lowered, as certain nutrients are less available to plants above that range. Soil amendments such as sulfur fertilizers, pine needles and peat moss will lower the pH. Since it takes time for the soil pH to change, it is best to correct soil pH prior to establishment.

Nitrogen - A hop crop will require a substantial amount of nitrogen (N) to meet growth requirements. A high yielding hopyard can remove between 100 to 150 lbs of N per acre from the soil. Nitrogen application rates are often based on knowing your whole plant biomass yield. Higher yielding plants will obviously require more N per acre to promote plant growth and development. A whole plant biomass yield of 1000 lbs/acre will remove 80 to 90 lbs of N per acre from the soil. As the cone yield increases to 2000 lbs/acre the hop plant can remove 150 to 170 lbs/acre of N from the soil. Nitrogen rates should be based on yield but also soil organic matter level and/or soil type. Nitrogen should be applied about 30 to 45 day after emergence or mid May to mid June. The primary N uptake period for hops occurs during the vegetative stage (May through early to mid July). It is important to not apply N after flowering as this can lead to unwanted vegetative growth. Split applications of N are recommended on lighter textured (i.e. sandy) soils where leaching is an issue.

Phosphorus - Hops do not require high levels of phosphorus for acceptable yields. It has been shown that a 2000 lb/acre crop of whole plant biomass removes an average of 30 lb/acre of P from the soil. Most of the P in hops is found in the cones and the rest in the remaining plant parts. If leaves and vines are returned to the soil, there is actually very little P exportation from the soil. If soils have optimum levels of P, approximately 20 lb/acre of P should be applied to the soil. Low levels of soil P would warrant an application rate of between 60 and 100 lbs of P per acre. Soil test P levels in the Medium range would require 40 to 60 lbs of P per acre.

Potassium - Hops will remove 80 to 150 lbs of K per acre. Interestingly, most of the K taken up by the hop plant is retained in the leaves and stems with very little in the cone. Returning hop leaves and stems to the yard would be a means to replenish soil K levels. If your soil test K falls in the high range, K does not need to be added to the soil. A medium soil test K result might require the application of 80 to 100 lbs of K per acre. However, if soil test K levels are in the low range, 150 to 100 lbs/acre of K fertilizer should be amended to the soil.

Micronutrients – Boron deficiency has historically been a problem in the Northeast, especially in crops such as alfalfa and clover. Boron deficiency in hops has been reported in the Pacific Northwest. As a basic guideline, 1 to 2 lb/acre of B should be added annually to the hopyard. Zinc deficiency can also be an issue in hop production. Similarly, Zn deficient corn has been observed in the Northeast. Soils that have an especially high pH, low organic matter, and a light texture can be prone to low zinc levels. Based on PNW information, an application of 2-4 lbs/acre of Zn should be amended if soil test levels are lower than 1 ppm.

Pests and Management

Seven hop yards in Vermont were scouted for arthropod pests and natural enemies every other week June-August for three years (2012-2014). The goal was to identify the major arthropod pests. The major arthropod pests in NE hop yards were two-spotted spider mite, hop aphid, and potato leafhopper. Higher populations of hop aphid were observed in cooler, moister seasons while higher numbers of two-spotted spider mite were observed in seasons of dry heat. Secondary outbreaks of spider mite were observed following broad-spectrum pesticide sprays targeted at potato leafhopper. Proper identification and scouting (pests and beneficials) is important especially before insecticides are to be applied. More information on hop arthropod pests and management can be found at www.uvm.edu/extension/cropsoil/hops.

Downy mildew (Pseudoperonospora humuli, Miyabe and Takah,Wilson) is the primary disease issue of hops in the Northeast. Downy mildew can cause the complete loss of marketable hop yield, and even hill death in sensitive varieties. It is a very serious hindrance to successful hops production, but diligent integrated pest management (IPM) can help reduce disease infection, and/or help control downy mildew once the disease has reached your hopyard. A combination of scouting, mechanical control of early season disease combined with appropriate fungicide applications has been successful in controlling this disease in our region. Identification and control options can be found at http://www.uvm.edu/extension/cropsoil/wp-content/uploads/DownyMildew.pdf.

Harvesting and Processing Hops

The reintroduction of hops through-out the US requires scale-appropriate harvest and processing equipment. In 2011, there were no feasible mechanized harvest options for a 1-2 acre hop producer. Handpicking was the most wide-spread practice which is labor intense and time consuming leading to expense and quality impact due to delayed harvest. Mechanized harvesting can increase harvest rate by a factor of 100. Mechanized harvesters were available but were capitally-intense and required import and modification for use in our country. Early re-adopters of hops in the northeast are eager to have an option for mechanical harvesting of the crop to reduce production costs and improve overall quality. The presentation will summarize advancements in mechanized harvest options. A mobile, trailer-based mechanized hop-harvester was developed and documented as an open-source design for others to replicate at UVM. The design was the result of a collaborative design effort involving growers, brewers, agronomists, fabricators and engineers. Additionally, several hundred people have downloaded the plans for the machine and there have been 8 replicates partially informed by this work. Commercially produced, scale-appropriate harvesters are now available for the smaller scale producer. Some have been based on the open-source design work. Designs and videos of the UVM Harvester can be found at http://www.uvm.edu/extension/cropsoil/hops.

In addition to harvesting improvement, growers require systems for post-harvest management of the crop including drying, baling, pelletizing and storing. Small scale models of balers and driers have been designed through UVM as well as many farmers in the region. We will cover current best practices in this area as well.

Container Growing:
Managing Greenhouse Tomato for Consistent and Optimum Yields

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Greenhouse tomato yields have increased dramatically in recent years. Advanced knowledge of how this crop responds to cultural conditions combined with intensive environmental and crop management capabilities are the reasons for these advances.

Managing light, temperature, and crop water and fertility status are the keys to optimal production. How we manage these factors and how we manage the crop in response to seasonal and daily environmental changes, greatly influence plant productivity, consistency of yield and fruit quality. In this session I will show how changes in environmental conditions affect plant response and how these changes influence your crop management decisions.

It all starts with light
Yield potential all starts with light. The relationship between available sunlight and yield is fairly direct – the more light the greater the yield potential. A rule of thumb is that a 1% increase in light equals a 1% increase to crop growth. You can increase growth potential by increasing the amount of light available, by increasing the amount of carbon dioxide, or by maximizing the efficient utilization of the available sugars created from photosynthesis. We can split the year into the light limited season and the light unlimited season. During the light limited season growers need to take steps to maximize utilization of all available light.

Adjust temperature to match the prevailing light condition
Temperature, water, and fertility must all be managed in response to the prevailing light condition. Temperature controls the rate of plant metabolism. When night temperatures are high plants burn more energy in respiration but also have the ability to produce more growth. When night temperatures are lower, growth is slowed but energy lost to respiration is also reduced. On bright days, plants store a lot of food (sugars created from photosynthesis) and can sustain high growth rates. However, on nights following cloudy, dark days, plants have very limited energy

available for growth. To optimize growth you must balance energy lost to respiration with energy available for tomato growth. In this session I'll discuss strategies for achieving this aim.

Give plants adequate space

As a general rule each plant should have 4-6ft^2 of floor space. Most new growers jam too many plants into the house. This does not increase overall yield but it does result in smaller fruit and more difficulty in handling and managing the crop. Under light limited conditions growers should provide 5-6ft^2 per plant, but if you grow primarily during the high light late spring and summer months, 4-5ft^2 will be adequate. Over the range of 4-6ft^2 per plant, yields are pretty constant per acre. The big difference is in fruit size. With a more generous spacing each plant produces more fruit and the fruit tend to be larger.

Managing fruit load & size

Quality fruit start with pollination. There is a strong correlation between the number of pollen grains that pollinate a flower and the potential size of the fruit. Each pollen grain produces a single seed. Fruit with large seed counts have the potential to grow large but fruit with few seed do not. Bumblebees are the best pollinators and even for a small grower it is worth using bees to set fruit.

Matching fruit load to the carrying capacity of the plant is an important aspect of crop management. If consistent yield in important, you need to avoid the roller coaster of heavy set early followed by lost plant vigor and poor fruit set later. Growers can even out yield and maintain crop vigor over time by limiting the number of fruit on the plant to correspond with the seasonal light conditions. Cluster pruning can also be used to increase fruit size.

Water and nutritional management also influence the tendency toward either vegetative growth or fruit production. This is a balancing act you must manage. Too much generative growth (fruit production) and crop vigor will decline.

Water management

Irrigate before daybreak to put the plants in a good water status for active photosynthesis at first light. After daybreak, limit the amount of dry down between irrigation events to 8-10% in the morning. This will favor vigor and active growth. Increase water stress by increasing the dry down to about 16-18% in afternoon. This will favor generative growth.
Frequent light irrigations work best. Avoid daily extremes. Irregular watering and excessive stress favor a number of fruit disorders including concentric cracking, vertical cracking, crazing etc. Plants under low light will require less water than plants in a high light environment.

