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RUTGERS
New Jersey Agricultural Experiment Station

NEW JERSEY

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Educational Session Chairs:

Tuesday, February 5, 2019

Session 1 – Regulations & Risk Management
Michelle Infante-Casella, Agricultural Agent, RCE of Gloucester County

Session 2 – Specialty Crops
William Sciarappa, Agricultural Agent, RCE New Brunswick

Session 3 – Sweet Corn
Thierry Besancon, Extension Weed Specialist, Rutgers NJAES

Session 4 – Field and Forage Crops
William Bamka, Agricultural Agent, RCE of Burlington County

Session 5 – Wine Grapes
Hemant Gohil, Agricultural Agent, RCE of Gloucester County

Session 6 – Tomato
Thomas Orton, Extension Specialist in Vegetables, Rutgers NJAES

Session 7 – Greenhouse and Hydroponics
A.J. Both, Extension Specialist in Ag Engineering, Rutgers NJAES

Session 8 – Organic
Joseph Heckman, Extension Specialist in Soil Fertility, Rutgers NJAES

Session 9 – Future of NJ Agriculture
Rick VanVranken, Agricultural Agent, RCE of Atlantic County

Wednesday, February 6, 2019

Session 10 – Small Fruit & Strawberries
Peter Nitzsche, Agricultural Agent, RCE of Morris County

Session 11 – Niche Crops
Jenny Carleo, Agricultural Agent, RCE of Cape May County

Session 12 – Vine Crops
Michelle Infante-Casella, Agricultural Agent, RCE of Gloucester County

Session 13 – Soil Health
Stephen Komar, Agricultural Agent, RCE of Sussex County

Session 14 – Direct Marketing
William Hlubik, Agricultural Agent, RCE of Middlesex County

Session 15 – Peppers
Andy Wyenandt, Extension Specialist in Vegetable Pathology, Rutgers NJAES

Session 16 – IPM/Pest Control Updates
Joseph Mahar and Kristian Holmstrom, Vegetable IPM, Rutgers NJAES

Session 17 – Blueberries
Gary Pavlis, Agricultural Agent, RCE of Atlantic County

Thursday, February 7, 2019

Session 18 – Workshop: Developing a Recall system for Food Safety
Wesley Kline & Meredith Melendez, Agricultural Agents, RCE of Cumberland and Mercer Counties

Session 19 – Workshop: Produce Safety Training
Wesley Kline & Meredith Melendez, Agricultural Agents, RCE of Cumberland and Mercer Counties

Session 20 – Workshop: RU Ready to Farm
William Hlubik, Agricultural Agent, RCE of Middlesex County

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Rick VanVranken, Agricultural Agent, RCE of Atlantic County

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Regulations & Risk Management

NJDEP AGRICULTURAL WATER CERTIFICATION PROGRAM OVERVIEW

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Agricultural, Aquacultural and Horticultural Water Usage Certification Rules (N.J.A.C. 7:20A)

The Bureau of Water Allocation is responsible for the permitting of those persons diverting or capable of diverting 100,000 gallons of water per day. This includes those requiring water for agricultural, aquaculture and horticulture activities. The primary goal of the program is to ensure diversions of water are sustainable, protective of water resources and other users, consistent with State planning initiatives, and conserve water-dependent ecosystems. The Bureau also oversees regional water supply planning initiatives and assists with drought management.

Two Types of Agricultural Water Use Permits:

1. Agricultural Water Usage Certifications

Required for those diverting greater than 100,000 gallons of water per day for agricultural, aquacultural or horticultural purposes. Certifications are issued for a five year period. While applications must meet the criteria listed for water supply allocations before a certification can be issued, agricultural diversions are not evaluated to the same degree as those for non-agriculture uses. There are approximately **800 agricultural water usage certifications** in effect statewide.. Statistics show agricultural activities compose approximately 5% of the total statewide water demand. However, in certain basins (generally in southern New Jersey) agriculture water use is the primary demand. The universe of agricultural water certifications approaches that for non-agriculture user groups, but the Department does not charge a fee for administering the program. Essentially the application process for agriculture users is subsidized by other water users in the State. The regulations governing this activity are found at N.J.A.C. 7:20A-1.1 et seq.

2. Agricultural Water Usage Registrations

Required for those agricultural users having the capability to divert greater than 100,000 gpd, but who divert less than that amount. The program is essentially identical to the water use registration program, and no fees are assessed. There are about **140 agriculture water usage registrations** currently in effect.

Annual Water Use Reporting:

1. Reports must be completed and submitted to the NJDEP Bureau of Water Allocations by February 28th each year vial mailed hard copy or submitted online.

2. Both the cover page and the Water Use Report must be completed. Incomplete forms will not be accepted.

3. The quantity of water diverted from each well or intake must be reported in units of Million Gallons.

INDUSTRIAL HEMP, REGULATIONS AND QUESTIONS

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Industrial hemp is from the plant species Cannabis sativa and has been used worldwide to produce a variety of industrial and consumer products. Hemp is a source of fiber and oilseed grown in a number of countries worldwide. A wide range of products, including fibers, textiles, paper, construction and insulation materials, cosmetic products, animal feed, food, and beverages can be produced from hemp. The plant is estimated to be used in more than 25,000 products. By definition, industrial hemp is high in fiber and low in active tetrahydrocannabinol (THC), the psychoactive ingredient in marijuana that makes some cannabis varieties a drug.

President Obama signed the 2014 Farm Bill, which included Section 7606 allowing for universities and state departments of agriculture to begin cultivating industrial hemp for limited purposes. Specifically, the law allows universities and state departments of agriculture to grow or cultivate industrial hemp if:

(1) The industrial hemp is grown or cultivated for purposes of research conducted under an agricultural pilot program or other agricultural or academic research; and
(2) The growing or cultivating of industrial hemp is allowed under the laws of the state in which such institution of higher education or state department of agriculture is located and such research occurs.

The 2014 Farm Bill also required that the grow sites be certified by and registered with their state.

As a result, State legislatures began taking action to promote industrial hemp as an agricultural commodity. In November 2018, New Jersey Governor Phil Murphy signed a bill to begin a pilot program for New Jersey farmers to produce industrial hemp. The pilot program calls for rules to ensure that growers are not subject to criminal penalties and that federal guidelines and legal growing limits are followed. In addition, the pilot program allows for collaboration with higher education institutions. The NJ Department of Agriculture is required to adopt rules and regulations to administer the pilot program. These include creating requirements for the licensing or contracting of growers participating in the program, prescribing hemp testing procedures to ensure compliance with federal law, creating a fee structure for the administration of the program, and certifying germinating seeds and hemp cultivars if necessary.

At the Federal level, a bipartisan group of U.S. senators introduced the Industrial Hemp Farming Act of 2015 that would allow American farmers to produce and cultivate industrial hemp. The bill would remove hemp from the controlled substances list as long as it contained no more than 0.3 percent THC.

The 2018 Farm Bill, recently signed by President Trump, removes hemp and its derivatives from the Controlled Substances Act, thus legalizing the cultivation of industrial hemp and the hemp derivative CBD oil. The move stands to greatly change the hemp farming and product business. With legalization, growers can now move product across state lines and national borders. However, with that freedom comes more competition.

The new law doesn't allow a producer to start growing hemp today. Instead, Section 10113 of the Farm Bill describes the two situations under which a producer will be able to grow hemp in the future. In the first situation, the States take charge of the regulation of hemp production within their state. To do this, a State must submit a plan to the USDA through their state department of agriculture. A State plan must include:

- A way to keep track of land where hemp is produced within the state;
- Methods the state will use to test how much THC is in hemp plants;
- A way to dispose of plants or products that have a higher THC concentration than is legally allowed;
- A procedure for inspecting hemp producers;
- A plan for enforcing the law;
- A system for dissemination of a hemp producer's information to the USDA; and
- Assurances that the state has the resources to carry out the plan.

The second scenario is when a State chooses not to develop their own hemp production plan. A producer in a State that doesn't have a hemp plan could legally grow hemp by obtaining a USDA hemp license through the hemp regulations that the USDA will develop, unless the State has prohibited hemp cultivation. A State can outlaw hemp production within its boundaries or include additional restrictions and requirements in its State plan as long as the plan complies with the federal law requirements.

RUTGERS FARM SAFETY AND HEALTH PROGRAM

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Agricultural Agent, Michelle Infante-Casella was appointed to lead Rutgers NJAES Cooperative Extension Farm Safety and Health Program as a director to the Northeast Agricultural Safety and Health Coalition. Other key faculty on this team include Agricultural Agents William Bamka (Burlington) and Stephen Komar (Sussex) and Brian Schilling, Director for Rutgers NJAES Cooperative Extension.

The Rutgers team members are working with a Special Agent WMD Coordinator, with the US Department of Justice, Federal Bureau of Investigations to host a 2-day training in September 2019 titled, "Animal-Plant Health Sector Defense: Awareness and Outreach". In addition we will be organizing training for "Rapid Response Teams" for agricultural threats.

The working group received $1,000 in November 2018 from the Gerwig Fund at Rutgers NJAES. The funding covered educational supplies and the rental of a trade show booth at the 2019 NJ Agricultural Convention and Vegetable Growers Convention/Trade Show in Atlantic City.

The team is working on 3 areas of education to start off the program; hearing loss, silicosis, and sun exposure/skin cancer.

Hearing Loss

Daily life on the farm is characterized by high noise levels from tractors, implements, tools, ventilation systems and other machinery. As a consequence, farmers are particularly vulnerable to loss of hearing. This is reflected in a prevalence of hearing impairment far above the average found in other groups of laborers in other career sectors. More than 3 out of 4 farmers in the U.S. believe they have some level of hearing loss.

A study of 5,000 U.S. farmers were questioned about their hearing over a period of 10 years. The study found that 92 percent of the farmers were exposed to extreme noise levels while involved in farming activities. As a result, 78 percent suffered from hearing problems, yet only four percent used hearing aids.

Wearing hearing protection is the most obvious way to prevent hearing damage, but is not the only way to protect yourself. Additional ways to limit the noise include putting sound insulation in barns and other work rooms, selecting the equipment with less noise output, and repairing equipment with excessive noise due to worn or missing parts.

In addition to causing hearing damage the noise may adversely affect farm workers' concentration and contribute to physical exhaustion. Farmers often exert more energy in order to perform their tasks in a noisy environment, may be stressed, and may have difficulty verbally communicating with other workers. These factors may all result in other work related injuries.

Silicosis

Silicosis is defined as a disease resulting from chronic occupational exposure to silica dust. Silica is primarily composed of quartz dust. The International Agency for Research on Cancer (IARC) has designated crystalline silica as a known human carcinogen. Silicosis may lead to impairment of lung function resulting from fibrosis of the lungs – hardening of the lungs. This disease may also cause other lung-related illnesses. Silicosis is an untreatable, but preventable disease. The history of silicosis in the U.S. was first realized in the mining industry, but occurs in other occupations where workers are exposed to silica dust – including farming.

Silica is an abundant mineral that makes up the earth's crust. It can be found in sand, rock, and mineral ore. Silicosis is usually caused by exposure to silica particles smaller than 10 micrometers. Farmers may develop silicosis when exposed to crystalline silica in the soil of farmland during activities such as plowing or disking - when dust particles can enter the air. Breathing in silica dust may irritate the lungs and eventually lead to silicosis.

Filtered cab tractors, respirators, dust masks, not working soil when too dry, and other preventative measures to reduce dust exposure are critical.

Regular medical examinations and promoting a healthy lifestyle are important in preventing silicosis. Though smoking has not been proven to increase the risk of contracting silicosis, studies have shown exposure to silica is associated with chronic obstructive pulmonary disease (COPD), including bronchitis and emphysema; the results of some epidemiologic studies suggest that these diseases may be less frequent or absent in nonsmokers.

Since chronic silicosis is the most common form of silicosis, generally occurring after 10 or more years of exposure, this can give workers a false security, or "it will never happen to me" mentality. This is the type of thinking that needs to be altered.

There are three types of silicosis:

- **Acute silicosis** (also known as silicoproteinosis) - takes a few weeks up to a year to develop. Scarring of the lungs is minimal and symptoms may include coughing and a fluid buildup in the lungs resulting in possible low blood oxygen levels.
- **Chronic silicosis** - takes 10 to 30 years to develop. Scarring of the lungs is more severe and symptoms may include coughing and shortness of breath.
- **Accelerated Silicosis** - takes under 10 years to develop. Scarring of the lungs is minimal and the symptoms are similar to those of chronic silicosis but the disease develops over a shorter time period.

How do I know when I have silicosis?
Only a doctor can diagnose silicosis. A three step process is used to diagnose silicosis. First, the patient must have a known exposure to silica dust (e.g., a job or home near silica dust). Secondly, a chest x-ray must indicate that the patient has damaged lung tissue, and lastly a pulmonary

function test is administered to determine if airways are restricted. A bronchoscopy may also be done using a camera to inspect the lung tissue for damage and symptoms of silicosis.

What is the treatment for silicosis?
There are currently no treatments for silicosis - preventative protection and education is the first and only step for treating silicosis.

What are the symptoms of silicosis?

- Cough
- Weight loss
- Fatigue
- Difficulty breathing
- Scarring of the lungs
- Fluid buildup in the lungs
- Reduced lung capacity
- Low blood oxygen levels (which may lead to cyanosis)

Skin Cancer

Farmers and agricultural workers have a high risk of skin cancer because they usually work outdoors. Protect yourself from the sun and reduce your risk of skin cancer by wearing a broad brimmed hat, sunglasses, long sleeved shirts, long pants and sunscreen.

Become familiar with the ultraviolet (UV) index predicted for the day. UV index measures UV levels on a scale from 0 (Low) to 11+ (Extreme). Sun protection is recommended when UV levels are 3 (Moderate) or higher. It is important to note a number of factors including the time of day, time of year, cloud cover, altitude, how close you are to the equator, scattering and reflection affect UV levels. Avoid working outdoors in the middle of the day, if possible, when ultraviolet rays are at their highest.

Farmers are also at risk of eye damage from too much sunlight while working long hours outdoors. Always wear sunglasses fitted with side arms and sun hats to protect your eyes and to reduce the risk of facial skin cancers.

Skin cancer is a preventable disease and the majority of skin cancers can be successfully treated, if found early. Being familiar with your skin and aware of any changes should help you detect any suspicious lumps or spots as soon as they develop. Don’t just rely on an annual skin check to detect any suspicious spots.

Using the combination of five simple sun protection measures and avoiding outdoor farming tasks in the middle of the day or when UV radiation is highest, will assist in reducing the risk of skin cancer.

1. Wear long sleeves and pants
2. Apply 50+ sunscreen
3. Wear a sun-protecting hat
4. Work in shade when possible
5. Wear sunglasses

Session 2

Specialty Crops

Fall Strawberries and Goldenberries: Alternative Annual Fruits for New Jersey Growers

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Fruit crops require a substantial commitment of land resources over many years in order to be horticulturally and economically viable. In addition, many fruit crops require significant pruning, training and production skills for success. Over the last 3 years I have been examining two fruit production systems that fit into a standard annual vegetable crop rotation: fall strawberries and goldenberries. This report summarizes the work so far.

Fall Strawberries

In the late 1990's I developed a greenhouse based, off-season strawberry production system using photoperiod and temperature conditioned plants of the short-day cultivar 'Sweet Charlie'. Plugs were given short days followed by chilling in a walk-in cooler, then planted in a hydroponic greenhouse system for mid-winter production. The system was never commercially adopted due to the cost constraints associated with the conditioning protocol.

A much more feasible approach uses the long-day cultivar 'Albion', planted in the spring or early summer for fall production the same season. Numerous reports in the literature describe efforts to develop off-season strawberry production systems for temperate North America using long day cultivars in field or protected culture. Conditioning of plant material before planting may or may not improve off-season fruiting, depending on planting date.

The current recommendation for off-season LD cultivar production is to use dormant, cold-stored crowns planted directly in the field as early in the spring as possible (before May 1). Field conditions (wet and cold) often preclude early planting dates in the eastern US. In these situations, plugs can be produced in the greenhouse from dormant, cold-stored crowns then planted in the field when conditions allow however, later planting leads to a reduction in yield.

Photoperiod and nitrogen conditioning may enhance flowering and off-season, fall field production in long-day cultivars depending on field planting date and plug size. Elevated nitrogen during floral initiation enhances and accelerates flowering of long day cultivars. The response to conditioning is rapid (4 weeks after treatment) and cultivars respond with increased rate (enhanced precocity) and intensity (enhanced inflorescence/flower number) of flowering with elevated N. The reduced yield often observed with later planting (22 July) is alleviated with photoperiod and nitrogen conditioning, however, earlier plantings (2 and 22 June) do not benefit from conditioning. While larger plugs are often more productive than smaller ones, fewer larger plugs are produced per unit area, thus smaller plugs are often utilized. Smaller plugs of LD cultivars are often less precocious and productive due to a SD response

imposed by higher plant density during propagation. When smaller plugs are used, their precocity and early fall production is enhanced with conditioning.
If you are interested in trying such an approach, e-mail me at durner@sebs.rutgers.edu and I can provide you with more details on how to do it.

Goldenberries

Goldenberries (*Physalis peruviana*) are a South American, *Solanaceous* fruit quickly gaining attention in North America. It has many different common names, including: Cape gooseberry, Poha berry, Incaberry, and Pichuberry and is closely related to the tomatillo (*P. ixocarpa*) and ground cherries (*P. pruinosa*). Even though they are native to tropical South America and plants are injured at a temperature of about 30^{o}F, goldenberries can be grown as an annual in temperate regions. They have a very long growing season and are started in the greenhouse and transplanted outdoors much like tomatoes, peppers or eggplants as soon as the threat for frost is over.

A two-year Northeast Region SARE project 'LNE18-362- Goldenberries (*Physalis peruviana*): A New Fruit for CSA Farms and Farmers Markets' is underway trying to identify germplasm suitable for growing in the Northeast region. Some of you may have participated in this study in 2018 and will hopefully return in 2019. If you weren't involved in 2018 but would like to join our efforts, please send me an e-mail at durner@sebs.rutgers.edu and I'll be sure to include you in 2019.

Their long growing season is a problem for more northerly growers. Researchers at Rutgers, Cornell, Cold Spring Harbor Labs and the University of Florida are investigating the possibility of developing a goldenberry with a much shorter growing season requirement. The work is in it's infancy (a Specialty Crops Research Initiative pre-proposal has been submitted to the USDA), but you'll be sure to hear of our progress as work progresses.

Goldenberry has been cultivated for years in the Andes mountains of South America. The fruit has spread worldwide however; it has not become a significant crop in most regions. Localized industries have developed in South America, South Africa, Australia, New Zealand and India but large-scale commercial production is not common.

There are over 100 species of *Physalis* and many are considered weeds. However, four are grown for their fruit (tomatillos (*P. ixocarpa*), ground cherries (*P. pruinosa*, *P. pubescens*), and goldenberries (*P. peruviana*)). Goldenberries are often confused with ground cherries (*Physalis pruinosa*, *Physalis pubescens*) however, they are easy to distinguish. Goldenberry foliage is extremely pubescent (hairy) while ground cherries are glabrous (smooth). In addition, the calyx (husk) of goldenberry has 10 ribs while husks of ground cherries have 5. Mature goldenberry plants are much larger (up to 5 or 6 feet) than ground cherries (at most 3 feet).

One of the distinguishing features of *Physalis* species is their husk. Goldenberry flowers are yellow, up to ¾ inch wide, pendulous and bell-shaped with purplish spots in the throat. They appear in the leaf axils. Flowers are cupped by a purplish-green,

hairy, 5-pointed calyx which expands after the flower falls following pollination and fertilization to form the husk. The fruit, which is a berry, is encased in the husk which starts out soft and green when young but becomes tough, brown and paper-like when the fruit is mature. The husk is much larger than the fruit it encloses and it is inedible.

Unlike ground cherries, goldenberries do not abscise (fall off the plant) when ripe and are harvested directly from the plant. Fruit are ½ to 1-inch-wide globe-like berries with smooth, glossy orange skin with a juicy pulp containing many very small edible seeds when fully ripe. Fruit has a pleasant tropical flavor, tasting like a mixture of pineapple, strawberry, sour cherry and citrus.

Seeds must be obtained from a reliable source. Goldenberries are often mislabeled by seed companies, often being *P*. *pruinosa* or *P*. *pubescens* (both ground cherries) or *P*. *ixocarpa* (tomatillo). Seeds are sown in flats of a sterile seeding mix of your choice, barely covering the seeds, and are kept moist. Seeds germinate in 14 to 21 days in a moderately warm greenhouse and seedlings transplanted when they are about 1-inch-tall into 24 to 50 cell plug trays. They are grown in the greenhouse for at least 6 weeks before they are transplanted to the production field. Plants are large enough to transplant outdoors when they are 6 to 8 inches tall and there is no chance for frost.

Goldenberries produce best on well-drained 'poor' soils but they need adequate moisture as they tend to 'go dormant' during a drought. We recommend planting goldenberries on standard raised beds covered with black plastic mulch with trickle irrigation, much like you would use for tomato production. Do not supply any pre-plant fertilizer or any at the time of transplanting as fertilization greatly reduces fruit production. Beds can be spaced according to your equipment measurements but should be at least 4 feet on center. Plants should be spaced 4 to 5 feet apart within the row. Plants tend to have a sprawling habit and are sensitive to high winds thus they should be supported with a simple 1 wire (at 3 to 4 feet) trellis with main stems clipped or tied to the wire. We use T stakes with heavy duty twine and standard tomato clips.

Goldenberry plants grow as a single stem for 9 to 15 nodes when they then bifurcate (branch as a Y). This branching habit continues during subsequent stem growth. All axillary shoots and suckers should be removed up until the first bifurcation of the main stem. A trip through the field once every week or two should suffice. Pruning normally lasts for 3 to 4 weeks, thus labor requirements for pruning are not excessive. Once the plant has branched, minimal sucker removal is required.

The first flower appears at the node of bifurcation (approximately a month or so after transplanting) and flowering will continue until frost in the fall. Flowers are wind and insect pollinated and are self-pollinating. Cross pollination within goldenberry is rare and pollination between species (i.e. goldenberry with ground cherries or tomatillos) is even rarer. Genetic lines stay true to type when seeds are collected and saved from

year to year. Goldenberries typically produce 150 to 300 fruit per plant, beginning in late August or early September and continuing until the first fall frost.

We have seen two significant insect pests during our trials: the three lined potato beetle (*Lema daturaphila*) (particularly the larvae on young plants) and tobacco and tomato hornworms (*Manduca sexta* and *Manduca quinquemaculata*, respectively) particularly later in the season on mature plants. The tobacco hornworm is more common than the tomato hornworm and can be distinguished from the tomato hornworm by its seven diagonal white stripes and its usually red 'horn' while the tomato hornworm horn is bluish-black.

Fruit are ripe when they turn a golden color which is often easily seen through the husk, which by the time of fruit ripening has faded and turned yellowish brown and translucent. Green fruit are not ripe and will not ripen once removed from the plant. Ripe fruit do not abscise like ground cherries and are harvested by hand. Fruit should be harvested when they are dry; if they are moist from dew or rain they are likely to mold. Fruit is normally left in the husk for sale in pint containers, but sometimes the husk is removed and the golden berries displayed in half-pint containers for sale. Many chefs prefer fruit with the husk as it is often used for decoration. Additionally, fruit will keep at room temperature for up to 3 months if they are left in the husk.

Fruit is eaten fresh or cooked. Fresh goldenberries fit well in in mixed green or fruit salads, make a wonderful addition to salsas and make an elegant dessert when partially dipped in chocolate. The fruit makes excellent pies, jams and jellies and is naturally high in pectin. A serving of fresh goldenberries (100 g) provides approximately 75 calories, 0.3g protein, 0.2g fat, 19.6g carbohydrate and 4.9g fiber. The medicinal qualities of goldenberry are too numerous to list. We will provide a well-researched chapter complete with references and citations on the medicinal properties of goldenberry in our forthcoming production manual.

Numerous internet reports suggest that goldenberry plant tissues and green fruit are poisonous. Green tissues including unripe fruit contain solanine which can cause gastroenteritis and diarrhea, thus consumption of unripe fruit should be avoided.

This material on Goldenberries is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under sub-award number LNE18-362.

