New England Vegetable and Fruit Conference

2009 Proceedings

Crunching Numbers

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- How do you Know if you are Making Money?
  Mike Sciabarrasi, UNH Cooperative Extension
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- How we grow certified organic pumpkins & winter squash
  Howard Prussak, High Meadows Farm
- Pumpkin Varieties: What's new and what's coming
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  Steve Siegars, Yankee Farmer
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  Chris Hillier, Johnny's Selected Seeds
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- Matted Row Strawberries: The Basics
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  Dr. David Handley, University of Maine Cooperative Extension

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- The ABC's of Inground Heating and Alternative Fuels
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- Profitable Winter Greens in Ground-Heated Tunnels
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- Marketing Year-Round with Rowcovers & Moveable Tunnels
  Skip Paul, Wishing Stone Farm
- Year-Round, Horse Powered Membership with Full Diet, Free Choice
  Mark and Kristin Kimball, Essex Farm

Pepper and Eggplant

- Pepper varieties for your markets: from bells to habaneros and everything in between
  Dr. Frank Mangan, University of Massachusetts
- Grafting eggplant for Verticillium wilt management
  Dr. Mike Orzolek, Pennsylvania State University
- Management update of Phytophthora and other diseases in peppers and eggplants
  Dr. Rob Wick, University of Massachusetts
- Growers' Panel: How we grow and market peppers and eggplant
  Brian Reeves, Reeves Farm,
  Gideon Porth, Atlas Farm,
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So You Want to Farm - Five Farmers Share their Beginnings

- The First Year . . .
  Kristen Wilmer, 1st year farmer
- CSA Start-Up
  Marcy O'Connell, Holland Farm CSA
- The Incubator Farm Experience
  Pat McNiff, Manager, Casey Farm, RI
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  Nate Drummond and Gabrielle Gosselin, Six River Farm
- Restaurants, Direct
  Paulette Satur, Satur Farms

Strawberry II - New Ideas

- Weed Management
  Dr. Rich Bonanno, University of Massachusetts Cooperative Extension
- Growing in High Tunnels: Expanding Our Market
  Bob Gray, Four Corners Farm
- Runner Management to Boost Efficiency
  Sonia Schloemann, University of Massachusetts
- Strawberry Varieties for Today and Tomorrow
  Nate Nourse, Nourse Farms
- Variety Performance in New England
  Dr. David Handley, University of Maine Cooperative Extension

Tree Fruit I

- Whats new in IPM trapping of oriental fruit moth and dogwood borer in NH?
  Alan Eaton and George Hamilton, UNH Cooperative Extension
- MOPUP-The Massachusetts Orchard Production Upgrade Program and what we have learned about planting and managing tall-spindle orchards
  Jon Clements, University of Massachusetts
- Organic apple production in eastern US- Pennsylvania perspective
  Greg Krawczyk, Pennsylvania State University
- Whole farm approach to manage insect pests
  Greg Krawczyk, Pennsylvania State University
- Harvest and storage practices to optimize and prevent loss of apples
  Renee Moran, University of Maine

Tunnel Innovations

- A Tour of Tunnels of All Types
  Dr. Vern Grubinger, University of Vermont
- Growing Diverse Crops in Walk-In Caterpillar Tunnels
  Ted Blomgren, Windflower Farm
- Profitable Production in Diverse Types of Tunnels
  Michael Kilpatrick, Kilpatrick Family Farm, Middle Granville NY
- Economics and Marketing of Winter High Tunnel Production
  Adam Montri, Ten Hens Farm/MSU Student Organic Farm

- Plastics on Tunnels For Different Seasons
  John Bartok, University of Connecticut

Blueberry I

- Integrated Management of Insect Pests in Blueberry
  Dr. Alan Eaton, University of New Hampshire Cooperative Extension
- Integrated Blueberry Disease Management
  Frank Caruso, University of Massachusetts
- Integrated Blueberry Weed Management Principles and Practices
  Dr. Rich Bonanno, University of Massachusetts Cooperative Extension
- Post Harvest Handling of Blueberries - a grower's perspective
  Gene Kosinski, Kosinski Farms
- Pollination Issues in Blueberry Production
  Sonia Schloemann, University of Massachusetts

Efficiency on the Farm

- Optimizing Harvest Efficiency at Roxbury Farm
  Jean-Paul Courtens & Jody Bolluyt, Roxbury Farm
- An Efficient System for Winter CSA Crop Storage
  Andy Jones, Intervale Community Farm
- Increase the Efficiency of Your Greenhouse(s)
  John Bartok, University of Connecticut
- Creating a culture for labor efficiency
  Dale Riggs, Stonewall Hill Farm
- Paper-Pot System for Transplanting Efficiency
  John Hendrickson, Stone Circle Farm

Leafy Greens

- Growing for the high-end restaurant: What they want, and quality considerations
  Jack Algiere, Stone Barns Center
- Leafy Greens and Good Agriculture Practices (GAP) - Not as hard as you think
  Brian Reeves, Reeves Farm
- Fertility to pest control - How we grow leafy greens on Long Island
  Bob Nolan, Deer Run Farm
- Field Finesse & Marketing Success - How refining your technique can imporve your bottom line
  Paulette Satur, Satur Farm
- Leafy Greens - Our strategy for cover crops and rotation
  Jane and Bob Pomykala, Pomykala Farm

Soil Health

- Soil Health and Crop Rotations
  Lauchlin Titus, Ag-Matters
- Reduced Tillage Impact on Soil Organisms
  Rob Johanson, Goranson Farm
- Measuring the Impacts of Farm Practices on Soil Health
  Lisa Krall, USDA-NRCS

- Compost; A way to Diversify Soil Microbial Populations
  Will Brinton, Woods End Laboratory
- Brassica cover crops and seed meals as soil biofumigants in vegetable crop production
  Dean Kopsell, University of Tennessee

Tree Fruit II

- Apple rootstocks, an update frm th eNC-140 research
  Wesley Autio, University of Massachusetts
- New tools to manage insect pests
  Greg Krawczyk, Pennsylvania State University
- The basics of cherry production
  Greg Lang, Michigan State University
- IPM Heresies- What is true for you
  Glen Koehler, University of Maine

Blueberry II

- Blueberry Scorch Update - what you need to know
  Peter Oudemans, Rutgers University
- Winter Moth Damage and Management in Blueberries
  Robert Childs, University of Massachusetts
- PYO Blueberries - a grower's perspective
  Maurice Tougas, Tougas Family Farm
- Blueberry Varieties - what's new, what's tried and true
  Mike DeGrandchamp, DeGrandchamp Farm
- Blueberry Pruning
  Cathy Heidenreich, Cornell University

Grower Experiences with Deep Zone Tillage

- Why Deep Zone-Tillage/Verticle-Tillage
  Jude Boucher, University of Connecticut
- Transitioning to Deep Zone-Tillage
  Nelson Cecarelli, Cecarelli Farm
- Stabilizing Profitability on Your Farm
  Tom Scott, Scott's Yankee Farmer
- Zone-Tillage - 12 Years Later
  George Ayres, Fresh Ayr Farm
- Why We Switched from Conventional-Till to Strip-Till
  Gary Sweet, Sweet's Gourmet Sweet Corn

Organic Pest Management

- Managing Weeds with Crop Rotation
  Eric Gallandt, Univesity of Maine
- A Whole-System Approach to Managing Weeds
  Andy Jones, Intervale Community Farm
- Efficacy of Various Biological and Microbial Insecticides - Does that really work?
  Abby Seaman, Cornell University Extension

- Efficacy of Various Biological and Microbial Fungicides - Does that really work?
  Meg McGrath, Cornell University Extension
- A Whole-System Approach to Minimizing Pests
  Jean-Paul Courtens and Jody Bolluyt, Roxbury Farm

Sweet Corn

- Adapting to the Twenty-First Century
  Gary Sweet, Sweet's Gourmet Sweet Corn
- Retail Opportunities with Sweet Corn
  Ed Harbes, Harbes Family Farm
- Scheduling Sweet Corn Plantings, the easy way
  Hank Bissell, Lewis Creek Farm
- Corn Stars, Highlighting the best varieties in each of the genetic classes
  Blake Meyers, Siegers Seed Company

Tree Fruit III

- IPM Options Evaluation Tool: A New Pesticide Evaluation and Selection Tool for Agriculture
  Joe Bagdon, Natural Resources Conservation Service
- The ABC of TRV- Tree Row Volume is not rocket science
  Glenn Koelher, University of Maine
- High tunnel production of cherries
  Greg Lang, Michigan State University
- Biointensive IPM and disease management of comparing biopesticides and conventional pesticides in apple disease management
  Dan Cooley, University of Massachusetts
- New, antique and different apples
  Duane Greene and Jon Clements, University of Massachusetts

Brambles

- Getting Started with Raspberries
  Dr. David Handley, University of Maine Cooperative Extension
- Raspberry Varieties for the Cold
  Pam Fisher, Ontario Ministry for Agriculture, Food and Rural Affairs
- Raspberries in High Tunnels: Opportunites & Challenges
  Kathy Demchak, Pennsylvania State University
- Raspberry Insect Management
  Pam Fisher, Ontario Ministry for Agriculture, Food and Rural Affairs
- What About Blackberries? Options for the Northeast
  Kathy Demchak, Pennsylvania State University

Brassica

- Improve your cash-flow with winter vegetables
  Jan van der Heide, Bejo Seeds, Inc.
- Winter sprouting broccoli: new crop for early spring
  Becky Sideman, University of New Hampshire Cooperative Extension

- In search of the perfect brussels sprout
  Ruth Hazzard, University of Massachusetts Cooperative Extension
- Downy mildew, Alternaria and other diseases
  Ann Hazelrigg, University of Vermont
- Growing broccoli and cauliflower from spring through fall
  Jim Golonka, Golonka Farm
- Selecting brassicas for freeze-hardiness and yield
  Brett Grohsgal, Evenstar Farm

Nutrient Value of Plants for Human Health

- Production of Hydroponic Tomatoes Rich in Flavor and Bioactive Compounds
  Chieri Kubota, University of Arizona
- Changes with season of nutrients in salad greens grown in high tunnels
  Martin Gent, Connecticut Agricultural Experiment Station
- Phenolic Phytochemicals in Fruits & Vegetables are Linked to Health Benefits
  Kalidas Shetty, University of Massachusetts
- Post-harvest changes in Squash
  Dr. Brent Loy, University of New Hampshire
- Improving carotenoid phytochemical concentrations in vegetable crops
  Dean Kopsell, University of Tennessee

Tomatoes

- The ABC's, I mean NPK's, of tomato production
  Dean Kopsell, University of Tennessee
- Properly Identifying Tomato Diseases
  Dr. Cheryl Smith, University of New Hampshire Cooperative Extension
- How to Develop a Season-Long Disease Control Program
  Meg McGrath, Cornell University
- Late Blight: What Happened in 2009
  Jim Dill, University of Maine Cooperative Extension
- Late Blight Discussion Session: What worked and what didn't
  Dr. Cheryl Smith, University of New Hampshire Cooperative Extension, Meg McGrath, Cornell University, Jim Dill, University of Maine Cooperative Extension

Viticulture I

- Managing Insect Pests in Grapes
  Greg Loeb, Cornell University
- Powdery and Downy Mildew; major problems in eastern vineyards
  Peter Oudemans, Rutgers University
- Wine and Table Grape Varieties for New England
  Bruce Reich, Cornell University
- Winegrape Cultivar Trials in CT
  William Nail, Connecticut AG Experiment Station
- New Technology in Vineyard Spraying
  Andrew Landers, Cornell University

Greenhouse Tomato

- Review of Instrumentation to Control the Greenhouse Environment
  Chieri Kubota, University of Arizona
- IPM Methods for Insect management
  Margaret Skinner, University of Vermont
- Growing Greenhouse tomatoes at Holmberg Orchards
  Russ Holmberg, Holmberg Orchards
- Organic Greenhouse Tomato Nutrient Management
  Vern Grubinger, University of Vermont
- Reciculating used Nutrient Solution for Greenhouse Tomato
  Martin Gent, Connecticut Agricultural Experiment Station

Irrigation

- Basics of an Adaptable Irrigation System
  Fran Dellamano, Belle Terre Irrigation LLC
- Moving to a Mostly Drip System and Why
  Trevor Hardy, Brookdale Fruit Farm
- Finally Filtering the Pond Water for Drip
  Rich Bonanno, Pleasant Valley Gardens
- What's Everybody Up to Out There
  Dan Lenthall, NRCS
- A Fixed Spray System for Fruit Crops
  Andrew Landers, Cornell University

Marketing

- Market Trends: Organic, Local and Eco
  Michael Rozyne, Red Tomato
- Extending your Markets with High Tunnels
  Michael Orzolek, Pennsylvania State University
- Going from 3 to 40 Farmer’s Markets in Four Years
  Maria Moreira, Flats Mentor Farm
- Using Good Agricultural Practices (GAP) certification for your marketing
  Dr. Rich Bonanno, University of Massachusetts Cooperative Extension
- How to Get Locally-grown Fresh Produce into the Boston Food System
  Frank Mangan, University of Massachusetts

Vine Crops

- Evaluation of pickling and slicing cucumbers varieties
  Mark Hutton, University of Maine
- Cucumber-tomato intercropping production system
  Heather Bryant, University of New Hampshire Cooperative Extension
- Pests and Partners: the effects of cucumber beetles on pollinators, mycorrhizal fungi and yield in cucumbers
  Nick Barber, University of Maine
- Growing Cantaloupes in Cool Climates!
  Mark Guzzi, Peacemeal Farm
- What's New with Vine Crop Diseases and their Management
  Meg McGrath, Cornell University

Viticulture II

- Canopy Management for Quality
  Justin Scheiner, Cornell University/NY Ag Expt Station
- Table Grapes- a growing market
  Dennis Rak, Double A Vineyards
- Vine Training and Pruning for New England
  William Nail, CT Ag Exp Station
- IPM for Cold Climate Viticulture
  Sonia Schloemann, University of Massachusetts

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and

New England Vegetable and & Berry Growers Association

and

Massachusetts Fruit Grower's Association

and

Maine Organic Farmers and Gardeners Association (MOFGA)

TRACKING SALES AND PER-ACRE PROFITS FOR FARMERS' MARKET

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We started Pleasant Valley Farm from just bare land over 20 years ago; we grow a diverse selection of more than 40 types of vegetables and fruits with organic methods on about 7 acres of land, and everything we grow is sold at three area farmers' markets that operate year-round.

Good business management is probably the key factor to our success. We treat our farm as a business so that farming has become a lifestyle that we thoroughly enjoy. Our goal from the beginning was to reinvest $10,000 each year back into the farm and it was critical to know what would give us the best return on our money in order to continually increase our profitability. In our early years, we realized that irrigation was essential because we felt the farm was losing at least $10,000 each year due to inconsistent seedings and low yields. The year after irrigation was installed (at a cost of about $15,000 for 4 acres); the result was an increase of $30,000 in the first year of irrigating! Another early purchase was a barrel washer, which cost $1000 (built by farmer Dick DeGraff). We could calculate from our records that the barrel washer paid for itself in only two weeks! Similar improvements we found to be good business expenditures over the years included: a walk-in cooler, field tiling for drainage, basket weeders, potato planter, tater point to dig potatoes, manure spreader specific for spreading compost, and a vegetable washer.

Some of our management decisions are made by a "hunch", but many are based on the records that we keep on our farm. Record keeping is very valuable for running a farm business. Maintaining very simple records works well for us and it requires minimal time outlay. We keep field seeding records in a notebook which consists of: date of seeding, variety, row footage, and spacing. From these few numbers, the square footage of each crop can be calculated. For example, many of our crops are planted in beds which have 4 rows planted 14" apart and are 100 feet long and have two feet between beds; each of these beds is therefore 550 square feet. We also use a simple spreadsheet in a notebook in the washing station that is filled in each harvest day showing the product, quantity packed for the market (bunches, heads, pounds, etc), and the quantity that returns from the market. From those few numbers, a total quantity sold of each product can be determined at the end of the year, and therefore its total approximate value.

These simple records help us utilize two rules that we employ in our management. The first rule is what we call the "$15,000 per acre rule." What that means is that each crop is expected to have a minimum gross value of $15,000 per acre **if extrapolated out**. This calculation is determined by using our records that show the square footage of each crop that is grown on and the actual dollar value that each crop produced for the entire year. The extrapolation is necessary because we do not grow an acre of most crops and we need to have a system to compare them evenly. Planting most crops intensively in rows 14 inch on center is important to utilizing small acreage to its fullest extent on our farm. If a particular crop is not making us $15,000 per acre, then we must once again make a management decision on that crop to raise its value. Some of the options to accomplish this are by: improving our production and harvesting techniques; changing the variety; packaging or displaying it differently; increasing the price; or extending its

growing season. Another option is to discontinue growing the crop, which we rarely do because that would reduce our diversity.

To give an example of how this rule has worked for us, we will examine pea production. In an average year (or an average over several years), our records showed the following:
SUGAR SNAP PEAS: Income = 538 pints @$3/pt =$1,614 The Field space = 2,700 squ. feet
Since 1 acre = 43,560 square feet, the actual acreage planted is 2,700/43,560 = .062 acre
Then, extrapolating to show the crop value for one acre: $1,614/.062 acre = $26,032 per acre
Using these same formulas and our records, the values of the other peas were:
SHELL PEAS: $8,614 per acre ($2.50/quart) & SNOW PEAS: $48,214 per acre ($3.00/pint)
Thus, we decided to stop growing shell peas because the market would not bear a high enough price to make it profitable to grow according to our standards and there were no other options available (we do however grow some for ourselves each year to eat and freeze!). We increased our plantings of sugar snap and snow peas to accommodate what quantities the markets would bear. All numbers will vary by each farmer's spacing, so specific calculations should be done by each farmer to determine his/her most profitable crops.

Each year we evaluate some of our crops during the winter based on those simple records we keep 2 days per week on our harvest days; the calculations take only a day or so to give us the final data. We are beginning to use our computer more and more, but for the most part, pen, paper and a calculator give us the valuable data! The second rule that we employ in our management to maintain profitability is the "$30 per hour rule." What that rule means is that each employee, while harvesting and preparing produce for the markets, must be earning a minimum value of $30 per hour for each crop. For example, an average worker can pick 25 pounds of beans in an hour and for us, that is a value of $75 since we retail them at $3 per pound. Beans therefore meet our criteria and are profitable enough to grow. We maximize our income for the market by harvesting the most profitable crops first.

Season extension has been important to our farm since it makes certain crops more profitable and it extends our growing/selling season. Our traditional farmers' markets begin May first each spring, and season extension has given us the opportunity to provide customers with an abundance of produce in May, which is in high demand after a long winter. Selling early crops also produces an income of much needed spring money. Having produce for the first markets gives us the advantage of getting customers in the habit of coming to our table first, and hopefully sticking with us all season long. Likewise, season extension allows us to have the greatest amount of diversity for our October and November markets. Creating a colorful display filled with a diverse supply of abundant, fresh, quality produce draws customers every week.

Through the use of floating row covers and season extension houses, we have been able to extend the seasons successfully. Row covers have been used extensively on our farm to enhance growth and protect crops in the spring and fall from light frosts. Some of the crops that benefit from row covers are: peas, radishes, beets, spinach, lettuce, carrots, potatoes, swiss chard, beans, cucumbers, squash, turnips, herbs, and rhubarb. As an example, by placing row cover over our 30 ft by 27 ft bed of rhubarb in March, production starts one to two weeks earlier (May 1st in our area). We only harvest rhubarb for the month of May, and with the rowcover, our yield was 774 bunches @ $2.50, hence $1935 which extrapolates to over $104,000 per acre!

Since 1992, we have been building season extension houses on our farm. We have termed these structures "fieldhouses" because they are temporary, sit directly on our growing fields, and lend themselves easily to rotations. We have utilized two homemade designs that have worked well for us; they are all 14 feet wide by 96 feet long with a 6-7 foot height in the center. We

built plastic-piped fieldhouses costing approximately $600 each and metal-piped ones costing about $800 each (materials only for both). The metal-piped houses can remain up all winter, since they can withstand snow loads. Each house takes 2 people about 4 hours to construct.

Many different vegetables can benefit from being grown in a fieldhouse. We have trialed lettuce, spinach, peppers, tomatoes, beets, swiss chard, basil, and interplanted radishes and scallions. We choose to extend the season on a particular vegetable due to the fact it is in high demand by customers, it is a high value crop, and we would not be able to have it at that time of year if it were not grown in fieldhouses. For example, lettuce is seeded weekly in 200-cell speedling trays in the greenhouse starting in February. Then in March, we transplant 600 lettuce plants each week for three consecutive weeks into one fieldhouse. Planting them 12 inches between rows and 8 inches in row gives us a total of 1800 early, marketable heads of lettuce. Therefore, this one fieldhouse provides us with lettuce for the month of May and the lettuce has a value of about $4500 in gross sales (extrapolates out to $145,000 per acre!).

Similarly, we start spinach in the greenhouse in late February in 200-cell speedling trays. As with lettuce, spinach is seeded every week then transplanted into two fieldhouses with 5-inch spacing between plants and 12inches between rows. We plant one fieldhouse with Tyee or Renegade spinach over a 1 to 2 week period and it produces a crop valued at about $4700 gross when sold at $8 per pound (extrapolates out to $152,000 per acre!). The spinach leaves are re-picked about 5 days apart for 5-7 times. Our timing of transplanting crops out in the fields provides a continuous supply throughout the year. These fieldhouses have given us a great return over the years, especially since the structures are used over and over each year.

In 2006, we started a new venture utilizing high tunnels, with one completed in early 2007 and another completed in May 2008. They are permanent Rimol high tunnels (one 30'x144' and one 34'x144') with extended posts to allow us to have the sides open up extra high. We are learning how wonderful these high tunnels are for growing crops for year-round production. Our summer crops have included transplanted beans, basil, tomatoes, summer squash, and cucumbers. Winter markets are growing and expanding all around our area, with seven within an hour's drive of our farm! For fall, winter, and spring production, we are growing spinach, lettuce, mesclun, Asian greens, arugula, kale, and chard. We harvest weekly for our one Saturday market, and the greens in the winter are increasing our sales by over $1000 each week. Spinach grown on only 11 rows (1632 square feet) yielded over $11,000 in sales, which extrapolates to over $293,000 per acre; similarly, the swiss chard was harvested off 800 square feet from Dec 13th to the end of June and yielded $4998 in value, which extrapolates to over $272,000 per acre!

Along with winter growing, we utilize our 20ft by 30ft root cellar, buried on 2 ½ sides under our large barn, to store unwashed crops. In the spring of 2007, a specialized cooling system was installed, which maintains a constant high humidity and cold condition (85% rh and 34-37 degrees). We increased production on crops that will store well for winter sales, and are learning more and more varieties of produce that lasts well under the right conditions. November harvested kale and swiss chard stored for over 6 weeks! Cabbage and leeks are lasting well into February, and the carrots, beets, and potatoes, will look near perfect in mid-summer when the new crops come in. Other crops we store are: radishes, celeriac, turnips, rutabagas, brussels sprouts, celery, kohlrabis, and cauliflower. Our root cellar holds about 24 tons of produce with a value of over $85,000. The $10,000 cooling system paid for itself in a matter of months!
We will continue to raise our standards for our rules to insure our profitability; most of our prices and crops are at or above these thresholds of $30 per hour and $15,000 per acre already.

Using Quickbooks to Monitor Returns of Crops and Markets

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Presentation: **About Our Farm** – *for judging relevancy for your farm.*
About Our Recordkeeping - *minimize, Quickbooks, bi-weekly timesheets.*
About Analyzing our Records – *for tweaking next year's farm plan.*

About River Berry Farm - *for judging relevancy for your farm.*

* Family-owned organic small fruit, vegetable and flowers farm, located on the Lamoille River in Fairfax, Vermont, since 1992.
* Markets: 1/3 regional wholesale, 1/3 local wholesale, 1/3 retail- CSA, stand, farmer market.
* Employees: 8-10 seasonal and 10-14 temporary, about 20 -24 yearly.
* Gross Sales: about $500,000.
* Net "Income": about $70,000 for mortgage, taxes, insurance and living/personal expenses.

About Our Recordkeeping - *Quickbooks, bi-weekly timesheets, minimize data entry.*

* We use Quickbooks. Not an expert but enough to get what we need, reluctant bookkeeper,
* Set up Quickbooks in Farming, which provides categories of expenses (Chart of Accounts).
* Make a Yearly Budget in Quickbooks: a great tool to discipline yourself to identify expenses and estimate income, good for business plans often requested by banks and lenders.
* Budget vs. Actual Report in Quickbooks: Can check how you are doing to date, anytime.
* Profit & Loss Statement in Quickbooks: Is same as Budget vs. Actual without the Budget, it's what we use for filling in Schedule F.
* Use "Class" in Quickbooks for crops When Entering Customers' Sales. Can generate Custom Reports tracking sales by crop & customer.
* Two-Week Timesheet by Crop: Employees fill out at end of day, record to ¼ hour by crop. We use Quickbook's Paycheck Detail to enter each employee's hours by crop (Class).
* Profit/Loss by Crop: Can record income and expense by crop. This is where we simplify. Field crop expenses are lumped together except payroll. Greenhouses expenses are by recorded by crop.

About Analyzing our Records – *for tweaking next year's farm plan.*

* Calculate/Review Yearly Our Living on the Farm/Personal Expenses - *what we need to net just to live on the farm without farming expenses.* We don't draw a salary. Our target is 15% - 20% of total sales.
  - Mortgage and Loans.
  - Taxes.
  - Insurances: Property, Workers Comp., Health, Vehicle.
  - Homestead Expenses: Utilities, Vehicles, Food, Housewares, Entertainment, &Retirement.

Using Quickbooks to Monitor Returns of Crops and Markets (continued)

About Analyzing our Records – *for tweaking next year's farm plan (continued)*

* Calculate Relative Profitability of Each Crop: We Generate a Report in QuickBooks to get Profit/Loss by Class (crop) at year-end: to determine profitability of each crop. Have to modify report to get Classes in columns.
    - We have determined a criterion of 1:3 minimum of labor cost to crop sale; i.e. If crop sales are less that 3 times the labor cost, we need to review this crop.
    - We discuss the variables that might have influenced: weather, bad variety, timing of crop, harvesting techniques, and market.
    - In deciding whether to continue or decrease a crop that isn't measuring up, we consider:
        + how the crop could be more profitable-different harvesting technique, variety…
        + how the crew feels about the crop.
        + lost leader, need to have at the stand/CSA, ie. Eggs.
        + how we want to spend our time…just love the crop anyway.
    - We Generate a Report in Quickbooks to get Sales to Customer by Class (crop) for discussion with the Customer.
    - Set target total sales for next year.

* Calculate Capital Improvements Budget: generally about 2% - 7% of projected sales.
    -Decide our priorities for coming years and budget for the next.
    - Discuss long=term capital improvements and decide if loan is warranted.
    - In tight years we will decide for next year to invest only in capital improvements that will pay for itself in that year.

* General Goal for Breakdown of Expenses (both farm and personal) to be Paid for by Sales
    15%-20% for living (on the farm) expenses.
    33% for payroll expenses.
    2%-7% for capital improvements.
    40%–60% for farming overhead:
        - Repairs and Maintenance
        - Supplies
        - Advertising
        - Fertilizer and Lime
        - Predatory Insects and Organic Pesticides
        - Utilities and Fuels
        - Miscellaneous.

An Economic Study of 19 Organic Vegetable Farms

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Growing great produce is not the biggest hurdle facing most fresh market vegetable growers; earning a reasonable living poses the greatest challenge. From 2002-2004, the Center for Integrated Agricultural Systems worked with a group of 19 fresh market vegetable growers on a participatory, farmer-led study. The growers collected data on sales, labor and other aspects of their businesses. They then created financial ratios that allowed them to compare small, medium and large operations in a way that respected their confidentiality. Their goal was not a standard economic analysis, but to create a basis for comparisons between farms and discussions of how to forge a quality livelihood from farming. Growers wanting a standard economic analysis of their farms can use balance sheets, financial statements, and cash flow statements.

This is a very brief summary of a longer report titled *Grower to grower: Creating a livelihood on a fresh market vegetable farm.* The report can help guide growers as they set financial and quality of life goals for their farms and structure their operations to realize those goals. The averages and ranges for some measures and ratios used in the study are shown here. The growers used additional ratios, described in the full report. This case study involved a small number of farms that were not randomly selected. The results, therefore, may not be generalized.

	Market Gardens < 3 acres		***Market Farms 3-12 acres***		***Veg. Farms >12 acres***	
	Range	Average	Range	Average	Range	Average
Gross/Acre	$8,888 - $25,605	$15,623	$6,267 - $15,276	$11,121	$6,750- $14,466	$10,810
Net cash income/Acre	$1,892- $9,487	$5,664	$1,331- $8,547	$4,679	$1,103- $7,430	$3,757
Net cash/Gross	9% - 57%	36%	16%-57%	40%	16%-51%	31%
Owner hourly wage	$3.32- $6.57	$4.96	$2.26- $16.92	$7.45	$3.46- $14.90	$11.36

Labor: Labor hours on the market gardens with fewer than three acres ranged from 933 to 2,994 hours per acre, and averaged just under 2,000. Payroll amounted to between 0% and 42% of gross sales. Labor on the 3 to 12 acre market farms ranged from 402 to 1,443 hours per acre and averaged just under 850. Payroll expenses consumed as much as 34% of gross sales on these farms. Labor on the four large-scale organic vegetable farms ranged from 462 to 613 total hours per acre and averaged 554. Payroll expenses consumed between 19% and 41% of sales.

Gross sales per acre: Small plantings of organic, fresh market vegetables, herbs, flowers and berries can garner large gross sales. The farms in this study realized three-year average annual gross sales between $6,267 and $25,605 per acre. The most impressive sales per acre were seen

at the smallest scale. These figures are based on the land being used for cash crops in a given year. If land in cover crops or fallow were included, these figures would be lower for most farms.

Net cash income per acre: Expenses, especially labor costs, can quickly eat into gross sales on a vegetable farm. Net income matters most in terms of financial sustainability. The term 'net cash income' is used here to describe gross sales minus all current year cash expenses. Depreciation and opportunity costs were not included. In the growers' own words, they wanted to know "how much cash they had at the end of the season to provide for themselves and their households." Three-year average net cash income for the farms in this study ranged from under $2,000 to over $8,000 per acre. Under 3-acre market gardens experienced more year-to-year variation in net cash income per acre than the two larger farm types. Community Supported Agriculture (CSA) appeared to help stabilize income. CSA farms are assured relatively steady sales because members pay for their share of the harvest at the beginning of the year. Other marketing strategies are subject to the vagaries of the marketplace and weather.

Comparing net cash income to gross sales: Dividing net cash income by gross sales results in a net cash to gross ratio. Higher net cash to gross ratios were strongly associated with farms that concentrated on CSA. The smaller farms with higher net cash to gross ratios had lower payroll expenses, with the farmer doing the bulk of the work. Some larger farms maintained high net cash to gross ratios through careful training and management of labor crews.

Livelihood and quality of life

Most of the small market gardens provided part-time livelihoods for the growers. For most of the market farmers and all of the vegetable farmers, farming represented a primary or full-time livelihood. All of the growers in this study reported that they were generally, but not overwhelmingly, pleased with their quality of life. They said that they would like more personal time, health insurance and retirement security. The mid- and large-scale growers felt that dedicated, skilled employees would improve their quality of life.

Special challenges

There are many challenges faced by vegetable growers that may vary with scale of production. Some of the most common are: (1) finding affordable land near urban markets, including enough for crop rotations, (2) achieving a scale of production meeting income needs without extensive paid labor, (3) balancing hand labor with scale-appropriate, inexpensive tools and machinery, (4) finding employees who are a good match with the farmer's management style and who stay longer than a single season, and (5) balancing the demands of a farm with personal time, health considerations, personal relationships, raising children, and, in some cases, off-farm jobs.

Applying the findings to your operation

There is no ideal size for a fresh market vegetable farm; growers need to use their management skills and economic analysis tools to figure out the scale and level of mechanization that makes the most sense for them. To learn more about the financial information and ratios described here, please see the full report *Grower to grower: Creating a livelihood on a fresh market vegetable farm*. This report is available from CIAS at the address above and at www.cias.wisc.edu.

Onions in the Northland

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Checkerberry Farm is a diversified, certified organic operation located in Maine's central highlands. The soils are very stoney, clay silt loam, all on south and south west slopes. We typically enjoy 100 frost free days on the cusp of zones 3 and 4.

We produce onion seedlings for our own field production and for other growers as well.

Onions are seeded in open flats or cell trays mid-February through March in our production greenhouse. When bench space is needed the trays are moved into high tunnels as cold or even freezing does not harm them. They are moved out of the high tunnels beginning in May.

As soon as the ground can be worked, usually mid-May, the onions are transplanted into rich and fertile well-drained soil into 36 inch rows. Depending on type, they are planted singularly 8 inches apart for large Spanish types or in clusters of 2 to 4 for storage varieties.

Keeping onions well weeded with shallow cultivation is a must. We blind cultivate with a tine weeder to start, then switch to sweeps and side knives. If Mother Nature conspires against us and the weeds get ahead of us, we have a Reigie pto powered cultivator to clean it up.

Scouting for thrips and other potential threats is advised. Entrust works well on thrips, our only insect problem to date.

Once the plants start to finish, skins develop and tops fall over. They are then pulled and are placed in a windrow. A week or two later on a dry day, the onions are collected and run over a topping table which deposits them into bins. The bins are stored in a storage room at low humidity and low temperature.

Onions are bagged as orders com in.

GROWING ASPARAGUS, NOT BY THE BOOK

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THE FARM

Hurricane Flats is going into its 15 season located in central Vermont on the silty loam soils of the White River Valley. We organically grow a mixture of 50 plus vegetables, 97% of them are marketed either on the farm's stand or at a farmer's market. We also make and sell 5,000 bales of hay a year.

The farm is operated on an as needed bases. We do not invest in equipment because it looks bright and shiny, rather, no equipment is purchased unless we can show a five-year pay back by owning a tool. Thus a lot of what you hear from me is based on the equipment that I have, you might have tools that perform a job better, but an expensive tool doesn't always mean more profit.

Over the years we have started cutting corners (in terms of how the text books read) in growing asparagus and have still been achieving the same positive results. We are firm believers in cheating the system until such point that we get bit, then we know exactly how far we can cheat and still achieve our ends.

PLANTING

Most books say to start asparagus from crowns planted 6-8 inches deep with a layer of compost laid below them. The crowns are 12-16 inches apart with rows being 55-62 inches apart. We start Jersey Knight seed in the greenhouse in early May in 2 inch blocks. The plants are not planted until mid to late August. Since we have kept the area that they are going into weed free, the transplants never need to be cultivated. We have found that earlier planting doesn't gain any benefits but makes life difficult in weeding around the extremely delicate plants. We use a one-bottom plow to dig a trench, adding nothing to the trench, and plant them 6-8 inches deep. Our plants are 12 inches apart and rows are 102 inches part. Since we lay down hay mulch over the rows, this large spacing gives us a tractor's width to plant, mow, till or disk any cover crop or early season crops of greens between the mulched rows of asparagus.

HARVESTING

We spread compost over the beds first thing in the spring then till it in with a shallow pass of the rotovator. We then mulch the beds with hay and wait for the shoots New plantings are left for two years. Picking depends on how old the plants are, how fast the shoots come up, and how healthy they appear, we harvest shoots for up to 8 weeks. A three year old planting may only be harvested for 2-3 weeks.

The shoots are snapped off, and banded by size into half pound bunches, then placed in the cooler and wrapped in plastic. The books say to pick the shoots at or below ground level. We allow the shoots to get quite tall, picking them just before they branch out. In doing this we provide the customer with a shoot that is totally green, they don't have waste by being forced to trim out the purple hard part at the bottom. Because of that, we are sometimes snapping off shoots leaving 8 inches above ground. A lot of our shoots can be very, very fat with as few as 4-5 shoots to the half pound. New customers challenge the fat shoots assuming that they are woody; however, they are much more succulent then the thin shoots and customers are soon won over and buy the big fatties.

MID SEASON CARE

During the actual harvest season we will plant greens between the rows of asparagus, after the harvest season the asparagus will grow tall enough to create a canopy blocking most weeds from growing. It should be stated that we do not do weeds, our beds are very clean. We will spend the time to make sure of this. The only insect pressure we have is an early June attack of asparagus beetles. The only plants they can affect are the newer transplants that are not being harvested. Since the other plants are being harvested, there is no established growth for the battles to consume and lay their eggs in. They are easily controlled with 1 or 2 applications of BT. We have never had any disease issues. With the first killing frost we bush hog down the plants and wait till next year.

THE NUMBERS

The most important part of growing asparagus is the numbers, can we make money. Planting an asparagus plant our way cost $1800 per acre or .20 cents each plant. Doing it by the book would come to $5300 per acre or .34 cents each plant. Using a 10-year life span per plant and including the two years that there is no production the average yearly cost of a 550-foot bed of asparagus is $1300. That cost includes planting, picking, cultivating, tractor costs, marketing costs, and every other small cost we could think off. That comes to $2.36 per plant. The average price we get for asparagus at the market is a bit over $6 a pound. That comes out to $1800 per 550-foot bed, or $3.27 per plant. Another way of looking at it is our break-even price (which pays for all costs-including my time) is $4.33 a pound, the extra $1.76 per pound goes right into our bank account.

We have never had to sell asparagus wholesale, as the demand at the farmers market is very high. Our record was selling $600 worth in an hour. It is fantastic in taste and is not unusual for individuals to buy 2 pounds a market week after week.

THINGS I'M THINKING ABOUT TRYING

Because of the long-term nature of the plant, and our success with Jersey Knight, we have no experience with any other variety. We are thinking about tinkering with the system a bit and considering making a tighter row spacing, maybe down to 72 inches and not planting greens between the rows, but why mess with success. We are also thinking about growing purple asparagus. Every year we increase our production but we still haven't met demand. At the point in which we meet demand, we'd like to try reverse asparagus. That is when you let the asparagus grow in the spring then mow it down mid to late summer and harvest the new shoots they then send out.

Never Enough Garlic

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Garlic needs fertile well drained soils with no weed competition. We plant sometime in October and as a rule have done the raised-bed method using a 6x6 or 6x8 spacing. This method allows for a good stocking density but is dependent on a lot of hand labor. All fertility needs to be in place when the beds are being made as side-dressing during the growing season would be labor intensive.

This coming year ('09/'10) I will be trailing row cropping garlic, like onions, to both ease fertility management, labor and disease potential. We will see how it works.

In July the scapes (bulbil and curled portion of stalk) are cut for market and to promote a larger bulb as well.

In August* when the lower leaves start to brown, but while there are still four or five green ones, the beds are lifted, bulbs are pulled, bundled, and washed. The bundles are then hung in the top floor of the barn with several fans moving the air to promote drying.

As time and weather allows, the garlic is trimmed, graded and sold.

*coincidentally, a day or two after the barn swallows leave, never fail.

Speaking of Leeks

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Cultural Requirements

Leeks like other alliums enjoy relatively high ph of 7-7.5 for vigorous growth in their early stages and an inch of water per week. The land for leeks should be "under the hoe" for at least three prior seasons and be void of perennial and grassy weeds. A friable soil with good moisture holding capacity accommodates hilling for blanching prior to harvest as well as survival of transplants which are extremely tender. If the season or the land require irrigation at transplanting it is better to irrigate prior to transplanting rather than after. Watering in leek transplants requires small droplets if overhead irrigation is used. Leeks thrive in cool temperatures of spring and fall. They can be started outdoors in flats and held in the field till the ground freezes. Warmth and humidity promotes purple blotch which is probably the most economically damaging fungus since it festers at the crown where the layers of leaves join and penetrates many leaf layers.

Allure of Leeks

Leeks are prized by cooks for their depth of onion flavor without the heat of other onions, they are not sweet but their leafy tops add very strong flavor to soups, stews and salads. The milder blanched stalks will not color broths and are considered the finest onion for soups. Potatoes and leeks are considered one of the finest culinary combinations and their harvests are timed together as well. Potato Leek Soup, Cockaleekie, Vichyssoise, Colcannon etc. are renowned traditional dishes that rely on leeks. Chicken stock is the preferred broth, though fish stews often require leeks. Parsley, chive and thyme are the herbs which compliment leek flavor and nutmeg and white pepper are the preferred spices. They are a cold weather vegetable essential to haute cuisine as well as common country cooking. Leeks with long white shafts and leafy green tops make a colorful addition to accent a farmstand. The strong scent of fresh leeks penetrates a farmers' market.

Growing Transplants

Unless they are being grown for plant sales, the leeks for planting into the field can be started outdoors in any rich soil medium and they are not bothered by frost. Spun-bonded row covers and fertilizer can accelerate growth when necessary. However, depending on the variety there is no rush to get them in the field since they do not tolerate weeds in early growth stages and crops planted in mid-June will size by October. For grower economy and market consideration, transplants should be heavily rouged when prepared for planting. Large leeks sell! Spindly transplants make spindly leeks that need to be bunched for sale. Likewise careful seeding into flats so there is no crowding will produce better seedlings. When they are 1/8" thick they are ready for the field. Tops should be trimmed to minimize water loss and drooping which hinders hoeing, cultivating and irrigating. Root trimming which should be kept to a minimum, may be needed as well, depending on the transplanter.

Planting and Spacing

Traditionally long leeks with blanched stalks have been marketed, which requires space and soil for hilling. For this type of leek 36" rows with 6" between transplants works fine. If weed control and land allow, wider row spacing is easier for large equipment. If a leafy leek is grown with short stalks a bedding system can be used but the grower should have fine cultivating equipment for tight spacing. Leeks, like onions, will create no crop canopy to compete with summer annual weeds. The hilling of leeks is used as vigorous cultivation and weed control during their long season. Transplants should be set 1"-2" deep depending on their size and well watered. Afternoon planting on hot days will minimize drooping and facilitate hoeing.

Varieties

Leeks that are long sell best since many don't use the leafy top, only the stalk. Among these King Richard is one of the most reliable. It is susceptible to purple blotch. Varieties with deep blue-green leaves are generally less susceptible and hardier (Tadorna, Carina). Short season leeks such as Poncho have very brittle leaves and are difficult to harvest without leaf loss and breakage. As a grower and a cook I prefer a medium length leek with lots of deeply colored leaf.

Harvest and Storage

Leeks can be pulled by hand but some loss will occur from breakage, especially if deeply rooted. A digger facilitates large harvest but lots of dirt works into the crowns. Cleaning and packing is the biggest chore. Leaves should be left as long as possible and washing is best if the tops are kept down so that dirt from the roots is not washed into the crowns. The biggest complaint from customers about leeks "they are so dirty". Roots should be trimmed and rinsed as well. Lots of leaf packs them tightly and makes a heavy crate. Refrigeration or cold room are necessary once packed. If weather is warm harvesting what can be sold readily is best there is little worry about frosts from most varieties. Hardy varieties can be over-wintered and harvested in spring before they blossom.

How We Grow Certified Organic Pumpkins & Winter Squash

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Our Farm Background in Organic Winter Squash , Pumpkins, Gourds

This farm was established as an organic farm in 1971, by Howard, when he settled in Southern Vermont. The original focus was growing diverse produce sold wholesale or at farm market. Currently do direct to store delivery in 4 states focusing on greenhouse grown potted plants March through June and into July. We continue with fall-harvested organic produce, mainly garlic, onions, winter squashes, and raspberries certified organic by NOFA-VT (Northeastern Organic Farmers Association Vermont) since 1978. We will go over what we currently do, but keep in mind each farmer must learn to adapt their approach to their unique set of circumstances and use what works best for that location, that soil, as well as the equipment at hand.

Why Organic? To Protect Our Topsoil. Why Winter Squashes? – We Know How

Organic growing is a way of farming that replenishes topsoil and preserves topsoil and aquifers from contamination. Organic techniques that protect and build topsoil that we use on this farm include: crop rotation, incorporation of organic matter into the soil, mulching, low-impact pest and disease control, field sanitation, cover-cropping. We grow winter squash, pumpkins and gourds, because their harvest season is late summer, and because it is an American food native to our landscape, historically adapted to bridge the food gap between fall and spring.

Varieties We Grow

We look for flavor, yield, vigor, Powdery Mildew Resistance (PMR), marketability. We grow vining and bush varieties. The following squashes are typically part of our mix: Butternut (Waltham, trial bush varieties), Acorn (High Mowing's Reba or Johnny's Jet), Delicata JS (Johnny's type/High Mowing type – *not* Cornell Bush type), Kabocha (Johnny's scarlet Sunshine), Blue Ballet Hubbard, Red Kuri, Buttercup (Burgess), Spagetti, Dumplings ("Sweet" or "Sugar" Dumpling and Carnival), Pie Pumpkins (Baby Pam). We also do Halloween Pumpkins (Howden and PMR Varieties like "Cider Jack") and an everchanging mix of gourds that includes minipumpkins (ribbed and smooth, orange and white).

Why Transplant Instead of Direct Seed?

We choose transplants over direct seeding into the field for several reasons. A vibrant transplant has a two week head start on a seed planted the same date, and have a better chance than seeds do against set back from cold wet springs. In our experience, transplanting gets less blanks in the row, as with proper care most transplants take, whereas seeds can fail to germinate or seedlings can die off in imperfect (hot *or* cold) outdoor weather conditions. Further, while the transplants are rooting, we have ten extra days of field weed control, and we try to cultivate the field one last time between rows with the tractor.

Propagation - Plug Size, Timing, and Temperature

We use a 50 count plug tray on heated benching. Speedling trays and 804 packs work well also. 50s are easier to count *and* the root size is large enough to hold the plants a few extra days if we are late. It takes us about 10 days to produce a ready to go transplant with a a 50 count size, a bit longer in a larger size. Avoid holding the plugs too long, but there is some forgiveness that will

allow you to wait for proper planting conditions. If holding the plugs longer then 10 days, you might give a supplemental feeding with Daniel's Pinnacle or other organic liquids. The benching is set to 70 degrees to ensure prompt and even germination. We use hot water tubing controlled by a thermostat, and done in sectors. We assume 2 seeds a plug, and over 95% germination. We seed extra plugs to hold in reserve, and refill blanks in the field that way.

Propagation – Soil Mix

We fill our plug trays with a ready-to-use organic mix, which we are able to buy by the truckload for our potted plant side of the business. This grow mix is composed of certified compost, peat, perlite, and micronutrients. We like to use bagged mix for consistency and portability. Bulk mix can become infested with airborne weed seeds if sits around uncovered. We add Actino Iron to this potting mix, because it promotes healthy root development. Fill the plug trays with this.

Propagation – Seeding

Insert 2 seeds up to a ½ inch below plug surface of each of the cells of your plug tray. Mist finished tray so evenly damp. Cover tray with clear dome lid. Covers promote even heat retention and protect against drafts that cause erratic germination. Monitor moisture and temperature of covered trays carefully on sunny days. At night and on cloudy days keep covers on; but during heat of sunny days prop up or temporarily remove. Remove completely once germination is well begun, or baby plants will quickly get too warm and stretch. Let grow on in the greenhouse about a week, then harden off

Propagation – Hardening Off

3-5 days before setting into the field, and watching the forecast, set start trays outside to adjust to the outdoors before planting. Choose a location protected from excessive cold, sun, or wind. Be prepared to temporarily bring in (or cover) the trays if the weather turns extreme. Skipping hardening off increases chances of setting back your crop. Don't forget to monitor tray moisture, (especially around edges). Direct sun causes faster evaporation than sun filtered through plastic. If the worst happens, don't give up - they can recover from what looks like certain death! Just add water and wait. The plants that survive up to this point are hardy survivors at our farm.

Make Raised Beds

Our soil is typical upland soil, described as sandy loam with some rocks thrown in to keep us honest. Our squash beds are typically over 200 feet long and spaced 6 to 7 feet apart center on center. Each bed has one row of plants down the center with 24" spacing. So we plan on 100 feet per 50 count tray and assign the acreage accordingly. We make raised beds, because raised beds improve drainage and reduce damage from cold rainy weather and raised beds hold more warmth. A Rain Flo bed-maker makes a 6" high bed.

Irrigate

To prevent transplant shock and plant setback monitor field soil moisture for a few weeks. We always water in at planting time (by hand), and sometimes a second time if dry, hot weather. That, and mulching, has been enough, and the rest is up to nature. One can use irrigation tape laid in the bed as insurance against dry spells, but it is not necessary for us. Adequate and consistent water does promote growth and health while lengthy dryness can set back harvest dates and make the fruit smaller and yield lower. When we water in we usually fortify the drink with something like Daniel's plant food or fish emulsion.

Mulch

We recommend mulch! Mulch keeps weeds out, keeps moisture in, moderates soil temperature, protects topsoil (from wind/rain). We use black plastic mulch. Some years we run out of mulch before the end of a row but set the plants out anyways. The resulting yield difference always

reminds us why we use the mulch. We use 4 foot wide mulch and lay it with a mulch layer that makes raised beds with more than a 3 foot surface width.

Spacing

Holes are punched into the plastic mulch every foot down the center of the row, using a tractor and a water wheel. That gives us flexibility. Most plants will be set in every 24" down the row, but larger vining pumpkins are spaced every 36". We might make the between row spacing 8 foot on center for that area of the field. Large vined varieties get the extra room to allow easier tractor cultivation between the rows. First week of June we set out over 2,000 plugs of squash and pumpkins by hand this year. The good thing is, we know low tech can work!

Basic Techniques to Reduce Insects, Diseases, Molds

Visually inspect every tray for insect infestation before bringing to the field, because you don't want to carry the squash bugs that found your trays while they were hardening off into your field. As soon as possible after planting and watering, place hoops over the beds and cover them with Remay or Agribon (ideally the same day – days do matter to). The Squash Bug is insect enemy number 1. The Cucumber Beetle is insect enemy number 1 ½. Remember mechanical blockage doesn't work if not sealed, so check edges when regularly walking the field to monitor for pests and disease. If well done, very few insects will get under. Row covers protect against late frosts as well as pest infestation. Keep row covers on until plants are established. Remove them when plants are too big to stay underneath. We left covers about a month until July 4th. Many fruit had already set in spite of cold and wet, and vining was beginning. After plants are exposed, and as needed based on monitoring, we spray with a combination of Entrust, pyganic, and M-Pede. (This season we needed 4 applications.) Field rotation also helps reduce bug population (and molds and disease). Rotate out of squashes for at *least* 2 *years* before replanting them. We might follow a season of squash with one of onions or garlic followed by one of cover crops. Finally since we cannot eliminate bugs, we regularly scout the planted rows for signs of hot spots and while we're scouting, we look for signs of molds like Powdery Mildew. For mildew we alternate sprays of Oxidate with Copper sprays (Nu-Cop). We use an air-blast type sprayer (Solo). Good coverage is essential.

Basic Techniques to Reduce Weeds

Regular and prompt cover cropping reduces weed seeds in the soil over years. They can't get established . When weeds sprout after making the raised beds, we cultivate between the beds with a tractor. We make sure the area is clean prior to planting out. After row covers are on, it is impossible to tractor cultivate, so we cultivate with our 30 year old rototiller (still going strong!) between the beds as weeds sprout again, careful not to catch the fabric. Once the row covers are removed, vines spread out quickly, foliage meets between rows, blocking out weed growth.

Cover Crops and Soil Sanitation

Complete your harvesting in time to allow establishment of a good cover crop before winter. We clean up our fields fast, removing all plastic mulch, and most remaining non-marketable fruit. We disc the field well, burying all debris. Then as soon as possible we plant cover crops, first a mix of oats and field peas and we also use winter rye as we get closer to late fall. Cover crops capture the available nutrients (especially nitrogen) and hold it for the following year's crops. Why let your fertilizer float away? Building organic matter and protecting the soil from erosion and the beating of the rain is a primary job for a passionate farmer, so cover crops, compost, year-old cow manure, and organic amendments are routinely added to our fields to improve fertility, tilth, and PH.

Harvest!

We start micro harvesting mid August any varieties or spot locations that are ripe and ready. Spot harvest ripened fruit weekly enough to fill orders. Only pick fully ripe fruit!. Sell quality! Let other growers sell on price. In September we finish full-scale harvest. Squashes and pumpkins are picked and stored and sorted. Pick carefully (use clippers to cut fruit off stems/don't yank off) and don't bruise or knick the fruit (don't throw into the pickup). We wash the fruits with a ½ % Oxidate treatment to prevent mold, let them dry, and box them. Store in a cool, dry location. Congratulations for a job well done!

Pumpkin Varieties – What's New and Coming

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Introduction

Discounting the Maine potato crop, pumpkins are the third leading vegetable crop in New England. But how profitable are pumpkins for New England growers? There are two challenging problems for New England growers. First, periods of humid and rainy prevalent in New England result in more disease problems than growers encounter in the western and southwestern U.S. Typically, ornamental pumpkin is a crop that does not receive as much cultural attention as food crops, and as result, there is often considerable crop loss due to fruit being unmarketable. Secondly, supermarkets have grabbed an increasing share of the market by selling the large, 18 to 25 pound, pumpkins practically below cost of production for growers in New England. And the quality of the large pumpkins sold by supermarkets if often quite good. What can New England growers do to beef up pumpkin profits? One major way to increase pumpkin sales is for growers to offer a larger variety of pumpkin types that are appealing to consumers and not sold by supermarkets. There are over 100 pumpkins varieties offered in seed catalogs, representing all sorts of shapes and sizes. The second, perhaps more challenging approach, is to use better cultural techniques and disease-resistant varieties for reducing crop loss. Breeding work on pumpkins at UNH focuses on both of these approaches: developing novel types of pumpkins and developing pumpkins with better tolerance to diseases prevalent in New England.

New Types of Pumpkins

Based on feedback from garden centers, there appears to be tremendous demand for white pumpkins. For some years, we have had a breeding project to develop white jack-o'-lantern pumpkins with good stems. UNH has recently released a mid-size white jack o'lantern pumpkin, Moonshine, but seed supplies were limited last year, and it may not be available until next May. Moonshine is early, reasonably productive and has a good stem, but if foliage cover is not good, it may acquire either a bluish or creamy yellow hue. Once harvested, the color appears to hold up well. We have also tested a smaller white pumpkin that is quite attractive and holds the white color better than Moonshine. However, we currently do not have a timetable for release of that hybrid.

We are also testing pumpkin hybrids with other shades of color, mostly yellow hues. Production is commencing on a yellow pumpkin in the 4 to 5 pound class that looks quite attractive when grouped with white pumpkins. Next year we plan to evaluate yellow pumpkins in the 15 to 20 pound size class. Eventually we hope to introduce pumpkins with stripes such as we have introduced into our ornamental gourds, but that project is long term. It is possible with genetic engineering to introduce other colors into pumpkins such as purple and blue, but the value of the pumpkin crop is not high enough to justify the current cost of producing such variation.

There are a couple of novel warted varieties of pumpkins that have been recently introduced, Super Freak and Goose Bumps (Siegers Seed). We had both of these in our trials and thought

they were sort of ugly, but nonetheless, they appeared to be a hot item at a garden center where we test-marketed them. These varieties will not be easy to use as carving pumpkins because of the hard shell associated with the warty character.

Disease Resistance in Pumpkins

The focus of most disease resistance programs in pumpkins both at public institutions and seed companies has been to introduce varieties with powdery mildew resistance. Harris-Moran was the first seed company to introduce good varieties with PMR and has introduced several attractive varieties during the last five years. Many of these varieties are a bit late for growers in central and northern New England, and may not have good tolerance to some of the diseases prevalent in our region. One of the new, moderately early Harris-Moran varieties in the 15 to 20 pound class which performed well in our trials this year is Magic Wand. The degree of powdery mildew resistance in pumpkins is intermediate and in many circumstances will not eliminate the need to use chemical control. Hollar Seeds has developed breeding material with a higher level of resistance, but it may be awhile before acceptable varieties are available with their improved resistance. At UNH we got a late start breeding PMR in pumpkins, and we have released only two varieties that I would recommend trying - Cidar Jack (High Mowing Organic Seeds), a 12 to 18 pound pumpkin, and Prankster (Rupp Seeds), a popular pumpkin in the 3-4 pound class. Both of these hybrids are semi-bush and reasonably early for New England growers. We continue to cooperate with several seed companies in the Northeast, and we hope to be releasing several new varieties in the near future. Our focus is not only on PMR, but also on varieties with fruit tolerant to black rot (*Phoma cucurbitacearum*), fusarium fruit rot (*Fusarium sp.*), bacterial leaf spot rot (*Xanthomonas* campestris pv. Cucurbitae) and angular leaf spot (*Pseudomonas syringae*). One advantage of breeding in New England as compared to the West coast is that we can make field selections against these pathogens, and hopefully introduce new varieties that suffer less field loss than those offered by the larger seed companies. We are also searching for germplasm with tolerance to Plectosporium blight (*Plectosporium tabacinum*), a disease that appears to becoming widespread in New England. This disease, if not controlled with fungicides, can be devastating, causing brittle vines, leaf curling, and diamond-shaped white streaks on stems and fruits of pumpkins.

Timetable for new introductions

Breeding progress can be very slow, especially for traits that can be selected only under certain environmental conditions. We plan to introduce one or two new varieties every year in the immediate future, but they will not begin to solve all of the grower disease and marketing problems. New England growing conditions have been especially challenging during the past five years. There are always new diseases and other problems on the horizon, and so our quest for the ideal pumpkins in different size classes is never reached. Hopefully the UNH breeding program will continue assist seed companies in a meaningful way to deliver new varieties to growers that will enhance local markets and increase profitability.

Sales Trends and New Pumpkins from Johnny's Selected Seeds

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Pumpkins are a MUST-HAVE crop if you market your produce direct to consumers (e.g. farm stands or farmers' markets) or wholesale to grocery stores. Knowing what your customers want for a pumpkin is also a necessity. Here at Johnny's, we select for the traits your market demands. Around the country and here in the Northeast we're seeing the direct marketing growers use specialty pumpkins (i.e. Long Island Cheese, Moonshine, Knucklehead) to draw customers into their stand and sell mostly Jack-o'-lantern pumpkins. Typical size range customers are looking for is the 14-20# types with nice, dark, orange color and deep ribbing with a strong, green handle. Other trends are the decorative, heirloom pumpkins that can be stacked (including Jarrahdale, Valenciano, and Musque de Provence) and pie pumpkins that can double as "kid" sized pumpkins (including Baby Pam and Baby Bear).

Breeding programs here in the Northeast and around the country are selecting for the above traits with different shaped pumpkins (i.e. upright and tall vs. round with high shoulders). Johnny's and many other breeding programs select for disease resistance. The main disease resistances that are the most important for New England growers are Powdery Mildew, Phytophthora and Viruses.

Breeding for Powdery Mildew Resistance (PMR) is important to pumpkin crops to protect the quality of the pumpkins, including allowing them to size-up, keeping the handles strong with good green color and aiding in the post-harvest appearance during transporting and retailing. Some genes for PMR are stronger than others, giving the pumpkins different levels of resistance. Some can be resistant but under heavy PM infection the leaves succumb to the disease but the stems (handles) and vines don't, keeping the pumpkin healthy.

Phytophthora shows up under rainy conditions in September combined with poorly drained soils when the fruit is ripening. There are currently no Phytophthora resistant varieties on the market.

Viruses are a problem that comes and goes here in the Northeast. There is one virus resistant variety on the market currently. That is Harris Moran's Magician, which is resistant to Zucchini Yellows Mosaic Virus. Presently, the Johnny's breeding program is not breeding for any virus resistance.

The 2009 season was a tough pumpkin growing season with the cold, wet conditions here in the Northeast. Pumpkin crops that fared better than others were crops grown on poly mulch to keep soil temps higher in the colder weather, started with transplants to give the plants a head start, used row covers to increase air temperature around the plants and used early growing varieties, such as Racer from Johnny's, which matures in 85 days. Growers with crops that grew the best employed more of these techniques.

NEW PUMPKINS from the Johnny's Selected Seeds breeding program have been released! Racer Plus PMR is an early Racer-type (85 days) with intermediate resistance to PM. It has a burnt orange color and a nice handle like Racer. Champion is a large Jack-o'-lantern that is 25-45 pounds depending on the weather, soil and plant spacing. It is a bright, deep orange, deep ribbed, upright, tall and has a big handle. Maturity is 90 days, which is earlier than other big Jack-o'-lantern pumpkins. For more information and price and availability of these varieties and more please go to www.johnnyseeds.com.

How to Grow Pumpkins with Zone Tillage

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I have been growing crops with zone tillage since 1997. I started with corn and soybeans and gradually added other crops as I became an experienced zone tiller. I added pumpkins in 1999 and now grow all the crops on my farm with either zone tillage or no tillage. The reasons for learning about, and switching to, zone tillage were a long-time concern for soil health and a need to reduce the number of field operations on my farm. Added benefits for pumpkins were better weed control and cleaner pumpkins at harvest.

A zone tillage system begins with an understanding of four principles:

1. Till only to plant the crop, not to grow weeds.
2. Fertilize only the crop, not the weeds.
3. Keep soil covered at all times-plant cover crops between harvested crops.
4. Don't burn up the organic matter left from harvested and cover crops by plowing it under the soil-**Leave it alone on top.**

If you don't embrace these principles, and insist on some type of full-width tillage before planting your crop, zone tillage is not for you.

Zone till pumpkins begin with planting rye in the fall, in September or early October, 1-2 bu./acre to get a good thick stand. The taller you can let the rye grow in the spring before killing it, the more mulch you will have to keep the pumpkins clean. But don't wait until it gets too tall to spray or roll. I spray glyphosate by the time the rye is 3-feet high so I can raise the spray boom over it. You can also kill it mechanically. Steve Groph uses a modified Buffalo rolling stalk chopper, and the Rodale Institute has developed a large tractor-mounted roller with cutting knives around the circumference in the shape of a V.

About 10-14 days before planting, use a strip tillage tool with a long narrow shank to till the row. I use an Unverfurth Zone-Builder, but there are several others on the market now. The Zone-Builder has a tillage shank that is only ¾-inch wide and that will go as deep as 18-20 inches. Probe the soil to find out how deep the compacted layers are (plow pans, clay layers, etc.). Then run the shank just below that depth to make a channel through the compacted layer for crop roots to follow toward nutrients and moisture later in the season. There is a single disk ahead of the tillage shank to cut through the killed rye so it doesn't make any difference if the rye has fallen with the row or sideways. A pair of disk coulters is mounted behind the tillage shank to hill soil into a ridge about 4-6 inches wide and 2-4 inches high. This ridge will settle by planting time, and the rye will form a mat between the rows to hold moisture and suppress weeds. You only till a narrow row for the crop with this machine, not the row middle that grows nothing but weeds.

To plant the tilled strip, I use an Unverfurth Zone-Till cart and pull a conventional John Deere planter behind it. The cart is a big fertilizer tank with a toolbar under the hitch that has three coulters mounted per row. These coulters till only the row to be planted, about 4 inches deep. The two outside coulters are set about 3.5 inches to each side of the center of the row and include a spring-type injector for liquid fertilizer. The fertilizer nozzle is set about 3 inches deep, and all fertilizer for the pumpkin crop is injected at planting, one-half on each side of the row. That way I'm not spreading dry fertilizer across the whole row and fertilizing the weeds that come up in the row middles. I use all liquid fertilizer because it is easy to handle and store, and I can blend two or more kinds together right in the tank to get whatever analysis I need.

The planter is towed behind the cart and has several modifications to improve its performance for zone tillage. The original John Deere gauge wheel tires have been replaced with reduced-inner-diameter gauge wheel tires from a Case-IH planter to prevent sidewall compaction in the row. Keeton seed firmers have been added to all rows for more uniformity of stand, and Martin spading closing wheels and drag chains have replaced the original John Deere closing wheels to reduce compaction over the seed. Finally I removed ¾ of the fingers in the John Deere finger pickup meter so I could plant pumpkins to final stand without having to thin them with hand hoeing. The greatest seed spacing with the original meters was 16 inches. Now the planter will singulate individual pumpkin seeds and space them 64 inches apart in the row.

I have a spray tank with a 12-volt electric pump on my planter and flood nozzles mounted across the back over every row. I spray glyphosate and pre-emergence herbicides as I plant for weed control. I come back in 30 days with a reduced rate of a broadleaf herbicide and a grass herbicide to clean up any escapes.

Over the years of zone tillage on my farm, I have noticed a gradual weed shift toward perennial weeds and fewer annual weeds. Annual weeds often germinate after tillage, and by reducing tillage to only a narrow band in the row and not cultivating the row middles, fewer annual weeds emerge. Perennial weeds are often killed with tillage, so over time they begin to build up with zone tillage. But they are easily controlled in the fall. The rye cover crop at planting also helps control weeds, the thicker the rye the fewer the weeds. And the mulch remaining between the rows reduces weed germination and holds soil moisture for the crop to use later in the summer.

One of the biggest advantages for zone till pumpkins is that they are usually cleaner at picking. Soil does not splash up on the pumpkin as easily from hard rains. The only real difficulty for beginners with zone till pumpkins is having a planter that will successfully plant through the thick mulch and learning how to do it. Start on a small acreage until you are confident about planting into killed rye. Then get on with it.

Matted Row Strawberries: The Basics

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

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

Selecting A Planting Site

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

Preparing the Soil

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

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

Planting and First Season Care

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

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

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

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

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

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

frost protection as overhead irrigation can, and care must be taken to avoid damaging the trickle lines during the renovation process.

Mulching

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

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

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

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

Frost Protection

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

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

Renewing the Planting

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

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

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

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

4. Plant Thinning: Strawberry rows should not be allowed to get more than 24 inches wide. Till the sides of the rows to narrow the beds back to a width of ten to twelve inches. Set the tiller so it incorporates the mowed leaves and fertilizer, and spreads about one inch of soil over the remaining crowns. During the summer, new daughter plants should be allowed to root to fill out the row to the desired 24-inch width.

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

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

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

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

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

Pest Management

Numerous pests can potentially cause problems to strawberry plantings. Consult local University Extension recommendations for the best management techniques for problems in your area. It is important to note that weed infestations are the most common cause of poor production in matted row strawberry plantings. This is due to the fact that the plantings are in place for several years, allowing weed populations to build up, and the relatively small selection of chemical weed control options available.

Good pre-plant weed control is essential for the successful establishment of a profitable strawberry planting. Strawberry growers should develop a planting rotation, which includes the use of cover crops and/or alternate cash crops for which herbicides different from those used on strawberries can be utilized. Crop rotations should allow fields to have at least three years between strawberry plantings. This will prevent the build up of weed species that defy strawberry weed management programs and will also help to renew the soil, so that the next planting of strawberries will be as good as or better than the last.

There are several types of cultivators that will provide good control of weeds between the rows of strawberries. Multi-head rotary tillers; spring-tooth harrows; and basket, finger and rolling cultivators can all be very effective, depending on the soil type, weed species and frequency of use. Weeds emerging within the strawberry rows will not be controlled. However, in combination with good pre-plant weed control and some hand-pulling of weeds within strawberry rows, cultivation can form the basis of an effective weed management program.

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

Day Neutral Strawberries: Off-Season Opportunities

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Day neutral strawberry production offers New England growers an opportunity to market fresh strawberry fruit during the late summer and fall when market demand is high and supply, especially local supply, tends to be low. Although day neutral plants don't produce a concentrated fruit set like their June-bearing counter parts, which limits their attractiveness for the pick-your-own market, they will continually set fruit over several to many weeks, stretching out the harvest season well into the fall, and providing a high value specialty item for roadside stand, farm market and restaurant sales. Growing these plants differs considerably from growing typical June-bearing strawberries in the classic matted row system. Day neutral plants are often grown as an annual crop, and are typically grown on raised beds with plastic mulch and very high planting densities. As result, the establishment costs and labor commitment tend to be quite high, and prices charged for the fruit must reflect this in order to return a reasonable profit.

Site Selection & Preparation

Selecting an appropriate planting site is critical to the success of the planting. While strawberries can tolerate a variety of soil types, they grow best in a well-drained, deep sandy loam, rich in organic matter. Do not plant strawberries in an area where tomatoes, potatoes, peppers, or eggplant have been grown in the past four years. These crops carry a root rot (*Verticillium*) which also attacks strawberries. Do not plant strawberries into recently plowed grass or sod areas. This can lead to devastating weed problems and damage by white grubs, a common turf pest, which will feed upon strawberry roots. Finally, choose a site where there is ready access to a water supply. Irrigation is important for good plant establishment and to maintain plant growth and fruit quality during dry periods. Strawberries prefer a soil pH of 5.8 to 6.2. Soil testing information is available at your Cooperative Extension office. If the organic matter level of the soil is low (less than 2%) and/or perennial weeds are a problem, a cover crop such as buckwheat, Sudan grass or oats can be sown and plowed into the soil the year before planting. Applications of compost can also be used to increase organic matter. Fertilizer can be applied and worked into the soil prior to planting, or banded into the soil prior to applying plastic mulch and planting. Rates should be determined through soil tests taken the previous fall. In general, a rate of approximately 100 lbs. of nitrogen, 50 lbs. of phosphorus (P_20_5) and 50 lbs. of potassium (K_2O) should be incorporated into the soil prior to planting (e.g. 600 pounds/acre of 20-10-10 or its equivalent).

Beds for day neutral strawberries should be prepared as early in the spring as possible, or beds may be pre-made during the fall before planting. Raised bed heights and widths vary depending on the type of equipment and amount of land available. In general, beds should be four to twelve inches high with a one and 1 ½ inch crown sloping from the center of the bed down to the edges to promote the shedding of water off of the bed surface. Bed width depends on how many rows of plants will be established on each bed, ranging from 18 inches (one plant row) to 46 inches (three to four plant rows). In New England, growers have generally found the one or two plant

rows per bed are easiest to manage and use a bed width of 18 to 42 inches. Having a smooth, well-packed, well-shaped bed will greatly improve the fit and performance of the plastic mulch on the bed, because good mulch to soil contact improves the ability of the mulch to warm the soil, and to shed water. Beds will form best when the soil is moist and friable. Trickle or drip irrigation lines are typically installed during bed forming at about a 4 inch depth in the bed, with either one or two lines, depending on how many plant rows there will be on a bed. They should be placed to a few inches to the side of the plant rows to prevent being punctured during the planting process. The plastic mulch should be laid tightly over the beds immediately following bed forming. Black plastic is most commonly used to promote soil warming and to provide weed control. White plastic is sometimes used where summer temperatures can get very high and fruit tends to break down on the hot black plastic. However, white mulch keeps soil temperatures cooler and may delay plant growth. To ease the planting process, the mulch is often marked with small holes or dimples after it is laid to show where to put the plants. This can be done by fixing bolts or cleats to a wheel spaced such that they will leave a dimple at the appropriate spacing on the plastic (10 to 14 inches apart within the row). The wheel is attached to a frame and handle which can be pulled over the plastic so that the dimples will form a line at the correct row spacing and on the bed.

Planting and Pre-Harvest Care

Dormant, day neutral strawberry crowns should be planted in the spring as soon as the beds are prepared. Planting is done by hand using a simple planting tool. A piece of 1/8 inch iron flat bar about 12 inches log is bent at a 90° angle about 4 inches from one end to create a handle. This end is often wrapped in duct tape to provide a soft grip. The opposite end of the bar is notched from the edges to the middle to about a ¾ inch depth, creating an inverted "V" at that end of the metal. The notched edge is slightly sharpened to ease penetration through the mulch and soil. To plant the crowns, the roots of the plant are laid on the plastic mulch such that about ½" of the ends of the roots are over the mark on the mulch for planting. The notched edge of the tool is placed over the mark so that it will "grab" the ends of the roots as the tool is pushed into the soil and draw the plant into the bed. Push the crowns straight down through the mulch with the tool and into the soil so that the soil surface comes to halfway up the crown. Gently pinch the soil around the crown as you withdraw the planting tool. Plants should be spaced 10 to 14 inches apart with a row. Planting in a double row, 24 inches apart, on 42 inch wide beds with 13 inches between plants within the rows will require about 13,400 plants per acre.

All flower blossoms that emerge during the first 4-6 week after planting should be pinched off. This encourages root growth and plant vigor and leads to better yields and fruit quality. Additionally, all runner plants that emerge during the summer should be removed. These interfere with harvest and root in planting holes and along the edge of the plastic, becoming "weeds". While runner removal is labor intensive, studies have shown it is beneficial to both yield and fruit quality. The new planting should be irrigated after planting and regularly thereafter to insure optimum growth. One to two inches of water per week is ideal. Trickle lines can also be used to deliver soluble fertilizers to the plants. While rates of fertilizer will vary depending on the number of plants per acre, soil type, and variety, about two pounds of actual nitrogen per acre per week applied through the drip lines will typically provide good plant growth.

Harvest
Depending on the planting time, weather and variety, harvest should begin in mid to late August and continue until a hard frost kills any remaining flowers. Fruit can typically be harvested two to three times a week, but the frequency will drop as the temperatures get cooler in the fall.

Frost Protection
Flowers and fruit can be protected from frost in the fall to extend the harvest season. Fabric, "floating' row covers may be placed over the plants during the evenings when frost is predicted and removed for harvest. These lightweight fabrics create a greenhouse effect that will provide three to five degrees of additional temperature protection.

Overwintering the Planting
Day neutral strawberry beds are not usually carried over for a second year. These plants can produce an early spring crop the following year, and fruit again in the summer and fall if carried over, however fruit quality, especially size, is generally much lower in the second year and runner control becomes a major problem. If the beds are to be carried over, winter protection is required in the form of heavy weight rowcovers, applied in the fall when the plants are dormant.

Pest Management
Numerous pests can potentially cause problems in day neutral strawberry plantings. Tarnished plant bugs, spider mites, gray mold and anthracnose are common and potentially devastating pests. Consult local University Extension recommendations for the best management techniques for problems in your area.

Varieties
The most popular day neutral strawberry variety being grown in New England is ‘Seascape’, which is known for dependable performance and good fruit quality. ‘Albion’ is also being grown for its high fruit quality, but it is very late ripening. ‘Evie-2’ is grown for its earliness and high yield, but it is very soft and shy of flavor. ‘Tristar’ and ‘Tribute’ are being grown in some areas. They are hardy and disease resistant, but have small fruit size and relatively low yields. Yields from day neutral strawberries vary widely, ranging from 4000 to 12, 000 pounds per acre. The differences in production tend to be the result of management. Following good management practices, especially in regards to variety selection, plant stands, nutrient management, water management and pest management will maximize crop yield and prolong the profitable life of the planting.

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

Strawberry Insect Management, December 2009

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To me, **tarnished plant bug** is the most important arthropod pest of New England strawberries. It attacks flower buds, flowers, and young fruit, up to about 1/3 grown. TPB overwinters as an adult, and feeds on a huge range of plants --- over 500 species. The severity of attack in your strawberries relates strongly to location. If there is a lot of early succession vegetation nearby (especially alfalfa or fallow fields with weeds), you can expect very heavy pressure. If your bed is surrounded by woods, you can get very little TPB pressure.