Nutrient management

The ratio of potassium (K) to nitrogen (N) in the nutrient solution influences the tendency toward vegetative or generative growth. Maintain a K:N ratio of 1K:1N during seedling development. This will favor strong vegetative development. At first flower the ratio should be about 1.5K:1N. As fruit approaches ripening a ratio of 1.7K:1N will favor good color development. If plant vigor starts to decline too much, shift the ratio in favor of vegetative growth by temporarily increasing the relative proportion of nitrogen (1.25K:1N) until vigor recovers. Limit the amount of ammonical-form nitrogen to less than 10% of the total nitrogen.

Overall salt levels also impart a water stress on plants and affect the vegetative/generative growth tendency. High EC favors generative growth

Growers should note that water management involves adjustments on a daily-basis as dictated by prevailing weather conditions. However, nutrient management involves adjustments over a longer period of time based on crop performance and seasonal expectations.

Using grafted rootstock
Grafting is widely used in horticulture for a variety of reasons. Increasingly greenhouse tomato growers are using grafting to both decrease susceptibility to root diseases and to increase fruit production through increased plant vigor.

Grafting involves splicing the fruit-producing shoot (called the 'scion') of a desirable cultivar onto the rootstock of another cultivar to increase disease resistant and/or vigor and yield. Two cultivars still widely used for rootstock in the greenhouse are 'Maxifort' and 'Beaufort' but many other rootstock with outstanding disease resistance characteristics are commercially available (http://www.vegetablegrafting.org/wp/wp-content/uploads/2015/02/usda-scri-tomato-rootstock-table-feb-15.pdf).

Vigorous rootstock change the way we manage the greenhouse tomato crop. With non-grafted plants, the management challenge is to keep the plants vigorous enough so that they don't stall-out and lose production. With grafted rootstock, the opposite is true. Growers need to work to rein-in plant vigor so that they don't become too vegetative. This is an easier management challenge because you can control vigor by increasing plant stress or by limiting the number of leaves on the plant

Reading the plant
A big part of successful greenhouse tomato management is being able to quickly recognize how the crop is responding and then make the proper adjustments before problems develop. This ability to 'read the plant' comes with experience, and is vital to optimizing production. Here's what to look for. Leaves should be closely spaced and deep green with a slight downward curl. Early in the day plant leaves should appear bright and turgid (indicative of low water stress). Later in the day, leaves should appear darker under moderate water stress used to induce generative growth. Plant stems should be thick, about 0.5 inches at 6 inches down from the growing tip. Stems that are thicker indicate growth that is too vegetative, while stems that are thinner indicate too much stress. Most importantly, flowers should develop and open without aborting, and fruit should set easily and size rapidly.

Greenhouse Container Vegetable Production at Four Town Farm

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The goal of this presentation is to offer a complete overview of how and why we grow vegetables in containers at Four Town Farm. The talk will be geared towards farmers from a farmer in hopes of providing a realistic, achievable approach to becoming successful at growing your own vegetables in containers. Many talks that are not done by farmers are often times bogged down with charts, graphs, confusing vernacular, expensive equipment, and a lack of usable information for the average farmer. The nice attribute about this seminar is that I am a farmer, just like you. My slides and information are aimed at supplying you with easy to understand and attainable methods on how YOU can be profitable growing vegetables in containers. I will provide a thorough overview of container growing, including what vegetables we grow, container types, media, nutrition, and much more.

The presentation will have a section on pest & disease management, with a focus on using beneficials to control pests. Using beneficial insects to control pests is an excellent alternative to conventional spray methods, especially when dealing with vegetables under cover. However, I know from experience that breaking the ice with beneificals can be overwhelming, confusing and frustrating. I will have plenty of pictures and simple instructions for implementing beneficials into your IPM.

Timing is a crucial factor when dealing with container vegetables in the spring and fall, so I'll briefly touch on dates for seeding of different vegetables to insure your success. Since there is a wide array of irrigation methods available for containers, I'll discuss the different styles we use so you can make the best decision for your application. I'll briefly overview high tunnel design and setting up your high tunnel/greenhouse for maximum efficiency of labor and transitioning from one season to the next.

Finally, one of the most often overlooked topics is the how to of actually raising and maintaining your vegetables. I'll provide an overview of the our growing techniques, including variety selection, pruning, trellising & lowering, leaf removal, equipment selection, nutritional deficiency identification, fertigation, etc.

Managing P and S in your Soil's Nutrient Bank

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Environmental concerns and regulations have brought changes to the both the phosphorus (P) and sulfur (S) economy of soils, which forces us to look for more efficient ways to cycle both nutrients on farms. Phosphorus, largely responsible for eutrophication of water bodies, is increasingly regulated in nutrient management plans. Additionally, there are global limits to P supply that make efficient P use essential. Sulfur, a component of acid rain, was rarely deficient in agricultural soils in the past because atmospheric deposition generally exceeded crop removal rates, but clean air regulations have brought lower S deposition and S deficiencies are emerging. This presentation will look at some possible ways to increase nutrient use efficiency for P and S by increasing overall soil health and using biological tools like cover crops.

Managing the soil's nutrient bank cannot be decoupled from managing overall soil health. This is especially evident for P. Traditional soil testing is not perfect for predicting crop response to P additions[1], and while it is advisable to follow soil test recommendations for P additions, physical and biological conditions of a soil that are not assessed in traditional soil tests can affect plant acquisition of P. Nonetheless, one of the most important factors influencing P availability, pH, is reported on most soil tests and is also one of the most easily managed aspects of a soil. A pH lower than 5.5 or greater than 7.3 increases the extent to which P is tightly bound to the mineral portion of soil and therefore maintaining pH within this range is critical to P management. Even with optimal pH, a soil's physical condition can limit P acquisition, especially when root growth is restricted by soil compaction, which is common on vegetable farms where heavy machinery and foot traffic are necessary for multiple field operations. Finally, biological activity influences P availability in multiple ways including overall microbial activity that can release P from organic matter, mycorrhizal associations that can increase effective rooting zones and increase P acquisition, and specific plant-soil interactions that can change the location and form of P in soil.

The biological components of crop-soil interactions and P dynamics are very complex and much is unknown. There is evidence, however, that certain management techniques including the use of some cover crops can increase P use efficiency in soils, thus reducing the amount of P fertilizer required for cash crop production. Not all cover crops increase P availability, however, and cover crop P uptake is not necessarily indicative of P availability to subsequent crops. For example, although white lupine (*Lupinus albus*) is known for its exceptional P uptake, it has been shown to decrease P availability after incorporation[2]. Therefore, if maximizing P availability is a goal of cover cropping, cover crops should be chosen carefully.

Anecdotal evidence that buckwheat (*Fagopyrum esculentum* Moench) increases soil P availability has been corroborated by some[3] but not all research reports. In one study, buckwheat had neither a positive nor negative effect on P availability for a subsequent crop while phacelia (*Phacelia tanacetifolia*) increased and ryegrass decreased available P[4]. Forage radish (*Raphanus sativus*), a non-mycorrhizal cover crop, has been shown to increase extractable P in the area directly around its taproot hole[5]. Results indicating that specific cover crops increase P availability to subsequent crops raise the possibility of precision cover cropping in place of or to complement fertilizer banding for the following crop.

Encouraging mycorrhizal associations that increase the effective rooting area and enhance P uptake is another biological strategy for efficient P cycling in agricultural soils. While there is little evidence to show that inoculation of soils with mycorrhiza is effective (unlike inoculation with *Rhizobia* for legume production), there is evidence that fallow periods are detrimental to indigenous mycorrhizal populations and crop P uptake[6]. Cover crops and careful crop rotation can increase indigenous mycorrhizal populations. For example, mycorrhizal cover crops interseeded with a non-mycorrhizal cash crop (cabbage) increased the mycorrhizal colonization and P uptake of the subsequent crop[7]. None of these biological management strategies is easy or well understood, but as nutrient management becomes more restrictive and P fertilizer harder to get, using the innate abilities of plants and microbes like mycorrhiza to increase P use efficiency will become more important.

Sulfur does not face the same global limitations as P, but some of the same strategies discussed for biological P management may be used for S management. The bulk of S in most agricultural soils is in organic matter, and biological activity is responsible for organic matter turnover and release of plant available sulfate. Therefore, total organic matter levels and biological activity are critical to S fertility. Sulfate is prone to leaching, however, so considerable amounts of plant-available S may be present below the rooting zone of many crops. Deep-rooted cover crops like forage radish or related cash crops like cabbage can capture this deep S, and crop rotations that include deep-rooted brassicas can increase overall S use efficiency. Forage radish cover crops increased sulfate-S on average 9 lb acre^{-1} compared to an oat cover crop (unpublished data).

Except in soils with excessive nutrient levels (which do exist!), there will always be a need to replenish P and S to the soil system because of crop removal. Most fertilizer recommendations exceed crop removal rates, however, which indicates that over time, a build-up of these nutrients will occur. Managing overall soil health and capitalizing on specific plant-microbe-soil interactions may provide a key to reducing fertilizer inputs.