CONNECTING NEW JERSEY FARMERS WITH A NOT-FOR-PROFIT CULINARY SCHOOL TO DEVELOP NEW VALUE-ADDED PRODUCTS: A FEASIBILITY STUDY

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Can small farms growing mainly specialty crops work together with non-profit culinary schools to create opportunities in value-added product sales for both farmers and food entrepreneurs? We believe the answer is "yes", and in this planning project, funded by a Local Food Promotion Program grant from the USDA AMS, our goal is to find out what kinds of programs might work best.

Value-added products are widely recognized as an important potential source of revenue for small farms, especially in areas where the direct-to-consumer market for fresh produce, via CSAs and farmers markets, is becoming saturated (Born and Bachmann 2006; Ohmart 2003). However, small farms rarely have sufficient resources to manufacture at scale value-added products on their own (Center for Profitable

Agriculture 2007; Harvard Food Law and Policy Clinic 2017). Central New Jersey is an area where the market for direct-to-consumer fresh produce is indeed increasingly saturated, yet many local farms aspire to continue agricultural operations and new and beginning farmers are looking for opportunities to enter the agricultural business sector. Central New Jersey is therefore an excellent example of an area in which local farms growing specialty crops would benefit from being able to develop value-added products as an additional source of revenue.

Not-for-profit culinary school programs (nfp-CSPs) give individuals from low-income communities the opportunity to develop the skills needed to succeed in the food service industry. These kinds of programs, and their students, would benefit from being able to prepare their students for careers in value-added entrepreneurship and small-scale food manufacturing. In many cases, nfp-CSPs own and operate a professional-level kitchen, where students have access to versatile food production and processing equipment. But, these valuable resources are often used only for training in hot food preparation, and not for food processing or the manufacture of value-added products. To establish successful food processing training programs, nfp-CSPs would benefit from validated guidelines for best practices related to establishing contracts with farmers, developing recipes, and marketing their products.

Farm operations growing specialty crops in Central New Jersey face an increasingly saturated market for direct-to-consumer sales of fresh produce. At the same time, Promise Culinary School (PCS), a vocational education program run by the non-profit organization Elijah's Promise in New Brunswick, is exactly the kind of nfp-CSP we have just described. PCS was founded at Elijah's Promise in 1997, and currently graduates 50-60 students each year. However, very few PCS students have so far started their own independent local food businesses, despite the excellent training they receive in food service and the outstanding kitchen facilities at PCS.

In this project, we are exploring agribusiness models that will assist in the development of local food businesses in and around New Brunswick, New Jersey. Specifically, we are engaging in a planning process aimed at jumpstarting productive, mutually-beneficial food manufacturing partnerships between local farmers and Promise Culinary School. Our work is funded by a Local Food Promotion Program grant from USDA AMS. The result of our project will be a plan for a new local-food-to-value-added supply chain in the greater New Brunswick area, where: 1) fruits, vegetables, and herbs produced by local NJ farms are made available to PCS; 2) PCS students work with nutrition and food manufacturing experts at Rutgers University to develop recipes and processing protocols for new value-added local food products; 3) resulting products are piloted for sale at local farmers markets offering participating farmers and producers real-time market feedback in a traditionally underserved community; 4) experience gained by PCS students, and the relationships forged with local farms, contributes to the development of new food businesses; 5) a comprehensive final report outlines a path toward a fully implemented program.

We are currently in the first phase of this project. Our first objective is to assess the interest and ability of local growers of specialty crops to supply PCS with fresh market produce for value-added food manufacturing through one of four proposed agribusiness models:

1. *Fee-for-Service Model.* Local farmers pay PCS to process their surplus produce into a value-added product, which is returned to the farmer for them to sell directly to consumers via their current market outlets.

2. *Wholesale Model.* Local farmers sell surplus produce to PCS at a reduced rate, allowing PCS students to process the produce into value-added products which either the students themselves or entrepreneurial community members sell via direct retail outlets in a new business venture.

3. *Revenue-Share Model.* Local farmers provide produce, which is processed and sold by PCS; a portion of the revenue from value-added product sales is then returned to farmers. Or, the farmer can choose to donate the produce to PCS for a tax deduction in lieu of receiving their share of the sales revenue.

4. *Product-Share Model.* Local farmers provide produce at no cost to be processed by PCS. Some of the value-added products made are then sold by PCS, and some are returned to the farmer to sell at his/her own market outlets.

We expect to accomplish this first objective by conducting a survey of local fruit and vegetable growers and holding focus groups and interviews with farmers in New Jersey, especially those who sell at farmers markets in reasonable proximity to the City of New Brunswick.

After receiving valuable farmer input regarding the financial viability of the proposed agribusiness models, our second objective is to determine the specific value-added food products that could be a viable focus for new local food businesses in the greater New Brunswick area, with particular attention paid to both low-income and low-food access communities. Community focus groups conducted with urban New Brunswick residents will provide important information to the research team regarding the specific types of value-added food products desired by potential customers and the price points at which customers are willing to purchase the value-added products. As part of this objective, recipes and manufacturing processes for 3 to 5 proposed products will be developed by PCS staff and Rutgers University project investigators. Data to inform the product development aspect of this objective will be gathered through focus groups conducted with New Brunswick-area community members. A final report synthesizing all of the information collected through this planning process will inform the next steps toward increasingly widespread implementation of the initiative to connect local farms with nfp-CSPs for successful value-added agribusiness development.

Many small and mid-sized farms in Central New Jersey could potentially benefit from assistance with turning produce into value-added products for additional business opportunity. Promise Culinary School at Elijah's Promise needs help preparing their students, especially students from low-income communities, to succeed in value-added entrepreneurship and small-scale food manufacturing. For Elijah's Promise, these job training opportunities are how we can change our model from one of charity to one of justice. Putting the pieces together by connecting farmers and culinary students for improved value-added food production will contribute to an improved agricultural and

food system in the greater New Brunswick area to serve as a model for the State of New Jersey and beyond.

Session 3

Sweet Corn

BIRD DAMAGE: RISK FACTORS AND MANAGEMENT STRATEGIES

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Risk factors for crop damage by birds

General Principle 1. When there is less fruit or vegetables in a given area, there will be a higher proportion of damage to the crop that is available. One should expect higher proportions of damage in: 1) low-yield years (**Fig. 1**), 2) early-ripening varieties, 3) small blocks.

General Principle 2. Blocks near resources important to crop-eating birds are at higher risk. One should expect higher proportions of damage: 1) in blocks under wires, 2) at edges of blocks, particularly edges near non-crop areas (**Fig. 1**), 3) near night roosting sites, 4) in isolated blocks with little human activity, 5) in blocks near dairy farms.

Each farm is unique and should be assessed for risk factors. For example, wooded edges of blocks can provide "staging areas" for crop-eating species like American robins. The birds enter the blocks from the woods, eat, and then return to the woods. If a low-yield year is anticipated, or if your farm has some of these risk factors, it is recommended that you prepare bird management strategies early in the year.

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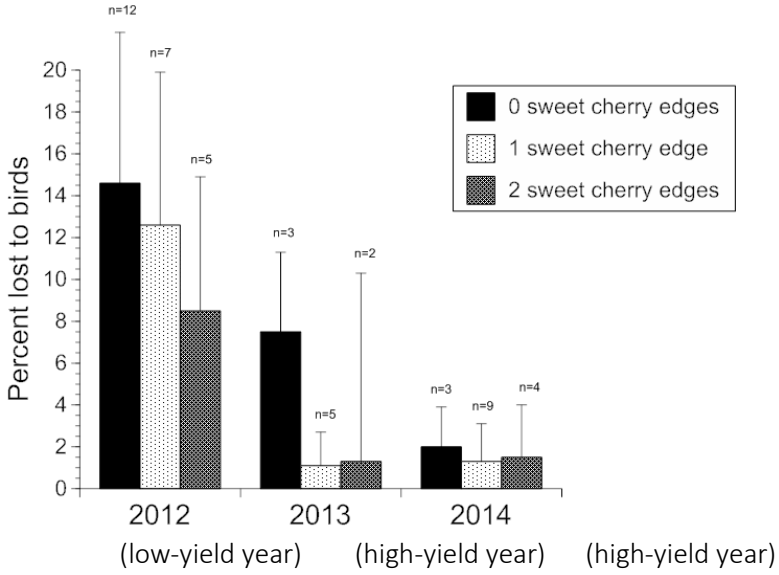
Figure 1. Michigan sweet cherries had higher percent bird losses in 2012, a low-yield year, compared to 2013 and 2014, high-yield years, although this effect varied with the number of block edges adjacent to other sweet cherry blocks. In other words, blocks near other blocks are protected to some degree from bird damage.



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Bird management strategies

Bird management strategies can be grouped into several categories: 1) scaring, 2) barriers, 3) cultural management practices, for example encouraging natural predators, 4) deterrent sprays 5) lethal control and 6) more recently, interfering with birds' perception of their environments.

Scaring strategies. Birds habituate quickly to sounds and visual devices that are supposed to scare them. Simply placing decoys of predators or scare-eye balloons is not likely to deter birds for long. If one employs scaring devices, they should be deployed early in the season. Also, they are more likely to deter birds if there is some random component to their movement or sound. For example, inflatable tubemen should be moved within or around a block and, ideally, go on and off randomly. Propane cannons and devices that play recordings of distress calls or predator calls can be programmed to go on and off randomly. Some scaring strategies, like lasers, work in particular situations. For example, lasers deter Canada geese in low-light situations. Effigies (dead birds hung in the crop) may deter crows.

Preliminary studies of "laser scarecrows", where a laser beam sweeps over a field, show some promise in reducing bird activity in sweet corn.

In recent preliminary work with drones in sweet cherry orchards, our results were inconsistent but suggest drones may deter birds in some contexts. On some days in some orchards, fruit-eating bird numbers were lower when drones were flying over a block. Larger-scale trials to investigate this strategy are warranted.

Barriers. Some growers use netting to deter birds; it was considered the most effective bird deterrent in a survey of 1500 fruit-growers (Anderson et al. 2013). Netting requires considerable effort and materials. If one employs netting, it is important that the netting enclose the vulnerable crop. Birds will easily get under the netting if there is a gap left between the bottom of the netting and the ground. Also, ideally, the netting will be on a frame to maintain some distance between the crop and the netting. If the netting lies on the crop, birds will simply reach the crop through the netting.

Increasing resources for predators of birds. American kestrels, small predatory birds, can be attracted to fields with nest boxes. Kestrels prey on insects, small mammals, and birds and we have good evidence that they deter pest birds in Michigan sweet cherry orchards (Shave et al. 2018). Occupancy rates of kestrel boxes can vary greatly from region to region. Eighty to 90% of nest boxes in northern Michigan sweet cherry orchards attract kestrels while in blueberry fields in western Michigan, occupancy rates are between 30-35%. Western Michigan nest boxes are also often occupied by starlings, an invasive pest species. Areas with plentiful pasture or short-grass areas tend to be more attractive to kestrels. At the end of this hand-out is information about building and maintaining nest boxes and the best locations. An important consideration is that kestrels eat voles and mice, so rodenticides should not be used in fields when kestrels are present. Also, kestrels nest in May and June and sometimes July. They are more likely to be helpful as a bird deterrent if your crop is ripening during those months. As a final point, our research shows that consumers are enthusiastic about this type of

bird management and so informing your customers about your use of predator nest boxes may be valuable in marketing (Herrnstadt et al. 2016).

Chemicals. Anthraquinone can be applied to protect corn seeds and seedlings from sandhill cranes. The chemical has been shown to reduce corn seed and seedling damage by birds. Avipel is one brand containing this chemical. Product labels and availability vary among states.

Bird deterrent sprays (there are several on the market) contain methyl anthranilate, a chemical allowed for use on fruits and vegetables. Methyl anthranilate is also a food additive that imparts a fruity odor to products. The method of action of methyl anthranilate is that it irritates nerves in birds' bills. Tests of the efficacy of methyl anthranilate products have not produced strong evidence that it deters birds in field situations. If you use sprays containing methyl anthranilate, apply them following the label as closely as possible to increase the likelihood of effectiveness. For example, bird deterrence may be improved if they are applied with foggers, which produce smaller droplets, than typical sprayers. Also, the sprays need to be reapplied after it rains.

Lethal control. Lethal control doesn't have a strong track record for reducing bird damage although it may be warranted in specific contexts. Whether or not one needs a permit to kill pest birds depends on the bird species and the context. This website has some limited information for farmers: https://www.njfishandwildlife.com/farmer.htm#wild

Interfering with birds' perception of their environments. Recent developments in bird management impair birds' abilities to perceive their environment and may have applicability in fruit and vegetable-production systems. "Sonic nets", for example, broadcast noise at the same frequencies at which birds communicate, potentially interfering with birds' ability to warn each other about danger. One test showed that the nets deterred birds from an airfield. By reducing birds' abilities to communicate and perceive predators, these techniques may be less susceptible to habituation than scare techniques.

Take-home messages

Assess risk
Decrease resources for fruit and vegetable-eating birds
Use a combination of bird management strategies

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U.S.D.A. Specialty Crop Research Initiative; National Science Foundation; Michigan state fruit grower industry groups; Michigan Horticultural Society; Avian Control Inc.; Fruit growers in several states; Staff at Michigan State University field stations.

Building, Installing and Monitoring American Kestrel Nest Boxes* Plans for the "Spartan" kestrel nest box and mounting tower can be found here: http://www.nestboxbuilder.com/nestbox-article-spartan.html. Additional plans for kestrel nest boxes can be found here: 1) https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_063830.pdf 2) https://nestwatch.org/learn/all-about-birdhouses/birds/american-kestrel/. Boxes should be installed away from wooded areas to reduce the risk of occupancy by European starlings. Open habitat with sparse trees/shrubs is desirable. Boxes mounted on their own poles can be installed within the block, either at the end of a row or within a row in an open spot. Boxes should be installed at least one-half mile apart to allow for kestrel territoriality and 10 – 20 feet from the ground. Kestrel nests are more likely to produce young from boxes facing southeast. The bottom of nest boxes should be lined with wood shavings or animal bedding. Boxes that were occupied during the summer should have the wood shavings replaced during the fall or winter in preparation for the next breeding season. If a European starling occupies a box, it will add grass and other materials to the box and lay 5 – 7 pale blue eggs. A starling nest should be removed from the box, and new wood shavings added to the box if needed. Starlings are not native to North American so no permits are needed to remove their nests. Please contribute to the nationwide kestrel nest box monitoring effort by registering your boxes with the American Kestrel Partnership: http://kestrel.peregrinefund.org/begin-obs

SWEET CORN TRIALS COMPARING NON-*B.t.*, *B.t.*, and STACKED *B.t.* VARIETIES

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Corn earworm (CEW) is the primary ear-damaging insect in sweet corn production in the Mid-Atlantic states, and is the principle driver of silk stage insecticide applications on this crop. In New Jersey, CEW moth populations are generally low, to very low from late May through mid-June. This is followed by a period through mid-July when CEW adults are nearly non-existent. This situation changes in August and September, with weather-aided migratory influxes of CEW moths from the lower Atlantic Coast states. IPM programs monitoring CEW moth numbers are able to provide critical information to growers so that they can adjust their silk stage insecticide applications in response to increasing pest pressure. In an effort to minimize insecticide applications during this later part of the season, many growers have opted to use sweet corn varieties that incorporate toxins from the soil inhabiting bacterium *Bacillus thuringiensis* (*B.t.*).

There are currently three types of *B.t.* sweet corn available commercially: Attribute® hybrids (expressing Cry1Ab toxin), Attribute® II hybrids (expressing Cry1Ab and Vip3A), both from Syngenta Seeds, and Performance Series™ hybrids (expressing the Cry1A.105 and Cry2Ab2 toxins) from Seminis Seeds. While all hybrid types provide excellent control of European corn borer (ECB), and fair (Attribute) to excellent (Performance, Attribute II) control of fall armyworm (FAW), the control of CEW has deteriorated rapidly and dramatically in *B.t.* hybrids as field resistance to Cry toxins has developed in that insect.

In response to increasing instances of poor CEW control in the mid-Atlantic region, and in order to better track regional changes in CEW field resistance to *B.t.* toxins in sweet corn, a multi-state sentinel plot study was begun in 2017 and repeated in 2018 (see figure 1). *B.t.* sweet corn is an ideal crop with which to monitor resistance to these toxins because 1) the toxins are expressed at higher concentrations in sweet corn than in *B.t.* field corn, 2) we have years of data on CEW ear infestations in non-*B.t.* corn as a baseline for expected damage, 3) changes in infestation rates are easy to track because CEW is almost exclusively an ear infesting insect and 4) there are true isogenic hybrids among non-*B.t.* and *B.t.* varieties, meaning that the only difference between them is the inclusion/type of *B.t.* derived toxin.

2018 sites and harvest dates for *B.t.* sentinel sweet corn plots :

Riverhead, NY – 8/27/18
Geneva, NY – 9/18/18

Rock Springs, PA – 9/6/18

Pittstown, NJ – 9/5/18
Upper Deerfield, NJ – 9/20/18

Vincent, OH (WVa) – 10/9/18

Beltsville, MD – 9/5, 10/4, 10/21/18
Wye River, MD – 8/29, 9/18/18
Sudlersville, MD – 8/31/18

Georgetown, DE – 8/30/18
Newark, DE – 8/30/18

Abingdon, VA – 8/17/18
Blacksburg, VA – 8/9/18
Suffolk, VA – 8/23/18
Painter, VA – 9/4/18

Plymouth, NC – 7/30/18

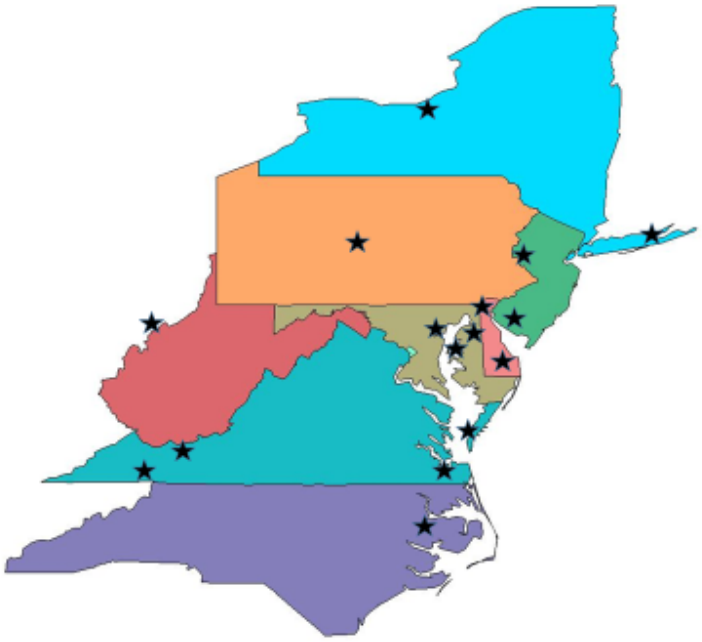

Fig. 1 2018 Sweet Corn Sentinel Plot Sites

In 2018, all field plots contained the isogenic bicolor hybrids 'Providence' (non-*B.t.*), 'BC0805' (Attribute - Cry1Ab) and 'Remedy' (Attribute II – Cry 1Ab, Vip3A). Plots at Wye River and Beltsville, MD, Pittstown, NJ, Rock Springs, PA, Georgetown and Newark DE, Geneva and Riverhead, NY, Abingdon, Blacksburg, Painter and Suffolk, VA, and Vincent, OH (conducted by WVa) also contained the isogenic hybrids 'Obsession' (non-*B.t.*) and 'Obsession II' (Performance Series – Cry1A.105 +Cry2Ab2). Plots were planted such that the silking periods would fall in the later summer when CEW moth numbers were at their highest. No insecticide applications were made. All evaluations of ear damage occurred at fresh market maturity. Data recorded included number of ears damaged by CEW, size of surviving CEW larvae, kernel area consumed and proportion of larvae reaching later instars. Of greatest concern to growers is the number of ears damaged by CEW, which is what is addressed here.

Non-B.t vs. Attribute I vs. Attribute II

Although some sites had lower *overall* infestation rates (Pittstown, NJ and Rock Springs, PA, Suddlersville, MD), a trend was consistent throughout all sites. CEW field resistance to Cry1Ab toxin in sweet corn is widespread and significant enough that there is rarely a difference in CEW infestation between non-*B.t.* 'Providence' and Attribute I 'BC0805' (see Figure 2). Even at the lower infestation sites, ear damage by CEW would be considered unacceptable. At the same time, the Attribute II variety 'Remedy' shows at all sites that the Vip3A toxin is providing excellent control of CEW, with only limited (although slightly higher than in 2017) numbers surviving over all

locations. Sites followed by an asterisk (*) indicate multiple harvests. Figures at these sites are averages of two or more evaluations.

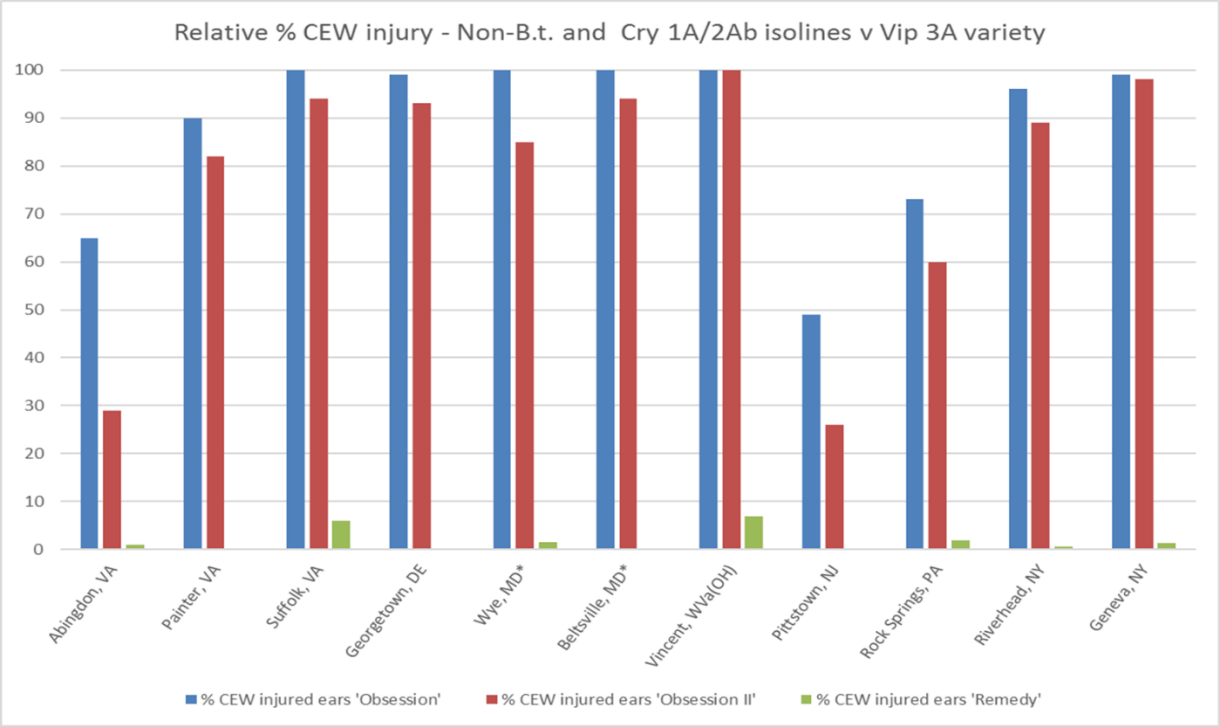

Figure 2. CEW injury – non B.t., Attribute I and Attribute II

Non-*B.t.* vs. Performance Series vs. Attribute II

The 11 sites in the mid-Atlantic region where 'Obsession II' (Performance Series – Cry1Ab, Cry 2Ab2) was paired with its' non-*B.t.* analog ('Obsession') showed that Cry 1Ab/Cry2Ab2 toxins no longer provide acceptable control of CEW (see Figure 3). Sites followed by an asterisk (*) indicate multiple harvests. Figures at these sites are averages of two or more evaluations.