Nymphs do most of the injury. For June-bearing varieties, the overwintered adults and their nymphs are the primary concern. If you have alfalfa nearby, avoid mowing it when strawberries are in bloom, or have green fruit present. That drives them into your strawberries, just when they are vulnerable.

Scouting really pays off for this pest, since pressure varies so much. Details are in the New England Small Fruit Pest Management Guide. In recent years we have slightly shifted our emphasis on when you scout. We prefer to avoid spraying during bloom (protect pollinators), so we've shifted our emphasis to starting scouting shortly before bloom, when there are flower buds present. For those who like simple scouting, use the old threshold: treat if four or more trusses (branches of flowers or flower buds) are infested, out of 30. For large acreage, a more complicated method is described in the guide. It really saves time.

I won't list pesticide choices here --- you should go to the guide for that. I often steer people away from Brigade; in NH I've seen serious two spotted spider mite problems triggered by Brigade spraying. It has been seen elsewhere, too.

Clipper could be called other things on pesticide labels: strawberry clipper, strawberry weevil, or strawberry bud weevil. No, strawberry root weevil is something else. Clipper overwinters as an adult, and has just one generation per year. "June bearing" varieties are regularly attacked, but in "ever-bearing" varieties, the fruit in late July and later are not hit. Clipper only attacks the flower buds, not opened flowers. The female lays an egg in the bud, then clips it off. Inside, the tiny grub feeds and grows, emerging in mid-summer.

Some varieties can compensate for some clipper injury, by making the remaining fruit larger. Jewell and Senecca compensate well, so clipper attack is less serious in those varieties. Moderately compensating varieties include Lateglow and Primetime. Some varieties show little or no compensation, including Earliglow, Cavendish, Northeaster, and Honeyoe.

The edges of fields are usually hardest hit, especially when beds are new. They move in about 30 feet (10 rows) each year, so older beds can have injury throughout. Scouting pays off for this pest, too. Details are in the guide. You sample at least 5 sites per field, when the unopened buds are present. Our threshold has changed a bit, to recognize the difference in severity, on buds of different types: *3 clipped primary buds/meter* or *30 clipped secondary or tertiary buds/meter* makes it worthwhile to spray. You might not need to treat the whole bed.

Black vine weevil and its two smaller relatives can be very serious pests. There are three species here that hit strawberry. The largest, most common, and most damaging is black vine weevil. Slightly smaller (almost identical) is rough strawberry weevil. I don't see many of

those. The smallest and least damaging is strawberry root weevil. They're common. The biology of these three is virtually identical, so we usually manage them as a group.

Adults hide from the light, so they're in soil or under leaf litter during the day, and come out to feed at night. In southern NH, adults appear about July 1st. One clue that they are present is that adults chew notches in the edges of the leaves. They begin laying eggs about August 1st, and continue into Fall if temperatures are mild. The eggs hatch into white, C-shaped grubs **with no legs.** They feed on the roots and crowns, and overwinter as larvae. In spring, the larvae are at their largest size, and feeding gets most intense.

Black vine weevil can survive a long time as an adult, even over one year, if it has some winter protection. Older adults lay more eggs than the younger ones, so if we give them good winter protection, populations can build even higher. To me, the potential for this problem is where winters are milder (southern New England?), and we try winter row covers.

Controlling black vine weevil can be very difficult. Chemicals (Brigade, Platinum) don't seem to work well here. You could try insect-attacking nematodes. They can sometimes be very effective, but many attempts are disappointing, in part due to several problems. 1) You must use the correct species of nematodes: *Steinernema feltiae, Heterorhabditis bacteriophora*, or *Heterorhabditis megidis*. 2) You must apply them at a very high rate: 3 Billion/acre for *Steinernema*, or 1 Billion/acre for *Heterorhabditis*. 3) Timing is critical: May 15th to 25th, **or** Aug 28-Sept 10. 4) Avoid applying them on a hot, sunny day. 5) Irrigate just before & immediately after applying, or many will die. 6) Check the viability of your shipment when it arrives. 7) To apply with a low pressure sprayer, remove the fine screens first. You'll have to use agitiation, or they quickly settle. They are expensive; it pays to shop around.

Option 3: destroy the infested bed, and make sure no plants that can support BVW larvae grow there for the next 2 years. You have to keep out *Achilea*, *Adiantum*, *Asters*, *Astilbe*, *Azaleas*, *Begonia*, *Bergenia*, Blackberry, Calla lily, Christmas fern, *Cinquefoil*, *Cyclamen*, Dandelion, Dock, *Epimedium alpine, Epimedium grandiflora,* Hemlock, *Heuchera, Hosta, Hydrangea, Impatiens, Isoloma,* Lily of the valley, *Lythrum,* Mountain laurel, *Phlox*, Plantain, *Physostegia,* Primrose, Raspberry, *Rhododendron*, Rhubarb, *Sedum,* Strawberry, Sheep sorrel, Wood sorrel, *Taxus.* Move your new bed 100 yds away (farther is better).

You could completely surround your new bed with a barrier fence of plastic sheeting stapled to (outside of) wood stakes (10" above ground plus 2-3inches of plastic buried). It prevents adults getting into a new field (they can't fly). Spraying the outside of the fence with horticultural oil helps make it difficult for them to climb. The same is true if the plastic is dusty. Problems: you've got to keep the barrier up July 1 through the fall until the mild weather stops. Also, you can't drive field equipment over them, or you'll breech the barrier.

Two-spotted spider mite (TSSM) can be serious in hot, dry years or where predators have been killed. When you scout, don't forget the undersides of the leaves. You'll need a hand lens or magnifying glass. Threshold:15 or more infested leaves, out of 60. Be sure you check a number of spots across the field! The guide lists pesticide options.

White grubs: avoid planting strawberries where grass grew last year , and control grassy weeds. Admire Pro and Platinum are now labeled for controlling white grubs in strawberry. **Sap beetles**: no good choices to deal with them. Do your best to keep the field free of over-ripe fruit! That odor strongly attracts them. There are pesticides, but they have problems…

Strawberry Disease Management

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Successful management of strawberry diseases requires constant vigilance on the part of growers to assess strawberry plant health and diagnose any disease symptoms as soon as they occur. In general, the important diseases of strawberries in New England are caused fungi, or in the case of angular leaf spot, bacteria. These organisms require moisture to successfully grow and multiply. Planting only in well-drained soils, growing on raised beds, using straw mulch, and maintaining narrow plant rows, will help keep the plants and soil surface dry, greatly reducing the potential for disease development.

Gray Mold: Bloom is *the* critical time to protect the fruit against **gray mold** caused by the fungus *Botrytis cinerea*. This fungus overwinters on old leaves and plant debris. Infections take place almost exclusively through the flowers. This is why gray mold control efforts should be focused on the bloom period. If the bloom period is dry and/or good fungicide coverage is maintained, incidence of gray mold at harvest should be low. Two to three sprays of fungicide during bloom are typically required to provide good protection against this disease. If you tank mix insecticides and fungicides, avoid spraying when bees are active.

There are several excellent fungicide choices for control of gray mold in strawberries. Elevate® (fenhexamid) has good to excellent activity against Botrytis. Captevate® is a pre-mix of captan and fenhexamid and has a broader spectrum of activity than Elevate® alone. Switch® (cyprodinil and fludioxonil) and Pristine® (pyraclostrobin and boscalid) are also excellent products for gray mold control. Topsin M® + Captan is also a good fungicide combination, but remember that Captan is strictly a protectant and can be washed off by rain or irrigation water. Thiram (thiram) is similarly effective but susceptible to wash-off. Cabrio® (pyraclostrobin) and Abound® (azoxystrobin) are NOT suitable for gray mold control, but are effective against anthracnose and other fruit rot and leaf spot diseases. All fungicides mentioned above have a 0-day pre-harvest interval, except Topsin M® (1 day) and Thiram (3 days). Remember to alternate fungicides with different modes of action for resistance management purposes.

Leather rot (*Phytopthora cactorum*): This disease may become an issue when there is lots of standing water in the fields during bloom and fruit ripening. Infected fruit have a dull, lifeless appearance and may have a lilac color. The fruit will have a very bad flavor. Eventually, white, cottony growth may emerge from the infected fruit. Leather rot can also be a problem in fields that have been irrigated frequently for frost protection. This disease is best controlled by growing strawberries in well-drained soil and by applying straw mulch between the rows to prevent the berries from touching the soil and preventing soil from splashing up onto the berries. Foliar sprays of Aliette®, Agri-Phos® or Phostrol® (similar to Aliette) may also provide control. Spray during bloom and fruit development.

Anthracnose: This fruit rot is favored by warm, humid conditions and can spread rapidly during rains or frequent irrigation. In cool seasons, it tends to appear close to harvest or may not show up at all. Anthracnose fruit rot can be identified by black sunken lesions with wet, orange (and sometimes gray) spore masses in them. The anthracnose fungus is able to multiply on the leaves without visible symptoms, which may explain its sometimes widespread and sudden appearance in fields. Fungicides such as Cabrio® and Abound® can provide good control of anthracnose fruit rot.

Red stele root rot: Cold damp soils can create ideal conditions for red stele root rot. Don't assume that plants dying in the field are the result of winter injury unless you have first checked for symptoms of red stele. To diagnose red stele, pull up a few plants that look weak, i.e. have small leaves, scrape the roots of these plants to see if the center of the root, known as the stele, is a rusty red in color, instead of the normal white. The red color would indicate an infection. Red stele is cause by *Phytophthora fragariae*, a soil borne fungus that infects the roots when soils are saturated with temperatures around 50°. The fungus grows into the roots and blocks the vascular system causing the plants to become weak, stunted and eventually die. Symptoms are most evident in the spring, and can be mistaken for winter injury. Ridomil Gold®, Alliette® or Phostrol® are fungicides that can be applied in the late fall or early spring for control of red stele. Many varieties have some level of resistance to the disease, but the most effective management strategy is to plant only into well-drained soils, and or plant on raised beds.

Powdery Mildew: Periods of humid weather can often stimulate symptoms of powdery mildew on strawberry plants. The most obvious indication of this fungus is the upward curling of the leaves. Purple or reddish blotches, and/or white, powdery growth may be observed on the undersides of the leaves. Mildew infections weaken plants and can reduce yield the following year. Some varieties are more susceptible than others, for example Annapolis is quite susceptible, while Mira and Mesabe are thought to be resistant. Abound®, Captan, Pristine®, Cabrio®, Topsin-M® and Stylet oil are presently registered to control powdery mildew.

Angular leaf spot is a bacterial disease that is characterized by translucent leaf spots that may turn yellow and eventually black. The symptoms tend to start on the lower leaves but may move upwards as bacterial spores are splashed up by rain or irrigation water. Infection of the calyxes may result in a blackening of the berry stems and caps, reducing their marketability. Bacterial angular leaf spot is favored by extended cool, wet weather and nights with temperatures close to freezing. Frequent irrigation for frost protection can greatly encourage the development and spread of the disease, as will extended cool, damp weather. Susceptibility to this disease appears to vary significantly between varieties. Copper-containing chemicals, such as Kocide, Cuprofix, and Bordeaux are the only materials that have much effect on this disease. Some labels suggest adding lime as a "safener" to reduce the risk of crop injury. In susceptible varieties, start spray applications before bloom to prevent multiplication of the bacteria on the leaves before they jump to the berry caps. **Application of copper sprays after bloom can result in fruit injury and is not recommended**. Recent research suggests that hydrogen dioxide (OxiDate) may also have some activity against angular leaf spot when used on strawberries as part of a gray mold management program.

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

High Tunnel Construction and Internal Environment and Pest Management

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High Tunnel Construction:

Farmer Decisions Impacting High Tunnel Structures:

High Tunnel Site: The first and foremost decision that you will make related to your high tunnel is where to position it on your farm. If you are interested in season extension, or even think that you might like to build a high tunnel at some point on your farm, it is important to start thinking about this as far in advance as possible. Things to watch for include how the **shadows** from trees and other outbuildings change throughout the year. Short shadows in June and July will be long in December and January and could impact production if you are thinking about producing year-round. It is also important to think about **access** to the structure. You might be able to drive a truck back to a location on the farm in the summer that will be difficult to reach in the colder months. The third consideration for the site is **orientation**. We have enough sunlight in the lower 48 states in the summer months to grow in high tunnels, but conventional knowledge tells us that if we want to grow year-round and are above 40N latitude we should orient the house East-West. While East-West orientation will maximize light and is preferable, there are an increasing number of farmers who produced year-round in high tunnels oriented North-South. From their experiences we have seen that clearly it is possible to produce year-round in high tunnels with North-South orientation. Lastly, a major consideration for positioning your high tunnel is proximity to water and electric sources. Clearly water is required, and we will discuss some considerations that might make electricity necessary.

Kit or Homemade: There are a number of decisions that should be made prior to constructing a high tunnel. The first that should be made related to the structure is whether to purchase a high tunnel "kit" or to construct a homemade one. For the most part we recommend purchasing a kit, especially if you have limited experience with high tunnel structures. The inclusion of the hardware and nearly all the required materials in the kit can save time and money, not to mention multiple trips to the hardware store for additional materials.

Shape: In the past most high tunnels were Quonset shaped as they were structures commonly used for overwintering nursery stock. In recent years as high tunnels have grown in popularity the structures have switched to being more gothic shaped than Quonset. This has allowed for improvements in venting as well as working environment and comfort levels.

Covering and Venting: The polyethylene covering commonly used on high tunnels is usually 6-mil and can be applied as either a single or double layer. If a single layer is used there is no need for electricity to run the small inflation fan that is necessary for a double layer covering. A double layer tends to be approximately 4-5F warmer than a single layer. Year-round production is possible with a single layer. Venting in high tunnels is done passively and is usually achieved by the use of either roll-up or drop down sides at a minimum, although some farmers build large doors that can be opened wide in the warm months for ventilation. Ventiliation may also be achieved using butterfly or louvered vents in the ends or even a ridge vent. All of these, as well as the side ventilation can be either manual or thermostatically controlled.

Construction: When we build high tunnels we usually use a 13 or 14 step process. This includes: squaring the site, pounding the ground posts, assembling bows, standing bows, attaching purlins, plumbing the structure, attaching the hipboards and baseboards, installing the windbracing, building the endwalls, hanging the doors, attaching the plastic, and installing ventilation.

Internal Environmental/Pest Management

It is impossible to cover environmental and pest management in detail in a short time but we can talk generally about both the root zone (soil) and shoot zone (air) in terms of management. For the **root zone** we are mostly talking about managing soil organic matter, fertility and moisture. We tend to manage our organic matter with compost applications. In the first few years of production at the SOF after initial soil prep we applied ~5 cubic feet of compost/100 square feet of production area in the fall each year. More recently we have moved to this application rate between each crop, which is between 3 and 5 times annually. We do not use cover crops in the stationary high tunnels because it takes time out of our cash crop production in a very premium space. The compost application also has the potential to help suppress soil-borne diseases. Compost application is also our chosen method for fertility in the high tunnels. In the past we have also used some alfalfa-based fertilizer that provided the fertility and resulted in similar yields as the compost application but did not provide the soil building benefits of the compost.

We apply around one acre inch equivalent/week in the high tunnels in the summer months. In the winter this can drop dramatically, although we do water occasionally in the winter. We have observed that soil moisture headed in to the fall is important for good winter crop production. In the fall we generally increase our soil moisture and then water in the winter when it is sunny. This could be as often as every seven to ten days, like at the SOF, or as few as five or six as was the case at our home farm in Winter 08-09. So that we can water in the colder months we install frost free hydrants and bury our water line below 40 inches. In the Midwest we have seen an increase in pH over time in the high tunnels. This is linked to a lack of leaching and the fact that we have limestone aquifers that cause our well water to have high amounts of dissolved calcium. In a way, when we water from a well we are liming our soils. To counteract this we have started to apply elemental sulfur in the high tunnels.

For the **shoot zone** we manage differently in summer and winter. In the summer we are venting with both roll-up sides and louvered peak vents to keep it fairly cool. In the winter we are covering the crops in two different ways. The first is with polyethylene supported by EMT conduit. It is very durable and for places like the SOF, where there are a number of volunteers and students in and out of the tunnels the more heavy duty polyethylene stands up to the various levels of pushing and pulling. We also cover with row-cover (0.55 oz weight) supported on high tensile wire. For our 34 X 96 ft house we use four runs of wire to support the rowcover, which is 3 pieces each at 40 X 30 ft turned sideways so that the overlaps run the width of the house. This allows us to access the area in the middle of the house without having to move the covering from one of the ends.

For **pest management** we utilize certified organic approaches at both the SOF and Ten Hens. The main pests we have in the hoophouses are aphids, loopers, winter cutworms, and

occasionally flea beetles. Above all else we try to ensure that any transplants we bring into the hightunnels are clean of both diseases and pests. For aphids we often utilize insecticidal soaps. For the loopers in the fall we utilize bT. For the winter cutworms we utilize a combination of bT, soil applied nematodes, and Spinosad applications. In an extreme case in 2007 we removed all plant material from one of the houses at the SOF and allowed chickens to access the house. The flea beetle damage often occurs on the early brassicas, especially arugula. For this we try to have the row cover in place and leave it there as much as possible to exclude any of the flea beetles.

In general we try to practice good sanitation techniques as well as **good crop rotation** to decrease the probability of disease and insect outbreaks.

ABC's of In-ground Heating & Alternate Fuels

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Root zone temperature is more critical than leaf temperature in achieving good plant growth. If the optimum root zone temperature is maintained, then air temperature in the greenhouse can be 5 - 10ºF cooler, saving energy.

For winter operation, installing 1" thick polystyrene or polyurethane insulation board to a depth of 18" – 24" below grade will save considerable heat and keep the soil near the sidewalls at a warmer temperature. Insulating above grade to bench height or so that the plants are not shaded will also give significant savings.

System components

The basic floor system consists of pipes embedded in the concrete, sand or soil. Warm water pumped through the pipes conducts the heat to the plants placed on the floor or in the soil. The floor material distributes the heat evenly across the floor surface. In New England, a floor heat system will provide about 25% of the greenhouse heat needs on the coldest night. Typically, 15 to 30 Btu/sq ft of floor area can be obtained from the root zone heating system. The remainder has to be made up with above ground perimeter radiation or air heaters.

Heat source

For heating small areas, less than 3000 sq ft, a low-cost, domestic hot water heater is usually the best choice. These are available in natural gas, propane and electric models in sizes to about 45,000 Btu/hr. Select a heater with a glass lined tank. The installation is simple in that besides the water heater all that is needed is an expansion tank, air eliminator, PRT safety valve, circulating pump and remote bulb thermostat. The thermostat on the water heater is usually set at 100 to 110ºF. The soil thermostat that controls the pump is set at the desired soil temperature.

Hot water from an existing or new boiler can also be used. One or more circulators and tempering valves are needed to feed the root zone heat. Because the return water from the root zone is cool, a non-condensing boiler should not be used. Cool water, less than 135ºF can cause condensation that is highly acidic and can damage the boiler. A tempering valve that protects the boiler could be installed to warm the return water. A better option is to have a condensing boiler that uses the heat from the flue gases to warm the return water.

Another installation that works well is to install a heat exchanger between the boiler and the root zone heat. A heat exchanger isolates the boiler water from the root zone tubing water. A circulating pump moves the hot boiler water on one side or the heat exchanger and a second pump passes the water through the other side. Heat exchangers are used if the root zone tubing is filled with glycol solution in a greenhouse that is shut down during the winter. It is also a common installation in a system that doesn't have an oxygen diffusion barrier such as polyethylene pipe.

To reduce heating costs, an outdoor wood boiler or corn fired boiler could be used. These are available in many sizes. As there are state and local restrictions on their installation, check with the local building department before purchasing one of these units.

Heat distribution in the root zone
It is best to use a material such as PEX, a cross-linked polyethylene tubing that has an oxygen diffusion barrier. PEX tubing is available in sizes from 3/8" to 2" and in roll lengths to 1000'. Typical size for floor systems is ½" for loops up to 200' and ¾" for loops to 400'. Tube spacing is usually 9" to 12" on center.

Some growers have used low-cost Schedule 80 polyethylene pipe in soil or sand installations. With a glass lined hot water heater and no ferrous components, the life has been good. For soil grown crops, placing the pipe 8 – 12" deep will allow roto-tilling of the soil. Installation can be done by plowing a furrow and then laying the pipe in the bottom or by purchasing a pip-laying chisel that attaches to the drawbar of a tractor. For surface installation, the pipe is laid on top of the ground underneath gro-bags or containers. The piping is installed as loops fed by a supply header with the other end connected to a return header. Using a reverse return system, the flow through each loop travels the same distance giving uniform heating.

Pumps
Circulating pumps are used as a good flow is created without much energy. Inline or wet rotor circulators are most common. Place a shut-off valve and a union on both sides of the pump so that it can be serviced or replaced easily. When sizing the pump, the flow should be about 2.5 feet/min for ½" or ¾" pipe. This keeps the temperature difference between the supply and return ends of the loop to between 5 and 10ºF. The head or pressure loss is determined by the number and length of loops in the system and the pipe size. The pump is best located near the expansion tank to reduce pressure differences.

Controls
A remote bulb thermostat is the common control. Placed in the soil or container it activates the circulating pump when heat is needed. When water is supplied by a boiler, controls that modulate water temperature or a variable speed pump may be used.

Profitable Winter Greens in Ground-heated Tunnels

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Slack Hollow Farm is a market farm growing mixed vegetable on 15 acres in Washington County, NY. As a market farm our crops are grown for specific markets we have developed. Our crops are also driven by the changing market conditions we experience. Unlike commodity farming our growing is entirely linked to our markets.

For years we farmed as many market growers in New England have done- growing and selling enough on 10-15 acres in the 5 months from June through October to generate an income to cover the entire year. We have marketed in several ways, including CSA, bulk storage vegetable sales in the fall, retail at markets, and wholesale. For the last 10 years we have settled on a mix direct retail at farmers markets and wholesale to a medium sized natural food store in Albany, NY. To stay profitable at our scale of production we have found we need to keep wholesale marketing down to about 1/3 of total sales.

While our climate and soils certainly allow for the creation of enough value in the five month growing season, this style of growing makes for a very busy growing season, with a labor force that must fluctuate a lot over the year, and income that when plotted over the year looks like a classic extreme bell curve. It also creates a basic disharmony in our lives at this point. We are now raising two young children, and during their summer break we are too busy to spend much time with them.

The decision about 10 years ago of our retail Farmer's Markets to stay open year round has had a big impact on our business. We began supplying this winter market with crops grown in the summer and stored over the winter- onions, potatoes, carrots, beets, and shallots. To this we added fresh spinach, which was and still is grown in an unheated high tunnel which was built for in season tomato cultivation. This was our start in growing greens in the winter.

This winter we will have just over 10,000 sq feet of growing area under cover, in three high tunnels. . Two of those tunnels have a ground heating system. We will grow baby spinach, a mild and spicy mesclun, baby bok choi, and arugula. Our goal is to generate nearly a third of our income from November to May. The story of how we got to this point on our farm is about markets primarily, and about our preferences and skills as growers.

Our strategy for this first winter market went something like this: We had some experience with season extension under row covers, and we had built our first high tunnel which was a Ledgewood model, 21' X120'. This was a simple structure, no heat, single layer poly, and manual roll up sides. We built this tunnel for tomato production, and had had success with that crop because it gave us a one month jump on the season, and eliminated many desease issues.

We also much preferred the permanent overhead support provided by the structure of the house- we find it makes supporting the tomato plants much simpler. We also used this house for early greens production in the spring, and squeezed in some crops, basil and greens, in between the tomatoes before they grew too large. For this first winter market we planted this house to spinach.

The spinach production has gone something like this: We fertilize with heavy applications of compost. We fill the house in two plantings, the dates we use at our latitude is just before and just after the 1st of October- say Sept 25th and October 5th. We plant close and densely, using resistant varieties is important. The first planting is ready by the middle of November, and the spinach continues to grow until late December. The second planting is ready by mid December, and is "stockpiled" fully grown for harvesting during the part of winter when there is no growth in this unheated house. Growth restarts in February- early or late depending on the severity of the winter. The amazing thing about spinach is that it seems able withstand any low temperature. This unheated house obviously gets quite cold at night, thought the ground never freezes more than and inch or two down. When frozen the spinach cannot be harvested, but once it thaws is looks great. During a cold (or cloudy and cold) spell we will use row covers to keep it from freezing ahead of that weeks harvest. We have been able to cut this spinach once or twice again in February and March. Often some of this spring crop is wholesaled, as growth rates at that time exceed the capacity of our retail markets. The total yields have been very impressive from this low input, unheated house.

The availability of fresh spinach at our first winter market was very well received by our customers, That first year the market quickly grew to the point where we could sell more spinach than at a busy summer market, which makes sense given that we were the only game in town in the fresh local greens department. For the next few years we perfected this spinach production method, and grew and stored enough root crops and squash to supply this ever-growing market. We saw that the economics of the spinach in this low input system were quite good.

The Next Step

As the Market grew demand exceeded supply, so we built another high tunnel, this one a larger Rimol brand, 30' X 120', with automatic roll up sides, also unheated. That first year in this house, we also planted some of our mesclun and arugula in the fall, and with the use of row covers kept production up until mid December. What happened next is when things really got interesting for us. Some of the row cover was left on the ground where it had last been put when the arugula was uncovered the last time in the fall. When we lifted this in the spring, there was a long row of Arugula that had survived the winter under multiple layers of row cover. It was at this point that we realized that perhaps with a small amount of additional heat, just enough to keep the ground from freezing, we might expend our production of winter greens. There is not much new under the sun in agriculture, its all been done before, but this is when it occurred to us that a small amount of additional heat might work for our situation.

That spring we dug up the ground in the new house, and installed a ground heating system using basic radiant floor materials, and oil-fired hot water. We buried the pex tubing underground at 1' intervals 16-18 inches under, deep enough so that tractor tillage was still an option. The next

winter we planted a variety of winter greens- but not lettuce. We used wire hoops and 3 layers of row covers to cover the whole house at night. We maintained a soil temperature of 47 degrees 6 inches under the surface, and found that under the row covers at night the temperature never dropped below 27 degrees. We burned 400 gallons of oil, 90% of it between November 15th and February 1st. We have found that by February, no matter how cold the nighttime temperatures, if the weather is sunny there is enough solar gain during the day (5 degrees of soil temp rise) that no additional heat is necessary.

The next two years we worked on our growing techniques for all these new (to us) wither crops. Many of the mix ingredients are the same as in the warm season, with a few changes made to accommodate the different light levels and temperatures. The planting schedule is critical for continuous production. Succession planting begins the first of October, and proceeds weekly. Unlike in the spring, when plantings need to be stretched out for continuous harvest, at this time of year 3 days apart in the seeding schedule can translate into 3 week intervals in the harvest. Most crops are harvested 2-3 times before renewing the beds with new seedings later in the winter. Productivity really jumps in the late winter and early spring, when light levels, temperature, and day length are up. In February and March, production is way up, and in late March, April, and early May, which are usually considered the lean times for local food around here, the production from these established, well rooted crops, many of which were planted in January and February, is off the charts, and in addition to all the mixes our market table is full of lots of large greens, which have grown too large for mixes, and are sold on their own.

Regarding spinach: As mentioned, spinach production from the unheated house was very good, but when we planted spinach in the heated house the results were even more impressive. In March and April spinach planted in January can be cut every other week, with high very quality and quantity.

Final Notes

Needless to say, the addition of a wider variety of fresh greens in midwinter was met with great enthusiasm by our customers at market. We can sell 2-3 times as many greens at a winter market vs. a summer market. Prices are slightly higher then as well. Demand has again exceeded our supply, so we just completed our third and largest tunnel, a Rimol 34'X 120', also heated. We enjoy gardening in the winter, the greenhouses are a cheerful place to be. The type of work now being done in the winter is all for the highest value crops- greens! We have cut back on out fall root crops- fewer carrotsand no potatoes- eliminating these large crops during the growing season means we need less labor then. Our winter labor now will be less washing of roots and more work in the greenhouses. Our labor force is more oriented towards year round full time workers. By offering year round work we can keep more experienced and committed people.

As oil prices rise by large percentages, we will have to keep an eye on costs. We could add supplemental wood heat, or increase nighttime insulation. Covering the earth inside these houses at night is critical. Oil use would be 3 or 4 times as much without a covering system. As soon as solar gain stops as the sun goes down, which around the solstice can be as early as 3:30pm, the covers need to be in place. Currently we use 3 layers of row cover, and have developed a system to roll the covers on and off; as we expand covering and uncovering becomes a bigger chore.

No doubt our farm will continue to change, we'll see how all this plays out this year. We definitely feel less pressure to produce this summer, and are glad to concentrate on the crops we grow best, and have more time for family activities. Our hope is that even during the winter we can earn enough to pay off debt incurred building these rather expensive high tunnels and heating systems.

Essex Farm's Full Diet, Year-Round, Free Choice, Horse Powered Membership: a Presentation for the Year-Round Growing & Marketing Session

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Essex Farm is located on 500 acres near Lake Champlain, in the small town of Essex, New York. Our founding goal was to create a CSA-model farm that provides a full and interesting diet year-round, including meats, dairy, fats, vegetables, grains and flours, etc. We built the farm around the desire to use draft horses instead of tractors whenever possible.

We have grown from seven to one hundred members in six seasons. Members pay $2800 per person per year, with a $400 discount for each additional person in a household. Children under 13 are currently free, and children 13 and over are full price. We offer a sliding scale for people who cannot afford the full share price. Our projected gross for 2009 is $200,000.

Our facilities include two large barns, a state-inspected milk house, a greenhouse, a distribution pavilion, and a butcher shop. We currently have three full-time employees, four year-round part-time employees, and several more seasonal employees and volunteer helpers. Two years ago we bought 80 acres of land plus the farmhouse, barns and outbuildings, and have a lease on the rest of the 500 acres. We currently have about 80 acres of tilled ground in a rotation of row crops, small grains and cover crops. Most of the rest of the land is in pasture and hay, with about 90 acres in wood lot and sugarbush.

All our animals are pasture-raised, and slaughtered and butchered on-farm. We use no spray of any kind, nor any fertilizer except compost. We produce all of our own hay (7000 to 10,000 bales), and about 25% of our own grain. We purchase the remaining 75% from organically certified neighboring farms.

Here is a brief explanation of our farm's five main elements:

Full Diet
We strive to make the grocery store obsolete for ourselves and our members. We produce beef, pork, chicken, eggs, dairy, about 50 different kinds of vegetables, herbs, some fruit, grains and flours, dry beans, lard, and maple syrup, plus some bonus items like cut flowers, breakfast cereal, sauerkraut, kimchi, and soap.

What are some benefits of the full diet model?

1.We all eat like kings.
2. Diversity makes for a dynamic, interesting farm.

3. Providing a full diet creates “atomic loyalty”.
4. We benefit from the agricultural and economic advantages of highly diversified farming.

Year Round
Members pick up their share every Friday, year-round. During the growing season, members are encouraged to take extra vegetables to put up, to supplement the storage vegetables we offer in the winter and early spring.

What are some benefits of a year-round distribution model?

1. It highlights how satisfying and delicious it is to eat locally, directly from a farm, even in winter in zone 4.
2. We do not have to make a huge annual marketing push in early spring when we’re busy with other things.
3. It spreads our work and our income more evenly throughout the year. There is no cycle of boom and bust.
4. Members learn to permanently shift their cooking and eating habits in order to use the share effectively, year-round.

Free Choice
With a few exceptions, there is no limit on how much members may take, or in what combination. We ask that they take no more than they can use in a week, and that they do not hoard meat. We sometimes place limits on items that are always in high demand, like pork chops, and products that are only available in limited quantity, like maple syrup.

What are some benefits of the free choice distribution model?

1. It acknowledges the fact that everyone eats differently. It makes the share more user-friendly.
2. We do not have to police what members take. We don’t spend any time boxing or bundling produce. Members even wrap their own meat.
3. We can sell the feeling of abundance. Members get to eat like farmers.
4. Because we don’t choose food for people, there is less waste.
5. For members, it divorces food choices from dollar values.

Horse Powered
We do all of our field work, sugaring, and some of our haying and hauling with three teams of draft horses.

What are some benefits of draft-horse powered farming?

1. Stewardship issues: Horses help close the loop of production, decrease soil compaction, increase fertility.
2. Community issues: Horses help create good will and loyalty among members and neighbors.
3. Horse pace & premeditation makes us more careful farmers.

Membership

Most of our members sign a contract committing to a full year, though they may pay quarterly or monthly or even weekly. This year, for the first time, we offered a summer share to seasonal residents, with a 25% markup. We do not do any retail sales.

What are some benefits of offering membership over retail sales?

1. If we do our job right, we only have to make a sales pitch ONCE per member.
2. We have no need for organic or other certification, since all of our members are invited to see and understand our agricultural methods for themselves.
3. We know our income projection at the beginning of the year.
4. It gives us the freedom to farm as we see fit, taking into account the health and happiness of our family, employees, animals, and the long-term health and fertility of our land. We do not have to make decisions based on the retail value of our products.
5. It allows us to legally slaughter and butcher on-farm.

About Mark and Kristin

Mark Kimball graduated from Swarthmore College with a degree in Agricultural Science. He bicycled across the country, working on farms, and apprenticed on biodynamic vegetable farms on the east coast before starting a vegetable CSA at Tate Farm in State College, PA. Kristin Kimball graduated from Harvard College with a degree in English Literature. She worked as a freelance writer and editor in New York City until she went to interview Mark about his farm in 2002. They founded Essex Farm together in 2003. Kristin's book, *The Dirty Life*, will be published by Scribner in 2010.

If you would like to receive the weekly Essex Farm Note by email, send a request to kimball7@localnet.com.

Pepper Varieties for Your Markets: from Bells to Habaneros and Everything in Between

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Peppers (*Capsicum* spp.) are from the Tropical Americas and were introduced to the United States via Europe and later Latin America. They are in the Solanaceous (nightshade) family, which includes tomatoes, eggplant and potatoes. Peppers are a perennial plant normally grown as an annual in most of the world, including the United States. In tropical areas there are varieties that are grown as perennials. Peppers are named after the spice pepper (*Piper negrum*) since ground peppers (*Capsicum* spp.) could be used as a substitute,

Mexican heirloom pepper mix produced at the UMass Research Farm in 2008. (Photo by Zoraia Barros)

Peppers are a very diverse vegetable with an amazing range of shapes, colors, and also "heat". Some peppers have a compound called capsaicin that is responsible for the pungency in peppers. This is measured using Scoville units, which is a dilution factor of the capsaicin levels in peppers – the higher the Scoville units, the more heat in the pepper.

Many pepper varieties popular among ethnic groups and traditional markets, have been evaluated at the UMass Research Farm and on commercial farms. Table 1 provides some information on a number of these crops. More detailed information on these and many other peppers are available at a website maintained by Frank Mangan: www.worldcrops.org

Table 1. List of Mexican peppers evaluated at the UMass Research Farm.

Crop name	Latin name	Scoville units*
Ají ducle	*Capsicum chinense*	0
Bell pepeprs	*Capsicum annuum*	0
Cascabel	*Capsicum annuum*	1,500 – 2,500
Chilaca	*Capsicum annuum*	1,000 – 1,500
Chile de arbol	*Capsicum annuum*	15,000 - 30,000
Chile manzano	*Capsicum pubescens*	30,000 – 50,000
Guajillo	*Capsicum annuum*	15,000 – 30,000
Habanero	*Capsicum chinense*	200,000 – 350,000
Jalapeños	*Capsicum annuum*	2,500 – 5,000
Malagueta	*Capsicum frutescens*	60,000 – 100,000
Poblano	*Capsicum annuum*	1,000 – 1,500
Serrano	*Capsicum annuum*	15,000 - 30,000

*Scoville units are used to measure the pungency of peppers; the higher the number the more pungent the pepper

Here is information on several of the more promising peppers form Table 1:

Ají dulce (*Capsicum chinense*) is a small, light green pepper that turns red if left long enough on the plant. In Puerto Rico, it is known as *ají dulce* or *ajicito* (sweet pepper and small pepper, respectively, in Spanish). In the Dominican Republic, it is also known as *ají gustoso* or *ají cachucha* (tasty pepper, and cap-shaped pepper, respectively, in Spanish). It has the shape and size of a habanero pepper without

the intense heat. Unlike many other countries in Latin America, hot peppers are not commonly used in the cuisine of Puerto Rico, Dominican Republic, or Cuba. However, there can be some ají dulce fruit that is pungent, probably due to out-crossing.

Jalapeños are the most well known and most popular type of hot peppers produced in Mexico. The name comes from Jalapa, the capital of the Mexican state of Vera Cruz. Much of the production in Mexico and in the US is pickled or canned. This very versatile pepper is used in many ways, including used as an ingredient in cooked or raw sauces, charred and peeled to be stuffed with cheese, meat or fish. When allowed to ripen to a deep red on the plant and then dried, it is called chipotle, or more correctly "Chipocle" in Mexico. They are also used fresh when red in certain dishes.

Jalapeños have become very common place in the US market, not only for the large Mexican and the other Latinos groups that use them, but also for the non-Latino market. In general, the Mexican market prefers the fruit to be more mature, with cracks and some red; the non-Latino market prefers green fruit with no cracks.

Poblano peppers produced at the UMass Research Farm in 2008. (Photo by Zoraia Barros)

Poblanos are one of the most popular peppers in Mexican cuisine. Sometimes in the US it is called "pasilla", which is something dried or wrinkled. When ripened on the plant and then dried, the poblano pepper is called ancho.

Serranos peppers are perhaps the second most common pepper in Mexico after jalapeños. They are usually used fresh, but are also canned as "serranos en escabeche" (packed in vinegar, onions, carrots and herbs) which is used as a popular relish that is sometimes added to sauces. For fresh or cooked sauces, it is used either raw or grilled, chopped, or ground with other ingredients. The seeds are usually not removed. Serrano varieties evaluated at the UMass Research Farm produced a lot of fruit, but a major constraint is the small size which would lead to high labor costs to fill a box.

Serrano peppers produced at the UMass Research Farm in 2008. (Photo by Zoraia Barros)

CSA Start-up

Holland Farm
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We got the opportunity to operate the Holland Farm in fall of 2007. We had a business plan and a notebook full of ideas. Our first season farming was our first season running the CSA. The CSA is our main source of income for the farm.

The farm is 89 acres of fields and woods. Everything but the land right around the house is in a conservation easement. We have a lease arrangement with the owners of the farm.
That fall of 2007 we put a nice wooden sign out front saying "Holland Farm CSA coming spring of 2008." It had my name and the website address. The house was under complete renovation and people's curiosity brought them to the website. We answered endless emails of "what's a CSA" and "how does it work". Our local paper did an article on the renovation and the future plans for the farm. It worked, we met our first season member goal of 95 and we had 30 people on a wait list. In 2009 we had 147 members.

Our website is vital. We also have listings on Local Harvest.org. Our listing gets hundreds of hits per year. Local Harvest only asks for a small yearly donation. It's well worth it.

We grow on about 5 acres of rock free sandy soil. We grow pesticide free but use both organic and conventional fertilizer. We grow on 4 ft. wide black plastic mulch rows with drip irrigation. Almost all of our fertilizing is done through the drip. Between the rows I plant a cover of clover and grass. It's mowed once a week with a 5 ft. finish mower. We grow things like salad mix and arugula in open soil beds. We have a small 14x 48 greenhouse where I plant 96 greenhouse tomatoes. All our seedlings are grown in hoop houses on my parent's farm across town.

Our CSA has full memberships and half memberships. We don't call them shares. A half membership is adequate for 2 adults. A full is adequate for a small family of 4 or 2 vegetarians. Members are not required to work on the farm.

We don't box the pickups. Members come to the farm once a week on their chosen day. We offer Tuesday/Thursday or Saturday for pick up. Member's names are checked off a list . All the vegetables are rinsed and put up in the farm stand. Things like radishes and carrots are kept loose. Each item has a sign saying what it is and the quantity to choose. If they don't like it they don't take it. Quantity is determined by the level of membership. The sign also has a space for the retail price to the public. We laminate the signs so we can change them and reuse them. We have a "seconds" table where members can help themselves. We have a large table that we fill with buckets of fresh herbs. Members take what they like and will use. We go through a lot of basil. We had about 200 ft. of double row basil last year.

Last year we offered pick your own flowers for an additional $40.00/ season. We grew 9 rows 75 ft. long of snapdragons, zinnias, asters, dahlias, cosmos and fillers. Flower members bring their own clippers and buckets. The flowers were ready in mid July. They picked 10 to 15 stems each week. We had 35 flower pickers.

We have a large pick your own area in the garden. Members pick their own green and yellow beans, hot peppers and cherry tomatoes. Not picking beans for 150 people is huge. The members really enjoy the pyo. It gets the kids involved. People socialize and have fun when they're out there. They find out fast that picking beans isn't that much fun. They usually reach their" fun max" at about a pound without us setting a limit. Cherry tomatoes we say "pick about a pint". We'll pick some beans and cherry tomatoes and keep them under the counter for our favorite little old ladies. It makes them happy that they get special treatment.

It's proven to be very important to have someone outgoing and knowledgeable running the pickup. The high school kids are ok but a chatty adult who knows how to cook makes a huge difference. We encourage members to add recipes to our bulletin board. This Summer I think we'll have some cooking contests.

Our animals are real popular with our members. We have four goats and between 150 and 200 laying hens. Members can visit with the goats and feed the chickens bread they bring from home or scraps from the wash area. Our eggs are available for sale. They are not included in the CSA. Communication with the members has also proven to be very important. We use Constant Contact.com to send e-mail updates to members year round. We don't send them every week, just when something's going on. Constant Contact is reasonably priced and it's fun. We have a large white board in the farm stand that members look to for the "Coming soon" veggies and crop updates. The spring start of the CSA is the time we really have to focus on good communication. Many members are new and they are unsure of what to do and how things work. A good person in the stand helps by letting new members know that as the garden matures the bounty increases. New members get nervous when they just keep getting greens and radishes. Our members sign up with a membership agreement form. It states our commitment to provide fresh pesticide free vegetables in reasonable quantities at pick up, also to provide a positive farm experience, and to stay committed to our members as they are the back bone of the Holland Farm. They have a commitment to use also. We ask that they accept fluctuation in harvests due to weather, to pick up on their selected day or send someone else, and to understand that the CSA is one form of revenue produced on the farm. We also have a small farm stand and attend a farmer's market. The form is available off our website. We accept cash, checks and PayPal. We have one strict rule. If you can't pick up on your day you need to send someone to pick up for you. Members are not allowed to change days. Having friends and neighbors pick up while people are off on vacation works well for us because it exposes more people to our CSA. We've gotten a couple new members this way.

Members choose their pick up day when they sign up. We accept 50 members each day. Our days are Tuesday 11:00 – 6:00, Thursday 11:00 – 6:00 or Saturday 9:00-5:00. They can come by anytime during these hours. Picking and quantities can get tricky to make sure we don't give out too much stuff on one day and come up short the next pick up day. I get nervous in the mornings. I think "we'll never make it and we have no food today." We always make it fine.

I always try to be positive about the crops in front of the customers. They have pre paid and trusted me to produce quality vegetables for them. Showing confidence in myself and not whining about the weather or bugs gives them confidence in me. Once again good communication has paid off for us in the past. Last spring we delayed pickups one week because of the rainy weather. An e-mail to members letting them know what was going on worked great. Not one complaint.

We use Quick Books ’08 for our book keeping. I like it because it’s easy enough for me to use and the paperwork is professional. We use Quick Books for payroll also. Using their payroll is very easy and quick.

We have a line of credit with First Pioneer Farm Credit. First Pioneer also does the taxes for the farm.

Restaurants Direct

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Satur Farms was started 11 years ago by me and my husband, Chef Eberhard Mueller, on ¼ of an acre of land in the wine country of eastern Long Island. We are currently farming 180-acres of specialty vegetables there, along with an additional 150 acres in Florida for our winter production.

As Chef, my husband was awarded four-stars from The New York Times when he opened Le Bernardin in NYC in the mid-eighties, and his reputation among his colleagues for quality is impeccable. Although I have a graduate degree in Plant Physiology, I had been in the premium wine business, selling wines to top restaurants in the city. From the start, we had a huge advantage in selling to restaurants. My husband knew what he wanted us to grow; I knew how to sell to restaurants. This is an insiders' view of what restaurants want and how to sell to them. To succeed in selling restaurants direct, you must run your farm as a top chef runs his kitchen. You must be rigorous in growing for and offering **quality**; meticulous in grading, washing, packing, chilling and handling. The common wisdom is that retail stores demand the high quality produce and restaurants took what's left. This line of thought will not work for you today and you cannot build from there. Below is an excerpt from the website of Per Se, the highest rated restaurant in NYC.

SATUR FARMS THE STORY OF EBERHARD MULLER
Dinner service at per Se is in full swing and the garde manger reaches for the cilantro shoots, part of the garnish for the night's foie gras course. The fact that he does so without even a cursory inspection says a lot about how highly he regards the farmer.
Excerpted from restaurant per se, menus & stories at www.perseny.com

Consistency in product availability is crucial in selling to restaurants. When chefs add an item to their menu, they don't want to be told that you're out of it the following week. We have a brutal seeding schedule that takes into account day length and temperatures as they affect maturity, so that we can achieve steady supply. We create our seeding schedules in the winter, and work into it our proper crop rotations.

It is advantageous to offer a wide **variety** of items. Orders must be a minimum size in order to cover cost of delivery. We grow specialty items that are not typically available in the distribution network in addition to commodity items. Because chefs want or need certain things from us, they will also order commodity items such as our spring mix, which they know to also be of high quality, at the same time. It's easy to want to grow everything that anyone asks for. Running crew around fields to cut several pounds of this or a couple of boxes of that will ruin your labor costs and have a devastating effect on your bottom line. If we want to trial a crop, we have

specific beds to do it in. Only if we are convinced that it is appropriate to add to our list, will we do so. If you stretch yourself too far by growing too many different things, quality will invariably suffer. We also break done items into repack boxes, so that chefs can order ½ lb of thyme, 1 lb of rosemary, with 5 lbs of haricot vert. We have an employee in charge of all repack, and she pulls crew members from our packing facility as needed. In order to increase our offerings, we contract with our neighboring farms to grow the crops that we do not. Our customers appreciate this access to a large variety of locally-grown produce.

We deliver 6 days per week into NYC, and email our updated availability list daily. We include photographs of both the produce and the fields, which is extremely important in giving our produce a sense of place and **freshness**. We could harvest our herbs once a week and be done with it, but then we are no better than any commercial distributor. You should aim to transmit the excitement of the season- when things are gorgeous and flavors amazing. It helps to be a source of inspiration.

Your office must be staffed and operated in a **professional** manner to instill confidence in your operation. Order-takers must be versed every morning what's in, what's out, what's new, what's in short or long supply. Most restaurant sales are done from 2:30 pm – 4:30 pm, between the lunch and dinner service. Never call a chef during service hours. Since most of our orders come in during a 2-hour period, we know to put all office hands on calls during this time. We use Quickbooks for invoicing and truck routing. Once our trucks are loaded and closed out, we will call restaurants if any shorts or problems have arisen. They must know if they are not receiving an item the next morning. In dealing with chefs, you must have a heightened level of concern for everything and an acute sense of urgency and follow through.

Strawberry Weed Management Update

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Introduction

The 2010-2011 version of the New England Small Fruit Pest Management Guide will be available soon all small fruit growers should have a copy of this publication. Members of the New England Vegetable & Berry Growers Association can receive a copy of this publication free as part of their membership. This guide should be available by early April but the current and future versions are/will be available online at www.umass.edu/fruitadvisor . Copies will also be available from all 6 New England Extension services.

Major Herbicide Label Changes

Chateau (flumioxazin) is registered in strawberries. In DORMANT strawberries, the rate is 3 oz/acre. Chateau will provide preemergence control of many broadleaf weed species. 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. 2,4-D may still be required to control other emerged weeds. A residual grass herbicide such as Devrinol (napropamide) or Dacthal (DCPA) is still needed. Chateau can also be applied with a hood or shield to row middles of non-dormant strawberries prior to fruit set. This includes strawberries grown on both matted row and plasticulture systems. DO NOT allow Chateau to come into contact with actively growing strawberry fruit or foliage.

Prowl H2O (pendimethalin) is registered in strawberries. Uniformly apply Prowl at a rate of 1.5 to 3 pints per acre to the soil surface PRE TRANSPLANT. Once the strawberries are established, an application may be made up to 35 days prior to harvest BETWEEN crops rows. DO NOT spray over strawberry plants. Application may cause stunting of daughter plants. Prowl provides excellent control of many annual grasses and several broadleaf species. See the label for a complete list of weeds.

Late Summer Planting of Oats

Also in strawberry, growers have been experimenting with using oats as a living or dead mulch. The purpose of this is to add organic matter and to help hold added mulch in the late fall from blowing away. It is not a weed management option. Some tips to follow. They include planting in mid-August at a rate of 100 lb/acre either broadcast or banded. Use of Sinbar, Devrinol (napropamide), or Dacthal at renovation will adversely affect the germination and growth of the oats. If possible, band the herbicides only in the row so that the oats can establish between the rows. Herbicide applications or other weed control options may still be required after establishment. Look for the oats to grow at least 18 inches tall. The oats will winter kill

Using Row Covers Instead of Straw Mulch

Growers that use row covers for winter protection should take extra precaution to insure that winter annual, biennial, and perennial weeds are not present in strawberry field during the winter months. Row covers will increase daytime temperatures and cause these weeds to grow at a much faster rate than if they were under straw mulch. This is especially true in the Spring before the covers are removed.

Specific Timings to Control Weeds

Late Fall/Winter: after the strawberries are dormant.
1. Apply Chateau or Formula 40 (2,4-D) to emerged weeds.
2. Apply half the annual rate of Sinbar
3. Apply half the annual rate of Devrinol

Spring Weed Management: up until bloom
1. The only common herbicide options at this time would be either Poast or Select for emerged grasses. Either will control volunteer rye or other small grains that emerged in the spring from seeds in the winter mulch.

Renovation Options:
1. Formula 40 applied just after the last harvest to control, emerged broadleaf weeds.
2. Apply half the annual rate of Sinbar after mowing and tilling.

Late Summer: prior to the emergence of winter annuals
1. Apply half the annual rate of Devrinol to control winter annuals before they emerge.

Cultivation

During the establishment year, cultivation is an important tool until daughter plants start to grow and root.

The most common time for using cultivation in established strawberry fields is from renovation until daughter plants start to root. If herbicides have been used, cultivations should be shallow to avoid diluting the herbicide. Even when herbicides are not used, cultivations should not be deeper than 1 to 2 inches to avoid damaging crop roots and drying out the soil.

Runner Management to Boost Efficiency

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Prohexadione-calcium (Apogee®) was evaluated for inhibition of runner formation and plant performance in a modified plasticulture system used for growing strawberries in the Northeast. Application rates between 0.8 oz to 2.5 oz per 100 gallons (62.5 to 189 $mg \cdot L^{-1}$) in multiple applications were evaluated. Rates between 1.6 and 2.5 oz/100 gallons were most effective. Apogee® reduced runner formation but initiation of treatments within 3 weeks of planting and 3 sprays applied at 3-week intervals appeared to be necessary for complete runner suppression. The inhibitory effects from an application of Apogee® lasted for about 28 days. Apogee® decreased petiole growth, runner weight and runner number, but increased root to shoot ratio, the number of branch crowns, the number of flower trusses, and total marketable yield without affecting mean fruit size. The number of fruit harvested early was reduced, peak fruit production was delayed and harvest extended later into the season. The performance of plants treated with Apogee® was equal or superior to plants where runners were removed manually during the course of plant growth and development.

Table 1. Effect of Prohexadione-calcium (ProCa) application on growth characteristics of Darselect strawberries in 2006.

Treatment[z]	Runners per plant (no)	Crowns per plant[x, w] (no)	Root length (cm)	Leaves per plant (no)	Runner length (cm)	Petiole length (cm)
Control	9.8 b	2.3 b	23.0 a	20.2 b	44.9 a	17.7 a
ProCa 62.5 $mg \cdot L^{-1}$	7.1 c	2.6 b	24.7 a	21.7 ab	11.0 c	11.7 c
ProCa 125 $mg \cdot L^{-1}$	5.8 c	4.0 a	22.9 a	25.3 a	7.4 d	8.9 d
Runner removal[y]	14.5 a	2.6 b	23.3 a	23.4 ab	34.8 b	16.2 b
Significance						
Treatment	***	***	NS	*	***	***
ProCa	***	***	NS	**	***	***
Linear	***	***	NS	***	***	***
Quadratic	NS	**	NS	NS	***	**

[z] Treatments applied 30 July, 18 August, and 6 September. Strawberries planted 25 June, 2006.
[y] Runners were removed 18 August, 13 September, and 28 October.
[x] Mean separation within columns by Duncan's multiple range test, P = 0.05.
[w] NS,*,**,***Nonsignificant or significant at P = 0.05, 0.01, or 0.001, respectively.

Table 2. Effect of Prohexadione-calcium (ProCa) application in 2006 on yield and fruit size of Darselect strawberries in 2007.

Treatment[z]	Flower trusses[x, w] (no/plant)	Total yield marketable fruit (no/plant)	Mean fruit weight marketable fruit (g/fruit)	Total yield marketable & unmarketable fruit (no/plant)	Total yield marketable fruit (g/plant)
Control	4.3 b	25.8 c	18.5 a	28.4 c	476 c
ProCa 62.5 $mg \cdot L^{-1}$	5.1 b	33.6 b	17.8 ab	36.2 b	592 b
ProCa 125 $mg \cdot L^{-1}$	7.4 a	40.9 a	16.8 b	44.4 a	683 a
Runner removal[y]	6.7 a	35.2 b	17.5 b	40.0 ab	615 ab
Significance	***	***	**	***	***
ProCa	***	***	*	***	***
Linear	***	***	**	***	***
Quadratic	NS	NS	NS	NS	NS

[z] ProCa treatments applied 30 July, 18 August and 6 September, 2006.
[y] Runners were removed 18 August, 13 September, and 27 October 2006.
[x] Mean separation within columns by Duncan's multiple range test, P = 0.05.
[w] NS,*,**,***Nonsignificant or significant at P = 0.05, 0.01, or 0.001, respectively.

Table 3. Effect of Prohexadione-calcium (ProCa) application in 2007 on yield and fruit size of 'Jewel' strawberries in 2008.

Treatment[z]		Flower trusses[x,w] (no/plant)	Total yield marketable fruit (no/plant)	Mean fruit weight marketable fruit (g/fruit)	Total yield marketable & unmarketable fruit (no/plant)	Total yield marketable fruit (g/plant)
($mg \cdot L^{-1}$)	(oz/100 gal)					
Control 0	0	7.3 c	54.4 c	11.3 c	61.6 c	663.0 b
ProCa 125	6	24.4 a	84.6 a	13.3 a	116.4 a	919.4 a
ProCa 189	9	22.1 a	84.2 a	13.1 ab	111.6 a	917.6 a
Runner removal (3x)[y]		14.6 b	67.9 b	12.1 b	93.6 b	750.3 b
Significance		***	***	***	***	***
ProCa		***	***		***	***
Linear		***	***		***	***
Quadratic		***	**		***	**

[z]Apogee treatments applied as a dilute spray on 1 August, 22 August and 16 September, 2007.
[y]Runners removed 22 August, 19 September and 27 October, 2007.
[x]Mean separation within columns by Duncan's multiple range test, P = 0.05.
[w]NS, *, **, *** Nonsignificant or significant at P = 0.05, 0.01, or 0.001, respectively.

Strawberry Varieties for Today and Tomorrow

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A person could easily find a thousand different strawberry varieties in the world today. In North America, there are over 100 varieties offered by over 40 different companies. In 2010, Nourse Farms will offer 25 varieties of June Bearing and 2 varieties of Everbearing/Day-neutrals. This menu offers growers from zones 3 to 8 an opportunity to produce June bearing strawberries for approximately 30 to 45 days and everbearing strawberries for 3 to 6 months. I will focus on our top ten sellers and four new releases for the New England states.

For forty years, I have had the privilege to hear about many peoples most and least favorite varieties. Opinions are as varied as the growers and the land they use. The good news is strawberries are the most popular berries for consumers. The bad news is growing conditions in the North East are very different from year to year. I suggest growers consider less than perfect backup varieties to split the risk of poor conditions. In difficult situations and extreme field conditions, many of our top ten sellers will perform poorly. That is why we offer substitutes and I will cover five of those.

As a consultant, I like to prescribe several options to growers looking for advice. My recommendations are based on the following criteria. What varieties do you like and why? This helps me suggest varieties that can compliment the existing program. Where do you live? The choices will be different for every zone and microclimate. How are you planning to sell the berries? Wholesale, retail and pick your own are very different venues. What is your soil type? Varieties can like heavier soils better than light soils and vice versa. Are you organic or conventional? A few varieties are better suited for organic. Do you have irrigation? Early varieties are more consistent with frost protection. Drip irrigation will help any variety reach higher production potentials. Some varieties shouldn't be considered without irrigation. What were the previous crops planted in the area you are considering? This is a very important question for several reasons. Many growers will try to plant back where strawberries have been produced for several years. Another reason is to find out what herbicides had been applied, many have plant back restrictions, and strawberries may fail to grow in previously treated soil.

The following list comprises our top ten sellers, five alternates, and four new releases. Please keep in mind that the top ten list represents almost 80% of our sales and the entire group represents 90% of sales. The other ten varieties we offer are alternatives for exceptionally difficult conditions.

Jewel – This variety sets the standard for wholesale, retail, and pick your own strawberries. I estimate that Jewel comprises 15-20% of June bearing production in North America. For some growers, it is the only variety they grow. Jewel can be difficult to renovate and will perform poorly with heavier rates of Sinbar herbicide.

Darselect – Nourse Farms has the exclusive rights to sell this variety in the U.S. Darselect is similar to Jewel in many ways. It has very high yield potential and a long harvest season. It is very susceptible to Leaf Scorch and demands preventative sprays throughout the growing season. Give this princess the attention she deserves and you'll be rewarded with large sweet berries.

Seascape – This is the most popular everbearing variety for commercial production, outside of California and Florida. Seascape will have exceptional performance in the cooler microclimates of the Great Lakes, Saint Lawrence Seaway, and the Atlantic coast. In warmer areas, drip irrigation can aid in the management of heat stress, helping this variety reach 75-80% of its production potential.

Earliglow –Considered one of the best tasting varieties, it is the most popular early season variety. Earliglow is vigorous, adapts to many growing conditions, and shows resistance to Red Stele. Its lower yield is mainly due to the small berries that develop after the third harvest. I believe there is an heirloom marketing opportunity here, growers should consider asking for higher prices and selling Earliglow in pints.

AC Wendy – This is the first early season variety that challenges Earliglow for flavor. It has a very high yield potential. The combination of higher yields and bigger berries through the entire harvest period makes Wendy very attractive. While initial results are very positive, I am concerned about it's susceptibility to Leaf Scorch.

Honeoye – It is interesting how this variety has been a top ten seller since it was introduced, even though most growers will tell you how much the dislike the taste. While it will have off flavor in heavier soils during hot and dry periods, Honeoye is very consistent and forgiving. I will often joke: if you can't grow Honeoye, you should get out of the strawberry business.

Cabot – This is the largest berry that still tastes great. Cabot is not for beginners. The berries can be very soft, with many split king berries, and plants don't always produce enough runners. This variety has one the highest yield potentials, but it needs extra water, magnesium and boron from bloom through harvest. With drip irrigation and early morning harvest, I feel it can compete with any late season variety.

Allstar – This variety produces a good crop of sweet berries in almost any soil. Its disease resistance and adaptability allows growers to produce berries in the most challenging conditions. If it were a little darker berry, it would be even more popular.

Cavendish – This variety will excel in cooler conditions, like this past season, with very high production. The heavy crop load combined with hot and dry conditions will produce half red berries. Irrigation is very important in reducing uneven ripening. Cavendish is resistant to both Red Stele and Verticillium.

Eros – Is another variety exclusive to Nourse Farms. It can produce above average yields late into the season. Eros, in my opinion, will perform better on heavier soils. On our very light soils, it is not as sweet. This has been one of our largest berries during the Fourth of July sales week.

Eros has Red Stele resistance with the trade off of a softer skin. Due to its lighter color, many growers pick this variety past maturity.

The next five varieties offer their own unique advantages. They are staple varieties for some, while being backup for others.

Annapolis – This is the earliest variety to ripen. Similar to Earliglow for vigor and disease resistance, it also loses its size after a few harvests.

Brunswick – This variety can go head to head with Honeoye in cooler climates. It does not have flavor issues in heavy soils.

L'Amour – This is a lower yielding variety during Honeoye season. The fruits are much firmer and taste good. L'Amour's advantage is leaf disease resistance.

Clancy – This variety has the same season as Cabot. The berries are very firm and it has leaf disease resistance. Clancy will runner more freely and is much easier to grow than Cabot.
Ovation – Vigorous, disease resistant, and with very large berries, Ovation is a fit for organic growers. It usually produces too many runners and is a low yielding variety.
New to our catalog for 2010, these four releases offer several advantages over existing selections.

Galletta – This variety was developed as an alternative to Sweet Charlie. It should ripen before Earliglow and have larger fruit size than Earliglow or Evangeline. Time will tell if Galletta will be winter hardy enough for zone 4.

Daroyal – Harvesting at the same time as Honeoye, this very good tasting variety is bright and shiny. Daroyal will be recognized for its size and great shape.

AC Valley Sunset – Trialed as KRS-10, this late season variety has great flavor and color. It ripens at the same time as Ovation. Leaf disease resistance and vigor are very good. The downside for many will be the soft skin, it could be softer than Cabot.

Record – This variety will ultimately replace Idea, it seems everything about it is better. There will not be many who are thrilled with its color and taste, but it will out produce most varieties.

Like many things in life, I have yet to find the perfect strawberry variety. However, there are many opportunities for growers who are willing to change their growing practices in order to help varieties overcome their limitations. It is important to understand that variety development is a long process, taking 5-10 years before release. If a variety does well in Europe, it must go through a two-year quarantine before it can be sold commercially in the U.S. Consequently, I would recommend taking a few years to fully evaluate any variety before making a final decision.

Strawberry Variety Performance in New England

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Strawberry production in northern New England is limited by a relatively short growing season, severe winter conditions, and red stele root rot (*Phytophthora fragariae*). The market for strawberries is almost exclusively local and, because nearly all of the fruit is being sold fresh as either "pick-your-own" or at nearby farm markets, excellent fresh quality is essential. Demand for fresh fruit is strongest near concentrated population centers. However, suitable land for strawberry production is often very limited in such areas, requiring plantings to be high yielding in order to both meet demand and be profitable. There are presently no strawberry breeding programs in the northern New England region. Thus introductions from breeding programs in other regions must be tested in order to evaluate their adaptability and performance under northern New England growing conditions and cultural practices.

The trial was established at Highmoor Farm, part of the Maine Agricultural and Forestry Experiment Station, in Monmouth, Maine. Twenty-one strawberry cultivars were planted from dormant crowns on May 17-18, 2006 (Table 1). The site had a silt loam soil, previously planted to mixed vegetables. It was amended with 10-10-10 fertilizer at a rate of 500 lbs./acre prior to planting. The plots were established as narrow matted rows atop 8 inch high, 18 inch wide raised beds with a single drip irrigation line buried approximately 2 ½ inches deep in the beds. Crowns were planted 12 inches apart in rows four feet apart. Each plot was 18 feet long. Each cultivar was replicated three times in a randomized complete block design. Flowers were removed during the planting year, and runner plants were allowed to root to fill out the rows to a width of 0.5 m. Straw mulch was applied over the planting for winter protection on in the late fall of 2006 and 2007. The mulch was raked off of the plants in late April of each harvest year. Calcium nitrate was applied over the plants at a rate of 85 lbs. /acre on approximately three weeks after mulch removal. The planting was sprayed three times with a combination of recommended fungicides and insecticides during the bloom period to control fruit rots, tarnished plant bug and strawberry bud weevil. Harvest began on in late June of 2007 and 2008, and continued twice weekly through late July. Fruit was harvested from each plot, graded, counted and weighed.

Excessive rain following planting in 2006 flooded most of the plots in the planting. Despite this, the plants generally showed good growth and vigor during the summer months. The exceptions to this were 'L'Amour' and 'St. Laurent', which showed symptoms of red stele root rot by the fall and during the following spring, and produced poor yields during both seasons. The cultivars 'Mesabi', 'Sable', 'Cavendish', 'Mira' and 'Jewel' produced the highest yields of marketable fruit in this trial (Table 1). 'Wendy', 'Brunswick', 'Cabot', 'Seneca' and 'Darselect' also produced acceptable yields (Figure 1). 'L'Amour', 'St. Laurent', 'Canoga', 'Clancy', 'Evangeline', 'Orleans' and 'Allstar' produced relatively low yields. Itasca performed very well in the first year of harvest, but yielded very poorly in the second. Alternatively, 'Wendy' yielded very well in the second season, but had moderate yields during the first season. 'Cabot' produced the largest fruit in the trial, followed by 'Clancy', and 'Ovation'. 'Evangeline' produced the smallest fruit in the trial. Fruiting patterns showed a range of peak harvest dates and harvest durations among cultivars (Figure 1). Of the top five yielding varieties, 'Sable' showed the

earliest harvest peak, followed by ‘Cavendish’ and ‘Mesabi’. ‘Jewel’ and ‘Mira’ had the latest harvest peaks of the top five varieties, with ‘Jewel’ having the shortest harvest period. Based on these data, ‘Mesabi’, ‘Sable’, ‘Cavendish’, ‘Mira’ and ‘Jewel’ appear to be cultivars with the highest potential for northern New England, producing very good yields and having good fruit quality characteristics. Of the newest cultivars trialed, ‘Wendy’, ‘Brunswick’, ‘Cabot’ and ‘Darselect’ appear to be worthy of further trial in this region. The harvest patterns of the top yielding cultivars indicate a need for both very early and late maturing cultivars that produce large fruit and higher yields in order to extend the harvest season. Future breeding efforts for this region should also consider incorporation of resistance to the prevalent races of *Phytophthora fragariae*.

Table 1. University of Maine Strawberry Variety Trial: Narrow matted row, raised bed System, Highmoor Farm, Monmouth, Maine, 2006-2008.

Variety	2007 kg/plot	2008 kg/plot	2007 Berry Wt. (g)	2008 Berry Wt. (g)	2007 %Cull Wt.	2008 %Cull Wt.	Two Year Yield Rank/Comments
Allstar	10.03	11.55	11.04	10.31	15.05	32.52	16. Weak, variable plants; light-colored fruit, rough, firm, mild flavor; late
Annapolis	10.11	17.03	11.89	11.68	16.35	24.71	11. Vigorous plant; somewhat light color, dull, good flavor, somewhat soft; PM
Brunswick	18.57	16.56	13.48	11.35	14.31	29.03	7. Vigorous plant, fruit dark, variable, musky-sweet, a bit soft, picks well
Cavendish	20.04	21.55	13.58	14.04	18.32	33.75	3. Vigorous plant; good color, very sweet, firm, mildew; early-mid
Cabot	18.68	13.27	21.52	15.97	21.85	36.76	8. Vigorous plant; very large, rough fruit, light red, good, mild flavor, a bit soft
Clancy	10.36	7.599	19.23	10.44	25.45	24.05	19. Vigorous plant, fruit slightly dark, firm, nice appearance, flavor a bit flat, PM
Canoga	10.46	4.87	12.73	9.23	20.30	34.51	20. Short plant; fruit dark, glossy, very firm, sweet, mildew; mid-late
Darselect	16.65	11.70	13.11	9.77	19.71	28.07	10. Vigorous, rank plant; light color, sweet, ”melon” flavor, attractive, leaf scorch
Evangeline	10.06	9.47	9.67	7.59	11.29	31.06	18. Weak, short plant; fruit dark, somewhat soft with good flavor; PM; early
Honoeye	15.43	11.29	10.94	7.67	20.32	27.06	12. Plant vigorous, variable; fruit glossy, tart, flat, firm; early-mid
Itasca	20.47	2.08	11.43	7.91	18.96	47.10	13. Compact plant; fruit hidden, good color but dull, bland, a bit soft, leaf spot
Jewel	21.17	16.96	11.10	10.63	15.66	25.47	5. Vigorous but uneven plant; fruit good color, firm, attractive, flavor a bit flat
L'Amour	4.67	2.10	12.26	10.70	20.48	32.69	22. Weak, spreading plant; fruit good color, firm, attractive, good flavor; red stele?
Ovation	10.43	11.50	16.22	12.21	35.24	32.21	15. Vigorous, spreading plant; light color with mild, sweet flavor, firm, attractive
Seneca	16.40	13.55	13.93	10.49	17.69	27.76	9. Vigorous, upright plant; fruit somewhat dark, tart, firm. Late-midseason
Mesabi	27.63	17.12	10.80	10.88	18.12	37.97	1. Low, spreading plant; fruit good color, firm, tart, hard to pick, some leaf spot
Mira	18.40	21.14	11.06	10.75	15.01	27.36	4. Vigorous, upright plant; fruit light colored, slightly tart, firm, attractive
Orleans	14.53	6.40	12.53	9.88	18.75	25.22	17. Plant vigorous, rank; fruit dark, glossy, sweet-musky, soft, attractive; mid-late
Sable	20.73	21.07	10.46	10.33	13.23	31.27	2. Plant thin; med. size fruit, good color, flavor, slightly soft, leaf spot; early-mid
Yamaska	12.36	14.00	15.64	9.35	27.02	20.68	14. Vigorous but small plants; dark, glossy fruit, firm and tart; late
St. Laurent	9.45	4.22	12.30	9.68	25.06	37.67	21. Weak, spreading plant; fruit glossy, good flavor, soft; PM, red stele?
Wendy	14.40	22.33	13.09	12.77	11.68	29.09	6. Vigorous plant, attractive fruit, sweet, lacks acid; good color and firmness
KRS-10	10.87	8.39	17.34	13.11	24.62	32.17	Late, vigorous, upright plant; fruit large, glossy, sweet w/ acid, firm, skin tender.
K93-20	15.36	17.81	11.16	11.73	16.59	26.43	Vigorous, spreading plant; fruit dark, firm mild and sweet; mid-late
LSD 0.05[1]	7.64	5.70	3.10	1.737	8.35	9.754	Differences between means within a column must be this great for significance

[1] Data within a column must differ by this much to be considered statistically different according to the test for Least Significant Difference (95% confidence level). Plots 20’ long x 1.5’ wide raised bed matted rows, planted 2006.

What's New in IPM Trapping of Oriental Fruit Moth and Dogwood Borer in NH?

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Oriental fruit moth is an insect that attacks both stone fruit and apples. It overwinters as a fully grown caterpillar, on limbs or trunk. First generation moths appear in May, and lay their eggs on tip leaves of stone fruit shoots. When the caterpillar hatches, it bores into the shoot, killing the tip. Later generations attack the fruit of both stone fruit and apples. We don't know for sure how many generations there are here.

This insect supposedly has been in NH for years, but Alan set out many OFM pheromone traps in the early 1980's and trapped no OFM's, and found no damage.

In August 2006, a grower showed us damaged fruit that looked like OFM injury. When a nearby grower also reported injury, Alan set out a few OFM traps the next spring. They captured a few specimens that year, but we found no injury. That fall, George wrote an IPM grant proposal to NH Dept. of Agr., Markets & Food. They funded it, so we monitored at 9 orchards (mostly Hillsborough Co.) the next year. We set traps in both stone fruit and apples. We repeated the work (more NHDAMF funding) in 2009, at 10 orchards.

The 2008 data showed that there were a few adults flying in all locations tested. We had a relatively strong peak of flight in May, followed by low catches for the rest of the season. The pattern was similar to what entomologists had seen in NY, before OFM became a significant pest. We decided to continue the monitoring in 2009.

In 2009 our trap data had a similar pattern. But this summer, our scout Linda Kuhnhardt began to notice dead tips on stone fruit shoots at several orchards. One of the growers noticed it, too. To us, it is the first documented OFM shoot injury here. We did more stone fruit shoot counts in October, and found quite a bit of injury. The bottom line: this insect may become serious enough that some NH stone fruit growers will have to pay attention. It might involve adding a summer spray. We plan to keep monitoring, but want you to pay attention, too. <u>OFM seems to be increasing in New England</u>.

OFM traps are <u>not easy</u> for growers to use. The lures attract many lesser appleworms. They are very difficult to tell from OFM. On the other hand, the shoot injury to stone fruit is easy for growers to recognize and count.

Dogwood borer (DWB) is one of the Sessiid moths, small, wasp-like daytime fliers. It is an apple pest that increased in importance after we shifted to dwarfing rootstocks, especially those that produce lots of burr knots and adventitious buds low on the trunk. The adult females lay eggs there, or on wound tissue on trunks and limbs. The tiny caterpillars bore through the bark and cambium, leaving dark red-brown pellets of frass. In some cases, they can seriously affect tree growth.

Monitoring DWB has been a challenge for many years. There are sticky traps and pheromone lures, but they catch a bewildering mix of the target species plus a number of close relatives. Some trapped specimens are very difficult to tell from DWB. Also, many Sessiid

moths quickly turn black in sticky traps, so you have to check them frequently, while specimens are fresh. The DWB lures by Trece and Scentry have a field life of 4-6 weeks, so traps need to be re-baited frequently to cover the entire season.

This year, Dr. Tracey Leskey, an entomologist at the USDA Appalachian Fruit Research Station offered us samples of a new USDA-ARS lure for DWB. The lure is designed to last the entire season, and preliminary tests in West Virginia suggested it was better than the two major commercial lures, by Trece and Scentry. We agreed to set up a large array of traps on 7 farms, to compare the lures in cool New Hampshire.

At each site we tested all three lures, and checked the traps at least once a week. We rotated traps to new positions each time we counted, in case there was significant variability due to trap location. This study took much more field time than we expected, largely because of the "bycatch" of other species, and difficulty identifying specimens.

Dogwood borer flight stretched from early June through late September. (Remember --- lures attract the males only, so egg-laying period is probably shorter.) It peaked July 20th to August 3rd.

During the early part of the season, the three lures seemed to perform roughly equally, although the USDA lure caught few other species, while the Trece and Scentry lures caught a variety of species. As the season progressed, the USDA lure clearly out-performed its competitors. It caught many more DWB than the others, and it trapped very few other sessiid moths. By season's end, we had caught 2450 DWB's with the USDA lures, 808 with the Trece lures, and 412 with the Scentry lures. The Scentry lures actually caught more lilac borers than dogwood borers! The Trece lure caught quite a few DWB's, but many other Sessiids. By the end of the season, we were impressed. The USDA researchers have produced a lure that very specifically targets this species, out-traps its competitors, and lasts the entire season.

During the summer, concern about DWB injury at one of these farms prompted us to dig up some severely injured trees. We had a major surprise: **broad-necked root borer**, a large black beetle that lives several years as a root feeder, totally destroyed the roots of several 6-year old apple trees on Budd9 rootstock.