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Mid-Season N Management (PSNT)

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Soil testing for nitrogen (N) during the growing season of annual crops is one of the most useful recent developments in soil fertility management. Without the PSNT (Pre-sidedress Soil Nitrate Test) growers can only guess about the need for N fertilizer. As a consequence of not knowing they may often choose to apply supplemental N during the growing season as a matter of insurance.

The PSNT is especially useful in situations or fields where growers have adopted practices for building soil organic matter content and the soil N supplying capacity. Such practices as spreading compost or manures, growing legume cover crops, and following good crop rotations build soil fertility. These practices are commonly used in organic crop production, a farming system where the PSNT is especially helpful. In short, farming practices that build soil organic matter content and the ability of the soil to supply N during the growing season are ideal situations for where the PSNT can often save growers on the cost of N fertilizer.

On very sandy soils, or soils of low in organic matter content, or of degraded fertility status, the PSNT will nearly always find that sidedress N is needed. These situations are not good sites for employing the PSNT. The low N suppling capacity of such soils can be often be predicted without a soil test. Growers should instead focus their PSNT soil sampling efforts on fields well-endowed with organic matter and likely to be good suppliers of plant available N.

Soil sampling for the PSNT is different in many ways from traditional soil fertility testing. PSNT soil samples must be taken at an early growth stage of an annual crop. The probing to collect the soil samples should be from the 0 to 12 inch depth. The soil sample should be dried quickly. They should be sent to a soil test lab that can provide rapid analysis, reliable service, and report the results in a timely manner.

Soil sampling for the PSNT is performed during the early growth stages of row crops. This soil test works well for a wide variety of annual crops but PSNT soil sampling is not recommended during the production of perennial crops. The PSNT soil test results are used to determine if the soil has an adequate supply of available N. If, for example, the PSNT soil test level is found to be 25 ppm N or greater, the farmer can with confidence grow the crop without applying supplemental N fertilizer during that growing season. If, however, the PSNT finds that the soil test level is low, some supplemental N fertilizer may be recommended.

More information about how to use the PSNT soil test for a wide variety of vegetable crops can be found at Rutgers New Jersey Agricultural Experiment Station on the web: http://njaes.rutgers.edu/pubs/publication.asp?pid=E285

Organic Fertility in Greenhouses

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For a number of years I've studied the use of organic fertilizers for growing commercial greenhouse crops. To start I chose to evaluate fertilizers that could be mixed and applied using methods familiar to growers using traditional water-soluble or granular slow-release chemical fertilizers.

Right now I recommend Nature's Source 3-1-1 liquid fertilizer and Sustane 8-4-4 granular slow-release fertilizer. Both of these are readily available, cost effective, OMRI-certified, and have good label directions for greenhouses. I've also evaluated or am currently trialing other organic fertilizers and these are listed with comments in the table accompanying this article. Two liquid fertilizers which may have promise one day are Bombardier 8-0-0 and Espartan 2.0-3.03-2.6 manufactured by Kimitec in Spain. At this time these have limited availability, are rather expensive, and the labels are not written for greenhouses. Nature's Source, Bombardier, and Espartan are plant extract fertilizers and Sustane is made from poultry wastes.

My work has led me to recommend using different organic fertilizers in combination rather than relying on one fertilizer. I suggest using Nature's Source and Sustane together to take advantages of each fertilizer's strengths. This would be done by incorporating Sustane in the growing medium at planting and then fertilizing on a regular basis with Nature's Source starting about 4 weeks after planting. Combinations should be considered regardless of what brands or types of organic fertilizer are being used.

Here are some more important specific recommendations on how to use organic fertilizers to grow greenhouse plants.

1. Mixing and application. The fish fertilizers and plant extract fertilizers are sold as concentrates and they must be diluted in water to be safe for plants. Nature's Source, Bombardier, and Espartan have a pleasant "beery" aroma as concentrates, but within 7 days of being mixed with water they "spoil" and develop very unpleasant odors. The odor, however, is not as bad as fish fertilizer. The nutrient value of spoiled fertilizer is unknown and the colonies of bacteria which develop may plug irrigation lines, so diluted fertilizer solution should be used as soon as possible after mixing.

Fish fertilizer has the thickest and least consistent solution and should be agitated before mixing with water. Bombardier and Espartan concentrates are "syrupy" but mix well with water. Nature's Source is the thinnest concentrate and it mixes well with water and can pass fertilizer injectors.

Sustane is a granular fertilizer which would be mixed with the growing medium before planting. It is the easiest organic nutrient source to use in combination with the liquid types.

2. Fertilizer analysis. Some organic fertilizers supply only one or two of the NPK elements; an example is Bombardier which is 8-0-0. So a grower using Bombardier would have to use other fertilizer(s) to supply P and K. I recommend Sustane which has an 8-4-4 analysis or some other complete NPK granular organic fertilizer.

Organic Fertilizers Evaluated or Currently Under Trial at UMass Stockbridge School

Neptune's Harvest Liquid Organic Fish fertilizer 3-1-5 Fish fertilizer emulsion has been widely used for many years. The emulsion needs to be well mixed to give a consistent material for dilution and application. Once mixed with water it spoils and develops a bad odor, so mix fresh and use immediately. Leaf chlorosis, probably due to ammonium toxicity, is common. OMRI listed.
Plant Natural alfalfa pellets 5-1-2 Alfalfa is a legume and therefore is rich in nitrogen. Alfalfa pellets are often used as animal feed and are similar in size and shape to wood pellets used in pellet stoves. Pellets support plants for about 40 days and then are exhausted of nutrients. Also, they swell when water is added greatly increasing the volume of medium in a pot. Limited potential for this fertilizer.
Kimitec Bombardier 8-0-0 Bombardier is a liquid plant extract fertilizer made from fermented sugar beet molasses. It works well with Sustane which supplies the absent P and K and could be used by itself as a N supplement. Some plants develop interveinal chlorosis due to ammonium toxicity. Chlorosis is lessened or eliminated by combining with Sustane. Dilute solutions spoil within 10 days.
Kimitec Espartan 2.0-3.03-2.6 Espartan is a liquid plant extract fertilizer made from fermented sugar beet molasses. Some plants develop interveinal chlorosis due to ammonium toxicity and growth medium EC is rather high. Chlorosis and EC are lessened or eliminated by combining with Sustane. Dilute solutions spoil within 10 days.
Sustane 8-4-4 Granular slow-release fertilizer made from turkey litter, feather meal, and potassium sulfate. Release time is 45 days, but nutrients may run out a little sooner. Excellent fertilizer to combine with liquid organics especially those with no phosphorus or potassium. OMRI listed.
Nature's Source 3-1-1 Despite the low nutrient analysis, Nature's Source is currently the best liquid organic fertilizer. It is made from oilseed extract. Container has dilution rates expressed in familiar terms for greenhouse growers. I have seen no foliar chlorosis yet with this fertilizer. Nature's Source is widely available and a great improvement over its predecessor Pinnacle. OMRI listed.
Verdanta Eco Vita 7-5-10 Eco Vita is a granular slow-release fertilizer. It has a release rate of 100 days. The granules are composed of bone meal, soybean meal, cocoa shell meal, feather meal, and fermented sugar cane and sugar beet molasses. I see potential for this one and it's available from Griffin. OMRI listed.
Verdanta PL-2 2-0-6 PL-2 is a liquid fertilizer made from fermented sugar cane and sugar beet molasses. It should be a good supplement to use in combination with other organic fertilizers low in N or K. Available from Griffin. OMRI listed.
Ferti-Nitro Plus 13.6-0-0 I am currently testing this soluble powder fertilizer as a supplement to use in combination with other organic fertilizers low in N. It is made from hydrolyzed soybean protein and is soluble. Google this one on the web. OMRI listed.

3. Nutrient disorders. Plants may develop an overall light green or yellowed color caused by a general nutrient deficiency or, more likely, just N deficiency. For example, if Sustane is used alone the symptoms might occur about 45 days after planting, the end of its release time. This can be prevented by applying an organic liquid fertilizer supplement about 30 days after planting.

Interveinal chlorosis sometimes occurs about halfway through cropping time if plants are fertilized with some liquid organic fertilizers alone starting at planting. This chlorosis is most likely caused by an accumulation of too much ammonium-nitrogen in the plant, so-called "ammonium toxicity". Most greenhouse crops do best with a combination of ammonium and nitrate nitrogen.
Unfortunately organic fertilizers generally don't contain nitrate-nitrogen. The best approach is to rely on Sustane as the sole source of nutrients for the first month after planting and then start applying Nature's Source or another liquid organic fertilizer.

4. Organic fertilizer effects on growth medium soluble salts (EC). Sustane is a slow-release fertilizer and its use results in low EC, and potentially a deficient level after 45 days. As for the liquid organics, at the same N level the lowest EC results from Nature's Source (similar to chemical fertilizer) and then Bombardier. Espartan results in an EC significantly higher than the other liquid organic fertilizers which might be an aggravating factor in ammonium toxicity. In short, from the standpoint of EC, Nature's Source is the best.