Data from the 2018 study show that regionally, only varieties that incorporate the Vip trait (Attribute II) are providing excellent control of CEW without insecticide applications. Varieties that incorporate Cry toxins alone will require insecticidal intervention by growers at levels approaching that required on non-*B.t.* sweet corn. It bears repeating that all *B.t.* types to date are highly effective at preventing ECB injury at any growth stage, and Performance Series and Attribute II varieties provide excellent control of FAW as well. *B.t.* technology does not control sap beetles or corn leaf aphids. Because CEW populations in the southern U.S. are exposed to lower doses of *B.t.* toxins in field corn and cotton, they have developed strong resistance to them at the higher doses found in sweet corn varieties. This resistance is encountered in the Northeast U.S. later in the season because most of our CEW moths are migratory from points south. At times, there appears to be a slight decrease in CEW ability to survive on sweet corn expressing Cry toxins in some northern (inland) sites in this study. This may be due to susceptible individuals migrating from areas where resistance has yet to develop to the degree is has in the southeast. Resistance trends will be monitored further, as refugia requirements in field corn have been relaxed. This may intensify

resistance to *B.t.* toxins in CEW, and puts the Vip trait at risk for resistance development.

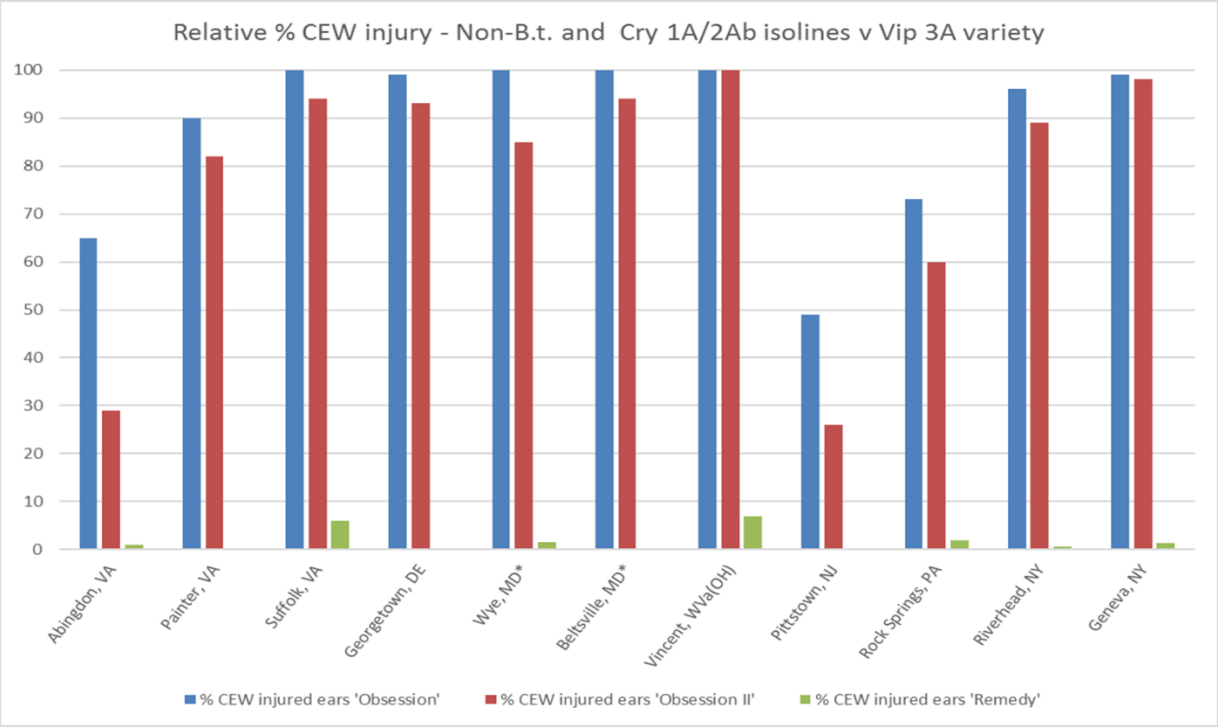

Figure 3. Ear damage from CEW – Performance Series

Potential changes in CEW response to Vip 3A toxin

While Vip 3A expressing Attribute II sweet corn varieties still demonstrate excellent control of CEW, FAW and ECB, several disturbing findings emerged from the 2018 study. The low levels of CEW infested ears in some of the 2018 Attribute II (Remedy) plots in this study represented a significant increase over those in 2017, and in the period from 2008-2016. Additionally, in CEW infested ears, CEW larvae survived longer in 2018 and consumed more kernel area than in previous years. Although control efficacy remains very high in Attribute II types, these findings indicate the possibility that CEW populations are beginning to develop resistance to the Vip 3A toxin, as has occurred with previous *Bt* derived toxins. Sentinel studies in the mid-Atlantic region are essential in monitoring changes in CEW population susceptibility to *Bt* derived toxins in commercial sweet corn varieties. The cooperators in these studies plan to continue this work in order to inform the grower community regarding the status of CEW resistance, as well as provide data to assist regulatory agencies in developing management plans to help preserve this trait as an effective management tool.

* *The author wishes to acknowledge Dr. Galen Dively (Uinv. Of MD) for organizing the 2017-18 sweet corn sentinel plot projects, as well as conducting efficacy work on genetically engineered sweet corn since its inception.*

TWO YEARS OF SWEET CORN CULTIVAR EVLAUATIONS

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To provide growers with information for successful, region specific cultivar selection, in 2012-13, we evaluated 25 cultivars of bicolor and white synergistic sweet corn grown in a conventional system across the state. Evaluations were located in southwestern Pennsylvania at Schramm Farms in Harrison City, Westmoreland County, in central Pennsylvania at the Russell E. Larson Research and Education Center in Rock Springs, and in southeastern Pennsylvania at the Southeast Research and Extension Center in Landisville.

The cultivars and year(s) evaluated and company from which seed were acquired from are listed below. The standard used was 'Temptation'.

Table 1. Synergistic Sweet Corn Varieties for Statewide Trial; 2012-13

Cultivar	Year(s) Evaluated	Seed Company
Bicolor		
Allure	2012-13	Rupp Seeds, Wauseon, OH
Attribute (BC0805)	2012-13	SeedWay, Elizabethtown, PA
SC1102	2012-13	Seminis Vegetable Seeds, Oxnard, CA
Cuppa Joe	2012-13	Rupp Seeds
Espresso	2012-13	Rupp Seeds
Jackie	2012-13	Harris Moran Seed Co., Modesto, CA
Ka-Ching	2012-13	SeedWay
Kristine	2012-13	Seigers/Crookham Seed Co., Holland, MI
Montauk	2012-13	Harris Moran Seed Co.
Primus	2012-13	SeedWay
Paydirt	2012-13	SeedWay
Profit	2012-13	SeedWay
Providence	2012-13	SeedWay
XTH 1273	2012	Seigers Seed Co.
XTH 1274	2012	Seigers Seed Co.
Synergy	2012-13	Seigers Seed Co.
Temptation*	2012-13	Seigers Seed Co.
Temptation II	2012-13	Seminis Vegetable Seeds
SV 9014	2013	Seminis Vegetable Seeds

White

Avalon	2012-13	SeedWay
Captivate	2012-13	Rupp Seeds
Edelweiss	2012-13	Harris Moran Seed Co.
Illusion	2012-13	Rupp Seeds
Mattapoisett	2012-13	SeedWay
Silver Duchess	2012-13	Seigers Seed Co.
Whiteout	2012-13	SeedWay

*se heterozygous (standard)

At all locations sweet corn was direct seeded with 8-10 inches between plants in a row. In the southwestern location 38 inch spacing was used between rows and in central and southeastern locations 30 inch spacing was used. Planting took place on June 6, 2012 and May 21, 2013 in southwestern Pennsylvania, June 1, 2012 and 2013 in central Pennsylvania, and May 21, 2012 and May 30, 2013 in southeastern Pennsylvania.

Fertility and weed management were site specific following recommendations from the Commercial Vegetable Production Recommendations guide.

Ears from 10-15 plants were harvested when all plants of an individual cultivar reached maturity. Data to estimate the work involved in hand harvest was recorded. Ears were categorized as marketable or unmarketable, counted and weighed. Ear quality from a subset of 10 ears per plot was also determined.

Husked ear appearance, unhusked ear appearance, the extent to which the husk covered the ear tip (tip cover), kernels filling the tip of the ear (tip fill), and the relative level of work involved in snapping the ear from the culm (picking ease) were rated using a 5 point scale. For husked ear appearance and unhusked ear appearance 1= poor and 5 = good; tip cover 1= exposed ear tip, 2 = husk cover less than 0.75 in past ear tip, 3 = 0.75 to 1.24 in, 4 = 1.25 to 2 in, 5 = greater than 2 in; tip fill 5 = kernels filled to tip of ear, 4 = greater than 0.5 in unfilled, 3 = 1 to 1.5 in, 2 = 1.6 to 2 in, 1 = greater than 2 inches; and picking ease 1 = difficult, 5 = easy.

All data were subjected to analysis of variance (ANOVA) using the GLM procedure in SAS (version 9.2; SAS Institute, Cary, NC). When P values were less than or equal to 0.05, means were separated using Duncan's multiple comparison test.

Statewide Results

In determining whether a cultivar was suited for statewide recommendation, the criterion was that it must have produced comparable or superior yields to 'Temptation' in a minimum of two of the evaluation sites over both trial years.

Note: Yield, ear quality, and estimating the work involved in harvesting tables (Tables 2, 4 and 5) are from Butzler et al., 2015.

Marketable Yield **(Table 2)**
Based on marketable yield results all cultivars met the criterion above for number of ears. Except for 'Paydirt', all cultivars met the criterion above for weight of marketable ears.

Ear Quality **(Table 4)**
Ear quality is just as important as marketable yield in making profits. Consumers are first attracted to the appearance of the ear, while taste can result in repeat purchases. In most US markets, consumers prefer an 8-9 in ear with a dark green husk, long and dark green flag leaf, and 16 straight rows of small deep and sweet kernels filled to the tip of the ear (Tracy, 2001).

In terms of ear length all cultivars met the criterion. For ear diameter 'Attribute' (BC0805), 'Espresso' and 'Cuppa Joe' did not meet the criterion while the remaining cultivars were comparable or superior to 'Temptation'. For husked and unhusked appearance all cultivars met the criterion. All ears were completely covered by the husk; however, 'Cuppa Joe' and 'Jackie' did not meet the criterion above while all other cultivars did. Regarding tip fill, 'Cuppa Joe', and 'Profit' did not meet the criterion above while all other cultivars did.

The number of rows was only evaluated in more than one location in one year of the study. Based on the criterion of producing comparable or superior results to 'Temptation' in a minimum of two evaluation sites, the number of rows for all cultivars except 'Paydirt' and 'Illusion' were not different or superior to 'Temptation'.

Brix levels were only evaluated in one year of the study. Based on the criterion of producing comparable or superior results to 'Temptation' in a minimum of two evaluation sites, all cultivars had brix levels not different than or superior to 'Temptation'.

Estimating the work involved in hand harvesting **(Table 5)**
The distance from the soil line to the base of the primary ear and picking ease were collected as an indication of the work involved in hand harvesting.

Except for 'Synergy', all cultivar met the criterion above for distance from the soil line to the primary ear. For the following cultivars picking ease rating met the criterion above: Mattapoisette, Primus, Edelweiss, Avalon, Temptation II, Montauk, Cuppa Joe, Jackie, Allure, Bicolor 1102, Illusion, Silver Duchess, Profit, Espresso, Kristine and Paydirt.

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Table 2. Marketable yield of 25 cultivars of synergistic sweet corn grown in southwestern, central, and southeastern Pennsylvania in 2012 and 2013.

	Marketable yield											
	(ears/15 plants)						(lb/15 plants)[z]					
	Southwestern Pennsylvania		Central Pennsylvania		Southeastern Pennsylvania		Southwestern Pennsylvania		Central Pennsylvania		Southeastern Pennsylvania	
Cultivar	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Allure	15.00 a[y]	13.50 a	12.50 a	13.25 a	14.75 a	15.00	12.59 a–c	7.07 b–e	10.38 c–h	10.55 b–d	11.55 ab	12.09 a–c
Avalon	15.06 a	15.00 a	14.75 a	14.75 a	14.75 a	15.00	14.10 a	9.16 ab	12.80 a–g	11.88 ab	11.00 a–c	12.41 a–c
BC 0805	14.50 a	14.25 a	14.05 a	13.25 a	12.75 ab	15.00	12.43 a–c	8.69 ab	10.65 b–h	12.33 ab	9.58 b–d	12.96 a
BC 1102	14.50 a	10.88 ab	14.00 a	6.88 c	14.25 a	15.00	11.59 a–c	5.11 c–e	11.30 b–h	5.60 e	10.43 a–c	12.43 a–c
Captivate	14.00 a	14.00 a	14.50 a	14.5 ab	13.50 a	15.00	10.69 a–c	8.01 a–d	13.53 a–f	12.55 ab	8.55 b–d	11.11 a–c
Cuppa Joe	14.50 a	8.25 b	13.75 a	13.00 b	13.50 a	15.00	10.64 a–c	3.31 f	11.00 b–h	11.58 ab	9.34 b–d	12.57 ab
Edelweiss	15.00 a	12.38 ab	14.00 a	14.75 ab	13.25 a	15.00	12.60 a–c	6.50 b–e	13.23 a–f	14.20 a	10.81 a–c	11.48 a–c
Espresso	15.00 a	13.88 a	13.75 a	15.00 ab	14.00 a	15.00	10.98 a–c	7.07 b–e	9.95 f–i	12.88 a	10.78 a–c	12.66 ab
Illusion	14.50 a	13.50 a	14.00 a	14.00 ab	13.25 a	15.00	12.67 ab	7.59 a–d	10.35 c–h	10.35 b–d	10.33 a–d	12.41 a–c
Jackie	13.50 a	13.50 a	13.75 a	14.50 ab	13.00 ab	15.00	9.03 c	5.87 b–e	9.05 j	11.30 a–c	8.60 b–d	10.29 bc
Ka-Ching	14.50 a	14.25 a	15.00 a	14.75 ab	14.75 a	14.75	12.56 a–c	7.25 a–d	12.75 a–g	12.40 ab	11.66 ab	12.38 a–c
Kristine	15.00 a	14.25 a	12.75 a	13.50 ab	11.75 ab	15.00	10.41 a–c	7.12 a–d	9.35 g–i	11.48 ab	7.50 cd	11.54 a–c
Mattapoisett	14.75 a	14.63 a	14.75 a	13.75 ab	13.25 a	15.00	12.15 a–c	8.10 a–d	14.13 ab	12.58 a	10.35 a–d	12.17 a–c
Montauk	14.66 a	13.13 a	14.5 a	12.50 ab	15.00 a	15.00	13.71 ab	8.47 a–c	15.93 a	11.23 a–d	13.59 a	13.92 a
Paydirt	13.00 ab	12.00 ab	13.00 b	12.00 ab	12.50 b	15.00	3.55 d	4.70 e	8.18 j	7.78 c–e	7.10 d	8.86 c
Primus	13.25 a	14.25 a	14.00 a	14.50 ab	12.50 ab	15.00	10.99 a–c	8.57 a–c	12.65 a–h	12.88 a	8.85 b–d	12.55 ab
Profit	14.50 a	15.00 a	14.00 a	13.00 ab	14.50 a	14.75	12.46 a–c	10.70 a	10.28 d–h	7.65 de	9.96 b–d	9.94 bc
Providence	13.00 ab	13.13 a	15.00 a	15.00 ab	14.25 a	15.00	11.68 a–c	7.45 a–d	13.58 a–d	14.20 a	10.81 a–c	14.21 a
Silver Duchess	15.00 a	14.63 a	15.00 a	14.75 ab	13.25 a	14.75	12.76 ab	8.56 a–c	13.80 a–c	13.38 a	9.95 b–d	11.51 a–c
Synergy	14.00 a	14.25 a	14.00 a	14.72 ab	13.50 a	15.00	9.91 bc	7.90 a–d	11.58 b–h	12.67 a	9.03 b–d	11.18 a–c
Temptation I	14.75 a	13.13 a	14.75 a	15.00 ab	13.75 a	14.50	10.20 bc	6.14 b–e	10.73 b–h	12.70 a	8.91 b–d	10.43 a–c
Temptation II	14.25 a	13.88 a	15.00 a	14.75 ab	13.75 a	15.00	10.58 a–c	6.19 b–e	11.00 b–h	11.58 ab	9.05 b–d	10.43 a–c
Whiteout	15.00 a	13.88 a	14.25 a	12.50 ab	13.75 a	14.75	12.43 a–c	6.56 b–e	10.08 d–h	7.70 c–e	9.68 b–d	10.47 a–c

[z]1 lb = 0.4536 kg.
[y]Values are the mean of four replications; values followed by different letters within a column are significantly different using Tukey's multiple comparison test at the 5% level.

Table 4. Ear size measured as diameter and length for 25 cultivars of synergistic sweet corn grown in southwestern, central, and southeastern Pennsylvania in 2012 and 2013.

	Ear size											
	Diam (inches)[x]						Length (inches)					
	Southwestern Pennsylvania		Central Pennsylvania		Southeastern Pennsylvania		Southwestern Pennsylvania		Central Pennsylvania		Southeastern Pennsylvania	
Cultivar	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Allure	1.81 a–c[y]	1.70	1.62 c–g	1.79 a–c	1.78 b	1.75	8.05	9.18 a	9.03 ab	8.25 a	7.94 ab	8.25
Avalon	1.86 a–c	1.76	1.88 a–f	1.71 a–c	1.63 b	1.75	8.80	8.69 ab	9.29 a	7.90 ab	8.50 a	9.00
BC 0805	1.68 bc	1.76	1.44 g	1.77 a–c	1.22 b	1.75	8.49	8.80 ab	8.98 ab	8.11 a	6.25 b	9.13
BC 1102	1.80 a–c	1.68	1.78 b–g	1.21 d	1.75 b	1.56	7.40	7.40 ab	7.96 ab	5.49 c	6.88 ab	7.75
Captivate	1.81 a–c	1.79	2.01 a–c	1.79 a–c	1.72 b	1.81	7.95	7.57 ab	9.02 ab	7.84 ab	7.44 ab	8.06
Cuppa Joe	1.44 c	1.50	1.57 e–g	1.62 a–c	1.72 b	1.63	7.25	8.50 ab	8.60 ab	8.08 a	7.44 ab	8.56
Edelweiss	2.14 a	1.75	2.21 a	1.98 a	2.00 a	1.88	7.15	7.23 b	8.10 ab	7.42 ab	7.25 ab	7.75
Espresso	1.59 bc	1.72	1.63 c–g	1.70 a–c	1.81 b	1.94	8.06	8.30 ab	8.36 ab	7.54 ab	8.00 ab	8.00
Illusion	1.83 a–c	1.71	1.57 d–g	1.50 b–d	1.72 b	1.81	8.33	8.44 ab	8.20 ab	8.10 a	7.63 ab	8.44
Jackie	1.77 a–c	1.61	1.62 c–g	1.79 a–c	1.75 b	1.63	6.99	7.24 b	7.72 ab	6.84 a–c	6.50 ab	7.25
Ka-Ching	1.76 a–c	1.65	1.79 b–g	1.62 a–c	1.75 b	1.63	8.35	8.69 ab	8.58 ab	7.76 ab	7.94 ab	9.00
Kristine	1.77 a–c	1.81	1.93 a–f	1.63 a–c	1.72 b	1.81	7.38	7.55 ab	7.66 ab	7.32 ab	6.81 ab	8.06
Mattapoisett	1.77 a–c	1.90	1.96 a–e	1.87 a–c	1.75 b	1.75	7.50	8.07 ab	8.83 ab	7.89 ab	7.75 ab	8.69
Montauk	1.91 ab	1.87	2.17 ab	1.74 a–c	1.91 b	1.94	8.03	7.62 ab	8.91 ab	7.69 ab	7.56 ab	8.44
Paydirt	1.68 bc	1.56	1.51 fg	1.73 a–c	1.56 b	1.56	7.55	7.33 b	7.59 ab	7.07 a–c	7.19 ab	7.00
Primus	1.68 bc	1.73	1.98 a–d	1.73 a–c	1.60 b	1.75	8.39	8.10 ab	8.95 ab	8.16 a	7.69 ab	8.88
Profit	1.83 a–c	1.80	1.78 b–g	1.58 b–d	1.78 b	1.75	7.24	7.18 b	7.86 ab	6.20 bc	6.94 ab	7.19
Providence	1.73 a–c	1.75	1.75 b–g	1.75 a–c	1.63 b	1.75	8.43	8.10 ab	9.03 ab	8.36 a	8.19 a	9.06
Silver Duchess	1.76 a–c	1.82	1.94 a–e	1.86 a–c	1.63 b	1.56	8.36	8.71 ab	8.68 ab	8.17 a	8.06 ab	8.88
Synergy	1.83 a–c	1.70	1.81 a–g	1.98 a	1.82 b	1.75	7.08	7.78 ab	7.67 ab	8.63 a	6.69 ab	7.88
Temptation I	1.86 a–c	1.64	1.82 a–g	1.84 a–c	1.75 b	1.86	7.30	7.24 b	7.46 b	7.45 ab	6.69 ab	7.20
Temptation II	1.81 a–c	1.63	1.67 b–g	2.0 a	1.75 b	1.90	7.59	7.29 b	7.62 ab	7.32 ab	6.81 ab	7.17
Whiteout	1.93 ab	1.82	1.58 d–g	1.44 cd	1.78 b	1.81	7.86	7.50 ab	8.29 ab	7.62 ab	7.63 ab	8.50

[x]1 inch = 2.54 cm.
[y]Values are the mean of four replications; values followed by different letters within a column are significantly different using Tukey's multiple comparison test at the 5% level.

Table 5. The work involved in hand harvest measured as distance from the soil line to the base of the primary ear (ear height) and the ease or difficulty of removing the primary ear by hand (picking ease) for 25 cultivars of synergistic sweet corn grown in southwestern, central, and southeastern Pennsylvania in 2012 and 2013.