The root chewing looks somewhat similar to damage from pine vole. Alan's August 4 newsletter has more details and photos: http://extension.unh.edu/Agric/Docs/Aug_4_2009.pdf If you've seen injury like this on orchard trees, please let us know.

Thank you to the NH Dept. of Agriculture, Markets and Food for the funding that supported much of this work. Thank you to Tracey Leskey and Starker Wright, USDA Appalachian Fruit Research Station, Kearneysville WV, for sharing expertise, and providing the new Agr. Research Service's dogwood borer lure for testing. We are grateful for the assistance of Linda Kunhardt and Steven Gatcombe for much of the field work.

MOPUP-The Massachusetts Orchard Production Upgrade Program and what we have learned about planting and managing tall-spindle orchards

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Massachusetts apple orchards have a long history of providing locally grown fruit, and a visit to an apple orchard is a fall tradition for many residents. But, increased land prices, development pressure, difficulty finding labor, and higher costs of fuel, fertilizers, and crop protection chemicals mean that Massachusetts apple growers must adopt new technologies to remain profitable so that the benefits of locally grown food and open space preservation provided by Massachusetts orchards can be sustainable.

Unfortunately, however, with a statewide production average of just two hundred 40 lb. bushels of apples per acre in 2006 (NASS, 2006), Massachusetts apple growers may not be production-efficient enough to remain sustainable and truly profitable. In fact, and admittedly for more than one reason, from 1997 to 2002 apple orchard acreage has declined by 20% in Massachusetts. The need to adopt new orchard production technologies that will improve production, profitability, and pest management efficiency is an increasing necessity. For example, the 'tall spindle' apple production system which utilizes high tree densities on dwarf rootstocks and minimal pruning is capable of producing 700-800 bushels of high quality (McIntosh) fruit in the 4th leaf (four years from planting) and may be the most profitable system for Massachusetts apple growers. (NYFQ, 2006.) But, the high cost of planting a new tall-spindle apple orchard – upwards of $17,000 or more per acre – has been a significant barrier to Massachusetts growers who may be unwilling to take the risk to be 'early adopters.'

The MFGA (Massachusetts Fruit Growers' Association) Massachusetts Orchard Production Upgrade Program (MOPUP) proposed that the Massachusetts Dept. of Agricultural Resources Agriculture Innovation Center help ten competitively selected, progressive apple grower/members (five in 2008, five in 2009) with the cost of planting, establishing, and maintaining one acre each (app. 10 rows, 400 feet long) of modern, high-density, 'tall spindle' apple orchard. MOPUP purchased trees, which are the single greatest expense in establishing a new high-density orchard or replacing an existing one, and provided some funds for technical support and outreach. Selected growers supplied labor, support system, irrigation, and deer fence (where necessary) as a match, plus pay a nominal administrative fee to MFGA to participate. Technical advice on establishing and managing the tall spindle apple orchard is provided by UMass. In addition, MOPUP growers are asked to keep records on labor, material costs, pesticide applications, and production history for five years so that profitability (net gain, loss) can be measured. Such production records will be compared to more common 'semi-dwarf' orchards to see if fruit can be more economically produced and if pesticide use per unit of fruit production can be reduced. If true, then apple growers can realize both economic and environmental benefits.

The overall objective over five years will be to demonstrate whether the tall-spindle apple orchard is both profitable and can reduce inputs – including pesticides and labor – per unit of fruit production in Massachusetts orchards. These orchards will be 'case studies' for other growers to observe and evaluate. The orchards will be open by appointment and used as backdrops for various outreach activities, including fruit Extension twilight meetings and industry orchard tours. Publication of results and observations will be in 'Fruit Notes' (UMass Extension) and other regional fruit publications and newsletters.

References

NASS 2006. National Agricultural Statistics Service, Non-Citrus Fruits and Nuts Summary 2006, USDA National Agricultural Statistics Service.

NYFQ 2006. The Tall Spindle Apple Production System. York Fruit Quarterly, Vol, 14, No, 2, 2006.

Organic apple production in eastern US - Pennsylvania perspective

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In 2004, an organic apple orchard was established at the Pennsylvania State University Fruit Research and Extension Center in Biglerville, PA to provide researchers and growers with the opportunity to explore and observe the best research based organic practices for local commercial organic apple production. The first certified organic fruit was produced and sold in 2006. The organic apple project was named PA Regional Organic Fruit Industry Transition (PROFIT). Two apple scab disease resistant cultivars "GoldRush" and "Enterprise" were selected for the demonstration orchard due to their resistance to diseases and for their potential as processing or fresh market varieties.

Organic pest and disease control programs consisting only of approved organic materials were utilized. During a normal growing season, copper, sulfur, lime sulfur and paraffinic/mineral oils were applied throughout the season to protect the trees from diseases. There were no major events of diseases except sporadic occurrence of powdery mildew and cedar apple rust.

Sex pheromone mating disruption materials, neem products, *Bacillus thuringiensis*, codling moth granulosis virus, natural pyrethrum and kaolin clay were utilized to provide insect pests control through the season. Intensive insect pest monitoring program utilized standard insect sex pheromones and attractants. While the management of direct fruit pests such as codling moth *Cydia pomonella*, Oriental fruit moth *Grapholita molesta*, or tufted apple bud moth *Platynota idaeusalis* resulted in excellent insect pests control, the occurrence of secondary pests such as plum curculio *Conotrachelus nenuphar*, European apple sawfly *Haplocampa testidunea* and Japanese beetle *Popillia japonica* challenged the quality of fruit at harvest. Increasing populations of beneficial insects such as lady beetles, lacewings and predatory mites, provided excellent control of numerous indirect pests.

Weed management alternatives: hand hoeing, weed mowing and “mechanical hoeing”, (i.e., Weed Badger^{TM}) and propane weed burner were also evaluated and demonstrated in the organic orchard. The use of herbicides containing vinegar/acetic acid was evaluated but did not prove effective. The crop load management practices included organically-acceptable fruit thinners such as paraffinic and fish oils and lime sulfur. Set and yield data revealed promising effect of applied treatments. The primary causes of grade-out at harvest evaluations were sunburn, cracking and incidences of cedar apple rust caused by *Gymnosporangium juniperi-virginianae*. The applications of kaolin clay made no difference in the tree response to the crop management treatments.

Overall, this commercial organic apple project demonstrated that high quality organic apples can be grown on commercial scale in the eastern United States with existing and alternative materials currently approved and available to organic fruit growers.

The example of seasonal insect pest control program (with various experimental treatments) utilized during the 2008 season is presented in Table 1. Established organic and transitional organic orchards were used for evaluations of organically approved products for insect pest control. The control block with a standard insecticide program was located about 500 yards away from the organic orchards (Pink Lady and GoldRush cultivars).

Table 1. Seasonal insect control treatments in organic orchard during the 2008 season. All applications conducted using 100 gal of water per acre as complete applications. PSU FREC 2008.

Date	Insecticide	Rate/acre	Comments
May 02	Surround	50 lb	All treatments
plus	Neemix/AzaDirect	7.0 oz/32 oz	Treatments comparison
May 05	Surround	50 lb	All treatments
May 06	Isomate CM/OFM TT		All treatments
May 09	Surround	50 lb	All treatments
p*lus*	Neemix/AzaDirect	7.0 oz/32 oz	Treatments comparison
May 19	Dipel	1.0 lb	All treatments
May 23	Surround	50 lb	All treatments
plus	Neemix/Entrust	7.0 oz/2 oz	Treatments comparison
or	AzaDirect/Dipel	32 oz/1 lb	Treatments comparison
June 12	Deliver/Dipel	1.0 lb/1lb	Treatments comparison
June 20	Deliver/Dipel	1.0 lb/1lb	Treatments comparison
July 24	Cyd-X	1.0 oz	All treatments (CM)
Aug 06	Cyd-X	1.0 oz	All treatments (CM)
Aug 15	Cyd-X	1.0 oz	All treatments
plus	Neemix/Deliver	12 oz/1 lb	Treatments comparison
or	AzaDirect/Dipel	42 oz/1 lb	Treatments comparison
Aug 27	Cyd-X	4.0 oz	All treatments (CM)
Sep 05	Cyd-X	4.0 oz	All treatments (CM)

WHOLE FARM MATING DISRUPTION APPROACH TO MANAGE FRUIT PESTS

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INTRODUCTION: Growers are looking for alternative pest management options beyond the solitary use of pesticides in order to continue the production of high quality fruit. Some growers decide to adapt new methods to meet consumer demand while others simply want to use new methods with lesser impact on the environment. Mostly, growers look to reduce their production costs in order to increase their profitability. Mating disruption (MD) technology represents a valuable choice for some growers in search of new pest management methods. As MD for fruit pests is strictly a species-specific tool and does not control all pests in the orchard, pesticides continue to be needed at appropriate times throughout the season.

The whole farm mating disruption (WFMD) program started in 2006 as a part of the PA area-wide mating disruption project supported by the PA Department of Agriculture and the State Horticultural Association of Pennsylvania. This program specifically focused on the efficacy of control against codling moth *Cydia pomonella* L. (CM) and Oriental fruit moth *Grapholita molesta* (Busck) (OFM). The main goals of this program were to educate the grower how to incorporate available mating disruption products into existing pest management practices, and how the intensity and choice of other compounds applied to the orchard would be altered as a result.

The WFMD program started in 2006 with a single grower and over the next three years expanded to include more than twenty growers across Pennsylvania (2009 season). While each orchard was unique, the commonality for all involved growers was that each functioned as a direct marketing operation in the form of farm markets, farmer's markets, pick-your-own, or roadside stands.

MATERIALS AND METHODS: In the 2009 season, the WFMD program placed over 1,000 acres of pome and stone fruit under mating disruption throughout various fruit growing regions of Pennsylvania. The size of each individual farm varied from 6.5 acres to 116 acres. The mating disruption products used for CM and OFM in apple blocks included CheckMate CM/OFM Duel (Suterra LLC) placed at 150 dispensers/acre or Isomate CM/OFM TT (CBC America) placed at 150-200 dispensers/acre. The mating disruption products used for OFM in peach blocks included Disrupt OFM mats (Hercon Environmental) placed at 10 mats/acre, CheckMate OFM (Suterra LLC) placed at 100 dispensers/acre, or Isomate M-100 (CBC America) placed at the rate of 100 dispensers/acre. Each grower was responsible for purchasing most of the MD product and applying the MD material to the orchard.

Each apple block in the WFMD program was monitored with one set of insect pheromone traps. One set of traps consisted of one trap each for CM, OFM, tufted apple bud moth (TABM), and obliquebanded leafroller (OBLR). Apple maggot, *Rhagoletis pomonella* (AM) was monitored in all orchards using red sphere trap baited with ammonium carbonate as attractant (Great Lakes IPM, Inc.). In the stone fruit blocks growers monitored OFM, TABM, OBLR, peach tree borer

(PTB) and lesser peach tree borer (LPTB). All traps (excluding AM) were white, large plastic delta (LPD) Pherocon VI traps (Trece Inc) and were checked by the grower at a weekly interval. Mid-season and harvest fruit injury evaluations were conducted in most orchards for each season.

As the growing season progressed, insecticide application decisions for each site were made based on local pest observations utilizing pheromone traps and fruit injury evaluations. The insecticide application record during the WFMD growing season was compared against the insecticide spray schedule from the year prior to the start of the mating disruption program.
SUMMARY OF RESULTS: An evaluation of results from this project proved difficult as it was a challenge to assign uniform judgment criteria across such individualized operations and environments. Each orchard possessed an unique ecosystem and contained pre-existing conditions different from the others. As a result, it was decided that since each grower was exposed to its own version(s) of success and challenges, therefore growers should not be directly compared against other participants in the program.

Through the WFMD program, the combined effort of detailed pest population monitoring and the incorporation of MD products into routine pest management strategies allowed for a significant reduction of the number of insecticide applications while maintaining effective pest control and high quality fruit. No grower experienced an increase in the number of injured fruit, and all growers reduced insecticide applications except for the Grower 2 operation (Table 1). All growers maintained regular insecticide schedule of 1-3 insecticide applications until petal fall stage to control rosy apple aphid, plum curculio, first generation oriental fruit moth, tarnished plant bug, and European apple sawfly present during the spring season. The application of CM and OFM MD materials during and after bloom provided an effective tool to successfully manage CM and OFM populations, and thus allowed growers to reduce insecticide applications normally applied throughout the remaining of the growing season. Pheromone traps for TABM and OBLR and red sphere traps for AM guided the assessment of needs for additional insecticides. The targeted applications against other pests were applied only if the control was warranted based on monitoring.

Although insecticide application needs varied significantly among participating growers, the average number of insecticide application was reduced by about 35 percent during the first year of using WFMD program (decrease ranged from 10 to 60 percent). In only one instance, for Grower 2, despite incorporation of MD materials, it was still necessary to apply more insecticides than during the previous season, when MD was not applied (Table 1). Intensive monitoring, a part of the WFMD program, detected the troublesome CM population and forced this increase in insecticide usage.

The two primary leafroller pests for fruit, TABM and OBLR, continued to be present in all orchards but no population difference was observed when comparing population numbers prior to and after the start of the WFMD program. The apple maggot traps on average caught less than five apple maggot flies throughout the season in all evaluated orchards suggesting that this pest population continued to be adequately controlled through existing pest management strategies. Apple maggot continues to be carefully watched for altered population trends.

The WFMD program has received very positive comments from participating growers who have utilized the concepts surrounding the practical aspects of mating disruption technology. Mating disruption of fruit pests takes conventional pest control methods one step further and applies concepts involving biology, ecosystems, and weather factors into the practice of pest management. The growers who have worked with the WFMD program have had the opportunity to practically learn how to integrate the mating disruption into their own pest management system. Understanding the challenges and possible pitfalls associated with mating disruption technology leaves the grower better equipped for success when making pest management decisions.

TABLE 1. Comparison of intensity of insecticide treatments (as complete sprays) applied after bloom in participating orchards. If multiple blocks within a site received different number of applications, the average number was used for the comparison. Pesticide insecticide application data based on grower's records from 2006-2008 seasons. PSU FREC 2009.

	Before MD	*1st year MD*	*2nd year MD*
Grower 1	4 (2005)	2 (2006)	3.5 (2007)
Grower 2	6.5 (2006)	8 (2007)	8.5 (2008)
Grower 3	10 (2007)	4 (2008)	
Grower 4	4.5 (2007)	2 (2008)	
Grower 5	6 (2006)	3 (2007)	2.5 (2008)
Grower 6	5.5 (2007)	3.5 (2008)	
Grower 7	7.5 (2007)	5.5 (2008)	
Grower 8	9 (2006)	5 (2007)	6 (2008)
Grower 9	7 (2007)	5 (2008)	
Grower 10	7 (2007)	5 (2008)	
Grower 11	5 (2006)	4.5 (2007)	4.5 (2008)
Grower 12	7 (2007)	3 (2008)	
Average	6.6	4.2	5

Harvest and Storage to Optimize Quality and Prevent Losses of Apples

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Harvest and storage practices are largely determined by our expectations for storage life and eating quality. When we expect apples to last a long time in storage, the general rule is to pick them in an under ripe state, but we sacrifice flavor to prevent losses. Apples that are picked fully ripe have better eating quality but a short life span and should marketed soon after harvest. These are the general guidelines for varieties we currently grow. Honeycrisp, to some extent, is like other varieties, but also has traits that make it unique in its harvest and storage requirements. Its flesh remains firm even when picked nearly ripe, but it loses flavor and becomes insipid in storage if picked too late. Its extreme susceptibility to storage disorders makes it tricky to judge when to harvest and how to store it preserve quality.

Honeycrisp is prone to bitter pit. Bitter pit is a well-studied problem, and we have reasonably successful methods of preventing it. Being associated with low levels of calcium in the fruit, repeated calcium applications can prevent or reduce it. However, methods we employ to prevent soft scald can worsen bitter pit despite our best efforts at applying calcium.

Honeycrisp is also prone to the chilling disorders soft scald and soggy breakdown. Symptoms of soft scald are external and resemble bruising. Soggy breakdown occurs internally. As fruit advance in maturity, they become more likely to develop soft scald. These disorders can develop within the first two months of cold storage. Temperatures used in storing other varieties, 32 to 33 ºF, cause chilling injury in Honeycrisp. To prevent soft scald, it may be necessary to store them separately from other varieties.

Soft scald and soggy breakdown are not new problems. Historically, they caused losses in susceptible varieties as the apple industry began to use cold storage in place of common storage. In the early 1900's, storage temperatures above 32 ºF and rapid cooling were the only solutions recommended when it first became a problem. Many of the highly susceptible varieties are no longer cultivated, and this susceptibility to chilling injury may be the reason. Today many of us are increasing production of Honeycrisp, so a method of preventing its postharvest disorders is becoming increasingly important.

Currently, harvest at early maturity, before a starch index of 5.0, storage at temperatures above of 36 ºF, or delayed cooling are recommendations for minimizing losses. In early studies, researchers discovered that delayed cooling, holding fruit at about 50 ºF for several days, increased soft scald and soggy breakdown. Decades later, this technique was used by researchers as way to induce the disorder in Honeycrisp. Seven to ten days of delayed cooling had the opposite effect when it was first tested on Honeycrisp. Unfortunately, delayed cooling and other methods have not always prevented soft scald, and some people have lost apples in to soft scald, soggy breakdown and bitter pit.

In research trials at the University of Maine, we have had good luck with delayed cooling when we did the same thing year after year. We harvested fruit at the same maturity each year.

For the delayed cooling treatment, we held fruit in the same location at the same temperature and then put them in the same cold storage room at the same temperature each year. The only thing that changed from year to year was the duration of the delayed cooling needed to prevent soft scald. When soft scald was severe, seven days was needed. In years with mild severity, shorter durations were effective.

Delayed cooling has not been effective in some Ontario studies, and in one instance has actually increased chilling injury. Why it works for some and not for others still unknown. One of the factors that differed in Ontario was the temperature during delayed cooling. In my studies, delayed cooling occurred at a temp of 60 to 68 ºF, but in Ontario, at temperatures of 50 ºF. A recent study in Nova Scotia has shown that delayed cooling is more effective if the temperature is above 70 ºF. At this time, it is not certain that temperature variation was the cause of failures, but this should be tested to a greater extent.

Maturity at harvest is another factor that varies between research labs. In 2008, we tested delayed cooling with different harvest dates to see if it contributed to the failure of delayed cooling. We harvested fruit from two different farms at the beginning of harvest period and again a week or two later, when fruit were nearly ripe. The delayed cooling and storage conditions were the same as in previous years. Fruit are less susceptible with an earlier harvest, so soft scald was not severe, but more than expected. Delayed cooling did not prevent soft scald with the first harvest. With the second harvest, it prevented soft scald in fruit from one farm. Soft scald was very low at the second farm. Soggy breakdown was not as prevalent as soft scald, but delayed cooling worsened it with the first harvest in fruit from both farms and with the second harvest at one farm. Delayed cooling was ineffective with fruit picked at the early stage of maturity. In this year, fruit maturity interfered with the use of delayed cooling to prevent soft scald.

Delayed cooling is an unpredictable technique when implemented under many different conditions such as harvest dates, and orchard factors or storage facilities, so it should be tested on small lots of fruit under individual conditions in a number of years before being implemented on a large scale.

TIPS FOR TUNNELS OF ALL TYPES

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Tunnel production is booming, for a number of reasons: consumer demand for local products, enhanced crop yield and quality, season extension, and fast payback. Tunnels can be as simple as some piping stuck in the ground and covered with a single layer of plastic, often called a low tunnel or field house, to durable structures with many features found in a greenhouse, except a permanent cover or foundation. In the middle are so-called high tunnels that have Quonset or gothic shaped frames, use passive ventilation, drip irrigation, and may or may not have heating or electrical systems. Tunnels may also be gutter-connected or have multi-bay structures.

Whatever you call them and whatever their size and sophistication it takes good management to make the most of these structures. I'm not a tunnel or greenhouse expert, but I've seen enough problems during farm visits to make up a list of things for tunnel growers to consider.

Layout for the future. If you're new to tunnels think long and hard about where you put that first one because it may not be your last. Many growers I know started with one or two houses and now have more than they ever imagined. In hindsight many would have sited their tunnels differently, to better accommodate materials handling, farm traffic, snow removal, and/or multi-house house heating systems.

Plan for wet conditions. Consider the worst-case surface water situation when you set up a tunnel, especially if you'll be growing crops in the ground. In rainy years many farms struggle with excess water flowing into tunnels because perimeter drainage is insufficient. That can cause delayed planting, slow growth due to cold soil, and root rots. Growers doing winter production should keep in mind that water flowing under a tunnel can remove heat from the ground. Some farms don't have water problems inside the tunnel, but outside, the driveways and walkways were not designed to deal with high traffic in the early spring when the ground is really wet. Plan ahead for effective water diversion to prevent mud, ruts, and soil erosion.

Err on the side of strength. There's a time and a place for low-cost, less substantial growing structures. Typically, this is early in the season for temporary protection of relatively fast crops like lettuce. Relatively flimsy field houses can speed production and be very profitable, at very low cost to construct. However, for longer-season crops grown in structures that will remain in place for some time, stronger is better. The tunnel should be designed to withstand the maximum snow load and highest winds in your area. Don't skimp on the quality of steel pipe, the spacing of hoops or the extra structural features such as purloins and cross-braces that provide strength and stability. Consider anchoring the corner posts with concrete.

Change the cover. Greenhouse films last longer than regular construction plastic since they contain additives that make them resistant to ultraviolet degradation. But most greenhouse covers are only designed to last three to four growing seasons. After that, the amount of light under the cover that can be used by plants (photosynthetically active radiation) may decline significantly. Some of this loss is due to changes in the plastic that reduce transmission of certain light wavelengths, but a lot is due to accumulation of soil particles, mold, scratches, and other

blemishes that collect on the plastic over time, both inside and out. Pushing the lifespan of your greenhouse cover may be penny-wise and pound-foolish if it reduces crop growth or quality.

Know your growing media. Commercial peat-based growing mixes that contain conventional fertilizers typically provide very consistent performance. It's still a good idea to ask suppliers for the nutrient analysis of a mix, so you can keep track of what works, or doesn't, for specific crops. In the case of organic growing mixes, which contain compost and natural fertilizers, it's trickier to get consistency from batch to batch. I suggest that growers not only ask their supplier for the analysis, but also have a saturated media test done well in advance of planting. That gives you a record of mix characteristics from year to year, and allows you to make adjustments if needed. Most land grant university testing labs offer this as a 'greenhouse soil' or 'potting soil' test.

Know your water. Many university testing labs offer a greenhouse water test, which includes pH as well as alkalinity (dissolved carbonates and bicarbonates). To maintain proper pH (and thus nutrient availability) in your growing media, you need to avoid pH problems with your water. If the pH is too high, you can add some type of acid, but it takes more acid to decrease the pH of water with high alkalinity. Water can also contain excess soluble salts, which harm roots and can lead to nutrient deficiencies. High sodium is another possible problem. Annual water testing is an inexpensive management tool to help optimize crop nutrition.

Be vigilant for pests. Growers keep an eye out for pests as they work in their tunnels, but a more systematic approach is to have a scouting form and a person assigned to fill it out on a weekly basis. That makes sure all tunnels and crops are examined closely and frequently, increasing the chances of catching insect or disease problems early, when they're easier to control. Another good tool is a low-cost hand lens to aid in the observation of small problems, before they become big ones. Hang one of these up in each greenhouse. Placing sticky yellow cards throughout the greenhouse is another low cost way to stay ahead of potential insect pests.

Natural ventilation. Tunnels needs the right set up to maintain good ventilation naturally. Smaller, narrow houses can get away with roll-up sides as their only form of ventilation, but even these may suffer when there is little or no wind, since that's what drives sidewall ventilation. Larger houses really need both sidewall and ridge vents to assure good air movement. That way, the greenhouse is vented by both wind and thermal gradients. Small roof vents, cut into the plastic, with heat-activated openers are a low-cost alternative to a ridge vent.

Mechanical ventilation. If a tunnel has electric power, fans can be used to draw cool air in and push hot, humid air out. But fans will pull from the point of least resistance, so a nearby open door, visible cracks in the endwall, or rolled up sides will diminish or even eliminate fan effectiveness. Be sure the tunnel is set up to force a fan to pull air from the desired location, usually the other end of the tunnel. Also, use of high-quality thermostats to control the operation of fans and vent motors can reduce unnecessary operation and lower electricity costs.

Horizontal air flow. In larger tunnels, HAF may be advisable to help mix the air to maintain uniform temperature and carbon dioxide levels, as well as to reduce the incidence of foliar diseases by removing moisture from plant surfaces. Small, 1/10 to 1/15 horsepower circulating fans can provide the air movement needed. The first fan should be placed about 10 to 15 feet

from one endwall to pickup the air that is coming around the corner from the other side. Subsequent fans should be located 40 to 50 feet away to keep the air moving.

Sanitation pays. Make greenhouse cleanliness a priority in your efforts to prevent pest problems. Recommended sanitation activities include regular washing of tools, containers, and equipment that comes in contact with plants or growing media using a greenhouse disinfectant. Employees should be aware that they can carry pests from one house to another and know how to minimize that risk.

To avoid the spread of disease, hose ends should not be left lying on the floor. It's pretty easy to set up hooks to keep these hung up. Benches and other working surfaces should be disinfected in between crops and kept as free of debris as possible. Under the benches, all weeds should be removed while still small, and efforts made to avoid standing water. Trash containers in the greenhouse should be emptied daily. If any plants are discovered to have insect or disease problems they should be put in a plastic bag to minimize spread of spores of bugs and then removed from the greenhouse.

Outside the greenhouse, weeds should be removed and turf kept closely mowed to limit the habitat for pests. Compost piles, dead plants, old pots and other breeding sites for insects and disease should be located as far from the greenhouses as practical.

There are many excellent web sites with tunnel information, including UMass Extension Greenhouse Crops and Floriculture: www.umass.edu/umext/floriculture, and a northeast High Tunnel Manual at: www.uvm.edu/sustainableagriculture/hightunnels.html.

Growing Diverse Crops in Walk-in Caterpillar Tunnels

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Walk-in tunnels are inexpensive alternatives to the greenhouse-like structures that come to mind when thinking about high tunnels. For an equivalent area under cover, they cost less than a quarter of the price of a more traditional high tunnel. With respect to environmental modification, they are intermediate between traditional high tunnels and the low tunnels commonly used by vegetable growers. Due to their segmented appearance, we call these structures caterpillar tunnels. We have used them to grow vegetables, cut flowers, greens, and herbs.

The size of walk-in tunnels is variable. They range from 8' to 18' in width and cover two to four beds. Their length may be up to 300' or more, depending on the length of beds they are intended to cover and limits to the sizes of available covers. The flexible tunnel length enables us to construct a walk-in tunnel virtually anywhere on the farm because it can be sized to fit virtually any bed. The tunnels are tall enough to walk in and are accessed by ducking under the sides anywhere along their length (hence their name).

Bows for walk-in tunnels may be made from PVC, electrical conduit, or galvanized steel hoops. To erect the tunnel, the bows are either slipped over ground stakes made of rebar or tubular steel, or the bows are set directly into the ground about a foot deep. Bows are spaced six to ten feet apart, depending on the site's wind exposure. It is best not to construct the tunnel broadside to the wind, but if that is unavoidable, the tunnel will serve as an effective windbreak for crops planted on its lea side.

A ¼" rope tied from hoop to hoop is used to form a ridge purlin; the purlin is attached to heavy-duty ground stakes at both gable ends. The structure is quite "loose" when uncovered; much of the tunnel's structural integrity comes from the cover and the way it is secured to the ground. Walk-in tunnels may be covered with greenhouse plastics, heavy spun-bonded fabrics such as Typar, or shade cloth. The cover should be matched to the intended use of the structure. The less expensive Typar might be the better choice, for example, if the goal is to give a boost (or insect protection) to cool-season crops such as spring greens. Greenhouse plastic would be the better choice for an early planting of tomatoes. And shade cloth might be selected for rooting strawberry tip cuttings.

The covering is held fast by ¼" ropes that are drawn over the top of the structure (Conestoga wagon-style) and are secured to stakes or earth anchors in the ground. These ropes give the structure its segmented, caterpillar-like appearance. The edges of the plastic are left loose, but the covering should be sized so that there are at least two feet of extra material on each side. In particularly windy locations, the covering may be secured by placing rocks or small sand bags on the edges of the plastic. At the gable ends, the plastic is bunched together using rope, and the

rope is tied to a secure stake. The tunnel's dimensions should be configured to fit commonly available greenhouse films or floating row covers.

While they have many advantages, starting with their cost, walk-in tunnels are really three-season structures. The wide bow spacing that keeps them cost-effective greatly reduces their snow load capacity, so the covering should be removed before winter. However, walk-in tunnels with a bow-to-bow spacing of 4' and a width of 10' have reliably withstood snow.

Walk-in tunnels must be ventilated manually to avoid excessive temperatures. During the coldest periods of the year, sections of the sides (the cover) are propped up with short "Y" shaped props or branches cut for the purpose. When temperatures warm, the sides may be rolled up along the entire length of the tunnel. Clamps or tall "Y" props can help hold the rolled up plastic in place. The sides must be rolled down when high winds threaten.

These tunnels are highly portable. They may be erected and dismantled relatively quickly. For example, we erected two 200' long units, each built to cover three beds of lettuces, with the help of a co-worker over the course of a morning. One way to reduce the annual costs of construction and dismantling is to leave the caterpillar tunnel in place from year to year, and to develop a list of tunnel crops around which a crop rotation plan might be developed. Walk-ins are highly adaptable structures. They may be built over existing crops, or over bare ground for a later planting. They may be built in the fall, left uncovered during the winter, and then covered in the spring for an early planting. Or they may be used to cover tomatoes during the spring and summer, and then taken down and reconstructed over an existing fall spinach crop.

We have found many uses for walk-in tunnels to produce vegetables and cut flowers. We construct some of our caterpillars with metal bows spaced 10' apart, and others using PVC bows spaced 6 to 8' apart. At any given time in the growing season, we might have as many as 10 or 15 walk-in tunnels on our farm, with the typical tunnel 200' long. Most are covered in 6 mil greenhouse plastic. Other walk-ins are skinned in 3 mil plastic or Typar. Caterpillars have become so important on our farm because they are easy to construct and cover, and are inexpensive, while providing many of the benefits of a multi-bay structure like a Haygrove. Steel hoops and plastic film for one of our 16' x 200' tunnels cost about $1,500, about one-third the cost of a Haygrove multi-bay high tunnel. In addition, air-flow in caterpillars is excellent – better than in a many conventional high tunnels – as caterpillars open fully like a Haygrove. (But unlike a Haygrove, management of high winds in a caterpillar requires closing the sides.)

To get high quality fruit early from their first planting, we transplant zucchinis and cucumbers into walk-in tunnels on May 1. These tunnels span three beds that are six feet on center. Early harvests of both vegetables are important in meeting their goal of delivering a diversity of vegetables to our New York City-based CSA membership. Our trellised cucumbers, planted two rows per bed into black plastic (or six rows across a tunnel), start yielding a substantial harvest by the end of June. On May 1 we set tomato transplants into three beds in walk-in tunnels for first harvest in July. Using the hybrid variety 'Mountain Spring' as our early variety, we get high quality fruit that bears well over a long period of time. We also produce eggplants and bell peppers in walk-in tunnels.

We initially experimented with walk-in tunnels to protect China asters from aster yellows. This disease is transmitted by leafhoppers, and the alfalfa fields that surround Windflower Farm are leafhopper habitat. We skinned these tunnels with Typar because we thought we could get away without rolling up the sides, something that wouldn't be possible for plastic-covered tunnels which trap heat more effectively. Besides preventing aster yellows, the tunnel environment produced China asters with stems three feet long. Short-stemmed cut flowers are not desirable, and we realized that the extended stem length was a benefit that tunnels could provide other cut flowers. The absence of wind and reduction of light in the walk-in tunnels are two factors associated with longer stems.

We currently grow stock, snapdragons, godetia, larkspur, Bells of Ireland, and lisianthus in walk-in tunnels to achieve much earlier blooms and longer stems. In some ways we prefer walk-in tunnels to regular high tunnels. We are convinced that plastic film is superior as a tunnel cover to Typar except for mid-summer and early fall production. In the summer we might use Typar to protect against insects, diffuse the brightness of the sun, and shelter the flowers from wind. Though we are moving away from Typar, it does have two virtues. It costs about half as much as plastic, and its light weight makes it easy to use. I can cover a 200-foot tunnel myself. It takes a minimum of two people to install a plastic cover.

On walk-in tunnels built for fall lettuce and salad mix, we might still use Typar as the cover. We sometimes build tunnels over beds where we have already set transplants. Using a marking rod, we pound in stakes at 10' intervals and then lower hoops over the stakes. For an inside cover, we use mid-weight fabric, such as 0.9 oz. Covertan, suspended over low wire hoops. We harvest mature lettuce from these unheated tunnels as late as Thanksgiving. The environment inside is suitable for even later production, but walk-in tunnels have little capacity to bear snow.

Profitable Production in Different Types of Tunnels

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Kilpatrick Family Farm was established in 2003 by brothers Philip and Michael Kilpatrick. In 2005, we put up our first hoop house and the cucumbers and tomatoes that came out of it were the best we had ever produced. That fall we put up our first greenhouse, a 17 x 48 propagation house. The next year we put up our first high tunnel, a 30 x 96 gothic house. Since then, our operation has grown to more than 15,000 sq. ft of covered space. Currently we produce for a 130+ member CSA (40 members year round), 4 weekly Farmers' Markets (2 year round), and various wholesale accounts, all on 8 acres of rotated land.

There are several types of tunnels we use to produce our vegetables: Mini tunnels, hoop houses, our transplant house, and our high tunnels. All have their purpose and function, and fit very well into all different sizes of farms.

Our mini tunnels are constructed out of ½ inch metal conduit bent in a greenhouse bow shape. They are covered first with rowcover and around late November, a single sheet of greenhouse plastic is used. These are the cheapest and easiest to set up but have the most management. They are mainly used for season extension and overwintering of very hardy crops like kale, spinach and chard. The cost is under $100 for a 6' by 150' tunnel if you are reusing old greenhouse plastic and rowcover. If you have to buy all materials new, it can cost around $300 per tunnel.

Our 15' x 150' hoop houses were purchased from Rimol greenhouses. Rimol allowed us to customize the houses to our specifications to keep the costs down. Our summer tunnels are Ted Blomgren's (farmer in NY) caterpillar style, while our winter houses are more of a traditional hoop house design with only duct tape and baling twine used to hold them together. The summer design allows us to vent and water much more easily. The winter design makes for a much tighter house and also doesn't suffer as much wind damage. We will put late fall lettuce/salad mix, spinach, kale, summer peppers, basil, okra and eggplant in these houses.

Our 17' x 48' transplant house is a double poly, heated hoop house with propane bench and air heat. We use this to start all our transplants for our 8 acres of vegetables and also we raise transplants in it for spring Farmers' Market sales. We have a misting system set up on the center bench which we use to start our annual bed strawberry tips and also for midseason lettuce and other crops so we can keep them moist.

We use our high tunnels (two which are 26' x 148') as intensively as we can because they cost the most per square foot and we can achieve the greatest atmosphere control through roll up sides, heaters and end vents. The first improvement we made on these houses was to extend the sidewalls higher as the coldest areas in a house are the edges and we want to be walking there, not growing there, so needed the head-room. We also added roll-up sides as we have found the best way to achieve fewer diseases in the crop is to vent. Peak end vents are used for mid-winter

ventilation and also to get the humid peak air out. We are using two types of heat: in-ground hot water hooked to a Takagi flash water heater and oil air heat which we only use for 6 weeks in the spring to heat the air for our early tomatoes and peppers. We try to keep our soil organic matter in our high tunnels between 5-7 %. Our larger house cost us between five and six dollars per square foot.

There are 8 crops that are both stellar producers in the various houses/tunnels and also crunch the numbers and give us a high return value: spinach, mesclun, basil, cucumbers, peppers, turnips, kale and early tomatoes. Some other crops that have high value didn't make our list to grow because they didn't fit well with our system or marketing. For example, fall tomatoes don't fit well for us because at that time of year we have 35 other crops vying for space on our table. We included financial information were we could.

Spinach is one of the greens that we try to have all winter long. We accomplish this through mini tunnels and hoop houses for our leaf spinach and high tunnels for our baby spinach. We seed the leaf spinach outside until September 10th, and then the house is place over it in early to mid November. The spinach in the mini tunnels is planned for harvesting until Christmas, and then when the ground thaws in mid-March, we can harvest it again. The spinach in the hoop house will be harvested for the 8-10 weeks that we can't get into the mini tunnels because of temps and snow. We prefer Space or Renegade varieties for green spinach in this winter set up. Our baby spinach is seeded up till October 10th in our high tunnels. We'll use either of the above varieties for green and the Bordeaux for red or Christmas spinach. Spinach grosses around $300,000 an acre for our winter systems.

Mesclun is grown in our high tunnels also. Unlike our salad mix, we only grow winter mesclun, as the summer markets already have an abundance of good quality mesclun. We seed with our 6-row seeder from Johnny's; after lubricating all the friction points with silicon spray, it is a tool we really like. We feel this seeder gives a better stand and smoother bed. For Arugula, we seed every other row; for all other crops, we seed every row and aim for around 12-18 seeds per foot. We don't look so much for winter hardiness in our mesclun but more re-growth speed and interesting leaf shape. We try to seed every 10 days starting October first and end up with a really big planting the end of October for our January and February sales as growth slows way down then. We will start replanting the end of January, planting every 10-14 days.

Basil is a very easy crop that we usually grow along the edges or just fit in where we can, as the demand is not great. We transplant 6 week old transplants into the tunnel at a 12" x 12" spacing in the late spring, and basically just come back and harvest them. One thing we learned is that you are harvesting the leaves and therefore it wants lots of nitrogen. Basil can gross around $250,000 per acre when extrapolated out.

Another crop we have specialized in for the high tunnel is early season cucumbers. We plant them when we plant our early season tomatoes along the sides of the greenhouse for early season (May) cash flow. These are grown on a raised, ground cloth covered bed. We use double drip tape as they love water. They are trellised up with hortanova fencing, and kept in the greenhouse until end of June when we replant the area with mid season basil. Although this crop only grosses $160,000 per acre we feel it is worth growing as a loss- leader.

Peppers are a big greenhouse crop for us. Although we have tried numerous varieties, we have found that the two that do really well for us are Carmen and Flavorburst, a red Italian and yellow bell, respectively. We plan on putting the transplants in the high tunnel April first, stake them May 1st and start harvesting Red peppers mid- July. The hoop house peppers we plan on putting out mid May or after all chance of frost is past in the house. The quality of these peppers is amazing, no sunscald and rot. Staking is key, as these plants will have up to 15 peppers on them each when in full production. Peppers net around 230,000 per acre after all labor and production costs are subtracted.

We do Hakurei turnips in the hoop house in the spring. Planted 4-5 seeds per cell in 200-cell speedling trays, they are transplanted out on 8" x 8" spacing. The turnips are ready in about 5-7 weeks (by mid May) and although they don't bring in a high value per acre, they are a welcome addition in the early spring as something different than all the winter and spring greens customers have seen week after week.

Kale is direct seeded in our mini tunnels around August 1st or planted into the hoop houses at the same time as transplants in 2 rows 28" apart in our standard 6' bed; the plastic coverings are then put on around late November. Our favorite kale varieties are Starbor, Redbor, and Red Russian. We will harvest all winter from these houses, planning our harvests on a sunny day to take advantage of the sun thawing the tunnel. With a value of about $90,000 per acre, the kale more than pays for itself in these tunnels.

Cherry tomatoes are another crop we really like in the high tunnel. We plant them 2' apart in a single row on a raised bed covered with ground cloth. The plants are trellised up and pruned to 2 leaders like our regular greenhouse tomatoes. This way we don't have to look for the fruit among a lot of foliage. We will get clusters of up to 60 fruits when pruned this way. Our favorite variety is Favorita, although we will also do some rainbow cherries this way also. This crop grosses us around $380,000 per acre.

Although we have uses for all of our tunnels, our favorites are the high tunnels. Over the years, we seemed to have upgraded every year. First we started with the simple hoop houses, then the high tunnels, and now fully automated tunnels. As our farm gets larger, it comes down to time versus money and not having to think about ventilation or watering is HUGE. Our point is, although you may only spend several thousand dollars on a hoop house, it is well worth spending twenty-five thousand on a high tunnel that you don't have to babysit all the time.

Economics and Marketing of Winter High Tunnel Production

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Now that we know it is possible, with the assistance of some protected structures, to harvest food year-round in most northern climates it is important to ask ourselves just why we would do that. By this point a lot of the arguments for why we should produce year-round in Northern climates are fairly established, but they are worth revisiting to form a background for what we are going to talk about. Some of the main reasons, though clearly not an all-inclusive list, from the farmer perspective are the potential for increased sales and subsequent increased farm income, year-round contact with customers, and additional year-round activity on the farm. That being said, we need to make sure that the farm is in fact making money from the increased sales and that the farm can pay-off the investment in the high tunnel structure(s). We also need to make sure that we realize that farming year-round is hard work and that the winter "down-time" on a northern farm can be important for our health and longevity.

Marketing Options

There are similar marketing outlets to the traditional spring through fall growing season, and similarly to that time period, there are challenges and opportunities with each. Extending farmers markets to function during longer periods of the year is a natural fit for year-round production farms. The customers are already in a habit of coming to a specific place at a specific time and by extending the time the market runs the customers tend to continue to come as well. Considerations for year-round markets should include an indoor space (although some markets do function year-round in outdoor venues), close proximity to the "in-season" location if that location is outdoors, and enough vendors to ensure that there will be a variety of products available for consumers.

CSA is another marketing outlet that can continue your-round. Some farmers who are operating year-round CSAs have stated that they either offer weekly or bi-monthly distributions. Most are also supplementing the produce from their high tunnel(s) with either storage crops such as onions, garlic, potatoes, winter squash, etc. that are coming out of cold storage and/or value-added products such as jams or jellies, pickled or preserved vegetables, baked goods, and even alcohol in some cases.

At Ten Hens Farm we harvest everything to order. When we started selling in the winter we didn't know how much we would sell so rather than harvest a large amount, not sell it all, and have less to harvest out of the tunnel the following week(s) we decided that we would only harvest what we sold. We send an email on Sunday nights and customers place their email orders by Tuesdays at 4pm. We then harvest either Tuesday night or Wednesday mornings for pick up at our farm on Wednesdays from 5-7pm. This has worked well for us, especially as we are both working full-time, off-farm jobs.

Restaurants and other institutional sales such as schools, hospitals, etc. are also an option.

Pricing

Pricing for winter production can be a challenge as it is difficult to compare to field production when nothing is growing in the field. There are a number of ways to approach pricing for winter growing high tunnel produce.

The first would be to know the cost of production, including a cost for the high tunnel structure over time, and to price a certain percentage above the cost of production. For example, if it cost $1 to produce a head of lettuce, $2/head may be a reasonable price.
Another option would be to consider how much the customers will pay based on your market/marketing option(s). Customers at one location may not necessarily pay the same as customers at another location. At a minimum, I think that the price for winter production should be at least 50% higher than what you would sell the same product for out of the field "in-season."

Another approach would be to check at the local grocery store for the same products. If they are carried there and are shipped in from a distant location that has weather more conducive to outdoor growing, then that can be used as a minimum price for your products. Local high tunnel produce is going to be much fresher than what is available in the store and that should be reflected in the selling price. A premium product should have a premium price.

A different approach to pricing that we have used and are developing more on our farm is to decide how much we want to make from the hoophouse on a whole over a 12-month period. We have 20 beds (~100 sqft each) that run the short distance across the tunnel. If we pick the gross sales number that we want to meet for the year and divide that by 20 then we know how much we need to make from each bed over the course of the year. We also know that we will have approximately four crops/bed/year. So, if we take the gross sales per bed and divide that by the number of crops we can determine how much we want to make/crop. If we have a good idea of the yield per area/crop then we can use that to set the price per unit. For example, if we want to gross $20,000 in our high tunnel and we have 20 beds, then we know we need to make $1000/bed/year. If we have four crops/bed then we would need to make $250/crop. If we can fit 100 heads of lettuce in one bed then we would need to sell them at $2.50/head to gross the $250 for that crop. We know that there are some crops that will not make that much but that our customers like to purchase (i.e. radishes in our case). But we also know that crops like baby salad mix and tomatoes make more than that $250/bed. We can grow some of the crops that make less than the $250, we just do not want to grow too many of them. This has worked out fairly well so far and as we are able to spend more time and energy in our tunnel to refine what we are growing and how we are growing it I think the $20,000 gross for about 2000 sqft of production space is possible.

Plastics on Tunnels for Different Seasons

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Polyethylene plastic has many properties that make it useful as a covering for high tunnels. Its low cost, large sheet size, ease of attachment and good light transmission are properties that have helped to expand the use of tunnels as a means of extending the growing season.

Most polyethylene film is manufactured as a coextrusion of several layers. This allows manufacturers to include additives that enhance its usefulness. The following summary may help you in selecting the right film for your crops.

Life – the life of polyethylene films is limited due to degradation processes induced by sunlight and heat. Co-poly is a low-cost material that is good for one season. This is a better choice on tunnels than construction grade material that has less strength. Greenhouse grade poly is warranted for 4 years or more and costs about double that of co-poly. It contains an ultra-violet (UV) stabilizer that reduces degradation. If additional strength is needed, such as windy locations, a nylon scrim-reinforced material is available from several manufacturers.

Thickness – one-year co-poly film for use on tunnels is available in 3, 4 and 6 mil thickness. Three or four mil film is common for one year use on narrow tunnels. Greenhouse grade material, only available in 6 mil thickness is best for multi-year application.

Condensate control (AC) – also referred to as anti-drip is a wetting agent that reduces surface tension allowing condensation to flow rather than form droplets. This can be sprayed on the film or incorporated in the center layer. Condensation droplets reduce light transmission and can lead to disease problems where they drip onto plants. An anti-fogging additive may be included to prevent early morning and late afternoon fog formation.

Reduced nighttime heat loss (IR) – his is additive that traps the inside radiant heat from escaping. In heated greenhouses, the savings have been measured to total from 10 – 20% depending on whether the sky is cloudy or clear. Research at several universities has been inconclusive as to whether the IR additive slows warming of the tunnel in the morning. In research at Penn State University during October, the tunnels warmed up significantly faster in the morning than outdoor ambient but there was no difference between standard poly and IR poly. During the day, the IR film did not increase the overheating problem as compared to standard clear poly. At night, the tunnels with the IR film retained heat better than the standard poly by 2 - 3ºF but with both types the tunnel was cooler than outdoor ambient. In double layer poly installations, the IR film is always placed as the inner layer to retain nighttime heat.

In the Penn State trials, yield of colored bell peppers was higher with standard poly. On sunflower, there were no significant differences.

Reduced daytime heat gain – in areas with strong sunlight, blocking part of the infrared spectrum can lower inside temperature up to 10ºF. Selective reflective pigments are added to the outside layer. Along with greater diffusion of the light, the advantages include lower cooling costs, greater worker comfort, less irrigation needed, reduced plant stress and improved fruit taste.

Ultra-violet (UV) – bees need UV to navigate. If you are using bees to pollinate plants in the tunnel, purchasing a film that allows some of the UV part of the light energy spectrum to pass through may be important. Otherwise, UV blocking film will reduce whiteflies, thrips, aphids and other insects. It can also control some fungal diseases.

Controlled diffusion – light diffusion is another property that has recently been added by manufacturers. This increases the amount of diffused light that reaches the plants, reducing scorching and increasing light to lower leaves. It is especially important with crops such as tomatoes, cucumbers and peppers. Research has shown that diffused light also reduces fungus spore development and insect propagation.

Light transmission – photosynthetically active radiation (PAR) light transmission varies with the type of additive in the film. Typical values are UV stabilized film – 88 - 91%, IR-AC film – 82 - 87%, IR-AC with diffusion – 77 - 88%. Dust, smog and plastic deterioration can also reduce light transmission. A "rule of thumb" is one percent increase in light equals one percent increase in plant growth. Some growers replace the plastic every year just to get a few percent higher light levels if growing plants during the short days of winter. Some manufacturers make an anti-static film that repels dust, dirt and smog.

Photoselective films – these absorb or reflect specific wavelengths of light. They can enhance plant growth, suppress insects and diseases and affect flower development. Red films such as Dupont IR and Smartlite Red film reduce PAR light and create a shading effect. They have also been shown to improve rose yield and quality.

Single or double layer poly – for normal operation, a single layer is adequate. If you are growing early in the spring or late into the fall and are providing supplemental heat, an inflated double layer may be desirable. It reduces heat loss at night by about 40%. It also reduces the stress at the attachments and the rippling of the plastic on a windy day. Air inflation at ¼" water static pressure is best.

Plastic failure – early failure of poly can be attributed to stress as noted above, abrasion on rough surfaces and sharp edges or heat build up in that area of rafters, purlins and extrusions. Contact with chemicals from pesticides or pressure treated lumber can also affect the life of the plastic. Poly that is left on the tunnel during the winter is subject to cuts from blowing ice especially if there are multiple tunnels adjacent to each other. A scrim reinforce poly may be desirable in this situation.

Integrated Management of Insect Pests in New England (Highbush) Blueberries

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An integrated approach really pays off when dealing with highbush blueberry pests: 1) monitor for pests, signs, or symptoms 2) use preventative measures when available 3) apply controls only if there is a need. Blueberry growers who "manage" insects by spraying alone will often spray more than necessary, and sometimes get injury they didn't expect. Using all three components above is much more effective, and reduces spraying, too. Using traps also gives a public relations boost to PYO growers; customers see the traps, and get a favorable impression.

Cranberry fruitworm is the earliest of the common highbush blueberry insects in New England. The tiny moths fly during the bloom period, and lay eggs at the calyx end of the tiny fruit. The small green caterpillar bores into the green fruit and fills them with tiny brown droppings. Each caterpillar can damage several fruit. Damaged fruit blue up prematurely, and get webbed together with a bit of silk. Wild or minimally managed plants seem to be more heavily hit. That may be because they offer lots of places to safely overwinter. Insecticides applied right after bloom (often twice) are effective to control this pest. The same statement applies to cherry fruitworm. Some growers have few enough problems that they don't need to spray for either species of fruitworm. The New England Small Fruit Pest Management Guide lists the insecticide options, which keep changing. **Cherry fruitworm** is very similar in its biology to cranberry fruitworm. We manage it the same way. The caterpillar is pinkish-red with a brown head. Timing and materials are nearly identical to those for cranberry fruitworm. **Preventive/suppressive methods** for both species: destroy nearby unmanaged blueberries, prune properly each year, and keep weeds under control.

Blueberry maggot is our most serious insect pest. It has one generation per year, and overwinters as a pupa in the soil. The flies are present from very late June through August, sometimes longer. Female flies lay eggs just under the skin of ripe blueberries. The eggs hatch into maggots that consume the flesh, turning the fruit mushy.

BM numbers vary greatly from site to site. Occasionally, they build up to very high levels. I recommend all blueberry growers should use traps to monitor this pest. They are easy to use, and help you learn if and when you should spray. The best traps are red sticky spheres, and there are also green spheres and yellow sticky rectangles. Some growers try to make their own. I advise against that, unless you know precisely what pigments are used in the commercial traps. Matching the color so that it looks right to us isn't good enough --- insects have different color perception from us. It is important that the traps look correct <u>to them</u>! Stick with commercially available ones. If you buy the yellow rectangle traps, look for "baited Trece yellow rectangles". If you go for the red spheres, use unbaited ones --- baited ones are designed for apple maggot. Be sure you purchase some tangletrap or bird tanglefoot to spread onto the sphere traps --- they are shipped in non-sticky condition. Yellow rectangles come pre-stickied.

Traps go up just before the first of your fruit start to turn blue. I look for a "gap" in a bush, so the trap is in a spot where wind is reduced, within the canopy, well visible, and with fruit fairly close by. Spheres can be heavy (especially the wooden ones), so sometimes I use overhead wires or tall stakes to hold them. If you do that, don't suspend them high over the bush. They should hang within a bush, but visible. Yellow cardboard rectangles are lighter, and tend to

blow in the wind (onto your fruit). It is easy to see the flies against the yellow surface. They last only a couple of weeks before needing replacement. The spheres last all season, and can be used many seasons, if properly stored & handled. This year we worked with USDA entomologists Tracey Leskey and Starker Wright to test the apple maggot "curve ball" traps as a control for blueberry maggot. The first data are a bit disappointing, but we may do more.

You can buy traps from Great Lakes IPM www.greatlakesipm.com 800-235-0285 (Vestaburg, Michigan) or Gempler's www.gemplers.com 800-382-8473 (Madison, Wisc.)

Check traps weekly for the adults, and write down the data. Keeping records helps for decision-making in future years. I squash the flies as I count. You recognize blueberry maggot flies by the small white dot on their backs, almost between the wings, plus the particular pattern of black bands on the wings. They are small flies, about 4mm long (1/6 inch). A magnifying glass is helpful. When the flies are present, you know they can be attacking your fruit. There isn't a particular number of flies that triggers action. You be the judge of that.

There are several chemical insecticides registered, and the current New England Small Fruit Pest Management Guide lists them. The only "new" pesticide I could find for this pest was Assail. For organic growers, Aza-direct and GR-120 Naturalyte Fruit Fly Bait are registered. Surround is listed for "suppression" of BM, so to me this implies that it isn't too effective.

Yellow-necked caterpillar sometimes is a problem. It has one generation per year, and is usually found in August or September. The species is gregarious, so you rarely find just one. In addition to chemicals, *Bacillus thuringiensis* sprays (caterpillar strains) work well. Some growers ignore them, and if customers ask, point it out as "proof " that they don't spray much!

Fall webworm seems to be increasing in blueberry plantings. The insect has just one generation per year, but egg-laying isn't very synchronous. Some webs appear in early August, and new ones appear as late as mid-September. Plantings bordered by woods have more of them than others. In NH, southern Maine and Massachusetts, I find very few webs near the coast. Some growers ignore them, as with yellow-necked caterpillars. If you'd rather control them, there are chemical pesticides plus caterpillar strains of *Bacillus thuringiensis.* The trick to controlling them is to do so when the webs (and caterpillars inside) are fairly small, use a wetting agent, and a coarse spray. That helps penetrate the web.

Adults of **blueberry stem borer** appear in mid to late June, and lay eggs just under the bark of a branch. Then the beetles chew a messy girdle, so that the branch tip browns and dies. The girdle isn't as neat as that of its close relative, raspberry cane borer. The egg hatches and the grub then bores down the inside of the branch. The insect takes two or three years to complete its development. Plantings that are infrequently (or never) pruned suffer the greatest injury, and pruning shears are the best control device, not insecticides. One clue to infestation is light, fibrous pellets of frass at the base of the bush.

Preventative and Suppressive Measures:

Eliminate nearby unmanaged blueberries, keep up with pruning, and eliminate weeds from your plantings. All will help with insect problems!

Integrated Blueberry Disease Management

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This discussion will concern diseases of highbush blueberry (*Vaccinium corymbosi*), although some of these pathogens can also infect lowbush blueberry (*V. angustifolium* and *V. myrtilloides*). Fungal diseases will be exclusively discussed, including mummy berry, Botrytis blight, Phomopsis twig blight, Fusicoccum (Godronia) canker, anthracnose, Phytophthora root rot, witches' broom and black shadow. Important virus diseases (scorch, shock and possibly red ringspot) will be discussed by Dr. Peter Oudemans in the afternoon session.

Mummy berry: This is the most important disease in terms of its widespread occurrence in New England and because it has the potential of causing the most economic crop loss. It occurs sporadically and is at its highest incidence during cool, wet springs. There are two phases of the disease, a leaf and stem blight and a flower blight which results in the formation of the mummified berries. The disease is caused by the fungus *Monilinia vaccinii-corymbosi*. The fungus overwinters in the fallen mummies on the ground as mycelium. When temperatures are favorable, an apothecium (the perfect or sexual stage) forms and ascospores are released. These spores are the primary inoculum of the fungus and these infect the emerging leaves and young shoots, resulting in blighted tissue. Eventually, the fungus sporulates on this tissue, producing conidia (the imperfect or asexual stage). These conidia infect the flowers, but the symptoms are not apparent until the berries begin to ripen. Infected berries are initially tan or pink and as they harden and shrivel, they eventually turn gray and fall to the ground. The majority of the mummy consists of fungus tissue. Management of the disease consists of several strategies: resistant or less susceptible cultivars; removal of the mummies from the field by raking them or covering them with 1-2 inches of soil or mulch to prevent spore release; application of urea to the exposed mummies in the spring; pruning canes to allow for good air circulation; application of fungicides during the period between green tip and the end of bloom; and protection of tissue after frost events.

Botrytis blight: This is normally uncommon in blueberry fields, but there are occasional outbreaks of the disease when the weather is cool and rainy during bloom when it is difficult to apply protectant fungicides. The fungus *Botrytis cinerea* overwinters on blueberry stems or on a variety of other plant hosts and produces conidia that infect the flowers, resulting in blossom blight. The fungus produces a second crop of conidia on the blighted flower, resulting in the 'gray mold' phase of the disease. These conidia can cause a second round of infections, resulting in further damage to the plants, or infecting other later blooming blueberry cultivars. Symptoms are usually confined to the flowers, but in severe epidemics, infected twigs are blighted and turn brown or black and later bleach tan or gray. This symptom can be confused with winter injury or scorch. Infected leaves may also show blackened areas of dead tissue. If wet weather persists into berry development, the fungus can also infect the fruit, resulting in gray mold symptoms on the berries. These conidia can infect other nearby fruit. Management of the disease consists of creating an open canopy to reduce moisture and increase fungicide penetration; pruning out

diseased canes and destroying them to remove inoculum; removing wetness duration by watering in the early morning; and application of fungicides from green tip through bloom.

Phomopsis twig blight: This disease can be found in most fields every year. Its incidence tends to be linked to stresses on the bush such as winter injury or drought injury. The fungus *Phomopsis vaccinii* overwinters in the cankered stems in the blueberry field or in neighboring cranberry beds or on lowbush blueberry in the uplands. Conidia (or possibly ascospores, although the perfect stage is very rare in nature) infect the emerging new growth in the spring into the mid-summer, resulting in blighted stems. The infection may advance downward on the stem and reach the main stem. There may be multiple infected twigs on a single bush. Entire canes may eventually be killed, as the fungus enters the vascular tissue of the stems and blocks water transport. There is a fruit rot phase of the disease, but this is not observed in New England. Management of the disease is achieved through the use of resistant cultivars; removal of infected canes or those injured by cold temperatures; avoidance of wounding the canes; irrigation to avoid drought stress; creation of a good air circulation around the bush; and application of fungicides from green tip through petal fall and as a dormant treatment in the late winter/early spring.

Fusicoccum (Godronia) canker: This canker disease is much less common than Phomopsis twig blight. It tends to be confined to the more northerly climates. The fungus *Fusicoccum putrefaciens* overwinters as mycelium on infected wood. Conidia produced from these old cankers infect newly produced tissue, resulting in blighted twigs similar to those caused by *Phomopsis*. A unique difference between the two cankers, however, is a red-maroon-brown lesion centered around a leaf scar for this disease. As the lesion enlarges, a bulls-eye pattern results. The center of this lesion dries out, turns gray, and the fungus will produce numerous black pynidia (asexual stage) on the stems. The infected twigs may suddenly wilt and die during especially hot and dry periods. This fungus can also overwinter in cranberry or lowbush blueberry stems. Disease management is achieved through the use of resistant cultivars; pruning out infected canes; and application of fungicides from green tip through the end of bloom.

Anthracnose: This disease has increased its incidence in New England during the past decade. The fungus *Colletotrichum acutatum* causes tremendous losses in New Jersey in certain growing seasons. The pathogen primarily damages fruit but may also infect twigs and leaves if environmental conditions are favorable. Symptoms may initially be observed as blossom blight, but normally symptoms are not seen until the berries mature. The fungus develops within the green ripening berry as a latent pathogen. At maturation, the blossom end of the berry becomes soft and sunken and masses of salmon-colored conidia appear on the fruit exterior. One sporulating infected berry can spread the disease very quickly to other berries in a cluster on the bush or to other berries in post-harvest containers. Losses are most serious when long periods of warm and wet weather occur during bloom and/or just prior to harvest. Management of the disease consists of planting resistant cultivars; removal of older canes that harbor the fungal inoculum; irrigation during the early morning hours to avoid long wetness periods; creation of an open canopy to provide good air circulation; fungicide applications from green tip through the first blue coloration in the berries; and refrigeration of the berries after harvest if the disease is a problem.

Phytophthora root rot: This disease normally occurs in the poorly drained areas of a field where water puddles for an extended period of time. The fungus *Phytophthora cinnamomi* is soil-borne, and infects the fine absorbing roots of the plant. The root systems will have many dead roots that are discolored or black. Above-ground symptoms include stunting, reddening or yellowing of the foliage, poor fruit production and death of the plant in some instances. The fungus overwinters as chlamydospores in the soil or in the infected plant's root system. These spores germinate in the spring and infect the fine rootlets where water is abundant. Water movement within a field can spread the pathogen to other uninfected plants. The fungus is a major pathogen of cranberry plants, and consequently, cranberry beds can be an important source of inoculum. Rhododendrons, azaleas and other Ericaceous plants in the landscape can also serve as inoculum sources. Management of the disease consists of planting in a well-drained field and improving the drainage if low spots develop; planting tolerant cultivars; preventing spread of inoculum on footwear or equipment from infested to non-infested fields; and fungicide applications in the spring and fall.

Witches' broom: This disease is more common in lowbush fields, but may occasionally be found on a single highbush plant. Affected plants have broom-like masses of swollen shoots, and no fruit will be produced on the affected canes. There may be several brooms on a single plant. The rust fungus *Pucciniastrum goeppertianum* carries out its life cycle on two hosts, blueberry and several species of fir. Spores produced on fir are spread to blueberry via wind/rain in the summer and infect the leaves and stems. It takes one year after infection for the first appearance of symptoms. Eventually the fungus in the broom will sporulate and these spores will infect fir trees, thus completing the life cycle. Brooms will continue to serve as inoculum sources for several years, if they are not removed. The disease can be avoided by removing fir trees within 1,500 feet of the field and removing infected bushes; fungicide applications do not usually warrant the expense.

Black shadow: This disease was initially described in New Jersey, but I have seen it in several blueberry fields in Massachusetts and I suspect it is present throughout New England blueberry fields. Symptoms are usually confined to 1-2 year old stems and appear as black mycelium on the surface. Affected bushes may eventually decline and suffer reduced yields. All cultivars appear to be susceptible to the fungus *Aureobasidium pullulans* (although molecular analyses indicate that the pathogen may be in another genus of fungi). Because there is a very weak relationship between disease incidence and effects on crop production, management strategies are not presently warranted.

Blueberry Weed Management

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The primary goal of weed management is to optimize yields by minimizing competition between the weeds and the crop. Weeds reduce yields by competing with the crop for water, light, and nutrients. Weeds also harbor insects and diseases and encourage vertebrate pests. Timely cultivation, wise use of herbicides, and never permitting weeds to go to seed are integral parts of a good weed management system. Many of the weeds found in these fields are difficult-to-control perennial weeds that are not common in annual crop culture. New plantings usually have fewer perennial weed problems than older plantings. Annual and biennial weeds can also exist in these fields. Fields should be scouted at least twice a year (spring and fall) to determine specific weed problems. The selection of a weed management tool should be based on specific weeds present in each field.

The most important weed management strategy is employed prior to planting that is, eliminating all perennial weeds. Fields that have been dormant or have been in pasture may have perennial weeds that at well established. Fields that have been in cultivation are less likely to have established perennial weeds in them. Common perennial weeds include common dandelion, Canada thistle, stinging nettle, field bindweed, field horsetail, goldenrod, and quackgrass. Once these perennial weeds become established or remain established in a berry field, they are very difficult to remove. The most common way to remove perennial weeds is with Roundup (glyphosate) applied in the fall prior to planting. Perennial broadleaf weeds should be treated after flowering but prior to a killing frost. Perennial grasses can be treated well into November.

Cultural weed management in blueberry plantings includes mulching, cultivation, and soil pH management. Mulching is a major weed management tool in blueberry production. Mulches that are free of weed seeds and placed thickly enough can be very effective at reducing or eliminating most annual weeds from the crop row. They are seldom effective on perennial weeds, however. Use of cultivation is difficult and often is counter productive in blueberry plantings. It destroys surface feeding roots and does not work well where mulches are used. All cultivations should be timely and shallow to minimize crop root injury, to minimize loss of soil moisture, and to avoid repositioning new weed seeds to the soil surface. The low pH soil that blueberry plantings thrive in is not a good environment for most weed species. Keeping the soil pH at the right level will help to reduce weed pressure.

The areas between the crop rows are usually maintained with a mowed cover of sod, clover, weeds, or a combination of these. This cover is used primarily for erosion control and to improve trafficability in the field.

Several herbicides are labeled for use in this crop. Herbicides can be broadcast or applied as a directed spray to the base of the crop. With a band treatment, only 1 to 2 feet on either side of the row is treated. With banding, less herbicide is needed in each acre. For example, a 3 foot band (1.5 feet on either side of the row) where rows are spaced 9 feet apart will require only on third

the amount of herbicide normally required for a broadcast treatment. Where mulches are used in combination with herbicides, use the lowest recommended herbicide rate to avoid crop injury. Herbicides registered in highbush blueberry production are listed in the current version of the New England Small Fruit Guide and are also available on line at www.umass.edu/fruitadvisor . Newer registrations for herbicides in blueberries follow:

Chateau (flumioxazin) is registered in highbush bluebery. In blueberry, it is registered for both preemergence and postemergence control of weeds. For preemergence control, apply to weed free soil at a rate of 6 to 12 oz/acre. Moisture is necessary after application to activate the herbicide. If emerged weeds are present, the residual activity of Chateau will be reduced since weed foliage will intercept some of the herbicide. A residual grass herbicide is still needed. For postemergence control of certain weed species, apply Chateau at 6 to 12 ounces per broadcast acre. For postemergence control, use a crop oil concentrate at 1% by volume or a non-ionic surfactant at ¼% by volume. For broader control of emerged weeds, check the label for tank mix applications with glyphosate or paraquat.

Rage (carfentrazone) is registered in highbush and lowbush blueberry. The label also covers currant, elderberry, gooseberry, and huckleberry. Apply at a rate of 20 to 40 ounces/acre to control emerged grass and broadleaf weeds. A non-ionic surfactant or crop oil concentrate should be used to improve the activity of Rage. See the label for rate suggestions. Rage will not provide residual control of weeds. A dormant application can be made using a directed spray to the base of the crop. Once the crop breaks dormancy, all applications must be made with a hooded sprayer to avoid crop contact. Sufficient water must be used to provide complete coverage of weed foliage to obtain control. Contact with green bark, foliage, or fruit will cause crop injury and spotting. Rage can also be used at a rate of 3 to 4 oz/acre to suppress the vegetation growing in the row middles. This application must also be made with a hooded sprayer. Do not apply more than 40 oz/acre per application. Do not apply more than 80 oz/acre per season using a hooded sprayer. The total of all applications per acre per season must not exceed 120 oz/acre. Do not apply within 14 days of harvest. See the label for tank mix suggestions with other herbicides that will provide residual weed control.

Callisto (mesotrione) is registered for use in highbush and lowbush blueberry. The label also covers lingonberry. In highbush blueberry and lingonberry, apply as a directed spray to the base of the plants prior to bloom. In lowbush blueberry, applications can only be made during the dormant year. Apply at a rate of either 3 or 6 oz/ acre. If 3 oz is used, a second application can be made no closer than 14 days apart. Use of a crop oil concentrate at 1% by volume with improve postmergence activity. Callisto will provide preemergence and postemergence control of many broadleaf weed species. See the label for a complete list.

Other options

Cultivation: A= effective on all emerged weed growth D= not effective in wet soils, not effective when mulch is used, quick regrowth of perennial weeds

Mulches: A= effective on annual weeds when applied at the right thickness D= not effective on perennial weeds, not effective when adjacent weeds drop seeds and contaminate mulch

Overall, weed management options are sufficient and effective. Using mulches and herbicides in the crop row combined with mowing in the row middles results in the most effective control of weed pressure, minimizes competition with the crop, and maximizes crop yield.

POST HARVEST HANDLING
A Grower's Perspective

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We need to start our discussion of post harvest handling of blueberries with blueberry bloom. In order to obtain high quality fruit for retail markets we need to prevent frost injury and control disease and insect damage. It is imperative the grower has perfect, premium fruit ready for harvest on the bush. Consumers purchase fresh blueberries on impulse and are prompted primarily by their perception of quality. There are two factors that can not be controlled. At harvest time growers generally have to battle environmental conditions such as high temperature which hastens ripening, and possible periods of extended rainfall which can also hasten ripening and cause splitting. Both of which will greatly reduce storage quality. On the other hand, the factors that can be control include avoiding harvest of wet blueberries, avoid harvesting fruit during peak high heat hours of the day and prompt removal of fruit from the field which avoids buildup of excessive heat within the harvested fruit.

Care of fruit during harvest is determined by the type of harvesting done. For example growers who manually harvest fruit must adhere to the following rules:

Manual Harvesting - Rules for Blueberry Pickers

1. *Keep hands clean*
2. *Pick all ripe blueberries on bush*
3. *Avoid dropping berries (discard dropped fruit)*
4. *Do not squeeze or roll fruit*
5. *Do not put trash or cull berries into the container*
6. *Never allow harvested fruit to remain in sun*

Growers who use mechanical methods should adhere to the following rules:

Mechanical Harvesting - Rules for Minimizing Damage to Fruit

1. *Harvest only dry fruit during the coolest part of the day*
2. *Minimize drop heights*
3. *Eliminate as much vibration as possible*
4. *Limit the depth of fruit in field containers to 4 or 5"*
5. *Handle and dump field containers very gently*
6. *Cool fruit as soon as possible after harvest*

Every effort should be made to keep defective fruit within the package to a minimum. The common defects are insect damage, broken skin, decay or mold, and overripe and shriveled fruit. This will aid in delivering a high quality package to the retailer and result in a satisfied consumer.

Harvested berries should be cooled as quickly as possible and the process can start in the field by placing the harvested containers of fruit in shaded areas. Prompt removal of harvested fruit to the packaging area insures that excessive field heat does not build within the harvested fruit. Fruit should be cooled to 50°F immediately upon arrival to the packaging shed.

Additional cooling to temperatures lower than 50°F may result in a condition known as sweating during packaging at ambient temperatures which results in poor package appearance.

Blueberries are packaged in either paper pulp or plastic clam shell containers. The paper pulp is generally covered with cellophane or netting. The pint are then placed in 12 pint master trays and palletized for cooling and subsequent shipping. Once packaged, the fruit should be refrigerated at a minimum of 45°F if delivery is imminent and within approximately 24 hours. A temperature of 32 to 34°F (-0.6 to 1°C) and a relative humidity of greater than 90% is recommended for extended shelf life.

Pollination Issues in Blueberry Production

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Growers can prune, fertilize, irrigate, control pests and otherwise care well for their blueberry plantations, but without proper pollination their efforts would be in vain. Highbush blueberries are capable of setting fruit on 100 percent of the flowers produced by the bushes, although 80 percent set is considered a full crop. Once set, some fruit may succumb to injury from insects, birds, diseases or environmental conditions. But, the high initial set of fruit is key to the profitability of the crop. Understanding the anatomy of blueberry flowers and the behavior of some of the pollinating agents will help the grower make good decisions that promote optimal conditions for pollination. This presentation will cover the information growers will need in order to make good pollination decisions.

The Blueberry Flower - Blueberry flowers are 'perfect' and 'complete'. That is, they have calyx, corolla, stamen and one or more pistils (complete). And they have actively functioning organs of both sexes (perfect). The male parts are the anthers and filaments, which comprise the stamen and the female parts are the stigma, style and ovary, which comprise the pistil. This means that blueberry flowers are theoretically capable of being self-fertile. However, the structure of the flowers is such that the pollen will not make contact with the stigma without active pollination by insects. Thus, pollinating insects are a must for attaining the high level of fruit-set growers expect. This is accomplished by insects visiting blueberry flowers foraging for nectar and pollen. Pollen adheres to their bodies and is carried with them as they move from flower to flower. Then when bees probe for nectar inside another flower, they brush against the stigma and unwittingly leave behind some of the pollen they are carrying.

Pollinators - There are many species of pollinating insects, both wild and domesticated. In the wild the wide variety of pollinators includes bumble bees (*Bombus* spp.), mason bees (*Osmia* spp.), leafcutting bees (*Megachile* spp.), and feral, or wild, honey bees (*Apis mellifera*). Another species of wild bees can be found foraging in blueberry plantings, but does little to promote pollination is carpenter bees (*Xylocopa* spp.). Commercially, there are two types of pollinator available, domesticated honey bees (*A. mellifera*) and domesticated bumble bees (*Bombus impatiens*). Other pollinators (e.g., mason and leafcutter bees) are also commercially available, but are less common.

Domesticated honey bees have, by far, been the most important pollinators of highbush blueberries for decades. However, with the decline in availability of commercial hives following the epidemic of parasitic mite infestations and disease problems, growers are turning to conservation of wild pollinators and alternative domesticated pollinators.

Pollination Needs - Whether or not a grower will need to import domesticated pollinators into a blueberry planting as well as the number of colonies needed, will depend on several factors:

1) the number of surviving wild pollinators in the area of the planting in a given year
2) the number of other plants that compete for the attention of the pollinating insects during the bloom period
3) flower-set in a given year
4) attractiveness of individual cultivars to the pollinators.

5) the weather conditions during the bloom period

It has long been observed that bees work different cultivars preferentially. That is, they like some cultivars more than others. Some suggest that this is because some cultivars produce more nectar or pollen. Others have observed differences in the size or shape of the corollas in different cultivars making it easier or harder for pollinators to reach the nectaries of the flowers. Yet others have observed the tendency in some cultivars (e.g., 'Stanley' and 'Bluecrop') to have the corollas separate slightly from the ovaries allowing bees to gain access to the nectar from the base of the corolla, bypassing the pollen altogether.

Blueberry flowers are open and receptive to pollen for 5-8 days. However, research shows that if a blueberry flower is not pollinated within 2-3 days after opening, it is unlikely to set fruit. So, another benefit of high numbers of pollinators is that the most attractive flowers are pollinated first and drop off, thus forcing the pollinators to work the less attractive flowers and increasing the overall level of pollination.

Cross Pollination - Blueberry flowers, while 'perfect' and 'complete' as described above, frequently have pollen that is self-sterile. Many cultivars are parthenocarpic, or capable of forming fruit without pollination, However, parthenocarpic fruit is distinctly smaller and ripens later with less flavor. The use of giberellic acid can increase fruit size of parthenocarpic fruit, but is reported by growers to be unreliable. It is, therefore, very important for the formation of fully sized, ripe, flavorful fruit, that cultivars be cross–pollinated with pollen from other cultivars. For this reason blueberries should not be planted in large uniform block of one cultivar, but broken up into smaller sections with a mix of 2 or more cultivars.