5. Overcome reduced size caused by organic fertilizers. Many growers who have used organic fertilizers have observed size reductions compared to what they are used to with chemical fertilizers. Some growers say "raise the rate (ppm)" of organics to compensate. If you have done this and it works, carry-on! Otherwise give it a try starting with increases of 20% at a time. Increasing the rate in 20% increments is likely to be partially successful, but because of a nutrient imbalance, ammonium toxicity, or some unknown factor results may be disappointing or worse.

6. Plant species-specific responses. It seems that plants may respond differently to organic fertilizers. For example, marigolds and petunia grow as well fertilized with a combination of liquids and Sustane as they do with chemical fertilizer, but seed geraniums do not and are very prone to chlorosis from too much ammonium. At this point in the development of organic fertilizers for commercial greenhouse use, use them with caution on plants you know have exacting nutrient requirements or those prone to foliar chlorosis. Fertilizers should always be tried first on a small number of plants.

7. Best uses. The fertilizers discussed in this fact sheet are probably best for short-term crops of less than 6 weeks duration when environmental conditions are most favorable for plant growth (e.g., April-September). Bedding plants, herbs, and vegetable transplants are good candidates for trying organics. Assuming the plants are of good quality and color, reduce or stop using the fertilizer within a week or two of planned marketing. This practice will reduce the chance of ammonium toxicity symptoms.

Green Manuring for Fertilizer Reduction

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I've been growing vegetables commercially since 1975. I've been on my current land since 1981 and grow about 45 acres of mixed vegetables. I sell over half my crops wholesale. I have no almost animals on the farm (a couple of hundred laying hens.) and use little or no animal manures. Green manures are an important part of my cropping system.

Green Manures captured my imagination very early in my career, and over the years I have tried a lot of different crops for adding fertility to my sandy loam soils.
Above all else I'm hoping to convey in a contagious manner, my own passion for green manures.

I'm going to touch on my personal experience with a number of green manures including:

- Winter Rye
- Oats
- Hairy Vetch
- Sorghum Sudan Grass
- Japanese Millet
- Red Clover
- Buckwheat
- Winter Wheat
- Spring Wheat
- Barley
- Mustard

I'll reflect briefly on the benefits and idiosyncrasies of each of these green manures.
I'll talk about which ones I still use and why.

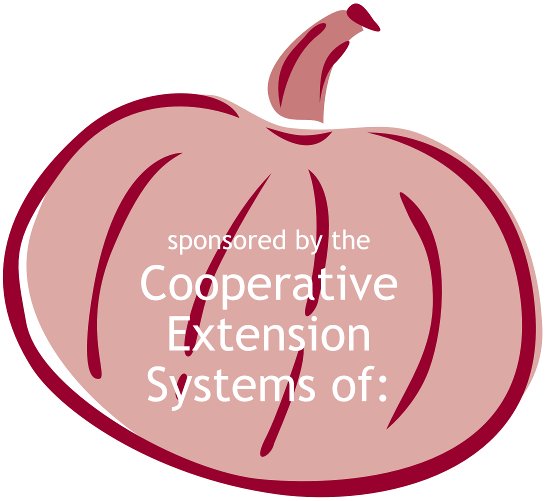
Why some of these crops didn't work for me, but might for you.
Some unusual techniques I really like.
Calculating fertilizer contribution for the crop to follow a green manure.
Green manures are probably not going to make you, or save you, immediate, tangible, big money. So why bother?
Why green manures, cover crops and rotations are the core of a sustainable cropping system.

My apologies: They wanted this thing for the proceedings by November 1st. OH, PLEASE!
We're still in the "Sprint to the finish" up here in Vermont. Trying to get all the winter storage crops in before something wintery happens in mid November. Snow. Total ground freeze. Something is inevitable. Anyway, I'll have a PowerPoint presentation for the conference, and they'll post it on the website... but that's in December. See you at the conference.

NEVF

New England Vegetable & Fruit

CONFERENCE '15



sponsored by the

Cooperative Extension Systems of:

Universities of Connecticut,
Maine, Massachusetts, New Hampshire,
Rhode Island, Vermont,
Cornell University,
Connecticut Agricultural Experiment Station,
Maine Organic Farmers and Gardeners Association
and
New England Vegetable &
Berry Growers' Association, and
Massachusetts Fruit Growers' Association

December 15, 16, 17, 2015
Radisson Hotel Manchester

MANCHESTER, NEW HAMPSHIRE

U.S. DEPARTMENT OF AGRICULTURE COOPERATING.

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Greetings and Salutations

Welcome to the 20th New England Vegetable and Fruit Conference and Trade Show. This meeting takes place every other year in December, and includes more than 30 educational sessions over 3 days. Topics include major vegetable, berry and tree fruit crops, and much more.

Farmer-to-Farmer meetings throughout the conference allow you to discuss specific issues in more detail. There is also an extensive Trade Show with over 100 exhibitors. We hope that you will enjoy your time here, and meet with fellow growers, advisors, researchers and industry representatives. We want you to leave with new ideas and information that will have a positive impact on your farm.

This conference is special because it is put together with close collaboration between growers and Extension from across the region. The steering committee gathers the best speakers from within our region and across the country to tell you about the latest innovations and advances in vegetable and fruit production. Almost every session includes both farmers and research or extension personnel, so you are getting the "best of both worlds."

The New England Vegetable and Fruit Extension team also collaborates to conduct research, hold other educational programs, and to create resources for the benefit of growers. These include the New England Vegetable Management Guide, the New England Small Fruit Management Guide, and the New England Tree Fruit Management Guide which are published every other year. For more information about New England Vegetable and Fruit Extension Programs contact your state Extension office.

Our sponsors invite you to visit the Trade Show during the conference. We invite businesses and organizations to exhibit at the Trade Show for the purpose of providing information to the participants. While we make responsible efforts to assure the integrity of the exhibitors, the conference sponsors do not guarantee or warranty any product exhibited; neither do the sponsors imply approval of or endorse any product to the exclusion of others that may be available.

We value your feedback! We use your comments and suggestions to plan the next program. Please fill out an evaluation form before you leave!

www.newenglandvfc.org

2015 New England Vegetable & Fruit Conference & Trade Show Steering Committee

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Hilary Sandler, UMass
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Kerri Senovitch, Grower, RI
Kim Stoner, CAES
Dave Tuttle, Grower, ME
Jim Ward, Grower, MA

Registration

Register online at

newenglandvfc.org

The pre-registration fee to attend any part or all of the conference or trade show is $115 for the first member of the farm or business and $85 for each additional family member or employee when pre-registered with first member. The pre-registration fee for students (high school or college) is $50 each when pre-registered by the instructor.

Pre-registration must be received by November 30, 2015. There is an additional fee of $30 per person ($20 students) for late registration or walk-ins. No refunds after 11/30/15.

Travel to the Conference

Location: Manchester is in the center of New Hampshire, located on US routes 3, I-93 and I-293, and state route 101. It is served by Manchester-Boston Regional Airport.

Hotel Accommodations

The conference host hotel is the Radisson Hotel in downtown Manchester, NH. Conference attendees are responsible for making their own arrangements for lodging. Rooms have been set aside at special conference rates at both the host hotel and at the Hilton Garden Inn. We encourage you to reserve early, because rooms typically sell out. Hotel reservation and parking information can be found in this brochure.

Hotel Information

Radisson Hotel – The Center of New Hampshire
700 Elm Street, Manchester, NH
1-603-625-1000 **www.radisson.com/manchesternh**

At the Radisson, a limited number of rooms are reserved at a special rate for conference attendees. The hotel rate for conference attendees is $114 single/double, $124 triple, $134 quad. To book a room please call 603-206-4109 (reservation desk). Please indicate that you are attending the New England Vegetable and Fruit Conference. When booking online use the reference code: NHVF15.

Comfort Inn Airport - 20% off when you mention NEVFC
298 Queen City Avenue, Manchester, NH, 03102
1-603-668-2600

Fairfield Inn - 20% off when you mention NEVFC
860 S Porter Street, Manchester, NH 03103
1-603-625-2020

Quality Inn - $95 per night for single/double and $105 for premier rooms when you mention NEVFC.
55 John E. Devine Drive, Manchester, NH 03103
1-603-668-6110
A hotel shuttle will run to the Radisson or anywhere else within in a 3 mile radius.

Parking

Limited parking is available at the host hotel parking garage next to the Radisson hotel. Additionally, a limited number of two hour and ten hour parking meters are available along city streets.