	Work involved in harvest											
	Ear ht (inches)[x]						Picking ease (1–5 scale)[y]					
	Southwestern Pennsylvania		Central Pennsylvania		Southeastern Pennsylvania		Southwestern Pennsylvania		Central Pennsylvania		Southeastern Pennsylvania	
Cultivar	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Allure	16.80 b–d[z]	22.25 a–d	13.54 a–e	16.03 b–f	15.28 c–g	23.09 d–h	2.8 c–f	4.0 a–c	4.1 a–c	5.0 a	2.9 a–e	3.9 a–d
Avalon	19.55 a–c	24.75 a–c	15.73 a–c	16.60 a–e	20.88 a–c	26.88 b–e	3.0 b–f	4.0 a–c	4.9 a	4.3 a–c	1.8 de	4.3 a–c
BC 0805	21.40 ab	26.33 a	13.07 a–e	16.08 b–f	19.00 a–e	28.63 b–d	2.8 c–f	2.5 b–e	3.3 a–c	4.7 a	1.6 e	3.1 a–d
BC 1102	21.75 ab	21.85 a–d	14.04 a–d	13.45 d–f	17.43 b–g	25.64 b–g	2.0 ef	2.9 a–e	4.3 a–c	5.0 a	2.5 a–e	3.3 a–d
Captivate	21.30 ab	27.81 a	15.96 ab	22.08 a	24.78 a	31.86 a	3.0 c–f	1.0 e	3.5 a–c	3.9 a–c	3.3 a–e	4.3 a–c
Cuppa Joe	19.10 a–c	23.43 a–d	15.18 a–d	16.80 a–d	16.65 b–g	25.71 b–g	3.8 a–f	3.5 a–c	4.7 a–c	4.8 a	1.8 de	3.0 b–d
Edelweiss	20.45 ab	25.20 ab	13.25 a–e	16.58 a–e	17.95 b–f	22.59 e–h	5.0 a	3.8 a–c	4.7 ab	3.4 a–c	3.6 a–c	3.8 a–d
Espresso	13.85 cd	15.23 e	9.95 c–e	13.73 d–f	13.20 e–g	20.84 f–h	5.0 ab	4.3 ab	4.5 a–c	4.7 ab	2.5 a–e	4.8 ab
Illusion	16.20 b–d	20.05 b–e	13.07 a–e	15.00 c–f	15.20 c–g	23.41 d–h	3.5 a–e	3.6 a–c	3.7 a–c	4.5 a–c	2.5 a–e	3.8 a–d
Jackie	17.15 b–d	23.40 a–d	9.88 c–e	15.85 b–f	16.83 b–g	23.75 c–h	3.5 a–e	2.8 a–e	2.9 cd	3.8 a–c	3.9 ab	2.3 d
Ka-Ching	19.05 a–c	21.90 a–d	12.18 a–e	14.48 c–f	16.58 b–g	23.54 d–h	3.0 c–f	2.5 b–e	4.8 ab	4.7 ab	1.9 c–e	3.3 a–d
Kristine	12.65 d	14.60 e	7.86 e	13.40 d–f	12.58 fg	17.41 i	2.5 d–f	4.3 ab	4.3 a–c	4.7 ab	2.0 c–e	4.0 a–d
Mattapoisett	24.20 a	26.85 a	16.72 a	21.23 ab	22.40 ab	30.65 b	4.5 a–c	1.5 de	3.8 a–c	4.6 a–c	2.4 a–e	2.6 cd
Montauk	19.40 a–c	23.80 a–d	16.36 a	18.43 a–d	19.58 a–d	26.45 b–f	3.0 c–f	2.8 a–e	5.0 a	4.8 a	2.3 b–e	3.0 b–d
Paydirt	11.70 e	14.55 e	9.78 de	14.03 c–f	10.73 h	17.21 i	3.8 a–e	3.0 a–d	4.3 a–c	4.6 ab	2.5 a–e	3.5 a–d
Primus	18.48 a–d	25.25 ab	14.89 a–d	17.15 a–d	18.80 b–e	27.06 b–e	4.0 a–d	2.8 a–e	4.7 a–c	4.7 a	1.8 de	3.0 b–d
Profit	16.80 b–d	19.00 c–e	9.97 b–e	10.78 ef	13.58 e–g	20.42 gh	3.3 a–f	3.0 a–d	3.9 a–c	4.3 a–c	2.8 a–e	3.3 a–d
Providence	20.53 ab	24.25 a–c	12.54 a–e	16.58 a–e	18.35 b–f	26.03 b–f	3.0 c–f	2.3 c–e	3.4 a–c	–[w]	2.1 b–e	3.8 a–d
Silver Duchess	20.70 ab	19.55 b–e	12.37 a–e	17.68 a–d	17.90 b–f	21.21 e–h	3.0 c–f	3.5 a–d	4.5 a–c	4.7 ab	3.1 a–e	3.4 a–d
Synergy	16.15 b–d	18.20 de	10.25 b–e	10.05 f	11.73 g	19.67 h	1.5 f	2.3 c–e	3.0 bc	2.6 c	4.1 a	2.8 cd
Temptation I	20.90 ab	24.18 a–c	13.37 a–e	19.83 a–c	14.18 c–g	24.48 c–h	4.5 a–c	4.0 a–c	4.5 a–c	4.9 a	3.4 a–e	4.8 a
Temptation II	23.10 a	24.05 a–d	14.95 a–d	19.10 a–d	17.08 b–g	24.58 b–g	4.3 a–d	3.8 a–c	4.5 a–c	4.3 a–c	3.5 a–d	3.7 a–d
Whiteout	23.55 a	23.95 a–d	14.92 a–d	19.45 a–c	22.35 ab	29.51 bc	2.0 ef	4.5 a	1.1 d	2.9 bc	2.8 a–e	3.4 a–d

[x]1 inch = 2.54 cm.
[y]5 = easy, 1 = difficult.
[z]Values are the mean of four replications; values followed by different letters within a column are significantly different using Tukey's multiple comparison test at the 5% level.
[w]Data were not recorded.

WEED MANAGEMENT IN SWEET CORN

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Efficient weed control continues to be a key component of sweet corn production. While genetic modification has allowed corn to be resistant to some herbicides, growers need to rely on a diversity of herbicide modes of action to control troublesome weeds. As such, including recently registered herbicides for use in sweet corn is of prime importance for New Jersey sweet corn growers, especially with the spread of herbicide-resistant weed species.

Thus, we conducted field trials investigating new herbicides and commercial mixes at the Rutgers Agricultural Research and Extension Center (RAREC) in Bridgeton, NJ, and 2018. Randomized complete block design with four replications was used for all trials and systematically included an untreated weedy check. Sweet corn was planted using a seeding hitch on the back of a tractor and was seeded at a rate of 35,000 seeds per acre. Trials were planted on June 18th.

Acuron® and Acuron® Flexi herbicide were tested preemergence and compared to the Aatrex®. Postemergence program included either Roundup® PowerMax, Aatrex® alone or mixed with Halex GT®, or a mix of Callisto® Xtra, and Sequence®. Preemergence spray was applied at planting and postemergence application occurred when corn was at the V4 stage.

ImpactZ® herbicide was also tested in a different study. Treatments included ImpactZ® postemergence alone or associated with RoundUp® PowerMax or Liberty®. Growers standards included tankmixing Callisto® and Aatrex® at 2 different rates each. Dual® Magnum was used as the standard preemergence herbicide for all treatments. Preemergence and postemergence sprays were applied at planting and at V4 growth stage, respectively.

Herbicides were applied using a 3-nozzle boom with 11002VS flat fan nozzles spaced 20 inches apart. Weed control and crop injury ratings were taken 14, 21, 28, 31, 42, and 59 days after planting (DAP). Weeds present in the trial were rated on a percentage scale ranging from 0 (no control) to 100 (complete control). Necrosis, chlorosis, and stunting of the crop were rated on this scale as well. Commercial-sized corn was harvested September 10, 2018 from the two center rows of each plot. The ears were weighed and were used to calculate total yield per acre for each treatment.

Our data show that Acuron® provided excellent control (> 90%) of common purslane, common lambsquarter, and stinkgrass as well as good control of common ragweed. Limited stunting was noted for some of the treatments and affected ears yield. Postemergence use of ImpactZ® herbicide alone or tankmixed with other herbicides provided full control of stinkgrass and carpetweed. Common ragweed control required the mixing of another postemergence herbicide with ImpactZ®. Temporary necrosis and stunting were noted following ImpactZ® application but did not cause any ears yield reduction.

Session 4

Field and Forage Crops

BEYOND RYE: COVER CROPS

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Maintaining healthy soil conditions can be a great challenge, especially in sandy soils where organic matter is quickly lost. Additionally, land preparation and tillage adds to the loss of organic matter and in many crops multiple tillage operations are needed to for crop establishment. Increasing organic matter levels in soil can greatly improve soil health and can result in many other agronomic advantages.

Cover crops can provide multiple benefits. For example, they can improve soil health, add soil nutrients, suppress weed population and competiveness, manage pests, produce biomass, provide a forage source for livestock and attract beneficial insects. The incorporation of cover crops can also reduce surface runoff and can provide other potential water quality improvements.

Although many cover crop species are adapted to use in the northeast, it is important to select the crop that provides the desired benefits while fitting properly into existing crop rotations. This presentation will review some of the traditional cover crops used in the northeast region, the potential benefits of cover crop species, their adaptability for use in traditional cropping systems, and potential complimentary mixes suitable for muli-use plantings.

SOIL FERTILITY FOR HAY PRODUCTION

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Hay is grown on more acres of New Jersey farmland than any other crop. Soil fertility is an important part of producing high quality hay to feed an estimated 50,000 horses and other livestock in The Garden State. Hay for equine must be leafy, green, and free of mold, dust, and foreign materials.

Perennial hay crops in a crop rotation helps control soil erosion and build soil organic matter content. A regular cutting schedule for hay is also an effective way to eradicate some types of perennial weeds. While a grass hay crop can build the organic matter aspect of soil fertility, mineral fertility is being withdrawn with each harvest; every harvested ton of hay withdrawals substantial amounts of P, K, and other essential nutrients from the soil. On average each ton of harvested hay uptakes and removes 15 lbs. P_2O_5 and 50 lbs. of K_2O per acre. To sustain hay harvest productivity over a period of years, these nutrients need to be replenished with commercial fertilizer or as applied manures. Because grass hay has such a high demand for N, P, and K, fields intended for hay production are excellent locations, as part of a long crop rotation cycle, for utilizing livestock manures.

Over a growing season a typical 4 tons per/acre hay harvest would uptake an estimated 200 lbs. of N, 60 lbs. P_2O_5 and 200 lbs. of K_2O per acre. Replacing these nutrients with commercial fertilizer would cost an estimated $122 for N, $30 for P, and $87 for K per acre (Total of $239 per 4 tons hay or $1.20 per each 40 pound bale of hay). One must remember this is only the cost of purchasing NPK. It does not include cost of other nutrients and limestone. It also does not cover other costs (cutting, baling, hauling, storage, etc.) associated with hay production.

Sometimes hay is produced as a mixed stand with a legume, such as alfalfa. When forage legumes are included in the mix, soil fertility recommendations should favor maintenance of the legume within the mixed stand. The presence of 25% or more legumes in a mixed forage stand means that the hay crop is essentially self-sufficient with respect to nitrogen via biological N fixation. It also means zero application of N fertilizer - which eliminates the cost for purchased of N fertilizer.

Nutrient recommendations for hay production should be based on a recent soil test and a realistic crop yield goal. Specific soil fertility recommendations guided by soil test results are given in bulletins available at Rutgers NJAES website: http://njaes.rutgers.edu/

Session 5

Wine Grapes

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Introduction:

Why fruit wines in a world dominated by grapes?

Wine consumers often will state that a fine Merlot will have notes of blackberry. Or compare Cabernet Sauvignon with black currant. How about Chardonnay with apple or Gewurztraminer with Lychee? What would you think if a blackberry wine would be described to have notes or Merlot? A cassis wine to taste like a fine Cabernet Sauvignon. Or an oaked apple wine to remind them of a California Chardonnay. Or eating some Thai cuisine with a nicely chilled Lychee wine that reminds them of a Gewurztraminer they had last week?

Innovative and top-quality fruit wines, fruit fusion and fruit-centric alcoholic beverages are emerging to worldwide applause and exponential growth in popularity. Wine drinkers the world over are waking up to a fruit basket of new flavours and the industry is racing to keep up with the trend. The possibilities for wine beyond the vine are endless. For the past 20 years, we have seen development of fruit wines across the world. We will see what we have learned and provide insights for growers, winemakers, winery owners, marketers and export leaders.

• A paradigm shift – the big fruit wine shake-up and what it means for an evolving wine industry

• Versatile and adaptable – fruit wine styles, regional trends and producers that are leading the way.

• Opportunity and innovation – market potential and the marketing challenge

Premise:

The perception of fruit wine only being made by amateur winemakers and consumed by unsophisticated consumers is history. The future of fruit wine production in the world is looking bright - potential opportunities are great with so many different types of fruit to work with where almost any country in the world can make a fruit wine.

Part 1:

Premise:

Currently the typical wine consumer is changing and changing very fast.

Proof:

Concepts of the new type of consumer:

- There has been a dramatic historical development in the history of the fruit wine industry
- Open to try new things
- Not stuck in tradition
- Short attention span, not stuck with a particular style
- Adventurous
- Less status oriented
- Craft beer and cider phenomenon is an expression of this trend
- Stories of fruit wine consumers, entry level
- Story - Perception of the average fruit wine drinker has changed - not just the entry level drinker
- Fruit forward trend going one step further

Part 2:

Premise:

Fruit wines are presenting a tremendous opportunity for fruit growers, wine producers and marketers.

Proof:

- The fruit wine business is virtually untapped territory, so growers, producers, distributors, and marketers can have a hand on shaping the industry with a clean slate. There are a tonne of opportunities for creative ways to make fruit wine compelling.
- Variety is also one of the most exciting things from a marketing standpoint. Introducing a usual wine such as a quality blueberry wine to the market is a story that writes itself. There is an entire audience of people who will be thrilled to try something they didn't even know existed or was possible.
- It makes economic sense on a technical standpoint to make fruit wines (will provide a list of give advantages)
- Provides greater flexibility:
- can make wine year round, less inventory to hold
- can make wine outside traditional grape growing areas (will provide many real-life examples)
- Why less than grape wineries? You need <1/3-1/2 the tank space and can do with smaller size/speed equipment.
- You can produce at up to 3 production cycles a year instead of just one as with grape wineries.

Part 3:

Premise:

There are challenges with fruit wines, however they can be overcome with some focus.

Proof:

a) Production and technical challenges and how to overcome:

- Enology programs now offer R&D with fruit wines
- Will explore in detail the entire fruit wine production process and emphasis the differences between fruit wine and grape wine production.
- Will go through specific technical challenges and solutions

b) Marketing challenges:

- *Where the industry was 20 years ago and where it is today.*
- Perception now - becoming accepted, viable consumption alternative (will give example of success stories)

- Export potential (in Asia, a wine is a wine, it doesn't matter what fruit it is made from – grape or raspberries or kiwi…)
- Fruit wines in India sold in supermarkets, 5* hotels and restaurants
- Fruit wine already part of some Asian cultures, i.e. Japan, Korea
- International wine competitions are increasingly including fruit wine categories
- Overcoming "old world" snobbery that fruit wine is not a wine.

c) Overcoming grape wine challenges with fruit wine alternatives:

- Red wines don't go with many foreign cuisines
- Examples of China mixing red wine with coke
- Spicy cuisine of India and Thailand needs lower tannic and fruity wines
- In fruit-forward cuisines such as Thai, Vietnamese, Moroccan, Hawaiian, Caribbean, etc.…fruit wines are perfect and there is so much variety to match distinct varieties of cuisine.
- Fruit wines are applicable to these cuisines and consumers are increasingly open to and want.
- Fruit wine can be elevated to deserving gastro-pairing status
- Enhancing your wine portfolio with fruit wines will broaden your market range and appeal to a different set of consumers.

<u>Part 4:</u>

Premise:

Fruit wines are versatile, can be made in any style to fit any market and any application.

Proof:

Will go through all the different styles and have an example of a successful wine in each style category.

Examples of quality fruit wine recipe formulations will be presented which will provide the detailed aspect of creating a quality, world class fruit wine that can be commercialized and be profitable to any forward-thinking producer.

Conclusion:

We live in a world that embraces diversity and choice. The quality of fruit wines in the marketplace is increasing exponentially and sections of the wine consuming public are interested and coming back for more.

The world's preference for tastes and their food palates are increasingly full bodied and fruit forward. This also means the average consumer is looking for a fuller, more authentic, fruitier wine. Consumers seems to go for the fleshier, and fruitier wines these days. Forward thinking producers have capitalized on this. Fruit wines allows producers, marketers and distributors to take it one step further.

While fruit wines will never become equal to grape wines there are some markets where they are close to becoming mainstream and will attain that level in the near future. However, that's not the point, as it is such a different entity and only adds another world of options to wine drinkers.

Consideration should be given where in a changing world where consumer's expectations are constantly adapting. Ecological reality of grape growing regions with increase of droughts, blights, global warming and other viticulturally difficulties in some areas opens up opportunities to produce wines with other raw materials.

Fruit wines can become a very viable alternative to the grape and needs to have a place in any forward thinking and innovative producers' portfolio.

(Will paint a picture of wine in 20 years where the wine writers will write about flights of blueberry wine from different terroirs. Describe the difference between the different varietal pear wines (Anjou or Bartlett), similarly like the difference between a chardonnay varietal versus sauvignon Blanc - same fruit type.

It's time to open the doors to quality wines made with the fruit bounty the world has to offer.

In last 20 years of producing fruit wines and consulting with many wineries on four continents, there has been tremendous progress and development in the fruit wine industry. As far as I am concerned this is just the beginning….

Session 6

Tomato

WEED MANAGEMENT STRATEGIES FOR GRAFTED VS. NONGRAFTED TOMATO

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In the United States, farmer's interest in the use of grafted tomato as an alternative to methyl bromide to manage soil borne diseases and pests is increasing. In addition to pest management, grafting is a promising tool to achieve greater fruit yield, and enhance tolerance to abiotic stresses such as thermal stress, salt stress, water stress, and organic pollutants. The increase in plant vigor and yield of grafted plants is attributed to a vigorous root system that helps to increase water and mineral uptake. Yellow nutsedge, common purslane and large crabgrass are listed among the ten most common weeds present in tomato production system. Management of these weeds in tomato production systems is very important to produce good quality fruit and yield. In the absence of weed control, tomato plant growth is inhibited, individual fruit size, number, and weight is reduced. The critical period for weed control (CPWC) in crops is the period of time during the cropping season that weeds must be controlled to prevent yield, and quality reductions in crops. The CPWC for tomato has been studied for different weed species and it ranged between 3 to 7 weeks after tomato transplanting (WAT). Fumigation, herbicides, and hand removal are the primary methods of weed control in plasticulture tomato production. Although several herbicides [Dual Magnum (*S*-metolachlor), TriCor (metribuzin), Devrinol (napropamide), Sandea (halosulfuron), and Treflan (trifluralin)] are registered in tomato production, a lack of information exists on the effect of herbicides on grafted tomato. The goal of this research is to provide growers information related to herbicide safety and adequate timing of weed control in grafted tomato. Tomato production cost increases about $2 to 3 thousand per acre when grafted plants are used, therefore farmers cannot afford failure of their crop due to herbicide injury.

Greenhouse and field experiments were conducted to determine herbicide tolerance of grafted tomato. In greenhouse experiments, Sandea, Tricor, and Dual Magnum were applied posttransplant to nongrafted 'Amelia' and Amelia scion grafted onto 'Maxifort' or 'RST-04-106-T' tomato rootstocks. Although herbicide injury was observed, no differences were observed in grafted and nongrafted tomato response including visible injury assessments, plant height, and fresh weight (Table 1). In field experiments under plasticulture, herbicides applied pretransplant included Dual Magnum, TriCor, Devrinol, Sandea, Reflex (fomesafen), and Treflan. Amelia was used as the scion and the nongrafted control. 'Anchor-T', 'Beaufort', or Maxifort tomato were used as rootstocks for grafted plants. Initially, Devrinol, Sandea, Reflex, and Treflan initially caused greater injury to grafted tomato than to nongrafted tomato regardless of rootstock (Anchor-T, Beaufort, or Maxifort) (Table 2). However, by 28 days after treatment, all grafted and nongrafted plants had recovered from herbicide injury and no impact on yield observed. Grafted tomato exhibited similar tolerance as nongrafted tomato for all herbicides applied post- and pretransplant.

The removal and establishment studies were conducted to determine CPWC of grafted and non-grafted. Tomato plants included non-grafted Amelia and Amelia grafted onto Maxifort tomato rootstock. In establishment study, weeds were transplanted at 1, 2, 3, 4, 5, 6, and 12 WAT and remained until tomato harvest. In removal study, weeds were transplanted on the same day of tomato transplanting and removed at 2, 3, 4, 5, 6, 8, and 12 WAT. Each planting hole contained one grafted or non-grafted tomato plant and six weed seedlings (2 yellow nutsedge, 2 common purslane, and 2 large crabgrass). In both grafted and non-grafted tomato treatments, plant biomass increased as establishment of weeds was delayed and plant biomass decreased when removal of weeds was delayed. In both grafted and non-grafted plants, the delay in establishment and removal of weeds resulted in weed biomass decrease and increase of the same magnitude, respectively (Figure 1). To avoid 5% yield losses, predicted CPWC was from 2.2 to 4.5 WAT in grafted tomato and from 3.3 to 5.8 WAT in nongrafted tomato (Figure 2). The length (2.3 or 2.5 wk) of the CPWC in fresh market tomato was not affected by grafting; however, the CPWC management began and ended 1 week earlier in grafted tomato than in nongrafted tomato. Overall, results from both studies show that weed management of grafted tomato is similar to non-grafted tomato.

WHAT'S NEW IN MANAGING TOMATO DISEASES

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Effectively managing the many diseases that plaque tomatoes is essential to obtain a good crop. Achieving this necessitates knowing about new management tools and changes in disease occurrence.

Early Blight. Pathogens affecting tomato and potato have proven more adept at developing resistance than was initially expected. Resistance to QoI (FRAC Code 11) fungicides has been detected in the tomato pathogen, *Alternaria linariae* (pka *A. tomatophilia*). More research has been conducted with *A. solani* causing early blight in potato. Resistance has developed to three chemical classes of fungicides in the USA. Resistance to QoI (FRAC 11) fungicides was detected in 2001, after 2.5 growing seasons of commercial use. Resistance to boscalid, the first SDHI (FRAC 7) fungicide, was detected in 2009, the fifth year of use. Resistance to the AP (FRAC 9) fungicide pyrimethanil, an active ingredient in Scala and Luna Tranquilty, was detected in ID in 2010, which was five years after first registration. Isolates resistant to multiple fungicides did not exhibit significant fitness penalties compared to sensitive isolates in laboratory studies, therefore they are expected to be able to compete and persist in the pathogen population when these fungicides are not used. Isolates with one of the SDHI resistance mutations were more aggressive than sensitive isolates. A recent survey revealed that multi-fungicide resistant isolates are common: over 95% of isolates examined from several states in the west had mutations conferring SDHI resistance and most also had mutations for QoI resistance. Loss in sensitivity to DMI (FRAC 3) fungicides was documented in 2010-2012, but *A. solani* isolates examined more recently (2013-2015) were fully sensitive.

In tomato crops it is critical to use a good resistance management program, select resistant variety when feasible, start applying fungicides preventively or at first symptom, alternate among fungicides in different chemical groups as indicated by FRAC Code, monitor disease occurrence, and report poor control despite good fungicide program to extension specialist during the season so isolates can be collected for testing. Also use long crop rotation. Pathogen surviving in crop debris is an important source of inoculum and can be a source of resistance if the field has a long history of use of targeted fungicides for early blight. Minimize use of QoI (FRAC 11) fungicides: Cabrio, Flint, Priaxor, Quadris, Reason, Tanos, Topguard, etc.) Other labeled fungicides include: Rhyme (FRAC 3), Aprovia Top (3 + 7), Inspire Super (3 + 9), Scala (9), Luna Tranquilty (7 + 9), Miravis Prime (7 + 12), Switch (9 + 12), and Previcur Flex (28). Alternate among products based on FRAC code and tank-mix with chloro-thalonil or another protectant fungicide. Most can be applied at most twice sequentially.

Late Blight. While there were few occurrences of late blight last season in the U.S., despite conditions being favorable (frequent rain) in several areas, there were

noteworthy occurrences. A new genotype (US-25) was detected in upstate NY. It is especially noteworthy because US-25 is mating type A2 whereas US-23, the dominant strain in the Northeast for the past 6 years, is mating type A1. This is important because if these two genotypes occur together, the pathogen could produce a specialized spore (oospore) that enables the pathogen to survive in soil without living plant tissue and oospores form as a result of sexual reproduction, thus they are an important way to increase genetic diversity. Infested tubers is how the pathogen normally survives. Also US-25 is insensitive to mefenoxam, whereas US-23 is sensitive and so can be managed effectively with Ridomil fungicides. US-25 was found on tomato but determined to also be able to infect potato.

Late blight caused by genotype US-23 was found 7 Oct on Long Island. This first occurrence in an area is noteworthy for its extreme lateness, especially considering it was an atypically wet season there which should have provided favorable conditions for late blight to develop much earlier. The source of inoculum for this outbreak and the one in 2017, which started in late Aug to early Sep, was not determined. Since 2009 first observations on Long Island have typically been in June. No late blight was found in 2015 or 2016. Unexpected occurrences serve as a reminder to remain vigilant about late blight through the end of the season even when there are no reported occurrences anywhere nearby.

Information about late blight is available at http://www.usablight.org/ and http://blogs.cornell.edu/livegpath/extension/tomato-late-blight/.

Powdery Mildew. This disease is common in high tunnels and greenhouses, but also occurs outdoors. It has been occurring sporadically but more frequently. Recent increase in high tunnel production at least partly accounts for increased importance of powdery mildew in the Northeast. Symptoms are the typical powdery white spots characteristic of this type of disease. They usually appear first on lower leaves inside the plant canopy. Left unmanaged, powdery mildew can quickly kill affected leaves. See images at: http://blogs.cornell.edu/livegpath/gallery/tomato/powdery-mildew-on-tomatoes/.

When purchasing seedlings, ask producer about powdery mildew management program being used and inspect plants thoroughly when received. Rejecting affected plants is worth considering because of the cost of needing to start a weekly fungicide program so early in crop production.