How Many Pollinators Are Enough? - How can a grower tell if pollinators (domestic or wild) are doing an adequate job? One method is to assess the "buzz" level in the field. During sunny warm periods of the day during bloom (>60˚F), there should be an audible "buzz" in the field. Another rule of thumb is that 4 - 8 bees should be foraging on each blueberry plant at any one time during the warmest part of the day during bloom. When wild pollinators are not abundant, domesticated honeybees can be introduced.

Once pollinated, the corolla separates from the ovary of the blossom and is easily knocked off the plant. One indication of good pollination is a carpet of white corollas lying beneath the blueberry bush. If in doubt, a grower may gently shake a few branches and observe whether or not the corollas fall to the ground. Brown corollas on the plant or on the ground usually indicate frost damage.

Protecting Your Pollinators - Pollinating insects have a host of natural enemies. Hives are an irresistible attraction for some mammals, especially bear. Electric fencing is often required to protect honey bee hives from predation by mammals who go after both brood and honey. Nesting shelters for solitary bees may need protection from mammals (see Figure 3). There are also some parasitic insects and colonies should be closely monitored for infestations. More importantly though, is conserving pollinators, both wild and domestic, by taking great care with the use of pesticides in and around the blueberry planting, especially during bloom. Always protect the water supply from contact with pesticides. If contaminated, replace the water with water from a clean source. Insecticides should never be used during the bloom period unless absolutely necessary to avoid major losses. If needed, insecticide sprays should always be made

at night when pollinators are not active and materials should be chosen that have the lowest bee toxicity. Charts with this information are usually found in spray guides and recommendations. Always have hives moved out of the planting before resuming the use of insecticides.

Harvest Efficiency

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Growing a wide variety of crops to supply a CSA is difficult and can drastically decrease your harvest efficiency. Diversified farms are at danger of losing valuable time transitioning from crop to crop as each one has slightly different needs. There are greater demands on the crew to have a diverse set of skills for harvesting each different crop. While we will never be as efficient as farms that grow only a few different crops, over the years we have worked out systems that allow us to make the best use of our time. We hope our systems can help farmers who are increasing their crop diversity continue to maintain their harvest efficiency.

Planning: All of our fields are divided into 50 ft sections (eight 6ft beds) with a 12 ft. grass driving lane in between. This allows us to access the field in all weather conditions without creating compaction in the crop production areas while we also never have to carry a harvest crate more than 25 ft. Carrying produce long distances is hard on the body and increases the time it takes to harvest.

Our crop rotation is also planned according to harvesting. We plant the crops that are harvested at the same time in the same field or section. For instance we plant all of the leafy greens together: head lettuce, kales, leaf lettuce, broccoli rabe or all of our bunching roots together: radishes, baby beets, baby carrots, salad turnips. That way we don't have to drive all over the farm to get the harvest. We lose the most time by switching tasks, if the crew can just stand up and walk a few steps to the next crop our harvest time is decreased.

By grouping different families together in the same section we have to make sure we have a wide crop rotation. We still want to make sure we do not follow too closely with crops of the same family. A wide variety of cover crops are mixed into our rotation. We try to have half of our vegetable acreage in cover crops each season. The grasses and legumes break up the disease cycle and weed cycle in our vegetable fields (although we do have to be careful, some legume cover crops host the same diseases as our vegetable crops). Keeping careful records of our crop planting is important to make sure we don't follow too closely with the same family in the same bed.

Pest control: Another way to increase harvest efficiency is to have healthy, weed and pest-free crops. We use compost and a composted dried chicken manure product as a side dress for fertility. Another reason we include many legumes in our crop rotation is to increase our soil fertility without additional expensive inputs. Bed forming and stale seed bedding are important tools to create weed-free soil for our vegetable crops, especially for the direct seeded crops. We form raised beds two to three weeks before we plant a crop. Then we stale seed bed three to four times before we seed or plant the crop. Pest control options for the organic grower have also improved. We use floating row cover, scouting, beneficial insects, Entrust, and Dipel (Bt) for pest control.

Communication, Standards and Facilities: Once the crops are ready to harvest we make sure to have a system for clear communication and expectations with the harvest crew. We created a

harvest manual that has a sheet for each crop we grow. (You can find the harvest manual on our website at www.roxburyfarm.com) This sheet describes how to identify when a crop is ready to harvest, the harvesting technique, the tools needed, how to pack in the field, washing and storing techniques, and how to pack in the barn. We also train the crew on each crop but the harvest manual provides them a written description and reference if they forget something. The manual states the standards for how many boxes, heads, etc. we expect an average harvester to harvest in an hour. This gives the crew an idea of how long something should take and if it is taking much longer we can work on techniques to increase the efficiency.

We create a clear harvest schedule and keep to it each day. All of our harvesting is done by 1:00 pm each day. We don't want to harvest crops in the afternoon sun and heat. The crew has a written harvest list so that they can easily move from one crop to another. They know how many boxes/buckets to take to the field and what tools they will need. This reduces trips back to the barn. The list states how many bunches, pounds, or heads to put in each box. We have a same number in each box so that we can easily keep track of how many more bunches to make.

Two people manage the harvesting. This reduces tension among the crew when there is confusion, they can go to the harvest managers with questions. The harvest managers also make sure the crops in the boxes are up to standards. Below standard crops in the boxes reduces the washing and packing efficiency in the barn. The different tasks are divided up among the crew members and they keep to these tasks each day. For instance we have a crew that harvests the sweet corn each day and at the same time another crew is harvesting the tomatoes and peppers. That way everyone becomes comfortable in a job and knows the routine.

We grow a large amount of root crops so that we can continue to deliver crops until mid-December. There is a different system for these crops. We harvest all of our storage crops into 20 lbs buckets. We don't want to spend a whole day lifting heavy boxes. We lay out the number of buckets we will need for the whole bed so that time is not spent walking around for buckets. When one bucket is full the next bucket is right there. The full buckets are moved to the driving lane. We then empty the buckets into 20 bushel bulk bins carried by a forklift on a tractor. This system is used for all of our storage crops from winter squash to sweet potatoes.

We have a large well-lit barn for our sorting and washing. While we do a lot of sorting the field, the final sorting and packing are done on tables under the lights in the barn. The harvest manual also describes how we wash and pack all of our crops. The washing of the cut greens is the same for all of the greens. The number of peppers, squash, cucumbers, etc counted into a box is the same every day. We wash all of the bunched roots the same way. This keeps the washing and sorting moving efficiently in the barn.

While we grow many different crops, we work on creating systems that allow us to treat similar crops in the same way so that it seems that we only grow a few different crops. Emphasizing clear communication and having clear standards helps the crew to be as efficient as possible.

Increase the Efficiency of Your Greenhouses

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With up to 50% of the cost of producing vegetable and ornamental plants classified as labor and 10 – 20% as energy, exploring ways to reduce these costs makes sense. Installing improved handling methods, simple mechanization, insulation and better controls can result in greater efficiency. The following is a review of some of the methods and equipment that growers are using to address the energy and labor issues.

Labor Efficiency and Productivity

Let Controls Make the Decisions

Growers spend a considerable amount of time making routine decisions. Do the plants need to be watered? Should the vents be opened? Is it time to draw the shade or energy curtain? Simple, low cost devices, such as electronic controllers, time clocks or alarms can make these decisions for you. Computers can integrate environmental factors and keep a history of crop growing conditions.

Workstation Design

Workstation height – the best table height is elbow height. Adjustment should be provided for different size workers. It is best to provide for both standing and sitting positions as greater efficiency is achieved when workers alternate position.

Hand and arm motion – the reach from the normal arm rest position should be limited to 24" radius to the side and front for women and 27" for men. The location of the flat that is being transplanted into should be no more than 18" from the resting elbow.

Location of materials – materials should be located as close to the work area as possible. Walking 10' to pick up or set down a flat will add about two cents to its production cost. Tipping the plug flat toward the transplanter can reduce reaching distance. Prefilled containers eliminate one operation. They can be supplied to the transplanters by belt conveyor or on pallets. Removal of materials from the workstation can be by cart or conveyor.

Materials Handling

Overhead conveyors – good for moving pots or flats to or from the growing area. Track is usually suspended from greenhouse trusses. Track can be run to greenhouses, headhouse or shipping area. Plant carrier will hold 10 to 20 flats at one time. System is low cost.

Carts – Most large department stores require that plants be shipped on carts. They should be selected for the size of container to be carried. Hard level surfaces are needed to aid movement. They can be pushed by hand or pulled with a power unit. Most carts have removable shelves to accommodated different size plants.

Pallet handling equipment – Most materials that growers receive is transported on pallets for ease of handling. A pallet truck or forklift can save considerable time in unloading. Dock facilities may be needed.

Energy Conservation

Increasing energy costs make conservation and efficient use of facilities an important part of today's greenhouse operation. New greenhouse designs, better glazing, improved heating and ventilating equipment and new management systems should be included when upgrading or adding on. With typical annual energy usage being 75% for heating, 15% for electricity and 10% for vehicles, efforts and resources should be put where the greatest savings can be realized.

Reduce Air Leaks

Keep doors closed - use door closer or springs.

Weatherstrip doors, vents and fan openings. Close gap around stovepipe penetration.

Lubricate fan shutters frequently so that they close tight. A partially open louver may allow several air changes per hour. For example, a 48" fan louver that fails to close properly leaving 1" gaps, allows 23,000 Btu/hr of heat to escape costing $0.46 if you are burning $2.00 fuel oil. Shut off some fans during the winter and cover openings with insulation or plastic to reduce infiltration of air.

Use poly with an infrared inhibitor on the inner layer for 15% savings. Payback is 2-3 months.

Energy Conserving Screen

Install a thermal screen overhead and on sidewalls for 20%-50% savings. Cost is $2.00 - $3.00/sq ft. Payback is 1-3 years. A double screen will save an additional 10 – 15%. Tight closures should be maintained where curtains meet sidewalls, framing or gutters. Heat and water lines should be insulated or located below the screen.

Insulation

Insulate the kneewall or sidewall to bench height. Use 1" to 2" of insulation board. Applying 2" of foam insulation to a 3' high kneewall on a 28' x 100' greenhouse will save about 400 gallons of fuel oil/year.

Space Utilization

Increase space utilization to 80% - 90% with peninsular or movable benches.

Install multi-level racks for crops that don't require high light levels.

Grow a crop of hanging baskets on overhead rails or truss-mounted conveyor system.

Efficient Heating System

Installation of floor or under-bench heat will allow air temperature to be set 5º - 10ºF lower.

Yearly maintenance - Check boiler, burner and backup systems to make sure they are operating at peak efficiency. Have furnaces cleaned and adjusted and an efficiency test run before heating season. A 2% increase in efficiency for a 30' x 150' greenhouse will save about 200 gallons of fuel oil.

Check accuracy of thermostats – correcting a reading that is 2ºF high will save $100-$200.

Install electronic thermostats or controllers with a +/-1□F accuracy. Potential yearly savings of 500 gallons of fuel oil in a 30' x 100' greenhouse when changing from a mechanical to an electronic control.

Aspirate thermostats or sensors for more uniform temperature control. Differential between on and off can be reduced as much as 6ºF.

Install horizontal air flow (HAF) fans to get more uniform temperature in the growing area.

Additional information can be found in **Energy Conservation for Commercial Greenhouses** – NRAES-3, 100 pages, $21.25 available from CIT Resource Store, Unit 4035, W.B. Young Building – Rm 2, Storrs CT 06269-4035. Make check payable to UConn. Price includes postage and handling. Revised – September 2008.

Paper-Pot System for Transplanting Efficiency

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The paper pot transplanting system is an innovative, labor-saving technology developed in Japan. It relies on using paper pots that are connected in a chain so that they feed themselves through the transplanter. The transplanter itself is hand-pulled. With it, I can put 264 plants in the ground (one flat) in less than a minute...all while walking upright (no kneeling, crawling, or stooping).

The transplanter opens a narrow furrow, the paper chain goes down into the furrow, and then the plants are covered by a set of metal flanges. At the start of a row, the lead cell of a flat of paper chain pots is pulled down into the furrow, staked to hold it in place, and then you pull the transplanter forward. The transplants all follow each other into the ground. Packing wheels firm the soil around the transplants as you go.



The paper-pot flats come compressed in cases of 75 to 150. In the greenhouse at seeding time, the paper flats are opened (not unlike an accordion or perhaps unfurling a Japanese-style paper fan) using a pair of metal rods and held open on a frame while being filled with potting soil. The paper pots resemble a honeycomb of cells. Once filled, the metal frame can be removed. Seeding is accomplished by hand or with a seeding device that seeds an entire flat at once.

Because the pots are in a chain, the in-row spacing is pre-determined. Generally, the system is best suited for closely spaced crops. It is absolutely perfect for allium family crops. It can also be used for things like spinach, chard, various salad greens, many cut flowers, beets, and some herbs. The in-row spacings that are available are 2”, 4” and 6”. Longer in-row spacings are possible if you skip cells when seeding.

The cell size for the paper pots are small, with the standard size being 1.25 inches in diameter and 1.25 inches deep. Slightly larger (1.33 inch diameter) and deeper (1.5 to 2 inches) cell sizes are also available.

The transplanter is like nothing else available in the U.S. and is somewhat difficult to describe in words. For this reason, I recommend the following YouTube video:

http://www.youtube.com/watch?v=EWd8gBJgEMY

Traditional transplanters require a tractor, tractor-driver, 1 to 3 people riding on the back, and often an addition person to shuttle flats to the crew. With the paper pot transplanter, one person can do the whole operation without using a tractor. The transplanter has many attractive attributes: no moving parts to wear out or break, no fuel use, no noise, and no stoop labor.

The primary drawback is the short in-row spacings available and small cell size which disallows transplanting larger seedlings or crops that need a longer in-row spacing. On my farm, I use the transplanter primarily for allium crops and spinach. It has been a very good investment. I grow quite a lot of alliums (leeks, bunching leeks, onions, shallots, and scallions) and do a good amount of spinach. Our spinach production has increased and improved significantly. I can now seed and germinate spinach consistently in the paper pot flats somewhere cool for my fall crop and therefore get a consistent and solid stand after they are transplanted. In the past, with direct seeding, I always had gaps in my rows due to imperfect germination in hot and dry field conditions in July and August.

The transplanter works best in lighter, well-tilled soils. It does not do well in clay. I use a rotovator to prepare beds for transplanting. Excessively clumpy soil or lots of residue affects the performance in terms of how well the paper chain pots are buried. I sometimes need to go back down my rows and cover up sections that did not get buried adequately. I consider this a very insignificant price to pay for the speed and ease of planting using the system.

The cellulose paper is not bleached but does contain resins (the same as used to strengthen paper grocery bags) to keep them from disintegrating when wetted. The paper decomposes in the soil after a season. My Wisconsin-based certification agency (Midwest Organic Services Association) approved them for use on my certified organic farm starting in 2006.

There are several models of transplanters. The standard, and best-performing, unit weighs 29 lbs and is about 80 inches long. The cost in 2009 (not including shipping) is around $1100. The paper chain pots range from $1.75 to $2.75 per flat (depending on cell size). The other required components of the system include rigid plastic trays to hold the paper pot flats and a metal frame to hold the paper pots open before filling with potting mix.

I learned about the paper pot transplanter while living in Japan. I am now importing and selling the transplanters and related components. So far, there are people using the transplanter in Wisconsin, Iowa, New York, and Washington.

For more information, please contact me using the information above, (email preferred).

Growing for the High-End Restaurant

Jack L. Algiere
Stone Barns Center for Food and Agriculture
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As a co-speaker titled Growing for the High-end Restaurant: What they Want and Quality Considerations

The purpose for this presentation is to provide insight into the dynamic and evolving high-end restaurant market for specialty greens growers.

The objective of this topic is to identify tools and methods that can help shape and improve relationships between chef's and growers.

Crop Selection and Diversity in Greenhouse Production

1. Offering a spectrum of products to inspire Restaurant interest
2. Offering a spectrum of crop families to suit a proper rotation plan

Soil Quality and Nutrition

1. Soil as basis for plant nutrition and health
    a. Regulated pathogen pressures (less spray)
2. Increased quality and flavor of product

Grower, Chef, Consumer Perception

1. Passing along the perception of value
2. Developing pricing based on perceived value

Product Quality and Integrity

1. Keeping the customer
2. Developing the customers standards of quality
3. Year-Round Production

Niche Products

1. The Very Special Products
2. Organized and coordinated experimentation

Economic Value

1. Basics of tracking a diversified year round production
    a. Records
    b. Observations

This presentation will include a power point projection.

Fertility to Pest Management – How We Grow Leafy Greens on Long Island

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I'm a 4th generation farmer from Long Island. I have a 30 acre vegetable farm where I grow lettuce, spinach and cabbage. I'd like to talk today about my fertility program and then outline my pest management program.

The first step in a good fertility program is a soil test. I take soil tests every year in November. I also have a complete soil analysis done every year. In addition, I have records dating back thirty years. This comes in very handy as I can keep track of developing trends over time. Using my soil test results, I develop an appropriate liming and fertilization program. I apply lime every spring, usually in March. The next step is fertilization. I use a specially tailored excel spread sheet to calculate my needs. For the past several years, I have used a custom fertilizer blend with pelletized limestone. The latter is to offset the acidity of the fertilizer. We also spread leaves and horse manure to increase our organic matter content. On our sandy soils, this is especially important. Organic matter increases the cation exchange capacity (CEC) which improves nutrient retention and minimizes leaching.

Preplant operations include primary and secondary tillage with a moldboard plow, disk, and wheel harrow. I then broadcast the custom blend fertilizer. I also broadcast pulverized gypsum at a rate of 1000 lbs. /acre and incorporate it before seeding. Gypsum adds two crucial nutrients: sulfur, which is often times low or deficient on sandy soils, and calcium, which helps to prevent tipburn in lettuce and internal burn in cabbage. It has worked very well for us over the last several years. We also add molybdenum at 1 lb. /acre, preplant incorporated. Many vegetable crops require this trace element for optimal growth. We transplant lettuce early in the spring and then seed weekly the rest of the year. My observations indicate that seeding is superior to transplanting. Bolting incidence also seems to be reduced. All of our cabbage is transplanted. I seed spinach in the spring and fall.

For weed management in lettuce, I use Kerb banded and/or Balan incorporated. Rates are dependent on soil type, so be careful when first applying herbicide. It is better to experiment at the lowest labeled rate and scale up as necessary to ensure that no injury occurs. It may be necessary to increase to the full labeled rate to get the desired effect. In cabbage, we use the herbicide Goal preplant. This has worked very well for us. You have to be mindful of drift because I've noticed it can burn the lettuce leaves in adjacent fields.

Since we grow lettuce on the same ground every year, pest and disease management is a challenge. We don't have the luxury of rotating or fallowing because land is scarce. If at all possible, I would highly recommend rotating land as a first step in reducing disease pressure. We do rotate cabbage on a 2 year basis to reduce clubroot. The next step in developing a disease management program is to select high quality seed. In cabbage, select a black rot resistant or tolerant variety and a yellows resistant variety. In lettuce, ensure that the seed is MTO (Mosaic) certified. Lettuce Mosaic Virus is a potentially devastating disease transmitted by aphids.

Since crop rotation is not an option for lettuce production, I have to judiciously apply pesticides to manage disease and pests. On lettuce, I use insecticides to manage aphids, leafminers and worms. Some of the insecticides I have used include Avaunt, Proclaim and Warrior for worms, Assail and Provado for aphids, and Spintor or Radiant for leafminers. I apply Rovral fungicide to manage bottom rot and Endura fungicide to prevent sclerotinia (drop). Drop is a cool weather disease so I use Endura early in the season. Bottom rot favors warmer weather so I switch to Rovral mid-season. I come back with Endura late in the season to manage drop in the fall. It is very important to make the first application when the plants are small, either before or right after thinning. An early application ensures the plant base gets adequate coverage to prevent disease. To maximize the efficacy of the products, I schedule 2 further applications a week apart. Based on my observations, 3 applications are necessary because of the high disease pressure. I do believe that 2 applications will suffice if you can rotate land. In late summer and fall, downy mildew and anthracnose can become problematic foliar diseases in lettuce. Previcur Flex (downy mildew) and Cabrio (anthracnose) have worked exceptionally well.

Price is an important factor when selecting a pesticide, but it is not the only consideration. Some pesticides need to be applied in combination with another pesticide from another group or FRAC code to slow the development of resistance. It is very important to read the label and follow the instructions. When selecting a chemical to use, pay close attention to the FRAC Code or group of each product. Rotating chemicals between different groups is another way to slow (but not prevent) the development of resistance. However, repeated use of one chemical will result in the rapid development of resistant populations.

In cabbage, I use Blocker fungicide (incorporated pre-plant) to prevent clubroot. Wetter years typically mean a greater likelihood of club root. For maggot management, the insecticide Lorsban appears to be the only labeled material. Using the appropriate rate is crucial. A light dose will not do the job. When spraying cabbage for insects, avoid emulsions and gravitate toward powder or granular formulations. I believe that the emulsions have a tendency to remove the protective waxy coating from the cabbage leaves. This acts as a built-in defense against diseases and should be preserved. To date, I have never needed to develop a fungicide program against foliar diseases in cabbage.

With regards to spraying and spraying techniques: I use a high pressure sprayer set at 450 psi. It has worked well. I feel that the turbulence it creates provides good coverage for the leafy green crops I grow. It is also important to use high gallonage. I have settled on 125 gallons/acre. The sprayer has a hydraulic boom that I can raise and lower to achieve the optimal spray height. This is very important to get optimal coverage and to prevent drift.

Field Finesse and Marketing Success

Paulette Satur
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Satur Farms was started 11 years ago by me and my husband, Chef Eberhard Mueller, on ¼ of an acre of land in the wine country of eastern Long Island. We are currently farming 180-acres of specialty vegetables there, along with an additional 150 acres in Florida for our winter production.

Our broad theory is that if we can grow it and grow it well, the marketing takes care of itself. However, we can break down our success in marketing into several distinct reasons:

1. Location. Location. Location. We are near the most densely populated city in the U.S. Growing and processing in close proximity to NYC or any other large metropolitan area is a huge benefit no matter your size. Trucking costs are significant, and closeness to market becomes extremely important as fuel costs rise.

   Our trucks can make many efficient stops in NYC, all the while touting our brand on the sides of our delivery trucks. Our boxes carry the same logo and are visible from a distance and are very clear when photographed. As our brand has become known, customers request us, and distributors want and need to carry us.

2. Make an Impact with your Brand. We grow a large variety of specialty crops because we believe you can't base your business on nor make an impact with only ½ dozen items. To make an impact in a store or restaurant you need to have many SKUs on the shelves or menus. Our retail labels were professionally designed but we can add new item names, pack sizes, UPC Codes and expiration dates ourselves. In order to increase our line and exposure, we contract with our neighboring farms to grow the crops that we do not. Our customers appreciate this access to a large variety of locally-grown produce.

3. Carrot vs. Stick. The mix of items you grow and offer is very important to both marketing success and the bottom line. We entice customers to buy from us by offering specialty or intriguing items they cannot get elsewhere, or at least, not of the quality we offer. Because they need us, they then also order the commodity-type crops that we have.

4. Sell Everything but the Quack. We offer many of the items we grow in different sizes and packs for benefit of our food service and retail customers. For example, we grow and offer mizuna as a microgreen, as a 3 lb box of baby leaf for restaurants, as a 5 oz retail pack for stores, as a component in our mesclun, and as a component in our

braising/stir fry greens. Although we have many SKUs, we are not actually growing each SKU, we're just using them in many ways. We find it impossible to stretch too far with the number of items grown; the quality invariably suffers. Look at what you're growing and find ways to streamline and market that.

5. Jump! We try to be the first farm to have items available and the last to harvest. We experiment with season extension techniques so that we are harvesting baby leaf the end of April and can usually continue through most all of November. When we enter the market very early spring with brilliant baby leaf after everyone's winter version, we capture attention. Customers clamor after us and stay with us. We also grow in Florida in the off-season so that our brand is always available for our customers.

6. Know What You're Aiming For. We are constantly sourcing new seed varieties and equipment from Europe and other countries overseas, so that we have the most exciting varieties available and the best equipment to grow them for quality. The trade shows in Europe and Asia are phenomenal; we go routinely to keep our standards high and to stay on top. We dine out whenever possible to see what's happening and to talk to the chefs. Growers should be instructing customers on the newest and best.

7. Be Better than the Average Bear. Grading, sizing, washing, and packing to the highest industry standards are crucial for marketing success. We train our fieldworkers to grade and judge quality, and pay them piecework rates. We pay higher rates than most farms because we expect a high-quality pack from them. This way, they deliver that without continuous supervision. Immediately after harvest, our products are washed and chilled to guarantee excellent freshness and appearance. Not only are we GAP certified, but our refrigerated packing facility is HACCP certified. We solicit a yearly independent audit by a third-party certifying company to insure that our program standards are being met. This gives our customers confidence that our vegetables are produced professionally in a safe and sanitary manner.

LEAFY GREENS – OUR STRATEGY FOR COVER CROPS AND ROTATION

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Pomykala Farm is a small vegetable farm in Grand Isle, VT. We grow for retail and wholesale on about 30 acres. We are 30 miles above Burlington, and 30 miles below Canada. We are on an island, surrounded by Lake Champlain. We do not get terrible frosts in the spring, which helps with asparagus and strawberries. Our soil is heavy clay-loam.

We try to have a cover crop or mulch on all our acreage at some time during the year. The exception is asparagus. Is someone could come up with a good way to grow a cover crop in asparagus; we would love to try it.

Our leafy greens cover crop strategy falls into 2 categories; transplanted and direct seeded

Transplanted crops are lettuce, kale, swiss chard

Direct seeded crops are spinach, beets, cilantro, dill, lettuce for salad mix

Direct seeded crops are planted with a 3 row planet junior seeder. They have shoe openers, and it doesn't take much to clog them up. Consequently, the ground either has to have very little cover crop residue, which works for early spring planting, or the ground has to be worked up well in advance of planting so the cover crop can start to decompose.

The transplanted crops are much easier to deal with. That is because we added disc openers to our 2 row Lannen transplanter. The disc openers slice thru unbelievable piles of trash and sod, and the packing wheels pack the plants just fine. We have irrigation anywhere we plant .

Our cover crop program is simple. We plant winter rye everywhere we can. We grow 8 acres+/- of Surghum-Sudan grass hybrid to chop as straw for our strawberries. If all goes well, we will chop the Sudax in the late fall and immediately spread or drill winter rye in the stubble.

We were fortunate to buy a tow behind combine to save our own winter rye seed. A side benefit is that after combining, there is plenty of seed left in the field to grow another crop.

Soil Health and Crop Rotations

Lauchlin W. Titus, CPAg
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Soil Health Factors?

- Tilth
- Microbial Activity
- Moisture Movement
- Moisture Retention
- Fertility

Tilth

- Description of how well the soil is worked
- Often described as friable, or crumbly
- Soils with good tilth can often be worked earlier in the growing season and better seed beds established, fewer clods, less crusting after planting and rain

Microbial Activity

- Living organisms in the soil respire, live, die and in the process recycle carbon, oxygen, and other plant required nutrients that may be otherwise bound in the soil. Improved tilth helps optimize air and water in the soil to promote microbial activity

Moisture Movement

- Soils with good microbial activity tend to have more ability to accept moisture and allow it to pass through the soil layers.

Moisture Retention

- Soils with good soil health, as a result of microbial activity and other factors, should have improved organic matter content which helps to retain moisture for subsequent use of the crop.

Fertility

- Good soil health fosters good air and water levels which fosters microbial activity which recycles nutrients that may otherwise be bound in the soil and unavailable for crop nutrition.

Why Crop Rotations

- Break pest life cycles
- Insert species that provide needed benefits
- Improve tilth

Break Pest Cycles

- Corn Rootworm
  - Rotate out of corn to break life cycle
- Verticillium Wilt
  - Rotate with Sorghum X Sudangrass to reduce inoculum
- Long rotations suggested to break many soil borne root diseases

Insert species that provide needed benefit

- Provide Nitrogen
- Improve Tilth
- Improve Organic Matter Level
- Biofumigation

Provide Nitrogen

- Legume Crops
  - Peas, Beans, Soybeans
- Legume Cover Crops
  - Alfalfa, Clovers, Vetch, Sweet Clover
    - Added benefit of bee pasture or pollinator nursery

Improve Tilth

- Sorghum X Sudangrass
  - Root exudates improve flocculation and friability characteristics of the soil
- Soybeans
  - Noticeable improvement on moderately heavy soil after use of Soybeans in Maine

Improve Organic Matter Levels

- Return as much dry matter biomass to soil as possible
  - Sweet Corn Stover
- NEVER, let soil lie fallow
  - USE COVER CROPS as soon as crop is removed
- Reduce number of tillage passes
- Adopt zone till or no till

Biofumigation

- Brassica Crops Provide Biofumigation
  - Need to chop up and incorporate green material while soil temp and moisture are adequate for microbial activity.
- Species matters
  - Lots of research, but even chopped up broccoli is better than nothing at all

Rotation Considerations

- Try to insert grasses into rotation
  - Corn
  - Small Grains
  - Grass Forage or Cover Crops
    - Longer the rotation the better
- They break disease cycles that impact other crops

Rotation Considerations

- Be aware of serious pests of your principal crops, especially soil borne diseases
  - *Sclerotinia, Phytophthora, Pythium, Verticillium, Fusarium, Rhizoctonia*
- Will rotation crops improve situation or make it worse?
  - Example: Potatoes after beans is not a great idea
    - *Sclerotinia, Rhizoctonia, Pythium*

Questions?

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Reduced Tillage Impact on Soil Organisms

Rob Johanson/Goranson Farm

Goranson Farm is a second generation vegetable farm located in Dresden, Maine. First generation farmed primarily potatoes using conventional chemical inputs. Since taking over the farm in 1986, we transitioned to a sustainable, and then to an organic system. We obtained MOFGA certification in 2002. Currently we farm 54 acres organically. We use a four year rotation with half of the acreage in cash crop and the other half in soil building cover crops and soil amendments in any one year. Our biggest concern in growing crops organically was our dependency on herbicides in controlling weeds in potatoes and sweet corn. We invested in numerous types of mechanical weed control implements that include traditional soil tillage equipment like rotivators, plows and disc harrows. Through the years we moved away from the traditional equipment to tine weeders, side knives, Lilliston rolling cultivators, subsoilers, and later, propane burners. While transitioning types of equipment, we also were learning a great deal about ways to improve weed management and soil health.

The first implement we parked was the 8' rotovator. We learned that the impact on the soil structure created a plow pan potentially harder than what using a plow creates. Certainly, plowing an acre was faster than rotovating an acre. We learned that we were saving time by plowing but soil structure and soil organisms were still negatively impacted.

In 2006 we began working with Eric Gallant and Tom Molloy at UMO and Mark Hutchinson at Extension, using reduced tillage techniques for weed management. We planted one acre of winter squash into a hairy vetch/oat cover crop. We used a single shank ripper to loosen up a zone; we then fertilized that zone with fish meal and incorporated it with a small tiller (all but the center tines removed). The first observation was the reduced weed pressure in the no-till zone.

In 2007 we planted an acre of strawberries using the same technique using Yeoman subsoiler instead of the rippers. The Yeoman allowed for deeper tillage with less surface disruption. We also purchased wavy no till coulters to incorporate the fishmeal and thus eliminating the need to reconfigure the rototiller.

Managing the weeds within the row still requires hand hoeing. Between rows we now use a propane burner with shields to protect the plants. The advantage of using propane versus mechanical cultivation is that the soil remains undisturbed, not bringing more weed seeds up into the germination zone.

In conclusion, we feel reduced tillage is better for soil health as well as being an effective weed management strategy. Through the zone till and propane combination there has been a net reduction in fuel use and significant time savings in preparation for field planting.

Measuring the Impacts of Farm Practices on Soil Health

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Soil health refers to the capacity of a soil to function. Soil functions include maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, cycling nutrients and providing physical support. We use certain soil properties as indicators of a soil's health and its ability to perform these functions. Generally, these are "dynamic" or "use dependent" soil properties that are sensitive to changes in soil functions as a result of management, are easily measured and reproducible, and respond to management changes in a relatively short time period.

To assess the effects of farming practices on soil health, selected properties (indicators) should be monitored on a site over a number of years and compared to a baseline condition. Another option is to compare management systems to a reference site on the same soil.

Soil health cards have been developed and used since the mid-nineties to evaluate differences or changes in soil quality. This field tool is generally developed collaboratively by local farmers, NRCS, universities, conservation partners, and others. Indicators and ratings are selected using regionally appropriate properties and terminology. The card can be used to assess the current status of soil quality or, when used over time, can help determine changes in soil quality that are affected by field management. For best results, the evaluation should be performed by the same person, at the same time (or times) of year and under the same general moisture conditions. Evaluating several areas in a management unit will provide more meaningful results.

In 2003, development of a soil health card was initiated in Maine. A template from another state was adapted to fit conditions in the northeast and used as a sample card to generate input. The card was trialed and circulated at training sessions, field days, trade shows, and via email lists in order to generate comments and suggestions. A survey was included with the card which asked questions about the wording, ratings, indicators, format, and potential uses for the card. Most comments and suggestions came in jotted on the card itself. Over a period of 2 years the card was continuously adapted in response to these comments.

The Maine soil health card combines whole field observations (drainage, moisture holding, erosion, and crop vigor) and soil evaluations (crusting, color, tilth, structure, compaction, and organisms). Descriptive ratings: describing the best (1), worst (10), and intermediate (5) conditions for each indicator are included to help users evaluate their site on a scale of 1 to 10. The card has instructions for use and room to keep brief records on field activities.

More on soil health cards is available at http://soils.usda.gov/sqi/assessment/sq_card.html

A soil health card offers a qualitative assessment of soil response. It is an inexpensive, accessible, and practical way to understand a soil's response to management. Other evaluation tools are available that provide a more quantitative analysis.

Soil quality test kits allow measurement of chemical, physical, and biological indicators such as pH, bulk density and aggregate stability, respiration and number of earthworms. Like the health card assessment, soil quality kit evaluations used to monitor changes due to farm practices shoul be completed over a number of years, at the same approximate time and soil moisture level, and replicated throughout a management unit. Additional information on the soil health kit can be found at http://soils.usda.gov/sqi/assessment/test_kit.html

Soil testing programs that expand beyond chemical properties are available. One recently developed program is at Cornell University. In addition to nutrient testing, several physical and biological properties are also measured. See http://soilhealth.cals.cornell.edu/ to learn more.

• Turn over a shovel full of soil (about 6-8" deep) and rate each indicator (6-10) by making an "X" or shading out the box that best represents the value for th
• Determine soil compaction by simply pushing the probe or wire flag into undisturbed soil and noting the resistance.

Date: Evaluation by: County: Farm: Field: Crop Rotation:

Tillage System: Soil Moisture Level (check one) Good for planting ___ Too wet for planting___ Too d

Indicator	Best ----------→ Worst										Indicator Rating		
	1	2	3	4	5	6	7	8	9	10	1	5	10
1. Soil Erosion											Little or no soil erosion	Some visible soil movement	Excessive soil movement
2. Drainage, Infiltration											No ponding or runoff, water moves through soil steadily Soils drain and warm quickly in the spring. Limited delays in field operations. Yield reductions only in very wet years.	Water ponds for short periods and/or some runoff occurs. Field may be water-logged after heavy rains, causing minimal yield reduction. Soils drain and warm somewhat slowly in the spring. Some delays in field operations.	Water ponds for long periods of time and evaporates more than it drains. There may be excessive runoff. Soils stay wet for long periods and delay field operations, reducing yields.
3. Soil Moisture											Soils hold water for long periods of time without ponding. Crop stress rare.	Water runs out after a week or so. Crops occasionally are stressed.	Plant stress two days after a good rain.
4. Crop Growth											Even stand, vigorous and uniform.	Somewhat uneven stand or somewhat stunted or discolored	Uneven stand or stunted or discolored
5. Crusting											Soil maintains an open and porous surface all growing season, seedling emergence is not impeded.	Some surface sealing, minimal effect on seedling emergence	Soil surface seals after rain events or tillage. Seedling emergence inhibited. Rain soaks in slowly.
6. Soil Color (org. matter)											Topsoil clearly defined and darker than the subsoil.	Surface color closer to subsoil color.	Topsoil color similar to subsoil color.
7. Soil Tilth, Friability											Crumbly, easily worked, breaks apart easily	Some visible crumbly structure, Somewhat cloddy, Somewhat difficult to work, breaks apart with some pressure.	Cloddy, hard, crusty, or difficult to work. Difficult to break apart clods or soil is dust like and blows easily
8. Soil Structure and stability											Soil aggregates remain intact and easily seen after soil disturbance.	Observable, intact soil aggregates make up less than half of the soil mass after disturbance.	Soil aggregates are not observed after disturbance. Soil is too loose or too cloddy.
9. Compaction											Probe or flag enters soil easily; unrestricted root penetration	Can push probe or wire flag in soil with force; some restricted root growth	Can not push probe or wire flag into soil severely restricted root growth
10. Biological Activity / *Earthworms*											Many signs of animals in the soil, earthworms, holes or casts. Soil has fresh earthy smell	Some living organisms or signs of life in the soil Some earthworms, few holes and casts	Little or no sign or animal life in the soil of animal
Other													

Maine Soil Quality Assessment Card

Questions or Comments?
Contact Lisa Krall, Soil Scientist
U.S.D.A. Natural Resources Conservation Service
344 Merrow Road, Suite A
Tolland, CT 06084
(860) 871-4051

Instructions

How to Use the Card
Tools Required

- A shovel, a wire flag, and a pencil!

Soil Quality Assessment

- Select a field for evaluation and record the field and/or farm ID and the date on an assessment sheet.
- Soil erosion, drainage, and infiltration are “whole field” observations and can be recorded via “windshield surveys” during rain events.
- Keep track of your crop’s health throughout the growing season. Pay attention to responses to water stress to assess your soil’s ability to maintain adequate moisture.
- Pick a day when the soil is somewhat moist to examine the soil and record what you see.
- Turn over a shovel full of soil about 6”- 8” deep.
- On the Assessment Sheet**,** rate each indicator by marking an X or shading out the box that best represents the value for that indicator. Refer to the explanations for ratings of 1,5, and 10 for help in determining your choice. Enter additional observations and comments (such as weather conditions and additional dates of observations) in the space provided for “observations”.

Do this yearly and track progress towards your soil quality goals.

- This card is most effective when filled out by the same user over time and under similar soil moisture levels.

- Using the card in more than one spot per field will improve accuracy.

Other activities, comments, observations

Additional records about this field

Use this space to record planting, tillage, and soil amendments as well as additional activities and observations that are significant. This will help you determine

Last Soil Sample Taken: / /
Notes:

Crop History

Date	Crop (s)	Comments (seed rate, germination rate, etc.)

Soil Amendments Added

Date	Material	Rate	Comments (application method, weather)

Tillage Operations

Date	Operation	Comments (weather, soil conditions, etc.)

Rotations Planned:

Year	Crop

BRASSICA COVER CROPS AND SEED MEALS AS SOIL BIOFUMIGANTS IN VEGETABLE CROPS

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The web address for project descriptions is http://web.utk.edu/~tkarpine/EnhBiofum.html.

Data now supports the concept that many classes of biological pest management are effective in controlling diseases caused by soilborne pathogens. The volatile compounds released from *Brassica* plants are known to release biocidal compounds that are able to suppress soilborne pathogens when incorporated into the soil. Sustainable control of soilborne phytopathogenic fungi is likely to be achieved through the enhancement of biologically based methods via the integration of multiple techniques. Even sub-lethal doses of biofumigants can act to weaken pathogen propagules making them more susceptible to the actions of the microbial antagonists that can be delivered through compost applications. It is clear that a fundamental attribute of an effective integrated organic system is its ability to decrease pathogen numbers in the soil and establish a soil microecology suppressive to pathogens.

Biofumigation

Biofumigation is the use of volatile plant chemicals for control of soilborne pests. The viability of biofumigation to control pathogens has been investigated for many years. Studies conducted at The University of Tennessee showed that mustard seed meal has extremely high concentrations of isothiocyanates (ITCs). The seed meal is also a fertilizer source of nitrogen and other nutrients. When incorporated into the soil, ITCs act as effective biofumigants, reducing populations of pathogenic fungal species (*Sclerotium*, *Rhizoctonia*, and *Phytium*), nematodes, weeds, and certain insect species. These products have been shown to suppress the pathogens *Botrytis cinerea*, *R. solani*, *F. oxysporum*, *Didymella lycopersici*, and *Cladosporium fulvum*. In these studies, we found that the volatiles from several Brassica species suppressed the growth of the tomato pathogens *P. ultimum*, *R. solani*, and *S. rolfsii*. The biocidal activity of *Brassicas* against fungal pathogens, nematodes, weeds, and insects is frequently attributed to ITCs from Brassica tissues. ITCs are effective, broad-spectrum pesticides, and substantial quantities of them can be produced for field application. Research has shown that Black mustard (*B. nigra* L. W. Koch) and Indian mustard (*B. juncea* L. Czern and Coss.) produce high levels of ITC, and could be utilized in a biofumigation cropping system.

Since 1999 field trials have been conducted at Knoxville Experiment Station. Significant decreases in the incidence of Southern Blight of tomato were recorded, as well as increases in fruit yield, when integrating biofumigation into a sustainable production system. The research yielded important knowledge pertaining to the development of the appropriate production methods utilizing biofumigation as a management technique. Both *Brassica* cover crops and mustard seed meal incorporations have been evaluated. The ability to amend production soils

with the spreadable meal, in conjunction with its high ITC content (3-4 x leaf tissue), give this enhanced biofumigation technique great potential. Problems associated with growing cover crops such as variable stands and weather complications are avoided when using the meal. As a fully organic product, pre-plant mustard meal applications give the grower superior ability to control soilborne pests.

Tomato Production and Blight diseases as a Model System

The use of raised-bed plasticulture methods for fruit and vegetable production is becoming increasingly prevalent within the United States. Advantages include increased crop performance by conserving moisture and nutrients, stabilizing soil temperature, reducing some diseases, reducing or eliminating weeds, and increasing early harvest yields. Often grown without rotation, tomato fields can develop high pathogen inoculum densities. Southern Blight, caused by the phytopathogenic fungus *Sclerotium rolfsii*, represents one of the major disease threats to tomato crops (both organic and conventional) in the southeast United States. Various control methods have traditionally been utilized to lessen the incidence of Southern Blight in commercial vegetable fields, all with no definitive control of the disease. A prevailing hypothesis is that by altering the composition or activities of soil microflora, including the addition of biocontrol agents such as antagonistic microorganisms, that there is a potential for improved control of soilborne diseases.

Introduction

The effects of different combinations and techniques of mustard meal and compost application and chemical fumigants on vegetable production are studied in four field experiments in Tennessee and North Caroline and in three on-farm trials with commercial growers during 2003-2005. Yield and quality of tomato and strawberry plants and their diseases were measured to characterize the effects of enhanced biofumigation on productivity. The web address for the project is http://web.utk.edu/~tkarpine/EnhBiofum.html.

The objectives of the studies were to study the effect of *Brassica* cover crop and mustard meal application in combination with composting on soilborne diseases and tomato yield.

Treatment combinations applied in several locations included: 1) Control (no amendments); 2) Brassica plants (fall incorporation); 3) Brassica plants (spring incorporation) + Basamid at 175 lb./acre; 4) Brassica plants (fall incorporation) + mustard meal at 1000 lb./acre (spring incorporation); 5) Mustard meal at 500 lb./acre; 6) Mustard meal at 1000 lb./acre; 7) Mustard meal at 2000 lb./acre; 8) Compost at 30 tons/acre; and 9) Compost at 30 tons/acre + Mustard meal at 1000 lb./acre.

Impact of Results/Outcomes

The following results of the study are practically and scientifically important and will impact on sustainable agriculture.

1. Combination of mustard meal incorporation with compost increases the yield and quality of tomatoes, but the effect may only be achieved after 1-2 years of the application.
2. Combination of mustard meal application with compost protects tomato plants from Early Blight.
3. Mustard meal application increases the yield of strawberry plants and protects them against Anthracnose. These positive effects may accompanied by an increase in the number of weeds.
4. The application of mustard meal disturbs the bacterial and fungi communities in the soil during the first two weeks after the application. Both, a decrease and an increase in the number of heterotrophic bacteria and fungi may take place. To the end of the growing season the bacterial and fungi population is stabilized and deceased in number.
5. The response of nematode population to mustard meal and compost application depends on soil and weather conditions. Both a decrease and an increase in number of total nematodes, fungal feeders and bacterial feeders may occur. Mustard meal treatment and basamid treatment decrease the number of spiral nematode in soil associated with damage to some crops.

The following technique of mustard meal application is recommended for vegetables production:

1. Compost may be incorporated before the mustard meal application in fall, or in spring. Usual rate is 30 tons per acre. It may also be applied together with the mustard meal.
2. Mustard meal should be incorporated two weeks before the expected date of plating at a rate 1000 - 2000 lb. per acre. Mustard meal should be applied only to beds that will be covered with plastic to prevent lose of the biofumigant.
3. Mustard meal must be tilled in the soil. The beds need to be covered with plastic and irrigated with at least 1 inch of water the same day of application. The irrigation must be repeated in a day at the same rate (1 inch). The irrigation is necessary to trigger reactions of mustard meal with the soil and soil organisms. The heat under the plastic kills pathogens and stimulates reproduction of beneficial microbes and nematoes in the soil.
4. Plants may be planted in two weeks after mustard meal application. This delay is necessary to avoid toxic effect of mustard meal on germinated seeds or roots of seedlings

Apple Rootstocks, an Update from the NC-140 Research Committee

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The NC-140 Multi-state Research Committee began officially in 1977 with a membership of 21 scientists from 20 U.S. states and one Canadian province. Many people have come and gone during its 32 years of its existence. Currently, NC-140 is comprised of 44 scientists from 24 U.S. states, 3 Canadian provinces, and one Mexican state. NC-140's original and continuing mission is to evaluate tree-fruit rootstocks in a wide range environmental conditions for potential adoption in North America. The candidate rootstocks have come from North American, European, and Asian breeding programs. To date, 25 cooperative apple rootstocks trials (as well as several pear, peach , cherry, and plum trials) have been established, averaging 12 North American sites per trial. Over 100 different apple rootstocks have been evaluated in these trials. These rootstocks include 13 of the Budagovsky series from Russia, 37 from Cornell-Geneva in New York, seven JM rootstocks from Japan, 14 East Malling rootstocks (including 8 strains of M.9), four MAC rootstocks from Michigan, six of the P series from Poland, nine Pillnitz rootstocks from Germany, and a number of others. The geographical distribution of NC-140 plantings range from Georgia, Texas, and California to Oregon, Minnesota, and Maine in the U.S., including 32 states. In Canada, five provinces from British Columbia to Nova Scotia have planted trials. One Mexican and one Australian state have also been the location of NC-140 plantings. This wide distribution of climates and soils has allowed a very thorough evaluation of these rootstocks. These evaluations are the foundation of all North American apple rootstock recommendations.

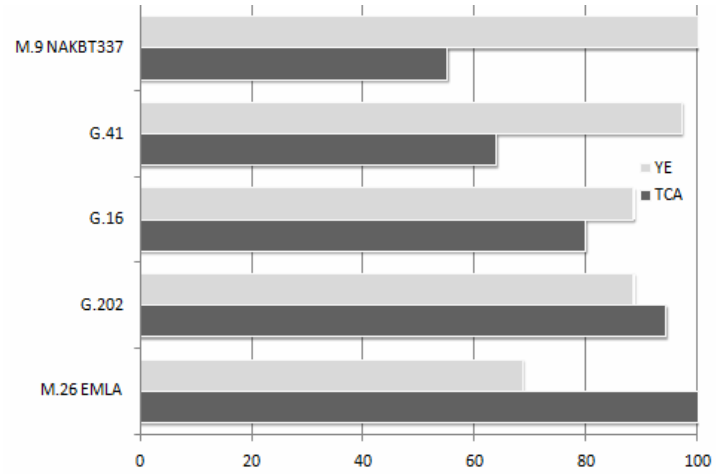

Figure 1. Relative performance of Fuji apple trees on several rootstocks in the 1999 NC-140 Dwarf Apple Rootstock Trials (through 10 growing seasons).

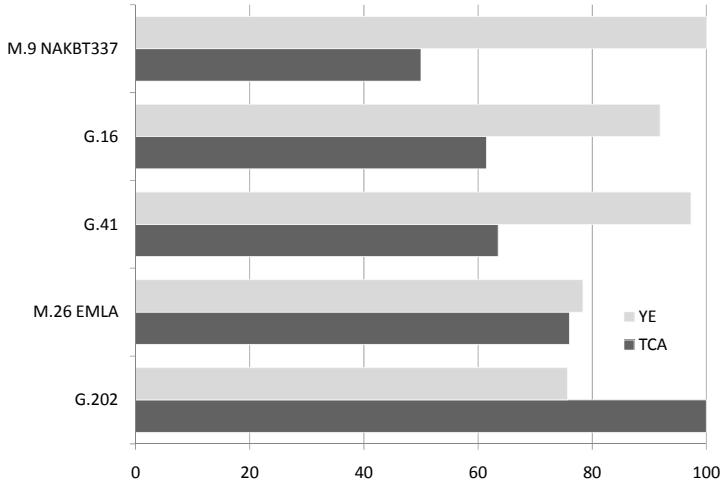

Figure 2. Relative performance of McIntosh apple trees on several rootstocks in the 1999 NC-140 Dwarf Apple Rootstock Trials (through 10 growing seasons).

As you might expect, most of these rootstocks did not perform well, or at least well enough to recommend widespread adoption. Throughout all of these many trials, one of the oldest rootstocks, M.9, has consistently

produced high yield efficiencies with large fruit size. Unfortunately, it has also experienced the greatest tree loss, due mostly to its sensitivity to fireblight. B.9 was first planted in 1984 and has performed well also. It produces a tree similar to the small M.9 strains and has not experienced a great amount of tree death. Tree size and yield efficiency of trees on some of the newer rootstocks in current trials are presented in the following figures. The standout in these trials is G.41 for a moderate M.9-sized tree. G.41 may have somewhat greater yield efficiency than M.9 NAKBT337, but it certainly has better survival (87% of trees on G.41 alive after 10 years in the 1999 NC-140 trials, and only 63% of trees on M.9 NAKBT337 alive).

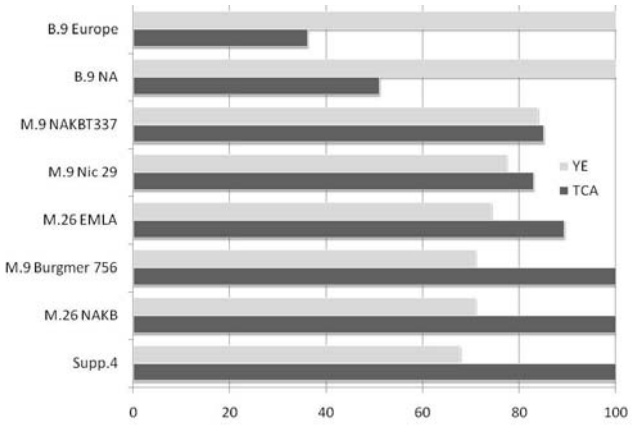

Figure 3. Relative performance of Gala apple trees on several rootstocks in the 2002 NC-140 Apple Rootstock Trials (through 7 growing seasons).

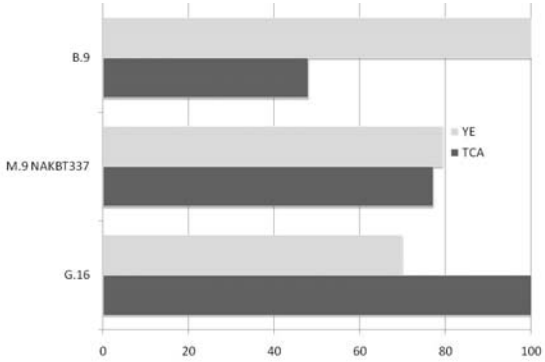

Figure 4. Relative performance of Cameo apple trees on three rootstocks in the 2002 NC-140 Cameo Apple Rootstock Trials (through 8 growing seasons).

Several new releases are imminent. These include one in the M.26 size, G.214. Others soon to be released are closer to semidwarf size: G.890, G.969, G.087, G.874, and G.210. We do not expect to see any of these in the commercial market in the near future.

The NC-140 Research Committee will continue to evaluate new rootstocks. New rootstocks are becoming available from East Malling in Great Britain, but most new rootstocks will be from the very active breeding program in Geneva, New York (a cooperative effort between USDA and Cornell University).

Of the newest rootstocks, the Geneva rootstocks are likely to be the ones of choice. All have some degree of fireblight tolerance or resistance. Some resist collar rot and wooly apple aphid. The fireblight tolerance, however, is the most significant improvement over older rootstocks and those from many other parts of the world. Many Geneva rootstocks are in the pipeline. G.16 and G.30 are generally commercially available. Newer rootstocks which are considered good alternatives to M.9 and B.9 are G.11 and G.41. G.11 has been built up in the nurseries so that it will be widely available in about 2 years. G.41 possibly will be a year behind.

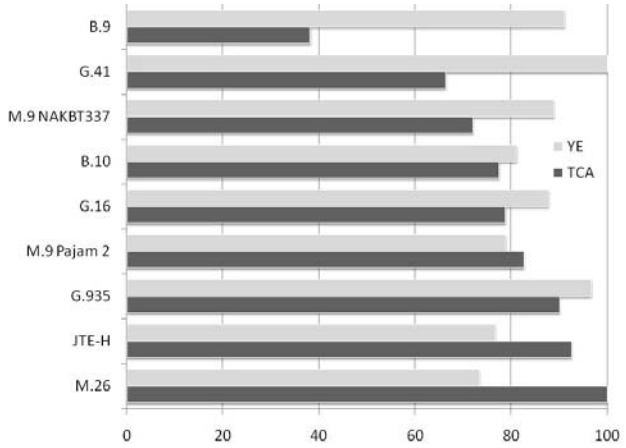

Figure 5. Relative performance of Golden Delicious apple trees on several rootstocks in the 2003 NC-140 Dwarf Apple Rootstock Trials (through 6 growing seasons).

IPM Heresies – What is true for you

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Integrated pest management (IPM) by definition encompasses every aspect of tending an orchard. The intent is to bring a multifaceted, systematic approach to whole orchard management picture. The point is to consider interactions and secondary effects of each action taken, and to make decisions that optimize your goals in running the orchard. This presentation will focus on "classic IPM" as a set of decision tools to determine if, when, and where insect and disease pest suppression is needed, and the selection of a strategy and mix of tactics to provide cost effective, environmentally sound results when treatment is needed.

Different people place different emphasis on different goals, and have different approaches to reaching those goals. Added to that are differences between orchards in rootstock, cultivar, orchard size, site characteristics, size, work force, equipment, finances, pest pressure, wholesale vs. retail vs. pick your own, different types of customers etc. As a result, IPM like other aspects of each orchard business is unique to each situation.

This variability complicates efforts to standardize IPM for use as a marketing tool, to document food safety, and measure progress in reducing environmental and human risks associated with pesticides. There is a set of recommended practices promoted by Extension IPM Programs, based on what are perceived to be preferred options for maximizing benefit from cultural and biological controls; optimizing the timing, selection and application of pesticide; and minimizing potential for potential for negative impacts.

Nature, science, and orchard management are full of nuance, ambiguity, circumstance and complexity. The word heresy comes from the Greek word for "able to choose", and is applied to those persons who do not conform to orthodoxy, which is the "established opinion of scholars". Orthodoxy comes from the Greek words for "having the right opinion."

If IPM decisions could be reduced to black and white rules, the right choices would be self-evident and we wouldn't bother talking about them. But management decisions are often judgment calls, and the "truth" is often a matter of opinion. By necessity, apple growers are IPM heretics to one degree or another. Growers have to sort through a variety of recommended practices, some practical, some not, and choose which IPM decision tools and pest suppression methods make sense for their situation. Which practices are likely to justify the time and other costs they require in return for equal or better crop value, lower risk, or lower pesticide costs? How do you prioritize and choose among different pesticides for characteristics like worker safety, conservation of beneficial species, or minimal environmental impact?

This presentation will review general observations about apple pest priorities and use of IPM practices, followed by interaction with the audience about the benefits and costs for a list of specific IPM pest monitoring methods, management practices, and pesticide selection criteria. Growers will be able to create a personal scorecard for defining their own right opinions for choosing among IPM options.

BLUEBERRY SCORCH UPDATE - WHAT YOU NEED TO KNOW

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PE Marucci Center for Blueberry and Cranberry Research and Extension
Rutgers, The State University
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Blueberry scorch is a virus disease that is increasing greatly in frequency in the northeast. The pathogen causes flowers to die without being fertilized and can result in major crop losses. After being introduced to a field the virus will infect a large percentage of the plants if it is not managed. Thus, this disease represents a serious threat to the blueberry industry.

Introduction of the disease to new planting should be avoided by using only clean planting stock. Use of cutting wood from noncertified sources such as production fields and noncertified nurseries should be avoided at all costs. In addition, growers should avoid purchasing plants from nurseries that are not certified. Introduction of scorch on to a farm will increase the risk of spreading the disease to other fields and also increase the cost due to removal and replanting. The NJ Department of Agriculture developed a scorch testing program as part of their voluntary nursery certification of NJ blueberry nurseries. Several nurseries are now certified to be free of the Scorch virus.

A virus causes blueberry scorch. For viruses to infect a plant they must enter a living plant cell through a wound. In the case of Blueberry Scorch, aphids can carry the virus on the sucking mouthparts or the stylus and inject the virus into the cell while feeding on plant sap. Once inside the cell the virus begins to multiply and spread to other cells in the plant. Eventually, the entire plant becomes infected and develops symptoms. Once a plant is infected it does not recover. Although infected plants may appear healthy during some years the infection is persistent and will greatly reduce berry production over the long term. Furthermore, the infected plants represent a source of inoculum that can be transmitted to healthy plants. For these reasons, it is a very good practice to remove infected plants. The virus is easily transmitted from mother plants to rooted cuttings making it critical to obtain cuttings from healthy mother plants only.

Growers and scouts should watch for development of scorch in the spring during bloom and mark all suspect bushes. Symptoms are easily seen during bloom. Growers should be aware if this disease is present on the farm and where the infected bushes are located. Mark locations of the disease on a farm map and monitor these areas in subsequent years. When suspect bushes are found they should cut back and removed. Aphid scouting and management should be made high priority in fields with infected plants.

Symptoms of the disease vary depending on the cultivar. In Weymouth, Duke, Elliott, and Chanticleer classic symptoms of scorched blossoms and a *Phomopsis*-like die-back are commonly seen. In other cultivars such as and Bluecrop the blossom scorch is less common and fruit may appear to set but will not develop. The plants may also appear chlorotic (yellowing similar to nitrogen deficiency) and partially defoliate. The disease may be easier to see by standing back from the bushes rather than close inspection. Shortly after bloom the plants will begin to recover. Even though symptom expression may not occur every year, infected bushes remain a source of inoculum in the field increasing the possibility for disease spread.

PYO Blueberries A Growers Perspective

New England Fruit, Veg and Berry Growers December 2009
Maurice Tougas
Tougas Family Farm
Northborough,MA 01532

The purpose of this presentation is to discuss my perspective on the pros and cons for growers considering planting or expanding commercial PYO Blueberry plantings. I will look at some of our experiences with cultural practices including pest challenges, marketing and a stab at a prediction for future trends.

Background:

We made our first planting of 4 acres in 1982. The planting was made on old orchard land, consisting of Paxton Fine Sandy Loam soil. Varieties included Earliblue, Blueray, Bluetta, Bluecrop,Jersey, Coville and Lateblue. Spacing was at 5'X 9', more or less. We were very stretched labor wise, and so the more or less part of the 9' varies from closer to 8' to 12'. Our inexperience at planting this many bushes resulted in varieties not being planted in as organized a fashion as I would today. Great for pollination, not so great at harvest time. Live and learn. Soil prep was minimal, about right for the dollars available at the time, and the desire to get plants into the ground ASAP.

Irrigation was not in place, nor was adequate weed control. This resulted in rather slow growth the first couple of years, and a delay in first harvest.

Since then we have added a total of 2 more acres of Berkley, Duke, Liberty and Draper, 5'X10' spacing.

Our first significant harvest was in 1987.

We will be planting another acre or so in the next year or so. We have limited our expansion due to our desire to market the entire crop via PYO. We have managed to balance production with demand for these past twenty or so years, and only this past season did we not manage to market the entire crop. That said, it was our largest crop ever, and the harvest season was spread out over an unusually long period of time. We began harvest the first of July, and finally gave up the first of October when demand fell off to being negligible.

We are open five days a week for PYO Blueberries. We feel that for the most part a week should pass between picking fields to allow the fruit to sweeten. This can vary of course depending upon temperatures.

I will be discussing more details regarding how we market soon. It also gives us a breather from having the public on farm seven days a week.

Cultural considerations:

We like to plant bushes at least a foot tall. We will have irrigation in place when we make plantings. Proper soil prep is a must, and we include addition of organic matter and sulfur to the planting rows.

We mulch our planting with aged wood chips for weed control, moisture retention and to keep the soil temp constant. I'll have more to say about mulching later.

We will use post emergent herbicides the first couple of seasons, and perhaps a mild pre emergent.

We attempt to deflower plants the first couple of years to encourage the bushes to fill their space. We use compost, Ammonium Sulfate, SulPoMag and sometimes triple 15 for fertilizer.

Pests:

#1 BIRDS! - We are surrounded by wood lots, and dare not be late in applying netting every season. We have used the black extruded 3/4" netting in the past, but we have been using "Smart Net" these past couple of seasons and are happy with that. The difference is that it is a knitted material rather than extruded, and so is much easier to handle. I cannot tell you if it will have a longer life than the extruded. It is about double the cost to purchase. It can be purchased as wide as 50' and so we are able to cover five rows at a time. With the 14' wide extruded we could only cover 1 row at a time, and needed to seam each row rather than every fifth row, so the savings is in labor in the long run. The Smart Net system also utilizes a wire within each edge, so spreading and retrieving are easier. We've tried balloons, audio distress and predator calls, flash tape and repellants. None of these have worked to our satisfaction.

#2 Weeds - I'm shy with the use of herbicides around my bushes. For better or for worse. The plants are shallow rooted and appear to me to be sensitive to herbicide use, and so I probably tend to err on the side of caution.

We have a good supply of wood chips, and so have depended on the use of these to supplement herbicides. The continued use of the chips tends towards a different weed complex over time, favoring perennials which are of course often more difficult to control. Also the very high organic content tends to limit the effectiveness of some herbicides, while of course it safens the use of others. We have also been recently been using a hybrid Reggi hydraulic cultivator/ Phil Brown herbicide boom to do in row cultivating. This leads us to our third most important or difficult pest

#3 Voles - Being a perennial crop which tends to get ignored in apple season, voles can be a real headache. Add to that the fact that they love compost, which wood chips ultimately become, and you have ideal conditions for mice/voles.

Close mowing and good in row weed control help, but the critters love the home you provide with mulch. Remember you are keeping the birds out for a couple of months, and that includes owls, hawks and probably foxes and coyotes, and so the mice will soon fall in love with you blueberry planting.

The difficulty we've had controlling these critters has lead us to alternate mulching with cultivation as described with the rotary type cultivator earlier to break up vole habitat to discourage population buildup. Upping herbicide use to keep a clean a row as possible also helps a great deal.

#4 Diseases - Mummyberry has not been a major concern probably due to some of our cultural practices such as cultivation and/or the use of wood chip mulches. We do also apply fungicides as appropriate.

Cane blights such as Phomopsis have been problems for us. We utilize pruning and fungicides as needed.

Anthracnose has been a problem for us as well, but have been controlled with the use of fungicides.

#5 Insects - Maggot has not been a problem for us.

Japanese Beetles are a problem some years.. Adult populations can be very difficult to control as they appear during harvest, and with PYO, applications of insecticides when there are pickers soon to be in the field can be problematic to say the least. This goes for fungicides as well. Since

these beetles will travel a distance to enjoy your berries, much of your control effort will need to take place outside of the planting as well. keep an eye on parking lots and other grassed areas nearby.

Marketing PYO.

Be patient, fair and firm. If you can't be, either hire someone who can, or don't do PYO.
A couple of points I mentioned earlier I will repeat. In central MA harvest will begin around the first of July, and continue well into September.
Fields/bushes need a week or so to ripen and develop flavor between pickings. This is especially important because as many time as you tell you customers that they are called "BLUE" berries, they will still pick green and or purple berries. One my best pickers is a blind women, and you cannot fool her. She picks blue fruit, and knows it if she is on a bush not ripe enough from her sense of touch. And so we have learned to explain to pickers that the fruit will come off the bush easily when ripe. They will still pick immature fruit, and so it is better to let the fruit get riper before you let them have at it. Without netting, you'll probably be tempted to let them in when the birds start so you have a fighting chance.
I don't want to be having my crew picking blueberries if it can be helped. We market essentially all of our crop PYO.

Who picks blueberries?

1) Family outing.
Maybe better stated, mom with her kids and a bunch of their friends. Blueberry picking tends to be less of a "Family" thing than say apple picking, and so fewer dads are along. Since blueberry season is largely in the summer and the kids are out of school, picking is more spread out over weekdays and less concentrated on weekends. In fact, you might just find that many of those "less interested in buying fruit, more interested in eating fruit" tend towards the weekend in blueberry season. Because of these two factors, the tourist pickers and the neighborhood gang, we have instituted a prepay system into our marketing. Everyone pays $3.00 before entering the field. Your $3 is applied towards your purchase when you are finished picking and you weigh out. If you are not interested in purchasing $3 worth of fruit, I'm not interested in having you in the blueberry planting. I started by saying you need to be patient, fair and firm. The $3 helps with the patience, as at least they will not walk away without having spent 3 bucks to be entertained, and fed. It is fair since it is not my job to provide customers with free entertainment nor a free lunch, and it does require being firm if you have not required prepay in the past. In the long run it is a whole lot easier on staff than dealing with the likes of the freeloaders who have no intention of doing anything but graze their way thru your farm. Some farms have started charging a non refunded entry fee. It is something we've considered for years, and probably a good way to go in the future.
2) Serious pickers
These are the blueberry lovers. These are the people who remember the good old days when they picked berries along side the road on the way to the beach. Some of these people just plain like to pick blueberries. We want to reward these pickers and encourage them to return. They cost us less to handle and they are usually very pleasant. I'm not telling you where to find them.
We reward them by giving them a discount when they purchase larger quantities, for example, they get a 50 cent /lb. break for 10 lb..... and a dollar or so break for 20 lb. or more.
These pickers tend to be less influenced by the weather, and can't wait to be able to pick again.

They tend to be older, and so the future will bring fewer of them.

Handling harvest.
We have divided our fields into pretty distinctive units. We rope off areas not to be picked that day, and direct customers to open fields. Within those fields we attempt to direct pickers to areas where we know the picking is the best. Not doing so will result in everyone insisting that we saved the 6 acres for them to be the first to pick, and so there is no need to proceed past the first bush. Everyone wants to pick on that poor first bush. Of course there are those who think we make money by assigning them the worst bushes to pick from, and that we're saving the best for grandmother. They will not listen. Let them pick where the good pickers already picked.
We provide customers with containers to fill and a quart plastic container with string attached to hang from their neck. Signage explains how to pick and we also poition field supervisors to help out.

Future Trends?
If I had a dollar for every time I was wrong.....
Our sales have been growing every year the crop allows it to. That is a good thing. However, 2009 was the first season we did not sell our entire crop. Partially due to the weather, partly due to the large size of the crop and partly due to increased competition. We have been seeing an increase in plantings in our area over the past 5 years or so, as has the nation as a whole. I'm told that in Michigan growers are not making new plantings and that wholesale prices dropped to below cost of harvest last season. Sort of sounds familiar.
Blueberries have been a "hot" item these past several years with all the talk of anti oxidant health benefits, and so this has helped sales keep pace with increased plantings. Unfortunately we begin harvest at about the time the glut in NJ begins, and when the supermarkets use them as their loss leader for he fourth.
Certainly the "buy local" and "staycation" phenomenon are helping.
As with pumpkin and apple picking I am optimistic that blueberry picking will evolve into the thing to do every summer and so demand will grow as strongly as supply is bound to.

Why Deep Zone Tillage/Vertical Tillage

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What is deep zone tillage (DZT)? Deep zone tillage is a type of reduced-tillage that combines strip tillage and sub-soiling. Unlike no-till, which relies on a heavy blanket of plant residue to protect the soil and which delays the warming of the soil and crop growth in Northern climates, DZT uses a 5-inch-wide tilled strip to simultaneously break up plow pans, warm the soil and prepare a seedbed. The field is prepared for planting using a zone builder, which consists of series of tools, mounted on two tool bars welded together into a single frame. A lead coulter cuts through the killed cover crop, followed by a narrow sub-soiling shank that breaks up the deep plow-pan, then a pair of opposing fluted coulters cut and prepare a narrow strip in the cover crop residue, and finally, rolling baskets help break up soil clods to prepare the narrow seedbed. Finger-like residue managers or additional coulters are usually mounted in front of the shoe on the planter provide a finished seed bed by removing any remaining residue or stones that may interfere with seeding. Most of the ground between the crop rows retains the heavy surface residue from the killed cover crop. The 5-inch-wide tilled strip is slightly raised (2-5 inch mound), warms faster than covered soils, and does not allow water to stand, or to build up enough speed to erode a slope.

What is wrong with conventional tillage? The extensive tillage practices used on vegetable farms in the Northeast are expensive, time consuming, fuel intensive, and result in problems with soil degradation, soil compaction, and soil erosion. Multiple tillage trips across the field are becoming cost prohibitive as fuel prices continue to rise. There is also a substantial investment in machinery and labor associated with tilling.

Between plowing, harrowing (several times), cultipacking or bedding, and cultivating (several times), we are literally working the life out of our soils. Constant tillage oxidizes soil organic matter (OM) away as CO_2. With conventional tillage, more organic matter is lost than can be replaced by incorporating crop residues and through the use of winter cover crops. Loss of OM reduces the reserve fertility in a field.

As the OM disappears, so do the earthworms, beneficial fungi and other beneficial organisms that depend on OM to survive. Many of these organisms provide the “glue” that hold the soil aggregates together to give us good soil structure. As the aggregates are broken down by tillage, and not replaced due to loss of OM and soil organisms, the soil air pores associated with the aggregates disappear too. This chain reaction leaves the soil devoid of oxygen and with an inability to hold water, nutrients and pesticides (which may run off and become pollutants). Obviously, plant root health suffers in such an environment, as do crop yields.

Loss of OM can also cause surface soil to plate or crust, making an almost impenetrable barrier, which reduces seed emergence and leads to water pooling, low oxygen conditions and even lower biological activity. The horizontal pressure at the bottom of a plow or harrow can produce sub-surface plow and disc-pans. Compacted plow pans often prevent root growth beyond 8-12 inches deep and lead to drainage problems, disease problems (think Phytophthora, etc.), reduce yields and additional tillage costs (i.e. subsoiling). A compacted soil depleted in

OM retains too little water during dry weather and floods during wet periods. Of all the problems associated with tillage, the most important problem is erosion, because soil lost, can not be replaced.

In 2006, one CT grower using conventional tillage actually resorted to building rock "bridges" every 100 yards or so across four-foot-deep erosion ditches, so that he could spray his sweet corn for insect pests, and then ended up rebuilding the bridges when they washed out. This type of soil loss makes it hard for future generations to acquire open land to grow our food. As land trusts and municipalities buy up the remaining open land in crowded New England towns, they often institute policies that prevent vegetable farmers using conventional tillage from renting land for fear of damaging the property. As urbanization spreads across New England, new neighbors along the farm boundaries object to the dust and noise. DZT is capable of reversing soil degradation and compaction problems, halting erosion, and even solving some of our urban/land value issues, and its faster and cheaper than conventional-tillage.

2008 Compaction and Organic Matter Survey. In 2008, I conducted a survey across CT to compare fields using reduced-till systems to those using conventional tillage. I surveyed 55 fields on 53 farms across the state; 46 conventionally-tilled fields and 9 reduced-till fields. While I was in the fields, I used a penetrometer to measure both surface (down to 6 inches) and subsurface (down to 18 inches) compaction (in p.s.i.), and took a soil sample and had it analyzed for percent OM, pH and macro and micro nutrients. I also recorded the depth that I encountered layers which were compressed to 300 psi because plant roots can not penetrate through soil that registers over that density. Multiple readings at 300 p.s.i. throughout a field can tell you the depth of your plow pan and thus, how much soil the plant roots can utilize. It can also tell you how deep to set the sub-soiling shank on the zone builder to put a slit through the plow pan, which improves drainage under the plants and allows for deeper root growth.

When we looked at farms where <u>most</u> penetrometer readings per field "maxed-out" at 300 p.s.i. (at least 6 of the 10 samples), it included 89% of the conventionally-tilled farms and only 33% of the reduced-till farms. This indicates that most conventionally-tilled fields have already formed an impervious plow pan, while most reduced-till fields have not. So, who should be looking for ways to break up their plow pans? Almost all conventional-till farmers! The average depth of plow pans (depth to 300 p.s.i. reading) were similar (11-12 inches) under both tillage systems.

For conventionally-tilled farms, 59% of the fields were low in OM (< 4% OM) and 41% were at moderate levels (4-8%). For reduced-till farms, 56% of the fields had moderate OM and 44% had high OM (>8%). The overall average for conventional fields was 3.9% OM, while reduced-till fields had 7.5% (almost twice as much). Perhaps the lesson from these results is that most conventionally-tilled farms could use more OM, and that OM levels in the reduced-till soils may be closer to the original (natural) levels before we started oxidizing it away through excessive tillage operations

Measuring Soil Health before Converting to Deep Zone-Tillage. A healthy soil is one that has optimum chemical, physical and biological attributes and is capable of sustaining crop productivity. Cornell's new Soil Health Test uses 12 different critical indicators to help measure and quantify a healthy soil. We used the new Soil Health Test to provide preliminary soil status data for 28 fields on 3 CT and 2 MA farms that were converting to DZT. Our goal is to re-test the soil on these farms in 5 years and detect some of the soil improvements that are expected to take place using DZT.

Even though all 5 growers that converted to DZT were very good farmers, all 28 fields had low OM levels and 64% of the fields were at very low levels (<2.5%). Ten of the 28 fields (36%) earned a red or unhealthy soil rating for organic matter, while 61% were rated yellow (medium soil health) and only one field rated green (healthy). A total of 24 out of 28 fields (86%) earned a rating of red, or unhealthy, for active carbon, which means that beneficial biological activity in those soils is very limited (the soil is a dead media instead of a healthy, functioning ecosystem). All the other fields were rated medium or yellow for active carbon. A plow pan was detected in all 28 fields between 9-13 inches deep. Eleven of the 28 fields (39%) earned a red rating for subsurface hardness, while 53% were rated yellow and only 7% were rated green. At least 2 of the 5 farms had most of there fields earn an unhealthy red rating in the following soil health indicators; potentially mineralizable nitrogen (reserve fertility), soil aggregate stability and phosphorus levels (P too high). Many fields also scored poorly in surface hardness.