Other parking options:
Hampshire Plaza Parking Garage
2 Plaza Drive, Manchester, NH, 03101

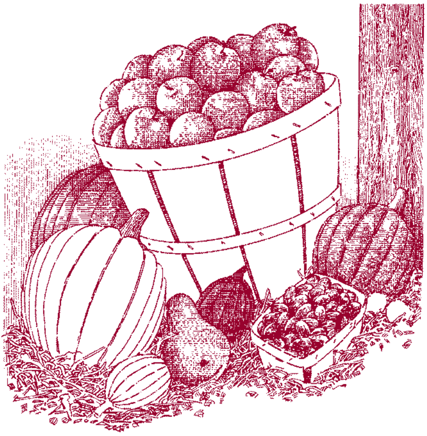
Victory Park Public Garage
25 Vine Street, Manchester, NH, 03101

Pesticide Education Credits

Certified pesticide applicators from New England are eligible to receive recertification credit. Growers from New York are NOT eligible to receive pesticide recertification credits. Pick up a form during registration and complete the information on the top portion. Be sure to have your certification number with you. This form is to be used for the entire conference. To get credit for a session, you must attend the entire session and forms must be signed by the Session Moderator at the end of the session. Turn in both the pink and yellow copies of the form at the registration desk when you leave the conference and keep the white copy for your records.

Certified Crop Advisor: Continuing Education Units

Certified Crop Advisors who attend certain sessions are eligible to receive Continuing Education Units. A sign in/ out sheet will be available for each session in the room. CCA members must SIGN IN at the beginning of each session and SIGN OUT at the end of the session. You must attend the entire session to receive credit. Be sure to include your CCA membership number.



Lunch

Each day of the conference, a selection of lunch offerings featuring local ingredients will be set up in the Food Court section of the Trade Show exhibition hall. In partnership with the Radisson Manchester Downtown, the New England Vegetable and Fruit Conference Steering Committee has made an effort to source locally grown ingredients from producers in all six New England states. Many restaurants are also available nearby in downtown Manchester.

Social Mixer and Awards Program

On **Tuesday** evening, the Trade Show is sponsoring a social from 4:30-to 6 pm. Light hors d'oevres and non-alcoholic beverages will be provided. On **Wednesday** evening, the Conference is sponsoring a social mixer and awards ceremony from 6:00 to 7:30 pm with cash bar and light hors-d'oevres. The purpose of this event is to bring everyone together including guests from various state Departments of Agriculture and the New England Land Grant Universities. There will be a short speaking program that will include a brief awards program for the New England Vegetable Berry Growers Association to honor two outstanding contributors for local agriculture. The cost of this event is covered by the Conference and Industry supporters of local agriculture. All are invited to this free event. Dinner will be on your own.

NEVBGA

The New England Vegetable & Berry Growers Association (NEVBGA) is the oldest vegetable growers association in the United States. We support and promote the vegetable and berry industries in New England.

The Association is a co-sponsor of the New England Vegetable and Fruit Conference. Made up of farmers and research and Extension personnel from Universities and Industry, we provide educational programming, publications, and networking opportunities for growers of all scales and production practices. We also support University research projects relevant to New England growers. You are invited to become a member!

We are offering a REDUCED RATE on Association dues
for FIRST TIME MEMBERS attending the CONFERENCE!!
Visit us at our table by the registration booth.

Farmer-to-Farmer Sessions and Other Events

WHAT ARE FARMER-TO-FARMER SESSIONS?

They are informal "chat" sessions where farmers learn from farmers and other knowledgeable presenters. There will be very short or no presentations at these sessions. Farmers can brainstorm and talk about what works for them and what doesn't, while learning new ideas from all who attend these roundtable discussions.

For each of the topics, bring photos on a stick drive, real photos, your favorite tools, short videos, or anything you have to share with the group.

WHY SHOULD I ATTEND?

Much can be learned from a mixed group of farmers, presenters, Extension people, researchers, and other interested folks. It will allow you a chance to ask questions of presenters and also of those who have experience in farming. These sessions have been very popular and successful, so come help and make these sessions a success for everyone again.

Tuesday, December 15

SPECIAL MORNING F2F SESSION

9:30 - 12:00 am **GROWING BEAUTIFUL CUT FLOWERS**
Location: PIERCE

REGULAR MORNING F2F SESSIONS

12:30 - 1:30 pm **DISEASES AROUND THE FARM & CONTROL OPTIONS**
Location: BALLROOM A

12:30 - 1:30 pm **HERBS, DOWNY MILDEW & HOT WATER TREATING SEEDS**
Location: CURRIERS

4:30 - 6:00 pm ***TRADE SHOW SOCIAL***
Location: EXPO CENTER

REGULAR AFTERNOON F2F SESSIONS

4:45 - 5:45 pm **POLLINATOR PROTECTION**
Location: CURRIERS

4:45 - 5:45 pm **WINTER GROWING/SEASON EXTENSION**
Location: ARMORY

SPECIAL EVENING SESSION

6:00 - 9:00 pm **$100,000 PER ACRE ON A SMALL FARM**
Location: BALLROOM ABCD

Wednesday, December 16

12:00 - 12:45 pm	**MASSACHUSETTS FRUIT GROWERS' ASSOCIATION ANNUAL MEETING** Location: ARMORY

MORNING F2F SESSIONS

12:30 - 1:30 pm	**TIPS & TRICKS FOR SMALL SCALE FARMING PROFITS** Location: BALLROOM A
12:30 - 1:30 pm	**WASHING STATION SET-UPS & EFFICIENCIES** Location: CURRIERS

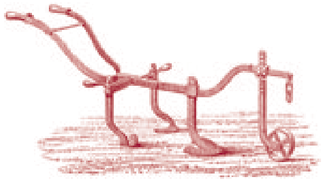
AFTERNOON F2F SESSIONS

4:45 - 5:45 pm	**HARD CIDER** Location: Armory
4:45 - 5:45 pm	**TOOLS, TRACTORS & TECHNIQUES OF WEED MANAGEMENT** Location: BALLROOM A
4:45 - 5:45 pm	**INSECTS IN OUR FIELDS & CROPS/ORGANIC CONTROLS** Location: CURRIERS
4:45 -5:45 PM	BOOK SALES AND SIGNING BY JEAN-MARTIN FORTIER Location: Foyer outside Ballroom BCD
6:00 - 7:30 pm	SOCIAL MIXER & AWARDS PROGRAM Location: BALLROOM BCD

Thursday, December 17

MORNING F2F SESSION ONLY

12:30 - 1:30 pm	**GREENHOUSE TOMATOES** Location: BALLROOM A
12:30 - 1:30 pm	**BEGINNING FARMERS: STARTUP DECISIONS** Location: CURRIERS



Tuesday, December 15
Trade Show - 8am - 6pm

Morning Sessions, 9:30 - 12:00
Farmer to Farmer, 12:30 - 1:30 & 4:45 - 5:45

BLUEBERRY I
LOCATION: FROST/HAWTHORNE (UPSTAIRS)
*Moderator: **LAURA MCDERMOTT***
Pesticide credits: 1.5, CCA credits: 1.5

9:30 **Winter Moth - Detection and Management**
Heather Faubert, University of Rhode Island

10:00 **Finding Revenue in your Blueberry Business**
Dan Welch, Cornell University

10:30 **Weed Control & Fertility in Organic Blueberry Production**
Bernadine Strik, Oregon State University

11:00 **Invest in Pollination for Success with Highbush Blueberries**
Emily May, Xerces Society

11:30 **Innovations in Blueberry Product Marketing**
Teresa Gaffney, Highland Blueberry Farm, Stockton Springs ME

TREE FRUIT I
LOCATION: ARMORY
*Moderator: **DUANE GREENE***
Pesticide credits: 2.0, CCA credits: 2.0

9:30 **Improving Branching of Apple Trees from Nursery to Orchard**
Win Cowgill, Rutgers University

10:00 **Climate Change - a Review**
Glen Koehler, University of Maine

10:30 **Getting the Upper Hand on Fire Blight**
Kari Peter, Penn State University

11:00 **The Young Grower Alliance and Precision Management Innovations - Panel**
Harvista for Precision Harvest Mgt - Mark Boyer, Ridge Top Orchard, Fishertown PA
The Apple Fruiting Wall & Precision Pruning/Hedging - Andre Tougas, Tougas Family Farm, Northborough MA
Innovative Grant for Orchard Pruning - Russell Holmbuer, Holmberg Orchards, Gales Ferry CT
NEWA Technology for Precision IPM and Crop Load Mgt - Ben Lerew, Lerew Bros. Orchard, Inc. Gardners PA

GROWING BEAUTIFUL CUT FLOWERS
LOCATION: PIERCE
*Moderators: **MIKE HUTCHISON & SANDY ARNOLD***

9:30 **Growing Beautiful Cut Flowers**
Polly & Mike Hutchison, Robin Hollow Farm, RI

This session will be run as a full length Farmer-to-Farmer Workshop

SPECIALTY & ETHNIC CROPS

LOCATION: BALLROOM BCD

Moderator: ***ANDREW RADIN***

Pesticide credits: 2.0, CCA credits: 2.5

9:30 **Some Interesting Discoveries Growing Brussels Sprouts**
Becky Sideman, University of New Hampshire