Fungicides with targeted activity that move through leaves are needed to effectively manage powdery mildew because of the challenge of getting spray material to the leaf underside. It is important to examine the underside of leaves when inspecting a crop that has been treated with a broad-spectrum protectant fungicide like chlorothalonil to determine if powdery mildew is present. Sulfur can provide some control on the underside of leaves due to its volatility enabling it to redistribute to the underside of leaves. For field-grown crops choose fungicides with FRAC Code U6, U8, 3, 7, and/or 11 active ingredient(s). Alternate among products in different FRAC Groups to manage resistance and to ensure effective control. Torino (FRAC U6), Vivando (U8) and FRAC 3 products like Rally are only effective for powdery mildew. Products with 2 active ingredients that have activity for other diseases include Aprovia Top (FRAC 3 + 7), Luna

Tranquilty (7 + 9), Quadris Top and Topguard (3 + 11), Inspire Super (3 + 9), Priaxor (7 + 11), and Miravis Prime (7 + 12). Revus Top (3 + 40) is a good choice when late blight is also present. Drop nozzles will improve coverage in trellised tomatoes and thus improve control especially with protectant fungicides. Fungicides listed above that can be used in high tunnels and greenhouses are Inspire Super*, Luna Tranquilty, Switch (not on cherry, grape, or other small fruit types), Torino*, and Vivando* (*no statement on label prohibiting which other product labels have). Additionally, Trionic (FRAC 3) is only for use in commercial greenhouse crops and on transplants. Fungicide program suggested for organic high tunnel and greenhouse tomatoes is a micronized sulfur like Microthiol Disperss until first fruit are nearing maturity, a non-oil product for 2 wks to avoid sulfur toxicity, and then a mineral or botanical oil during harvest period so visible residue will be minimal on harvested fruit.

New Fungicides.

Miravis Prime. pydiflumetofen (FRAC 7) + fludioxonil (FRAC 12). 12 hr REI. 0 d PHI. Labeled diseases include early blight, leaf mold, powdery mildew, Septoria leaf spot and gray mold (suppression only). Not permitted used on greenhouse crops. Accumulates in the wax layer of leaves and then translocates through them. Apply up to 2 times. Use in alternation with fungicides in different FRAC group.

Some Results from Recent Fungicide Evaluations.

Early blight and Septoria leaf spot. Excellent control of EB and good control of SLS were achieved with Bravo Weather Stik alternated with Fontelis or with Miravis Prime at low or high label rates. Among organic treatments tested, Stargus + Badge were effective for both whereas Stargus applied alone or with Regalia was ineffective; Badge was not tested alone. In another trial with just SLS, similar results were obtained with Bravo alternated with Miravis Prime or Luna Sensation or Aprovia Top, but alternating with Fontelis was not as effective. Aprovia Top, Fontelis, Luna Sensation, and Miravis Prime all have an SDHI (FRAC 7) fungicide. Control was reduced when Serenade was applied for 2 of 4 Bravo applications. Trials done in OH in 2018. In a trial conducted in PA in 2018, EB was also well controlled with Miravis Prime alternated with Bravo, better than Bravo alt Quadris + Bravo, which was similar to LifeGard, Double Nickel, or Champ alt Quadris + Bravo.

New Disease Resistant Varieties. An important component of a successful, integrated management program is resistant varieties. Some new round red tomato varieties and some of the important diseases in the Northeast that they are resistant to are: Mountain Gem (late blight, TSWV), Mountain Rouge (late blight), Mountain Vineyard (Fusarium wilt race 3, TSWV), Roadster (TSWV), and Resolute (TSWV, nematode). Edox is a leaf mold-resistant truss cherry for whole cluster harvest. Goal of the Cornell tomato breeding program is developing varieties with resistance or tolerance to early blight, late blight, Septoria leaf spot, bacterial speck, bacterial spot, and TSWV plus general resistance to insects. Varieties released recently with resistance/tolerance to early blight, late blight, and Septoria leaf spot include Brandywise (cross with Brandywine; organic) and Summer Sweetheart (heart-shaped large saladette; organic). Plum Perfect has resistance to late blight, Verticilium wilt, Fusarium wilt, and rootknot nematode.

Scientific Advancements for Developing Disease Resistant Varieties. Ability now to sequence DNA of plants and pathogens inexpensively and the CRISPR/Cas9 genome (gene) editing technology have enabled scientists to discover the molecular basis of plant-pathogen interactions, to find new genes for resistance, and to engineer plants to make new resistant varieties. Genome editing technology allows knowledge-based alterations to a plant genome such as to precisely knock out (silence) gene(s) responsible for susceptibility or to insert a gene for resistance from a related plant.

Grafting and Anaerobic Soil Disinfestation for Managing Soilborne Diseases in High Tunnel Tomatoes.

Over successive years of producing tomatoes in high tunnels, common due to it being the most popular and economic crop for this system, pathogens that survive in soil can increase to a level impacting yield. Grafting tomatoes to a resistant rootstock such as Maxifort has proven effective for root-infecting pathogens. Recent on farm studies in OH documented that anaerobic soil disinfestation is another viable option. First soil is amended with a carbon source such as wheat bran or molasses (both can be purchased at feed mills) at 4.5-9 tons/A (0.2065-0.413 lb/sq ft). Dilute molasses 1:3 to 1:4 with water. A watering can is suitable for applying the molasses solution. Green cover crop is also a suitable carbon source. Incorporate the carbon source to a depth of 6 to 8 inches with a rototiller. Beds can be formed after the carbon amendment is worked into the soil. Next irrigate to saturate soil to the depth of incorporation and until water ponds on the surface, which will take at least 4 hrs depending on soil type. The last step is covering treated area with a heavy grade black or clear plastic mulch promptly after irrigation, and burying edges well with soil to prevent air exchange. Leave for 3-5 wks. Beneficial soil microbes will break down the added carbon source, deplete oxygen in the soil and produce toxic byproducts that kill soilborne pathogens and a strong odor. Weed seeds are also killed. Treatment efficacy increases with increasing soil temperature and tarping duration. Three weeks can be enough time when soil temperature stays above 85 F. Afterwards remove the plastic and let soil dry and breath for at least 5 days before planting. Survey of OH farms revealed black dot root rot was present at most. Corky root rot, Verticillium wilt, and root knot nematodes were also found.

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

ARE YOU REALLY MAKING A PROFIT
OUR EXPERIENCE SELLING AT THE NYC GREENMARKET FOR 42 YEARS

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It was 1976 and we were all waiting on line to get gas in our cars. The price of gasoline went to .60 cents a gallon and my father was concerned that we could not stay in business due to rising costs. Along comes a guy from New York City who asked us if we would be interested in a new concept called Greenmarket. The idea was for local farmers to harvest and bring their fruits and vegetables direct to the people thus cutting out 2 -3 middlemen. The consumer got better veggies and the farmer would make more money….but does the farmer make more money...really? After a year or 2 at market we realized that we all had the same veggies..tomato, pepper, eggplant, corn etc., so in an effort to increase revenue we thought it was wise to have something when nobody else had it. Isn't that the secret to any business? Henry Ford had it. Thomas Edison had it. They seemed to be successful ...right?

So we started growing greenhouse tomatoes in 1981. We put 1 plant in one bushel basket of potting mix and filled a 30 x 96 greenhouse with them. We fed them when we could. We did not have any fertilizer injectors or ph monitors...so the plants got 20-20-20 and that was it. We did produce nice tomatoes, but the key was that we had tomatoes at the end of May when the rest of the region did not pick any until mid July. For 2 months we had something that people wanted and nobody else had. We could name our price and customers beat a path to our door. Home run right? Well….yes at least for a year or 2 until other growers started doing the same thing. To counter this we started to produce greenhouse tomatoes later in the fall. We planted August and harvested from October 10 to end of November. However this created other issues for us. In August we did not have the time to plant as we were busy with other things. The greenhouses are really hot then so we needed shade cloth and we needed labor to install it along with the added labor to trim and water the tomatoes. As we were still outdoor farmers we did not invest in automatic valves and timers to water so, although we had drip tubes in every basket, someone still had to turn it on a few times a day and wait for it to be done….more unanticipated labor! Fall tomatoes do not produce the same as spring grown due to shorter days, so we had all this added labor and half the production. Then we get to market in November and the outside temperature is 35-45 degrees...not good for tomatoes. Of course there is always that farmer who has a bunch of field tomatoes picked before frost and is ripening in the barn. He thinks its just extra money so he puts them out for .50 cents a pound. He thinks he's rich and although we had a better product we struggled because there is a huge segment of our population that shops by price alone. So like typical farmers we continued this insanity for many years because we thought that NEXT YEAR WILL BE BETTER! I think most farmers are all guilty of this thinking but I have found that radical change is not a bad thing. We have found that you regret the things you didn't do more than the things you did.. We do not have all the answers but it is our hope that today we can help you to be better at market

Our presentation today will focus on 3 areas of marketing. We will speak about **display**, **economics** and **social media** in an attempt to help you be better at market and to figure out if you are really making money or just spinning your tractor wheels.

DISPLAY

I remember on day 1 in 1976 we showed up with some old wood tables from the barn, patio umbrellas that were from the truman administration, and that was it. Many items were stacked up on the ground.

Fast forward to today and what we have learned. Our display is now way more slick and neat. We have as many items as possible on tables. Things for sale need to be between the thigh and the eye….that's not new but it needs to be said because many are not doing it.

Signage I have seen so many really good growers with really bad signs. Do not make signs from ripped or cut off cardboard. Make sure the message is short informative including the name of the item, price, common name. Most people would rather walk away if they have to ask a price...its intimidating for some people. Use waterproof signs and two colors. If you are not good at this find someone who is...or get a computer sign program. Make sure you have a larger banner with your farm name and town. Chalk boards are quaint but not good on a rainy or windy day.

Color We can't emphasize this enough. When people approach your stand 75% of their mind is already made up before they get there about whether they will be purchasing from you or not. Vegetables need to be on the table with color separation. You should not have collards next to broccoli etc. Try radishes next to anything all green. Yellow tomatoes next to red. Purple eggplant in rows..white, purple, blush, black. Have a color change at least every couple of feet. Consider a table cloth and be sure all the tables are the same color cloth.

Containers The container that your product is displayed in make a difference. Back in the day we used half bushel and bushel baskets. We put them on the table and we were open for the day. Today, although we still use some baskets we have found that we need new clean baskets. At our Lincoln Center market we use a lot of wooden apple boxes to create different levels of display. It looks just farmy enough and it creates other ways to showcase our product. Do not have boxes in your display that say another farms name especially if it is a farm from Florida or Canada etc. We grow greenhouse tomatoes and in NYC there is a segment of the population that thinks this means lab coats, clip boards and scientists. Our 10lb flats say the words "Greenhouse Tomatoes" on them so to avoid the questions and comments like "When will the real tomatoes be ready?" we either do not put the boxes in our display or we put tape over the word Greenhouse.. A bigger issue is how many people see the word greenhouse on the box...don't ask...and don't buy.

ECONOMICS

So you picked it all and went to market. It was a great day and you brought home $2,000. So how much did you make…? It's time for a reality check. This is a breakdown of costs for a market for us at NYC Greenmarket

1. Picking the day before..3 people...8 hours.$360..(payroll tax add $50)..$410
2. Truck tolls...turnpike,,tunnel….$48
3. Fuel .25 tank..$36
4. Insurance for vehicles and liability at market… $75
5. Market Employees...4 @ $140….$560...add food..$50…$610
6. Bags, scales, canopy, tables etc...per day..$40
7. Rent…. 36 feet….$300
8. Owner salary if they are working at market...(Ahhaa)....$200

9. Unloading the day after...2 people...1 hour…$30
10. Total expenses……$1774….profit….$226

Things to consider - Just because you take in a lot of money does not mean you are making a lot of money.
Farmer logic…. "I grew 2 acres of radishes and sold them all at $1/bunch. I did not make any money so next year I will grow 4 acres of radishes" This is the wrong approach and we sometimes get sucked into thinking this way. I would rather grow ¼ acre of radishes and sell them at $2.50/bunch. I would make more money and do an eighth of the amount of work. Let's compare 2 stands at my market
Farmer #1….takes 50' of space..has 10 employees...2 trucks..so double tolls,fuel,insurance
They sell tomatoes for $1.50/lb and they sell 50 boxes/day…$1875
Gross for all other vegetables……..$6,000
Expenses…….$3500…….. Net of $4,375
Farmer #2...takes 12' of space...has 1 employee
They sell microgreens, day neutral strawberries, and hydro lettuce
Gross…….$3800
Expenses……..$660……..net of $3,140

SOCIAL MEDIA

You need to have a presence on social media. If you don't know how to do it you better hire someone who can do it for you. If you are anti - computer and want to be old school just remember that Darwin was right. If you don't adapt and change you will perish.

FACEBOOK Your farm needs to be on here to alert people about what's going on...what crops are coming to market etc. People love pictures and they love to see what you are doing. Include your failures as well as your success stories. If you have a CSA you should make a private group just for them to share recipes and to alert them to any specials available for CSA members only.

INSTAGRAM This is a newer platform which is more photo oriented. It is faster than facebook. Have someone be in charge of it. Take photos and post regularly. Remember to put up a sign at your farm stand with your address so people can follow you. If you are older and resistant to this remember, you don't have to like it...but you really should do it if you want to increase sales.

Some thoughts about the ever changing consumer

1. They want what they want...they don't care about drought or rain or your problems.
2. They will give you $8 for a bunch of flowers which will be dead in 5 days but they will complain about your vegetable prices.
3. The reasons they shy away from common vegetables…..Do I have to cook it?...Do I have to clean it?.... For younger people..they won't do either.
4. They don't know the difference between quarts, pints, half pints. We have heard them ask why our strawberries (quarts) are more expensive than the other guys (pints) . Our sign says $8/ quart...his sign says $6/ box….he sold out.
5. They cannot do addition unless its on their phone
6. They are very entitled. I WANT IT NOW!
7. Above all they want convenience. In and out quick. Pre packaged etc.

8. Like it or not customers now have YELP and can leave you a bad review

TRAINING AND PRUNING HIGH TUNNEL TOMATOES

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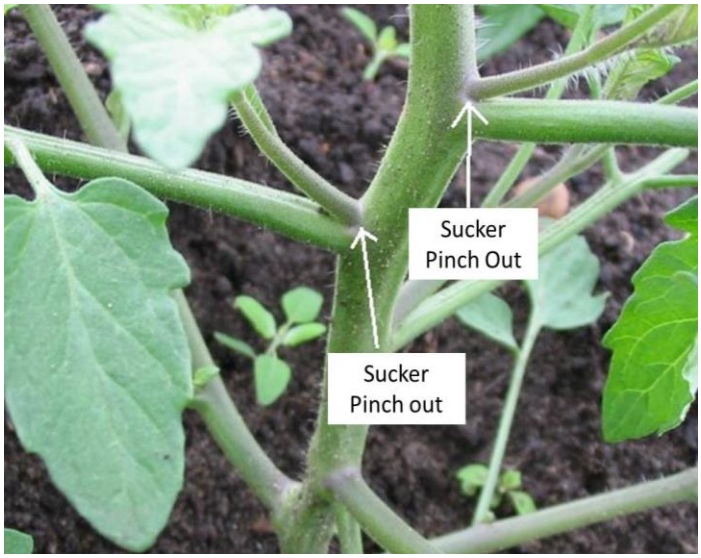
Tomatoes thrive in the protected conditions of a high tunnel. Well trained and well pruned tomatoes are easy to work around, have better air circulation, optimum light penetration, and have higher yields since excess foliage is removed to focus plant energy on producing and ripening fruit. If left untrained, tomatoes will quickly form a tangled mess that is difficult to maneuver through and harvest, and problems can go unnoticed until they are too late to stop.

A well-managed planting allows room for the grower to move down the aisles for harvesting, training, and scouting to catch any pest and disease problems early. There are two key types of tomatoes based on their growth habit called determinate and indeterminate, and they are managed differently.

Determinate tomatoes grow to about 4 feet high and produce most of their fruit in a few weeks, although they will continue to bear some until frost. They have a bushy habit and do best with support along their sides to hold the plant upright.
Indeterminate tomatoes keep growing and bearing as long as conditions stay warm enough. They are essentially a vine and produce the most fruit when carefully pruned and trained vertically.



All tomatoes produce suckers above every leaf. Left unpruned, each sucker will grow into a shoot with leaves and fruit. If every sucker remains, all those shoots, leaves and fruit compete with each other for food, light and water. By limiting the number of suckers and leaves, plant energy is directed to the remaining shoots for optimum yield and quality. It is best to remove suckers while still small to direct plant energy upward.

As tomatoes grow taller their lower leaves become unnecessary. Removing the lower leaves allows for better air circulation for less disease pressure.

Training and Pruning *Determinate* Tomatoes
(ex. Red Bounty, Red Deuce*, Celebrity, Primo Red*, Volante)
** leaf mold resistant variety*

Provide *horizontal* support
1. Set the plants at the proper spacing.
2. Set a 5' stake into the ground between every 2 plants.
3. Weave the twine around and between each plant in a Figure 8 pattern, starting at 8" from the ground and repeating every 6-8" as the plants grow. The plants will grow to about 4' tall so continue adding twine to provide even support for the plants.
4. This is called the basket weave, the Florida weave, and/or the stake and weave system.

Prune to the 'Strong Y' (see photo, right)
1. Remove the leaves up to the first flower cluster.
2. Leave the sucker just under the first flower cluster and remove all suckers below that point.
3. The stem should now look like the letter 'Y' (yellow dotted line in Figure A).
4. No more pruning is required.

Training and Pruning *Indeterminate* Tomatoes
(ex. Arbason, Big Beef, Geronimo*, most Heirlooms, Panzer*, Rebelski*)
** leaf mold resistant variety*

Provide *vertical* support
1. Decide on 1 or 2 leaders per plant. Heirlooms and grafted plants do best with 2 leaders, newer growers find 2 leaders easier to manage. Hybrids do well as a single leader.
2. Set the plants at the proper spacing. Allow 24" in-row spacing between each leader.
3. Drop a line down from the overhead support, 1 line for each leader.
4. Use a tomato clip to fasten the line below the first leaves, add clips every 6-12" up the stem. Be sure the clip holds the line in its hinge.
5. Ensure the structure can bear the weight of the crop without bending the frame.
6. Consider running the lines from a spool so the plants can be lowered as they grow to facilitate harvesting. Several models are available.

Pruning Indeterminates
1. For a single leader, remove all suckers and all leaves below the first flower cluster. The result is one long vine-like leader with no side shoots.
2. For a double leader, establish **The Strong Y**. Each arm of the Y will become a leader, 2 leaders per plant.
3. Maintain the leaders throughout the entire growing season by continually pruning off all suckers that form. This will need to be done at least weekly, especially during the first 6 weeks.
4. Continue removing lower leaves as each fruit cluster is harvested. Remove leaves gradually, a few each week, rather than too many at once.

5. When using a spool, lower the vines as the lowest fruit clusters are harvested; this brings the ripening fruit down to a level easier to reach for harvesting and pruning. The vines will bend as they are lowered.

Tip: Removing Lower Leaves

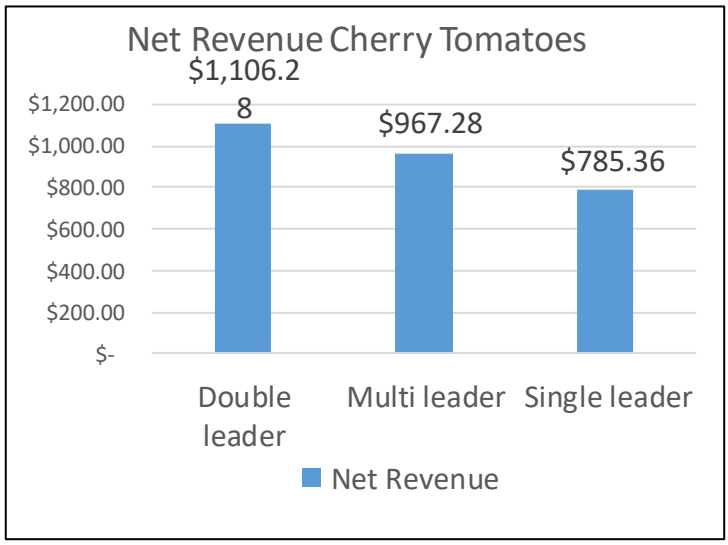
A handy method of removing leaves is to first bend the leaf upwards and then downwards. Listen for a soft 'snap' with each movement. If the leaves only bend and do not snap, use a sharp knife to cut them off close to the stem.

Snapping is preferred to cutting so the leaf can separate at its natural point of attachment. Use caution to not tear off the leaves which may leave a ragged stump or tear that will be slow to heal over. A clean snap will seal off quickly. Remove lower leaves up to the first fruit clusters for increased air circulation. *The photo (right) shows bare stems with plenty of air circulation and no leaves touching the ground.*

Cherry Tomatoes Pruning Trial 2017 Results

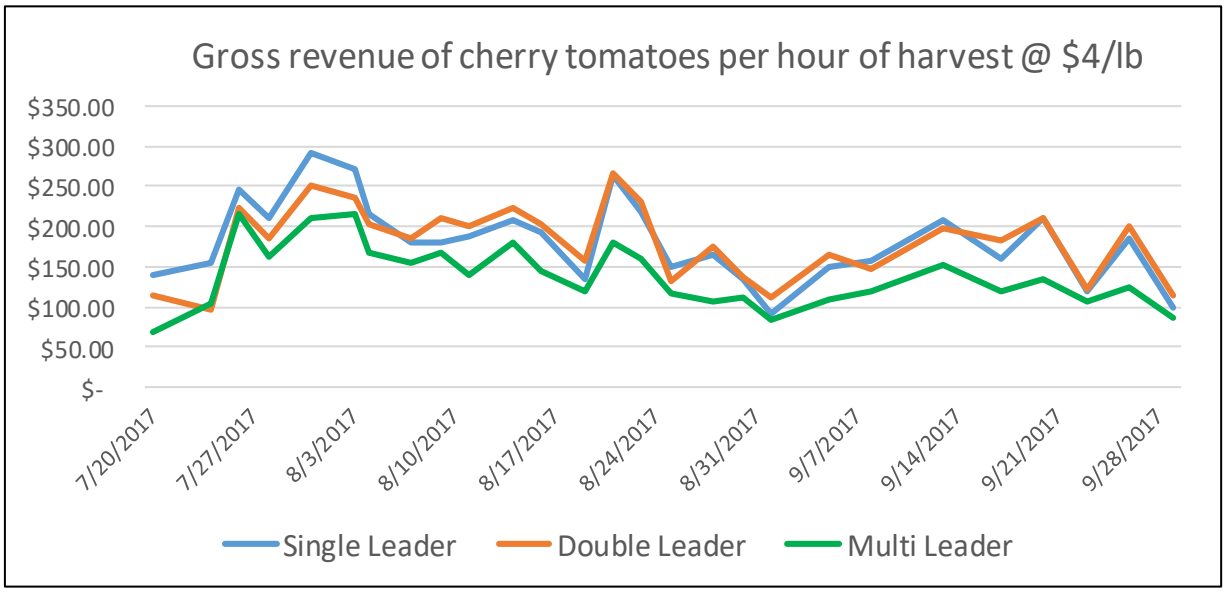
Left unpruned, cherry tomatoes quickly become a tangled mess, especially when grown under the protection of a high tunnel. Growers question whether it's worth the time and effort to prune and train them. This was the second season we studied three different pruning methods and our conclusion is even stronger: training to the double leader system provided the most benefits as measured by labor efficiency, yield, and net revenue.

The three systems we studied were single leader, double leader, and multi leader. We began the multi leader treatment as a double leader but stopped pruning at the first harvest, doing only minimal training to keep the long shoots out of the aisles. We continued to prune and train the single and double leader treatments throughout the project.



The single leader took the least time to prune, train and harvest but had a significantly lower yield. Using $12/hour for labor and $4/lb for gross price for 200 plants, the double leader system in our trial would have brought an additional $1390 in net profit over the multi leader system.

And because labor is the largest expense on most vegetable farms, the increased efficiency of harvesting the double leader system over the multi-leader is another important factor. Our average yield per hour of harvest was 45.1 lbs/hr for the double leader compared to 34.8 lbs/hour for the multi leader due to the dense, tangled growth that develops when left unpruned.



This graph shows the efficiency of harvesting each treatment. The multi leader (green line) is consistently the least efficient to harvest due to denser growth.

This project was funded by the Northern New York Agricultural Development Program which is supported by the New York State Senate and administered by the New York State Department of Agriculture and Markets. The detailed report of these trials will be posted at www.nnyagdev.org

For more information on high tunnel production and detailed factsheets to download visit: http://hightunnels.cals.cornell.edu

Session 7

Greenhouse and Hydroponics

TRENDS IN COMMERCIAL HYDROPONIC FRUIT AND VEGETABLE PRODUCTION

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The hydroponic production of commercial horticulture crops is anything but new. After a very short Google search one will realize that the Dutch have been producing crops in controlled environments using hydroponic irrigation methods for decades.
What is new, however, is the current evolution and revolution the commercial hydroponic production industry is undergoing outside of that small country in northwestern Europe. Whether in the United States, Canada, Japan, Dubai, Australia or other countries around the world, entrepreneurs are dreaming up new ways to farm.
New ways to solve current production problems created by increased labor costs, climate change and shifting consumer demands. New ways to generate interest from investors and a new generation of workers now interested in farming. And finally, new concepts to solve future problems and future “food” demand issues by changing the way we look at farming and value food.