Fortunately, the common management solution for all of these deficiencies is to reduce tillage, and by adopting DZT, these 5 growers are now on their way to healthier soils. What are you doing about the unhealthy soils on your farm?

Why not simply sub-soil fields? First of all, sub-soiling, followed by conventional tillage doesn't improve soil structure and just allows you to sink equipment deeper into wet fields. Secondly, a sub-soiler doesn't put the slit through the plow pan directly under the plant row the way DZT does, which facilitates deep rooting that can fully explore the soil profile for water and nutrients. It wasn't until one grower tried DZT for the first time, that it dawned on him why he still had a plow pan despite years of sub-soiling. With conventional tillage he would travel over his field another 8 to10 times with heavy equipment and re-compress the soil each year. With DZT you can prepare and plant the field with one or two passes. We saw this re-compaction first hand this past season on a CT farm with a bit of clay in his soils. This farmer also sub-soiled to start the season, but after plowing, harrowing and cultivating, we could no longer detect the soft slot left by the sub-soiler with the penetrometer.

Why use DZT? From a grower's point of view, perhaps the very best reasons for adopting DZT are because it is faster and easier to prepare a field for planting and you save money on fuel and equipment maintenance. The New England growers who have recently transitioned to DZT estimated that they cut field preparation time by 40 to 66% and reduced fuel consumption by 30 to 66%. The fuel delivery man on one of the farms actually complained that the farmer was not using near as much fuel as he used too. Now that is a complaint we would all like to hear! Less time preparing a field means more free time for other chores and fewer tractor hours, and since that is the most expensive piece of equipment on your farm, it pays big dividends to conserve tractor hours.

One farmer from a large NY farm did a breakdown of field preparation saving and found that he reduced his fuel consumptions from 100 to just 40 gallons per day (60% less), reduced his labor by 40% and saved a total of $50,803.60 or $46.18 per acre. He saved an additional $9.56 per acre on fertilizer with the new system, bringing his total saving (not including tractor hours savings) to $55.74 per acre. He figures he paid for his zone builder several times over the very first year.

This same NY grower also estimated that he improved his yields by switching to DZT by 13 boxes per acre (at $8/box that's an additional $104 per acre). One of the CT growers claimed that he increased his yield with DZT in a dry season (2007) by 50 bags per acre (50 bags more than he had ever yielded). He attributed this to the fact that the DZT preserves soil moisture

while planting during droughts so you get a better plant stand than in conventionally-tilled fields that take a week to prepare. He also had no problem with dry ear tips in 2007 while almost every grower in the state had dry tips that year, and he has experience the same problem during droughts with conventional tillage.

In the two wet seasons since then, he had a bumper crop in both years, while conventional-till growers really struggled with yields in 2009. He feels that DZT increases his yields in several ways during wet years. Fields that are moldboard plowed and/or harrowed absorb rain like a sponge and quickly turn into a quagmire that can result in stuck tractors, wasted time, delayed plantings and compacted soils. DZT fields with a heavy rye cover crop can usually be prepared and planted on time without putting a rut in the field. Even low fields that never get planted in wet years can usually be planted using DZT without tearing up the surface, resulting in increased acreage and yields compared with conventionally-tilled farms. Over 3 years breaking up the plow pan with DZT, we have watched one large, wet hole in one of his fields, turn from an unproductive piece of ground, with stunted or flooded-out crops, to a productive piece of ground that produces great crops. Another CT grower with a small farm noted, that because he didn't have to prepare a whole field at once using DZT, he could easily avoid the wet spots until they dried later in the season, and he claimed planting was faster because the rows were marked out by the zone builder. DZT also eliminates dead furrows. All the DZT growers noted that they were able to keep planting in a timely fashion this year, throughout the wet June and July, which resulted in some of the DZT farmers having corn to harvest when neighboring conventional-till farmers did not.

This year, 2 of the DZT growers who planted in fields highly infested with Phytophthora, experience much better drainage and far less damage from this destructive disease than they have in recent years, despite the exceptionally wet season. Far fewer rocks are pulled to the surface using DZT, almost eliminating the back-breaking chore of picking rocks before planting. Occasionally a large rock will get hooked by two or more sub-soiling shanks and get pulled to the surface. These large rocks are easily removed from the field with a front loader or bucket.

DZT stops soil erosion which can rob you of your most valuable resource. When combined with the use of cover crops, over time DZT reverses the deterioration of the soil, helps replace lost OM, improves soil drainage, increases soil water and nutrient holding capacity, eliminates compacted plow pans and surface crusting, allows beneficial soil organisms to thrive, creates more soil aggregates and pore spaces, and minimizes pesticide and nutrient runoff. Because of fewer trips across the field, growers say DZT reduces dust and noise when preparing fields near a crowded neighborhood, and completely eliminates dust-devils after field preparation. Growers find that they harvest much cleaner pumpkins and winter squash on the mulched surface than they ever could with conventional tillage, and one grower even acquired new rental land from a nearby municipality that will no longer rent to farmers that use conventional tillage. Could you really ask for more from a system that prepares your fields for planting?

Zone Tillage – Twelve Years Later

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I have been growing crops with zone tillage since 1997. I started with corn and soybeans, and as I gained experience from success and many mistakes, I added other crops. Today, all the crops on my farm are grown with either zone tillage or no tillage.

A quick explanation of zone tillage is " till only enough in the row to plant the crop, and do not till the row middles to grow weeds". Start by probing the soil to find any density changes caused by previous tillage operations. Then use a vertical tillage tool with a narrow shank to till a slot just below the higher density layer in the soil. This vertical tillage should not lift or invert any soil, just cut a narrow slot through it to allow crop roots and water to move deeper into the soil. I use an Unverfurth Zone Builder with two rolling coulters behind the vertical shank to build a 6-inch wide ridge of soil 3-4 inches high. This operation should be performed far enough ahead of planting to allow the soil in the row to warm and dry a little and to settle enough for a good seedbed for the planter. I prefer to do this in the late fall to eliminate one job in the spring that is always too busy anyway.

In heavier clay soils, performing the zone-building in the fall lets the freezing and thawing of winter break down clods and leaves a perfect seedbed for planting. When I tried zone-building in the spring in heavy clay soils, I always got too many clods to plant through. I had to go over the field with a cultipacker to break down the clods. I tried adding rolling baskets behind each row of the Zone Builder, but they were not aggressive enough to break the clods. I finally added three cultipacker wheels behind each row of the Zone Builder to break down the clay clods just as they were formed and was able to plant satisfactorily. However, I always have a nicer seedbed in the row if the zone building is done in the fall, and I recommend that.

After many years of zone building, I tried planting into my heavy clay soils without using the Zone Builder, and had no success. My soils are too tight for good root penetration, they stay cool and wet too long in the spring, and water runs off instead of moving into the soil. I have always had a better crop where I operated the Zone Builder.

That is not the case with gravelly loam soils. I have stopped using the Zone Builder on them with no decrease in crop growth. After several years of zone building, density layers are gone, and if you don't do something stupid, like disking, to put one back in, they don't form. On those soils, I have gone to just a zone tillage planter pass, or a no-till drill. One trip over the field in the spring and that's it.

On sandy soils, I have never used the Zone builder. I don't want to do anything to dry them out. I just use a zone tillage planter for corn and pumpkins and a no-till drill for cover crops and hay crops. One pass planting, and that's it. My sandy soils have compacted enough

over the past 10 years to grow good crops, even in a dry summer, and I want to leave them that way.

My zone tillage planter consists of an Unverfurth Zone tillage cart with a fertilizer tank and a tool bar with three coulters per row. The outside two coulters for each row have fertilizer nozzles, and all the fertilizer for each crop is injected 2-3 inches deep on each side of the row. A John Deere planter is pulled behind the cart with each planter unit centered over the tilled row. I have made several modifications to the planter to make it work better, and I highly recommend each one. I replaced the original John Deere gauge wheel tires with reduced-inner-profile tires from a Case/IH planter to lessen sidewall compaction. The John Deere tires were developed for full width tillage systems where the soil near the surface had dried and light compaction was needed to firm soil around the seed. With zone tillage, the planter is working in moist soil that does not need compaction. I added Keeton seed fimers to each row to stop seed bounce in the bottom of the seed furrow for more uniform spacing. I replaced the original rubber closing wheels with Martin spading closing wheels and drag chains to eliminate compaction over the seed and leave the soil on top of the row loose to warm up quickly. I added flood-type spray nozzles over each row at the back of the planter to apply a pre-emergence herbicide at planting so when I leave the field, everything is done and I don't have to worry about getting back in after a rain. In all but my clay fields, this planter is the only field operation for the crop. Seed, fertilizer, and herbicide are applied in one pass.

I have been doing more and more no-till over the last few years with a no-till drill. I think this is a natural transition for zone tillers after their soils have healed sufficiently to not need a zone building operation. The no-till drill is really just a very narrow row zone tillage planter with almost no soil disturbance. I still prefer the zone tillage planter for sweet corn and pumpkins because I like the warming of the tilled row and I need to inject fertilizer. I also use the zone tillage planter for soybeans following wheat or rye because I have had very bad slug infestations where small grain straw remains on top of the ground. The zone tillage planter cleans off a 5-6 inch row, and the slugs won't crawl over the bare soil. I can find them under the straw between the rows, but they leave the beans in the row alone. When I use the no-till drill in the same field, slugs will cut off whole sections of row wherever there is straw.

Today, most zone tillage planters do not use a fertilizer cart like I do. They have row cleaners ahead of the opener to clean a narrow row, and one or two coulters ahead of and to the side of the row to inject fertilizer. Floating row cleaners should always be used to avoid operating too shallow or too deep. With these planters, a fertilizer tank is needed either on the planter if it is heavy enough, or on the tractor. I use three coulters/row to till a wider row because my planter is trailed separately and tends to drift sideways on side hills. With a planter equipped with row cleaners instead of a cart, two coulters, one on each side, are enough.

The final part of successful zone tillage and no tillage is to always keep the soil covered. Plant cover crops to protect the soil, add organic matter, and grow nutrients for the next crop. Cover crops are the heart of zone tillage and no tillage and the subject for another discussion.

Managing weeds with crop rotation

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"Rotation of crops...is the most effective means yet devised for keeping land free of weeds. No other method of weed control, mechanical, chemical, or biological, is so economical or so easily practiced as a well-arranged sequence of tillage and cropping."

— C.E. Leighty. 1938 Yearbook of Agriculture

Diversity is key. Dissimilar crop species with disparate management practices impose a wide range of stresses and mortality factors, creating an unpredictable environment to which the weed community is continually adjusting (Liebman and Staver, 2001). Diversity, however, may also establish and/or perpetuate weed problems. Fall cucurbits, for example, may permit considerable weed growth after vines run, causing abundant seed rain (see sidebar, Figure 1, below). Cover crops, while frequently noted for their ability to reduce weed biomass, often contain weeds going to seed. Perennial legumes or sod crops favor perennial weeds such as quackgrass, and do not include timely soil disturbance events that promote germination losses of annual weeds. Thus, while diversity *is* key, successful weed management requires cropping sequences that feature practices that minimize, or better, eliminate, "credits" to the weed seedbank, while maximizing seed "debits."

Short-season cash or cover crops, whose growth is terminated before weeds set seed, are the most useful elements in preventing weed seed credits (Figure 1). The tillage events necessary for these crops are often well-timed to preempt seed rain of winter annual weeds. Ideally, the crops are then terminated before their associated summer annual weeds set seed. In considering longer-season crops, good weed control, a competitive canopy, and opportunity for hand roguing surviving weeds are key attributes.

Debiting strategies require consideration of weed seedbank ecology (Gallandt, 2006). Because germination is the most effective way to deplete the seedbank, it may be useful to consider primary tillage practices that maintain seeds at or near the soil surface, in the "active seedbank," where seeds are most likely to experience environmental conditions that encourage germination. Seed predation is also an important source of loss from the seedbank, and a further reason to keep seeds at the soil surface. Avoiding fall tillage and rapid weed seed burial maintains seed at the soil surface where they are more readily consumed by predators.

Initial conditions of the seedbank should be carefully considered in short-term crop sequence planning. Where the starting weed pressure is very high, a clean fallow period is the best strategy for drawing down the seedbank (Mohler, 2009; Nordell and Nordell, 2007). Because weed species vary in their seasonal patterns of emergence, the timing of fallow periods should target the most problematic species or group of weeds. Winter annuals, for example,

exhibit peak emergence in the late fall and early spring—summer annuals, in the warmer periods of June and July. Shallow tillage coincident with this emergence periodicity will stimulate germination of the targeted group of weeds, and subsequent tillage kills these seedlings.

If the seedbank is at a moderate level, cropping options may be expanded to include crops that are both amenable to effective cultivation, and are sufficiently competitive that abundant weed seed rain is unlikely. These so-called "cleaning crops," seem to vary from farm to farm. Onions, for example, are a cleaning crop for some growers. A long-season and uncompetitive crop, growers know onions must be nearly weed free, so they make frequent cultivation a priority for this crop. This frequent, shallow cultivation offers benefits similar to fallowing strategies, encouraging successive flushes of weeds that are removed by subsequent cultivation events. While the need for repeated cultivation may be viewed negatively in the short-term, the long term effect is depletion of the seedbank. Potato and sweet corn are cleaning crops for some growers. These crops can be aggressively cultivated and weeds kept at a minimum. Slow to establish, uncompetitive species, e.g., carrot and parsnip, onion and leek, are ideally planted in the cleanest of fields.

Weed Seed Rain

We measured common lambsquarters weed seed rain in a broccoli, winter squash rotation, managed without cover crops (control), with fall cover crops, two consecutive years of red clover (2-Yr. CC), or alternate years of vegetables and cover crops with summer fallowing (e.g., after strategies described by Nordell and Nordell, 2007; Figure 1). The alternate year cover crop system consistently had the lowest common lambsquarters seed rain (see Alt.-Yr. CC, solid boxes, below). This, combined with the seedbank depleting fallowing periods during the cover crop years, prevented this species from increasing over the four years of the experiment (data not shown).

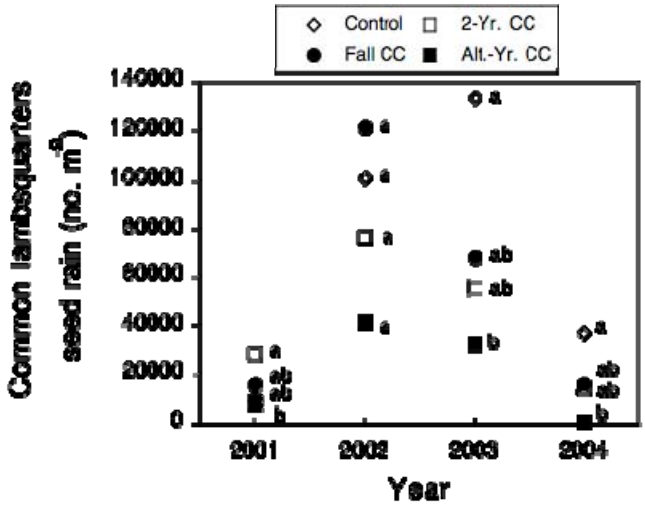

Figure 1. Effect of cover crop systems on common lambsquarters seed rain in 2001 through 2004. Within a year means labeled with different lowercase letters are significantly different based on Tukey's HSD ($P < 0.05$). Gallandt, E.R. unpublished data.

Given the importance of the relative size of the weed seedbank to the success of subsequent weed management practices, it seems counterproductive for an otherwise clean rotation sequence to include a crop likely to result in abundant weed seed rain (e.g., my problem with winter cucurbits). Rotation blocks could consider likelihood of seed rain as a first separating criterion. "Weed-free" blocks could be managed with a long-term vision for improving weed management conditions. Elsewhere, the commonly used "critical period" for weed control can continue to guide management, focusing on control of weed seedlings in the

early to mid-period of crop growth. Before the start of this period, weeds are too small to reduce crop yield; after this period crop competition alone will avoid weed-related yield losses. In other words, “beat the weeds back” early to ensure a good crop and don’t worry about weedy crops late in the season. There are many successful farmers who rely on this approach to weed management. They focus on repeated cultivation and hand weeding until crops are judged to be sufficiently weed-free. However, seed rain from weeds surviving the critical period means that weed pressure is likely to increase over time. In response, the frequency of cultivation and hours of hand weeding will have to increase to simply maintain a given level of weed control. The alternative, managing for improving weed conditions, requires careful deployment of diversity, minimizing credits and maximizing debits to the seedbank (Gallandt, 2006).

Forcella, F., K. Eradat-Oskoui, et al. (1993). "Application of weed seedbank ecology to low-input crop management." Ecological Applications **3**(1): 74-83.

Gallandt, E. R. (2006). "How can we target the weed seedbank?" Weed Science **54**: 588-596.

Leighty, C.E. 1938. “Crop Rotation.” in Soils and Men, U.S.D.A Yearbook of Agriculture. pgs. 406-430

Liebman, M. and C. P. Staver (2001). Crop diversification for weed management. Ecological Management of Agricultural Weeds. M. Liebman, C. L. Mohler and C. P. Staver. Cambridge, UK, Cambridge University Press**:** 322-374.

Mohler, C. L. (2009). The role of crop rotation in weed management. Crop Rotation on Organic Farms. A Planning Manual. C. L. Mohler and S. E. Johnson. Ithaca, NY, Natural Resource, Agriculture, an dEngineering Service (NRAES)**:** 44-46.

Nordell, A. and E. Nordell (2007). Weed the Soil, Not the Crop. A Whole Farm Approach to Weed Management. Trout Run, PA**:** 42.

Efficacy of Various Biological and Microbial Insecticides: Does that Really Work?

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Although this presentation is about the efficacy of insecticides approved for organic production I am going to start out with an argument for building the foundation of your insect management program on cultural practices that influence insect pest populations. Because……

* Relying on products is not in line with the spirit or rule of the National Organic Program.
* Insecticides approved for use in organic production systems tend to be relatively expensive.
* With a few exceptions, they kill a smaller percentage of pests than insecticides used in conventional production systems.
* Some are broad spectrum and can have a negative impact on natural enemies.
* We don't have a lot of information about how well they work

These materials should be thought of as "rescue treatments" to use in situations where cultural practices do not maintain pest populations below acceptable levels.

Practices that can help reduce insect pest populations include:

- Promote plant health by maintaining a healthy, microbially active soil
- Rotate away from overwintering sites (works for some pests)
- Maintain nutrients in balance, avoid excess N
- Conserve natural enemies
- Purchase and release natural enemies
- Use row cover to get crops through vulnerable stages (for small acreages)
- Choose resistant or less attractive varieties

Some insect pests have proven to be quite recalcitrant to being managed by cultural practices and are problems year after year on many farms. These include:

- Striped cucumber beetle
- Squash bug
- Tarnished plant bug
- Potato leafhopper
- Flea beetles, esp. on crucifers and eggplant
- "Worms" pests in crucifers
- "Worm" pests in sweet corn

There may be others that you struggle with on your farm. For these pests, it's important analyze the economics of crop loss vs the cost of control, to be familiar with your control options, their cost and efficacy, and to have products on hand prior to detecting unacceptably high pest levels.

Timing becomes more important when using materials with limited efficacy and you want to be targeting a relatively low population or a vulnerable life stage whenever possible. Understand the biology of problem pests so you can anticipate when they will arrive and when vulnerable stages are present.

Excellent coverage is also important, and spray adjuvants may be needed for some crops to improve spreading and sticking of the product. Several spray adjuvants are approved for use on organic farms. Rotate product types whenever possible to slow the development of resistance. Keep in mind that pesticide manufacturers are not required to demonstrate efficacy to list a pest on a product label. The Organic Materials Review Institute (OMRI) is a non-profit that has undertaken the task of interpreting the National Organic Program rules and maintaining a list of products approved for organic production. Many certifiers use the OMRI list as the basis for their list of approved products, but products go on and off the list for a variety of reasons. **Always check with your certifier before using a product for the first time.**

PRODUCTS:

Microbials

Bacillus thuringienisis (Bt) is a bacterium containing a crystalline protein toxin that paralyzes the insect's midgut causing it to stop feeding. They must be ingested to be effective. Bt is specific to its host family and has very little impact on natural enemies. Different strains of bacteria are effective against different families of insects. Bt *kurstaki* and *aizawi* are effective against lepidopterous larvae, for example the "worm" pests that feed on brassicas. Several products containing kurstaki or aizawi strains are OMRI listed. Be very careful to match the product name and formulation exactly with the OMRI listing. Other strains (*tenebrionis* and *san diego*) are available that work against beetles such as Colorado potato beetle, but no products containing these strains are currently OMRI listed. Another strain, *israelensis*, works against fly larvae such as mosquitoes, fungus gnats, and black flies. One product containing Bt *israelensis* (Gnatrol WDG) is OMRI listed.

Beauveria bassiana and *Metarhizium anisopliae* are entomopathogenic fungi that have been formulated into foliar or soil-applied insecticides. The fungal spores germinate on the surface of the insect cuticle and invading the body cavity with threadlike mycelia, eventually killing the insect. When the food resources have been consumed the fungus grows through the surface of the insect and produces spores that can then infect other insects. Entomopathogenic fungi rarely cause epidemics because they require high humidity to infect and sporulate. These fungi tend to have a broad host range and can have a negative impact on natural enemies. Insect mortality is not spectacular, and their residual activity is short because the spores are killed by untraviolet radiation from the sun. They may be most effective for long-term population reduction in insects that pupate in the soil, where conditions are more conducive to infection. Products containing *Beauveria bassiana* are currently on the OMRI list.

Botanicals

Pyrethrin is extracted from the flower heads of a type of chrysanthemum. It is a broad-spectrum nerve toxin with a very short residual on the leaf surface, so often needs to be applied frequently to be effective. In trials pyrethrin products have been shown to be effective against a wide range

of insects including potato leafhopper, striped cucumber beetle (inconsistent results), squash bug, and "worm" pests on brassicas. Some trials have shown that mixing pyrethrin products with azadirachtin (neem) products increases their effectiveness against certain pests, particularly squash but and Japanese beetle.

Neem products are extracted from the seed of the neem tree, which is native to southern Asia. The two main types of products are: azadirachtin extracted by solvents from crushed seeds, and neem oil pressed from the seeds. Azadirachtin acts mainly as an insect growth regulator, but also has anti-feedant and oviposition (egg laying) deterrent properties. It has shown some efficacy against certain caterpillars and squash bug, as well as some aphid species. Azadirachtin products have been shown to improve control against some insects when mixed with pyrethrin products, especially against squash bug and Japanese beetle. Neem oils act similarly to other horticultural oils, smothering and killing small insects such as aphids and mites. Neem oil is also has fungicidal properties. Several azadirachtin-based and neem oil-based products are OMRI listed

Several products that are mixtures of essential oils have been developed for insect control. I have not been able to find trials demonstrating their efficacy or lack thereof.

Fermentation products

Spinosad is a compound produced during fermentation of an actinomycete soil microorganism. It is generally safe for many natural enemies. It is very effective against several important insect pests including Colorado potato beetle larvae, cabbage flea beetles, many species of caterpillars, and onion and western flower thrips. Because it is so effective, it is tempting to use it repeatedly against the same pest population. It's important to use it in rotation with other materials, reserving it for critical times in pest or crop development, to avoid pests developing resistance.

Online resources:

Resource Guide for Organic Insect and Disease Management
www.nysaes.cornell.edu/pp/resourceguide/

Organic Production Guides
http://nysipm.cornell.edu/organic_guide/

Organic Materials Review Institute
omri.org

National Sustainable Agriculture Information Service
http://attra.ncat.org/

Efficacy of Various Biological and Microbial Fungicides - Does That Really Work?

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Many different products have been registered and approved for managing diseases in organically-grown crops in the USA. Active ingredients include botanical oils (e.g. sesame, rosemary, tea tree), plant extracts (giant knotweed, garlic), and chemicals (hydrogen peroxide, potassium bicarbonate, mineral oil). Other products have as their active ingredient a microorganism that acts as a biocontrol agent, directly affecting the pathogen (e.g. Contans), or produces a compound during fermentation that provides control (e.g. Sonata). Some products suppress disease by inducing the plant to activate its defense mechanisms (e.g. Companion, Regalia). There is a long list of crops and diseases on the labels for many organic fungicides, thus growers now have a lot to choose from.

There is, however, limited data on efficacy of these products for specific uses from replicated experiments conducted under field conditions. Efficacy is not a requirement for pesticide registration in the USA. Federal registration decisions are made by the EPA, thus focus is potential negative impact on the environment, including non-target organisms. And additionally, many products for organic agriculture are produced by small companies lacking the resources to support efficacy experiments for all labeled uses. Laboratory tests are conducted to determine pathogen sensitivity. Recognizing the need for efficacy data to promote use of registered biopesticides and to foster develop of new products, the IR-4 program has been running a federally-funded grant program for evaluating new and labeled uses of biopesticides. Most biopesticides are NOP compliant. But there are organic products that are not considered biopesticides (e.g. JMS Stylet-oil) and there are biopesticides not suitable for organic production (e.g. phosphorous acid fungicides).

Below is a list of OMRI-approved products and labeled uses, followed by a list of results from efficacy experiments found. Focus is on efficacy for the product used alone, and on non-copper products. Several treatments tested have been combinations of products including conventional ones. It is important to note that some products have continued to be developed and improved following registration, thus results obtained with an early formulation might not reflect the degree of control obtainable with the current formulation. Additionally, performance of some products is thought to have been negatively affected by the adjuvant used (e.g. Biotune). Other factors that can affect product performance include whether applications were started when there were few or no symptoms, frequency of application, and disease pressure. Most efficacy evaluations have been conducted on crops grown with conventional production practices. Anecdotal results from organic growers are being sought to add to this list.

Actinovate SP. 0.0371% *Streptomyces lydicus*. Labeled for suppressing several foliar and soil-borne diseases on many crops; diseases and crops listed separately. The biocontrol agent colonizes roots, protecting them from pathogens and making minerals and micronutrients more available to plants, which thus are more vigorous and larger. EPA Reg. No. 73314-1. Natural Industries, Inc.

Cease. 1.34% *Bacillus subtilis* QST 713 strain. Labeled for many diseases on many crops grown in the greenhouse. EPA Reg. No. 69592-19-68539. BioWorks, Inc.

Companion. 0.03% *Bacillus subtilis GB03.* Activates induced systemic resistance in plants. Labeled for several soil and foliar diseases on many crops. EPA Reg. No. 71065-2. Growth Products, Ltd.

Contans WG. 5.3% *Coniothyrium minitans* strain CON/M/91-08. Soil-applied product for *Sclerotinia sclerotiorum* and *S. minor*. Labeled for several crops. EPA Reg. No. 72444-1. Sylvan Bioproducts, Inc.

Copper fungicides. OMRI listed products include Champ WG, Nordox 75 WG, and NuCop HB. Labeled for many fungal and bacterial diseases on many crops.

JMS Stylet-oil. 97.1% Paraffinic oil. Labeled for fungal diseases, aphid-transmitted viruses, and insects on several crops. EPA Reg. No.65564-1. JMS Flower Farms.

Kaligreen. 82% potassium bicarbonate. Labeled for powdery mildew only on many crops. EPA Reg. No. 70231-1. AgBio, Inc.

KeyPlex 350 OR. Combination of defensive proteins (alpha-keto acids) and secondary and micronutrients. Elicits systemic acquired resistance in plants against fungal and bacterial pathogens. EPA approval for organic production. EPA Reg. No. 73512-4. KeyPlex.

Mildew Cure (formerly GC-3 Organic fungicide**)**. 30% cottonseed oil, 30% corn oil, 23% garlic extract. Labeled for powdery mildew on various crops. Exempt from EPA registration. JH Biotech, Inc.

MilStop. 85% potassium bicarbonate. Labeled for powdery mildew and several other diseases on many crops. EPA Reg. No. 70870-1-68539. BioWorks, Inc.

Organocide. 5% sesame oil. Labeled broadly for several fungal diseases and insects. Exempt from EPA registration. Organic Laboratories, Inc.

OxiDate. 27% hydrogen dioxide. Labeled for several diseases on many crops. EPA Reg. No. 70299-2. BioSafe Systems.

Promax. 3.5% thyme oil. Labeled for several soil-borne fungal diseases and nematodes on many crops. Exempt from EPA registration. Bio Huma Netics, Inc.

Proud-3. 4 qt/A. 5.6% Thyme oil. Labeled as a broad-spectrum fungicide, insecticide, and miticide on several vegetable crops. Exempt from EPA registration. Bio Huma Netics, Inc.

Reglia SC. 5% Extract of *Reynoutria sachalinensis.* Boosts the plants' natural defense mechanisms against certain fungal and bacterial diseases. Labeled for use against several fungal and bacterial diseases on several crops. EPA Reg. No. 84059-2. Marrone Bio Innovations, Inc.

Saf-T-Side. 80% petroleum oil. Only labeled as an insecticide and miticide on vegetable crops; powdery mildew and rust on other crops. EPA Reg. No.48813-1. Clawel, division of Brandt Consolidated.

Serenade Max. 14.6% *Bacillus subtilis* strain QST 713. Labeled for many diseases on many crops. AgraQuest. EPA Reg. No.69592-11.

Sonata. 1.38% *Bacillus pumilus* strain QST 2808. Labeled for several diseases on many crops. AgraQuest. EPA Reg. No. 69592-13.

Sporatec AG. 18% rosemary oil, 10% clove oil, and 10% thyme oil. Labeled for several bacterial and fungal diseases on many crops. Exempt from EPA registration. Clawel, division of Brandt Consolidated.

Sulfur fungicides. OMRI listed products include Microthiol Disperss, THAT Flowable Sulfur, and Yellow Jacket Sulfur 80 DF. Labeled for powdery mildew as well as mites on several crops and a few other diseases on select crops.

T-22 HC (formerly PlantShield HC)**.** 1.15% *Trichoderma harzianum* Rifai strain KRL-AG2. Protects plant roots against fungal pathogens. Apply to seed, transplants, or soil mix. EPA Reg. No. 68539-4. BioWorks, Inc.

Trilogy. 70% clarified hydrophobic extract of neem oil. Labeled for several diseases and insects. EPA Reg. No. 70051-2. Certis USA L.L.C.

Yield Shield. 0.28% *Bacillus pumilus* GB34. Seed treatment labeled on several crops for *Rhizoctonia, Fusarium* and other fungi that attack roots. EPA Reg No. 264-985. Bayer CropScience.

Carrot

Alternaria leaf blight and Cercospora leaf spot. Sporan provided limited control.

Celery

Pythium root rot. ZeroTol (hydrogen dioxide) ineffective.

Collard

Downy mildew. Sonata (2 qt/A) ineffective.

Garlic

White rot. Contans ineffective applied at planting.

Lettuce

Downy mildew. Oxidate (76 fl oz/A) provided limited control.

Sclerotinia drop. Contans effective in 2 experiments; against Sclerotinia sclerotiorum but not S. minor in one experiment where both pathogen tested separately. Serenade ineffective in one experiment.

Cucurbit Crops

Anthracnose. Actinovate 6 oz/A + Latron ineffective.

Downy mildew. Sonata (2-4 qt/A) + Biotune provided low to moderate control in 3 experiments; ineffective in 1 experiment. In another experiment, all products were effective based on at least one assessment: Sporatec AG (1 qt/A) and Organocide (1 oz/gal) + NuCop HB (1 lb/A) were most effective; Actinovate (12 oz/A), Regalia SC (0.5%), Serenade MAX (3 lb/A), Sonata ASO (4 qt/A), Taegro (3.5 oz/100 gal), and Timorex Gold (0.75%) were also effective.

Gummy stem blight. Serenade (3 qt/A) + Biotune ineffective.

Phytophthora blight, Companion (3 qt/A) ineffective.

Powdery mildew. Almost all products tested have been effective, including sulfur (Microthiol Disperss (4 lb/A), copper, Actinovate (3-6 oz/A), Companion (32 fl oz), Eco E-Rase (0.5%), Kaligreen (4 lb/A), Milstop (2.5 lb/A), Organocide (2 oz/gal), Regalia (1%), Serenade MAX (2 lb), Sonata ASO (4 qt/A). Microthiol Disperss and Organocide were among the most effective.

Pepper

Bacterial spot. Actinovate ineffective. Serenade Max (1 lb/A) ineffective.

Potato

Scab, silver scurf, black scurf. Plant Shield provided inconsistent control when applied to cut seed day before planting or sprayed onto stems and then irrigated plus applied to foliage (4 treatments tested).

Tomato - field

Bacterial spot. Regalia SC (0.5 and 1%) as effective as a conventional fungicide program with Kocide 2000, Maneb, and Bravo. Actinovate ineffective. Serenade Max (1 lb/A) + Sonata (1 qt/A) + Biotune ineffective; disease pressure high in this study.

Bacterial canker. Serenade Max (1 lb/A) + Kocide 2000 + Biotune ineffective. Disease pressure high and limited control achieved with conventional treatment.

Powdery mildew. Almost all products tested have been effective: Actinovate (12 oz/A), Regalia, Companion (0.5 gal/A), Sporatec AG (2 pt/A), Organocide (2 oz/gal), and copper (Kocide 3000).

Septoria leaf spot. Actinovate (12 oz/A), Regalia (0.5%), Companion (0.5 gal/A), Sporatec AG (2 pt/A) when applied with Saf-T-Side (1.5%), Organocide (2 oz/gal), and copper (Kocide 3000).

Tomato – high tunnel and greenhouse

Botrytis gray mold and leaf mold. OxiDate effective and similar to Kocide 3000. It was applied every 7-10 day.

Botrytis gray mold. Serenade Max (2.5%) was effective; PlantShield HC was not.

Please Note: Before obtaining a product confirm state registration and organic approval with certifier. The specific directions on fungicide labels must be adhered to. Any reference to commercial products, trade or brand names, is for information only; no endorsement is intended.

Adapting to the 21st century

Gary Sweet
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Sweet's Gourmet Sweet Corn has been in business for over 100 years. During those years, we have developed a systems approach to our business to evaluate everything that you can do to improve your operation and profitability.

Our fall season is for making sure of a strong planting of the cover crop, managing surface and subsurface drainage, removing rocks and taking and evaluating soil samples. Also included is spot spraying for perennials, clearing the field edges and putting in a deep strip for next year's zone tillage. We also try to determine our customer base- especially the retail customer. This helps to determine the crop size and the goal of harvest for the fourth of July.

The winter season includes the attendance at three to five regional vegetable conferences. We also meet with our crop consultant for his recommendations on improvements for the next year. These include which types of herbicides and pesticides to use as well as which fertilizers and mirconutrients will enhance the crop. Seed varieties round out the consultation.

The spring season involves the planting, spraying of herbicides, placement and removal of floating row covers (at 2-3' stage) sidedressing, foliar feeding and animal control. We always monitor the fields for the three W's- weeds, worms and woodchucks.

Summer is of course harvest. Prior to picking, we "top" the corn. This makes it much easier to pick and assists with the prevention of storm damage. Picking at the right time is of utmost importance- not too young and not too old.

Packing involves first grading the corn by large, small and questionable ear appearance. Those ears then go into our name branded bag of small (4-5ears), medium (7-8 ears) or large (13-15 ears). Once the packing is complete, orders are loaded into vans or trucks for delivery to our retail outlets which are mostly chain stores.

Questionable ears go to our main outlet for further grading. At that outlet only, we sell a ' value pack' in addition to our other bagged corn. Many families like the option of a smaller ear for a reduced price and it means less waste for us as well.

Marketing is the most important part of our operation! Our customers are our lifeline and they

- Like our dependability
- They like the flavor
- They like EXCELLENT corn everytime they make a purchase
- They like tenderness
- They like the corn to come off the cob cleanly and not stick in their teeth

We also include cooking instructions as we have found that many people overcook the corn- well beyond the recommended three minutes in boiling water or two minutes per ear in the microwave.

Keep the price the same throughout the season for quality doesn't cost- it pays.

SCHEDULING SWEET CORN PLANTINGS
THE EASY WAY
By Using Plant Maturity

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Most experienced Sweet Corn growers are familiar with the problem of several plantings maturing all at the same time, and many of you have at least heard of scheduling planting using growing degree days (GDD) to avoid this problem. I have developed a very easy and intuitive method for measuring growing degree days that involves observing the stage of corn plant development rather than temperature recording devices. Jake Guest of Kildeer Farm in Norwich VT remarked enthusiastically the first year he tried it: "This thing really works!"

Corn plants mature proportionally to the number of growing degree days transpired since they were planted. On warm days they grow more than they do on cool days. That's why the method of scheduling corn plantings using the transpired growing degree days works. The plant maturity method of measuring transpired growing degree days, correlates specific stages of corn plant maturity with the number of growing degree days it took to get them that big, and allows a grower to schedule the next planting by observing the maturity of the previous planting.

Visual Growth Stages of Young Corn Plants

First we need to be able to visually recognize incremental growth stages of young corn plants. This is done by counting the number of leaves the plant has on it, and then by defining which of 4 stages the youngest leaf is in.
The 4 discernable stages each corn leaf goes through before the next leaf emerges are: Spiking, rolled, rolled-plus and flat. See the photos and descriptions below.

Stage 1: Spiking
The leaf is tightly rolled and pointing straight up. In this photo the 4th leaf is a thin spike in the center of the plant.

Stage 2: Rolled
The tight roll in the leaf is loosening and the leaf starts to point away from the previous leaf.

Stage 3: Rolled +
The Roll in the leaf is open, but still provides enough rigidity to the leaf that the outer half does not fall below 45 degrees from the vertical.

Stage 4: Flat:
The leaf is fully open and the outer half of the leaf has fallen below 45 degrees from the vertical.

After the leaf goes through the flat stage, the next leaf appears in the spiking stage. You end up with maturity descriptions like "Second leaf, rolled" or "Third leaf, spiking" These stages can be correlated to transpired GDD and used to time your next planting of sweet corn.

The basic procedure is as follows:

1) Planning: Figure out how many GDD you want between plantings (see below) and correlate that with a plant growth stage. A planting can be either one variety or a group of sequenced varieties planted on the same day.
2) Plant your first planting.
3) Watch the plants in that first planting. You're looking for the "early majority" of the plants in that planting to reach the specified growth stage.
4) When your first planting has reached the specified growth stage, it's time for you next planting.
5) Continue with the same procedure for subsequent plantings.

In actually implementing the critical step of identifying the growth stage you are looking for in the field it's a good idea to learn to anticipate the desired plant stage. Once you've found the photo showing the stage of maturity that will tell you it's time to make your next planting, take a good look at the photos and descriptions of the stages that come before it. This will help you recognize the subtle differences in maturity, and help you anticipate the stage that you're waiting for. Those of us who have used the system much have come to realize that it's hard to find out that today is the day to make your next planting of corn, and to actually get it done today as well.

How many GDD do I want between my corn plantings?

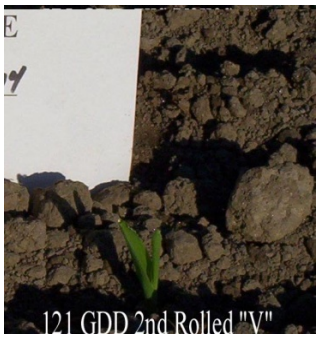
This depends on 2 variables:
One, how many varieties are there in one planting? We'll call this variable "V".
In my example I have 3 varieties: Mystique, Precious Gem and Delectable. So, V=3
Two, how many days to harvest are there between the earliest variety and the latest variety in your grouping? We'll call this Variable "DH"
In my example the earliest variety, Mystique, is 75 days, and the latest, Delectable, is 82 days, so in my case DH is 7 (82 -75).
Insert your numbers into this formula:
{DH + (DH/[V-1]} x 17* = GDD
In my example this becomes {7 + (7/ [3 – 1]} x 17 = 178 GDD

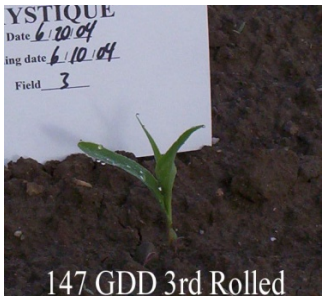
*17! Where did 17 come from? One of the basic assumptions of the growing degree day method of spacing Corn Plantings is that there are approximately 17 GDD in a mid summer's day. This is one of the standardizing assumptions used in specifying "Days to harvest" by seed breeders and is the number used to spread out corn planting in the GDD method.

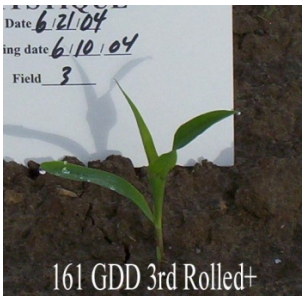
So, I'm looking for the plant growth stage that is 178 GDD. From the Photo Scale below, it appears that I'm looking for something between 3rd leaf flat and 4th leaf spiking.

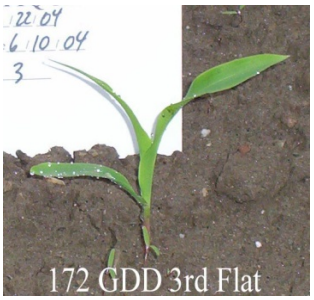
In my example, I will look for the early majority of the plants in my first planting to reach the "3rd leaf flat" stage, and I will plant my second planting the next day, with a very early 4th leaf spiking.

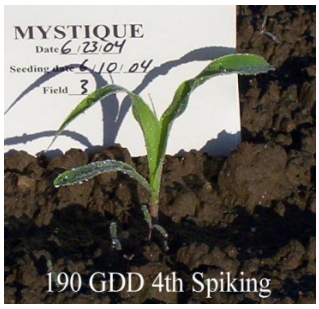
Photo Scale of Corn Plant Maturity Correlated with Growing Degree Days











Corn Stars

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Very few species in the vegetable industry display the rapid changes and advances that are seen in sweet corn. Corn genetics are relatively well understood by the breeders (scientists). There are billions, if not trillions of possible gene combinations.

Corn is highly hybridized. Each year, breeders work with hundreds of new inbred (parent lines), and cross them with other parent varieties that have known, desirable traits (Test lines). The outcome is tens of thousands of new hybrids. Often, these new hybrids are trialed in research plots. Numerous notes are taken in an effort to understand what specific traits each parent line contributes to their offspring. In the final stages of the development of hybrids, a breeder, assistant breeder, skilled technician or perhaps a salesman walks the plots. Varieties are scored on several dozen traits. A small percent of them show commercial potential and are advanced into naming and production.

A variety that shows "star" potential in a test plot still has a lengthy process to complete before it is a "Superstar," in the marketing world. It is necessary to know if the variety will produce ample yields of strong seed. Will the Hybrid be adaptable across a broad enough geographic range to make it worthy of production? Does the variety fit a necessary niche in the market with the required appearance, color, flavor and maturity?

Today's markets are highly fragmented. Varieties can be classed by color (bicolor, white, or yellow), maturity (generally early, mid or late), and isolation group (the su group, including se's, and also the sh2 group). Today, there are also many subcategories of the aforementioned gene types, such as synergistic and augmented.

Less than a generation ago, a "superstar" variety like "Silver Queen," sold upwards of 2 million pounds of seed per year. Today, partly due to market fragmentation, a very successful fresh market variety would have sales of 100,000 pounds annually. In today's fresh market category, few varieties actually reach the 100,000 lb mark. To be a commercially viable variety, most production companies would target a minimum of 10,000 lbs of seed sales. This means that there are many more varieties filling the market niches, and it appears that the varieties often have a shorter market lifespan.

Breeding, trialing and marketing has become increasingly competitive. And just because many of the new varieties don't sell a million plus pounds, doesn't mean that they are not improvements. Many of us would have a hard time choking down a "superstar" variety of bygone days.

So, what varieties may rocket to the top of our favorite lists, over the next year?

Stellar is new in the 76 day slot. It is a bicolor, high quality, augmented sh2. Stellar is marketed by Stokes, Seedway and Siegers. It is an augmented sh2, with excellent productivity. It was a real standout in several of the trials this summer, and seems to working as far south as Georgia. In one trial, Stellar had long shanks, and it always seems to make a large package. Large packages are a concern for some growers, and other growers view them as a benefit. The husk is beautifully dark.

7143 is a new release from Seminis. It is very similar to Obsession, but has an improved rust package. There may also be some other slight changes, but overall, it appears to be an improved Obsession. Depending on supply, you should be able to purchase 7143 from any dealer that markets Obsession or other Seminis products. Like Obsession, 7143 appears to be a real workhorse!

Awesome is a relatively new release from IFSI. It is available from both Stokes and Seedway. Its release number was 2574. Awesome's maturity is between Fantastic (73 day) and Triumph (77 day), so about 74 or 75 days. Awesome is less likely to lodge than Fantastic, and has better cover than Triumph. It is also more of a shipper style.
Sweet Surprise is also a release from IFSI. It is marketed exclusively through Rispens Seeds, Inc., out of Illinois. It has excellent husk color and flags, along with a short shank. The kernel appearance is very good. Its tenderness is average, but its sweetness was very good. Sweet Surprise has been commercially planted and the feedback from growers is excellent
XTH 2170 is a 73 day bicolor from IFSI. It falls into the 73 day range, along with Fantastic, XTH 2573 and XTH 2673. XTH 2170 has excellent refinement, quality and large ears. Although it isn't bird proof, it appears to resist bird damage better than many varieties, and growers are often slotting it into their second early plantings. Its 8" ears are fitting into both the roadside and shipper markets, making it one of Siegers Seeds, and Harris Seeds, top selling varieties in the NE.
Mirai 310 is new and will be tested in strips for 2010. Mirai 310 is in the 75/76 day range. It had good vigor in our early tests. The ears were 7.5" with perfect fill. Sweetness, tenderness and the overall ear rated a 4/4, making it one of the highest quality varieties tested. Additionally, it had a dark, attractive husk. It should be commercial in 2011.
Garrison is a new yellow, sh2 workhorse from Syngenta (Rogers Brand). Its vigor rated a perfect 4/4. Garrison has a great package, and plant, and is very productive. It has been used from Florida, through the Northeast. Garrison has a high level of disease tolerance, and is used extensively in the shipper's market.
BSS 0982 is an 82 day, sh2, Attribute variety. It has become very popular and is really the first high quality sh2, bicolor, with BT traits. BSS 0982 has been available for about 2 years.

Additionally, in the sh2 category, you can expect to see many of your favorite varieties, such as "Fantastic" and "Triumph" being re-released with improved rust tolerance to the new races of rust.

BC 0805, is not new. It's been available for about 10 years or more, but it deserves "superstar" recognition. BC 0805 is a high quality se, in about the 84 day maturity very similar to Providence but with BT traits. It's sold by a variety of dealers, that handle Syngenta (Rogers Brand), and is a top seller with many dealers.
New corn releases seem to be occurring more often in the supersweet isolation group, than the se group. There are many strong players in the mid-season (73 to 78 day) class. The industry is still struggling to find outstanding "first early" and "late" varieties.

The ABC of TRV - Tree Row Volume is not rocket science

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Effective use of pesticide to prevent or reduce pest damage in apple orchards requires choosing the right material and applying it at the right time. It also requires knowing how much water and how much pesticide to apply to each acre of trees.

Pesticide application guidelines originated in a time when apple trees were much larger than those found in most orchards today. Apple orchards are a three dimensional target, and the target area volume varies tremendously between orchards with small versus large trees. The use of "acre" as the basis for stating pesticide dosage and spray volume is inadequate because acre is a two dimensional measure of flat area. Acre based recommendations do not specify how spray volume and pesticide dose should be adjusted for the size of the trees and the volume of tree canopy on that acre.

The Tree Row Volume (TRV) concept was devised as a simple formula to adjust spray volume and pesticide dosage for smaller trees, using the larger trees of the past as the "standard" reference point. It should be simple to scale from a known standard for big trees down to today's smaller trees. And mathematically, it is simple for growers to use the tree height x width x row length per acre formula described in the New England Tree Fruit Management Guide to calculate the TRV dilute gallons per acre for different blocks with different size trees.

But unfortunately it is not that simple in practice. This presentation will begin with a review the justification and procedures for using TRV adjustments. It will then discuss some of the different assumptions and complications involved in using TRV, constraints on concentrate spray application, and complications in translating pesticide dosages stated as amount per acre into rates per 100 gallons dilute spray per acre based on a TRV calculation.

The formula for estimating TRV gallons of water for a dilute spray application for a block of apple trees is:
Tree height X Canopy diameter X Row length per acre X 0.0007* gallons

For tree height use the average of the tallest trees in the block measured as feet.

For canopy diameter use the average width of trees looking along the row, i.e. how far do the canopies extend into the alley on each side, measured as feet.

Row length per acre is the 43,560 feet per acre divided by the distance between trunks across the alley. For example for a 20 foot row spacing, the row length per acre is 43,560 / 20 = 2178 feet row length per acre.

0.0007 is a conversion factor of 0.07 gallon of water dilute spray per 1,000 cubic feet of tree canopy volume. This is based on canopy density at Petal Fall. Many growers use this value throughout the season for calculating spray concentration.

An adjustment can be made for reduced canopy density in early season sprays (Green Tip to Tight Cluster) by using 0.05 gallon per 1,000 cubic feet of canopy density, i.e. 0.0005.

As canopies reach maximum density in July and August, a conversion factor of 1.0 gallon per 1,000 cubic feet of canopy density (i.e. 0.0010) is recommended.

Changing the gallons per minute output of the sprayer to adjust for change in TRV dilute gallons per acre through the season to achieve a desired spray concentration would be too difficult. It is easier to use the different estimates of TRV dilute gallons per acre to adjust the concentration of pesticide in the tankmix. For example if the sprayer is set to deliver 66 gallons per acre as a 3X spray at Petal Fall, then most pesticides would be added to the spray tank at 3 times the dilute rate per 100 gallons. At Green Tip, that same 66 gallons per acre could be considered at 2.2X spray, and in late July and August it could be considered at 4.2X spray.

This is one of the areas where TRV becomes controversial. Are you confident that this adjustment to the amount of captan per tank will be fully effective?

Another question and controversy is about the basic assumption of how a pesticide works. Using a concentration factor based on TRV assumes that it is the total amount of pesticide applied per acre that matters. That may not be true for all pesticides. For some pesticides, such as oil applied to smother mite eggs, it is the concentration of active ingredient in solution directly contacting the pest that matters. In that case, there is less reason to adjust the amount of product added per 100 gallons of tankmix based on that number of gallons of spray solution applied per acre.

Yet another complication is that many pesticide labels only state the dose on a per acre basis. Unless stated otherwise, the standard assumption is that you divide this amount by 4 to get a dose per 100 gallons of TRV dilute spray because the standard orchard used to be defined as requiring 400 gallons for a dilute spray. But some labels assume a 300 gallon per acre basis. And some labels require a fixed amount per acre regardless of the estimated TRV dilute gallons per acre.

So while it's not rocket science, using TRV it not always as simple as we would like. But knowing the TRV dilute gallon per acre for each block is important for effective and efficient pest management.

Biointensive IPM and Disease Management in Apples

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Apple growers were among the first to adopt integrated pest management (IPM), and New England apple growers have a thirty-year history of leading in utilization of IPM. Yet in recent years, the enthusiasm for apple IPM, or at least for advancing apple IPM, has decreased. Faced with global competition, labor issues, dealing with pest resistance, and juggling decreasing pesticide options, apple growers have not pushed forward with new IPM methods. In fact, in some areas, notably disease management, the use of older, conventional pesticides has actually increased in recent years. For example, for many years the annual use of captan in a typical New England apple orchard averaged three to five applications, or about 12 lbs. of Captan 80W per acre. Over the last five years, captan use has shot up. This past season, some growers approached the annual label limit, 40 lbs. per acre, applying the fungicide eight to twelve times. Admittedly, last year (2009) was an extreme, but captan use has gone up steadily since resistance to the demethylation inhibitor fungicides (SI or DMI fungicides such as Rally, Rubigan and Procure) became widespread.

Risk and expense drive decreased innovation in apple IPM. Generally, as IPM systems develop they reach a point where the expense of using more advanced IPM tactics become greater than the money saved on reduced sprays. At the same time, growers perceive the risks of these new tactics as much greater. So, while consumers and society in general still want fewer pesticides, growers who have to pay the cost of IPM and deal with risks of pest damage and crop failure, are increasingly reluctant to try more advanced IPM methods.

Consumers increasingly want food that they feel is produced with few if any pesticides. However, apple pest management, even with IPM, is focused around pesticide applications. What can be done? To address this, it's useful to listen to one of the originators of apple IPM, Ron Prokopy. He wrote that "the essence of IPM may be summarized as a decision-based process involving **coordinated use of multiple tactics** for optimizing the control of all classes of pests (insects, pathogens, weeds, vertebrates) in an ecologically and economically sound manner". In other words, to get more advanced IPM systems, several tactics have to used, not just pesticides, and they have to be coordinated to work together.

It's difficult to coordinate different management tactics even when dealing with just one class of pests, such as pathogens. The diagram below shows the multiple tactics that may be used in plant disease management, including cultivar resistance, cultural controls, biological controls and chemicals. It also shows how forecast models based on weather or sampling may be used to determine the need for treatment. To date, apple IPM has focused on using forecast models to guide chemical control, for the most part ignoring other kinds of management tactics. Prokopy felt that for IPM to advance, it needed to balance use of all management tactics. In disease management in apples, this would mean employing more resistance to disease in apple cultivars, incorporating cultural practices into the program on a regular basis, and using biological controls or chemicals that have less environmental impact when such materials can be effective. This kind of system, which is less focused on conventional chemicals, has been referred to as biointensive IPM.

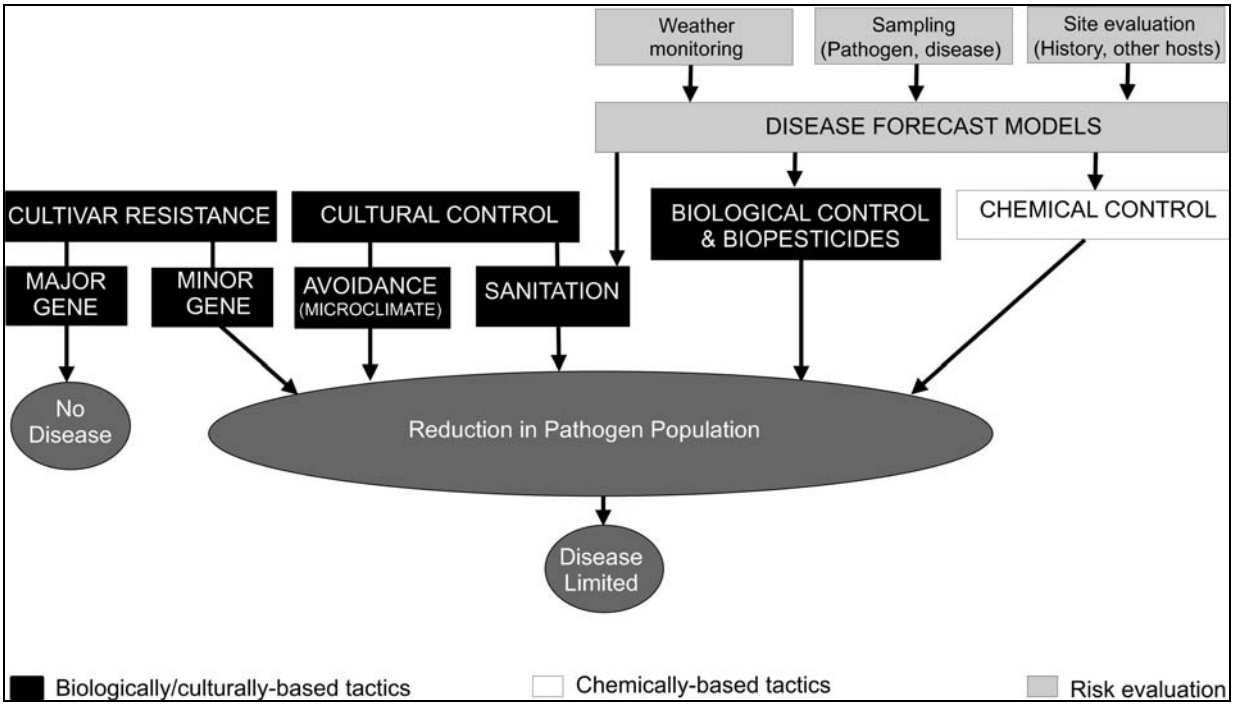

Figure 1. Schematic of disease management tactics that may be used in biointensive apple IPM (Cooley, 2009).

There are a surprising number of biointensive IPM options available to New England apple growers. They are not widely used, but it may be time to look at them and see which might be useful in getting the disease management elements of apple IPM back on track.

Cultivar resistance has been an idea that has yet to have an impact in the US. Almost always, disease resistance in apples means resistance to apple scab, so-called scab-resistant cultivars (SRCs). Prokopy felt that an orchard built around SRCs had great promise in reducing fungicides, and therefore planted his own experimental orchard with them. Since then, extensive testing has shown that scab-resistance alone will not eliminate the need for fungicides, and that the existing named SRCs can be both difficult to grow and have limited market appeal in the US. In Europe, where growers are increasingly planting disease resistant apples, such as 'Topaz', there has been greater market acceptance. However, other serious problems threaten extensive SRC use. Most SRCs depend on a single source of resistance, the V_f gene, which has started to fail in Europe, and a race of scab that can infect V_f apples has recently been identified in the US. There is a principle in plant disease management that suggests that extensive planting of one type of resistance will inevitably lead to that resistance failing, and this appears to be happening with apple scab.

In the long run, rather than depending on single-gene resistance as a magic bullet against disease, it may be better to use several minor genes. This is the sort of resistance that is seen in some cultivars such as 'Honeycrisp' and 'Golden Delicious', cultivars that can be infected by scab but are not nearly as susceptible as 'McIntosh'. In Europe, growers are planting mixed blocks of cultivars with varying degrees of resistance. Such blocks require fewer fungicide sprays, and have less chance of producing new, virulent scab races. In a coordinated advanced

IPM system, new blocks would incorporate mixed cultivars, using either partial or complete resistance in economically viable cultivars.

Cultural controls present a largely untapped source of disease management options. The canopy of a high-density apple block is radically different from that of the old M-7 blocks. Yet we spray both blocks in much the same way. Air circulation, and leaf drying, are known to discourage development of diseases, particularly the summer blemish diseases. Fungicide coverage is better in well-pruned, open trees. So, a slender spindle block may require less fungicide than a semi-dwarf block. In addition, new types of spraying technology may be adaptable to smaller trees. For example, over-the-row shielded sprayers could deliver fungicides precisely to trees, capture drift, and ultimately use less pesticide than a traditional airblast sprayer. Ultimately, it may be possible to build fixed, over-the-tree pipelines that would be able to rapidly deliver fungicides and other pesticides without the time-consuming process of driving a sprayer through the orchard.

Cultural controls can also reduce or eliminate inoculum that is the source of disease. Growers are familiar with, and generally use, the practice of removing old fire blight cankers. Yet reducing scab inoculum is not a widely used management tactic, even though there is no doubt that it is a good idea to use some form of scab inoculum reduction.

Similarly, virtually all of the inoculum for the summer blemish diseases (sooty blotch and flyspeck) comes from reservoir hosts, plants in the woods and hedgerows next to orchard blocks. To reduce infections from this inoculum, it is useful to keep as much separation as possible between apple trees and the reservoir hosts. Bu this can be an expensive undertaking, involving cutting or otherwise destroying plants along orchard borders, or leaving large amounts of open buffer land between apples and the woods.

Other cultural management tactics, including pruning dense trees and regularly mowing, changes the ‘microclimate’ in the orchard, making it drier and making it more difficult for sooty blotch and flyspeck to develop. Ultimately, sooty blotch and flyspeck can be cleaned from apples using post-harvest bleach solutions and rubbing. Whether or not this is a ‘cultural control’, it is a tactic that could be used to reduce fungicide use. However the machinery to do this has not been developed.

Biological controls, strictly speaking, involve the use of one organism to control a pathogenic organism. In plant diseases, this usually means using one microbe to manage another microbe. Today, the EPA and other organizations have developed a more general term, biopesticides. Biopesticides are used much like conventional pesticides, but, according to the definition, depend on modes of action that present fewer risks to the environment and human health. Biopesticides, also called biorationals, may be relatively benign chemicals like potassium bicarbonate (e.g. Armicarb), bacterial protien (e.g. Messenger) or a bacterial preparation (e.g. Serenade). It would be simple to substitute these relatively benign chemicals for the conventional fungicides like captan that raise public concern. The problem is that they are often not as effective, and that they are not consistent in their efficacy. Still, some new classes of these chemicals, such as the phosphites (e.g. Phostrol, Agri-Fos, ProPhyte), have shown promise in managing apple diseases, and need to be further evaluated to see how best to use them. Under the right conditions, biorational pesticides could play a role in a more biointensive apple IPM system.

Forecasting models have been used in apples primarily to manage apple scab and fire blight, and there is growing use of one or another model to manage sooty blotch and flyspeck. These models are generally used to determine when a fungicide or antibiotic spray is needed. Growers are very familiar with the Mills Table and its revisions, which relate how long apple leaves are wet to temperature, and determine whether an infection has occurred. Note the past tense. In order to use the Mills Table, growers need fungicides that are effective when applied

after infections have started, or they need reliable weather forecasts, or both. Similarly, programs such as Maryblyt and Cougarblight relate the growth stage, most critically bloom, to rain or heavy dew and temperature, as well as the history of blight in a block, to determine whether streptomycin sprays are needed to control fire blight. For sooty blotch and flyspeck management, the accumulated hours of leaf wetness are recorded from petal fall or first cover, and as a threshold is reached, varying from 170 to 250 depending on which model one uses, a fungicide is applied. These models are highly dependent on the chemical control being used. They can provide useful guidelines for sprays, but are not a solution by themselves.

One interesting use of a forecasting model is the potential ascospore dose, or PAD, evaluation developed by Bill MacHardy. This model evaluates the amount of apple scab present in a block in the fall, and estimates the number of infection periods or the tree growth stage at which the first scab fungicide needs to be applied the next year. In blocks with very little or no scab, the first spray may be delayed until pink or after the first three Mills periods. The PAD evaluation may be combined with leaf treatments that reduce scab inoculum. Growers have not widely adopted this approach, perhaps because there is concern that early-season infections present more risk than other infections, and there are no fungicides to provide a safety net in case the delayed sprays fail.

This last example of a biointensive IPM tactic illustrates how risk influences adoption. While the PAD and delay method can eliminate up to three scab sprays, growers fear a catastrophic scab outbreak. From an economic perspective, the insurance of two or three fungicide applications outweighs the cost of those sprays.

Given this, it's important that researchers and growers work together to design a mix of the biointensive options, combine them with biointensive options for insect management, and test them as systems on a small scale. By testing and demonstrating what works, and what doesn't, both growers and researchers can gain confidence and knowledge about more advanced IPM tactics. Ultimately, this may allow the New England apple industry to once again lead in the adoption of cutting edge IPM for apples.

Cooley, D. R. 2009. "Biorational Approaches to Disease Management in Apples." pp. 214-252. In: T. Leskey, M. Aluja and C. Vincent, eds. In Biorational Tree Fruit Pest Management. CABI Publishing. 320 pp.

NEW ANTIQUE AND DIFFERENT APPLES

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Massachusetts has a along history of apple production. Over the past few years the dynamics of apple production have changed, due in large part to the rapid expansion of apple production overseas, especially in the southern hemisphere and a logarithmic increase in production in China. While New England has a climate that favors the production of high quality apples, other geographic locations produce significantly higher yields per acre because of high light conditions, a long growing season and abundant water. Consequently, apple production has shifted in New England from one dominated by wholesale production to one that is focused on direct sales to the public. This situation provides growers with a unique opportunity to offer directly to the public a variety of fruits and different varieties of apple that are usually not available to the public at conventional grocery stores.

New varieties of apples are being released periodically from breeding programs or are being discovered as chance seedlings. However, unlike in the past where the best varieties were made available to growers, club varieties and other permutations restrict the availability on new varieties to a few growers. While it is acknowledged that the availability of the best varieties will be restricted, there are many new and old varieties available that may be different and have unique characteristic that make them attractive choices to grow. These varieties may have a flaw that precludes their selection as a club variety but this flaw may be irrelevant when sold locally and for a limited period of time.

Consumers a looking for variety in the produce section and they are very interested in purchasing new and unique apple varieties and this is especially true for individuals who frequently shop at roadside stands. We have documented this in a recent survey and based upon the results of this survey we are presenting a strategy for operators of roadside stands to benefit and capitalize on consumer interest in new apple varieties. Most roadside stands are open throughout the growing season. We have divided the apple sales season into five different marketing periods. We suggest that growers plant at least two new and different varieties for each marketing period. Plant only enough of a variety to last for no more than a month. This is a safe approach and there is the added advantage of creating the perception of the need to buy apples now before the supply runs out. Customers can be introduced to several new varieties throughout the season. Have a featured variety every week or two. It is important that customers be given the opportunity to taste these new varieties. A down side is that you must learn to grow, harvest and market varieties where there is little information. There is a learning curve, but once you have this knowledge, you will have an advantage. Customer tastes and preferences differ thus making it necessary to offer variety. It was found in the survey and confirmed in the literature that 16% of customers like sweet apples, 48% prefer sweet/tart apples, 30% like tart/sweet while the remaining 6% select tart apples. It is important to recognize that you do not have to have apples that everyone likes. Avid lovers of a variety may frequent a roadside stand simply to purchase one variety that is unavailable elsewhere.

Marketing Periods and New/Antique /Different Varieties for each marketing period.

August 15 to August 30
- Redfree
- Ginger Gold
- Sansa
- Zestar! ™
- Paulared

September 1 to September 15
- Akane
- Sweetango™ (restricted)
- Silken
- Arlet (Swiss Gourmet)

September 15 to September 30
- CrimsonCrisp
- Shamrock
- An early Fuji (Daybreak, September Wonder, Rising Sun)
- NY 428
- Golden Supreme

October 1 to October 15
- Creston
- NJ 90
- Hudson's Golden Gem
- Hampshire
- Shizuka
- Topaz

After October 15
- Cameo
- CandyCrisp
- Suncrisp
- GoldRush
- Pink Lady (Cripps Pink)

Antique varieties worthy of consideration
- Golden Russet
- Northern Spy
- Baldwin
- Hawkeye Delicious
- Esopus Spitzenburg

Raspberries in High Tunnels: Opportunities and Challenges

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High tunnel raspberry production offers several advantages over field production, such as an extended growing season, improved fruit quality, and decreased occurrence of certain problematic diseases such as gray mold. However, the high tunnel environment also presents some new challenges. These challenges include the type and intensity of pest occurrences, issues surrounding fertilizer and water use, soil health, and finding time to manage the tunnels. Some challenges are crosses between those typically faced in greenhouse vs. field production.

Most growers with high tunnel raspberries in the northeastern U.S. are using single-bay tunnels, usually covered for all 4 seasons - thus they are the focus of this presentation. Tunnel effects are generally more pronounced in these types of tunnels as compared to 3-season tunnels where plastic is removed for the winter and the tunnels are fully vented by gathering the plastic during high wind events or during very hot weather.

It helps to understand what effects the tunnel has on the environment, and the results of these effects. In tunnels, air temperatures are warmer overall, being milder in winter, sufficiently warm to sustain growth in spring and fall, and sometimes very hot in the summer. Soil temperatures are also warmer, and the soil is less likely to freeze deeply over the winter. Placement and amount of water is controlled, so there is no moisture on leaves from rain or overhead irrigation. Relative humidity is higher in the tunnel, and there can be moisture present on the leaves from condensation when the tunnel is closed.

The temperature changes result in a longer growing season. Tunnel use adds at least 3 to 4 weeks to both the beginning and end of the growing season. This means that we can grow varieties of raspberries that require a longer growing season than we have in the field. These could be primocane-bearing cultivars that have improved or unique flavor and size. Because plants start growing earlier in the spring, summer-bearers fruit earlier thus allowing growers to capture the early market. The longer growing season means that plants have time to grow larger, and yields are higher, typically at least 2 to 3 times that expected from field production. These higher yields result in (hopefully) higher sales and increased potential for profits. With a sufficiently long growing season, we can tip primocane-fruiting plants to stagger the production season of an individual cultivar.

The increased plant growth, however, results in some challenges. Large high-yielding plants remove more nutrients from the soil, so requirements for certain nutrients such as potassium are thought to be higher in tunnels than in the field. Very little work has been done to work out fertilizer and water requirements to optimize raspberry growth long-term in tunnels. Bramble fruit has a relatively high potassium content – roughly equal to that of nitrogen, and the concentration of both are much higher than that of other macronutrients such as phosphorus, calcium, and magnesium. Upon occasion, we've run into potassium deficiencies that have been difficult to correct. We now recommend applying fertilizers balanced in nitrogen and potassium such as a 20-10-20 with micronutrients, rather than applying only nitrogen yearly as in the field, and conducting tissue tests yearly to stay on top of potential problems regardless of nutrient

source used. Counteracting the large amounts of fruit and biomass removal, however, is the fact that leaching of nutrients is likely to be very low. Compost can also be used as a nutrient source, but at this point, the dynamics of nutrient release from organic sources in a tunnel are not characterized. Higher soil temperatures could result in higher mineralization rates.

Because the tunnel roof protects the plants from rainfall, the only water applied is through the irrigation system. This has both some advantages and disadvantages. Within the area of disease management, because leaf wetness is reduced, fungal sporulation of most diseases is reduced. Some of the diseases that result in crop loss in field production such gray mold or anthracnose are greatly reduced, and therefore shelf life is also often greatly improved. Powdery mildew, however, is an exception since it is worse under conditions of high humidity and reduced leaf wetness. It can be a problem in high tunnel raspberry production, though rarely problematic in field production. Good air flow through the tunnel should be maintained whenever possible.

The change in leaf wetness also affects insects and mites. Those pests that are problematic in greenhouses, such as whiteflies, aphids, and thrips are commonly greater problems in high tunnel production than they are in the field. Aphids and thrips are problematic even at low levels due to the potential for virus transmission, and two-spotted spider mites are frequently identified as the greatest problem in high tunnel raspberry production. The combination of dry conditions and warm temperatures can increase the number of pest generations per year for certain pests. Finally, soil- and crown-dwelling insects can be an issue, perhaps because the milder soil temperatures over the winter allow them to either be protected, or to continue to multiply year-round. Crown borers have been a problem in blackberries, but not in primocane-bearing raspberries, perhaps because the removal of the canes each year disrupts their life cycle. Ants prefer the dry environment, and can be problematic on the foliage, especially if aphids or other honeydew-excreting insects are present, and they end up in harvest containers.

Fortunately, biocontrol agents such as predatory mites, ladybird beetles, and lacewings have established and worked quite well in tunnels, and some pests have been manageable with softer pesticides. This results in the increased feasibility of organic raspberry production in tunnels compared to the field.

With water application being dependent on the irrigation source, water quality takes on added importance in a tunnel. Water high in calcium and magnesium or other elements can result in imbalances in nutrients, cause the soil pH to change, or cause precipitation of soluble fertilizers. It is recommended that the water source be tested, and treatment such as acidification used if necessary. Also, the fact that the tunnel roof remains over the winter means that there is no opportunity for salts from either synthetic fertilizers or composts to be leached. While less of a problem with raspberries due to their relatively deep root systems, this has been an issue with crops such as strawberries that are extremely salt sensitive, or when salts are incorporated during tillage operations prior to a subsequent crop. This situation appears to be quite easily rectified by leaving a tunnel roof off for the winter in years when plastic needs to be replaced anyway, but early season benefits are likely to be nonexistent in that particular year.

When profits for high tunnel crops are compared, the big winner appears to be tomatoes - raspberries fare well in the comparison, but still are in second place at best. Most growers report pay-off of the tunnel in either the second or third year with raspberry production. The big factors for long-term profits are yield, the price received, and the cost of labor for harvest. Good yields (10,000 lb/a equivalent or higher), a decent price received ($2.50 per half-pint or higher), and minimizing harvest costs ($0.50/half-pint or less) result in good potential for very significant profits.

Raspberry Insect Pest Management

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Insect pests of raspberries are sporadic and few occur in every field or every year. Scouting on a regular basis is very helpful, however, monitoring techniques and thresholds have not been scientifically developed in many cases. Because few insecticides are registered for raspberry pests, sanitation and management practices in raspberries are very important. Another challenge is timing insecticides for important pests around bloom, because raspberry bloom is very attractive to bees and other beneficial pollinators. As growers switch from broad-spectrum insecticides to more specific products with shorter residuals, expect flare-ups of pests that were not previously a problem.

Primocane fruiting raspberries, if grown only for the fall crop, present a different set of pest problems compared to summer–fruiting types. Flat-headed borers, two-spotted spider mite, potato leafhopper, tarnished plant bug, sap-beetles and wasps can be major pests of primocane fruiting raspberries. Clipper weevil, raspberry fruitworm and rose chafer are not as important, because buds are not present when these pests are active. Loopers and spanworms are not common on fruit in late summer or fall. Raspberry crown borer, snowy tree cricket and raspberry caneborer can be kept in check by regular mowing and destruction of canes each year.

Following is a list and brief description of the most important raspberry insect pests and how to scout for them. Because insecticide registrations vary between the USA and Canada and also from state to state, they are not specified here.

Insects That Attack Canes and Crowns

Raspberry crown borer. Of the cane and crown borers, raspberry crown borer is the most common and devastating. The adult is a clear winged moth that is rarely seen. It is active during late July, August and September when it lays eggs on raspberry leaves. The larva hatches and travels to the base of the cane to overwinter. The following spring the larva enters the crown and tunnels around in the lower cane and crown for a year and a half. It pupates and emerges as an adult late in the second summer. During the first year, larvae are not obvious unless the crown is dug up and carefully examined for larvae, tunnelling and frass. In the second summer, canes pull away easily from the crown with a firm tug. The frass and larvae, much bigger by now, can be seen in the base of the cane. Prominent swellings from crown borer larvae are sometimes seen a few inches above the base of the cane. Damage from this pest is often confused with disease symptoms or winter injury. Canes are weak and often die back just before harvest. Primocane numbers decline over time.

Insecticides for this pest do a great job *if* they are applied at the correct timing. The window for control is short, as larvae must be controlled before they tunnel into the crown. Sprays are

usually applied in October, or very early spring. Research is focussed on developing a pheromone for the adult. If this work is successful, pheromone traps could be used to monitor adult activity and perhaps spray for this stage. Mating disruption may be possible in larger, more uniformly sized blocks.

Raspberry cane borer. This is a slender, small (1/2 inch), long-horned beetle, black with a bright orange thorax. The beetle is seldom seen, but easily recognized by antennae that are longer than the body. It is active in June and may be present for several months.