10:00 **Growing Ginger in the Northeast**
Sue Decker, Blue Star Farm, Stuyvesant, NY

10:30 **Getting Started with Rhubarb**
Nate Nourse, Nourse Farms, Whately MA

11:00 **All About Asparagus, & More**
Walter Czajkowski & Michael Zigmont, Plainville Farm, Hadley MA

INNOVATIVE IDEAS FOR SMALL ACREAGE

LOCATION: CURRIERS

Moderator: ***SKIP PAUL/SANDY ARNOLD***

Pesticide credits: 1.0

9:30 **Working Smarter, Not Harder with Innovative Tools at Pleasant Valley Farm**
Paul Arnold, Pleasant Valley Farm, Argyle NY

10:00 **Cost Effective Ways to Maximize Fertility Options**
Derek Christianson, Brix Bounty Farm, Dartmouth MA

10:30 **Innovative Production & Harvest Systems**
Dave Hambleton, Sisters Hill Farm, Stanfordville NY

11:00 **Geothermal, Hi Tech Bubble Roof & New Generation Wood Boiler for Greenhouses**
Sandy Dietz, WhiteWater Gardens Farm, Altura MN

11:30 **Innovative Ideas** - Panel
Foot Operated Electric Cultivation & Harvest Barge
Rob Rock, Pitch Fork Farm, Burlington VT
Allis Chalmers "G" Electric Conversion
Skip Paul, Wishing Stone Farm, Little Compton RI
Bicycle Tractor & Implements
Tim Cooke, Green Tractor Farm, Dorchester MA

FOOD SAFETY

LOCATION: BALLROOM A

Moderator: ***HEATHER BRYANT***

Pesticide credits: 1.0, CCA credits: 2.0

9:30 **Applied Research for Improved Post-Harvest Produce Washing**
Amanda Kinchla, University of Massachusetts

10:00 **Massachusetts Commonwealth Quality Program & the Intersection of State & Federal Food Safety Programs**
Michael Botelho, Mass Dept of Agricultural Resources

10:30 **Food Safety Considerations for Packing Sheds**
Robert Hadad, Cornell Cooperative Extension

11:00 **Farmer Experience with Audit Programs and/or Farm Food Safety Plans**
Mark Amato, Verrill Farm, Concord MA
Tyler Hardy, Brookdale Farm, Hollis NH
Peter Rogers, Rogers Orchard, Southington CT

4:30-6:00 PM: Social Mixer (Trade Show), Light hors d'oevres provided

Tuesday, December 15
Trade Show - 8am - 6pm

Afternoon Sessions, 2:00 - 4:30
Farmer to Farmer, 12:30 - 1:30 & 4:45 - 5:45

WINTER GROWING
LOCATION: BALLROOM BCD
*Moderator: **SANDY ARNOLD, SKIP PAUL***
Pesticide credits: 1.5, CCA credits: 1.5

2:00 **Season Extension Options for Your Farm**
Chris Lent, National Center for Appropriate Technology

2:30 **Growing Greens for Winter CSA Shares**
Ted Blomgren, Windflower Farm, Valley Falls NY

3:00 **Winter Insects, Disease & Rotations in High Tunnels**
Judson Reid, Cornell Cooperative Extension

3:30 **Frozen Ground Summary from 24 Top Winter Growers in US/Canada**
Michael Kilpatrick, Kilpatrick Family Farm, Granville NY
Sandy Arnold, Pleasant Valley Farm, Argyle NY

BRAMBLES
LOCATION: BALLROOM A
*Moderator: **MARY CONCKLIN***
Pesticide credits: 1.5, CCA credits: 2.0

2:00 **The Basics of Growing Brambles**
David Handley, University of Maine

2:30 **Nutrient Management in Brambles**
Bernadine Strik, Oregon State University

3:00 **Trellising Options for Brambles in Cold Climates**
Marvin Pritts, Cornell University

3:30 **Experiences with High Tunnel Brambles**
Bob Gray, 4 Corners Farm, S. Newbury VT

4:00 **Primocane Fruiting Blackberries**
Bernadin Strik, Oregon State University

BLUEBERRY II
LOCATION: FROST/HAWTHORNE (UPSTAIRS)
*Moderator: **HILARY SANDLER***
Pesticide credits: 2.0, CCA credits: 2.0

2:00 **Post-harvest Care to Enhance Blueberry Crop Value**
Craig Kahlke, Cornell University Cooperative Extension

2:30 **Blueberry Varieties for New England Farmers**
Adam Hausmann, Adam's Berry Farm, Charlotte VT
Aaron Libby, Libby & Son U-Pick, Limerick ME

3:00 **Improving Spray Deposition in Blueberries**
George Hamilton, University of New Hampshire

3:30 **Superfruit! Understanding Heatlh Benefits of Blueberries**
Diane McKay, Tufts University

4:00 **Manage Blueberry Fertility Through Your Trickle System**
Trevor Hardy, Brookdale Fruit Farm, Hollis NH

HARVEST, HANDLING & STORAGE

LOCATION: CURRIERS

*Moderator: **VERN GRUBINGER***

Pesticide credits: 1.0, CCA credits: 2.0

2:00 **Harvest Practices at Nature's Route Farm**
Kent Coates, Natures Route Farm, Point de Bute, NB Canada

2:30 **Vegetable Storage for Winter CSA Sales**
Laura Tangerini, Tangerini's Spring St. Farm, Millis MA

3:00 **Mechanizing Harvest of Greens & Roots**
Christa Alexander, Jericho Settlers Farm, Jericho VT

3:30 **Harvest & Handling Small Volumes of Diverse Crops**
Josh Volk, Slow Hand Farm, Portland OR

4:00 **Ideas for Harvest & Handling from California**
Chris Callahan, University of Vermont

TREE FRUIT II

LOCATION: ARMORY

*Moderator: **DUANE GREENE***

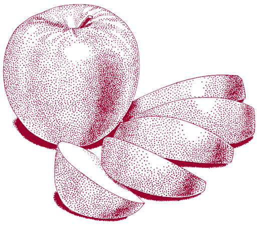
Pesticide credits: 1.5, CCA credits: 2.0

2:00 **Suggestions for Improving the Storage Potential of Honeycrisp**
Renae Moran, University of Maine

2:30 **Validation of the MaluSim Carbohydrate Model**
Greg Peck, Virginia Tech Univ.

3:00 **Where GMOs Stand Today**
Elizabeth Vierling, University of Massachusetts

3:30 **Pick-your-own Experiences & Suggestions for Stress-free Success**
Giff Burnap, Butternut Farm, Farmington NH
Greg Parzych, Rogers Orchards, Southington, CT
Maurice Tougas, Tougas Family Farm, Northborough MA



Special Evening Session, 6:00 - 9:00

PROFITS ON SMALL ACREAGE

LOCATION: BALLROOM ABCD

*Moderator: **SANDY ARNOLD***

Pesticide credits: 1.0

6:00 **$100,000 per Acre on a Small Farm**
Jean-Martin Fortier, Les Jardins de la Grelinette, Saint-Armand, Quebec Canada

Wednesday, December 16
Trade Show - 8am - 6pm

Morning Sessions, 9:30 - 12:00
Farmer to Farmer, 12:45 - 1:45 & 4:45 - 5:45

ON FARM TRIALS BY FARMERS
LOCATION: FROST/HAWTHORNE (UPSTAIRS)
*Moderator: **ERIC SIDEMAN***
Pesticide credits: 1.0, CCA credits: 2.0

9:30 **Designing an On-Farm Trial**
Becky Sideman, University of New Hampshire

10:00 **Analysing the Results of On-Farm Trials**
Iago Hale, University of New Hampshire

11:00 **Our On-Farm Trial to Test a Disease Management Technique**
Amy LeBlanc, WhiteHill Farm, East Wilton ME

11:30 **Our On-Farm Trial to Test a Berry Production System**
David Marchant, River Berry Farm, Fairfax VT

STONE FRUIT
LOCATION: ARMORY
*Moderator: **JON CLEMENTS***
Pesticide credits: 1.5, CCA credits: 2.0

9:30 **How to Use Plant Growth Regulators; ProGibb & Retain to Reduce Peach Flower Bud Density & Enhance Fruit Firmness for Retail Sales**
Win Cowgill, Rutgers University

10:00 **Bacterial Diseases of Stone Fruit: Spots & Cankers**
Kari Peter, Penn State University

10:30 **Brown Rot: Best Management Practices & Fungicide Resistance Management**
Guido Schnabel, Clemson University

11:00 **Growing Peaches in Michigan: How We Do It & What Keeps Us Up at Night**
Bill Shane, Michigan State University

11:30 **Varieties, Horticultural Practices & Challenges**
Win Cowgill, Rugers University
Ben Clark, Clarkdale Fruit Farms, Deerfield MA
Andre Tougas, Tougas Family Farm, Northborough MA
Sandie Barden, Barden Family Ochard, N. Scituate RI
Bill Shane, Michigan State University