In this 30-minute presentation we will look at three trends in hydroponic production methods. These trends will allow both forward-thinking and traditional growers to aggressively tackle current and future problems. These trends will also help to produce novel solutions that will hopefully create a positive economic outcome for these growers’ farming businesses.

The trends are:
1. The use of LED grow light technology in both supplemental and sole source lighting applications to produce crops close to markets in a wide variety of climates.
2. The use of hydroponic irrigation systems to tackle labor issues, climate change and loss of registered pesticides.
3. The modification of traditional production and irrigation systems to create novel systems that take advantage of optimization technologies like robotics and artificial intelligence (AI.)

It is not completely clear which of these trends will stand the demands and challenges of an ever changing and highly competitive market. However, it is quite clear that production horticulture and agriculture will need to evolve in order to solve both internal economic business issues and external challenges and opportunities.

ENERGY IN GREENHOUSES

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Energy is a significant concern for most New Jersey greenhouse growers. Heated greenhouses, particularly those in use during the coldest parts of the year, require substantial energy to keep plants warm enough for optimum growth. Heating is typically the largest component of greenhouse energy use in New Jersey. Electricity use, particularly in greenhouses that use extensive supplemental lighting to promote plant growth, can also be a large component of energy use.

Because heating can be such a significant part of greenhouse operating costs, it helps to understand how greenhouses lose heat to the outdoors. The largest component of greenhouse heat losses is through the surfaces of the structure. This includes losses to the ground, through the floor and the perimeter of the space, but most energy loss is to the outside air, through the roof and walls. The amount of heat transferred, by conduction and radiation through walls and roofs, depends on the difference between indoor and outdoor temperatures, the surface area of the greenhouse and the insulating properties of the exterior surfaces. In general, the warmer the greenhouse air is, the more heat energy will be needed. Also, greenhouses with more surface area will require more heat.

Because plants need sunlight, greenhouse walls and roofs are typically transparent or translucent. The most common materials are glass, polyethylene, acrylic and polycarbonate, usually in relatively thin layers, with poor insulating properties. Adding additional layers help provide more insulation, but typically greenhouse roofs and walls have little resistance to heat transmission to the outside. Greenhouses can also lose a lot of heat when warm air leaks to the outside and cold outdoor air takes its place. Any breaks in the roof or wall coverings, cracks and other openings allow air exchange that results in heat losses.

In addition to the energy efficiency of the greenhouse structure, the amount of fuel required to produce the heat required to keep plants warm depends on the efficiency of the heating system. Both the heating plant (boilers, furnaces, unit heaters, etc.) and the distribution system (pumps, pipes, blowers, etc.) contribute to the overall efficiency of the heating system. With these considerations in mind, an approach to reducing the energy used for heating greenhouses will minimize the heat losses through roofs and walls, reduce air infiltration through cracks and other openings, and improve the efficiency of the heating system.

There are several strategies for cutting down on heat losses through the greenhouse coverings:

- Use more layers – double polyethylene or multi-layer acrylic or polycarbonate coverings reduce heat losses by a third or more, as compared to single layer glazing.

- Install energy curtains – a well-sealed curtain can reduce heat losses by a quarter to a third. Installing multiple curtains will increase the savings, but with diminishing effect with each additional layer. Curtains can also help provide a better environment for the crop, by providing shading during warmer months and by increasing nighttime leaf temperatures during winter nights.
- When considering building new greenhouse space, evaluate the possibility of gutter-connected structures rather than stand-alone facilities like hoop houses – gutter-connected greenhouses have a lower surface to floor area ratio. Large contiguous spaces can also allow for more efficient space utilization and better labor management.
- In double polyethylene covered greenhouses, use infrared blocking plastic – this can reduce heating requirements by 5 to 25%, and is particularly effective in hoop houses which have relatively high surface areas and where it is difficult to install energy curtains.
- Use wind barriers – these are particularly effective in windy areas and can reduce annual heating requirements by 2 to 5%. Just make sure that they won't shade the greenhouse.
- Reduce nighttime temperature setpoints (as long as it won't affect plants) – this can result in savings of 5 to 10%.
- Install insulated knee walls.
- Insulate perimeter walls below grade.
- Maximize space utilization within the greenhouse, and reduce temperatures in areas that are not being used to grow plants.

To limit air infiltration:

- Caulk and weather-strip doors, windows and other openings.
- Repair damaged or misaligned ventilation shutter and vents.
- Repair broken, torn or damaged glazing as soon as possible.
- Seal all cracks in walls, paying particular attention to the bottom of the wall.

Higher efficiency heating systems can include the following:

- Use of high efficiency heaters and boilers – equipment efficiencies of as much as 95% can reduce energy use by 10 to 20%.
- In hot water systems, consider installing condensing boilers.
- When using gas fired unit heaters, consider direct-fired, high efficiency equipment with dedicated outside air intakes.
- When using oil as the primary fuel, install a flame retention burner that provides better mixing of fuel and combustion air, for energy saving from 15 to 20%.
- Insulate main distribution piping in hot water systems.
- Deliver heat where it is needed – use floor heat or under bench heat where practical. Hot water systems are typically more effective than hot air at providing heat to the growing area.
- Maintain equipment so that it is operating at peak efficiency – this can save 5 to 10% of energy costs.

Energy costs can also be reduced by purchasing fuel wisely. Shop around for fuel suppliers, watch trends in fuel prices, and, when possible, time fuel purchases to avoid high cost periods.

An efficient environmental control system can also reduce energy use by 5 to 10%. Modern control systems provide features that allow you to:

- Use ramping to transition between daytime and nighttime temperature setpoints for savings from 2 to 5%.
- Implement more complex control strategies that promote better plant growth and reduce energy needs.
- Avoid multiple thermostats for a single space – computer based controls only need a single sensor, avoiding the problems created by multiple mechanical sensors that aren't always consistently calibrated.
- Use historical data recording and review to discover problems that may occur when the greenhouse is unattended.
- Support the use of variable speed fans and pumps.

Greenhouse that use lights to supplement sunlight for plant growth typically have high electrical use, and in these facilities the cost for electricity can exceed heating costs. Measures to minimize electricity costs for supplemental lighting include:

- Using intelligent controls and advanced strategies for scheduling lights.
- Set fixture heights and spacing in accordance with manufacturer's recommendations and to achieve best uniformity and optimum illumination levels.
- Design for illumination levels and schedules that are most appropriate for the crops' needs.
- Use high efficiency fixtures – use LED lights where appropriate.

For greenhouses that don't use supplemental lighting, fans and pumps can account for much of the electricity use. Energy saving opportunities include:

- Installing variable speed exhaust fans.
- Running HAF fans only when appropriate – in mechanically ventilated greenhouses HAF fans may not be useful when exhaust fans are running.
- Use high efficiency motors in fans and pumps.
- Limiting the number of exhaust fans that run during nighttime hours.

Don't forget the energy use in headhouse and office areas:

- Use high efficiency lighting and task lighting in areas that are occupied for significant amounts of time.
- Turn off lights when not needed and use occupancy sensors where appropriate – Instant-on bulbs like LED and strip fluorescents may be more practical in some cases.
- Minimize air infiltration by keeping doors and other openings closed, using automatic openers and closers, sealing cracks and maintaining weatherstripping.
- Consider installing warm floors or other forms of radiant heat.

Useful resources:

- Scott Sanford, *Reducing greenhouse energy consumption – An overview*, A3907-01, University of Wisconsin, 2011.
- Erik Runkle and A.J. Both, *Greenhouse energy conservation strategies*, Extension Bulletin E3160, Michigan State Extension, November, 2011.
- eXtension Farm Energy IQ, Greenhouse Energy Efficiency. (https://articles.extension.org/pages/72634/greenhouse-energy-efficiency)
- Robert Aldrich and John Bartok, *Greenhouse Engineering*, NRAES, 1994.

SUPPLEMENTAL LIGHT IN GREENHOUSES

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Recent advances in light emitting diode (LED) technology have resulted in an explosion of product offerings from a wide range of lighting manufacturers. Potential advantages of LED lamps compared to conventional light sources such as incandescent, fluorescent and high-intensity discharge lamps include increased efficiency and the option to manipulate the light spectrum. The increased efficiency reduces the cost to operate the lamps, and tailoring the spectrum to specific plant needs can produce a higher quality crop. It is also common to read a statement like: *LED lamps do not produce any heat*, but this is misleading. LED lamps do produce heat, their conversion efficiency (converting electricity into useful light) is typically around 30%, but this heat is mostly convective heat.

Almost all high intensity LED lamps have a heat sink (often a metal casing with some type of fins) that is used to transfer most of the heat they produce to the surrounding air. By moving air (either actively with a fan or passively) around the heat sink, this heat can be easily removed from the plant production area. As a result, LED lamps can be placed closer to the plant canopy, reducing potential light losses resulting from light that does not reach the leaves. By contrast, high-intensity discharge lamps such as high-pressure sodium and metal halide lamps, produce mostly radiant heat (their conversion efficiency is very similar to that of LED lamps) that is directed to any surface within a direct line-of-sight from the bulb. This radiant heat is more difficult to remove from a growing environment and often causes a temperature increase in any plant tissue directly exposed to the radiation source.

While the advantages of LED lamps make them an attractive alternative for crop lighting, the better models are still more expensive to purchase and limited information is available about what the best lighting strategy is for a particular plant species. The ability to (continuously) adjust the light spectrum has opened up exciting new opportunities, but researchers still have a lot of work to do to determine the most effective and economical applications for LED lamps.

For seedling production and depending on plant species, plant germination does or does not require light. Growers typically cover seeds with a thin layer of growing media when plants only germinate in the dark. The higher the germination percentage, the more economical the production system, so growers aim to provide the best environment for optimal germination. When only small batches of seeds are germinated at a time, the conversion efficiency of the lamps is less critical because only a few lamps are used. Obviously, this is different for large commercial operations where

optimum lamp selection can make a big difference. While germination areas are typically designed for high plant densities, not all of the light will reach plant surfaces (especially during germination and seedling establishment). Therefore, increasing light intensities does not always result in improved seedling growth. Increasing the amount of red light immediately after germination can increase leaf surface area, but too much red light can result in too much stretching, resulting in spindly seedlings. Some experimentation may be needed to find the optimum light spectrum during germination and early seedling establishment.

When plants have established a full canopy, we can use LED lamps to provide supplemental or sole-source lighting, depending on whether plants are grown in a greenhouse or an indoor environment, respectively. Research has shown that plants use red (600-700 nm) and blue (400-500 nm) light most efficiently during the process of photosynthesis. Several lamp manufactures have used this information to design LED lamps that produce a combination of red and blue light, resulting in an overall magenta light color. While this light color may be very efficient in terms of photosynthesis, it makes it very difficult to observe true colors because plant surfaces appear mostly black. Thus, observing color changes as a result of nutrient deficiencies or diseases becomes virtually impossible. Adding green light, or using white light instead will alleviate this problem. Additionally, providing far-red light (between 700 and 800 nm) has been shown to improve plant photosynthesis. Finally, some plants accumulate antioxidants (e.g., anthocyanins) when grown under sunlight that contains a small amount of ultraviolet (UV) light (280-400 nm). Therefore, UV light (in addition to adequate amounts of blue light) is sometimes added to the spectrum provided by electric light to ensure an adequate accumulation of antioxidants (e.g., red lettuces). However, depending on the intensity and specific wavelength, UV light can be damaging to biological tissue, so care should to be taken so as not to harm plants and people exposed to UV light.

Because plants need a lot of light for proper growth and development, selecting the most efficient light source that produces the appropriate light spectrum is an important decision. In addition, other environmental factors (e.g., temperature, humidity, carbon dioxide concentration, growing media moisture content) are important and can interact with the light intensity and spectral characteristics. An excellent reference on his topic is the book: *Light Management in Controlled Environments (2017)*, edited by my Michigan State colleagues Roberto Lopez and Erik Runkle. For additional information, growers are encouraged to reach out to plant lighting experts and Cooperative Extension personnel to discuss the best lighting strategy for their operations.

Session 8

Organic

A CHRONOLOGICAL HISTORY OF ORGANIC AGRICULTURE: 1900 – 2018

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Students, farmers, and customers of USDA Certified Organic Products are often unfamiliar with organic agriculture's origin and evolution and are challenged to fully appreciate its distinctive characteristics. With biology, the importance of studying the origin and evolution of life is obvious and the principle is likewise applicable to teaching about organic agriculture. While the USDA National Organic Program (NOP) codifies the terms and practices that comprise organic production and handling, federal regulations fail to fully convey the nuances of an ecological, site-specific system of farming. Farmers interested in adopting organic practices and pursuing certification may read every word of the NOP standards without gleaning much insight into the foundational principles of organic management. For their part, students and customers investigating organic farming will routinely encounter anecdotal information about its practices, materials and outcomes which lack a meaningful connection to its origins and development. A display of the chronological history of more than a century of milestones in organic farming including people, places, events, and ideas can serve as an educational vehicle. A timeline organized into a poster can present the history leading up to the 1990 legislation authorizing the NOP and subsequent events involving implementation and market response to the federal certification program. The presentation will contain historic photographs, graphics, and facts to illustrate spatial and temporal trends and explain context. Highlights from the pre-NOP period will include an international perspective on how pioneers (Howard, King, Steiner, Northbourne, Price, McCarrison, Balfour, Rodale, Carson) of the organic agricultural movement were influenced by observing agricultural practices and food systems from around the world. Comments from current actors involved in the organic movement are invited to contribute new material and add to my proposed timeline and narrative.

References:

Heckman, J.R. 2006. A History of Organic Farming: Transitions from Sir Albert Howard's War in the Soil to USDA National Organic Program. Renewable Agriculture and Food Systems. 21:143-150.

Heckman, J.R. 2017. Securing Fresh Food from Fertile Soil, Challenges to the Organic and Raw Milk Movements. Renewable Agriculture and Food Systems, Cambridge University Press.

Organic Seed Selection and the Commercial Availability Standard

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We are closing in on the twentieth anniversary of of the USDA organic certification program which was formally established on December 21, 2000. There is much to celebrate about the public's embrace of the USDA organic seal and the opportunities it has created for farmers to receive price premiums for their hard work. Having a consistent national organic standard has also spurred innovative research at land grant institutions in core organic practices such as soil health, cover cropping and grazing that can directly benefit conventional farmers as well. No federal regulatory program is launched in perfect working condition and we could spend considerably more than the half hour I am allotted to discuss ways in which the USDA organic standards could be improved. However, my topic – the requirements for selecting seeds and planting stock for organic crop production - is one element of the original organic standard that USDA had right from the beginning.

Regrettably, more than a few voices in the organic community are currently pushing hard to advance an incorrect reading of the organic seed selection standard. These voices, among whom actual certified farmers are in short supply, cite numerous perceived benefits for having farmers significantly increase the amount of certified organic seed they plant. As co-author of the original USDA organic seed search standard and an inspector who frequently sees it misapplied today, nothing frustrates me more than having farmers jeopardize productivity – and their livelihood - by planting organic seed when a preferable but non-organic alternative exists. I'll first explain the conditions under which organic farmers can plant non-organic seed, then address why exercising that right is so important to them.

Two statutory provisions protect a farmer's right to plant non-organic seed when appropriate conditions have been satisfied. The first is their prerogative to plant the specific crop variety which they expect will perform best under the site-specific conditions on their operation. Variety selection can be based on performance attributes such as early maturity or disease resistance *or* on the variety's potential marketability. For example, a farmer with specific marketing requirements, such as raising crops under contract, can plant whichever variety best meets their need.

Deciding which variety to plant – a determination which rests solely with the farmer - is the basis for all subsequent decisions about the source and certification status of the seeds they plant.

The second provision establishing the right to plant non-organic seed is the commercial availability standard. This standard allows farmers to use a non-organic input when an organic version is not commercially available in "appropriate form, quality, or quantity." The commercial availability standard is narrowly written – there is no allowance to plant non-organic transplants, for example – but it specifically applies to seed and planting stock. Certifying agents typically require a farmer to search for their preferred variety by contacting a minimum of three seed suppliers before allowing them to plant nonorganic seed.

It is noteworthy that the definition of commercial availability includes "quality" as a criterion for planting non-organic seed even when that variety is available in certified form. Farmers are generally aware that seed from different suppliers can vary significantly in the attributes that matter most – germination, trait expression and yield. However, they may not realize the standards specifically authorize farmers to plant non-organically produced seed when it is known to be of superior quality to alternative certified sources.

Let me address three assumptions behind the position that increasing the amount of organic seed planted by organic farmers will be universally beneficial.

1. Certified organic seed is inherently better than non-organic seed.

At first glance this would appear to be more of a truism than an assumption, since organic practices are known to promote crop quality. However, there are far too many variables in seed production for organic certification to serve as a stand-alone indicator of superior quality. Primary among these variables are the quality of the genetic resources available to the breeder and their skill at raising, harvesting and handling seed that will germinate, breed true and yield well.

Let me illustrate this point with the experience of a farmer who had a long and successful relationship with a respected seed supplier who provided the majority of his planting needs. Most of the varieties he planted were not certified, but he documented his variety selection and seed search obligations as described above. His certifying agent, however, was not satisfied with these efforts. The certifying agent established an arbitrary threshold that 70% of all crop varieties be planted using organic seed and repeatedly pressured him to reach that threshold.

No farmer relishes a disagreement with their certifying agent – their business model is typically predicated on remaining organic. Time spent debating with the certifying agent is also time not spent farming. The farmer contacted his primary supplier and switched to newly available organic seed for a variety of slicing tomato he had long grown from conventional seed. He planted an entire high tunnel with organic seed but experienced complete crop failure as the tomatoes – managed comparably to his previous crops – never matured beyond the size of a golf ball.

The farmer contacted his seed supplier who informed him that to make that organic seed available to him, they had acquired it from a new contract grower. The supplier reimbursed the farmer the cost of the failed seed (and presumably dropped that contract grower), but the damage was done. The farmer let down longstanding customers and lost $30,000 in potential revenue. The fact that his certifying agent subsequently dropped the 70% organic seed requirement proved to be a very costly silver lining.

2. Farmers should plant varieties specifically developed for organic production.

Advocates for compelling organic farmers to increase their use of organic seed frequently assert that seed varieties bred under organic conditions will outperform varieties that were developed using conventional practices. They maintain that organically bred seeds will contain and ultimately express traits that optimize performance when those varieties are raised under organic conditions.

I will leave the merits of this position to those with more plant breeding expertise, but there are practical considerations why writing it into organic standards would be disastrous for farmers. There are far too few seed varieties that satisfy this criterion for farmers to have a reasonable opportunity to identify ones that will work for them. And since the identification, development and commercialization of new varieties requires years of expensive effort, it is unrealistic to think that a new generation of organically-bred seeds is imminent.

By contrast, the conventional seed industry offers thousands of time-tested crop varieties that can be expected to perform reliably under farmer's diverse growing conditions. Some of these varieties date back centuries while others were indeed developed using conventional breeding practices, though any seed bred through the use of genetic engineering is categorically prohibited in organic farming. The romantic notion that organic farmers should plant organic-specific varieties would eliminate the vast majority of the genetic material on which the organic movement has been built.

3. Requiring farmers to plant more certified seed will stimulate growth in the organic seed sector.

This is an appealing argument since, as Thomas Jefferson said, "The greatest service which can be rendered any country is to add a useful plant to its culture." However, placing the interests of the organic seed sector ahead of the broader community of organic crop farmers is both unfair and counter-productive. The farmer in the example cited above certainly did not benefit when a supplier sold him inferior seeds that happened to be certified.

The bottom line is that private seed breeding and sales companies control by far the deepest and richest repository of crop germ plasm in the world. Punishing organic crop farmers by restricting their seed choices cannot guarantee that these companies will make their resources available in certified form. Many of these companies are

simply too large for it to be worth their while – should that prevent farmers from accessing their invaluable resources?

The structure of the domestic organic produce market also reveals an important consideration on the topic of organic seed. As with its conventional counterpart, the organic produce market is dominated by extremely large producers operating primarily in California's Central and Salinas Valleys and Baja, Mexico during winter. These companies often plant proprietary varieties which by law they are under no obligation to certify. Why should these giants freely plant non-certified seeds if their far smaller competitors are being pressured *not* to do so?

Let's consider how basing standards these three assumptions would impact the most pressing challenge facing organic farming in America today – increasing the domestic production of organic corn and soybean. Heavy dependence on imported sources for these crops – much of which is known to have been fraudulent - has seriously undermined confidence in the integrity of organic certification. Raising certified feed crops here in the United States will be essential for the continued growth of the organic livestock sector. It would also represent a tremendous opportunity to recruit conventional farmers tired of below-cost-of-production grain prices.

Very few of the corn and soybean varieties needed to expand domestic organic production of these crops are available in certified form. I am not aware of any that were bred specifically for organic production systems. In the current marketplace, conventional seed suppliers make their varieties widely available in non-organic form and are capable of rapidly expanding production should demand increase. Significantly restricting the genetic resources available to farmers by pressuring them to plant certified seed from unproven suppliers would mean an end to increasing domestic production of organic corn and soybeans.

I sincerely wish that every farmer applying for or renewing organic crop certification fully understood their rights under the organic seed standard. I can't count the number of times while conducting an organic inspection that a farmer has revealed that they elected to plant an organic seed because they thought it was required or they wanted to avoid conflict with their certifying agent. I do not dispute that there are potential benefits to increasing the usage of organic seed and I applaud those seed breeders who are working within organic production systems to develop new and improved seed varieties. However, organic crop farmers should not be compelled to pay the very high costs that come with improperly limiting their seed choices to those often very limited options.

All organic farmers would greatly benefit from learning that the standards protect their right with proper documentation to plant non-organic seed. Is it too much for organic farmers to ask when they put their livelihoods on the line every planting season that they get to select the seed – both the variety and source – they believe gives them the greatest opportunity for success?

USING BIOCONTROLS TO MANAGE APHIDS IN HIGH TUNNELS

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Aphids are a key pest of high tunnel crops causing several problems. When populations are high, they cause cupping and distortion of leaves, which stunts plant growth and fruit and flower formation. They also secrete honeydew, on which sooty mold can flourish. Some aphid species can also transmit viruses. Populations can also grow rapidly if undetected and can be an unsightly for customers to find.

Using biocontrols to manage aphids can be an important part of an Integrated Pest Management or 'IPM' approach. Scouting to determine the pest infestation level is a crucial step in using biocontrols successfully. Plant damage is often the first and easiest sign of aphids. Look for cupping and distorted leaves and honey dew. In addition, other evidence of their presence includes ants and cast skins of aphids. As aphids increase in size, they shed their exoskeletons which are called cast skins. These are white in color and can be confused with whiteflies. Also look for ants as ants and aphids can develop mutualistic relationships where the ants receive honeydew in exchange for protecting the aphids. When a lot of ants are present in an area, check for the presence of aphids as well.

Record keeping is strongly recommended to keep track of when aphid and other pest outbreaks occur, the timing of biocontrol releases, and to assess the effectiveness of treatments (biocontrol or insecticide). It starts with developing simple scouting forms. Sample scouting forms can be found on these web sites: https://pestmanagement.rutgers.edu/ipm/vegetable/scouting/ https://ag.umass.edu/vegetable/outreach-project/new-england-pest-scouting-network.

These forms should serve as a starting point and will be adapted to your operation. Other records to keep include maps of the tunnels with types and cultivars of plants grown and IPM strategies used. The species of aphids and host plants, your personal tolerance for each pest and how you manage them will determine your action thresholds. An action threshold is the pest population level that you consider high enough to warrant treatment. For example, because it takes time for a natural enemy population to increase enough to combat an aphid problem, your action threshold for using biological control may be lower than for insecticides, which usually has a quick knockdown effect.

Every employee who works with the crop over the growing season should become familiar with aphids and other key pests and their biocontrols so they can alert you to an emerging problem. Personnel availability and time of year determines how often to scout. When starting out, you might want to scout each tunnel once a week. With experience you may change the frequency. More frequent scouting should be conducted when transplants are set or when seedlings emerge. Later in the season, every other week may suffice until plants are removed from tunnels. A set monitoring routine is ideal; however, whenever the plants are handled, scouting should be practiced.