The adult lays an egg in the primocane tip, then makes two rings of puncture marks in a ring around the cane, above and below the egg. The primocane wilts immediately, but damage to the entire cane is rare into the first year. The larva travels down the cane however, to overwinter, and remains a second year at the base of the cane. These canes usually die in the winter.

Growers usually control this pest by removing wilting primocane tips in July and August, before the larvae travel down the cane to the crown. Pruning out fruiting canes before the next growing season is also important. Be sure to cut canes close to the ground. Insecticides can be applied to control beetles. Apply controls when damage is first evident, generally before or after bloom.

Red-necked cane borer and bronze cane borer are more common pests of blackberries and raspberries in the southern USA. Adults are very small beetles (1/4 inch) and black in colour with a reddish thorax. In Ontario, beetles are present in July, and can sometimes be seen on foliage in the lower canopy, especially on sunny days. Adult beetles lay their eggs on primocanes, about 1-4 feet above the ground. Larvae hatch and tunnel in a spiral up and down the cane, which can be seen by scraping the bark away in the damaged area. Long swellings with cracked bark develop where the larvae have tunnelled. Canes often break off at the swelling before harvest; however these broken canes are sometimes attributed to rabbit feeding or wind damage. Damaged canes should be removed and destroyed during the dormant season. Insecticides can be applied to control adult beetles (in July) but nothing will control larvae inside the cane.

Tree crickets. These pale green delicate looking insects have long antennae and long legs. Both nymphs and adults can be found on raspberry foliage during the summer. Adults lay a series of eggs in a row along the primocane, leaving several to many puncture marks in a tight row lengthwise along the cane. Long cylindrical eggs can be found inserted into the cane. The egg laying wound can weaken the cane and provide an entry point for cane blight. Although a little tree cricket damage does not seem to be harmful, severely affected canes could die over winter, or might collapse above the point of injury just before harvest. Workers should be trained to identify the damage caused by this pest. Pruning out damaged primocanes in the winter is an important part of controlling this pest.

Insects That Attack Fruit and Leaves

Raspberry fruitworm. Adults are small (1/8 inch), brown, hairy beetles with clubbed antennae. Adults are active in May, as flower buds develop, and shred foliage and bite holes in fruit buds. Larvae may be present in fruit cup at harvest. To monitor for this pest, watch for shredding on

new foliage of fruiting canes and for holes in developing buds. Shake buds clusters over a small tray or dish to look for beetles. Quiet observers may also see beetles feeding on buds. Control beetles with pre-bloom application of registered insecticide.

Insects That Attack Fruit and Buds

Clipper weevil. The adult is a small weevil with long snout and reddish brown mottling on back. Adult weevils clip buds from the flower truss before bloom. Look for this pest in May, as flower buds develop. Tap flower clusters over tray or dish to look for weevils and clipped buds. Observe buds clusters for hanging or missing buds. Expect more problems where strawberries are also grown. Control beetles with pre-bloom application of registered insecticide.

Japanese Beetle. These are large, blocky beetles (1/2 inch), metallic brown-green colour with long legs. They feed extensively on foliage between the veins, and also on ripe fruit. Adults are active in late June and early July, just as fruit begins to ripen, and continuing for many weeks. To scout for this pest, look for leaf shredding and beetles, which will be obvious.
Control first beetles to reduce aggregation (they attract one another). Remove first beetles by hand. Japanese beetle adults are relatively susceptible to registered insecticides, but be aware of the preharvest interval. Control larvae in soil with soil drench of different registered products.

Rose chafer. Adults are oblong, beige beetles about ½ inch, with long spiny legs. They feed extensively on foliage and flower buds in the pre-bloom through bloom stage, typically when peonies are in bloom. Look where problems occurred in the past. Adults are relatively easy to control with insecticides. Identify the source of the infestation, which is usually an area of permanent sod or turf on sandy soil. Consider control of larvae on these sites, either by removing sod in the late summer or fall, or controlling with registered insecticides for white grubs in soil.

Tarnished plant bug. Adults are fast-moving brown insects, oval, with a yellow triangle behind the head. Nymphs are green, soft bodied similar in size to aphids. Damage from this pest is not well documented, or consistently a problem. Adults and nymphs feeding on blossoms and developing fruit may cause uneven fruit formation. Feeding by adults on ripe fruit can cause desiccation of drupelets and provide wounds for Botrytis grey mould infection. Tap blossom and fruit clusters over a tray or dish to look for fast-moving nymphs. Watch for adults feeding on ripe fruit in late summer and fall. Thresholds and control strategies have not been developed for this pest. To keep populations low, control weeds, which are attractive to adults. Timing weed control is important however. Do not mow weeds or adjacent alfalfa crops when raspberry flowers and fruit are present, because plant bugs will move from these favoured hosts to your raspberry crop.

Inchworms, loopers, spanworms. These are small, slender caterpillars, usually with brown or reddish angular markings. Caterpillars are found mostly on fruit, and may feed on individual drupelets. Most damage is caused by the presence of larvae in harvested fruit.

Monitor just before harvest by shaking fruit clusters over a tray or dish. Expect problems to be worse near woods and hedgerows and deciduous trees. Prebloom insecticides for caterpillars will provide control.

Paper wasps and yellow jackets. These pests are easily identified. Adults are attracted to ripe fruit as a source of moisture and sugar, especially in late summer and early fall when populations are at their peak. They are a nuisance and danger to people picking the fruit. harvest all ripe fruit on a regular schedule to reduce problems with these pests. Bait traps placed around the perimeter to the field may help

Insects That Feed on Foliage

Two spotted spider mite (TSSM). Overwintering females TSSM are bright orange. Otherwise these small 8-legged creatures are greenish white with two distinct black spots. Early damage appears as fine white speckling or stippling on upper leaf surface and fine webbing on the lower leaf surface. Leaves eventually develop brown dry patches and appear to be "sand-blasted". Severely damaged leaves eventually fall off the plant. Lower leaves are affected first. To scout for TSSM check foliage often for early signs of stippling. Check the underside of leaves with handlens for mites, webbing, and predators. Two spotted spider mites are worse in greenhouse and high tunnels than they are in the field. The cultivar Autumn Britten seems to be especially susceptible. Commercial sources of predator mites can be released for biological control. Take time to learn how pesticide use and climatic conditions affect the success of this method of control.

Raspberry sawfly. Adults are small (1/4 inch), black fly-like insects with four wings and rarely noticed. Larvae are bristly green up to ½ inch long. Larvae feed on the lower leaf surface, eating, chewing through most leaf tissue, except the veins. Watch for leaf feeding and green larvae , mostly on primocanes. Check routinely from the prebloom to green fruit stage. Control larvae with pre-bloom application of registered insecticide.

Potato leafhopper. Adults and nymphs are bright green, narrow wedge shaped insects. Adults are winged and quickly fly away when disturbed. Nymphs are soft-bodied and in the same size range as aphids. Leafhopper nymphs are found on the leaf underside and have the unique ability to move sideways when prodded. Adults and larvae feed on plant juices and inject a toxin that causes "hopper burn". Leaves turn yellow along the edges and curl downwards. New growth may be stunted. There are several generations each year from June through to September. Remember to check new plantings for this pest. Check new growth for yellowing and leaf curl and check the leaf underside for small green nymphs.

Control when damage is evident and leafhopper nymphs are easy to find. However, bloom, especially on primocane fruiting varieties, can interfere with timing these insecticides.

Suggested references

Berry Diagnostic Tool http://www.hort.cornell.edu/diagnostic/
Bramble Production Guide
Compendium of Raspberry and Blackberry Diseases
Midwest Small Fruit Pest Management Handbook

What About Blackberries? Options for the Northeast

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U.S. Census of Agriculture Reports from 1997 and 2007 showed that blackberry acreage across the U.S. increased from 8,300 acres to 10,717 acres, a 29% increase. In the Northeast, while acreage is comparatively very low, the upward trend is much more marked. In the Mid-Atlantic region (PA, NJ, MD, WV, and DE), acreage increased from 120 to 276 acres during this same time period, a 130% increase. For other Northeast states including New York and states northward, acreage increased from 122 to 392 acres, a whopping 221% increase. While some of this acreage could have shown up due to better tracking, or a better response rate of blackberry producers in later years, the fact remains that blackberry acreage is increasing greatly, an unusual trend for commodities in general. Northeastern growers who are able to produce blackberries indicate a strong demand and good price for the berries, but production can be very variable from year-to-year, with nearly complete crop losses for individual growers following winters conducive to winter injury. However, some options do exist that could allow more reliable production, and some of them could be used in combination to make consistent blackberry production possible. However, we recommend that you try any new crops or production techniques on limited acreage first to determine potential in your operation.

The first option often considered when looking for cold-tolerance in blackberries is variety selection. It has generally been assumed that plants that produce a summer crop reliably are truly more cold-hardy. It's also has been stated that thorny cultivars are generally more cold-hardy than thornless ones. While both statements are logical conclusions given what we've observed, they are over-simplifications of what is actually taking place. First, in the matter of being truly cold-hardy, one important mechanism that has been overlooked has been the ability of individual cultivars to compensate for winter injury. In a study conducted in southeastern PA in 2008 and 2009, primary, secondary and additional buds were examined for winter injury. While there were differences among cultivars in injury to buds over the winter, the cultivar 'Illini Hardy', frequently cited for its cold-hardiness, was found to have primary buds that were injured to similar extents as for many other cultivars. However, this cultivar did have a noticeable ability to produce a tremendous number of secondary and tertiary buds that produced fruit clusters, and percentage of cane length completely killed over the winter was low. Secondary buds are typically differentiated in the spring, after injurious weather events have taken place, and thus 'Illini Hardy' has the ability to reliably produce a crop to a greater extent than other cultivars, as long as temperatures are not sufficiently cold to completely kill the plants. Thorny cultivars were not always more cold-hardy. In fact, the cultivars with the next lowest winter injury ratings after 'Illini Hardy' were in order, Apache (thornless), Chickasaw (thorny), and Chester (thornless). Apache, however, compensated for damaged primary buds very little. Chester did moreso than most other varieties, so again, a combination of hardiness and ability to compensate for damaged buds may be the key to consistent crop production.

A second option that allows production of blackberries in cold areas is the use of high tunnels. Research in this area is limited, and only a few cultivars have been trialed in tunnels. In central PA on a site where blackberries typically are killed to the ground each winter, 'Triple Crown' performed extremely well in single-bay high tunnels that were kept closed for the winter. Based on casual observation, there may be differences in cultivar survival in tunnels, but only limited blackberry trialing has been conducted in high tunnels to date.

Another option for improving winter survival is use of the rotatable cross-arm trellis. With this trellis, canes are rotated to nearly ground level for the winter, and then are covered with row cover for protection. Briefly described, while they are young, 3 to 4 new primocanes per plant are trained along a horizontal trellis wire that is near ground level. These primocanes are tipped when they reach the nearest plant, which causes lateral buds to break and grow upward. The laterals are tied to a vertical series of horizontal wires as they grow upward. In late fall, the system is twisted to bring the canes down to ground level, and canes are covered with the row cover. In the spring, after fruiting laterals have broken and grown upward, the system is twisted back beyond the original vertical position, so that the fruit hangs downward where it can be easily picked. Commercialization of the trellis product using fiberglass components rather than metal is expected to reduce the cost of the trellis considerably. Simply covering canes with a row cover - if grown as usual without this trellis - appears not to offer sufficient protection.

The final and perhaps most exciting development is the release of primocane-fruiting blackberry cultivars from the University of Arkansas breeding program. Because canes of these plants are mowed to the ground in late winter or early spring during pruning, the degree of winter injury to the canes, which can be significant, has no bearing on the following season's productivity. The first cultivars to be released were 'Prime-Jim®' and 'Prime-Jan®'. Shortcomings of these cultivars were relatively low yields, small fruit, seediness, and lateness of harvest. Later advanced selections are much improved, and a more recent release, Prime-Ark® 45, shows very good potential in size, sweetness, and yields. Harvest, however, is still very late, which brings the ability of the plants to mature the fruit before the end of the growing season into question, if plants are grown in the field in a cold climate. Thus, these selections were also grown in high tunnels, which allowed a large portion of the crop to mature, and resulted in other improvements in quality attributed to high tunnels such as increased yields, fruit size, and decreased gray mold incidence.

While production of blackberries in the Northeast is still limited, changes in production methods and improvements in varieties should allow consistency of production to improve over time, allowing growers to meet the strong consumer demand for this crop.

Thanks to Catie Rasmussen and other Penn State high tunnel crew members for their help with high tunnel plant maintenance and data collection.

Improve your cash-flow with winter vegetables.

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Growing and selling in summer

For smaller vegetable operations in New England, the production of vegetables during the relatively short summer growing season is combined with immediate marketing of freshly harvested crops. This combination of seasonal production and marketing puts large demands on farm resources and management, and pushes the endurance of human resources to the limit. In addition, the concentration of production and marketing during the summer season results in dramatic fluctuations in the cash-flow of the operation (lots of money going around in the summer and fall, little activity in winter, expenses without income in spring.)

Efforts at creating a steadier stream of income throughout the year have focused on season extension of production in early spring and late fall through the use of frost protection materials to protect tender crops, to hasten maturity for early markets or by extending the harvest of some fall crops. Using these techniques, growers can gain a few weeks in the spring and a few weeks in the fall, depending on weather conditions.

Growing and selling in winter

Some growers have developed winter sales with winter production. Typically, the winter production of vegetable crops is limited to an indoor, protected environment (heated greenhouses, tunnels). Low temperatures and low light conditions in winter, however, often require large inputs of energy (heat, lights). Consequently, only crops with a short production cycle and high potential return (but short shelf-life) are economically viable under these conditions, and easy access to good markets is essential to generate enough income to offset the investments in the greenhouses or tunnels and the costs of operating them (labor, fuel). These crops typically are greens (spinach, chard, lettuce), with few others.

Growing in summer – selling in summer and winter.

Growers can even out the cash-flow of their operations by considering a variety of crops that can be grown in summer and that can be maintained in the field or in storage for sales in the "off-season" while avoiding the high costs of winter production in the Northeast. Growing a mix of crops for immediate fresh-market sales and storage crops during the summer months will still concentrate field labor during the growing season, but will generate opportunities for winter sales without major investments in structures for winter production, fuel and labor. The winter sales can help generate revenue for winter living expenses, and can off-set operating expenses of the coming production season.

Planning for winter sales
Winter crops do not grow in winter, but must be grown in summer! Typical winter crops will need more time to grow than the average summer crops – winter crops grow slower because they make smaller cells, contain less water, have higher dry matter, and often higher nutritional value. This hardy nature of winter crops makes them well-suited to extended storage without loss of quality.

In contrast to summer crops, winter crops must be harvested just before peak maturity. Crops that are over-matured will not store as well as crops that are slightly immature. Crops for storage should be grown to mature in late fall for harvest when pulp temperatures are low. This will help maintain quality in storage, and facilitate the management of the storage without expensive temperature and climate control equipment. Be careful to give the crops enough time to mature, because cooler temperatures and lower light conditions in the fall will stretch the traditional "days-to-maturity".

Storage in the field and in the barn
Most winter crops are traditionally brought into storage. In most cases, the crops are removed from the field with an excess of leaves and roots, leaving some soil on the roots, and washing should be avoided for best storage. For many crops, trimming is all that is needed to prepare the crops for sale, but some root crops will require washing to remove dirt, of course.

Some crops are hardy enough and can handle enough frost to be kept in the field for most of the winter, such as winter cabbages, winter hardy kales, Brussels sprouts, carrots, winter hardy radicchio, some types of leeks, and some winter cauliflowers. Depending on the winter weather conditions in your area, these types of crops can offer opportunities for winter sales without investments in storage facilities.

Other crops will not take repeated freezing, and need to be harvested and stored in (un-heated) storages (barn, root cellar, etc.). Examples of such crops are beets, celeriac, endives, Chinese cabbage, salad cabbages, rutabaga, root parsley, onions, shallots, etc.

Changing perceptions of winter crops
Not just your grandma's cabbage and turnips! Winter crops include a wide selection of tastes, colors and textures for tasty and satisfying dishes. Winter crops tend to have high amounts of flavor components and are supremely suited to slow-food dishes, although many can also be enjoyed as raw or minimally prepared foods.

Marketing of winter crops will take a commitment to consumer education, especially when it comes to the types of products that are not familiar to the average consumer (celeriac, leeks, rooted parsley, winter cabbage, kale, etc.).

It is sometimes easier to offer unfamiliar vegetables in pre-selected combinations with other vegetables in packages that explore familiar themes, such as soup and stew packages. For example, a soup packet would offer potatoes, carrots, onions in combination with leeks and celeriac. The consumer takes home all the ingredients for a home-made soup, and becomes familiar with celeriac in the process.

Packaging together vegetables can explore several themes, such as mashing vegetables (pairing potatoes with either celeriac, carrots, endive, or rutabaga), salad vegetables (beets, kohlrabi, salad cabbages, carrots, etc.), or roasting vegetables (carrots, shallots, baby beets, Brussels sprouts, etc.)

Winter Sprouting Broccoli – A new crop for early spring

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Sprouting broccoli is a traditional English crop. In England, it is planted in late summer, plants survive the fall and winter, and prolific amounts of small purple or white florets are produced on long leafy stems in late winter/early spring. Many varieties require a cold treatment, or vernalization, before making sprouts. Sprouting broccoli produces many small shoots, rather than a single head. Unlike broccoli rabe or rapini, the shoots are mild-flavored and sweet.

Growing in High Tunnels

New England winters are more severe than those in England. However, in Durham NH, sprouting broccoli can survive the winter in unheated high tunnels and produce early spring crops. Here, the shoots are harvested from March to May, when fresh green vegetables are in short supply and high demand. Winter sprouting broccoli can provide a source of income from high tunnels used for summer crops when they would otherwise be unoccupied and when little local produce is available, and can also serve as a rotation crop for the tunnel.

Varieties, Availability & Yields

Most sprouting broccoli varieties are purple, but some are green or white, like cauliflower. Currently, seeds of these varieties are available from only a handful of companies (Thompson & Morgan, Bountiful Gardens, High Mowing Seeds, and Territorial) but that will likely change if growers ask for them. The white varieties (White Sprouting Early, Colusa, Burbank, and Nine Star) tend to yield more than the purple varieties, averaging 0.25-0.6 lbs/plant. Red Spear was the highest yielding purple variety (approx. 0.5 lbs/plant), but Santee and Bordeaux were also consistent and early. Claret and Red Head had lower yields, consistently around 0.3 lbs/plant.

Variety	Seed Source	Description
Bordeaux	Bejo	Purple sprouts, Small plants, Early season
Burbank	Elsoms	White sprouts, Large plants, Mid season
Claret	Elsoms	Purple sprouts, Large plants, Late season
Colusa	Elsoms	White sprouts, Large plants, Mid season
Nine Star	Thompson & Morgan	White sprouts, Large plants, Mid-Late season
Red Arrow	Elsoms	Purple sprouts, Medium plants, Mid season
Red Head	Thompson & Morgan	Purple sprouts, Medium plants, Mid season
Red Spear	Elsoms	Purple sprouts, Small plants, Early season
Santee	Bejo/High Mowing	Purple sprouts, Small plants, Early season
White Sprouting Early	Elsoms	White sprouts, Large plants, Early-Mid season

In our 30x60 tunnel, we harvested 136 lbs of sprouts over the entire season. However, our experimental layout did not use space the most efficiently. At our spacing (2.25 sq.ft. per plant), a 30x60 tunnel could theoretically house 800 plants, yielding over 200 pounds. Higher yields may be possible with optimum spacing, timing and rowcover use.

Marketing. This crop will not be familiar to consumers, and it will require education about the crop and how to prepare it. It can be used in any way that broccoli or asparagus is used. It may be helpful to refer to it as '*asparagus broccoli*' or another creative name for marketing purposes. In our experience, trial consumers and chefs have been ecstatic about the crop once it is introduced to them and they then seek it out. Restaurants or specialty markets may be the best market for the crop since the harvest season is before most farm stands and markets open for the season.

Production Information. From 2006-2008, we grew several varieties of winter sprouting broccoli in unheated tunnels in Durham, NH. Within the tunnels, some plants were covered with rowcover (see below) in December. After establishment, the plants were not watered, fertilized, or otherwise managed during the winter. Winter temperatures remained below 0F for several days. The outdoor minimum temp in 2008 was -18F; at the same time, the low temp within the tunnel was 2F, and the low temp under rowcover within the tunnel was 11F.

FERTILITY: Compost and aged manure was added at a rate corresponding to approximately 50 lbs N/acre prior to planting. During the harvest season, plants were fertigated twice with calcium nitrate (15.5-0-0) at a rate of 5 lbs N/acre each time.

PLANTING DATE: We tested three planting dates: seed 8/10 (transplant 9/14), seed 8/26 (transplant 9/26), and seed 9/12 (transplant 10/10). All seedlings were grown in a greenhouse and transplanted into the high tunnel. Overall yield was similar for all three plantings, but we feel that additional work is needed to determine the best planting date.

SPACING: We used raised beds with 3' between row-centers. Plants were planted in staggered double rows, with 9" between each plant in a row. This corresponded to 2.25 square feet per plant. More trials are needed to determine the optimum spacing.

HARVEST PERIOD: Nearly all plants survived the winter. In early March, rowcovers were removed from covered plants. The first harvest has been in mid-March, with the last harvest in early May. For most varieties, the harvest period lasted for 3-5 weeks.

ROWCOVERS: The use of rowcover (Dupont 5131, 1.25 oz/sq yd) within the tunnel greatly increased yield. Compared with uncovered plots, plots with rowcovers were earlier, had a significantly longer harvest period, and had higher total yields (0.29 vs. 0.17 lbs per plant).

PESTS: Because the crop is grown outside the main production season, common Brassica pests are not present during harvest. In 2007, our plants became infested with aphids during harvest (March-April). Despite heavy infestation, aphids remained on lower leaves and did not affect the sprouts. We managed the aphids by removing infested outer leaves and introducing ladybugs (*Hippodamina convergens*) to reduce aphid populations.

With additional questions about this crop and/or our results, please contact Becky Sideman at becky.sideman@unh.edu or 603-862-3203.

In search of the perfect Brussels sprout

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Brussels sprouts (*Brassica oleracea var. gemmifera*) are getting more attention among consumers, in part due to their nutritional characteristics. They have high water content and low fat and carbohydrate content (which makes them low in calories), a relatively high protein content (4% of fresh edible part), high levels of vitamins (especially the two carotenoids anti-oxidants and vitamin C) and Lutein, and the highest amino acid content among vegetables (Gómez-Campo, 1999).

One advantage of this crop is its cold hardiness, which extends harvest into November or later. In retail markets in New England, Brussels sprouts are often sold on the stalk, and this method of 'packaging' could be used to distinguish locally grown sprouts in the wholesale marketplace. Selling on the stalk has the advantage of reducing labor costs but also requires that the stalk as a whole look consistent, healthy, and appealing. USDA market standards require that buds be >1 inch and that > 90% be firm and free of damage from insects or diseases. "Topping", the practice of removing the growing point to stimulate bud growth, is used to promote more uniform bud size along the stalk.. Brussels sprouts are a long-season crop ranging from 80-140 days to maturity from the date of transplanting in the field. They are typically transplanted from early June to early July in New England, depending on the target harvest date and days to maturity.

Some growers who are trying to produce for the wholesale market have struggled with losses to diseases. Brussels sprouts are subject to several diseases including black rot, Alternaria leaf spot, downy mildew, club root, and white mold. Alternaria (*Alternaria brassicicola* or *A. brassicae*) progresses later in the season, starting on the old leaves and moving up to the new leaves and onto the older sprouts as they grow. Alternaria may be seed borne, may move from other Brassica crops or weeds, or be transported by movement of people and machinery. Symptoms begin as small (<1/4 in) dark lesions on undersides of leaves, which expand into the classic target-like lesion of an inch across. Bud infections generally occur later and also start as small dark lesions on the outer wrapper of the bud. Black rot (*Xanthomonas campestris pv. campestris*) generally originates in infected seed, and can be introduced on one seed lot and spread to other varieties. Symptoms are V-shaped yellow or gray lesions that originate on the leaf margin and extend inward. Since both of these diseases are seed-borne, purchasing hot water treated seed could prevent or reduce infections.

Insect problems include foliar-feeding caterpillars (imported cabbageworm, cabbage looper, diamondback moth) which can feed on leaves or buds. Cabbage aphid is generally held in check by natural enemies with no effort from the farmer, but outbreaks can occur especially in late season or following use of non-selective insecticides.

Lodging of the stalks causes a 'gooseneck' shaped stalk, makes spray coverage and harvest more difficult and may increase disease. Height for a wholesale packout of stalks should be adequate to achieve a stalk length of 18-24 inches with sprouts that are 1-2 inches in size.

This variety trial was undertaken to evaluate seven varieties of Brussels sprouts for resistance to diseases and for market characteristics that are key for selling on the stalk, including :

1) weight, firmness, size and uniformity of buds
2) disease occurrence and intensity on buds,
3) response to mechanical topping
4) time from transplanting to maturity.

Methods: The experiment was laid out as a randomized complete block split-plot design, with variety as the main effect and topping treatment (topped and non-topped) as the sub-effect, and with five replicates. Fertilizer (60 N, 100 P, and 100 K lb/A from 5-4-8 CPS organic blend, bonemeal and potassium sulfate) was broadcast and incorporated before plastic and drip were laid over raised beds. Seedlings of Brussels sprouts were transplanted to the field in Mid June. Each main plot consisted of a double row of ten plants of one variety on 4' plastic with 17 " between plants in the row; each block was 90 feet long. When the lowest buds reached approximately ½" (approximately 1 month before harvest), 5 random plants from each plot were mechanically topped. No fungicides were used. Spinosad was applied 7/15 to control caterpillars.

Data collection: All plants were rated for the degree of lodging in the field. Each variety was harvested when most sprouts were between 1 and 2 inches in diameter. Measurements were taken only from the marketable part of the stalk (where most buds were between 1" and 2") and included the length of the stalk, total weight of buds, and number of buds. On 1 random spiral row per plant we measured were the diameter of the buds (using a digital caliper) to determine uniformity, firmness (estimated by touch), and the number and severity of diseased buds to determine disease intensity. Disease ratings on the buds were 0 (clean), 1 (up to 10% of bud surface covered with Alternaria symptoms), or 2 (>10% disease symptoms = unmarketable). Only three varieties were harvested before the NEVFC proceedings were prepared.

2009 Brussels Sprout Variety Trial
UMass Research Farm, South Deerfield, MA

Variety (seed source)	Transplant Date	Days to Maturity (as listed)*	Actual Date of Harvest according to market desirable size (sprouts (1"-2")
Vancouver (STO)	June 17	105-120	*Not harvested before Nov 1*
Nautic (BEJ)	June 25	115-140	*Not harvested before Nov 1*
Diablo (JSS)	June 17	110-125	*Not harvested before Nov 1*
Dimitri (BEJ)	June 17	103	Oct 28
Roodnerf (TSC)	June 17	100	*Not harvested before Nov 1*
Oliver (JSS)	June 17	90-100	Oct 19
Franklin (TSC)	June 17	80-100	Oct 26

Seed Sources: Stokes (STO), Bejo (BEJ), Johnny's Selected Seeds (JSS), and Territorial Seed Company (TSC). All varieties are hybrids except Roodnerf which is open pollinated.
*Days to harvest listed for the same variety can vary with different seed companies; the full range of the listed maturity time is given.
References: Gómez-Campo, C. and S. Prakash. 1999. Biology of Brassica coenospecies. Elsevier Science. B.V. Amsterdam. The Netherland.

Brassica Diseases

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There are several diseases that infect brassicas, including both foliar and soil borne pathogens. Foliar pathogens, especially fungi, were very prevalent this past summer as a result of the wet cool growing season.

Alternaria leafspot and headrot (*Alternaria brassicae and A. brassicicola)* is caused by fungi that like high humidity and wet foliage. The pathogens cause a target shaped spot with concentric rings on lower foliage first. The disease can spread by wind and splashing rain and cause defoliation and spotting on heads making them more vulnerable to further rot. The fungi can be seed borne but crops are usually infected from spores in crop debris. Best management options are 3 year rotations out of brassicas (and brassica weeds) and seed treatment with hot water. For cabbage and Brussels sprouts soak seeds for 25 minutes in 122 degrees F water. For Chinese cabbage, broccoli and cauliflower soak for 20 minutes. Exact time and temperature is essential. Cultivar differences also exist for susceptibilty. Overhead irrigation should not be used. Current fungicide recommendations are in the NE Vegetable Management Guide. Copper compounds are labeled for organic production but have not been effective in recent studies.

Downy mildew (*Peronospora parasitica*) can infect most brassicas but is not the same downy mildew that infects cucurbits. The fungus is favored by cool moist conditions from rain, dews or fogs common in late summer and fall in NE. Infection can occur at any growth stage. Severe infections can kill seedlings but most losses occur from leaf and head infections that cause crop damage and loss at later stages. Symptoms appear as irregular angular yellow to brown spots on the top and undersides of the leaves. In broccoli infected areas on the leaves enlarge and turn tan and papery under moist conditions. The diagnostic feature of the disease for all brassicas is grayish white, fluffy growth on the undersides of leaves.

On the heads of broccoli or cauliflower, dark brown areas develop in flower buds of the head. Stems and stalks of the flower head may be darkened or have black streaks, and this may be the first sign of infection in broccoli. In cabbage, internal darkening and purplish spots appear in the inner layers of the head or move upward in the head from stem infections. Secondary infection with soft rot bacteria (causing major stink!) may follow the downy mildew. In cabbage, systemic invasion of the stem may occur after infection of the lower leaves. The fungus may then invade the head leaves and sporulate after the cabbage has been stored.

Spores overwinter in the soil and on infected crop debris. Three year rotation out of brassicas and brassica weeds is the best management. Till under crop debris and use adequate crop spacing to encourage drying of leaves to avoid downy mildew. Control in the seed-bed is very important and includes the use of clean growing medium, good drainage, and an avoidance of overhead irrigation. Resistant or tolerant varieties of broccoli have been developed. For current fungicide recommendations see the NE Vegetable Management Guide. Preventive spraying of protectant foliar fungicides may be necessary if environmental conditions favor disease development. For organic growers, potassium bicarbonate can be effective if applied at the first sign of disease and continue at 7-14 day intervals while conditions remain favorable for disease development. Copper hydroxide may be used for cabbage only.

Black rot (*Xanthomonas campestris* pv. *Campestris)* is the most destructive disease of brassicas. This disease is caused by a bacterium causing V shaped yellow or brown lesions or patches along the margins of leaves. As the lesions expand, the small veins become blackened. Infected plants may die prematurely, heads may remain small and quality may be reduced. Plants can become infected at any growth stage. If brassica seeds are infected with the disease, young seedlings become yellow, drop lower leaves and may die. These symptoms can look like nutritional deficiencies or root rots. The bacteria can also infect plants by entering leaves through the hydathodes (natural openings) on the leaf edges, resulting in the typical V shaped lesion on the leaf margin. Bacteria can also enter leaves through wounds caused by insect feeding. Black rot spreads rapidly .during warm, humid weather with an optimal range of 80-86 degrees F and 80-100% humidity.

Managing this disease requires an integrated approach. Use hot water treated seed from your seed dealer or do it yourself by placing seed loosely in a cheesecloth bag, immersing and soaking in hot (122 degrees F) water for 20 minutes for broccoli and cauliflower and 25 minutes for cabbage and Brussels sprouts. Immediately immerse seed in cold water then spread in a thin layer to dry. Although this will not totally eliminate the bacteria, it will greatly reduce bacteria in seeds. Hot water treatment may affect vigor and viability of seed so test seed after treatment. Inspect brassica transplants and destroy any that have symptoms before moving to the field. Eliminate brassica weeds and volunteers. Avoid working in wet fields. Destroy crop debris after harvest, avoid overhead irrigation and use a 3 year rotation out of brassicas. Consult NE Vegetable Management Guide for spray recommedations.

Club root (*Plasmodiophora brassicae*) of cabbage is caused by a soil borne fungus. The first symptoms of the disease may appear as poor vigor in the stand, wilting during hot or dry weather or yellowing of foliage. When infection occurs at an early stage of growth, young plants are stunted and may die. Plants infected later in the season may fail to make marketable heads or growth. When entire plants are examined, the roots are swollen and distorted or "clubbed." The clubbing reduces the plant's ability to take up water and can make the roots more susceptible to invasion by soft rotting bacteria. The pathogen can survive in soils for 7-10 years or longer. Infested soils with the resting spores of the fungus can be moved around the farm by machinery, people, infected transplants, water, tools and animals. The disease is restricted mainly to members of the mustard family, both cultivated and weeds, and to a few other plants. Although clubbing symptoms are unique to members of the Cruciferae, ***P. brassicae*** is capable of infecting the root hairs of the noncruciferous hosts including some grasses and other plant families. Because of the existence of races in this organism, plants can respond to attack on different levels. Preventing clubroot introduction into a field is the best management option. Inspect transplants before planting in the field. Maintain soil at pH of 6.8. Apply 1,500 lbs of hydrated lime 6 weeks before planting to raise pH to 7.2 or more. A 4 year rotation is recommended for brassicas. If clubroot is detected, increase to a 7 year rotation. Some resistant cultivars are available. For fungicide soil drench info, consult the NE Vegetable Management Guide.

GROWING BROCCOLI AND CAULIFLOWER FROM SPRING THROUGH FALL

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Golonka Farm is a small, very diversified farm with about 95% of our sales being retail. Our goal is to grow and offer, for sale, a wide range of produce throughout the growing season. One crop we have been growing, and consistently offering for sale, is broccoli.

The first planting of broccoli is started in the greenhouse around March 10th in 72s. The next five or six plantings are in 98s. The last 2 plantings are outdoors in seed beds. Each planting consists of 2 or 3 varieties of different maturity.

Fertilization consists of discing in 100-120 pounds of NPK after plowing. Treflan is then applied with a field cultivator for weed control. Transplanting is done with a mechanical transplanter set at 14" plant spacing on 36" rows. Broccoli, cauliflower, cabbage and kohlrabi are planted together.

Soon after transplanting in the spring, root maggot control with Lorsban is applied using a banded soil drench. About three weeks after transplanting, 300 pounds of Ammonium Sulfate is applied as a side dress.

The keys to growing broccoli and cauliflower are maintaining high fertility, proper soil moisture and variety selection, good root maggot control and a little luck. Anything that stresses the plant will result in smaller heads.

Production of Hydroponic Tomatoes Rich in Flavor and Bioactive Compounds

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American consumers always appreciate flavorful produce but they are often disappointed by the tasteless produce typically available in retail stores. The producers and produce chains unfortunately consider yield (productivity) and produce appearance higher priorities than flavor. For them, one challenge is that flavor is a difficult factor to control in traditional farming systems, as it is largely affected by cultivation procedures, environmental conditions as well as cultivars (genetic make-up). Here I am presenting 'hydroponics' as an opportunity to guarantee both high yields as well as consistently good flavor, plus a bonus opportunity of increasing health promoting bioactive compounds.

Achieving high yields in hydroponic tomato production:
Greenhouse food production in the U.S. was negligible until the late 1980s, compared to more traditional open-field production. During 1990s, greenhouse hydroponic food production (particularly tomato) increased rapidly. In the U.S., introduction of greenhouse hydroponics (soilless culture) has been the most successful for tomato, as nearly 40% of tomatoes available in U.S. retail stores are from North American greenhouses (Cook and Calvin, 2005). Recently a new growers association (NAGHVG) was formed in North America to promote the high quality, low use of pesticides, and safety of the hydroponically grown tomato, showing that greenhouse soilless production is a significant means of fresh tomato production in North America. Hydroponic tomato greenhouse is now approaching yields as high as 100 kg/m^2 per year (or 405 ton/acre per year), more than 20 times greater yields than those in open fields.

Moderate salt stress to enhance flavor:
Enhancing flavor (often measured using a soluble solid concentration or Brix %) of tomato by applying water stress has been commercially practiced for many years in Asian countries. Under water stress, tomato plants allocate less water to the fruit, thus concentrating flavor compounds including sugars and acids. Beefsteak type tomato grown under water stress could have Brix as high as 9.0 while the typical values are around 3.0. However, higher Brix is associated with greater reduction of water in fruit and thereby smaller yields. Therefore, growers need to decide the level of water stress and the method to control the stress at a level under which the yield loss can be compensated with an increase in value of the produce. In hydroponic greenhouse, water stress can be applied and maintained relatively easily by controlling electrical conductivity (EC, an indicator of total ion concentration) of the hydroponic nutrient solution. The most economically feasible way to control nutrient solution EC is to add sodium chloride. In our standard tomato hydroponic solution, EC is around 2.5, and by increasing EC to around 4.0 to 5.0, tomato plants will be under mild water (and salt) stress and fruit flavor can be enhanced. At the University of Arizona's Controlled Environment Agriculture Center, we demonstrated a year round production of tomato with enhanced Brix by high EC. The average Brix of tomato fruit grown under high EC was 4.9, while that of control group under low EC was 4.1.

Lycopene and other bioactive compounds increase under salt stress in hydropoinics:
During our previous research, it was noted that fruit produced under high EC was rich in red color compared with the control fruit under standard low EC. We confirmed that lycopene, the red pigment and a strong antioxidant in tomato fruit, was enhanced under high EC (Wu et al., 2004; Wu and Kubota, 2008). As factors influencing lycopene synthesis in fruit include temperature (e.g., Krumbein et al., 2006) and light intensity (e.g., Dumas et al., 2003), we conducted a year-round production of tomato under high EC and low EC to quantify the seasonal change in lycopene in hydroponic tomato grown under these EC conditions. A two year study showed that tomatoes produced under high EC significantly increased Brix as well as lycopene concentration by 20% with some seasonal changes (higher lycopene in summer and lower lycopene in winter). Significant increases in β-carotene, phenolics, and ascorbic acid of tomato under high EC were also demonstrated.

Human health benefit:
In collaboration with a human nutritional scientist (Dr. Cynthia Thomson), our group has been working on the efficacy of consuming greenhouse tomato rich in lycopene and other bioactive compounds. Although our short term consumption study could not successfully demonstrated the long-term positive outcomes in the human body, the daily consumption of fresh tomato rich in lycopene could significantly increase the lycopene concentration in human blood (plasma), compared to that of standard tomato (Thomson et al., 2008).

Conclusion – "Quality matters":
Promoting consumption of vegetables and fruits has been a national effort to improve human health. While we are encouraged to eat more quantity of vegetables and fruits, selecting produce rich in flavor as well as health promoting bioactive compounds is equally important. Greenhouse hydroponics can provide opportunities of year-round production of such produce as demonstrated in our study.

References cited:
Cook, R. and L. Calvin. 2005. Greenhouse tomatoes change the dynamics of the North American Fresh Tomato Industry. USDA Economic Research Report No. 2. 22 Mar. 2006. < http://www.ers.usda.gov/publications/err2/>.

Dumas, Y., M., Dadomo, G., Di Lucca, and P. Grolier. 2003. Effects of environmental factors and agricultural techniques on antioxidant content of tomatoes. J. Sci. Food Agric. 83:369-382.

Krumbein, A., D. Schwarz, H.-P. Kläring. 2006. Effects of environmental factors on carotenoid content in tomato (*Lycopersicon esculentum* (L.) Mill.) grown in a greenhouse. J. Appl. Bot. Food Quality. 80:160-164.

Thomson C.A., N.R. Stendell-Hollis, J.L. West, E.C. Cussler, L.M. McCune, M. Kroggel, H.J. Kim, and C. Kubota. 2008. High-lycopene consumption increases serum carotenoid levels but does not have decrease levels of oxidative stress and inflammation in healthy adults. The Open Bioactive Compounds Journal. 1:7-12.

Wu, M., and C. Kubota. 2008. Effects of high electrical conductivity of nutrient solution and its application timing on lycopene, chlorophyll and sugar concentrations of hydroponic tomatoes during ripening. Scientia Hort. 116:122–129.

Wu, M., J.S. Buck, and C. Kubota. 2004. Effects of nutrient solution EC, plant microclimate and cultivars on fruit quality and yield of hydroponic tomatoes (*Lycopersicon esculentum*). Acta Horticulturae. 659:541-547.

Changes with season of nutrients in salad greens grown in high tunnels

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Growth and composition of leafy vegetables varies with season or time of year. This seasonal variation is related to changes in light and temperature that affect metabolism in leaves and roots, and the rate of chemical transformation of nutrients in the soil. The variation of nutrient availability with season may depend on whether the crop is grown with nitrate-based fertilizer or organic fertilizer. Similar yields are generally obtained with organic and inorganic fertilizer. In field trials, compost or mineral fertilizer gave equal yield for lettuce, cabbage, carrots, tomatoes, and peppers. Sometimes compost amendment increases the concentration of nutrients in leaves, compared to inorganic fertilization. Different species of salad greens react differently to fertilizer. Nitrate in mustard and turnip greens rose with N application up to 100 lbs acre, whereas nitrate in lettuce reached a maximum at 50 lbs, and composition of kale did not have a simple response to applied N. Although the leaf nitrogen did not vary among lettuce, spinach, and cabbage when grown with little or no fertilizer, it varied substantially among these species when excess N fertilizer was applied.

Because high tunnels allow growth later in the year, and at times when there is more extreme variation of day to night temperature, growth in high tunnels may exaggerate seasonal variation in composition of lettuce and other salad greens. I examined the growth and composition of crops grown in high tunnels and harvested at approximately one month intervals from September to June. Seven species of greens were grown either with organic fertilization, namely leaf compost amended with cotton seed meal, or inorganic fertilization, namely perlite watered with a complete nitrate-based nutrient solution.

Environment

Day-time average temperatures in high tunnels ranged from 40 to 70 ^{o}F in winter to 90 ^{o}F or more in summer. Night-time temperatures were below freezing from late November to early March. These cold temperatures were the primary limitation to growth in winter. Night-time temperatures in the high tunnels were only 2 or 4 ^{o}F degrees warmer than ambient, whereas day-time temperatures were 20 ^{o}F warmer than ambient throughout the year. Day-time temperatures were correlated with sunlight, but on a weekly basis, the maximum and minimum temperature lagged about one month behind maximum and minimum sunlight integral. Temperatures were warmer in fall than in spring at a given light level.

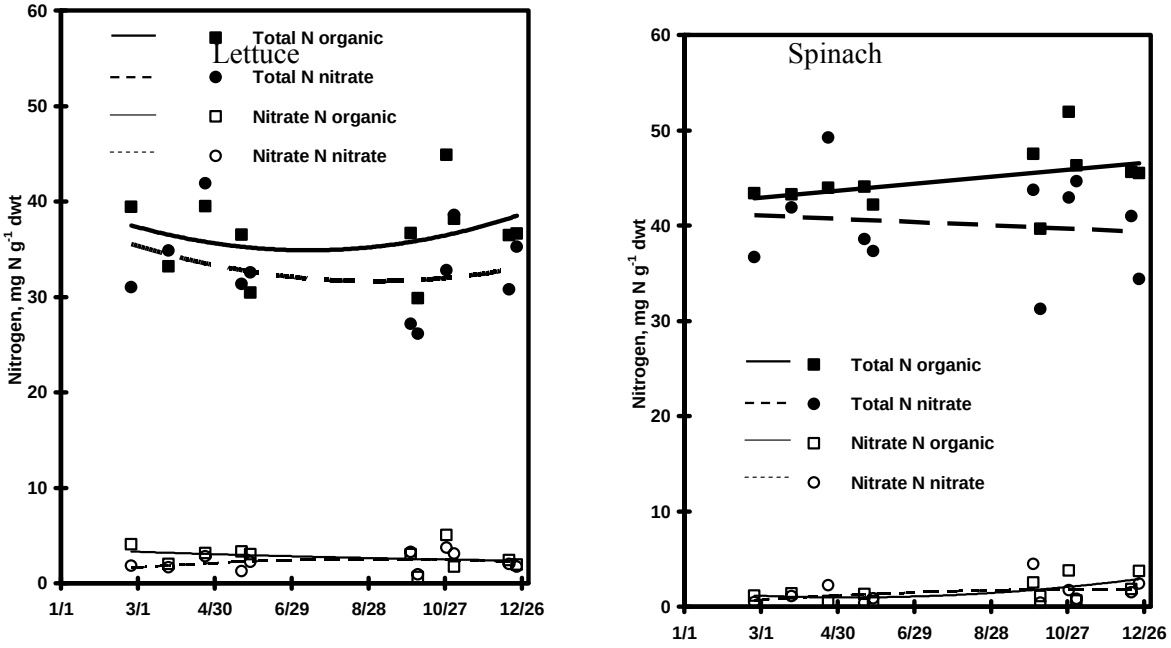
Growth

Growth in high tunnels was most rapid in May and September, 17 to 21% per day averaged over all species tested. Reasonable growth rates were also seen in April and October, 12 to 14% per day. Growth in the open field was much slower at this time of year, typically 5 to 10% per day. Growth in high tunnels slowed substantially in the fall, from about 15% in early October to 5 to 7% in late December. Quality of leaves was good, except when plants experienced sudden extreme cold after a period of mild weather. Growth in winter was extremely slow, between 0%

and 7% per day. Plants survived the cold, but leaves tended to desiccate, or have tip burn or translucent patches, and stem tissue turned brown. Some salad greens tended to bolt quickly in the heat of May and September.

Tissue composition of leaves

Total nitrogen and nitrate content as a function of fertilizer and time of year for:



In contrast to the wide variation in growth rate with time of year, elemental composition of leaves of salad greens varied little with season. Nitrate did not accumulate to high levels in leaves of salad greens when grown in winter under low light, a phenomenon often observed in heated greenhouses. Although nitrate-based fertilizer resulted in a dip in total leaf nitrogen for lettuce in early fall, no seasonal response occurred with organic fertilizer (Figure 1). There was a similar trend with time of year for total reduced nitrogen in spinach (Figure 2). The amount of nitrate and the seasonal variation in nitrate was much smaller than that for total reduced nitrogen in both lettuce and spinach. Cool air and soil in the unheated high tunnels may decrease uptake of nitrate by plants, and compensate for slow growth.

Cool temperature may restrict uptake of other nutrients. Concentrations of potassium and calcium varied more with season than did that of nitrogen. However, the variation with time of year of these nutrients had a pattern that was not simply related to seasonal pattern in growth rate or environment. Differences in leaf composition due to fertilizer often occurred in a particular species and at a particular time of the year. This was true for total nitrogen and calcium. The difference in nitrogen in lettuce due to fertilizer only occurred in early fall and it may be related to a high availability of nitrate in the organic root medium at this time of year. Arugula also had particularly high nitrate when grown with organic fertilizer in early fall, 10 to 12 mg g^{-1} compared to about 5 mg g^{-1} at other times of year. Fertilizer affected nitrate in kale only in spring, when leaf nitrate was about 10 and 5 mg g^{-1}, with nitrate-based compared to organic fertilizer, respectively. Spinach had higher calcium with nitrate-based than with organic fertilizer in the fall, but not in the spring. These differences among species, in time when form of fertilizer

exerted an effect on composition, suggest that environmentally sensitive processes within the plant, rather than in the root medium, were responsible for differences in leaf composition due to fertilizer.

Nitrate and Ammonium in the Root Medium

In part, these results could be due to seasonal and fertilizer differences in the available concentrations of the various nutrients in the root medium. More nitrate could be extracted from compost with cottonseed meal than from perlite with nitrate-based fertilizer. For both fertilizers, more nitrate could be extracted in fall than in the spring. Extractable nitrate concentrations with organic fertilizer were about 100 and 45 ppm in a 1:1 extract, in fall and spring, respectively, compared to 70 and 30 ppm N with nitrate-based fertilizer. Extractable ammonium was much lower than nitrate. Organic fertilizer resulted in about 2 to 3 ppm ammonium-N in the root medium. The medium with nitrate-based fertilizer always had less than 1 ppm ammonium-N.

Growth was not related to nitrate availability in the root medium. Greens grew quickly in late spring, when the lowest concentrations of nitrate were extracted from the root medium. There was more nitrate available in fall and early spring, than in late spring, which suggests that nitrate availability did not limit growth except possibly in late spring. The root medium and leaf tissue nitrogen reported here suggest that fertilization was not excessive. The values of leaf nitrate are at the low end of the range reported in field studies of salad greens in Missouri and in England.

Further reading.

Gent, M.P.N. 2002. Growth and Composition of Salad Greens as affected by Organic Compared to Nitrate Fertilizer and Environment in High Tunnels. J. Plant Nutrition 25:981-998

Gent, M.P.N. 2005. Effect of genotype, fertilization, and season on free amino acids in leaves of salad greens grown in high tunnels. J. Plant Nutrition 28:1-14

Phenolic Phytochemicals in Fruits and Vegetables are Linked to Health Benefits

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Introduction: It is evident from studies undertaken by the Center for Disease Control and others that diet and obesity-linked chronic diseases and specifically type 2 diabetes are a serious and expensive health-care challenge in America. African Americans and Native Americans are suffering disproportionately and this serious health disparity has to be addressed while advancing food security in these communities.

What would be of special significance is to optimize the amounts of in phenolic antioxidant-type phytochemicals and high fiber in these culture-specific fresh plant food sources since these biochemicals have the potential to inhibit type 2 diabetes-relevant metabolic pathways such as hyperglycemia, hypertension and oxidative stress. The first step is to analyze the type 2 diabetes relevant chronic disease protective fruits, vegetables, legumes, greens, herbs and whole grains that are culturally relevant and produce them locally and then extend this analysis to those commonly grown by other local and regional farmers and those found in the grocery stores. Based on this analysis and health-focused biochemical rationale then encourage at-risk populations to acquire and consume more of the most beneficial foods through community partnerships, innovations for growing locally and clinically validate the design and use of these foods by medical experts.

The above bioactive-specific approach to build fresh plant food systems and associated community partnership for food security with type 2 diabetes relevant food systems is innovative and cost effective. This rationale can be extended to many communities in the US that are challenged by food security and obesity-linked chronic diseases such as type 2 diabetes that are among the highest rates globally. From this foundation of community partnerships and innovations for food security we will also build community partnerships and share experiences for enhancing local food security and health in all communities across the globe.

Scientific Knowledge Gap: The major chronic diseases such as type 2 diabetes and associated complications of hypertension (and linked to cardiovascular diseases) are dysfunctional oxidation-linked diseases, meaning that the oxygen that we need to obtain energy can be deleterious (reactive free radicals) under high calorie diet. Integration of culture-specific and health-focused plant food systems has to be part of advancing food security in various urban and rural communities that are seriously affected by obesity-linked chronic diseases such as type 2 diabetes. Plant foods have a range of phenolic antioxidants (phenolic phytochemicals) that can counter “reactive” oxygen and we have developed an innovative strategy to screen such protective plant foods rich in protective phenolic antioxidants and fiber that can be consistently included in our everyday diet. We have preliminary evidence that traditional diet of Native Americans is rich such protective dietary factors (Kwon et al., 2007b). Further, we have developed *in vitro* assays to screen high phenolic antioxidant profiles to specific type 2

diabetes and hypertension enzyme targets, while at the same time countering the problems of “reactive” oxygen-linked cellular breakdown which has the potential to counter micro-vascular complications of type 2 diabetes such as slow wound healing, macular degeneration and kidney problems. This dietary health protective strategy will also be adapted to screen diverse culture-specific plant foods to be grown locally using an array of *in vitro* enzyme assays as the basis for food design and preparation for rationalizing future clinical studies for primary prevention of the overall disease and management of secondary of complications in partnership with the medical research community.

Current chronic disease drug strategies, though critical and necessary once diagnosis has been made and especially in later stages of disease development, only focus on structure-function breakdown targets (e.g., acarbose for α-glucosidase inhibition but results in high and at times deleterious inhibition of α-amylase). Further they do not prevent breakdown at cellular energy level linked to “reactive” oxygen that leads to many structure-function breakdowns. In contrast the right choice of fresh and whole foods enriched with phenolic phytochemicals as a part of a balanced diet can bring multiple bioactive profiles that can potentially prevent and manage oxidative-linked cellular breakdown moving towards type 2 diabetes and associated micro and macro vascular complications (Figure 1 in pumpkin specific varieties P5 & P6 have the best combination of multiple bioactive factors for potential management of hyperglycemia and overall oxidative stress). Therefore I will be presenting an innovative type 2 diabetes prevention and management strategy for designing and preparing healthy diet from a diversity of culture-specific and locally grown phenolic enriched protective plant foods that have adapted well to our living environment. This is a cost-effective strategy for chronic disease management.

Technology Solution: Using phenolic enriched and disease-focused food designs and preparation, food security and health challenges can be addressed by developing and nurturing effective partnerships between the targeted community and the scientific and medical community to address specific community needs for better health outcomes and reduce health disparity that is so serious in the United States. Based on sound biochemical rationale for healthy fresh food design, food security and health care can be delivered to targeted communities by a variety of community and community-linked technology innovations. Such options include technologies for growing locally in outdoor and indoor environments, community focused food sourcing and distribution centers, building partnerships with scientific and medical community to validate and enhance the use of healthy food systems. These combinations of technology and partnership strategies can be the basis of community food security and reduction of health disparities in terms of chronic diseases such as type 2 diabetes and associated oxidative stress and hypertension-linked complications.

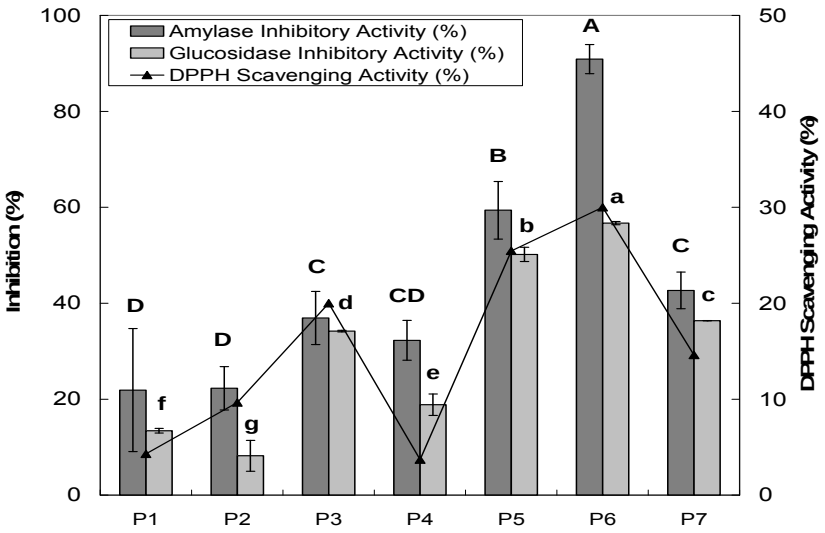

FIG. 1: The comparison of porcine pancreatic α-amylase, rat intestinal α-glucosidase inhibitory activity and free radical scavenging antioxidant activity of autoclaved extracts of pumpkin (Each assay carried out with 200 mg-FW sample/ml concentration. Round yellow: P1, Striped yellow green: P2, Striped round yellow green: P3, Elongated brown: P4, Round orange: P5, Spotted orange green: P6 and Round green: P7).

Preliminary results on select grain and legume sprouts, fruits and vegetables from foods commonly consumed in the United States indicate the presence of phenolic antioxidants (Cheplick et al., 2007; Kwon et al., 2007a; Kwon et al., 2007b; Kwon et al., 2008; Adyanthaya et al., 2009). Correlations between total phenolics, antioxidant activity and functionality have been observed in several cases. This background information could also be the basis of design of whole-food based prepared foods such as soups, cereals, legume-enriched breads and processed vegetables. The understanding of protective functions linked to specific inhibitory pathways linked to countering hyperglycemia, hypertension and oxidative stress by these designed fresh foods or prepared derivates of the same can be targeted to combat type 2 diabetes and there provides a basis for better and culture-specific food design and dietary counter measures.

	Phenolic content (mg/g FW)	Antioxidant Activity %	Alpha-Amylase Inhibition %	Alpha-Glucosidase Inhibition %	ACE Inhibition %
Broccoli	0.57	61	23	19	23
Brussels Sprouts	0.44	45	21	17	17
Cabbage	0.34	47	19	15	19
Cauliflower	0.42	33	14	11	14
Wheat sprouts	1.5	54	35	19	47
Buck wheat sprouts	1.3	45	39	28	65
Corn sprouts	2.2	45	38	30	45
Oats sprouts	0.5	48	47	26	55
Wheat seedlings	1.3	57	45	30	44
Buck wheat seedlings	1.3	47	39	28	58
Corn seedlings	2.7	43	40	27	33
Oats seedlings	0.7	45	55	45	45
Fava Bean sprouts	1.3	51	39	24	51
Mung Bean sprouts	0.42	45	31	17	43
Fenugreek sprouts	0.43	47	57	54	62
Soybean sprouts	0.53	59	52	42	56
Fava Bean seedlings	15.46	49	33	23	63
Mung Bean seedling	5.73	33	18	18	55
Fenugreek seedling	9.42	45	59	39	75
Soybean seedling	1.46	40	42	38	71

References:

Cheplick, S., Kwon, Y-I., Bhowmik, P. and Shetty, K. (2007) Clonal variation in raspberry fruit phenolics and relevance for diabetes and hypertension management. **J. Food Biochemistry,** 31: 656-679.

Kwon, Y.I., Apostolidis, E. and Shetty, K. (2007a) Evaluation of pepper (*Capsicum annuum*) for management of diabetes and hypertension. **J. Food Biochemistry,** 31: 370-385.

Kwon, Y-I., Apostolidis, E., Kim, Y-C. and Shetty, K. (2007b) Health Benefits of Traditional Corn, Beans and Pumpkin; *In Vitro* Studies for Hyperglycemia and Hypertension Management. **J. Medicinal Food,** 10: 266-275.

Kwon, Y-I., Apostolidis, E. and Shetty, K. (2008) *In vitro* studies of eggplant (*Solanum melongena*) phenolics as inhibitors of key enzymes relevant for Type 2 diabetes and hypertension. **Bioresource Technology,** 99: 2981-2988.

Pinto, M.D-S., Ranilla, L.G., Apostolidis, E., Lajolo, F.M., Genovese, M.I. and Shetty, K. (2009). Evaluation of anti-hyperglycemia and anti-hypertension potential of native Peruvian fruits using *in vitro* models. **J. Medicinal Food,** 12: 278-291.

Post-harvest Changes in Nutrition and Eating Quality of Squash

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Introduction

There are three major species of squash that are grown worldwide for their mature, edible fruit – *Cucurbita pepo*, *C. maxima*, and *C. moschata*. The species *C. moschata* includes tropical cultigens and round to oval to long neck pumpkins grown in parts of North America for processing. However, the major fresh market type grown in the northeast is the popular dumbbell-shaped butternut. The species *C. maxima* includes the humongous show pumpkins, Golden Delicious-type processing squash, Hubbard varieties, and the green to gray, 2 to 3 pound buttercup/kabocha varieties, the latter esteemed for their exceptional eating quality. Within *C. pepo*, acorn varieties predominate in supermarkets, but markets are expanding for 0.8 to 1.5 kg, striped, ribbed squash in the 'Sweet Dumpling' class. Although cultural methods for the above species of squash are similar, harvesting schedules and post-harvest handling may vary considerably, along with the development of traits that relate to eating quality and nutrition.

What are the key nutrients in winter squash?

Carbohydrates in the form of sugars and starch are the major constituents of squash flesh (mesocarp), comprising between 50% to as much as 70% of the dry biomass (solid portion after elimination of water) at harvest (Table 1). Varieties with a high content of dry matter (18-26%)) have better eating quality than those with low dry matter content because of high starch content and a lower proportion of fibrous cell wall material. Starch not only contributes to a desirable pasty texture of cooked squash, but also generates sugars during enzymatic breakdown.

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

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

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

[y]Data obtained from other sources.

In cooking tests, high sugar content is strongly associated with high consumer rating of eating quality. The sugar content at harvest can vary from over 20% in some acorn varieties to around 10% or less in some kabocha and butternut varieties. The relative sugar content can be estimated using a hand-held refractometer, with values given in % soluble solids (SS). Acceptable eating quality is generally attained when SS values are 11% or higher. In most varieties, sugar content will increase steadily increase during several weeks of storage as long as starch is not depleted. With longer storage times, fibrous cell wall matter comprises an increasingly larger portion of the constituents (Table 1), so texture eventually deteriorates, becoming more watery and fibrous and less pasty. This is especially true in low dry matter varieties because starch is rapidly depleted during storage.

Other than providing carbohydrates, the major nutritional benefit of squash is the high content of carotenoids, the yellow to orange, fat-soluble pigments. Beta-carotene, an abundant carotenoid in several varieties of squash, is an important precursor to vitamin A, an essential vitamin for normal eye development and function. Numerous epidemiological studies have implicated carotenoids in a protective function against several cancers, cardiovascular disease and cataracts, and also enhancing immune responses. Lutein, a carotenoid prevalent in large amounts in some squash varieties, is one of the two principal pigments in the macular region of the retina, and increased dietary intake may reduce incidence of age-related macular degeneration. Growers can and should identify nutritional benefits of their produce as a marketing tool. Jennifer Noseworthy has been studying carotenoid content and carotenoid profiles in squash and sweet potato as part of her doctoral degree at the University of New Hampshire. She has found that the popular butternut variety 'Waltham,' not only has relatively high carotenoid levels, but a large proportion (30 to 40%) of the carotenoid content is comprised of lutein. Zeaxanthin is another carotenoid important in eye health. It is absent in most fruits and vegetables, but found in ample supply in leafy brassicas such as kale. Among the kabocha/buttercup varieties analyzed, carotenoid levels were higher than butternuts and two kabocha varieties developed at UNH (Eclipse and Thunder) and the variety Sunshine (Johnny's Selected Seeds) have high levels of β-carotene and lutein and about 5% zeaxanthin.

When is a squash mature?

With many fruits and vegetables a mature fruit is defined as one that is ripe, and displays certain color, firmness and odor changes associated with ripeness. Squash maturity is more difficult to define. Most of the popular edible varieties of squash have relatively small fruit size, and near full size is attained by 20 days after fruit set. Whereas the change in rind color from green to orange can be a useful trait in ornamental pumpkins to determine harvest time, changes in rind color in edible winter squash do not relate well to squash maturity. For example, acorn squash turn a dark green, mature-looking color within two weeks of fruit set, 40 to 50 days before they should be harvested! By the same token, butternut squash turn a fairly mature tan color by about 35 to 40 days after pollination, some two to three weeks before they should be harvested. Harvest time should be based on compositional changes and maturation of the fruit. In most varieties the accumulation of flesh dry matter and therefore starch content peaks between 30 to 35 days after pollination. As mentioned above, high starch content is strongly associated with good eating quality. Peak dry matter, however, does not coincide with maturation of seeds within the fruit, and because the fruit is the reproductive organ of the plant, it is reasonable to define a squash as being mature when the seeds are mature. Seed fill in most squash grown in

the Northeast is not complete until about 55 days after pollination and fruit set. Most people do not eat the seeds of squash, so delaying harvest until the seeds are completely filled may not always be necessary, but maintaining a healthy plant and delaying harvest until about two months after fruit set is a good general recommendation. Seeds require photosynthates (carbon compounds produced from photosynthesis) to complete development. If the fruit is harvested before the seed is fully developed, then assimilates for seed fill are remobilized from the flesh to the seeds during subsequent storage. Under conditions of poor plant health or premature harvest, movement of carbohydrates from the fleshy mesocarp tissue to seeds can reduce flesh quality substantially, especially in varieties with inherently low dry matter.

Keeping track of when fruit set occurs may not realistically fit into a grower's crop schedule, so a reasonable rule of thumb for kabocha and acorn squash is to begin harvesting squash when the ground color of the fruit reaches a dark orange color. Acorn squash reach near full size and a dark green color by about two weeks after fruit set, so to the casual observer, the squash may appear to be mature. However, the ground spot on squash between 15 to 40 days after fruit set will vary from light green early on to dark yellow. Butternut squash does not show orange ground color, so harvest should not begin until at least two weeks after squash turn tan color. Maturity dates listed in seed catalogs are often in error, especially for acorn squash, where maturity is often stated as being between 70 to 76 days when in reality the actual maturities are probably closer to 90 to 100 days. Kabocha and buttercup varieties have very high dry matter content, and late seed fill in harvested squash does not appreciably detract from quality. Studies in New Zealand suggest that squash harvested at 40 days after fruit set may have a harder rind and be more resistant to storage diseases than squash harvested later. However, the sugar content is low in immature kabocha squash, so I recommend harvesting prior to 55 days only when vines have begun to go down, so as to minimize sunburn damage and fruit discoloration.

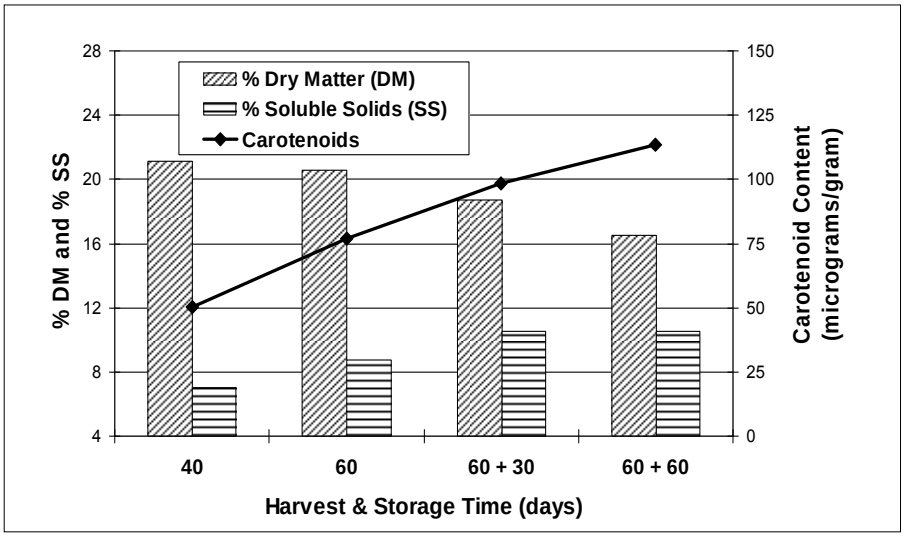
Post-harvest changes in eating quality and nutrition

In acorn and related varieties, starch to sugar conversion occurs relatively early in fruit development, and a soluble solids content of 11% or greater in the best culinary varieties may be attained within 45 to 55 days after fruit set. Therefore, acorn squash can be sold at harvest and recommended for immediate consumption, even though optimum eating quality may not be attained until a few weeks after harvest. Buttercup and kabocha used to be considered as the consummate varieties for connoisseurs of squash, but the recently introduced varieties of acorn and 'Sweet Dumpling' types of squash with high dry matter, such as 'Honey Bear' and Sugar 'Dumpling,' are being touted by many as having the most outstanding eating quality.

Given the popularity of butternut squash, there is a surprising lack of information on changes in eating and nutritional quality during storage. Most such studies were published in the 1960s and lacked good experimental design. In butternut squash harvested at about 55 days after fruit set, we have found that about 60 days of storage at 56 to 60 ^{o}F is required for soluble solids levels to reach minimum acceptable levels. Carotenoid content often increases even more than soluble solids with storage (Figure 1), so squash has more nutritional value in terms of carotenoid content if stored. Kabocha and buttercup varieties fall in between the butternuts and acorns in terms of edibility at harvest. Our results suggest that most varieties have sufficient sugar levels at a 60-day harvest, but not if harvested at 40 days after fruit set. Sugar content in kabocha will increase with additional storage time as will carotenoids. Occasionally a kabocha variety will

have an excessive dry matter at harvest (over 30%), and in such cases, additional storage is needed for depleting starch and raising sugar levels.

Figure 1. Harvest date and storage time affects eating quality and nutritional content of 'Waltham' butternut squash.



Post-harvest changes can be accelerated with increased storage temperature, but this in turn can adversely affect storage life. Studies with kabocha squash have shown that storing squash for one week at a high temperature (85 ^{o}F) can accelerate post-harvest increases in sugar levels following subsequent storage at 54 ^{o}F. In 2008, we harvested butternut squash at about 55 to 60 days after pollination and stored squash for three weeks in a greenhouse where daytime temperatures ranged from 75 to 85 ^{o}F. Out of 28 fruit sampled, 20% had soluble solids between 10 to 11% and 80% had soluble solids between 11 and 14%. Eating quality ranged from good to excellent for most samples. It would have been preferable to store the squash under shaded conditions, because some light discoloration of the rind was observed on some fruit. Based on our results, we would recommend that growers store butternut squash at a high temperature for one to two weeks for customers wanting to purchase butternut squash ready to consume.

Conclusion

The three major classes of winter squash - acorn, kabocha/buttercup, and butternut – have different attributes associated with maturation and post-harvest changes in eating quality and nutrition. It is important for growers to understand these differences so as to provide information to customers that will guide them in purchasing and utilizing squash for optimum culinary and nutritional benefits. In addition to species differences in maturation, there are also considerable varietal differences with respect to eating quality. It behooves growers to become more aware of varieties which exhibit good eating quality so that their customers are satisfied with their purchases, and realize the benefits of purchasing their produce at roadside retail markets.

IMPROVING CAROTENOID PHYTOCHEMICAL CONCENTRATIONS IN VEGETABLE CROPS

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Phytochemicals are broadly defined as food components that elicit profound effects on health maintenance and disease prevention. In the human body, oxidants produced during normal metabolism and immune defense against infectious and chemical agents are responsible for damage to DNA, proteins, and cellular tissues. This harmful oxidative damage is considered the major cause of aging and degenerative diseases such as cancer, cardiovascular disease, immune-system decline, and cataract (Kopsell and Kopsell, 2009). Compounds such as ascorbate, α-tocopherol, and carotenoids are examples of antioxidants that have the ability to quench reactive oxygen species. In fact, carotenoids are some of the most potent biological quenchers of reactive oxygen species.

Changing environmental factors can impose stress on plants (Kopsell et al., 2009). Organic phytochemicals are assumed to be utilized by plants to combat stress conditions. The topics discussed in this manuscript were designed to measure the influence of several environmental growing conditions on the production of carotenoid phytochemicals in leafy and other vegetable crops. Our overall goal was to investigate the potential of manipulating environmental growing conditions to increase the availability of functional components that may provide long-term health consequences.

Carotenoids in Plant Metabolism

Carotenoids are lipid soluble yellow, orange, and red pigments that are uniquely synthesized in plants, algae, fungi, and bacteria. In photosynthesis, carotenoids function to help harvest light and dissipate excess energy before damage occurs. In their main role, carotenoid pigments protect photosynthetic structures by quenching reactive oxygen species (ROS) to inhibit oxidative damage.

Carotenoids and Human Health

Carotenoids are lipid soluble which possess reported health benefits of reducing cancers (lycopene), cardiovascular (lycopene), and aging eye diseases [lutein (L) and zeaxanthin(Zea)] when regularly consumed in the diet. One of the most important physiological functions of carotenoids in human nutrition is as vitamin A precursors [β-carotene (BC)]. Humans cannot synthesize carotenoids; therefore, fruits and vegetables are primary sources of carotenoids in human diets world-wide.

Growing Air Temperature can Influence Carotenoid Accumulation

Environmental factors such as light, water and growing air temperatures can have significant influences on plant growth and development. Rapid fluctuations in growing air temperature can limit plant growth at both low and high temperature extremes. Plants can adapt to air temperature changes in the growing environment and usually easily adjust to conditions slightly above and below optimum air temperature ranges. Our goal was to investigate the influences of different air temperatures on the accumulation of carotenoid pigments in kale and spinach. 'Winterbor' kale and 'Melody' spinach were grown in environmental chambers that provided plants with set point air temperature treatments of 15, 20, 25, or 30 °C for the kale, and 10, 15, 20, or 25 °C for the spinach (Lefsrud et al., 2005). Carotenoid concentrations in the leaves of kale increased as the air temperatures increased from 15 to 30 °C, while the carotenoid concentrations decreased in spinach as the air temperature increased from 10 to 25 °C. Results from our study demonstrated that changes in growing air temperatures can influence the production of carotenoid pigments in the leaves of kale and spinach. Air temperatures in field conditions can be modified by growing kale and spinach at different times of the year.

Light Intensity can Influence Carotenoid Accumulation

As light strikes the surface of plant leaves, photons are absorbed by antenna pigments which funnel this energy to the photosynthetic reaction center. Carotenoids are bound to pigment-protein complexes within the thylakoid membranes and are utilized as antenna pigments. At high light levels, excess energy must be removed from the photosynthetic system to prevent damage. Our goal was to investigate the effects of different irradiance levels on plant biomass and accumulation of carotenoid pigments in kale and spinach. 'Winterbor' kale and 'Melody' spinach were grown in environmental chambers that provided plants with average irradiance treatment levels of photosynthetically active radiation (PAR) of 125, 200, 335, 460, and 620 μmol m^{-2} sec^{-1}. The daily photoperiod was16 h, with irradiance treatment daily integrals of 7.2, 11.5, 19.3, 26.5, and 35.7 mol m^{-2}, for the increasing PAR treatments (Lefsrud et al., 2006a). Kale leaf tissue L accumulation ranged from 9.1 mg 100 g^{-1} at 125 μmol m^{-2} sec^{-1}, to as high as 15.1 mg 100 g^{-1} at 335 μmol m^{-2} sec^{-1}. Similarly, BC accumulation in the kale leaf tissues responded significantly to irradiance treatments and ranged from 5.7 mg 100 g^{-1} at 125 μmol m^{-2} sec^{-1}, to as high as 11.1 mg 100 g^{-1} at 335 μmol m^{-2} sec^{-1}. The largest accumulation of carotenoid pigments in spinach leaf tissues occurred at the irradiance level of 200 μmol m^{-2} sec^{-1}, with L levels at 11.1 mg 100 g^{-1}, BC levels at 9.2 mg 100 g^{-1}. However, spinach leaf tissue carotenoid concentrations were not affected by irradiance treatments. Average field irradiance levels can vary dependent on location, time of year, shading, and atmospheric conditions.

Light Photoperiod can Influence Carotenoid Accumulation

The length of the photoperiod will influence a number of plant physiological factors including biomass production, bud formation, flowering, germination, leaf elongation, leaf emergence, and changes in secondary compounds. Proper photoperiod is critical for plant growth and development, and the length of the photoperiod can easily be controlled by growers using artificial growing environments or shading/lighting techniques. Our goal was to determine the influences of four different irradiance photoperiods on plant biomass and accumulation patterns of carotenoid pigments in the leaf tissues of kale. 'Winterbor' kale was grown in environmental chambers under irradiance photoperiods of 6, 12, 16, or 24 h. The plants were grown for 3 weeks under the photoperiod treatments (Lefsrud et al., 2006b). Maximum L accumulation (13.5 mg 100 g^{-1}) occurred under the 24-h photoperiod treatment, whereas the

lowest L concentrations (8.8 mg 100 g^{-1}) occurred at the 6-h photoperiod. Maximum BC accumulation was 10.4 mg 100 g^{-1} for the 24-h photoperiod treatment, whereas the lowest BC accumulation (6.3 mg 100 g^{-1}) occurred during the 6-h photoperiod treatment. Both L and BC concentrations significantly increased in response to increasing photoperiods. Photoperiod conditions can be easily manipulated in plant production systems to maximize plant biomass production and concentrations of plant secondary compounds, such as carotenoids.