MECHANICAL WEED CONTROL
LOCATION: BALLROOM BCD
*Moderator: **VERN GRUBINGER***
Pesticide credits: 2.5, CCA credits: 2.0

9:30 **Small Scale Cultivation in Diverse Crops**
Josh Volk, Slow Hand Farm, Portland OR

10:00 **Mulching & Weed Management**
Eric Gallandt, University of Maine

10:30 **Mostly Successful Stale Seed Bedding**
Tim Taylor, Crossroad Farm, Fairlee VT

11:00 **My Experience with the Fobro Star Hoe**
Charlie Tangerini, Tangerini's Spring St. Farm, Millis MA

11:30 **Be Courageous With Your Tine Weeder**
Dan Kent, Kent Family Growers, Lisbon NY

BRASSICAS/LEAFY GREENS
LOCATION: BALLROOM A
*Moderator: **SANDY ARNOLD***
Pesticide credits: 2.0, CCA credits: 2.0

9:30 **What's Bugging My Brassicas & Managing Cole Crop Pests**
Dan Gilrein, Cornell University Cooperative Extension

10:00 **Exploring Chinese Broccoli Cultivars**
Skip Paul, Wishing Stone Farm, Little Compton RI

10:30 **Producing Healthy Brassicas Spring Through Fall with Biocontrols & Rotation**
Andrew Knafel, Clear Brook Farm, Shaftsbury VT

11:00 **Twelve Months of Consistent Greens Production**
Michael Kilpatrick, Kilpatrick Family Farm, Middle Granville NY

11:30 **Growing Greens in Vermont for Profit**
Ben Dana, Root 5 Farm, Fairlee VT

STRAWBERRY I - DAY NEUTRAL WORKSHOP
LOCATION: CURRIERS
*Moderator: **DAVID HANDLEY***
Pesticide credits: 2.0, CCA credits: 2.0

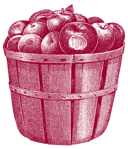
9:30 **Day Neutral Varieties, Strengths & Weaknesses - Panel**
Pam Fisher, Ontario Ministry of Ag., Food & Rural Affairs
David Pike, Farm to You, Farmington ME
John Lewis, Pereninia, Bible Hill, Nova Scotia Canada

10:00 **Bed Preparation & Planting**
David Handley, University of Maine

10:30 **Nutrition & Plant Management**
Laura McDermott, Cornell Cooperative Extension

11:00 **Pest Management in Day Neutral Strawberries**
Pam Fisher, Ontario Ministry of Ag., Food & Rural Affairs

11:30 **Growing Day Neutrals at Farm To You**
David Pike, Farm to You, Farmington ME



Massachusetts Fruit Growers' Association Annual Meeting,
12:00 - 12:45
Location: Armory

Wednesday, December 16
Trade Show - 8am - 6pm

Afternoon Sessions, 2:00 - 4:30
Farmer to Farmer, 12:45 - 1:45 & 4:45 - 5:45

CUCURBIT VINE CROPS
LOCATION: BALLROOM A
*Moderator: **KIM STONER***
Pesticide credits: 2.5, CCA credits: 2.0

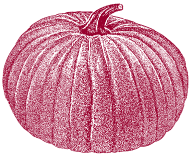
2:00 **Strategies for Managing Multiple Pathogens on Pumpkins**
Margaret McGrath, Cornell University/LIHREC

2:30 **Pollination of Pumpkin & Winter Squash - Thanks to Bumble Bees!**
Kim Stoner, Connecticut Ag Experiment Station

3:00 **Calabaza Squash & Personal-Sized Watermelons - Two High Value Specialty Crops**
Abigail Maynard, Connecticut Ag Experiment Station

3:30 **Use of Interspecific Hybrids in Squash for Fresh Market, Processing, & Grafting Rootstocks for Melons**
Brent Loy, University of New Hampshire

4:00 **Silicon Nutrition of Pumpkin for Suppression of Powdery Mildew**
Joseph Heckman, Rutgers University



STRAWBERRY - JUNE BEARING WORKSHOP
LOCATION: FROST/HAWTHORNE (UPSTAIRS)
*Moderator: **DAVID HANDLEY***
Pesticide credits: 2.0, CCA credits: 2.0

2:00 **After PYO: Mechanical Harvest Aids - Panel**
Ford Stevenson, Stevenson's Strawberries, Wayne ME
Joel Gilbert, Berry Fruit Farm, Livermore ME
Cathy Karonis, Fairwinds Farm, Topsham ME

2:30 **Living with Black Root Rot**
Marvin Pritts, Cornell University

3:00 **Strawberry Viruses: Why Worry?**
John Lewis, Perennia, Bible Hill, Nova Scotia Canada

3:30 **Weed Focus: Managing Persistant Problems**
David Handley, University of Maine

4:00 **Zone Tillage: Making it Work for Strawberries**
Tim Stanton, Stanton's Feura Farm, Feura NY

SOIL HEALTH

LOCATION: BALLROOM BCD

*Moderator: **MARK HUTCHINSON***

Pesticide credits: 1.5, CCA credits: 2.0

2:00 **Supplying Nitrogen from Organic Sources: New Tools for an Old Challenge**
Susan Erich, University of Maine

2:30 **Cover Crop Research at the University of Rhode Island**
Rebecca Brown, University of Rhode Island

3:00 **20+ Years of Reduced Tillage; How Has it Changed the Soil?**
Andy Williamson, County Fair Farm, Jefferson ME

3:30 **Impacts of Farm Management Upon Arbuscular Mycorrhizal Fungi & Production & Utilization of Inoculum**
David Douds, USDA-ARS, Wyndmoor PA

4:00 **Building Better Soils Through Soil Health Management**
Aaron Ristow, Cornell University

HARD CIDER

LOCATION: ARMORY

*Moderator: **TERENCE BRADSHAW***

Pesticide credits: 1.0

2:00 **Building a Bigger Orchard - An Overview of the US Cider Industry**
Jon London, The Angry Orchard, Boston MA

2:30 **Bittersweet Fruit & English Cider Making**
Neil MacDonald, Orchard Groundcare, Hornblottom, Somerset U.K.

3:00 **Considerations in Designing & Establishing a Cider Orchard**
Greg Peck, Viginia Tech

3:30 **Cider Apple Research in Vermont**
Terence Bradshaw, University of Vermont

4:00 **Innovations in Mechanical Harvest for Cider Apples**
Carol Miles, Washington State University

FARM DECISIONS: SCALING UP OR NOT

LOCATION: CURRIERS

*Moderator: **JUDE BOUCHER***

Pesticide credits: 1.0

2:00 **Staying Small & Profitable**
Jean-Martin Fortier, Les Jardins de la Grelinette, Quebec Canada

3:00 **Diversification & Downsizing for Optimum Growth**
Michele & Bill Collins, Fair Weather Acres, Rocky Hill CT

3:30 **Understanding Economy of Scale - Honing In & Finding Your Place**
David Liker, Gorman Produce Farm, Laurel MD

Social Mixer and Awards Program
6:00 - 7:30
Ballrooms BCD

Thursday, December 17
Trade Show, 8am - 2pm

Morning Sessions, 9:30 - 12:00
Farmer to Farmer, 12:45 - 1:45

ORGANIC PRODUCTION
LOCATION: BALLROOM A
*Moderator: **ERIC SIDEMAN***
Pesticide credits: 1.0, CCA credits: 1.5

9:30 **Nutrient Content, Availability, & Release Rates from Natural Fertilizers**
Bruce Hoskins, University of Maine

10:00 **How We Manage Fertility all Season at Roxbury Farm**
Jody Bolluyt, Roxbury Farm, Kinderhook NY

10:30 **How We Manage Fertility all Season at Clear Brook Farm**
Andrew Knafel, Clear Brook Farm, Shaftsbury VT

11:00 **What Works & What Doesn't for Disease Management: Recent Trials**
Meg McGrath, Cornell University Cooperative Extension

11:30 **Lettuce Production Using Plastic Mulch & an Update on Status of Biodegradable Plastic Mulch**
Carol Miles, Washington State University

NEW ENGLAND VITICULTURE I
LOCATION: CURRIERS
*Moderator: **SONIA SCHLOEMANN***
Pesticide credits: 1.5, CCA credits: 2.0

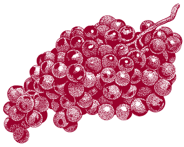
9:30 **Horticulture & Disease Mgt of Cold Climate Grapes in VT**
Terence Bradshaw, University of Vermont

10:00 **Site & Soil Parameters for Northern Grape Production**
Tim Martinson, Cornell University

10:30 **Cold Climate Wine Grape Cultivars for the Northeast**
Andy Farmer, Northeast Vine Supply, West Pawlet VT

11:00 **Under-Vine Cover Crops as an Alternative to Herbicides in Vineyards**
Ming-Yi Chou, Cornell University

11:30 **Vineyard Nutrition for Cold Climate Wine Grapes**
Diana Cochran, Iowa State University