Useful tools for scouting aphids include a hand lens, sticky cards, flags or flagging tape, bags and/or vials, and a camera. The hand lens allows you to magnify small items. A 10X magnification is generally sufficient. Sticky cards are useful for determining the presence of

winged aphids and other flying insects. Start out placing 1 sticky card per 100 feet of row and adapt the number of cards to your situation. Replace sticky cards periodically when they get dirty. It's important not to rely only on sticky cards for monitoring. Aphids show up on cards after they develop wings, which is commonly in response to overcrowding on an infested plant. Aphids on cards usually indicate a severe infestation on the crop, which may reduce the success of a biological control treatment.

Plant inspections are needed to find non-winged aphids and other wingless pests that have not reached high enough levels on the crop to be detected on sticky cards. It's useful to scout two types of plants: random plants and flagged plants. For random plants, arbitrarily select plants to scout that represent the crop mix in the high tunnel. If you are growing different types of vegetables in your tunnel, scout plants of each type and cultivar. A starting point is to scout 1 plant in each 20 feet long section of row, which equals 5 plants in a 100 foot long row, for spring and summer crops including tomato, pepper, eggplant, and cucumber. Start out scouting 2 plants in each 20 foot long section of row or 10 in a 100 foot long row for leafy greens. As with the frequency of scouting events, the number of plants you scout depend on your situation.

If high pest populations are found on any random plants, mark them with a flag or flagging tape. This is a reminder to come back and check that plant during the next scouting event and to mark areas that may warrant treatments. You don't need to flag all plants with pests, only a few to help determine if your management treatments are working. This allows for you to monitor the numbers of natural enemies relative to pests and to determine the efficacy of a pesticide application.

Each pest has a preference for where within a plant to colonize. In addition to scouting a representative number of plants throughout a tunnel, it's also important to look within individual plants. This means scouting the tops and bottoms of leaves and both old and new growth. We recently completed a research project investigating the use of biocontrols for aphid management in high tunnel vegetables. For that project, we scouted by visually dividing tomato plants into upper, middle, and lower sections and then examining the upper and lower surfaces of three leaves in each of those sections. For lettuce, we'd divide plants into outer, middle, and center sections and also examine three leaves in each section.

As a general rule, when using biocontrols, it can be essential to properly identify what species of pest you have. Many natural enemies such as parasitoid wasps are host specific, attacking a narrow range of species. If you are unsure of the identity of an insect you should collect several individuals and place them in a bag or vial or take a clear picture of it. Bags/vials and/or pictures can be sent to your local Extension Educator for identification. You can also purchase mixes of parasitoid wasps, if you are unsure of what aphid species you have. Information about aphid id and biological control agents are available at http://www.uvm.edu/~entlab/High%20Tunnel%20IPM/HighTunnelIPM.html.

Other biocontrols for managing aphids include flies such as *Aphidoletes aphidimyza* and syrphids, predatory bugs such as Orius, lacewings, and lady beetles. It's important to know what life stage the biocontrol attacks and kills its host. For example, parasitoid wasps and flies kill their hosts in their larval stages. The adult fly lays eggs around aphid colonies where their larvae/maggots consume the aphids. Several parasitoid wasps lay eggs within aphids. Their developing larvae turn the aphid into brown or black "mummies". Predatory bugs and beetles are predatory as both adults and immatures. Selecting which biocontrol to use at a specific time

depends on what aphid species are present, infestation level (high or low), environmental conditions, and time of year. It's also important to release biocontrols at the proper rate for the area in terms of pest infestation level. If you are unsure, contact your biological control supplier for general guidelines.

We recently completed a 3-year experiment focused on using habitat plants and banker plants in a biocontrol program to manage aphids in high tunnels. Habitat plants, such as alyssum, promote the establishment of natural enemies and encourage them to come in from outside the high tunnels. They provide pollen and nectars to adults of several biocontrols that require floral resources to reproduce. They can also provide attracted pests/hosts. Caution should be used to make sure these systems are not attracting too many unwanted pests then act as a source to the crop. That is another reason why routine scouting should be conducted.

Success when using biocontrols to manage aphids relies heavily on finding the problem before they reaches damaging levels. Early intervention is crucial to release biocontrols so they can become established at the onset of an issue. Monitoring aphids and biocontrols after releases are made is essential to observe biocontrol efficacy and to determine if additional releases are needed or an insecticide application warranted. Over time, your biocontrol plan will be adapted to reflect your specific operation and your experiences. Allow time to fine-tune your plan.

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INTRODUCTION TO ORGANIC CERTIFICATION & RECORD KEEPING

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Over the last 20 years organic agriculture has changed from a small niche production system into a viable agricultural business generating nearly 50 billion dollars a year in sales within the USA alone. New Jersey is home to over 90 certified organic farms, the majority of which are certified by the New Jersey Department of Agriculture. In the US, to be able to legally represent your products as "organic" one must know and follow the regulations published by the USDA's National Organic Program (NOP). Most operations will have to become certified by an accredited certification agent.

The New Jersey Department of Agriculture has been an accredited certification agent since 2007 (*certifications were performed by NOFA-NJ prior*). In this session the Supervisor of the NJDA Organic Certification Program will present a quick overview of how the certification process works, followed by a focused discussion on record keeping. How to start putting together your organic farming system, when to begin the organic certification process, and how the certification process generally unfolds will be followed by an in-depth discussion on what the regulations require in terms of record keeping. What types of records satisfy the regulatory requirements and what your certification agent will likely expect will be discussed.

Session 9

Future of NJ Agriculture

HOW WE MIGHT TRICK WEEDS TO STARVE THEMSELVES WITHOUT HERBICIDES

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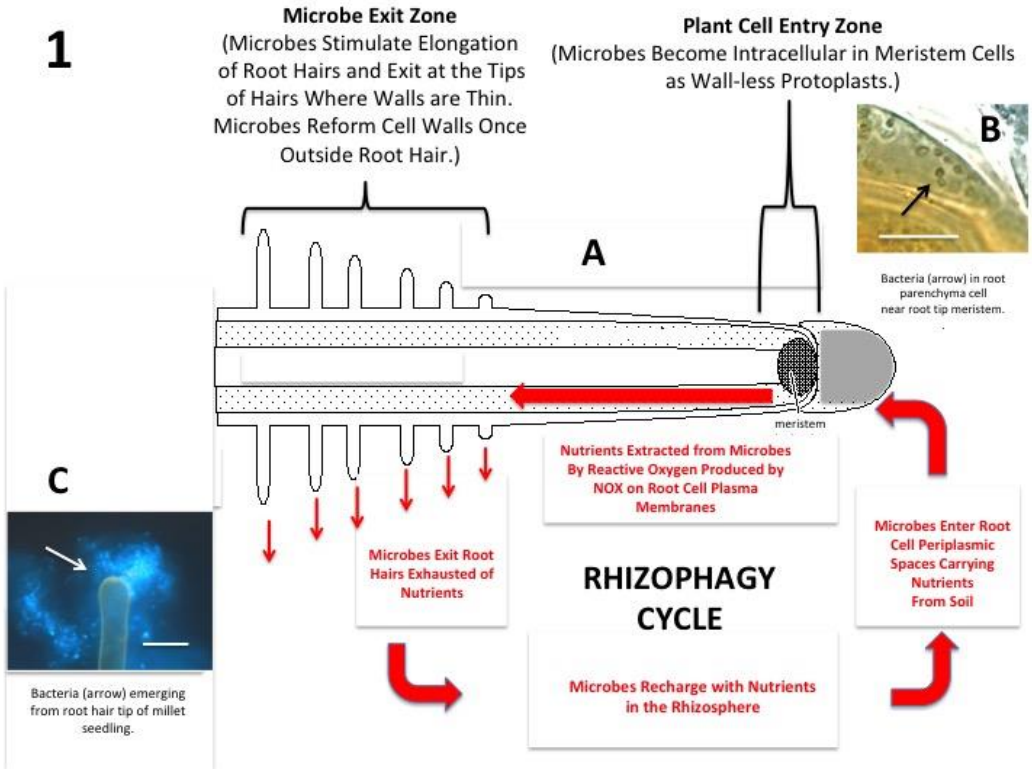
Plants 'Farm' and 'Consume' Symbiotic Microbes

Plants cultivate microbes (fungi and bacteria) around roots by secreting root exudates (containing sugars and other nutrients) into the soil around roots. The microbes cultivated by plants scavenge nutrients (nitrogen, iron, zinc, molybdenum, etc.) in the soils around roots. In the 'rhizophagy cycle' (pronounced 'rye-zo-FAY-gee', meaning 'root eating') (see Fig. 1), symbiotic microbes alternate between the soil and a phase inside root cells. Microbes acquire nutrients in the soil; nutrients are extracted from microbes through exposure to plant-produced reactive oxygen (superoxide) inside root cells. Nutrients like nitrogen and minerals are provided to plants directly from microbes through the rhizophagy cycle. In the rhizophagy cycle, microbes enter root tip meristem cells—locating within the periplasmic spaces (the space between the cell wall and plasma membrane). In the periplasmic spaces of root cells, microbes lose cell walls becoming naked protoplasts. As root cells mature, microbes are doused with superoxide produced on the root cell plasma membranes. Reactive oxygen degrades some of the microbes, also inducing electrolyte leakage—effectively extracting nutrients from microbes. Surviving bacteria in root epidermal cells trigger root hair elongation, and as hairs elongate microbes are ejected back into the soil from the root hair tips, reforming cell walls as microbes emerge into the soil where microbes may obtain additional nutrients, later to return to the plant root tip fully charged with nutrients. This sustainable cycle occurs in all root tips of plants. Plants with more root tips obtain more nutrients from the rhizophagy cycle.



Starve Out Weeds By Feeding Them 'Non-Digestible' Microbes

The microbes that function in the rhizophagy cycle are adapted to their particular hosts. Rhizophagy cycle microbes must be just resistant enough to superoxide produced by the plant root to resist being completely destroyed in root cells--but susceptible enough for some of the microbes to be degraded to provide nutrients to the plant and to remain under root cell control. If a microbe produces antioxidants and is too resistant to superoxide produced by the plant, the plant cannot derive nutrients from it, and it replicates out of control within plant root cells, and consumes plant nutrients, effectively inhibiting plant growth and development. The removal of rhizophagy cycle microbes from hosts to which they are adapted, and transference to hosts that cannot degrade them may result in: 1) internal colonization, 2) microbe overgrowth and consumption of plant nutrients, 3) inhibition of plant development, and 4) increase in seedling mortality. We have applied the term 'endobiome interference' to situations where a microbe internally colonizes plant cells and negatively effects plant growth or development. We have identified several microbes (bacteria and fungi) that stimulate their host plants, but inhibit weed species. Presently, we are testing microbes to evaluate whether products can be developed for use of these microbes in cultivation of crops where applications of the microbes may increase growth of target crops, but inhibit weed growth.

Reference

White, J.F.; Kingsley, K.L.; Verma, S.K.; Kowalski, K.P. Rhizophagy Cycle: An Oxidative Process in Plants for Nutrient Extraction from Symbiotic Microbes. *Microorganisms* **2018**, *6*, 95; https://doi.org/10.3390/microorganisms6030095

Session 10

Small Fruit & Strawberries

POST-HARVEST HANDLING OF SMALL FRUITS

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Strawberry harvest in the Northeast is limited to an average of three weeks. One way to extend the season and increase profits is to contain postharvest losses. Currently, there is no postharvest treatment to maintain freshness and control disease for strawberry. Postharvest losses of strawberries and other specialty crops is estimated to be as high as 25% due to disease, dehydration, and over ripeness, resulting in economic losses to farmers and consumer dissatisfaction.

To solve this problem, we use sachets containing anti-microbial essential oils encapsulated into cyclodextrin to control disease. These sachets are combined with modified atmosphere packaging (MAP) to prevent water loss of fruit. The results of this project will bring sustainable advanced packaging technology to the strawberry grower, and will demonstrate increased fruit freshness and storage life by evaluating disease, fresh weight and fruit firmness with postharvest treatment containing anti-microbial sachets and MAP, compared to conventional storage.

Essential Oils –History and Use

- Essential oils are aromatic and volatile liquids obtained from plants
- Leaves, flowers, fruits, bark and wood may all be sources of essential oils
- Essential oils have been used in medicine, cooking, cosmetics, perfumes, and pest control
- Ancient Egyptians used the herb thyme (*Thymus vulgaris*) as part of the embalming procedures for mummies
- Thymol, a component of thyme oil, was used as an antiseptic in late 19th surgeries because it is less irritating to wounds and more germicidal than carbolic acid (phenol)
- Evidence for anti-bacterial and anti-fungal activity

Factors Limiting Postharvest Storage Life

- Fungal diseases are a major factor limiting storage life of fruits and vegetables
- Most important diseases are Grey Mold (*Botrytis cinerea),* Anthracnose (*Colletotrichum sp.*), Blue Mold (*Penicilium sp.*)
- Infections generally occur during flowering and remain latent until the fruit ripen

Antifungal Activity of Thyme Oil is Easily Demonstrated

- On petri plates against pathogen cultures
- But thyme oil can be phytotoxic when directly applied to plant tissue
- Exposure to thyme oil vapors is much less toxic and can be more effective
- However volatile compounds are more difficult to work with and less persistent

Encapsulation Can Stabilize Thyme Oil

- Cyclodextrin (CD) has a cage-like structure that can trap small molecules
- Encapsulated thyme oil (TO) is stabile to at least 55°C

Flowers and Fruit Continue to Transpire after Harvest

- When the flowers or fruit transpire, the water vapor displaces the thyme oil volatiles from the capsules into the package
- The TO/CD capsules can be placed in a sachet or formulated into a coating and added to the packaging
- Clamshell packs or flower sleeves are enclosed in MAP films before storage or shipping at 0-4 °C

Wrapping the Packaging in MAP Increases Disease Control and Reduces Water Loss

- Modified Atmosphere Packaging (MAP) plastic films have micropores that stabilize the gas composition of the package
- MAP maintains a low O_2 (5%) , high CO_2 (2%) atmosphere in the package and prevents H_2O condensation

Table 1. Strawberry post-harvest disease control with thyme oil (TO) cyclodextrin (CD) capsules coated on the inner lid of 16 oz clamshells after 7 days at 1°C

Treatment	% initial wt	Mean % disease	Mean Firmness (N/cm2)	Mean Brix
(1) CD + MAP	99.6 b	16.6 a	12.3 a	4.9 c
(2) TO:CD + MAP	99.9 a	1.4 b	11.8 b	6.8 b
(3) CD no MAP	94.6 c	15.9 a	11.9 b	7.4 a
(4) TO:CD no MAP	94.6 c	7.7 ab	11.2 b	7.3 a
Initial			10 b	6.21 b
MAP vs No MAP	***	NS	NS	**
TO:CD vs CD	NS	**	NS	NS

Table 2. Strawberry post-harvest disease control with thyme oil (TO) cyclodextrin (CD) capsules coated on the inner lid of 16 oz clamshells after 7 days at 1°C PLUS 1 day at 11°C

Treatment	% initial wt	Mean % disease	Mean Firmness (N/cm2)	Mean Brix
(1) CD + MAP	96.9 a	26.2 a	13.4 a	7.2 a
(2) TO:CD + MAP	97.4 a	8.6 b	11.6 b	6.5 b
(3) CD no MAP	92.4 b	24.5 a	12.2 b	7.2 a
(4) TO:CD no MAP	91.8 b	17.3 ab	10.7 b	6.6 b
initial			10 b	6.2 b
MAP vs No MAP	***	NS	NS	NS
TO:CD vs CD	NS	**	NS	NS

What are the active ingredients in thyme oil for disease control?

- GC/MS Analysis indicated 29 volatile compounds mostly mono and sesquiterpenes
- 84% of the total amount of the compounds identified were:
  - thymol (44%), p-cymene (27%), gamma-terpinene (5%), linalool (4%), carvacrol (4%)

Effect of five monoterpenes on grey mold disease in strawberry fruit

- Test compounds (50 µL) were applied to a filter disc attached to the inner lid of a container with strawberry fruit inoculated with a *Botrytis cinerea* spore suspension and incubated at 4° C for 7 days
- Carvacrol was most effective

Conclusions

- Thyme oil (TO) can be encapsulated with cyclodextrin (CD) for postharvest disease control in strawberry fruit
- TO/CD is most effective when combined with MAP
- Carvacrol appears to be the most important active ingredient

USING RED STICKY TRAPS FOR SPOTTED WING DROSOPHILA

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Spotted wing drosophila (SWD), *Drosophila suzukii* Matsumura (Fig. 1), is an invasive vinegar fly that can damage many fruit crops including blueberry, cherry, raspberry, blackberry, and strawberry. Native to Southeast Asia, SWD was first detected in the continental USA in 2008. It has since established in many states across the country and was found in the Northeast USA in 2011 (Michel et al. 2015). Unlike most Drosophila, SWD females are equipped with a large serrated ovipositor which can saw through the soft skin of many ripening small fruits to lay eggs. In 2018, studies were conducted in New Jersey to compare the efficacy of two trap types: a standard, liquid trap baited with a lure (Scentry Biologicals, Inc., Billings, MT) (Fig. 2A) and a dry red-panel sticky trap baited with the same lure (Fig. 2B), on SWD adult captures.

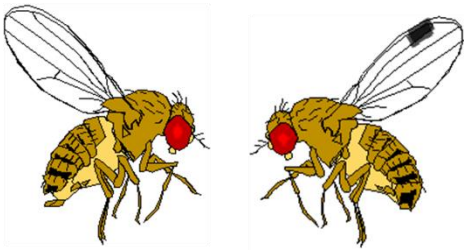

Fig. 1. Female (left) and male (right) SWD. Males have a distinctive black spot on each wing near the tip. Females are slightly larger than males and possess a large serrated

Small Scale Trapping: This study was conducted in five blueberry fields in New Jersey that were either organic or not sprayed for SWD. Four treatments were compared: A. the liquid (standard) trap with a Scentry lure, B. the dry, red-panel sticky, trap with a Scentry lure, C. an unbaited liquid trap, and D. an unbaited dry, red-panel sticky trap. Traps were placed at least 10 m from each other and checked weekly for SWD males and females for seven weeks from 13 June-25 July 2018. In addition, fruit was collected weekly to assess fruit infestation. Results show that SWD first catch in the liquid baited trap was on 13 June and

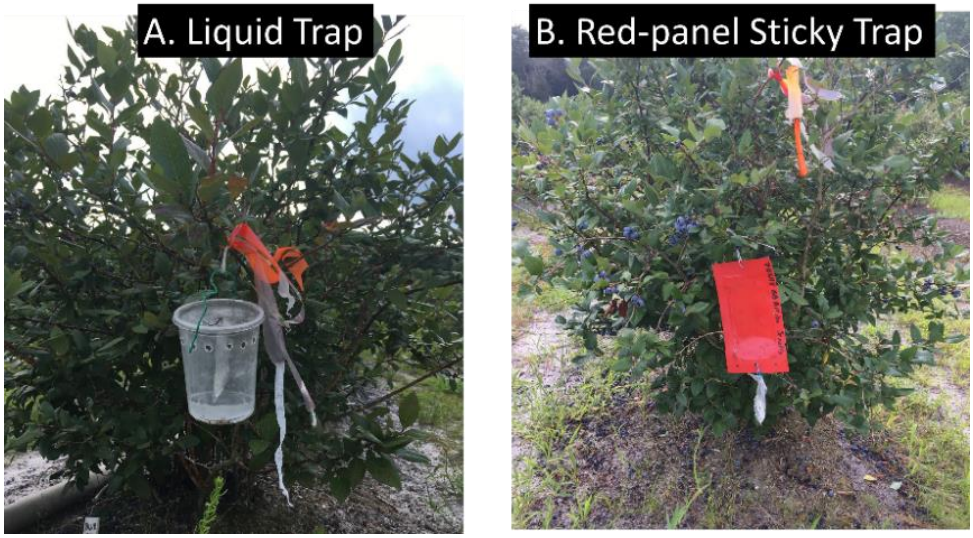

Fig. 2. Trap types: liquid (standard) trap (A) and dry, red-panel sticky trap (B).

first catch in the red-panel baited trap was one week after, on 20 June (Fig. 3). No flies were captured in either control trap type. Both trap types captured similar numbers of SWD males and females. Fruit infestation was first detected on 27 June, 1-2 weeks after first trap capture.

Large Scale Trapping: We established a network of 71 trap locations on commercial blueberry farms across the two NJ blueberry production counties, 51 in Atlantic County and 20 in Burlington County. Traps consisted of the red sticky card baited with the Scentry lure. Only adult males were monitored on the traps. Traps were placed on field edges by woods borders and checked every 7 days from late June through all of July. SWD flies were first found in mid June and increased throughout the growing season in Atlantic County, but peaked in Burlington County during mid July (Fig. 4).

In addition, we compared the efficacy of the liquid traps with the red sticky trap (both baited with the Scentry lure) for monitoring SWD males. The study was replicated in six commercial blueberry farms with five traps of each type at each site. The sticky red traps caught less SWD males than the standard liquid traps, but first male capture was still during the same week (Fig. 5).

In summary, first captures of SWD adults (males and females) were either on the same week or one week later between Scentry-baited red sticky traps and the standard liquid trap. Both traps captured the 1st SWD adult before infested fruit was first detected, indicating that they can provide early warning. Therefore, dry, red-sticky traps can be used for rapid detection of SWD males in blueberry fields in New Jersey.

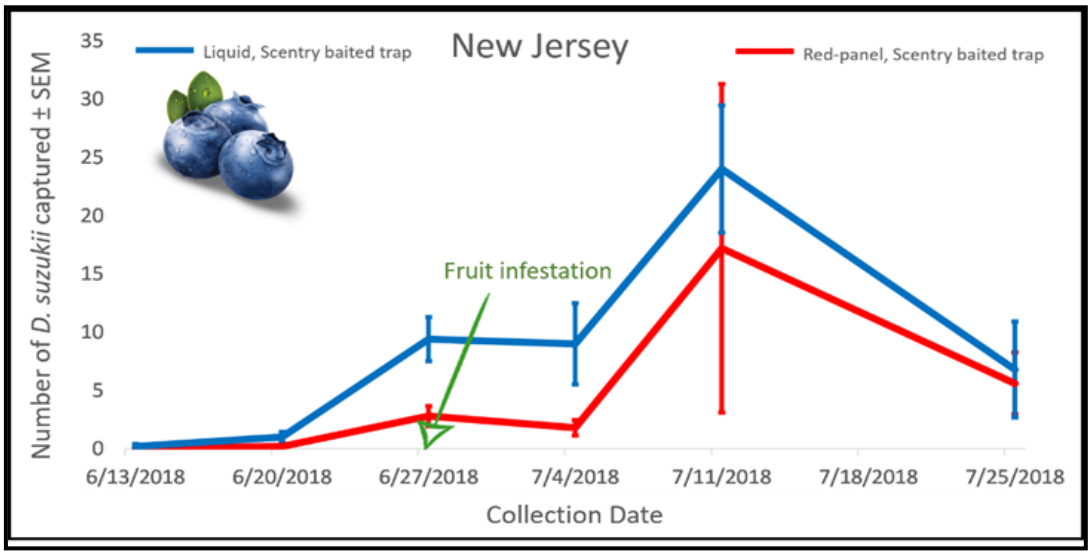

Fig. 3. Comparison of a liquid (standard) trap and a dry, red-panel sticky trap for monitoring SWD flies in blueberries in New Jersey. Both traps were baited with a Scentry lure.