Conclusions

Changing environmental growing conditions will impose stress on crop plants. Research conducted by our group demonstrates the influence of environmental growing conditions such as air temperature, light intensity, photoperiod, and other directed stress factors on plant biomass and the production of carotenoid phytochemicals in leafy vegetable crops. In many parts of the U.S., cool-season crops, such as kale and spinach, can be planted in both the spring and fall, two seasons having very different environmental conditions. Therefore, producers must recognize that, even though overall crop yield may differ little when crops are produced in different seasons of the year, there may be considerable variation in crop phytochemical concentrations among different seasonal production schemes.

Literature Cited in Text

Kopsell, D.A. and D.E. Kopsell. 2009. Carotenoids in vegetables: biosynthesis, occurrence, impacts on human health, and potential for manipulation, pp. 645-662. In: R. Ross and V.R. Preedy (eds.). Bioactive Food in Promoting Health: Fruits and Vegetables. Elsevier, St. Louis, Mo.

Kopsell, D.A., D.E. Kopsell, and M.G. Lefsrud. 2009. Pre-harvest cultural growing conditions can influence carotenoid phytochemical concentrations in vegetable crops. Acta Horticulturae 841:283-293.

Lefsrud, M.G., Kopsell, D.A., Kopsell, D.E. and Curran-Celentano, J. 2005. Air temperature affects biomass and carotenoid pigment accumulation in kale and spinach grown in a controlled environment. HortScience 40(7):2026-2030.

Lefsrud, M.G., Kopsell, D.A., Kopsell, D.E. and Curran-Celentano, J. 2006a. Irradiance levels affect growth parameters and carotenoid pigments in kale and spinach grown in a controlled environment. Physiologia Plantarum 127:624-631.

Lefsrud, M.G., Kopsell, D.A., Augé, R.M. and Both, A.J. 2006b. Biomass production and pigment accumulation in kale grown under increasing photoperiods. HortScience 41(3):603-606.

THE ABCs, I MEAN NPKs OF TOMATO PRODUCTION

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Tomatoes are a crop that is easy to grow, very responsive to changes in environmental growing conditions, and charact4erized by having a relatively high nutrient/fertilizer requirement. With that said, many experienced growers know that it is not a easy task to maximize the yield potential of a tomato crop, either in field production or greenhouse culture. There are several excellent resources available that can be consulted on other cultural aspects of tomato production, such as proper pruning, disease management, and fruiting maximization.

The functional roles of the essential (C, H, O, N, P, K, Ca, Mg, S, B, Cl, Cu, Fe, Mn, Mo, Ni, Zn) and beneficial (Co, I, Se, Si, Na, etc.) elements are all fairly well know. Several of the essential elements are involved in energy transfer reactions (P, Fe, Mn). Most have functional roles in photosynthesis (N, Mg, P, Fe, S, Cl). Some are constituents of genetic materials and proteins (N, P). Most are also used by plants as enzyme activators (K, Mg, Cu, Mo, Zn) (Jones, 2008). Sufficiency ranges for the essential elements are known for most horticultural crops. When concentrations of elements fall below sufficiency ranges, or are non-existent, deficiency symptoms result. When growing conditions cause too much uptake of essential elements, toxicity symptoms become evident. For the proper diagnosis of deficient and/or toxic conditions, there are many resources that can be consulted that provide descriptions and pictures for each of the elements in suspect. The information that follows in meant as a refresher on nutrient management in tomato production. Listed are the sufficiency ranges for tissue nutrient elements for proper tomato plant growth (which depends highly on stage of plant development):

Essential Macronutrients:

NITROGEN (N) is mobile* in the plant, with a sufficiency range of 4.0 to 6.0 %**.
Essentiality: Constituent of chlorophyll molecule, amino acids, nucleic acids, nucleotides; Involved in the synthesis and translocation of phytohormones like cytokinins (delay maturity). Deficiency: Photosynthesis inhibited, production of CHO's for growth is limited. Uniform yellowing of leaves (older to younger); Slow growing, weak, stunted plants; Reduced cytokinins causes rapid shift towards senescence, early matuation (yield/quality decreased). Toxicity: Chlorophyll production in elevated…dark green leaves; Ammonium N will cause lack of C for growth…stunting, reduced root growth, breakdown of vascular tissues; Leaf burning, shoot elongation.

PHOSPHORUS (P) is mobile in the plant, with a sufficiency range of 0.3 to 0.8 %.
Essentiality: Component of certain enzymes, ATP (energy transfer), RNA and DNA (genetic information). Deficiency: Enhanced anthocyanin production…red/purple coloring; Disruption

of Photosynthesis because of its effect of ATP; Slow growing, stunted plants. Dark green, older leaves. Toxicity: Very high levels can depress uptake of Zn, Fe, and Cu.

POTASSIUM (K) is mobile in the plant, with a sufficiency range of 3.5 to 6.0 %. Essentiality: Maintains cell turgor and water status by controlling the opening and closing of the stomata; Required for accumulation and translocation of CHO's; Involved in cellulose synthesis. Deficiency: Lack of stomatal integrity. Older leaves seem burned at the margins; Reduced lignification of vascular bundles causes stem lodging…plants fall over; Collapse of chloroplast and mitochondria; Droopy, flascid leaves because of reduced ability to conserve water. Toxicity: Competes with Mg and Ca for uptake.

SULFUR (S) is slightly immobile in plant, with a sufficiency range of 0.15 to 0.50 %. Essentiality: Component of amino-acids cysteine and methionine; Involved in protein synthesis; Di-sulfide bonds formed by –SH groups of cysteine and methionine are crucial for tertiary structure of proteins. Deficiency: Growth is significantly impared; Uniform yellowing of younger leaves, stunted plants with woody stems. Toxicity: Plants are relatively insensitive to high sulfate levels.

CALCIUM (Ca) is immobile in the plant, with a sufficiency range of 1.5 to 4.0 %. Essentiality: Maintains cell integrity and permeability. Calcium binds pectins in between cell walls…acts like cement; Removal of Ca from cell walls is part of leaf abscision and fruit ripening…very important in post-harvest quality; Involved in cell elongation and division; May detoxify some heavy metals inside the plant. Deficiency: Growing points of leaves and roots turn brown and die; Reduced growth of meristematic tissues; Leaves curl and become necrotic; Fruit quality reduced…most notably is blossom-end rot in tomato. Toxicity: Competes with K and Mg for uptake sites.

MAGNESIUM (Mg) is mobile in the plant, with a sufficiency range of 0.4 to 1.2 %. Essentiality: Center of chlorophyll molecule; Involved in transfer of phosphoryl groups of ATP/ADP; Cofactor for enzymes affecting phosphorylation; Stabilizes ribosome particles for protein synthesis. Deficiency: Chloroplast structure affected, chlorophyll and grana are reduced; yellowing or interveinal chlorosis of older leaves; margins of younger leaves become necrotic. Toxicity: No symptoms, but imbalances of Mg, Ca and K may reduce growth.

Essential Micronutrients

BORON (B) is immobile in the plant, with a sufficiency range of 30 to 100 ppm. Essentiality: Involved in cell division, cell differentiation, pollen tube development. Deficiency: Abnormal growth of growing points…twisted, stunted. Toxicity: Typical toxicity results in chlorosis of leaf margins or tips followed by necrosis.

CHLOROINE (Cl) is mobile in the plant, with a sufficiency range of 0.5 to 2.5 % ppm. Essentiality: Influences cell osmotic pressure, stomatal regulation. Deficiency: Cell tugor is decreased…wilting and veins pucker; Chlorosis. Toxicity: Reduced or stunted growth in non-tolerant plant species. Salinity is the #1 problem world-wide in growing plants.

COPPER (Cu) is immobile in the plant, with a sufficiency range of 5 to 15 ppm. Essentiality: Component of plastocyanin (chloroplast protein), involved in electron transport in PS I and II. Deficiency: Reduced, stunted growth, apical meristem becomes necrotic. Toxicity: Chlorosis of the leaves. May also induce Fe deficiency. In non-tolerant plants, reduced root growth develops.

IRON (Fe) is immobile in the plant, with a sufficiency range of 60 to 300 ppm. Essentiality: Involved in chlorophyll synthesis, PS I and II, ferredoxin. Deficiency: Formation of chlorophyll hindered, interveinal chlorosis of younger leaves…including bronzing. Toxicity: Results in the "bronzing" of leaf tissue, especially under waterlogged conditions.

MANGANESE (Mn) is immobile in the plant, with a sufficiency range of 50 to 250 ppm. Essentiality: Involved in the Hill Reaction (splitting of water). Deficiency: Interveinal chlorosis of young leaves, with necrotic spots. Toxicity: In most plants Mn toxicity is characterized by brown speckles on mature leaves. It may also appear as interveinal chlorosis and necrosis.

MOLYBDENUM (Mo) is mobile in the plant, with a sufficiency range of 0.6 ppm. Essentiality: Nitrate reductase enzyme…converts nitrate to ammonium in the plant. Deficiency: Limited nitrate reduction causes less N in plant…necrotic leaf margins, chlorosis, curling. Toxicity: Very high levels of Mo will result in malformation of leaf tissues and development of a golden yellow color on the shoots

NICKEL (Ni) is mobile in the plant, with a sufficiency range of 1 to 10 ppm. Essentiality: Urease is the only Ni-containing enzyme identified in higher plants. It is involved in necessary breakdown of urea-N during normal N metabolism. Deficiency: No real deficiency identified in field grown plants. Toxicity: Restricted root growth. Limited dry matter production.

ZINC (Zn) is mobile in the plant, with a sufficiency range of 30to 100 ppm. Essentiality: Needed for some enzymatic reactions (*carbonic anhydrase*). Also is involved in pprotein synthesis. Present in chloroplast. Deficiency: Interveinal chlorosis of older leaves. Stinted growth due to short internodes. Toxicity: In non-tolerant plants toxicity results in inhibition of root elongation. It can also lead to chlorosis in younger leaves by inducing a deficiency of Mg, Fe, or Mn.

*Mobility gives a good indication of the suspected deficient element. Mobile elements will display deficiency symptoms on older leaves, whereas immobile elements will display deficient symptoms on new growth. ** 1% = 10,000 ppm.

The critical macronutrient elements to tomato plant growth are N, Ca, P, K, and Mg. The critical micronutrient elements to tomato plant growth can be narrowed to Fe and Zn (Jones, 2008).

References:

Jones, J.B., Jr. 2008. Tomato plant nutrition, pp. 129-178. In: Tomato plant culture: in the field, greenhouse, and home garden. CRC Press, Taylor & Francis Group, Boca Raton, FL.

How to Develop a Season-Long Disease Control Program

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Prepare. The first step in disease management is determining what diseases could occur, learning the early symptoms and management practices, and deciding specifically what will be done. This is best accomplished when there is time during the winter. It is especially important to decide what diseases will be managed with fungicides applied starting after detection, as the early symptoms of these diseases are most critical to learn. Diseases are most effectively managed with fungicide applications started preventively or very early in disease development. This is because there are few products that can eradicate an established disease spot, thus these spots not only remain, but will continue to produce inoculum (fungal spores or bacterial cells) making the task of protecting the remaining healthy tissue more difficult; and starting when symptoms are common puts selection pressure on the pathogen to evolve to overcome the fungicides applied. Diseases most likely to occur are those caused by pathogens easily moved long distances, such as one producing a wind-dispersible spore, and pathogens able to survive over winter in the soil. State production recommendations/guidelines are a good source of information about diseases likely to occur in a particular area, as well as their management. Many images of disease symptoms have been posted on the web. These can easily be found using Google image search. I have a growing collection of vegetable disease images at: http://www.longislandhort.cornell.edu/vegpath/photos/index.htm. Being ready for unlikely diseases is also important as learned from the late blight outbreak last summer. Weekly newsletters are a good source of information about such developments.

Select resistant varieties. Check seed catalogues for new varieties to consider. Varieties with resistance to early blight, late blight, and Septoria leaf spot are expected to start being available in 2010. There are tables at http://vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm of resistant varieties.

Use seed that has been treated and tested for pathogens. Treatments for seed-borne pathogens include hot water, hydrochloric acid, and sodium hypochlorite. Hot water is effective for pathogens inside seeds but it can impact germination if not done incorrectly or there is a long period of time between treatment and planting or the seed is old. Fungicides are then applied to seed for seed decay. It is best to have seed treated by the seed company. Bacterial diseases, early blight and Septoria leaf spot.

Clean and sanitize greenhouses and planting materials, also trellising stakes. Several pathogens can survive between seasons in the greenhouse where transplants were grown and on planting materials. First remove loose dirt and debris. Organic matter decreases disinfectant activity. Sweep greenhouse floors and power-wash to remove dirt and debris stuck on surfaces. Use a greenhouse cleaner (such as Strip It or P.A.C.). Let stand a few minutes before rinsing. Trays and stakes also need to be cleaned of debris. Disinfect everything after cleaning with a product such as MicroBloc, Green-Shield, or OxiDate (OMRI-listed). Follow the label directions carefully to obtain full benefit. Important to soak used trays; cleaning and dipping is not enough

based on testing for fungal pathogens. Use weights to keep materials submerged while soaking in disinfectant. Replace solution used to soak trays if it becomes visibly dirty. Allow trays to dry before using. Clorox or other household chlorine bleach (5.25%) is another option for flats and pots. Use at 0.5% (= 1 part bleach + 9 parts water). Note that it is short-lived after mixing in water, with a half-life of only 2 hours, and it is corrosive. Bacterial pathogens are especially notorious for being able to survive on trellising stakes. Re-using stakes, even after disinfecting them, is not recommended following bacterial canker.

Inspect transplants for symptoms. Purchase certified transplants. Do not plant seedlings with symptoms. An entire tray with symptomatic seedlings should be discarded, especially with bacterial diseases, because the pathogen could have been spread.

Rotate land to control diseases caused by pathogens that can survive in soil on infested crop debris, which include anthracnose, bacterial diseases, early blight, and Septoria leaf spot. Very long rotation is needed for white mold. This practice should be used routinely rather than waiting to rotate out of a field after the pathogen has built up to the point that disease is very severe.

Plant in a field with good drainage on raised beds to manage root rots and seedling damping-off. Do not over water. Avoid practices that compact soil (e.g. driving on wet soils).

Mulch and trellise to physically and spatially separate foliage from pathogens in soil.

Minimize leaf wetness. Select a site with good air movement and use drip irrigation or overhead irrigate when leaves will have time to dry before evening dew period to manage foliar diseases. Plant parallel to the prevailing wind direction. Manage weeds. Most fungal and bacterial diseases.

Reduce humidity in protected crops (greenhouses and high tunnels) with fans and vents, spacing plants (5-ft row spacing recommended), and pruning lower leaves.

Physically separate successive plantings. To minimize pathogen movement between plantings, late plantings should be located upwind from earlier plantings, with as much distance between plantings as possible, plus a barrier such as a corn planting.

Manage volunteer tomatoes, solanaceous weeds and other weeds susceptible to tomato diseases. These can be primary sources of pathogen inoculum.

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).

Do not handle wet plants. Routinely clean hands and disinfect tools contacting plant sap. This is especially important for bacterial pathogens.

Inspect plants weekly for symptoms, especially during fruit production. Include leaves that are low and buried in the canopy where conditions are most favorable for several diseases. Early in

the day when humidity is high is the best time to look because fungal growth characteristic of some diseases is more likely to be present.

Keep records of disease occurrence. Note when symptoms are first seen. Likely this is when they might start to develop in the future. Note how severe diseases become. Take pictures of any symptoms of uncertain identity. Use the macro setting to get a good close-up. Pictures are worth a thousand words of description about the severity of a disease. Also maintain records of management practices used.

Make sure diseases are accurately identified. This is critical for ensuring the proper management practices are used. There are some highly effective but narrow-spectrum fungicides that are the best choice for the targeted disease but ineffective for other diseases. Submit fresh samples immediately by overnight mail to in-state diagnostic labs. For future reference, take photographs and/or press leaves between paper towel in a phone book with additional books on top for weight.

Check weekly extension newsletters. This is a good source of information on disease outbreaks and up-dates on management.

CT	http://www.ipm.uconn.edu/IPM/veg/htms/pestmsg.htm
MA	http://www.umassvegetable.org/newsletters/index.html
ME (organic)	http://www.mofga.org/Publications/PestReports/tabid/732/Default.aspx
NH	http://extension.unh.edu/Agric/AGFVC.htm
VT	http://www.uvm.edu/vtvegandberry/newsletter/welcomemain.htm

Weekly updates on late blight occurrence are being posted on the web at http://nysipm.cornell.edu/scouting/late_blight/default.asp and they will be available in 2010 through a listserv for growers. Contact Abby Seaman at ajs32@cornell.edu for information.

Apply fungicides and bactericides preventively or beginning at disease onset. Do not wait until a disease is well established to start treatments. Actigard, phosphorous acids, Regalia, Companion and other fungicides that activate the plant's defenses (systemic acquired resistance = SAR) need to be applied starting well before disease onset to be effective. Also begin applying copper fungicides for bacterial pathogens before symptoms are seen. Use TOM-CAST to determine when to apply fungicides for early blight. Do not spray when plants are wet and do not use an airblast sprayer on crops that have bacterial diseases to avoid moving the pathogen. A list of fungicides labeled for use on tomatoes is on-line at http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Tom_LabeledRts.html.

Fungicide program with conventional products for all diseases that could occur on field-grown tomatoes in the northeastern US:

Contans for white mold before or at planting or transplanting. Apply to soil. Treatment in the fall and again in the spring may improve control.

Streptomycin (ex Agri-mycin) for bacterial diseases, Decree (Group 17) for Botrytis gray mold, and copper for bacterial and fungal diseases during transplant production in the greenhouse.

Products for damping-off on seedlings include Ridomil Gold to soil at planting and Previcur Flex as a directed spray to lower stems and soil.

Protectant fungicides (copper, chlorothalonil, mancozeb) before disease observed. Alternate with Actigard for bacterial speck and spot.

Foliar fungicides for specific diseases (alternation amongst products in different FRAC Groups is needed for managing resistance and often is a label restriction, also tank-mix with protectant fungicides):

Anthracnose: QoI fungicides (FRAC Group 11; Quadris, Cabrio, Flint); apply one of these tank-mixed and in alternation with protectant fungicides.

Bacterial diseases: Actigard, copper fungicide applied with mancozeb. Tanos is labeled for suppression used with copper plus mancozeb.

Botrytis gray mold: Endura (no more than 2 sprays)(Group 7), Scala (9), Cabrio (11) (suppresses); apply these with protectant fungicides and in alternation. Uncommon in field-grown crops.

Phytophthora fruit rot and root rot: Quadris or Tanos (11), Ridomil (3), Gavel (22).

Early blight: Endura (FRAC Group 7), Scala (9), Tanos (27), QoI fungicides (11; Quadris, Cabrio, Flint or Reason); apply these alternately and with protectant fungicides. Pathogen strains resistant to QoI fungicides and strains with reduced sensitivity to chlorothalonil have been detected in a few locations in the US where these products are used intensively.

Late blight: Curzate or Tanos (both have same active ingredient in FRAC Group 27), Presidio (Group 43), Previcur Flex (28), Ranman (21), Reason (11), Revus (40), Gavel (22), and Forum (40). These need to be tank-mixed with a protectant fungicide, except for Gavel, which contains mancozeb. Note that applying chlorothalonil weekly starting before disease onset has provided good control in fungicide efficacy experiments. This disease is extremely difficult to control with fungicide applications started after detection. Curzate and Tanos have good curative activity but short residual activity, thus another fungicide will be needed about 5 days after application. Previcur Flex has good systemic activity and thus protects stems and new growth. Uncommon.

Septoria leaf spot: QoI fungicides (FRAC Group 11; Quadris, Cabrio, Flint, Reason, Tanos); apply one of these tank-mixed and in alternation with protectant fungicides.

Powdery mildew: Rally (3), QoI fungicides (FRAC Group 11; Quadris, Cabrio, Flint); apply these with protectant fungicides and in alternation.

Leaf mold: Tanos, protectant fungicides. Uncommon in field-grown crops.

Fungicides for organic production: Actinovate, Companion, Regalia SC, Sporatec AG, Organocide, Serenade, Sonata, and copper (e.g. Champ WG, Nordox 75 WG, and NuCop HB).

Destroy infested crop debris after harvest and incorporate deeply into soil to hasten decomposition for pathogens that can survive on debris in soil. Anthracnose, bacterial diseases, early blight, and Septoria leaf spot.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Check labels for local use restrictions (eg Reason cannot be used on LI). Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

Late Blight: What Happened in 2009

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What a year—2009!! Late blight is an extremely serious plant disease for all tomato and potato producers in New England. Early detection is critical for management of this disease. This disease (which helped to create the Irish Potato Famine and the "hungry forties" in England and throughout Europe in the 1840's) is caused by *Phytophthora infestans*, a fungus that overwinters on living tomato or potato tissue. The disease first appears as irregular, pale to dark green, water-soaked spots, often described as a greasy-look. These spots usually appear on the tips or edges of the leaves. In cool, moist weather or under humid conditions, the spots enlarge rapidly and form brown to purplish-black necrotic areas with wavy, indefinite borders, surrounded by a yellowish-green halo. Also under these conditions, a ring or a surface of white fungal growth may appear at the edge of the lesion on the underside of the leaf, which produces spores that move to other plants and continue the infection. Stems and petioles will turn brown when Infected and will be very brittle; white mycelium may be present under moist conditions. Tubers are readily infected in the soil by water movement of spores. Initial tuber infection will have a brownish discoloration of skin. Under the skin, the flesh will appear reddish brown with a granular texture. In moist weather, late blight spreads rapidly;
and all plants in a field can become infected. Diseased and decaying plants give off a strong noticeable odor. Potato late blight can be spread by windblown spores from infected plants.

In 2009, we had perfect late blight weather for the months of June and July. Unfortunately, there was also plenty of spore inoculum around from store purchased tomato plants to cause very early late blight infections in home and commercial gardens.
These spores continued to spread and caused severe outbreaks of late blight in both tomatoes and potatoes in southern and central Maine. Luckily, the weather in August was hot and dry and, eventually, slowed the outbreak down and brought it to a standstill.

However, before the outbreak was slowed, this strain (14/17) raised havoc on tomatoes and potatoes throughout the region. Normally we see the 8 strain which is slowed down and stopped when the temperatures reach into the 80's. This strain seemed to do quite well at the warmer temperatures at least for a while, even sporulating at these higher temperatures.

Several growers lost their entire tomato crop while others, both conventional and organic fought this organism the entire summer. Some managed to harvest reduced yields while others gave up in defeat!!

Managing Insect Pests in Grapes: Grape Berry Moth & Mealybugs/Soft Scales

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Introduction

Our applied grape research activities at Cornell over the past 3 year years have primarily focused on grape berry moth phenology and control and on the abundance of mealybugs and soft scales and their role in spreading grape leafroll disease in NY Finger Lakes vineyards. For this year's viticulture session I would like to provide you with an update on this research.

Grape Berry Moth

Grape berry moth (GBM) is a direct pest of grapes in much of the eastern US and Canada. The larvae feed on flowers and fruit, causing reduced yields, contamination, and in some wine grapes, entry points for serious fruit diseases such as bunch rot. GBM overwinters as pupae and the first flight gets started in May and into early June. There can be between 2 and 4 generations during the season. Prior to the 1980s in New York and other grape producing states in the east most growers applied broad-spectrum insecticides three to four times during the season to manage GBM, with insecticides applied mostly on a calendar basis. In the 1980s researchers initiated studies to evaluate risk factors for GBM damage (presence of woods, snow cover, history of damage) and developed the Grape Berry Moth Risk Assessment protocols. They categorized vineyards as high, intermediate and low risk for GBM damage and assigned spray recommendations according to risk. Because perhaps 50% of grape acreage in NY is considered low risk, wide adoption of these recommendations resulted in reduction of insecticide applications to an average of 1.5 from 3.

Despite the successes of the risk management protocols, problems have emerged. Perhaps the most important issue has to do with recommended timing of insecticide applications or monitoring for the middle and later part of the season. The protocols called for insecticides at the end of July/early August and end of August if warranted for high risk vineyards. We know, though, that GBM development and timing of egg-laying for each generation is mostly dependent on temperature, not specific calendar date. We therefore initiated research to test a temperature-driven phenology model to better predict the timing of adult flight and egg-laying for the second and third GBM generations. Based on laboratory estimates of GBM development at different temperatures, Michael Suanders' lab at Penn State estimated that GBM develops from egg to egg-laying female in about 810 degree days (°F), using 47.1° as a lower developmental threshold.

We (my lab at Cornell, along with Mike Saunders at PSU and Rufus Isaacs at Michigan State) have been testing this phenology model in 2008 and 2009 in high risk vineyards in NY, PA, and MI. The first step was deciding on a biofix to initiate the model in the spring. We have been using bloom date of a common species of wild grape (*Vitis riparia*). At two sites in the Finger Lakes we assigned small plots of grapes to one of three treatments: spray three times according to the risk assessment protocols (after bloom, end of July/early August, and end of August), spray twice according to the phenology model at 810 DD after bloom and 1620 DD after bloom, and no spray control. We also assessed adult female grape berry moth at these sites using panel traps or light traps. The adult traps were not very effective but did indicate peak

flights of females mostly consistent with model predictions. More importantly, damage of fruit was either the same or less in plots treated according to the model compared to the calendar-based risk assessment protocols even though they were treated twice compared to three times. These results, if replicated at more commercially relevant scale, will be used to develop new management recommendations for grape berry moth.

Mealybugs, Soft Scales and Leafroll Disease

Do you have soft scale or mealybugs in your vineyard? What are they and why should you care? I will briefly address these questions. Soft scales and mealybugs are sucking insects in the same insect order (Homoptera) as leafhoppers and aphids. They have fairly unusual life cycles and there is some variation among different species. They typically overwinter on canes or the trunk and then spend some of their time on leaves and fruit. The females are flightless and if males exist, they have wings. Mealybugs are more insect-like than soft scale, having some mobility and recognizable structures. The first instar stage of soft scale is mobile but later instars have greatly reduced structures and are not very mobile. They usually only have one or two generations during the season. Females are capable of laying large numbers of eggs.

There are two reasons you might be interested in soft scales and mealybugs. First, if populations get large enough they can cause damage to the vine (reduced vigor, perhaps overwintering survival) and also contaminate fruit with their sugary excrement or honeydew. In our surveys of Finger Lakes vineyards over the last few years we have found grape mealybug or soft scales (both European fruit leucanium scale and cottony maple scale) in most vineyards, but only very rarely have we found large populations of these insects. The other reason to be concerned about mealybugs and soft scales is all three species present in our area have been shown to be competent vectors of some grape leafroll-associated viruses. Survey work in Finger Lakes vineyards by my colleague Marc Fuchs has revealed high incidence of several strains of grape leafroll virus. Virus-infected *V. vinifera* vines tend to be less vigorous, show delayed fruit ripening and may be more vulnerable to winter damage. Marc and I now have documented that 1) grape mealybug and the soft scales are infected with several distinct "strains" of grape leafroll virus and 2) although most grape leafroll disease probably initially comes from infected nursery stock, natural spread of disease within vineyards does occur and that this is probably caused by insect vectors. The question then becomes when, if ever, does it make economic sense to control mealybugs or soft scale to manage spread of grape leafroll disease? We have started a study to investigate this question but the results are not yet available. I will say that some of the insecticides available probably are not sufficiently effective to reduce rate of spread. We do hope to try a new, systemic insecticide (Movento) next season that may be much more effective.

Wine and Table Grape Varieties for New England

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In climates outside the range of typical grape growing regions of the world, grape growers are faced with challenges due to a range of climate related factors. Disease pressure may be more severe, and cold temperatures experienced either in mid-winter or just after bud break may result in catastrophic crop losses. New varieties are being developed at Cornell University with a number of goals in mind. Cold hardiness and disease resistance plus excellence in wine and table grape quality are of greatest importance. In this presentation, the role played by Cornell's new grape variety releases in expanding the spectrum of options available to growers will be reviewed. Four new varieties have been named at Cornell's New York State Agricultural Experiment Station since 2003. These and other breeding program varieties and selections are reviewed here.

White Wine Grapes:

'Valvin Muscat'™ - (formerly NY62.0122.01 - Muscat du Moulin x Muscat Ottonel) produces an excellent, high quality muscat wine, without bitterness, that may be made into a dessert wine or used in blending. Own-rooted vines are small (1.4 lb./vine in Geneva), and therefore grafting is recommended. Though grafting improves vine size, planting at somewhat closer than normal spacing (approx. six feet between vines within rows) may also improve vineyard productivity. The fruit is highly flavored, very juicy, and ripens mid-season. Released in 2006 and a royalty is charged on vine sales.
Spring 2004 % live nodes following a very cold winter: 28%
Trunks: Moderately hardy. Some trunks were damaged in 2004.

'Traminette' (Joannes-Seyve 23-416 x 'Gewürztraminer') – Gaining in popularity throughout the eastern United States, 'Traminette' is a late mid-season white wine grape, which produces wine with pronounced varietal character likened to one of its parents, 'Gewürztraminer'. It is distinguished by its superior wine quality combined with good productivity, partial resistance to several fungal diseases, and cold hardiness superior to its acclaimed parent, 'Gewürztraminer'. The balance between sugar, acidity and pH is excellent. Released in 1996 as a public domain variety for domestic use only.

NY76.0844.24 - ('Traminette' x Ravat 34) makes a top ranked floral, muscat wine. Own rooted vines have been highly productive and highly vigorous in limited testing in Geneva. Clusters are large and loose. Leaf phylloxera have been an occasional problem. Maturity is mid-season, ripening in mid-late September in Geneva.
Spring 2004 % live nodes: 81%
Trunks: Very hardy.

NY81.0315.17 - ('Cayuga White' x 'White Riesling') produces a floral and sometimes spicy light muscat wine. Highly rated for wine quality for several years. Own-rooted vines are small; therefore grafted vines were planted and added to our trials in 1999. Botrytis rot has been

negligible and winter primary bud hardiness ranks better than Cayuga, and with many French-American hybrids.

Red Wine Grapes:

'Corot noir'™ - (pronounced "kor-OH nwahr"; formerly NY70.0809.10 - SV 18-307 x 'Steuben') A late-season red wine grape, suitable for either blending or the production of varietal wines. The wine has a deep red color and attractive cherry and berry fruit aromas. A distinct improvement in the red wine varietal options available to cold climate grape growers, wines are free of the hybrid aromas typical of many other red hybrid grapes. The vine is vigorous and very productive at Geneva. Some cluster thinning is usually required to avoid overcropping. Vines are healthy with good powdery mildew and Botrytis rot resistance. Released in 2006 and a royalty is charged on vine sales.
Spring 2004 % live nodes: 75%
Trunks: Moderately hardy. Among 13 vines, 8 had no damage, and 5 were either killed to the ground or had crown gall.

'Noiret'™ - (pronounced "nwahr-AY"; formerly NY73.0136.17 - [(NY33277 x Chancellor) x Steuben]) The distinctive red wine is richly colored and has notes of green and black pepper along with raspberry, blackberry, and some mint aromas. A major distinguishing characteristic of this selection is the fine tannin structure. This combined with the relative freedom from hybrid aromas strongly distinguishes this selection from other red hybrid grapes. Vines have generally been highly vigorous and productive in the Finger Lakes of New York, though older vines occasionally show a slow decline in vigor that may be indicative of a need for grafting. The leaves show moderate resistance to powdery mildew, but both fruit and leaves require a regular spray program to control downy mildew. Fruit maturity is mid- to late-season, approx. Oct. 1 in Geneva. Released in 2006 and a royalty is charged on vine sales.
Spring 2004 % live nodes: ~53% (very little fruit production)
Trunks: Expect some damage after cold winters. All 14 vines at Geneva required trunk renewal in 2004. If grafted, the graft union must be protected by hilling up in the fall.

'GR 7' - ("Geneva Red 7") - (Buffalo x Baco noir) Vines are highly vigorous, highly productive and winter hardy, with moderate resistance to diseases. 'GR 7' makes dark red wines with a classical hybrid aroma. It has better tannin structure than 'Baco noir' and 'De Chaunac', yet it still has a short finish. Use hot pressing, short skin contact time or some carbonic maceration. It has a place in traditional red hybrid blended wines, and has been used for a number of years in commercial wine production. Released in 2003.

Spring 2004 % live nodes: 93%
Trunks: very hardy

Future plans: - what's on the "drawing board"?

Disease Resistance Breeding: A large portion of our program focuses on breeding highly disease resistant varieties selected under "no-spray" conditions. One selection with potential for production under no-spray or minimal spray conditions is described below:

NY95.0301.01 – Wine grape with high disease resistance and potential to produce red wines of good quality. Most years at Geneva, NY, fruit and foliage are free of downy and powdery

mildew, and only a low level of black rot appears under fungicide-free conditions. In 2009, under ideal climatic conditions for downy mildew development, moderate foliar symptom appeared in September, but not prior to that. The vine is moderately productive (>13 lbs. fruit/vine) and winter hardy (estimated temperature of 50% primary bud kill in mid-winter is –14 F). Wine is very drinkable and enjoyable, with clean light aroma, nice mouth feel, good structure, and blueberry fruit character. The color is dark red and it the wine has little hybrid character. It has been well-received by taste panels.

Selected Seedless Varieties for the Northeast:

Marquis, a cross of Athens x Emerald Seedless released in 1996, is a white seedless grape from Geneva, with excellent, mild American flavor. The berries are large, often 3.5 to 5.0 grams/berry, with juicy, melting texture. Clusters are large and attractive, while the vines are moderately hardy, and very productive. Ripening in New York is between 15 and 30 September. Diseases must be controlled due to powdery mildew and black rot susceptibility. The vine is sensitive to gibberellic acid use, which is therefore not recommended. Well-timed cluster thinning and cane girdling can increase berry size and improve cluster compactness. Vines are moderately hardy, medium in vigor and productive.

Himrod, produced from a cross between Ontario and Thompson Seedless, is the most successful table grape released from the Cornell University grape breeding program (1952). It produces large bunches of white seedless grapes with excellent, honey-like flavor and melting, juicy texture. The clusters are loosely filled, but cane girdling, gibberellic acid treatments, or cluster thinning may be used to increase cluster compactness and improve berry size. Despite these cultural defects, Himrod is presently the most commercially important of the seedless grapes grown in New York (cluster weight = 0.36 lb., berry weight = 2.1 g).

Einset Seedless (Plant patent 6160) is a winter-hardy, red seedless grape with a unique, strawberry-like flavor. The medium sized clusters produce bright red, ovoid berries that have good storage potential until the end of November. The skin is slightly tough and adheres to the tender flesh. Cultural problems include susceptibility to fungal diseases and a seed remnant that is occasionally noticeable. Along with Vanessa, Einset Seedless probably has the most commercial promise of the red seedless varieties that can be grown successfully in New York (cluster weight = 0.32 lb., berry weight = 2.3 g).

Vanessa was developed by the Horticultural Research Institute of Ontario, Canada, and is a red dessert grape of excellent quality. The vine is moderately vigorous and among the hardiest of seedless grapes. Grafting may be desirable on many sites to increase vine size (however, vines grafted on Teleki 5C at trials in Fredonia, New York have shown poor fruit set with very small berries). The seed remnant is usually large and soft; when noticeable, it is sometimes a cause for limited marketability. Berries are medium in size on medium, well-filled clusters. Storage potential is good. The flavor is mild and fruity, and berry texture is firm to crisp. The fruit quality is among the best of the red seedless types.

Canadice is more winter hardy than most seedless grapes, although trunk injury has occurred on some sites. It produces medium clusters with small red berries that are similar to Delaware in

flavor and appearance. With cordon training systems and careful management, Canadice clusters may average 0.5 lb., and the vines can be extremely productive. Fruit rot is a problem in wet years because the clusters are excessively compact (cluster weight = 0.50 lb., berry weight = 1.6 grams).

Mars (Plant patent 5680), a release from the University of Arkansas, is a vigorous, blue seedless grape. The flavor is mildly labrusca, similar to Campbell's Early, and the berries are slipskin. Clusters are medium-sized, cylindrical, and well filled. Hardiness has been good at Geneva, New York. High vigor; has the least susceptibility to common grape diseases among the Arkansas varieties, but still requires fungicide applications for disease control; resistant to fruit cracking; occasional seed traces found in some berries in some years. Mars has been recommended in Arkansas as a home garden grape with limited potential for commercial marketing (cluster weight = 0.40 lb., berry weight = 3 grams in Arkansas)

Jupiter (Plant patent 13,309) - This early maturing blue variety has large, firm, non-slipskin berries on medium sized clusters. Fruit has a distinct muscat flavor. It's in very early stages of testing at Cornell, so hardiness is not yet determined. In Arkansas, it is rated as hardier than Einset Seedless, Himrod, and Marquis, but not as hardy as Mars and Reliance. Medium vigor; resistant to fruit cracking; moderate resistance to common fungal diseases but does require fungicide sprays for successful production; small, soft seed traces observed occasionally but not noticeable due to berry texture. (cluster weight = 0.40 lb., berry weight = 4 to 5 grams in Arkansas)

Testing Cornell breeding program selections: As soon as the most elite selections in the breeding program are identified, they are propagated for testing beyond our Geneva campus. We typically offer these first to University and Experiment Station cooperators, and then to grower cooperators. Vines are distributed for test purposes prior to release via two commercial nurseries: Double A Vineyards (Fredonia, NY; <*http://www.rakgrape.com*/>) and Grafted Grapevine Nursery (Clifton Springs, NY; <*http://www.graftedgrapevines.com*/>).

For more information:
For current information about the Grape Breeding program at Geneva:

<*http://www.nysaes.cornell.edu/hort/faculty/reisch/grapeinfo.html*> and
<*http://www.nysaes.cornell.edu/hort/faculty/reisch/cultivars.html*>

Complete bulletins describing all Cornell grape variety releases are available on the internet, or as Adobe Acrobat PDF files, at the above web sites. In addition, general reviews of options available among grape varieties are found at these three web sites:

<*http://www.nysaes.cornell.edu/hort/faculty/reisch/bulletin/wine/*>
<*http://www.nysaes.cornell.edu/hort/faculty/reisch/bulletin/table/*>
<*http://www.nysaes.cornell.edu/hort/faculty/reisch/winehandout.html*>

Winegrape Cultivar Trials in Connecticut

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Connecticut has a variety of mesoclimates that dictate what winegrape cultivars can be grown in a given location. The climate on the southern border of the state is moderated by proximity to Long Island Sound or the Atlantic Ocean. The northernmost parts of the state regularly experience winter temperatures that can damage or kill many grape cultivars, and may not accumulate enough heat units (expressed as growing degree days) to properly ripen many popular winegrape cultivars. Soil fertility and internal drainage can range from very favorable to poor. The introduction of new cultivars has made quality winegrape cultivation possible in areas previously considered unsuitable.

Four cultivar trials were established by The Connecticut Agricultural Experiment Station to determine cultivars suitable to Connecticut conditions (Table 1). These trials were established at two Connecticut Agricultural Experiment Station research farms in Hamden and Windsor and at commercial vineyards in Colchester and Shelton.

Table 1. Grape cultivars planted at research vineyards in Connecticut.

Cultivar	Type	Color	Vineyard Sites
Cabernet Franc	*V. vinifera*	Red	Colchester, Shelton, Windsor
Cabernet Sauvignon	*V. vinifera*	Red	Colchester, Shelton
Cayuga White	Hybrid	White	Windsor
Chambourcin	Hybrid	Red	Colchester, Hamden, Windsor
Chancellor	Hybrid	Red	Colchester
Chardonel	Hybrid	White	Colchester
Chardonnay	*V. vinifera*	White	Colchester, Windsor
Chelois	Hybrid	Red	Colchester
Marechal Foch	Hybrid	Red	Windsor
Merlot	*V. vinifera*	Red	Shelton
Muscat Ottonel	*V. vinifera*	White	Colchester
Riesling	*V. vinifera*	White	Colchester, Windsor
Seyval Blanc	Hybrid	White	Colchester, Hamden, Windsor
Vidal	Hybrid	White	Colchester, Windsor
Vignoles	Hybrid	White	Colchester
Villard Blanc	Hybrid	White	Hamden, Windsor
Villard Noir	Hybrid	Red	Hamden, Windsor

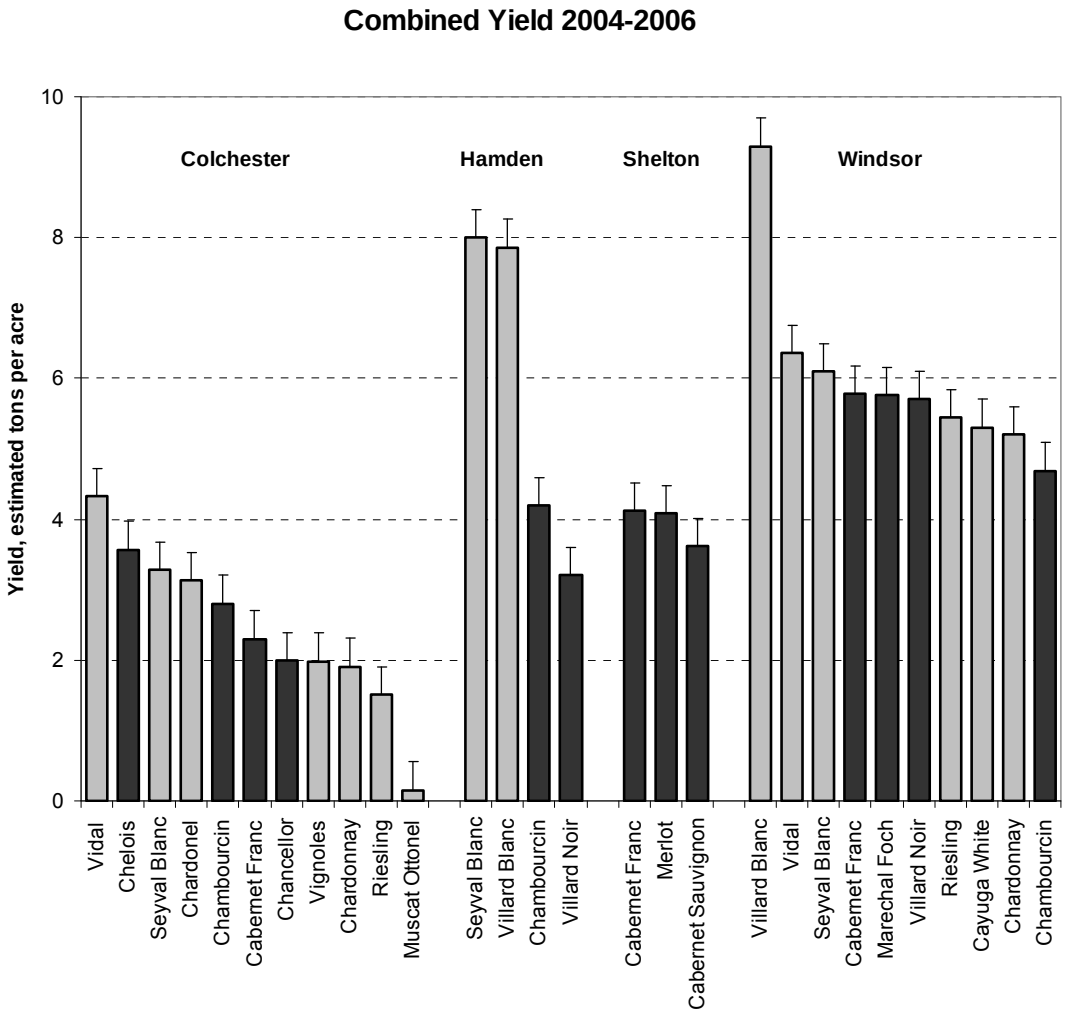
Yields varied considerably among vineyards (Table 2) and among years (data not shown). Variation among vineyards was likely due to different soil types, pest management, and weed control during vineyard establishment.

Overall, white hybrid cultivars had higher yields than the other categories (Figure 1). There was no significant difference between red hybrid and red vinifera cultivars. White vinifera cultivars had the lowest yield. However, white vinifera cultivars as a group performed poorly in 2004, and Muscat Ottonel had very little fruit in any year. The difference between red and white vinifera cultivars was not as great in 2005 and 2006.

Table 2. Average yields (pounds per vine) for common cultivars in four Connecticut vineyards 2004-2006.

	Vineyard			
Cultivar	**Colchester**	**Hamden**	**Shelton**	**Windsor**
Cabernet Franc	5.8		10.5	14.8
Chambourcin	7.0	10.4		11.4
Chardonnay	4.5			12.9
Riesling	4.2			11.9
Seyval Blanc	8.3	19.8		14.6
Vidal	12.1			14.2
Villard Blanc		19.5		23.1
Villard Noir		7.9		14.2

Figure 1. Combined winegrape yield data from four Connecticut vineyards 2004-2006. White cultivars are designated by light bars, red cultivars are dark bars.



Future projects

New cultivar plantings were established in 2008 at the CAES research farms in Hamden and Windsor. These plantings are part of NE-1020-:Multistate Evaluation of Winegrape Cultivars and Clones, a nationally coordinated research project involving over 30 states, including Massachusetts, New Hampshire, and Vermont. The planting in Hamden consists of 24 cultivars consisting of *V. vinifera*, French-American hybrids, and *V. riparia*- based hybrids from the Midwest. The planting in Windsor is smaller and consists of French-American and *V. riparia* hybrids. In each NE-1020 planting, certain "core" or "sentinel" cultivars are planted based on climatic condition. These are all the same plant material from a common source, so valid comparisons can be made among plantings in various states. Data collection from these plots will begin in 2010.

Table 3. Cultivar evaluations in Connecticut for NE-1020: Multistate Evaluation of Winegrape Cultivars and Clones. Types designated as "hybrid" are traditional French-American hybrids, while "cold hybrid" designates extremely cold-hardy cultivars derived from *Vitis riparia*.

Cultivar	Type	Color	Site	
			Hamden	Windsor
Auxerrois	vinifera	white	√	
Brianna	cold hybrid	white		√
Cabernet Franc	vinifera	red	√	
Cayuga white	hybrid	white	√	
Chambourcin	hybrid	red	√	√
Corot Noir	hybrid	red		√
Dornfelder	vinifera	red	√	
Frontenac	cold hybrid	red	√	√
Frontenac gris	cold hybrid	white	√	
Grüner Veltliner	vinifera	white	√	
LaCrescent	cold hybrid	white		√
Marquette	cold hybrid	red		√
MN 1189	cold hybrid	red	√	
MN 1200	cold hybrid	red	√	√
MN 1211	cold hybrid	red	√	
MN 1235	cold hybrid	red	√	
Noiret	hybrid	red	√	
NY76.0844.24	hybrid	white	√	
NY81.0315.17	hybrid	white	√	√
Petit Manseng	vinifera	white	√	
Pinot Blanc	vinifera	white	√	
Pinot noir	vinifera	red	√	
Rkatsitelli	vinifera	white	√	
Skujinsh 675	other	white	√	√
St. Croix	cold hybrid	red	√	√
Traminette	hybrid	white	√	
Vidal	hybrid	white	√	√
Zweigelt	vinifera	red	√	

NEW TECHNOLOGY IN VINEYARD SPRAYING

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Introduction

Spray application is an important and costly problem facing growers and effective application requires attention to detail if off-target drift and public outcry is to be avoided.

The majority of growers use older, traditional design airblast sprayers fitted with hollow cone or air-shear nozzles that provide a large amount of air to penetrate the canopy and beyond, often resulting in a vast plume of spray drifting above the target row, particularly when a sparse canopy exists in early to mid season.

Current spray practice is often to use the same settings on an airblast sprayer in the vineyard from the first application through to the last, irrespective of changes in canopy volume or density. Changes should be made to air flow (speed, volume or direction), forward speed and application rate as the season progresses and the canopy develops. Growers frequently drive too fast and often pay too little attention to deposition on the leaves and grape clusters where disease or insects may occur.

The objective in pesticide application is to find the optimum combination of parameters for different stages of canopy development to improve deposition while reducing drift.

Weather plays a critical role in improving spray application. Wind velocity, relative humidity, and temperature all affect the characteristics of the spray plume. As wind speeds increase, spray droplets will drift further. Humidity and temperature determine how fast the spray will evaporate. A higher temperature means the droplets are more apt to dissipate and in some cases vaporize completely. At lower humidity, evaporation occurs much faster

Droplet size is important in determining the amount of drift in conjunction with the wind, temperature and relative humidity. The size of a droplet strongly influences its trajectory after being emitted from a hydraulic nozzle at a speed of 45-67 mph. Training the operator to recognize conditions which lead to excessive drift such as high winds, fine spray, inversion layers etc. is so important.

Improving existing application techniques to improve deposition and reduce drift

1. *Weather monitoring equipment.*

All growers should purchase and use good quality instruments for measuring wind speed, temperature and humidity. Small, hand held anemometers cost around $100 and provide fairly accurate information. Spraying with no wind present is dangerous due to potential problems with vapourisation and inversion layer conditions, similarly, spraying when wind conditions are too high is equally dangerous. An inexpensive wind speed monitor is a get-out-of-jail card, court

judges in drift cases recognize professional applicators who know local weather conditions rather than rely on an airport weather station ten miles away!

2. *The Sprayer and the operator*

One of the simplest ways to help improve deposition is to maintain and calibrate the sprayer. A well trained operator will notice a spray plume drifting away as wind speed increases or changes direction. Replacing worn nozzles when they exceed the manufacturers flow rate by 10% and matching the correct nozzle to the type of application is a fairly inexpensive practice to improve effectiveness. In New York State the author is conducting 11/2 day operator training courses to improve the standard of application of pesticides to grapevines.

3. *Nozzle orientation*

Orientation of the nozzles affects the spray pattern being emitted from an air blast sprayer. Where the air flows the droplets will surely follow. At Cornell University an Italian vertical patternator, a MIBO, has been used for the past four years to evaluate 60 sprayers approximately. Results from patternator trials, figures 1 and 2, show not only the great variability in spray pattern produced according to nozzle orientation but also the lack of symmetry between each side of the sprayer. On a Berthoud S600EX sprayer, as an example, nozzles set in the "typical growers" pattern, Figure 1, pointing radially outwards, resulting in a large quantity of spray (about 33%) being blown above the target row. The best spray pattern for the grape zone, Figure 2, occurred when the right hand side nozzles were pointing horizontally and the top two nozzles were 20^{o} below horizontal on the right side, to counteract the upward movement of the air from the fan. Best results occurred with the left side nozzles pointing 45^{o} upwards to counteract the downward direction of the air from the fan. The results show the importance of correct nozzle orientation if pesticides are to be applied effectively onto the target.

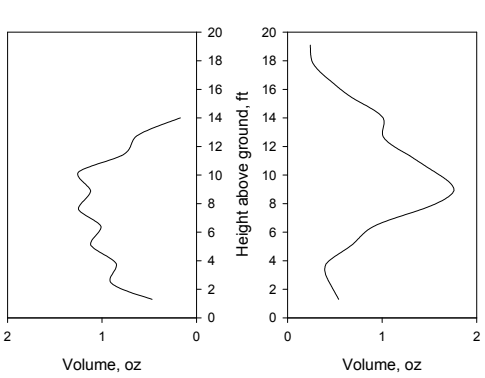


Figure 1. Original nozzle setting

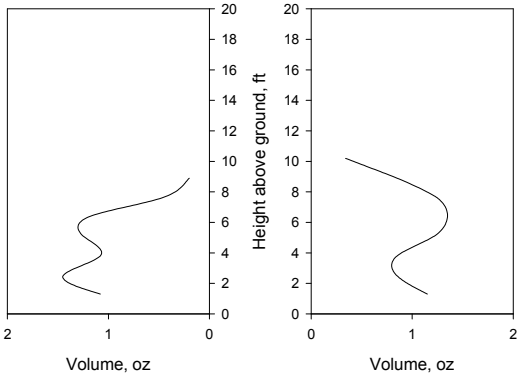


Figure 2. Improved nozzle setting

NOTE: Results shown are for a Berthoud S600EX sprayer, individual sprayer models will vary.

At Cornell University we have developed 2 simple vertical patternators which growers can build on their own farms to evaluate their spray plume and nozzle orientation in relation to the canopy. They are made from inexpensive materials and compare favourably to the more expensive Italian patternator. Plans are available on the author's web page.

4 *.Nozzle selection*

Droplets under 150 microns generally pose the greatest drift hazard; droplets less than 50 microns have insufficient momentum for impact as they remain suspended in the air indefinitely or until they evapourate. Deposition efficiencies mat be as low as 55% of the applied spray from an airblast sprayer, suggesting that 45% of pesticide hits the ground contaminating the soil and goes up into the air. Trials at Cornell University, using Albuz, Lechler and TeeJet air induction nozzles, can reduce drift by at least 50-65 percent. They work well with systemic products and are also ideal for use in weed sprayers.

5. *Regulating air speed and volume.*

Frequently the greatest culprit is excessive airflow for the available canopy. There are various ways to adjust airflow.

Regulating the PTO speed of the tractor is an inexpensive way to improve deposition and reduce drift. Where the air goes, the droplets will surely follow. Early – mid season sprays are frequently applied at full fan speed, resulting in a mighty plume of pesticide going towards a small leaf target on a small vine or up into the air above the vineyard. Is it necessary to have the fan rotating at all or even rotating at very slow speed? Do we really need to use an airblast sprayer creating an airspeed of up to 120-200 miles per hour when our leaf target is only a few inches long in early season? In trials at Cornell University**,** with an airshear type sprayer drift was detected up to 80 feet from the target row. When the tractor PTO speed was reduced by just 25%, drift was reduced by 75% .

Using a hydraulic motor to drive the sprayer fan will allow the operator to regulate wind velocity. A hydraulic control valve can be fitted in the tractor cab to allow the operator to infinitely vary the fan input speed from 0 rpm up to 540 rpm. The operator can adjust air speed according to canopy growth and if near neighbouring properties, drift-sensitive crops, roads or water courses. Ensure the tractor has a high enough oil flow (gallons/minute) to drive the hydraulic motor at speed.

Restricting air intake and air flow via a simple plywood “doughnut” that can be constructed using a jig saw and then attached to the sprayer air intake using bolts. A safety grill must be fitted to prevent fingers from entering the fan. For early season, a 1/2 diameter air intake doughnut can be used, allowing just enough air to penetrate just the target row. A $2/3^{rd}$ air intake hole can be used for early/mid-season to allow more air to flow. Finally in a full canopy, no doughnut is required. Results of trials indicate excellent improvements in deposition and drift reduction from a simple yet effective device.

In order to accommodate varying crop canopies, e.g as the season progresses, different trellis systems etc., a number of modern sprayers are fitted with adjustable pitch blades to provide a variable airflow. Operators can manually adjust blade pitch either by turning a handle or altering individual blades. Growers should assess air volume requirements by observing spray penetration into the canopy and the amount of spray going up and over or through the canopy.

The use of grape towers and end plates direct the air towards the canopy in a horizontal direction, improving deposition considerably. In some cases the horizontal airflow can be adjusted via internal deflectors to direct the air e.g. towards the fruiting zone.

Current research at Cornell University is to devise methods of reducing airflow on the move using an adjustable louvre and electric actuators (see below)

6. *Directed deposition sprayers*

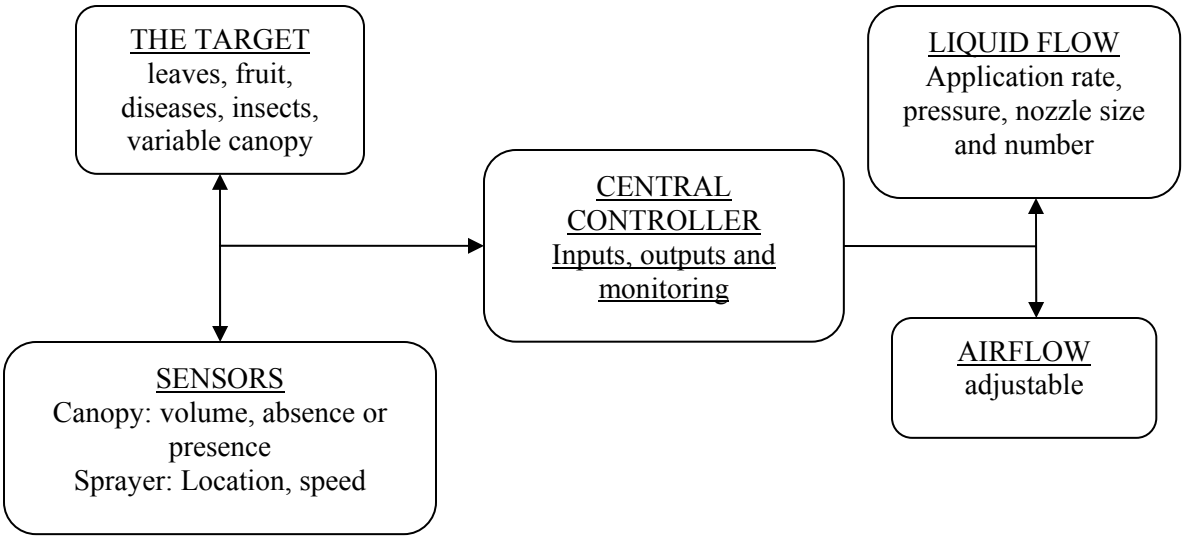
Modern sprayer designs such as directed deposition sprayers help improve deposition by spraying inwards to the canopy, often allowing the operator to vary the position of the air outlets towards the canopy or target zone. Multirow sprayers can improve deposition by upto 30% due to the converging airflow resulting from the airstream being targeted and meeting within the middle of the canopy. Many modern sprayers use low volume fans running at higher speeds to generate a localized airflow. Ease of maintenance, nozzle selection and the incorporation of modern ideas such as powder induction baskets, hand and tank washing systems result in growing popularity. Electrostatics may help improve deposition.

7. Logistics

Timeliness is all important for effective spraying, growers should review the logistics of their spraying operation and ensure rapid filling, reduced travel to refill and clear instructions per vineyard block. Good machinery and operator management, as always, will improve efficiency.

8. Precision spraying

The challenge for the fruit grower in the 21st century is to apply pesticides precisely to the target areas. Current research by the Cornell University Spray Team is on developing new canopy sprayers for vineyards to increase deposition within the canopy using adjustable air louvers and sensors. Trials have been conducted to evaluate their design throughout the growing seasons of 2008 and 2009. Results from field trials have shown improvements of up to 30% increase in deposition and a 75% reduction in drift using louvres and reductions in pesticide use of up to 40% have been recorded in using infra-red sensors in early season applications to vineyards.



Review of Instrumentation to Control the Greenhouse Environment

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"Measurement of environmental conditions accurately" is a basic key technique to understand your crop performance in greenhouse. Technology development of instrumentation (sensing, recording, and controlling) has contributed to expanding what we can do in controlled environment agriculture. Use of computers in agricultural (horticultural) instrumentation developed rapidly in the 1980s and we can now purchase small button-size sensors that can store weeks of recorded data to download to your computer in a spreadsheet format! Such technology development simplifies measurement of microenvironments and plant interactions, permitting greater understanding. However sensors and recording devices became so 'user-friendly' that they permit practically everyone to use such sensors by only following the short users' manual. One caution emphasized in this lecture is that sensor use and recording became so easy that one can easily make mistakes in their use without knowing that the data obtained has little value or needs careful interpretation, resulting from such inappropriate use.

Air temperature:
Temperature measurement seems so easy, but as you learn sensor characteristics, you will know that accurate temperature measurement is one of the most difficult tasks in greenhouse controlled environment. Air temperature measurement is often challenging especially under high radiation conditions. This is because radiation increases the sensor temperature, which is the temperature the sensor gives us, while what we want to know is the air temperature, not the sensor temperature. Therefore, aspirating the sensor is 'must' to accurately measure air temperature, as aspiration brings the sensor temperature close to air temperature. The air velocity recommended for accurate measurements is 3 m/s (10 feet/s or 7 miles/h), especially if the sensor size (diameter) is greater than 2 mm. The most commonly used air temperature sensor in the greenhouse is either thermocouple type or thermistor.

Relative humidity and VPD:
There are many relative humidity sensors that do not record accurate values. Sensors used in humid environments (like inside the greenhouse) need to be re-calibrated every year or two to maintain the accuracy. As most humidity sensor readings are influenced by the temperature, aspiration must be done for accurate readings. Vapor pressure saturation deficit (VPD) is a better indicator to understand potential transpiration. VPD of the air can be computed from air temperature and RH using a psychrometric chart.

Light intensity:
Two light intensity units are often used in greenhouse crop production. One is a quantum unit ($\mu mol/m^2/s$ or $mmol/m^2/day$) and the other is an energy unit (W/m^2 or $MJ/m^2/day$). Quantum sensor is generally for measuring photosynthetic photon flux (PPF), the photons (400-700 nm) usable for photosynthesis received on a horizontal surface (unit: $\mu mol/m^2/s$). Energy sensor is

generally used for quantifying much broader solar radiation (300 – 2500 nm) and is called a pyranometer. Both types of sensors are easy to use, but need calibration once in several years and need to be maintained without dust accumulating on the sensor surface, especially if placed outside the greenhouse.

CO_2 concentration:
CO_2 concentration measurement is often ignored despite the fact that CO_2 is a critical factor for plant photosynthesis. This is because we humans do not have a sensing capability for CO_2 gas. In a cold winter morning, when greenhouse vents are tightly closed, we often see very low CO_2 concentration due to the photosynthesis of the plants in greenhouse. Therefore having a capability to at least monitor CO_2 is always important for plant production. Most commonly used sensor for CO_2 is an infrared gas analyzer (IRGA). Various types of IRGAs are available nowadays at a reasonable price. Such models are usually equipped with a single sample cell without a reference cell. Models equipped with both sample and reference cells are generally more accurate and stable (therefore more expensive). Sensors that measure by diffusion of ambient gas to the sample cell have slower response times than the one with an internal pump to send the air to the cell. For controlling CO_2 inside a small volume of air (i.e., growth chamber), it is recommended to select a sensor that has a quick response.

Greenhouse environmental controllers:
There are various types of controllers available so that you can activate heaters, vents, irrigation, CO_2 enrichment, cooling systems, etc. based on the information recorded by the sensors in greenhouse. The price for these controllers varies depending on its capacity such as input and output channels, data storage capacity, alert capacity, as well as flexibility in programming logic.

Observation and record keeping:
No matter what capability of measurement and control of greenhouse environments the growers have, evaluating the recorded data to find if they make sense relative to what the growers observe in the greenhouse is critical. Instrumentation is a tool for growers to understand the past and current status of greenhouse environments and to develop near and long term strategies in crop management and resource saving. A key to success is not to maximize the instrumentation capacity but to effectively use available instrumentation in greenhouse crop production.

Useful information website:

NCERA-101 Plant Growth Chamber Handbook:
http://ncr101.montana.edu/Growth_Chamber_Handbook/Plant_Growth_Chamber_Handbook.htm

IPM Methods for Insect Management
Plant-Mediated Systems for Managing Western Flower Thrips

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Introduction. Western flower thrips (WFT) [*Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae)] are one of the most persistent and damaging pests of many greenhouse crops, including ornamentals and vegetables. Their cryptic behavior and rapid rate of reproduction make management difficult. When populations are high their feeding results in significant cosmetic damage. Even when populations are low, they pose a threat to crops by transmitting deadly plant viruses. Chemical pesticides are commonly used against WFT, often requiring frequent reapplications. Despite repeated chemical sprays, growers often find it difficult to keep populations below damaging levels. Several biological control options are available, but their effectiveness has been inconsistent. This presentation reports on our research to develop plant-mediated systems using granular formulations of insect-killing fungi for WFT IPM. Though this work focuses on use of these systems in ornamentals, they also could be used effectively in greenhouse tomatoes.

Several preparations of the insect-killing fungi *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii* have been shown to reduce WFT in greenhouse vegetable and floral crops. These products have many desirable traits–they leave no toxic residues, are generally harmless to beneficials and pose minimal risk to humans and the environment. In commercial greenhouses, results with fungal-based management have been unreliable. Good spray coverage is essential for pest control with mycopesticides, and our research shows that spray techniques used in commercial greenhouse crops are unlikely to provide the necessary coverage. In addition, efficacy may be reduced because a large portion of the WFT population is in the soil, protected from direct contact with fungal inoculum. Targeting the soil stage with a fungal formulation could enhance efficacy by reducing the number of emerging adults.

Though insect-killing fungi are commonly sold as wettable powder (WP) or suspension concentrate (SC) formulations for greenhouse use, they can also be formulated as granules, which have advantages over a spray when targeting a soil-borne insect. Nutrients can be incorporated into granules to support fungal growth and sporulation, baits can be added to attract target pests, and granules do not need to be incorporated throughout a potting mix, but in the top 2-3 cm of soil where thrips generally pupate.

Fungi are not the "silver bullet", and must be used as part of a total IPM program. Early detection is critical so action can be taken before WFT reach damaging levels. When plants are started in Jan or Feb, WFT populations are usually low, but increase rapidly as temperatures rise and day length increases. We tested marigolds as trap or indicator plants, and found that WFT were detected several weeks earlier on flowering marigolds than on sticky cards (Fig. 1). Beneficials are best used preventatively, and introduced early in an infestation when pest populations are low. We found the marigolds could serve as 'banker plants', which, when inoculated with the predatory mite, *Neoseiulus californicus*, served as a sustained source of natural enemies.

Based on our past results, we have initiated research to test a novel plant-mediated approach for WFT IPM, combining predatory mites, granular entomopathogenic fungi and indicator plants into one effective "habitat plant system". The concept of this system is that adult WFT will be attracted from the crop to the marigolds, where they will become established. The predatory mite, *N. cucumeris*, is released onto the plant, and is sustained on thrips in the foliage. A portion of the WFT escaping predation will drop to the soil to pupate, where they will come in contact with and become infected by insect-killing fungi, applied as a granular formulation. This nutrient-based formulation will enable the fungus to colonize the potting mix, eliminating the need for repeat applications. This concept represents a sustainable, low-cost, ecological approach to combating WFT.

Fig. 1. Marigold indicator plant in commercial greenhouse.

Methods. Lab-based caged trials were conducted to test several fungal formulations of GHA, the *B. bassiana* isolate found in the commercial mycopesticide, *BotaniGard* (Laverlam International Co., USA) in combination with marigold habitat plants (variety Hero Yellow). The following treatments were tested:

1. Granular millet-based fungal formulation of GHA (containing 1 x 10^8 conidia/g) applied at a rate of 2, 4 or 8 g/pot and introduced into the potting mix to a depth of 2-3 cm around the marigold plants;
2. Fungal drench of the wettable powder formulation (WP) of *BotaniGard* (2.0×10^{10} conidia/g) applied once to the potting soil around the marigold plants according to label recommendations.
3. Fungal spray of the WP formulation of *BotaniGard* (2.0×10^{10} conidia/g), applied to the marigold foliage for four consecutive weeks according to label recommendations.
4. Untreated control.

Fungal treatments were applied on the same day that WFT adults were released onto the flowering marigolds (3/plant). For 6 wk, plants were sampled weekly to determine the number of WFT per plant and the amount of damage based on a visual scale.

Results. WFT populations (adults and immature combined) were consistently less throughout the 6 weeks for the 8-g fungal treatment. At week 5 average populations were around 10 WFT per plant for the 8-g treatment compared with ~40 WFT per plant for the control and the spray treatments. WFT populations increased significantly at week 6 in the 8-g treatment resulting in similar pest levels to those in the non-treated control. Though overall differences in WFT populations throughout the trial were not detected between the 2-g and 4-g/pot fungal granular treatments, these two treatments were more effective than the *BotaniGard* foliar spray and drench treatments. WFT populations were less for the drench than the spray treatment.

Foliar damage was significantly less on plants for the 8-g treatment than plants for all of the other treatments at weeks 5 and 6. At week 5, damage in the 8-g treatment was half that of the other treatments (damage rating of 2 [feeding on 10-25% of the plant] compared with 3-4

[feeding on 51-75% of the plant). At the end of the experiment (week 6), 40-70% of WFT emerging from pots treated with the granular formulation and the drench were infected with *B. bassiana*. Less than 6% of the WFT emerging from the potting mix for the foliar spray treatment were infected with *B. bassiana*, and none were infected in the untreated control. Our results clearly demonstrated the potential of granular fungal formulations to reduce WFT populations. This treatment used once at a rate of 8 g/pot was significantly more effective than the standard recommended foliar fungal spray made weekly. Despite the promising results from this trial, WFT populations were not reduced below levels at which no damage occurred. The addition of predatory mites to the foliage of the marigold habitat plants may address this problem. Together, these two biological control treatments may effectively suppress WFT populations over a longer period. Studies are underway to test this hypothesis. Our research could revolutionize IPM for WFT though further refinement of the system is needed before it can be deployed widely in commercial settings.

Acknowledgements: The research reported herein is supported by funds from the following agencies: USDA Agricultural Research Service (Project #1907-22410-003-10S); USDA CSREES Northeast IPM Program (Project #VT-0060SG); USDA HATCH (Project #VT-H01408); USDA Multi-state HATCH (Project #S-1024)

Growing Greenhouse Tomatoes at Holmberg Orchards

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Background

Holmberg Orchards is a diversified fruit and vegetable farm in southeastern Connecticut. We have been in a transition since late 1980's away from wholesale apple production, towards a retail focused, multifaceted farm. We operate a successful pick your own operation from July through October and a farmstand that remains open year round. For the past ten years, a small greenhouse tomato facility has been a part of our operation. Greenhouse tomatoes are a good fit into our operation for the following reasons:

1. They provide local, high quality produce early the season. This helps to boost store sales by getting customers in the door.
2. It is a source of early season cash, adding to our goal of year-round revenue.
3. It is a fun, invigorating project to work on during the winter months.

Crop planning and timing

Greenhouse tomato production is input intensive, both in time and capital. A thorough investigation of the market is incredibly important prior to construction. At Holmberg Orchards, our goal is to produce only enough tomatoes to meet the needs of our own farmstand, purchasing tomatoes on the open market when necessary. We have no ambitions of entering the wholesale market.

To size our facility and plan for production, we started by looking at store sales and market prices for last 2-3 years. The greenhouse tomato supply in the wholesale market would peak and dip, while our customer demand was fairly constant. Our strategy was to have the bulk of our tomatoes come in early – 2 weeks before the first big peak on wholesale market – taking advantage of the highest price. As our supply dips, the wholesale market peaks and we can buy in tomatoes as we need them at a low price.

Given these parameters, we chose to build a small house and farm it intensively. The small footprint helps with heating bills and makes siting easier. Intense techniques like irrigation computers and leaf pulling ensure the highest production per square foot.

Production

We seed *Trust* tomatoes around the first of the year in a growth chamber in our propagation house. This chamber looks like a mini-quonset house made from pvc pipes bent over a bench. It is covered with milky white plastic and heated from below using propagation heat mats. With this structure over the bench, we do not have to heat the house surrounding it at all. The plastic is removed on sunny days and always applied at night in order to maintain a temperature over 55^{o}F. Daytime temperatures, even on the coldest day of winter, will remain around 90^{o}F

In early March the plants are moved to a clean, sanitized tomato house. Plant density is 3.5-4 plants/sq ft. We grow on at 85^{o}F days and 65^{o}F nights. They are planted in coir filled five gallon bags and trained to a single vine using twine and tomato clips. Leaves at or just below the lowest fruiting cluster are removed to aid in air circulation and control vigor. We also practice

fruit thinning on the first two clusters – taking them down to 5 or 6 fruit per cluster, depending on light conditions. This increases size without sacrificing weight per cluster. Bumblebees and hand pollination have been used with similar results; the later is tedious but provides a daily opportunity to scout for insects and diseases that bees ignore.

Nutrition is provided via drip irrigate using the standard two-injector, constant liquid feed, hydroponic setup. The amount of water is controlled by a small light-collecting computer and a solenoid. It is calibrated to irrigate at an approximate 10% dry down (by weight). We monitor our nutrition program weekly by checking the EC of our solution and also measuring stem thickness at the top of the plant. An EC test confirms the health of the injector and a stem caliper gauges the vigor of your plants. Appropriate adjustments are then made to the nutritional program based on the vigor of the plant and the growing conditions at the time.

We begin picking fruit in early June and continue through September. Yields per week vary considerably as the season progresses. We typically have one to two weeks of high production followed by one to two weeks of reduced production as we are between clusters. Our annual yield is usually 15-18 lbs per plant.

Over the years we have experimented with grafting as a way to increase yields. We conducted trials using *Maxifort* on a single head and on a double head. The single head *Maxifort* is indeed robust, but far too vegetative. The double head *Maxifort* provided a well balance plant, but we did not see an increase in production compared with Trust on its own roots. Our conclusion was that time and energy was better spent fine tuning plant growth during the season rather than grafting early in the season. This conclusion is based on our production circumstances where growth is occurring in a well sanitized house with a sterile planting medium. This conclusion likely does not apply to production in native soils.

Problems along the way

Our biggest problem with greenhouse tomatoes is the botrytis. Mild infections will kill blossoms and severe infections kill green tomatoes. Lesser infections will cause ghost spotting on the fruit. We have given up spraying for botrytis years ago. Instead, we have made every effort to reduce humidity. These efforts include: running higher night temp and cooler day temp, avoiding irrigations that occur at or around dusk, and pruning for air flow around the cluster.

Insect problems that we combat annually include aphids, mites, and fungal gnats. Whiteflies and tomato hornworms will make an occasional appearance. Typically, we only resort to a spray when we see mites, as the rest of the problems can be resolved with natural predators or cultural controls.

Looking forward

Perhaps our greatest foe in this endeavor is the oilman. In future years, we hope to see less of him. Our ambition is to heat our house with radiant floor heat, using pipes positioned directly under the bags and heated by solar panels. Additional heat would be provided by a remote wood boiler and a Modine-style heater. This would allow for an earlier start and certainly high profits.

Organic Greenhouse Tomato Nutrition

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Most organic greenhouse tomatoes are grown in soil amended with organic residues, such as compost or manure, and organic fertilizers. Managing crop nutrition in this situation can be challenging since nutrient availability can vary widely depending on the materials applied and the environmental conditions.

That said, in-ground soil-based culture is highly buffered and can be forgiving in terms of nutrient management, since you only need to be 'in the ballpark' and then let soil microbes do the work. The flexibility provided by growing in a large volume of amended soil reduces the need to maintain precise levels of individual nutrients, but that really doesn't justify simply adding lots of compost or manure and hoping for good results.

Organic residues are not just a source of nutrients but are also added to maintain or enhance organic matter levels in greenhouse soils. It takes some thought to select a residue type and amount that will contribute sufficient organic matter to maintain tilth and support microbial populations while meeting, but not exceeding, crop nutrient needs. Common residue options include compost, manure, and peat moss.