GREENHOUSE TOMATOES

LOCATION: BALLROOM BCD

Moderator: ***ANN HAZELRIGG***

Pesticide credits: 1.5, CCA credits: 1.5

9:30 **Weaving vs Stringing Tomatoes: Which is More Profitable?**
Tim Taylor, Crossroad Farm, Fairlee VT

10:00 **Fifty Shades of Gray Mold - Managing Tomato Diseases in High Tunnels**
Ann Hazelrigg, University of Vermont

10:30 **Growing Great Tomatoes All Winter in Minnesota**
Sandy Dietz, Altura MN

11:00 **Satisfying High Tunnel Tomato Nutrient Demands**
Steve Bogash, Penn State University

ROOT CROPS

LOCATION: ARMORY

Moderator: ***CHUCK BORNT***

Pesticide credits: 2.5, CCA credits: 1.0

9:30 **Using Deep Tillage at Wilson Farms for Root Crops**
Jim Wilson, Wilson Farms, Lexington MA

10:00 **Root Crop Variety Trials**
Crystal Stewart, Cornell University Cooperative Extension

10:30 **Growing & Marketing Root Crops at Tangerini's Spring Street Farm**
Laura Tangerini, Tangerini's Spring St Farm, Millis MA

11:00 **Getting Ready to Store Root Crops: What You Need to Know**
Steve Johnson, University of Maine

11:30 **Using Ridge Till for Root Crops at Roxbury Farm**
Jody Bolluyt, Roxbury Farm, Kinderhook NY

USING TECHNOLOGY

LOCATION: FROST/HAWTHORNE (UPSTAIRS)

Moderator: ***TORI JACKSON***

Pesticide credits: 1.5, CCA credits: 2.0

9:30 **Cabbige: A Price Optimization Tool for Small Farms**
Jessica Angell, Cabbige, Cambridge MA

10:00 **Free Apps for Pest Management**
Andrew Frankenfield, Pennsylvania State University

10:30 **MyIPM for Strawberries & Peaches**
Guido Schnabel, Clemson University

11:00 **Pros & Cons of UAV's or Drones in Agriculture**
J. Craig Williams, Pennsylvania State University

Thursday, December 17
Trade Show, 8am - 2pm

Afternoon Sessions, 2:00 - 4:30
Farmer to Farmer, 12:45 - 1:45

SWEET CORN
LOCATION: ARMORY
*Moderator: **CHUCK BORNT***
Pesticide credits: 2.5, CCA credits: 1.0

2:00 **Revisiting Reduced Tillage Sweet Corn Production at Wilson Farms**
Jim Wilson, Wilson Farms, Lexington MA

2:30 **Sweet Corn Genetics: Where We are & Where We're Going**
Blake Myers, Siegers Seed Company, Rochester NY

3:00 **Sweet Corn Planting at Goranson Farms: From Transplanting to Direct Seeding**
Rob Johanson, Goranson Farm, Dresden ME

3:30 **Producing the World's Best Popcorn at Hurricane Flats Farm**
Geo Honigford, Hurricane Flats Farm, South Royalton VT

4:00 **What Do I Do About Birds in My Sweet Corn?**
Alan Eaton, University of New Hampshire

NEW ENGLAND VITICULTURE II
LOCATION: CURRIERS
*Moderator: **SONIA SCHLOEMANN***
Pesticide credits: 2.0, CCA credits: 2.0

2:00 **Grape Pests & IPM Practices for Cold Climate Cultivars**
Anna Wallis, Cornell Cooperative Extension

2:30 **Root & Crown Diseases of V. vinifera for New England**
Elsa Petit, University of Massachusetts

3:00 **The Effect of Vine Architecture on Disease Mgt in New England Vineyards**
Frank Ferandino, Connecticut Agricultural Experiment Station

3:30 **Table Grape Varieties for New England**
George Hamilton, University of New Hampshire

4:00 **Growing & Marketing Seedless Table Grapes at Kimball Fruit Farm**
Carl Hills, Kimball Fruit Farm, Pepperell MA

HOPS

LOCATION: BALLROOM A
*Moderator: **HEATHER FAUBERT***
Pesticide credits: 1.5, CCA credits: 2.0

2:00 **Hopyard Construction**
Roger Rainville, Borderview Farm, Alburgh VT

2:30 **Hop Production**
Heather Darby, University of Vermont

3:30 **Harvesting & Drying Hops**
Chris Callahan, University of Vermont

GREENHOUSE CONTAINER GROWING

LOCATION: BALLROOM BCD
*Moderator: **BECKY SIDEMAN***
Pesticide credits: 2.0, CCA credits: 1.5

2:00 **Container Growing: Managing Greenhouse Tomatoes for Consistent & Optimal Yields**
Rich McAvoy, University of Connecticut

2:35 **Greenhouse Container Vegetable Production at Four Town Farm**
Brad Clegg, Four Town Farm, Seekonk MA

3:05 **Basics of Hydroponic Production: What You Need to Know**
Neil Mattson, Cornell University

3:45 **Success with Hydroponic Production in Maine**
Shawn O'Donnell, Olivia's Garden, New Gloucester ME

FERTILIZER DECISION MAKING

LOCATION: FROST/HAWTHORNE (UPSTAIRS)
*Moderator: **ANDREW RADIN***
Pesticide credits: 1.0, CCA credits: 2.0

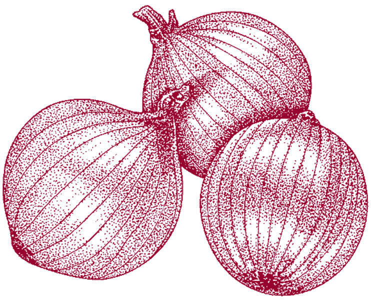
2:00 **Managing P & S in Your Soil's Nutrient Bank**
Natalie Lounsbury, River Rise Farm, Turner ME

2:30 **Mid-season N Management (PSNT)**
Joseph Heckman, Rutgers University

3:00 **Organic Fertility for Greenhouses**
Doug Cox, University of Massachusetts

3:30 **Green Manuring for Fertilizer Reduction**
Hank Bissell, Lewis Creek Farm, Starksboro VT

4:00 **Efficacy of Foliar Feeding on High Tunnel Tomatoes**
Steve Bogash, Penn State University



Trade Show Exhibitors

Adama
Adams County Nursery, Inc.
Alarm the Farm, LLC
American Stonecraft
Arthur Carroll Insurance Agency
Arysta Life Science
Ball Horticultural Company
BASF
Bayer Crop Science
Bejo Seeds, Inc.
Biosafe Systems
Brookdale Farm Supplies
Buxton Hollow Farm
Carovail
Casella Organics
Certis USA
Chappell Tractor
Charles W. Harris Co. Inc.
Checchi and Magli
Country Folks Grower
Crop Care
Crop Production Services
Decade Products
Devon Lane Farm Supply
Dow AgroSciences
Dubois Agrinovation Inc.
Dupont
Farm Credit East, ACA
Film Organic
Frazer Insurance Agency
Fred C. Gloeckner & Co.
Frost Farm Service Inc.
Globe Bag Company, Inc.
Gowan Company
Grimes Horticulture, Inc.
Growers Supply
Harvestech, Inc.
Helena Chemical
Hillside Cultivator
H.L. Emery, Inc.
IVA Manufacturing
JMT US LLC
Johnny's Selected Seeds
J.S. Woodhouse Co., Inc.
Kirby Agri
Kreher Enterprises LLC
Kube Pak Growers of Fine Plants
Kult Kress LLC
Marrone Bio Innovations
Mechanical Transplanter Co.
Miller Chemical and Fertilizer Corp.
Monosem
Monte Package Company
Moose River Media
NACHURS
Nature Safe Natural and Organic Fertilizers
North Country Organics
Nourse Farms, Inc.
Nutri-Cal
OESCO, Inc.
Payroll Management, Inc.
PCA Supply Services
Pratt Quality Carton
Resource Management, Inc.
Rimol Greenhouse Systems, Inc.
River Valley Fencing
Rupp Seeds
Seedway, LLC
Siegers Seed Company
Stanton Equipment
Stokes Seeds Inc.
Suntex CP
Syngenta
Tew Manufacturing Corp.
Toro Micro-Irrigation
Two Bad Cats LLC
Valent U.S.A. Corp.
Vermont Compost Company
Wafler Nursery
Wellscroft Fence Systems, LLC

**List as of print date for this brochure. Additional Exhibitors can be viewed by going to the NEVFC website: www.newenglandvfc.org*

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	Rate Before/after Nov. 30	Amount
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		No.	Amount
Additional Registrants	$85/115	____	$ _______
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Total Due: $ ____

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First Registrant Contact Info:

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Names of Additional Registrants (family member or employee)

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RETURN BY NOVEMBER 30, 2015 TO:
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University of Maine Cooperative Extension
PO Box 179, Highmoor Farm
Monmouth, ME 04259

No refunds after Nov. 30th

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