It's a good idea to test compost or manure before adding to greenhouse soil because the nutrient content, pH, soluble salts, and C:N ratios can be highly variable. The use of fresh manure in greenhouses is risky since it can result in the release of ammonia (especially with poultry manure) if it has a low C:N ratio, and it can also introduce weed seeds. Note that organic standards prohibit application of uncomposted manure less than 90 days prior to harvest of a crop that does not come in contact with soil. (If greenhouse tomatoes are allowed to sprawl on the ground then the waiting period would be 120 days.)

Fresh or partially aged manure will contain more available nutrients than mature compost, which is a slow-release source of nutrients. Relatively fresh manure, and even some compost, can be high in soluble salts, so applying a large quantity could be harmful to plants. Application of manure or compost that contains a lot of undecomposed straw, sawdust, leaves or other high carbon material can tie up nitrogen as it continues to break down in the soil.

Compared to manure or compost, peat is relatively inert, as it does not contribute nutrients, weed seeds or diseases. Coarse peat is acidic, with a pH of about 4, so in most cases it needs to be added in combination with about 8.5 lbs of ground limestone per loose cubic yard (17 lb per compressed year) in order to neutralize its acidity. If nutrient levels are already high in a greenhouse soil, peat is a good option to add organic matter without additional nutrients. In new greenhouse situations, to supplement or replace compost additions, up to 5 cubic yards of loose peat (or 2.5 yards of compressed peat) per 1,000 square feet may be needed, depending on the condition of the soil.

Since soil organic matter decomposes rapidly under greenhouse conditions, an annual application of about 1 cubic yard of loose peat (or 0.5 cubic yard of compressed peat) per 1,000 square feet

may be desirable. Broadcast peat and lime evenly, and incorporate thoroughly into the top foot or so of soil prior to making beds.

Organic fertilizers should be added to the soil based on the nutrient needs of the crop. That requires the growing medium to be tested. Prior to adding fertilizers, the saturated media extract (SME) test, often called greenhouse soil or potting test, should be performed. This test is offered by most Land Grant University testing labs. It uses water to extract nutrients prior to measurement, and it's typically used for soilless mixes that are high in fertility and organic matter. A regular field soil test uses a weak acid to extract nutrients, and the results for fertile greenhouse soils are often 'off-the- charts'. In addition, the SME test is more useful than a field soil test because it analyzes for soluble salts (conductivity) and nitrogen in the nitrate and ammonium forms.

Greenhouse soil should be tested early in the season, well before the crop is planted. That way, organic fertilizers can be added and incorporated as needed. Once the crop is in place it can be difficult to add nutrients since many organic fertilizers aren't very soluble so they don't go through a drip system well.

If a greenhouse soil has been well-amended in previous years, take the SME test before adding anything. If the soil is known to be relatively low in fertility from prior year's experience, or if the house is new to production, incorporate bulk organic amendments such as compost and/or peat, then take the SME test. The tables below can then be used to estimate the how much of what type of fertilizer to apply prior to planting.

Be sure that the greenhouse soil has been moist and warm for a couple of weeks before sending a sample in for a SME test. If necessary, take a sample and store it where it can incubate. Dry, cold soils have little microbial activity and that can affect the test results.

Commonly used organic fertilizers include: calcitic or dolomitic limestone (for Ca, Mg); greensand, potassium sulfate (for K) or sul-po-mag (for K and Mg); rock phosphate or bone meal (for P); blood meal or Chilean nitrate (for N). Note that the organic standards allow Chilean to meet no more than 20% of a crop's total N needs. Plant meals such as alfalfa, peanut and/or soy are a source of N, P, K with a moderate rate of release. Check with your certification agency as to their allowability.

Table 1: Optimal soil test ranges for greenhouse tomatoes using the SME test:

Available Nutrient or Measurement	
pH:	5.8 - 6.8
Nitrogen (as NO_3)	125 - 200 ppm
Phosphorus	8 - 13 ppm
Potassium	175 - 275 ppm
Calcium	over 250 ppm
Magnesium	over 60 ppm
Soluble salts	1.50 - 3.00

Trace elements are usually provided in sufficiency by compost and/or plant meals. Some synthetic compounds (iron and zinc chelates, solubor for boron, etc.) are allowed under organic standards if a deficiency has been demonstrated by soil or tissue testing.

Table 2: Estimated fertilizer rates to increase SME nutrient levels:

Pounds/1,000 sq. ft needed to raise N approximately 10 ppm	
Chilean nitrate 16-0-0	3.2
Blood meal 12-0-0	4.2
Alfalfa meal 2.5-2-2	20.1
Pounds/1,000 sq. ft needed to raise P approximately 2 ppm	
Bone meal 0-15-0	26.6
Rock phosphate 0-3-0	133
Pounds/1,000 sq. ft needed to raise K approximately 20 ppm	
Sul-po-mag 0-0-22-11Mg	2.6
Potassium sulfate 0-0-52	1.1
Pounds lime/1,000 sq. ft needed to raise soil pH ~1 full unit	
Sandy loam	40
Loam	80
Clay loam or peat	120

(Tables 1 and 2 adapted from 'Greenhouse Tomatoes, Lettuce & Cucumbers, by S.H. Wittwer and S. Honma. Michigan State Univ. Press. 1979.)

Leaf analysis. Once the crop is growing and flowering, leaf tissue samples taken at regular intervals are useful for monitoring nutrient levels in the crop and determining whether supplemental fertilization is needed. The cost is about $25 per sample. Proper collection of leaves is essential, since nutrient levels vary among leaves of different ages. Select recently mature, fully expanded leaves just below the last open flower cluster. Take at least eight to ten whole leaves from plants throughout the greenhouse to get a representative sample. Based on the results, apply soluble fertilizer as needed through the drip system, watered in by hand, or blended with a fresh application of compost spread along plant rows.

Table 3: Optimal nutrient ranges in greenhouse tomato leaves (dry weight):

Macronutrients (%)		Micronutrients
Before fruiting	During fruiting	
N: 4.0-5.0	3.5-4.0	Fe: 50-200 ppm
P: 0.5-0.8	0.4-0.6	Zn: 25-60 ppm
K: 3.5-4.5	2.8-4.0	Mn: 50-125 ppm
Ca: 0.9-1.8	1.0-2.0	Cu: 8-20 ppm
Mg: 0.5-0.8	0.4-1.0	B: 35-60 ppm
S: 0.4-0.8	0.4-0.8	Mo: 1-5 ppm

(Table 3 from: Oregon State University Greenhouse Tomato Production Guide)

Recycling used Nutrient Solution for Greenhouse Tomato

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Recycled nutrient solution, or reuse of solution after it has once been used to water plants, is the preferred legislative solution to prevent groundwater pollution from intensive agricultural production. There are several potential problems that may arise due to using recycled nutrient solutions to produce vegetable crops. Accumulation or deficiency of elements in nutrient solutions could ultimately have deleterious effects on plant growth, product quality, and the dietary value of vegetables. We examined the composition of a nutrient solution as it was continuously recycled to a greenhouse tomato crop, in comparison to solutions that were used to water plants only once.

Irrigation

Crops were grown in spring and summer for two years in a greenhouse using rockwool as the root medium. Rock-wool is an inert substrate that looks like fiberglass insulation. It provides no nutrients and little exchange capacity. Plants take up a similar amount of water if grown in other media such as soil or peat, but it is harder to measure the amount used in these other media. Watering occurred several times a day. The frequency of watering was based on the integrated sunlight for the day. Plants were always watered at dawn. They were watered up to an additional 7 times depending on the sunlight for the day. As the plants increased in size, the duration of watering was increased so that a relatively constant fraction of water was in excess and leaked from the slabs.

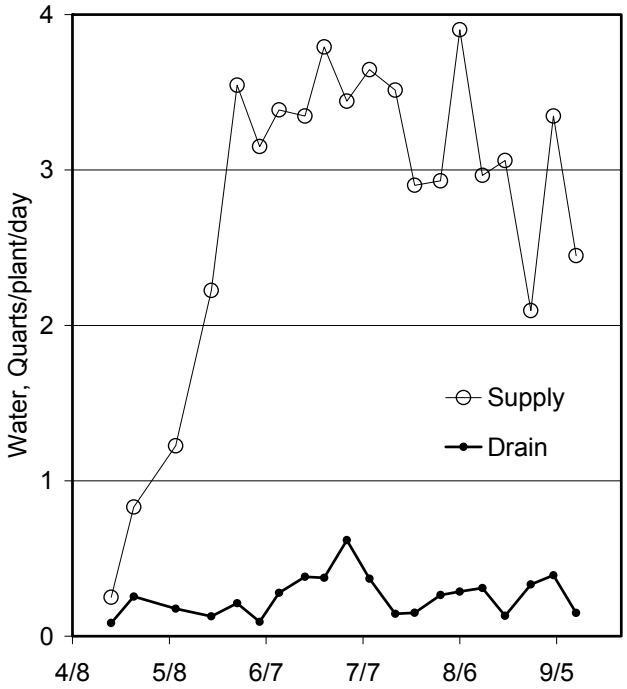
Greenhouse tomato plants use a lot of water. The amount of water required per day changes as the plants grow, and it also varies day-to-day according to sunlight. New transplants need less than 2 ounces per plant per day. However on sunny days during fruit production, plants may need up to 3 quarts of water per plant per day. Growers need to monitor plants closely during vegetative growth and fruit set, and increase the water supply as needed. Figure 1 shows there was a large daily variation in water use due to sunlight, and a more gradual trend as plants grow and develop over the season. When grown in soil, this daily variation may not be important, because over a period of a week, sunlight does not vary as much as from day to day. However, if plants are grown in a well drained medium, or in a small volume per plant, one should account for this daily variation in water uptake with sunlight. Plants during fruit production may need water several times a day to prevent drying of the root medium. Changes in water status in the root zone can crack the skin of tomato fruit and result in other disorders. Thus, it is best to control irrigation automatically, with the use of time clocks or electronic controllers. To insure that all plants receive enough water, irrigate so that 10 to 20% of the water supply drains after each watering.

Fertilization

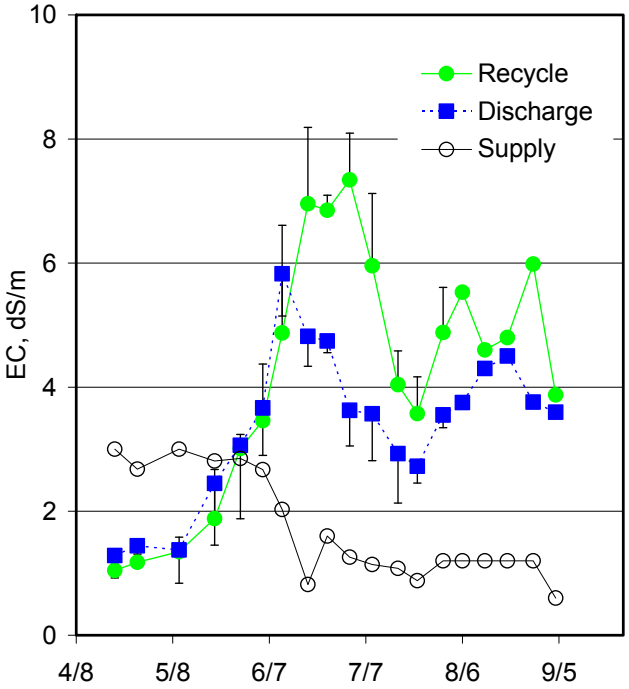
A successful nutrition program for greenhouse tomato includes the following:
Knowing the EC of the nutrient solution and the concentration of each nutrient in the fertilizer.
Measuring EC and pH of the media or drain solution, and responding in a timely manner.

Tomatoes need continuous fertilization unless they are grown in a large volume of soil. Otherwise, vegetative growth ceases and fruit lose their taste. Over a season, I calculate a single tomato plant takes up 0.7 ounce of nitrogen (N) and 0.9 ounce of potassium (K). Tomatoes require high N, K, and calcium (Ca), but low phosphorus (P). A single complete nutrient mix of 20-10-20 N-P2O5-K2O can be used to grow tomatoes. However, most growers use a complete nutrient mix with low N and high K, and supplement with calcium nitrate to provide most of the N. I have used a complete nutrient mix of 4-18-38 N-P2O5-K2O at a 1:1 ratio with calcium nitrate and a 2:1 ratio with magnesium sulfate, or a 3-15-26 mix at a 1.5:1 ratio with calcium nitrate.

Volumes of water per tomato plant taken up and drained per day, averaged over each week.



Electric conductivity of nutrient solution and supplied to tomato plants, and drained from recycled or discharged drainage systems.



I injected nutrients into the water supply using proportioners. Once or twice a week, the conductivity and concentrations of nitrate and potassium were measured in the solutions supplied to the plants and the solution in the rock-wool slabs. There was a rapid rise in uptake of nitrogen that closely followed the same time course as the rise in uptake of water. However, nitrogen uptake increased more rapidly than water uptake during early fruit growth of tomato plants. When nitrate was injected at a concentration of 100 ppm N, the concentration in the root medium fell to a low level in early and mid May, despite the rapid increase in the volume of water supplied per plant. Raising the nitrate supply to 200 ppm N eventually restored the appropriate level in the root zone. This depletion of nitrogen corresponded to the time when the roots had thoroughly penetrated the entire volume of root medium. A high concentration of N is recommended for seedling tomatoes in early spring to avoid this sudden depletion of nutrients. Water use continued to increase into early fruit ripening, while the demand for nitrogen was constant. Thus, a nitrate concentration of about 130 ppm N in the water supply matched the uptake of nitrogen by tomato plants during fruit production. The uptake of nitrogen generally

declined to about half the maximum rate by the end of the season. Nitrate at 100 ppm was sufficient after the plants were topped, because N uptake decreased more rapidly than water uptake.

Potassium uptake increased more slowly than nitrogen uptake in the spring, and reached a plateau about one month after the start of fruit production. Although potassium uptake increased faster than water uptake in May, it was not depleted in the root medium when the concentration in supply solution was increased to 220 ppm. A constant concentration of K in water of about 150 ppm was sufficient for the plants until this time. Potassium uptake continued to increase with water use for a month after fruit began to ripen. A potassium concentration of around 180 ppm in the water supply matched the uptake of potassium by tomato plants during fruit production. Thus uptake of potassium rose more slowly than nitrogen uptake during development of the crop in the spring. Potassium uptake declined slightly later in the season, as shown by the increasing concentration in the root medium.

The difference in composition of recycled compared to discharged solution developed gradually over more than one month of recycling. Typically, the transition from vegetative to fruit growth, which coincides with the beginning of the warm season, resulted in over-supply of nitrate, potassium and other nutrients. It took a longer time to return the solution to an optimal composition with recycled compared to discharged solution. There was little effect on composition of plants, despite the large but temporary differences in composition of nutrient solution.

In part, the change in nutrient uptake from spring to summer is due to a transition from cool to warm temperature. As hot weather arrives, plants require more water, but they do not need more nutrients. This is one reason why the concentration of nutrients can be decreased in summer. If the concentration is not decreased, then nutrients will accumulate in the root medium, and the EC will rise. If no adjustment is made to the nutrient solution, and it is recycled to the plants, this accumulation of nutrients may be enough to damage the plants or reduce fruit size.

Further reading.

Gent, M.P.N. 2003. Greenhouse Tomato Cultivar Trials in Connecticut 1999-2002. Connecticut Agric. Experiment Station Bulletin 990. 16 pp. www.caes.state.ct.us/Bulletins/2003/b990.pdf

Finally Filtering the Pond Water for Drip

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Early in 2008, we purchased a twin stainless steel sand filter system with a capacity of 350 gpm and a bypass for unfiltered water. This was the result of a series of irrigation transitions that had taken place since the 1910 on a 30 acre piece of land along the Merrimack River in Methuen, MA.

Over the years, irrigation was primarily overhead starting with a gravity-fed system and moving to a diesel-powered system with above ground mains and then buried mains. In 1995, we started using plastic mulch on the farm but continued to use overhead irrigation. Much of the irrigation on the plastic was with travelers but also included solid-set aluminum pipe.

The water supply on this land is from a family-owned spring that feeds our irrigation pond. The pond is approximately 100' x 300' and averages 6 feet deep. The spring adds about 30,000 gallons of water per day to the pond. About every 5 years we need to pump water from the river to fill the pond and in some years, we have done this on multiple occasions.

Due to a few dry years, concern over the need to use set up equipment to pump from the river, concern about possible government interference with that pumping, and just a general desire to reduce water use began a discussion of bringing drip to this field. Another consideration was to reduce the incidence of disease on warm season crops by reducing leaf wetness.

We spoke with Trevor Hardy at Brookdale Fruit Farm in Hollis, NH and Fran Dellamano from Belle Terre Irrigation LLC in NY and considered the options. We wanted to irrigate 12 acres of plastic all at one time, no zones, to minimize the time that the diesel pump was running. We decided to use our existing underground lines even though they were oversized (6") for the application. We also decided against separate disc filters for each area. Since there were 4 areas, each about 3 acres and each coming from the same water supply, we opted for a centralized system that was self cleaning.

The system has a bypass so that we can use unfiltered water for overhead irrigation on cool season crops such as lettuce, kale, beets, parsley, and leeks. An advantage of the combined system is that we have enough capacity to filter the water and run overhead and drip at the same time if we are not irrigating all the crops using drip at the same time.

This presentation will provide more background as well as a discussion about the system itself and how it worked. I will also mention and describe the irrigation on the rest of the farm.

A FIXED SPRAY SYSTEM FOR FRUIT CROPS

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http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp

Summary

A fixed spraying system was developed to improve application timing, reduce drift and improve deposition in a high density orchard in New York State. Indications from three seasons of trials indicate biological control to be as good as airblast spraying without the associated disadvantages of drift and high visibility. This paper details the layout of a field trial along with the main engineering challenges such as pipe diameter, siting, sizes, emitters, flow rate and pressure changes. A novel direct injection technique using a water driven Dosmatic A-80 2.5% pump was used on a mobile pumping station. Netafim DNA 7000 emitters provided an inexpensive nozzle arrangement.

1. Introduction

Traditionally growers have used airblast sprayers to apply pesticides to apple trees, creating a vast plume of spray, a variable proportion of which hits the target. The result is often poor distribution within the canopy leading to ineffective disease or insect control, off-target drift leading to environmental pollution and economic inefficiency.

Many orchards now have a myriad of planting densities and tree canopies, ranging from dwarf trees on narrow row spacing through to large trees planted in wide rows. Large scale, modern, high density plantings entail many hours of travel, along many miles of tree rows, resulting in high labour and machinery costs and affecting timeliness of application.

Direct injection sprayers have been developed by many researchers for boom sprayers in conventional field crops, but only one paper has been published in their application to fruit crops where they used four direct injection pumps inside a trailed tunnel sprayer.

A fixed spraying system was devised at Cornell University and preliminary trials were conducted to measure its efficiency at applying pesticides and controlling insects and disease. Spraylines were fixed to metal conduit poles at three different heights and fitted with Netafim DAN 7000 sprinkler emitters. Preliminary trials were conducted in two blocks of Red Delicious and Empire apples on M.9 dwarfing stock located in a research orchard at Cornell University, Geneva, NY, Agnello et al (2004). Tracer solution, using micronutrients was used to monitor spray deposition and a conventional airblast sprayer was connected, via a hose, to the spraylines passing through the trees. The fixed line system orchard blocks were compared to blocks treated with a conventional airblast sprayer. The scope of the preliminary trials was small, but results showed control of plum curculio was equal to that obtained with a conventional airblast sprayer.

In order to develop the system further, a large scale, 1 acre block, of dwarf spindle apple trees, *var*. Gala, was used on a co-operating grower's orchard in Wolcott, New York.

2. Materials and methods

A pesticide application system was devised, similar to a fixed irrigation system, where two 0.75" plastic pipes (laterals) were positioned through the canopy of the apple trees, following the top wire at 6 ft and the bottom wire at 3ft above the ground. Small emitters, Netafim DAN 7000 series with an 8 mm orifice and flat pattern spreader (Netafim, Fresno, CA) were installed at 3 ft and 6ft intervals along the length of the pipe (depending on the trial block). A 2" main pipe was run along the junction of the rows to a central filling position. Pipe diameters were calculated based upon a hydraulic analysis computer program devised by Walid Shayya for irrigation purposes.

The preliminary trial used a traditional airblast sprayer with a pipe connected from the outlet of the pump to the inlet connector of the canopy pipeline. The challenges associated with this design were the quantity of material to be mixed in the tank, tank rinsing, rinsate application and filling/rinsing time.

Direct injection sprayers offer the operator many advantages, including reduced environmental pollution and operator contamination, Landers (1992) and (1997). Injection sprayers eliminate tank rinsing and allow rapid changes in dose rate. The main tank of the sprayer holds clean water only. Pesticide is injected into the water flow via a piston or a peristaltic pump and the resultant mix flows through the pipes to the nozzles. A manual or electronic controller adjusts the pesticide injection pump according to changes in operating requirements, e.g. changes in application rate and pesticide required.

A trailed application unit was constructed using a 300 gallon water tank and a petrol driven centrifugal pump producing a flow of 90 gallons/minute at 36 psi. Two DOSMATIC A80-2.5% proportional injection pumps (Dosmatic USA, Carrollton, TX) were fitted into the water flow line after the pump. The water driven pumps were fitted with super corrosive transfer (SCT) kits to avoid damage to the pump seals from solvents in the pesticides. The pumps dispense pesticide at a known rate into the water stream in the spray pipeline, the injection rate being adjustable from 0.2 -2.5% or 1:500 to 1:40. The resultant mix is then pumped along the main pipe to the laterals within the tree canopy.

Specific objectives of the trial in comparing the fixed sprayline with an airblast sprayer are:

1. the biological effectiveness in controlling diseases and insect activity
2. the economics of a fixed sprayline system
3. the reliability of the components of fixed sprayline system over a number of seasons
4. the deposition characteristics of the sprinklers
5. the uniformity of pesticide concentrations from nozzle to nozzle
6. the uniformity of pesticide concentrations with changes in dose level
7. the system response time during filling and application of products
8. the use of a purge mode to rinse the sprayline pipes
9. the injection pump characteristics
10. further improvements to the system leading to grower acceptance

3. Results and discussion

The engineering challenges in this project have been numerous, but not insurmountable. The original lateral design used 0.3" risers between the laterals and the nozzles, this would cause excessive pressure loss, with subsequent changes in flow rate on such a large scale trial. Minimising pipe runs, branch points and using a high and low lateral and careful analysis of the hydraulic flows with an irrigation engineer overcame these problems.

As so many nozzles are required, traditional sprayer nozzles, nozzle bodies and anti-drip check valves would be prohibitively expensive. Micro-emitters are used in greenhouse irrigation systems and produce small droplets. Droplet size was of concern, the micro-emitters were tested at OARDC, Wooster, Ohio using an Aerometrics PDPA 1-D laser system. The VMD at 60psi was 310 micron. This is larger than we might choose, but is the smallest emitter available. Initial field trials over two seasons have shown extremely good biological control with these emitters.

Spacing, size and position of emitters were studied over the seasons, would emitters positioned outside the canopy be more effective? The longevity of the plastic irrigation pipe was also studied over a number of seasons.

Another hydraulic concern was overcome by using a mobile pumping unit. Originally we had hoped to use a central pumping station, but hydraulic flows, and costs were a major concern. The mobile unit can be transported from one block of trees to another.

A conventional airblast sprayer, used as the pumping station, suffers from a tank of mixed pesticide and water, plus operating at a high pressure. To overcome tank rinsing and pump pressures, we chose a direct injection unit. A water driven injection pump and petrol driven centrifugal water pump allows the system to be independent of tractors and PTO drive lines. The unit could, if desired, be pulled and operated with a pick up truck. A 12 volt electricity supply is required for the pesticide mixing unit fitted below the intake of the injection pump.

The large internal volume of a mains/lateral pipeline system through a block of apple trees presents many problems, such a filling and emptying the pipe. The direct injection pump allows us to fill the pipes with clean water for one minute, then inject pesticides for one minute and then push the pesticide laden water out with a clean water for a further minute.

Biological trials were conducted to measure the effectiveness of the spraying system at controlling insects and diseases, see webpage details below. Engineering trials investigated mixing efficiency, deposition and coverage and residue in the pipes. The efficiency of mobile sprayer at pumping and mixing pesticides with water was also investigated. The running costs and timeliness was also considered.

A future system may include a pump house and a sprayline system being incorporated within the trellis design, as the orchard is being laid out. The system could also be used for frost protection and for irrigation. Large blocks could be sprayed via an automated control system. Quietness and low visibility are hallmarks of this system.

Further information on this system, including results on biological efficacy is available on the internet at:-
http://www.nysaes.cornell.edu/ent/faculty/agnello/pdf/Agnello%20Fixed%20Spray%2007.pdf

Acknowledgements

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References

Agnello, A, Dellamano, F, and Robinson T. (2003) Development of a fixed spraying structure for high density apple planting, final report 1998. Personal communication.

Downer, R. (2004) Test report on the Netafin DAN 7000 nozzles. Personal communication.

Landers, A.J. (1992). An evaluation of the Dose 2000 direct injection crop sprayer. Proc. Of Ag Eng '92 International Conference on Agricultural Engineering, Uppsala. p.336. Uppsala: Swedish Institute of Agricultural Engineering.

Landers, A.J. (1997). A compressed air direct injection crop sprayer. Optimizing pesticide applications. Aspects of Applied Biology, 48. pp25-32. Wellesbourne: Association of Applied Biologists.

Tennes, B R, Burton, C L, and Reichard, D L. (1976).Concepts for metering sprays and spraying in high density fruit culture. Paper No. 76-1505. ASAE. St Joseph MI: American Soc of Agric Engineers.

Extending the Production Season with High Tunnels

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Introduction

For centuries a wide variety of techniques have been used to extend the growing season of horticultural crops. glass jars; glass cloches, hotcaps, cold frames, hotbeds, and greenhouses of various types have all contributed to season extension. More recently high tunnels have become popular with growers because of their simplicity and effectiveness in protecting crops from low temperatures, wind, and moisture stress in both spring and fall.

High tunnels do not offer the precision of conventional greenhouses for environmental control, but they do sufficiently modify the environment to enhance crop growth, yield, and quality. Although they provide some frost protection, their primary function is to elevate temperatures a few degrees each day over a period of several weeks.

In addition to temperature control, there are also the benefits of wind and rain protection, soil warming, and in some instances control of insects, diseases, and predators such as rodents and birds. Overall, this growing system should be considered a protected growing system that enhances earliness and promotes higher yields, improves quality and shelf life, and reduces the use of pesticides.

High tunnels have sufficient versatility to make them useful on a wide diversity of crops and in various cropping systems. Vegetables, small fruits, flowers and even tree fruits are all suited to this growing system; but the specific crops which might be grown will to a large extent depend on marketing opportunities for individual crops by individual growers.

High Tunnel System

High tunnels encompass a crop growing system that fits between row covers and greenhouses. They are relatively inexpensive (about $3.00/sq. ft, excluding labor), permitting a grower to enter into high tunnel crop production with limited capital. This system is particularly appealing to new-entry growers who utilize retail-marketing channels.

High tunnels are not conventional greenhouses. But like plastic-covered greenhouses, they are generally a peaked quonset-shape, constructed of metal bows that are attached to metal posts which have been driven into the ground about two feet deep. They are covered with a single layer of 6-mil greenhouse-grade polyethylene, and are ventilated by manually rolling up the sides each morning and rolling them down in early evening. There is no permanent heating system although it is advisable to have a standby portable propane heater to protect against unexpected below-freezing temperatures. There are no electrical connections. The only external connection is a water supply for trickle irrigation. Dr. Otho Wells, from the University of New Hampshire, was a pioneer in promoting the use of high tunnels in the northeastern United States and developed the New Hampshire design and system of production that involved covering the entire soil surface inside the tunnel with a solid sheet of 6-mil thick plastic. At Penn State we re-

designed the endwalls so that they can be raised up to facilitate easy access into the tunnel with a small tractor and tiller and a system of production that uses 18- inch wide raised plastic mulch covered beds with drip irrigation tape buried 2-3 inches beneath the bed. The raised mulch beds are 44 inches apart, which allows 4 rows in a 17 foot wide high tunnel or 5 rows in a 21 foot wide tunnel.

General Suggestions for High Tunnel Management

High tunnels are not automated. Consequently, for maximum efficiency, they require regular daily attention, especially in the morning and evening, and during heavy rain events or strong winds. Temperature and humidity are the two critical factors that should be controlled as much as feasible. Early each morning, the sides should be rolled up to flush out the humidity and to keep temperature in check. The temperature in a closed high tunnel rises very rapidly on a clear morning! In other words, don't put off rolling up the sides. Ken-Bar Inc., Reading, MA. has developed a top vent that fits right on the plastic and can be used to ventilate a tunnel in the early spring and late fall when one does not really need to roll the sides up for temperature control. In the early evening, roll down the sides to entrap as much heat as possible. To increase soil and air temperatures within a high tunnel the following materials have been used successfully over the last four years: floating row covers, thermal blankets, hoop supported low tunnels (plastic film with or without ventilation holes or row cover material). Close the sides each evening until the night temperature reaches about 65^{o}F. In the northeastern United States, this could mean that the sides would be rolled down each day well into the summer. Ventilation is best accomplished when wind moves through the tunnel from side to side; therefore orient the tunnel accordingly. The width of the tunnel also impacts ventilation. It is hard to be specific on the maximum width, but from experience, about 21-26feet seems to be the maximum high tunnel width that will allow for good ventilation, especially as plants grow taller and block the airflow.

Benefits of High Tunnels

The primary benefit of high tunnels is earliness. Tomatoes in a high tunnel mature on average about one month before field tomatoes. Earliness is the combination of being able to plant in high tunnels about two weeks earlier than in the open- field and faster ripening (about two weeks) inside the tunnel. Overall, the cost of a tunnel is usually recovered the first year when selling at retail prices. Another highly beneficial advantage of tunnels is disease control. The plastic cover acts like a rain shelter, the raised plastic mulch beds are a barrier against evaporation of soil moisture, and early morning ventilation reduces relative humidity. Therefore, the leaves of crops are dry for most of the day and night. Because of low humidity, plant leaves remain dry, impeding the incidence and spread of disease. Powdery mildew is the most serious and prevalent disease in high tunnels because the conditions in a high tunnel are more favorable for the development of this disease.

Crops

The following crops have been grown successfully in the high tunnels at Penn State High Tunnel Research and Education Facility.

Vegetables

The high tunnel allows growers to produce crops over a longer period of time and in some climates even produced year-round. Many times the plastic mulch is double-cropped with the first crop being removed and the second crop being planted on the plastic. The following vegetables have been grown successfully in the high tunnels: tomato (*Lycopersicon esculentum*), eggplant *(Solanum melongena*), pepper (*Capsicum annuum* Grossum group), muskmelon *(Cucumis melo*) summer squash (*Cucurbita pepo*), cucumber *(Cucumis sativus*), spinach (*Spinacia oleracea)*, Swiss chard (*Beta vulgaris var. cicla)* , lettuce (*Lactuca sativa*) , broccoli (*Brassica oleracea* var. *italica*)., cabbage (*Brassica oleracea* var. *capitata*), cauliflower (*Brassica oleracea* var. *botrytis*), kale (*Brassica oleracea* var. *acephala*), kohlrabi (*Brassica oleracea gongyloides*), okra (*Abelmoschus esculentus*), onions (*Allium cepa)*, leeks (*Allium ampeloprasum porrum)* , garlic (*Allium sativum)*, peas (*Pisum sativum*), specialty potatoes (*Solanum tuberosum*) for the red, white and blue potato salad for the 4th of July. In addition, a wide variety of herbs such as dill (*Anethum graveolens*) have been grown in the high tunnel.

Small Fruits

The extended production season and improved shelf-life of these products make high tunnel production a very viable option for the direct marketer. Primocane-bearing red raspberries (*Rubus idaeus)*, and thornless blackberries (*Rubus subgenus Eubatus)* are produced on bare ground with drip irrigation. Strawberries (*Fragaria x ananassa)* are grown using the small raised bed with drip irrigation.

Cut Flowers

There are many options for cut flowers in the high tunnels ranging from herbaceous perennials over-wintered for spring cut-flower production to summer annuals, and natural season fall mums. This production system permits cut flowers to be harvested earlier in the spring and later in the fall compared to cut flowers grown in the field, and provides excellent flower quality.

Tree Fruit

Sweet cherries on dwarfing rootstock have been planted in high tunnels since 2000. Generally fruit tress are grown in large multiple bay temporary high tunnels such as those sold by Haygrove US. Benefits of growing sweet cherries in high tunnels appear s to be earlier maturity, elimination of fruit cracking and bird damage.

Summary

High tunnels can provide an ideal protective growing environment for any number of crops, but all crops might not be economical for any number of reasons. Therefore, a good approach to take would be to try different crops in light of market demands and marketing strategies. Although tunnels do require more manual attention than do greenhouses, the benefits

of high tunnels in a diversified farm operation have proven to be a valuable asset in overcoming a short growing season and expanding the marketing season.

There are temperature limitations in high tunnels since they are not designed to be as warm as a greenhouse. Some type of supplemental heat should be available just in case there is a sudden unexpected drop in the temperature that would permanently injure the crop. The critical low temperature will depend on the crop. If the intent is to have a permanent heat source in a high tunnel, then if would be well to consider constructing a bona-fide greenhouse which easily could be used year around.

For addition information on plasticulture contact the following websites:

American Society for Plasticulture: **http://www.plasticulture.org/**
Center for Plasticulture, Penn State University: **http://plasticulture.cas.psu.edu**

Penn State High Tunnel Production Guide is available for $30.00 U.S. dollars from

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Beginning Farmers selling produce at 40 Massachusetts Farmers' Markets

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Farmers of the Flats Mentor Farm were selling at 3 farmers' markets in Massachusetts in 2005 and four years later, in 2009 they increased to 40 farmers' markets: This was due to the increased capacity of farmers' to grow crops for the markets and the tremendous increase of the number of farmers' markets in Massachusetts. In 2009 there were almost 200 markets offering consumers high quality fresh locally produced vegetables and other agricultural products. The increase in the number of markets and their popularity is an excellent option for all farmers to market a farmers produce. There is an increase on the number of established farmers are using Farmers Markets as their first option to market their produce locally. This type of direct market has many advantages for farmers. The customers come to you, farmers receive payment immediately, and the market can be very forgiving, certain product inconsistencies which do not affect taste or quality are among the many reasons for the popularity of Farmers Market in Massachusetts.

Challenges: Flats Mentor Farm didn't have the necessary cultural and language skills necessary to successfully sell their crops at farmers markets. This was revealed as part of constant input given by farmers market managers that although these farmers were a great asset to the consumers and to their market in general that we at the FMF needed to take the lead in providing training to farmers in the marketing component of their farming practices. Some were not comfortable selling at farmers' markets as they thought that they might be and thus that affected their ability to succeed. Self-assessment tools were used to assist these farmers and trainings in this area.

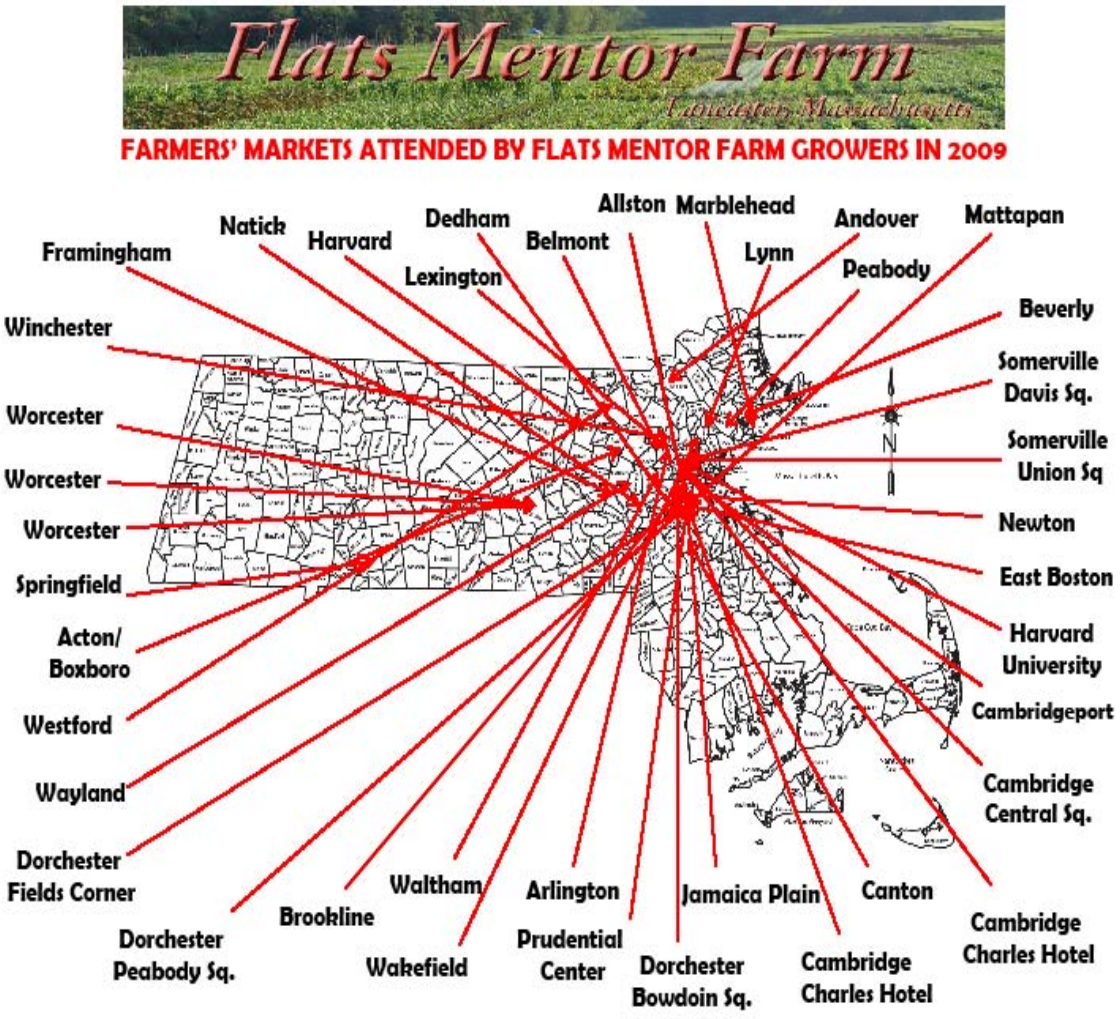
2009 farmers market Central Sq. Cambridge Massachusetts

Farmers Markets and Beginning Farmers at the FMF: In 2005 as a result of resources received from USDA cost share AMS grant, the Massachusetts Department of Agricultural Resources, Heifer International, The Society for the Promotion of Agriculture, USDA, RMA, CSREES, to support infrastructure development and to provide training and technical assistance to FMF growers, there was a significant increase in the capacity of growers to produce crops for markets.

Flats Mentor Farm staff embarked in an effort to provide the training and technical assistance necessary on all aspects of marketing to farmers who were now producing more crops than they had the ability to sell. These trainings focused on product quality, product presentation, setting up at each market, customer relations, market etiquette, developing relationships with key partners for their businesses, in this case the farmers' market managers, and assessing and addressing each farmers' language barriers. For example as part of these trainings, FMF staff

organized all farmers to visit other farmers to learn in the field how to set up a farmers market. We held mock customer handling situations where farmers acted like some customers and learned how to handle language barrier situations. Farmers also learned how to describe their produce, (this is ongoing and still a work in progress), they were provided with point of sales materials and signage for their stands. They also received trained on how to contact farmers' market managers and to fill out applications.

The 40 Farmers Markets that FMF attended in 2009



Using Good Agricultural Practices Certification for your Marketing

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What is GAP (Good Agricultural Practices)? It is an assurance to our customers that thought and actions have been exercised to minimize the potential for fresh produce contamination by pathogens.

GAP encompasses 5 main areas of food safety concerns on the farm. They include worker hygiene; water quality; sanitation of equipment, supplies, and containers; manure and compost; and domestic animals and wildlife.

Reasons that this issue has escalated to the forefront of concern include the 2006 spinach issue in California which still has not been resolved, Serrano peppers from Mexico…it really wasn't tomatoes, and a myriad of other earlier issues, some of which are not even related to fresh produce.

Certification of growers in New England is in its infancy. One packing plant is certified in MA, a group of growers in northern Maine are certified because of processing and international concerns, RI has had a similar program that has certified growers participating in the farm to school program, and there have been other growers recently certified in 2009. This recent list of growers is responding to requests by Hannaford and Price Chopper markets to require certification of their growers by 2010.

In addition to the 2 supermarket chains mentioned above, there is increasing speculation that Congress may mandate GAP, school programs may mandate it on their own, and other buyers my require it of their suppliers.

A more recent issue is that large growers in the western U.S. have petitioned USDA to create voluntary national food safety marketing agreements to mirror those that they created following the 2006 spinach situation. These marketing agreements use GAP as a core but require many additional protocols and audits in addition. The downside of these agreements will be less local food on the shelves and a move from "know your farmer" to "I have no idea who my farmer is".

Our biggest fears as New England farmers is that we do not have the issues of the "big guys" that co-mingle produce from many growers but we are lumped together anyway. We have concerns about time and dollars to comply. Animal issues, water issues, and the details of traceability also are of concern.

If you really think about all the possible issues regarding food safety you might ask, "How are we all still alive"?

The bottom line is that individual growers will need to decide if they will become certified based on their customer's needs, the desire of the farmer to keep that customer, and potential peer pressure

How to Get Fresh Produce into the Boston Food System: Example of East Boston and Chipilín

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Boston is the largest city in New England and Greater Boston is the tenth largest metropolitan area in the country. This represents a lot of "eaters", more of whom are interested in local sources of fresh produce. An understanding of the Boston food system is essential in order to be successful in providing these eaters with culturally appropriate local fresh produce. An important component of this food system is the growing immigrant population in Boston; for the first time in its history Caucasians of European decent are a minority. Boston is a city of neighborhoods, with many representing different ethnicities that have their own cuisine and culture, which strongly influence the types of fresh produce they prefer.

Retail vs. Wholesale. Retail sales of fresh produce among farmers in Massachusetts has increased significantly in recent years; retail sales are estimated to be much higher than wholesale sales among growers of fresh fruits and vegetables in Massachusetts. That being said; retails sales of Massachusetts grown fresh fruits and vegetables represent a very small percentage of total sales of fresh produce in Massachusetts, even during the growing season.

Retail options:

Farmers' markets: There were 197 farmers' markets in Massachusetts in 2009 and 24 in Boston proper. This is an excellent opportunity to bring fresh produce into Boston. For information on selling at farmers' markets in Massachusetts, contact David Webber, Farmers' Market Coordinator of the Massachusetts Department of Agricultural Resources (617-626-1754; David,Webber@state.ma.us)

Community Supported Agriculture (CSA's). There are CSA's in Boston, even though there is only one commercial farm with land in Boston that has a CSA (Allandale Farm; http://www.allandalefarm.com/). There are other commercial farms outside of Boston that offer shares to consumers that live in Boston (e.g. Stillman farm, www.stillmansfarm.com; Brookdale farm, www.brookfieldfarm.org)

Wholesale options:

Supermarkets and Independent Grocery Stores. In 2006, there were 35 supermarkets in Boston. This included 27 chain stores: Shaws (9), Stop&Shop (9), Wholefoods (3), Supper 88 (3), Save A Lot (2) and Roche Brothers (1). The remaining eight are independent stores with at least 10,000 square feet and over $2,000,000 in annual sales. Boston has more supermarkets per capita than many other major cities in the US, but there are still many residents that are more than 0.5 miles from a supermarket, limiting their access.

Corner stores (bodegas). There are literally hundreds of corner stores in Boston that are major sources of food items for residents. Many of them do offer fresh produce, but it is very limited,

due to lack of space and coolers. In ethnic corner stores, much of the fresh produce is made up of tropical root crops (e.g yautia, edodes) and tropical fruit (e.g. mangoes, plantains).

Chipilín produced at the UMass Research Farm for sale at a Latino store in Chelsea, Massachusetts.

Restaurants. There are thousands of restaurants in Boston and they represent an important market for locally-grown fresh produce. Many restaurants will use purveyors or "jobbers" to provide them with their produce. There are many farms that sell direct to restaurants. One example is Verrill Farms (http://www.verrillfarm.com/) which sells to 33 restaurants, 13 of which are in Boston. This also represents an opportunity to promote retail sales at their farm stands through the restaurants.

Example of Chipilín in East Boston

As an example of introducing culturally appropriate fresh produce into Boston, work done by UMass in East Boston is illustrative. East Boston, with a population of about 40,000, was dominated by Italian immigrants starting in the late 19th century. Italian immigrants coming to Massachusetts first moved to Orient Heights in "Eastie" before the North End became known as a destination for Italian immigrants. In recent years, the Latino population has exploded in this neighborhood; it is now home to the largest Latino population in Boston, estimated to be 70% of the total population. The dominant ethnicity among Latinos is Salvadorans; there are also large numbers of Brazilians and Colombians, among other Latino groups.

Several crops popular among Salvadorans and Brazilians have been researched at the UMass Research Farm in Deerfield MA and cooperating commercial farms. These crops were evaluated in markets serving the diverse communities in East Boston. These include pipián (Curcubita spp.), chipilín (*Crotalaria longirostrata*), taioba (*Xanthosoma sagittifolium*), and abóbora japonesa (*Cucurbita maxima X C. moschata*), and maxixe (*Cucumis anguria*).

Chipilín is an herb popular in Salvadoran, Guatemalan and Southern Mexican cuisine, where it is used in soups and also as an ingredient in tamales. This crop has been grown in Massachusetts for three years, at the UMass Research Farm and on two commercial farms, and has been evaluated in several markets that cater to eaters in East Boston. In interviewing members of the Latino community in East Boston, we learned that a high percentage of the Salvadoran population buys their fresh produce at a Market Basket store in Chelsea, MA. Market Basket has 62 stores in Massachusetts and New Hampshire and the store in Chelsea has the highest sales of fresh produce of all their stores; they have a new store that opened in 2009 that is one of the largest supermarket stores on the Eastern seaboard.

In order to introduce chipilín to the sore, which had never sold it before, an event was promoted among the Salvadoran population on a popular radio program. Over 100 pounds of this crop was sold at this event, at $5.99/pound. Due to the success of this event, this Market Basket store purchased chipilín on a weekly basis through their main warehouse in Tewksbury MA. They eventually began selling this crop to at least two of their other store locations outside of Boston, which also serve Salvadoran customers.

Another store identified by Latinos in East Boston as a popular place to buy Latino crops was an independent store also in neighboring Chelsea Mass. The owner, who is Cuban-American, was very much aware of her clientele (being mostly Salvadoran), but she was not intimately knowledgeable of Salvadoran cuisine, including chipilín. Most of the staff, including the produce managers, are Salvadoran and were very familiar with chipilín, making the introduction of this crop to this store easier than in Market Basket. This store averaged sales of 300 pounds/week, which was enough to justify direct deliveries by a grower cooperative in 2008 and a commercial grower in 2009.

Most of the crops mentioned above have been sold at the only farmers' market in East Boston at Central Square, located at the corners of Meridian, Bennington and Border streets. Chipilín produced at the UMass Research Farm was introduced to the market in 2008, where sales averaged over 40 pounds/week at $6/pound. In 2009 a cooperating farmer with the Flats Mentor Farm, grew chipilín for sale at this market with excellent results.

Chipilín produced at the UMass Research Farm being promoted and sold at the East Boston farmers market.

In 2008, chipilín was offered to a Latino bodega (corner market) in East Boston. The difficulties with direct sales of this crop in this store were two-fold: they only wanted a 5 – 10 pounds/week, making individual deliveries difficult, and they were not well-equipped to handle perishable fresh produce, a common constraint with many corner stores.

One efficient way to provide chipilín to these smaller stores and restaurants, which also would buy small amounts and make individual deliveries difficult to justify, is to sell through a broker at Chelsea Market (the terminal market of Boston). This is where many of the owners of small stores and restaurants will buy their fresh produce (and other grocery items). Fresh chipilín was sold at one broker at Chelsea Market who has over 2,000 accounts in New England. The wholesale price was lowered by 15% to allow the broker to sell the chipilín at the same price as the wholesale price to other markets.

Evaluation of Pickling and slicing cucumber varieties

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Introduction

New variety releases for both pickling and slicing type cucumbers has expanded the choices for New England growers. Cucumbers are a staple at local farm stands and farmers markets and can be quite profitable. Proper variety selection greatly influences the success of this crop.

Materials and Methods

Five pickling cucumber cultivars and ten slicing cucumber cultivars were evaluated at Highmoor Farm, Monmouth Maine during the 2009 growing season. The experiment was arranged in a randomized complete block with four replications. Each plot consisted of 10 plants spaced at 12" with-in the row on black plastic mulched raised beds spaced approximately 5' on center. Three seeds were sown in each hole on June 16, 2009 and later thinned to one plant. Prior to forming the beds, the field was fertilized with 10-10-10 at a rate equal to 500lb/acre. The plants also received 1 cup of starter solution at after seeding. No other supplemental irrigation was provided. No sprays were made to manage insect or diseases. Weeds were managed by cultivation.

Harvest dates were August 12, 14, 20, 28, September 3 and 11. Number of fruit and fruit weight were recorded for each plot. Fruit length, was determined from 25 randomly selected fruit of each variety on the August 28 and September 3 harvests. Plot yields were summed over all harvests prior to data analysis.

Results

Cool wet weather for much of the summer likely reduced plant growth and yield in this trial. These results may not reflect potential variety performance under better growing conditions. The days to harvest were very similar among the varieties and were probably the result of unfavorable weather and poor growing conditions rather than the genetics of the varieties themselves.

Pickling Cucumbers

'Eureka' had he highest yields of the pickle varieties, although the yield was not significantly different than 'Fancipak' or 'Alibi' (Table 1). 'Alibi' also produced good yields but tended to produce a high percentage of cull fruit compared to 'Eureka' or 'Fancipak'. 'Sassy' and 'Northern Pickling' had the lowest yields in the trial. 'Northern Pickling' had significantly higher cull rate than and other variety in the trial (62%), with many fruit of poor size, shape, and rapidly becoming over mature.

Slicing Cucumbers

All the slicing cucumbers performed well in this trial with acceptable yield, quality and cull percentages. The yield of the slicing cucumbers was similar for all varieties with the exception of 'Diva' (Table 2). 'Diva' is a Beit Alpha type cucumber and not an American slicing type. 'Rockingham' tended to produce more fruit of larger size than the other slicing varieties, although 'Talladega' also produced good yields and large fruit. 'Olympian' tended to produce fewer fruit than other varieties; while, 'Intimidator' tended to have the greatest number of culls.

Table 1. Average plot yield[z] and fruit length of pickling cucumbers grown at the University of Maine, Highmoor Farm, Monmouth Maine in 2009.

	Marketable fruit		Cull fruit		
Cultivar	Number[y]	Weight (kg)	Number	Weight (kg)	Fruit Length (in)
Eureka	147.3 a	27.0 a	48.8 b	12.4 b	5.4
Fancipak	125.3 a	23.4 ab	39.5 b	11.2 bc	4.9
Alibi	114.8 ab	21.3 ab	56.8 b	13.7 ab	5.0
Sassy	76.8 bc	16.7 bc	23.8 b	5.2 c	6.1
Northern Pickling	66.3 c	9.6 c	109.3 a	19.5 a	5.2

[z]Plots consisted of 10 plants spaced at 12" with-in rows. Means are the average of four plots.
[y]Means followed by the same letter are not significantly different ($p>0.05$)

Table 2. Average plot yield[z] and fruit length of slicing cucumbers grown at the University of Maine, Highmoor Farm, Monmouth Maine in 2009.

	Marketable fruit		Cull fruit		
Cultivar	Number[y]	Weight (kg)	Number	Weight (kg)	Fruit Length (in)
Rockingham	107.0 a	35.2 ab	35.3 a	11.2 a	8.7
Talladaga	99.8 ab	31.5 ab	27.5 ab	8.5 ab	8.4
Speedway	94.8 ab	28.2 b	27.8 ab	9.0 ab	8.0
Dominator	93.8 ab	29.8 ab	23.5 ab	7.2 ab	8.4
Cobra	91.8 ab	31.5 ab	29.0 ab	8.6 ab	8.4
Stonewall	88.3 ab	25.9 b	32.0 ab	8.5 ab	8.3
Raider	87.8 ab	26.3 b	23.3 ab	7.0 b	8.1
Intimidator	87.3 ab	27.1 b	36.3 a	10.8 a	8.6
Olympian	84.8 b	28.6 b	29.3 ab	8.1 ab	8.4
Diva	55.0 c	18.0 c	18.5 b	7.8 ab	8.0

[z]Plots consisted of 10 plants spaced at 12" with-in rows. Means are the average of four plots.
[y]Means followed by the same letter are not significantly different ($p>0.05$)

Hybrid Mulch System Impacts on Production and Economics

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The hybrid mulch system is a grower developed combination of sustainable agricultural practices designed to address concerns of growers in the northeastern United States. In this system vegetables are grown on fall established, plastic mulch covered, raised beds with a living mulch inter-bed of perennial ryegrass and white clover. The beds remain in place for up to 3 years, and the system aims to reduce waste plastic and the need for herbicides and tillage.

An evaluation of the system and its impact on production and economic factors was carried out at Highmoor Farm, in Monmouth, Maine from 2004 to 2007. The objective of this study was to evaluate a hybrid mulch system compared to a traditional spring bed system in terms of plastic durability, yields, depletion of soil nutrients and economic returns.

Two crop rotations of three vegetables; TCP: tomato (*Lycopersicon esculentum* Mill.), cucumber (*Cucumis sativus*), pumpkin (*Cucurbita pepo*) or CTP; cucumber, tomato, pumpkin were grown in a traditional production system with plastic mulch in the rows and bare ground between the rows and compared to the same two rotations grown in a hybrid mulch system.

The hybrid mulch system produced yields greater or equal to the traditional spring planted system in the first 2 years, but lower yields in the third year. The loss of phosphorus, potassium and organic matter was equal and nitrate nitrogen increased in the surface soils of the hybrid mulch system over the first two years in comparison to the traditional system. At the 20 cm sampling depth, the loss of nitrate nitrogen was higher in hybrid mulch beds after three cropping seasons than it was in traditional beds, but the loss of potassium and soil organic matter was same, and the loss of phosphorus was lower in hybrid mulch beds than traditional. Three types of long life plastic were tested and showed no differences in terms of either durability or yields. Economically, with a tomato, cucumber, pumpkin rotation, net returns were doubled and

with a cucumber, tomato, pumpkin rotation, net returns remained stable in comparison to a traditional production system. Major cost differences between the two systems were due to mowing, increased time spent weeding and planting, and increased harvesting costs in one rotation.

An important factor in the success of this system appears to be in its ability to allow earlier planting dates which is primarily important for growers in regions with short growing seasons or wet springs.

Pests and partners: the effects of cucumber beetles on pollinators, mycorrhizal fungi and yield in cucumbers

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Cucumber beetles (*Acalymma vittatum*) are important pests of cucurbit crops that are well-known for both inflicting direct damage on plants and fruits and spreading bacterial wilt. However, beetles may also have indirect impacts on cucurbits by affecting interactions between the plants and other organisms. The damaging effects of cucumber beetles are most evident aboveground, but their larvae develop underground and feed on roots. Thus plants may suffer negative effects from herbivores above and below the soil surface. However cucurbits also interact with beneficial organisms above- and belowground. Pollinator visitation is essential for fruit production, and associations between roots and beneficial mycorrhizal fungi help plants take up water and nutrients from the soil.

We studied how leaf damage by adult cucumber beetles directly affected cucumber plants and indirectly affected other interacting organisms (larvae, pollinators, and fungi). We enclosed the first four leaves of cucumber seedlings in mesh bags with beetles to impose different levels of damage in June and followed plants through the growing season. Given recent concerns of declines in both wild and domestic pollinators, we also applied an enhanced pollination treatment to half of the plants to determine if plants are receiving sufficient natural pollination.

Plants with higher leaf damage in June remained smaller throughout the season and produced fewer male and female flowers. Damage also reduced the size of petals on male flowers, which may reduce their attractiveness to pollinators. Beetle larvae tended to be more abundant on plants with low levels of leaf damage, but this pattern was not statistically significant. Beetle damage had strong effects on yield: low-damage plants produced more cucumbers than high-damage plants, and these fruits tended to be heavier.

Analyses of fungal colonization and pollinator visitation data are ongoing, but enhanced pollination did affect yield. Plants on which each female flower was hand-pollinated produced more cucumbers than plants that relied on natural visitation by pollinators. But this was not due to differences in pollination success – the proportion of female flowers that successfully developed into cucumbers was not different for the two groups. Rather, plants that received supplementary pollen actually produced more female flowers, leading to more fruits.

These results underscore that the negative effects of cucumber beetles may extend beyond their role as vectors of bacterial wilt. Early-season damage to only the first four leaves reduced plant yield all season long. By reducing the size of male flowers, beetle damage may reduce their attractiveness and lower the number of visitations by pollinators such as bees. Given our result that increased pollination led to greater flower production, reducing the number of visits by pollinators may result in lower cucumber production even if pollinators successfully transfer pollen to the flower they do visit.

In addition to examining fungal colonization and pollinator visitation data, in future years we will test the effects of root damage by experimentally altering the number of beetle larvae feeding on roots and the impacts of different fungal strains. By surveying fungal diversity in local fields, we hope to develop management recommendations that encourage the establishment of the most beneficial fungi to help growers maximize yield.

What's New with Vine Crop Diseases and their Management

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With several diseases occurring regularly and others sporadically in cucurbit crops growing in the northeastern US, disease management often is needed to avoid reduction in yield or fruit quality.

Powdery mildew management program often needs adjustments each year as the pathogen and management tools change. An integrated program with fungicides applied to resistance varieties is recommended to minimize selection pressure for pathogen strains able to overcome either plant resistance genes or fungicides. The pathogen has exhibited adaptation to both tools.

A new pathogen race has been detected in the south able to affect melon varieties with resistance to races 1 and 2. Fortunately these resistant varieties are still providing good suppression in the north. The resistance genes in squash and pumpkin are different from those in melon. With most crop types (exception being butternut), varieties with resistance from both parents (homozygous) have been less severely affected by powdery mildew than varieties with resistance from one parent (heterozygous). Another exception is varieties from Hollar Seeds, which have a different major gene for resistance.

Mobile fungicides currently recommended for powdery mildew are Quintec (FRAC Group 13), Rally or Procure (both Group 3), and Pristine (Groups 7 + 11). The Quintec label was expanded in 2009 to include pumpkin, winter squash, and gourd. Melon was labeled in 2007. Quintec is not labeled for use on edible-peel cucurbits. In 2009 it was again the most effective fungicide in efficacy experiments. Performance of other products has been affected by resistance developing in the pathogen. It is critical to apply Quintec in alternation with the other mobile fungicides for resistance management and to comply with label restrictions. The label specifies no more than 2 consecutive applications plus a crop maximum of 4 applications. Also each of the mobile fungicides should be tank-mixed with a protectant fungicide to manage resistance and to ensure effective control. Quintec, Rally, and Procure are only effective for powdery mildew. Procure was more effective than Rally in a fungicide evaluation conducted at LIHREC in 2009. The highest label rate of Procure contains almost twice as much active ingredient as Rally. Both of these DMI fungicides were more effective than Inspire, a new DMI fungicide; similar results were obtained in GA. It was anticipated that this new generation DMI fungicide would be inherently more active than Rally and Procure, just as these are more effective than the first DMI fungicide Bayleton, which is no longer labeled. Laboratory testing of isolates confirmed that the cucurbit powdery mildew fungus is less sensitive to the active ingredient in Inspire than Procure and Rally, and is more sensitive to the active ingredient in Quintec. A few isolates of the pathogen collected in PA and NY in 2008 were found to be completely resistant to both active ingredients in Pristine. However, Pristine was as effective as Procure in 2009 in both the NY and GA efficacy experiments. But it did not perform well in an experiment conducted in NJ. There are new, highly effective fungicides in development for powdery mildew. Hopefully these will

be registered before the pathogen has developed resistance to Quintec so that all can be used together in a fungicide resistance management program.

Downy mildew has continued to be important every year during the growing season. Before 2004 this disease occurred sporadically in the northeast and often late in the season. Now it can occur before fruit production is done, when loss of leaves, which can occur quickly when downy mildew is not managed, can impact yield and fruit quality. An important tool for managing downy mildew is the forecasting web site at http://cdm.ipmpipe.org. The risk of downy mildew occurring throughout the eastern US is forecast and posted three times a week. Plans for the future include customizable alerts that growers can subscribe to receive by e-mail or text message. The main management tool is fungicides. It is not possible to avoid the wind-dispersed spores. Cucumber varieties with resistance to the old pathogen strains provide significant but insufficient suppression. There are several mobile fungicides with different modes of action: Ranman (FRAC Group 21), Forum (40), Revus (40), Presidio (43), Curzate (27), Tanos (27), Gavel (22), and Previcur Flex (28). Alternating among fungicides in different FRAC Groups and tank-mixing them with a protectant fungicide is generally recommended. Curzate and Tanos have some curative activity but limited residual activity (about 5 days).

Phytophthora blight management has been improved with the recent registration of several mobile fungicides with different modes of action that have targeted activity for this group of pathogens. These fungicides are Ranman (FRAC Group 21), Forum (40), Revus (40), Presidio (43), Tanos (27), Gavel (22), and phosphorous acid fungicides (ProPhyt, Phostrol, Fosphite, etc)(33). These are also effective for downy mildew, thus growers applying these fungicides for blight have not had foliage loss to downy mildew. In recent years blight has been effectively controlled in fields where blight previously caused substantial yield loss by using an integrated program that also includes practices for managing soil moisture. Some growers have been starting the fungicide program with an application of a phosphorous acid fungicide along with Admire in the furrow at planting. It is critical to alternate among fungicides with different modes of action (in different FRAC Groups) to minimize selection pressure for fungicide resistance. Use either Forum or Revus since these are in the same Group.

Mustard and other plants with biofumigant activity have been found effective for Phytophthora blight through research conducted at LIHREC. Caliente 199 mustard was grown during spring prior to a cucurbit crop. Fertilizer (100 lb/A N) was applied to obtain adequate growth. This variety was selected because it has a high concentration of glucosinolates, which breakdown as the plant decomposes into allyl-isothiocyanate, which is similar to methyl isothiocyanate, the active ingredient in the chemical fumigant Metam Sodium. Several weeks after the start of flowering, when plants were about 5-ft tall, they were flail chopped and immediately incorporated by rototilling, then the soil surface was sealed by rolling with a cultipacker followed by irrigation. When done early in the morning and quickly, loss of biofumigant through volatilization will be minimized.

Fusarium crown and fruit rot has been increasing in occurrence in pumpkin, especially where there is minimal rotation (e.g. u-pik fields). In some pumpkin fields it has become more important than Phytophthora blight. Affected plants wilt. They usually are scattered in a field similar to the distribution for bacterial wilt, in contrast with Phytophthora blight, which tends to affect groups of plants. The crown area of affected plants generally appears firm, lacking the

collapsed, dark, water-soaked appearance of crown rot due to Phytophthora. The crown area may feel soft when squeezed and it will usually break near the soil line when the plant is pulled up, revealing brown rotted tissue inside the crown. There may be a thin layer of white fungal growth on part of the surface of affected crowns. Phytophthora can also produce white fungal growth on affected crowns. Crown tissue of plants affected by bacterial wilt will appear healthy and will not break when the plant is pulled up. In addition to causing a crown rot, *Fusarium* also causes round, brown spots on the side of fruit lying on the ground. Affected fruit will eventually completely rot. Labeled fungicides include the biofungicide Actinovate, which can be applied to soil, and Topsin M. Since the white fungal growth is mostly spores and the pathogen survives on affected plant debris, it may be worthwhile where incidence is low to physically remove affected tissue. Only the affected crown tissue needs to be physically removed from the field, but since the crown will break when the plant is pulled, a trowel will be needed to remove the part left in the soil. Deep plow immediately after harvest, clean equipment after working in affected fields, and rotate out of cucurbits for at least three years.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

Canopy Management of Hybrid Winegrapes to Improve Quality

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Cluster exposure is paramount in cool climate growing regions in order to improve Brix, reduce acidity, and improve the concentration of important flavor and aroma compounds. While many growers place a strong emphasis on improving cluster exposure through canopy management techniques such as shoot thinning, hedging, and leaf removal in *vinifera* winegrape production, these practices are often not implemented in hybrid vineyards due to the lower prices received for these grapes on a per ton basis. However, research in other cool climate growing regions has indicated that implementing canopy management techniques in hybrids can improve fruit quality.

In the Finger Lakes region of New York, we've been investigating the impact of shoot thinning, cluster thinning, hedging, and harvest date on both new hybrid cultivars (Noiret, Corot noir) as well as older hybrid cultivars (Marechal Foch, Vignoles) in cooperative studies with a number of commercial vineyards in a project funded by the New York Farm Viability Institute.

The impact of shoot thinning (no shoot thinning vs. shoot thinning to five primary shoots per foot of canopy) and harvest date (Sept. 11 vs. Sept. 18 in 2007; Sept. 10 vs. Sept. 23 in 2008) were studied on Marechal Foch vines trained to umbrella kniffen on 7 x 8 ft (vine x row) spacing. Yield was reduced by shoot thinning from 4.1 to 3.3 tons/acre in 2007, and from 7.0 to 5.3 tons/acre in 2008. Shoot thinning and later harvest generally improve Brix, reduced titratable acidity, and improved berry anthocyanin concentration. In triangle tests performed by a sensory panel, wine made from the shoot-thinned treatment in 2007 was preferred by tasters compared to wine made from the control treatment. Additionally, of the wines from the shoot-thinned treatments, the later harvest wine was preferred by the sensory panel over the earlier harvest in 2007. In 2008, the sensory panel preferred the wines from the fruit harvested on Sept. 23 over wines made from fruit harvested on Sept. 10, while shoot thinning did not have as great an impact as in the previous year.

While there is little additional cost in delaying harvest by a week or two, shoot thinning is another trip through the vineyard that involves additional labor, as well as lost revenue due to lower yields. Through timing shoot thinning in several hybrid vineyards, we've estimated the cost of the practice to be approximately $175 dollars per acre. When lost yield is taken into account, an additional $195 per ton in 2007, and $233 per ton in 2008 was required to ensure the same net revenue on a per acre basis for the grower (see Table 1), resulting in an additional per bottle cost at the winery of $0.27 in 2007 and $0.32 in 2008.

Table 1: Required price per ton and additional cost per bottle to cover the costs of shoot thinning in Marechal Foch in 2007 and 2008.

	Before Shoot Thinning	After Shoot Thinning (2007)	After Shoot Thinning (2008)
Cost/acre	$1,420	$1,595	$1,595
Yield (tons/acre)	4.1 *(2007)* 7.0 *(2008)*	3.3 *(thinned -0.80 t/a)*	5.25 *(thinned -1.75 t/a)*
Net revenue/acre	$1,040 *(2007)* $2,780 *(2008)*	$1,040 *(to maintain constant welfare)*	$2,780 *(to maintain constant welfare)*
Price/ton	$600	$795 *(needed for same rev, grower no worse off)*	$833 *(needed for same rev, grower no worse off)*
Add'l $/bottle *(can make 60cs/ton)*		$0.27	$0.32

Data from T. Martinson and T. Preszler

Table Grapes: A Growing Market Opportunity

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The trend toward consuming more locally grown produce has lead to an increased marketing opportunity for Eastern Table Grapes. In addition to the traditional roadside markets and pick your own operations there are growers successfully marketing their grapes to local grocery stores as well as regional stores. The opportunity also extends to home winemakers with the proper variety selection.

The key to any of these markets is proper variety selection, consistent supply, quality and packaging. It is important to develop a good relationship with purchasing managers and work toward growing the market. Start slowly and increase as the market matures.

Jupiter Grape

Vine Training and Pruning for New England

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Grapevines in the wild naturally grow on adjacent structures such as trees and fences. This usually results in healthy plants that produce small quantities of fruit on small clusters. Hundreds of years ago, vines were typically grown on primitive stakes or adjacent trees. This is still seen in some parts of Europe and western Asia. This provided adequate support, but did not always provide optimal canopy microclimate for fruit production and plant health.

Early growers of cultivated grapevines learned that by severely pruning the previous year's wood, fruit production greatly increased. These vines were generally grown in low-vigor environments, so vines were usually pruned to a few short spurs. Trellising systems for grapevines are a relatively new phenomenon.

The availability of wire greatly increased the possibilities for training grapevines. The first wiring systems were relatively primitive, but still increased production and vineyard efficiency.

Training and trellising systems have been developed to take advantage of the natural growth habit of the plant. Shoot growth in the early part of the season is rapid, especially in the presence of adequate water typical of most growing seasons in the eastern United States. Shoots do not start to lignify until the beginning of autumn, making them amenable to many kinds of shoot manipulation during the pre-veraison period.

Different species of grapes have different natural growth habits. The traditional European grape, *Vitis vinifera*, has shoots that tend to grow upright. Many American species such as *V. lambruscana* have shoots that tend to grow downward (procumbent). Many popular winegrape cultivars in New England are hybrids of *V. vinifera* and American species. Their growth habits tend to vary by cultivar. Some grow upright, some are procumbent, and many have growth habits that are somewhere in between. Trellis systems should be selected to work with, not against, the natural tendencies of the vine.

The current commonly accepted principles of trellising, training, and canopy management were established largely based on the research of the late Nelson Shaulis at the New York Agricultural Experiment Station in Geneva. These principles were expanded on by his student Richard Smart. Dr. Smart's seminal book "Sunlight Into Wine" (1991) describes these principles and gives many case studies of how creative growers throughout the world have adapted these principles to their own vineyard environments. The basic overarching principles are 1) to expose as much leaf surface and fruit to sunlight as is possible throughout the season, and 2) to have enough sun-exposed leaf area to properly mature fruit and maintain plant health. While different cultivars have different leaf sizes and vary in fruitfulness, a general rule of 12 to 15 well exposed leaves per shoot, or about 36 to 40 inches of shoot growth is usually adequate. If leaf removal is practiced to improve sunlight to the clusters and spray penetration, this should be taken into account.

The fruitfulness potential of individual grapevine buds is established during the previous growing season. Inflorescence primordia for the following season are developed during the weeks between fruit set and veraison. This is typically between mid-June and mid-August in most of New England. Sunlight exposure to leaves that are during this period is critical for the

development of inflorescence primordia. This is especially important for shoots that will be retained as canes or spurs for the following year. Environmental factors during the current growing season can also have major influences on fruit set. However, even the most ideal conditions cannot overcome the lack of potential if buds did not develop inflorescence primordia during the previous growing season.

Grapevines, especially those intended for the production of high-quality wines, are an expensive crop to grow. Every unit of linear row should be as productive as possible for maximum profitability. Each vine should fill its allotted space with fruitful shoots that are in an environment that will properly mature the fruit and provide productive canes for the subsequent growing season. For any particular combination of cultivar, site, and trellising system, this can largely be addressed by spacing plants a proper distance apart in the rows. However, this decision is permanent. The variable weather in New England combined with relative lack of knowledge of the effects of cultivar or species and rootstock on a specific site make planting and the choice of training system difficult in many cases. Most growers begin with a given trellis system in mind. If problems arise, modifications ranging from minor alterations to complete changes can be instituted if necessary.

Besides providing an optimal environment for sustainably producing maximum quantities of high quality fruit, trellis systems should also allow for maximum efficiency of vineyard activities. These include, but are not limited to, pruning, shoot positioning, leaf removal, fruit thinning, and spray penetration.

There have been relatively few experiments with different trellis systems in New England. The four described below were chosen either because they are common, have shown some potential in some vineyards, or have potential but are still undergoing evaluation in the area. These four training systems, as well as vine spacing, are being compared for the hybrid cultivars St. Croix and Cayuga White at a commercial vineyard in Wallingford, CT. Vines on six foot spacing will also be pruned to both cane and spur pruned to compare pruning systems.

Vertical shoot positioning (VSP)

This is the most common trellising system in New England. Most vineyards employ cane pruning with this system, although it also lends itself to cordon pruning, which is favored in many areas of the country. It is well suited to vines with a vertical growth habit. Establishment costs are fairly high, as significant amounts of wire are required. This typically consists of single or double fruiting wires as well as two or, preferably, three catch wires or pairs of catch wires above. This can add up quickly. However the use pairs of catch wires greatly facilitates the efficiency of canopy management activities. By having a single fruit zone just above the fruiting wire(s), activities such as leaf removal and cluster thinning are easily done.

Hudson River Umbrella (HRU)

This is the most common trellising system for procumbent grapes in most of the United States. HRU is especially popular for juice grapes, which have a procumbent growth habit and for which production costs must be minimized due the relatively low value of the fruit. It consists of a single wire five to six feet above the ground, although a lower wire approximately 30-36 inches high is frequently used to train young vines. This system also lends itself to cane or cordon pruning. Ideally, shoots are trained downward during the growing season. Shoots generally do not need to be tied, as gravity does much of the work, especially as the fruit becomes heavy in late summer. Leaf removal and cluster thinning are easily done, although at a less convenient height for most people than VSP.

Geneva Double Curtain (GDC)

GDC was developed in the 1960's by Nelson Shaulis at the New York Agricultural Experiment Station for juice grapes, primarily Concords. It consists of a horizontally divided canopy with fruiting wires at a similar height to the HRU system. Vines are planted in between the wires and are trained to both wires. This effectively doubles the fruiting area per linear unit of row length compared to non-divided canopies. Shoots are trained similarly to HRU. More work is involved, as the vines need to be trained outward from the interior onto the fruiting wires.

There are several variations on how vines are trained on GDC. The most common are to train each vine to both wires, usually as a bilateral cordon. Other systems train alternate vines to alternate sides of the canopy.

Scott Henry/Smart Dyson

These are similar systems, and the nomenclature is frequently contradictory. Both systems divide the canopy vertically. These systems are particularly useful for devigorating excessively vigorous vines in established vineyards. Generally, Scott Henry is used to describe this system when cane pruned, and Smart Dyson when cordon pruned. However, the terminology is not always consistent. The upper portion is similar to a VSP system, although the fruiting wire is higher. Consequently, the trellis system is about a foot higher than a typical VSP system. The lower portion consists of a lower fruiting wire about 10 inches below the upper one. Shoots in the lower fruit zone are trained downward during the growing season. Since the lower portion of the vine receives slightly less sun than the upper portion, it is common practice to have 50% less fruit on the lower section. This can be accomplished through leaving fewer buds at pruning, cluster thinning during the growing season, or a combination of both. Like GDC, more labor is involved compared to single canopy systems, but yields per linear row length can be increased by 50%.

References

Smart, R. and M. Robinson. 1991. Sunlight Into Wine: A Handbook for Wine Grape Canopy Arrangement. Winetitles, Adelaide, Australia.