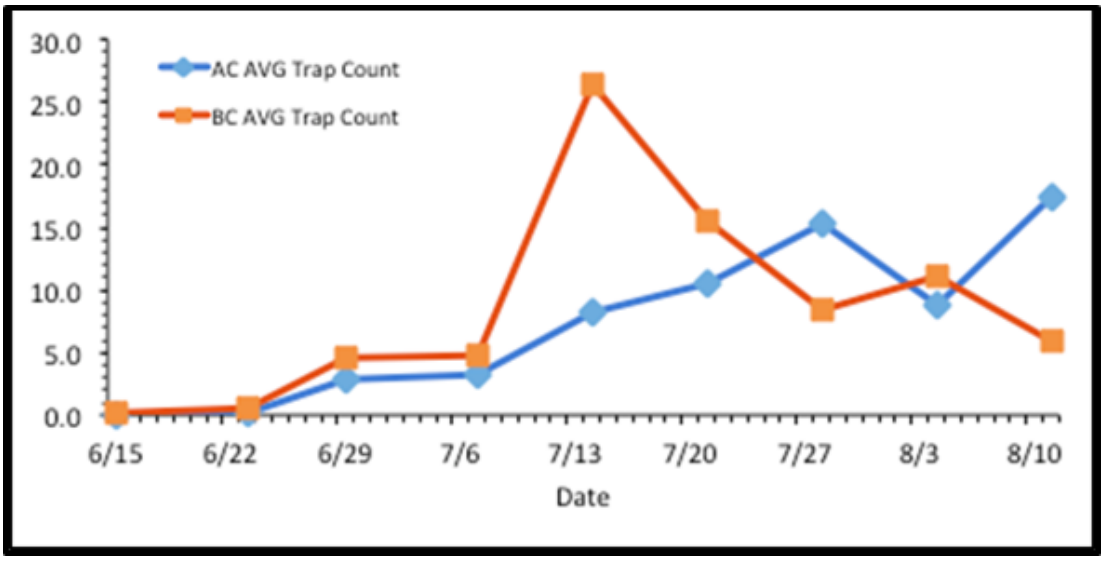

Fig. 4. Program-wide demonstration of red-panel sticky traps for SWD in commercial blueberry fields in New Jersey: Atlantic (AC) and Burlington (BC) Counties. Only males were counted.

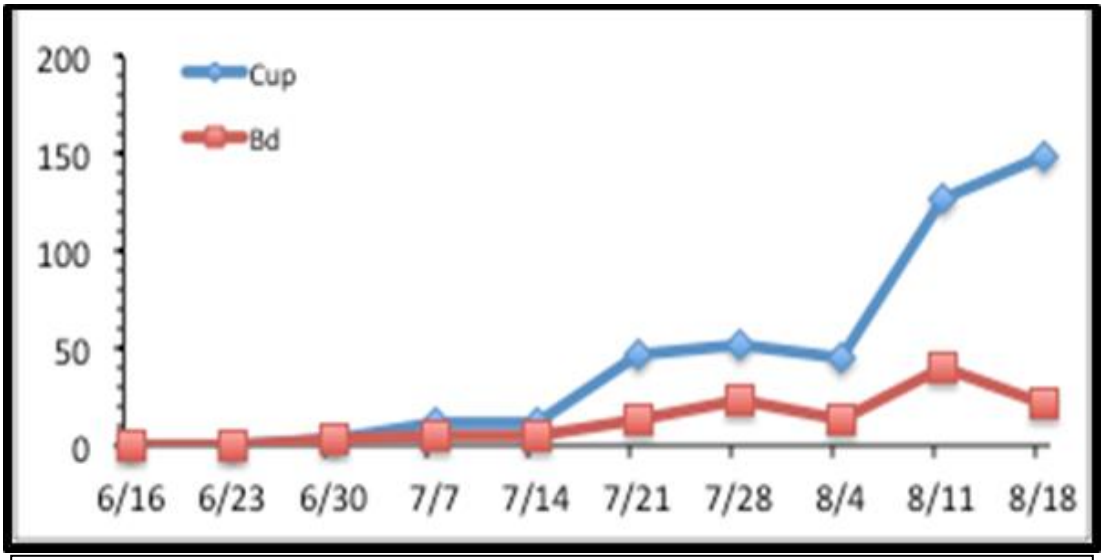

Fig. 5. Comparison of a liquid (standard) trap (Cup) and a dry, red-panel sticky trap (Bd) for monitoring SWD flies in commercial blueberries in New Jersey. Both traps were baited with a Scentry lure. Only males were counted on sticky

Acknowledgments. This project was funded through the USDA National Institute for Food and Agriculture (NIFA) Specialty Crops Research Initiative (SCRI) No. 2015-51181-24252 and the NJ Blueberry Industry Council.

Session 11

Niche Crops

CARING OF FIG TREES

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Mr. Muzychko is the founder and owner of Bill's Figs located in Hunterdon County, New Jersey. At Bill's Figs he manages every stage in the life of a fig tree including the planting, growing, picking, pruning and winterization of every tree he grows. He now has over 200 varieties of fig trees with even more in development.

Fig trees are warm weather plants that need special care in cooler climates such as New Jersey. Fig trees cannot survive outdoors in the northeast without being sheltered or covered. Remember helping your grandfather use tarp, burlap, insulation and whatever else was available to wrap his fig tree like a mummy for the winter? Or did your father dig a trench and try to get all the branches of the tree bent over and covered in the trench for the winter?

This explains the cumbersome and unsightly contraptions that folks have developed to protect their fig trees from killer frosts that are so common in our area during the winter.

Mr. Muzychko has developed a system that not only eliminates the need to "bury" fig trees during the winter months but also dramatically increases crop output. Each of his trees comes with a unique, built-in irrigation system that will allow you to bring your tree into your garage or barn for the winter, if purchased. His system guarantees that your fig tree will be given the correct amount of water and fertilizer that it will need at any given time during the year.

Come springtime, instead of being faced with the unpleasant task of having to remove all of the tar-paper, old carpets and cardboard boxes that you used to swaddle your fig tree during the winter, all you have to do is bring the fig tree that you purchased from Bill's Figs outdoors for the growing season.

Bill's watering and potting system eliminates all worries with over wintering your tree. Just move your tree into an unheated garage or shed and let it rest, dormant for the winter. Then remove it in the spring. No winter care at all! Below are your simple to follow care instructions.

1. **Placement of your tree**. Place your tree in a sunny outdoor place, once all chance of frost is over or cover the tree when frost is predicted. Bring it out in mid-April. It can remain outdoors until the end of November. If the weather remains warm a few of the fruit currently on your tree may ripen yet this year.

2. **Watering**. Water your tree using the patented watering system. There is a watering spout at top of the pot, near the base of the tree. In the cooler weather of the fall your tree can probably be watered every 3 or 4 days. In the summer your tree will need to be watered every day. With the EZ-Care watering system there is no worry or guesswork. You cannot over water your tree. On the side of the pot there is an overflow weep hole. When your tree has enough water it will overflow out of the hole. If you wonder whether your tree needs water, try watering it and your question will be answered virtually immediately. Do not permanently remove the black plastic

on the top of the pot. It insures that water is not lost to the air (and also helps keep the roots warm in early spring and prevents weeds from growing).

3. **Over-wintering**. Your tree will survive the first frost – so do not worry. It will not survive a heavy period of freezing. Given normal weather conditions, your tree can stay out doors until Thanksgiving, by which time it should drop its leaves and go dormant for the winter. Bring your tree into an unheated garage or shed and place it in a darker area for the winter and forget it until spring. The shed or storage place should not freeze and the temperature should be kept just above freezing. It should be watered periodically, ie. once a month, no other care is needed for the winter. Bring your tree out doors when all danger of frost has passed. Place it in sunny area and water! You are set.

4. **Trimming.** You should trim the tallest branches of your tree back by up to one third of their length before you bring it indoors. Do not worry. You can not make a mistake. Fig trees love being cut back and 3 or 4 new branches will appear the next year where you cut the branch back. And figs develop on the near year's growth so your trimming will bring you a larger crop. If you want to keep the tree its present size for over wintering storage or to make it easy to move, trim it to your needs in the fall. Your tree can be moved with a standard hand truck initially and then with a fig mover (see Bill).

5. **Fertilizing.** Your tree is already potted with fertilizer. However you should reinvigorate the fertilizer once a year in the spring. "This takes around 5 minutes". Remove the black plastic cover. Take about (7 oz) of Osmocote fertilizer for the garden (14 – 14 – 14) and work it into the top of the soil. **FOLLOW THE LABEL DIRECTIONS ON THE FERTILIZER**. Do not over fertilize. Your tree will be unhappy. Once in the spring is enough. When first potting the tree, stir in 10 cups of granular limestone to adjust the soil PH. Figs thrive at a soil PH of 7.75 – 8.00.

6. **Picking the fruit.** Fig trees do not flower. You will see the small figs develop late in the spring. Your crop will begin to come in, in late summer (late August or September). The fruit are ready when they start to feel soft. Some year's particular varieties may develop ripe fruit in the early spring and then again in the late summer.

How to Establish a Successful Hazelnut Orchard in New Jersey

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Hazelnuts have been profitable in the Pacific Northwest region of the United States for nearly a century, and significant research shows their potential to be a profitable temperate tree nut crop for New Jersey growers. Prior to establishing a hazelnut orchard, it is critical for growers to have an understanding on how to establish, maintain and harvest this crop. This presentation will serve as a primer for hazelnut orchard establishment considerations for New Jersey farmers. This presentation will focus on recommended plant material vendors and varieties best adapted to this region. Discussion will focus on selecting proper orchard sites, soil fertility assessments and amendments and orchard water requirements. This presentation will also provide an overview of major pests and diseases alongside the most current methods to control them. Hazelnuts do not require much pruning, however, there will be an overview of pruning techniques and other orchard maintenance issues. Finally, one major challenge in hazelnut production is harvest timing, orchard floor preparation and available equipment. This presentation will give recommendations on those areas, as well as West Coast harvest methods and thoughts on how they can be integrated into the New Jersey growing climate.

ELDERBERRY AND ELDERFLOWER

Michael Brown
Pitspone Farm

SUMMARY
Elderberry and elderflower production can be a profitable and easy-to-establish option for both small and large acreage farmers in New Jersey.

BACKGROUND
I am a small suburban farmer in central NJ. I currently grow an assortment of berry plants on about 1 acre of land. I have been growing elderberry and elderflower for seven years.

ADVANTAGES OF ELDERBERRY/ELDERFLOWER AS A CROP
Relatively easy and inexpensive to start with small plants or cuttings.
Myriad markets allow farmer to choose the most suitable for their situation.
Doesn't require spraying with chemicals.
Once established, doesn't require constant attention.

BASICS
Two species of elderberry are available to growers in our area: Sambucus nigra nigra (European elderberry) and Sambucus nigra canadensis (American elderberry)
Moist, well-drained sunny sites are best. Adapted to a range of soils.
1-2 inches of water per week for optimum growth and fruit development. However, elderberry is drought tolerant and a crop can be produced with minimal irrigation.
There is a lot of variability in elderberry depending on location, soil, climate and specific cultivar. It is best to start with trial plantings of several cultivars to see which work best in your situation.

PESTS
Birds
Depending on the local bird population and other food available, birds can seriously impact harvest quantities.
Deer
Depending on local conditions and other food sources, deer can seriously impact plant growth. They are especially fond of new spring growth.
Spotted wing drosophila
A potentially serious pest that affects ripening fruit.

AMERICAN VS EUROPEAN ELDERBERRY VARIETIES
Growers need to consider which varieties of elderberry they want to plant. The first major decision is American vs. European cultivars. Following are some things to consider.

EUROPEAN
Grows as a multi-trunk small tree up to 12-14 feet.

Fruits on second year + growth
Flowers are fragrant
Requires selective pruning for best production
Named cultivars are available
Best for flower production

AMERICAN
Grows as canes
Fruits on first and second year growth
Flowers have minimal fragrance
Can be selectively pruned or cut to the ground every year.
Will slowly spread via rhizomes to form a dense thicket
Named cultivars are available as well as seedlings.
Best for berry production

CROPS
Elderberry can be used for two types of crops - flowers and berries. Each have their advantages and disadvantages.

Elderflower
Advantages
Relatively easy and fast to pick - Vermont production guide cites estimates of 40-60 minutes to pick 5 lbs.
Most customers request relatively small amounts (1-10 pounds) so easy to enter market
Good price - $14-$18+/lb for fresh flowers
Very limited supply and therefore limited competition
Seems to be room for enlarged market
Can be dried for later sales or shipping.
Multiple uses and markets
Possibility for value-added products
Disadvantages
Short shelf life - needs delivery within a day or so

Elderberry
Advantages
Relatively easy and fast to pick
Range of sales possible from a few pounds to hundreds of pounds
Good price - $8-$12/lb for berries
Limited supply in local market
Varied markets for culinary, medicinal and other uses
Easy to preserve frozen without reducing quality
Disadvantages
Short life life fresh
Birds can severely affect harvest
Impact of SWD unclear

MARKETS

The supply of fresh elderberry is New Jersey is quite limited and this presents an opportunity for farmers to meet the needs of established markets, replace imported berries with local product and expand awareness of elderberry and elderberry products to create new customers.

Before committing to large plantings, farmers should test the local market with a trial planting which can be established with modest expense by use of cuttings or small plants.

Elderflower

Most of the markets below will prefer fragrant European flowers. Uses such as tea, tinctures and perhaps skin care can also use American flowers.

Upscale bars and restaurants

Bars will use elderflower to make a simple syrup to mix with their drinks. Elderflowers can also be used to make a delicious sorbet or used in other preparations.

wineries/breweries/cideries

Elderflower can be used to flavor beer, wine and cider.

Herbalists

Use for teas, tinctures

Upscale bakeries

Use as flavoring in baked goods (for example the wedding cake in the last royal wedding)

Individuals

Individuals will purchase flowers for all the above uses, including such home preparations as fritters, cordials, etc.

Other markets to explore - skin care

Elderberry

wineries/breweries/cideries

Elderberries can be used in wine, beer and cider. All these customers have the potential to buy large quantities.

Herbalists

Use primarily for syrup and tinctures, which are used as a cold remedy

Individuals

Jelly, pie, syrup

Others markets to explore - natural ink, natural colorant, juice

RESOURCES

Most of the current research on elderberry is occurring in the Midwest. An elderberry production guide is available for Vermont, but very little research is available that is applicable to the northeast or mid-Atlantic states.

http://www.centerforagroforestry.org/pubs/elderberrysymposiumguide.pdf

Growing Elderberries: A Production Manual and Enterprise Viability Guide for Vermont and the Northeast
Center for Sustainable Agriculture. University of Vermont Extension
https://www.uvm.edu/extension/sustainableagriculture/elderberry-production-vermont

Elderberry Market Research. Report based on research performed in 2009
The Center for Agroforestry
http://www.centerforagroforestry.org/profit/elderberrymarketreport.pdf

Elderberry Possibilities. [PowerPoint]
University of Missouri Extension.
http://extension.missouri.edu/greene/documents/Shared_Documents/SWregion/Byers/ElderberryPresentationMN.pdf

YACON A NEW NICHE CROP FOR NJ

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Introduction

Yacon or Peruvian ground apple (*Smallanthus sonchifolius)* is a crop which has been traditionally grown in South America for its edible storage roots. There is recent interest in yacon in the United States due to it's unique sweet flavors as well as the potential health benefits from its consumption. Yacon tubers contain fructooligosaccharides (FOS) which create a sweet taste but are also indigestible, and FOS have also been shown to possibly enhance digestive health. Yacon is typically eaten raw although it can also be dried, roasted, used in smoothies, or made into a low calorie syrup sweetener.

Figure 1. Yacon plants growing in the field

Figure 2. Yacon root system

Cultivation

Yacon is a long season crop commonly propagated vegetatively by division of the perennial rhizome. Rhizome pieces can be purchased from specialty nurseries and are usually started in a greenhouse or indoors under lights 4-6 weeks before the last frost in the area. Trials in NJ have utilized 3-4" pots for starting yacon transplants. Yacon transplants can be moved outdoors after the last frost and transplanted into the field. Raised beds are recommended since yacon does not grow well with poor drainage. Trials have been conducted on two different soil types in Northern and Southern NJ and the plants grew well on both sites. Sandier soils appear to make harvest and cleaning the roots easier. Since there are little to no herbicides labelled for yacon, straw or black plastic mulch can be used to help control weeds. Yacon can be spaced ~2' between plants and 5-6' between rows. At this spacing, yacon can grow ~4-7' tall during a season but fortunately does not typically need staking. The nutrient needs of yacon in NJ have not been studied but some success has been achieved with 70lbs/A nitrogen

There is also not a lot known about potential insect and disease pests of yacon in NJ. Bacterial leaf spotting was observed in the summer of 2018 but the causal agent has not been positively identified.

Yacon Cultivars
Very few nurseries currently sell named yacon cultivars. NJ trials examined the following cultivars: 'Bekya', 'Cajamarca', 'Early White', 'Late Red', 'Morado' and 'New Zealand'. In initial trials 'Bekya' was the highest yielding (~6lbs/plant) and 'Late Red' the lowest (~3lbs/plant). The best tasting cultivars were 'Early White', 'Late Red' and 'Bekya'. More trials are needed to determine if these results will be repeated under different weather conditions.

Root Harvest and Post-Harvest Handling
Yacon should be allowed to grow as long as possible in the field for maximum yield. The plants can tolerate a light frost but should be harvested before a hard freeze. The plants should be carefully dug out of the soil to avoid breaking the semi-fragile storage roots. Harvest can be done by hand utilizing a pitch fork or broad fork. Some success with mechanical harvest has also been achieved using mulch lifters and potato diggers. Once the plants are out of the ground the storage roots can be separated from the rhizome and washed.

Yacon roots will not be very sweet at the initial harvest and need to be stored to increase sweetness as the FOS in the roots is converted to simple sugars.
It has been reported that leaving the roots in the sun for a few days will increase sweetness but that has not been researched in NJ. The roots can be stored short term at 50F and for several months at 40F with high humidity. Roots from NJ trials have been stored in a walk in refrigerated cooler with open buckets of water to increase the humidity.

Rhizome Storage
The perennial rhizome of yacon can be stored over the winter to provide propagation material for the next year. The rhizomes should be stored at ~40F-50F and kept damp but not overly wet. Plant foliage and stalks are removed, leaving just the rhizome for storage. In NJ trials the rhizomes have been stored in plastic containers filled with dry peat moss or vermiculite and also with no other material in the bin besides the rhizomes.

Propagation
Yacon rhizomes can be divided with a sharp knife making sure each piece has at least one bud. In NJ trials each rhizome from a plant the year before yielded an average of 12-18 rhizome pieces.

Reference
Whitson, William. The Cultivariable Growing Guide: Sixteen Rare Vegetables for the Pacific Northwest. Cultivariable, 2015.
https://www.cultivariable.com/instructions/andean-roots-tubers/how-to-grow-yacon/

Session 12

Vine Crops

FERTILITY MANAGEMENT FOR PUMPKIN AND WINTER SQUASH

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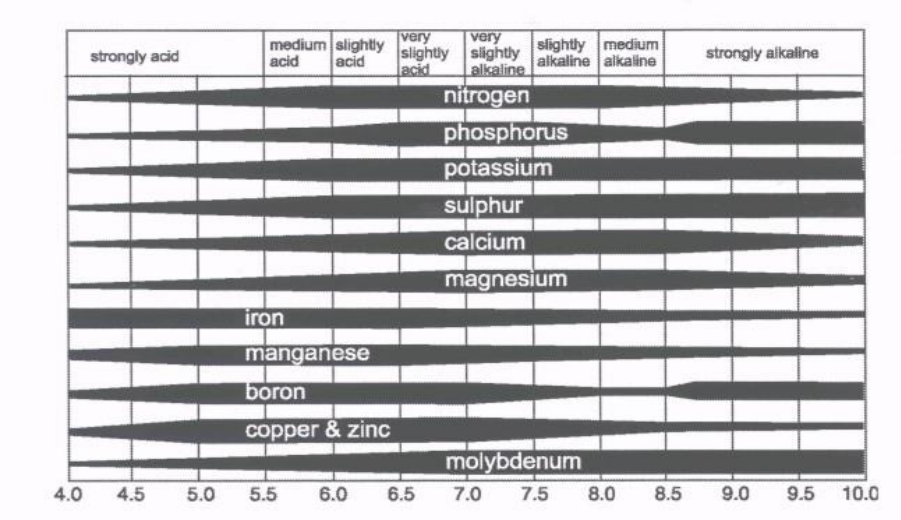
For many reasons, it is important to apply the correct amount of fertilizer to crops; economic reasons, crop success and environmental impacts are some factors. The first rule in fertility management is don't guess. Do a soil test. A reliable soil test should be performed at least every three years. For the price of a test $20 soil test through the Rutgers Soil Testing Lab you will learn the soil pH and the level of soil nutrients. Not knowing levels will leave you guessing and wastes money on fertilizers you may not need.

Pumpkins and squash grow best when the soil pH is close to 6.5. When soil pH is adequate, the availability of both major and minor nutrients are maximized (see Figure 1). When soil pH is not adjusted to the correct level dollars spent on nitrogen, phosphorus and potassium fertilizers and other nutrients are wasted. Because of this, we consider the soil pH to be the most important part of the soil test.

Figure 1. Availability of plant nutrients at pH levels of 4.0 to 10.0.



It takes at least two plowings to get the lime thoroughly mixed with the entire plow layer. For this reason, it is recommended that lime be applied in the fall of the year prior to when the crop will be planted. If lime is applied in the spring prior to planting, it is recommended that the application be split. Plow half of the lime down and disk the remainder into the surface. This will encourage a favorable pH near the seed and root zone of transplants to encourage a good start for the crop.

On some soils, it may be necessary to apply sulfur to lower the pH. Like limestone, it requires six months to a year to lower pH to the desirable range. Remember that many common fertilizers, especially those containing ammonium will often lower soil pH while nitrate fertilizers tend to raise pH.

There are 12 essential nutrients that all plants require to grow. All of the nutrients are absorbed from the soil. Six of these are needed by plants in relatively large amounts and are called macronutrients. These include nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. The other six are called micronutrients or minor elements and include iron, copper, zinc, boron, manganese, and molybdenum. Although these are considered minor and may be needed in amounts of less than one pound per acre, there is nothing unimportant about their role in plant health. The level of crop production can often be impacted by the most limiting of the essential nutrients.

Nitrogen is perhaps the most limiting nutrient in crop production. Deficiency symptoms include yellow plants and stunted, weak growth. Pumpkins and squash are able to absorb nitrogen in two forms, ammonium (NH4) and nitrate (NO3), but they do prefer the nitrate form. In soils, nitrogen may be tied up in organic matter (crop residues, soil organic matter, humus, microbes, etc.). In the organic form nitrogen is totally unavailable to plants. This organic nitrogen is first converted to ammonium and then to nitrate by soil bacteria. These microbes will be most active when the soil is warm, soil moisture is optimum and pH is optimum. Cool conditions, dry or waterlogged soils, or compacted soils all slow the conversion of nitrogen to available forms. About 75 - 100 pounds of N are recommended per acre. Higher rates may push foliar growth at the expense of flowers and fruit. A large canopy can shade female flowers and make it difficult for bees to find flowers pollination. Either way, high nitrogen rates can reduce fruit set. Be especially careful if planting pumpkins into fields where a legume cover crop has been grown or high rates of manure were recently applied. In these cases little if any additional nitrogen may be needed.

Like nitrogen, phosphorus can be found in organic and inorganic portions of the soil. The typical deficiency symptom is a purplish color on undersides of leaves. Soil tests may reveal high levels of phosphorus in soils, yet deficiency symptoms may still be observed if pH levels are off or when soils are cold. Phosphorus is found in three forms in soil, two of which are unavailable to plants. The unavailable forms include phosphorus in organic matter and phosphorus fixed or bound to iron and aluminum at low pH, and calcium and magnesium at high pH. Added fertilizer phosphorus is fixed with other elements and is only very slowly made available. Since the change in unavailable to available phosphorus is a chemical reaction, it occurs quicker in warmer soils as compared to cooler soils. Banding phosphorus rather than broadcasting is a more efficient way to apply this nutrient.

Potassium is the third of the macronutrients or "primary elements". Deficiency symptoms are categorized as "hidden hunger", meaning that a potassium deficiency does not usually show obvious signs. In severe cases, leaf edges may be scorched. Plants deficient in potassium will also not withstand droughty conditions as those plants with adequate potassium. Plants absorb potassium in the ion form K+. Potassium can be leached from sandy or gravely soils and be fixed and unavailable in the clay portion of soil.

Calcium is absorbed by roots in the ion form Ca++. Deficiency symptoms include young leaves that are stunted, distorted and spotted and necrotic at the leaf edge. Blossom-end rot has been seen in watermelon, cucumber, and summer squash. Blossom-end rot potentially may occur in pumpkin. Although calcium may be present in high levels in the soil, dry conditions will limit its uptake by plants and cause deficiency symptoms. Calcium is taken up by plant roots thorough a process called “mass flow”, meaning it must be in the soil-water solution. High levels of sodium, potassium, magnesium and ammonium may also cause calcium deficiency.

Magnesium is absorbed in the Mg++ form. Look for yellow regions between leaf veins of older leaves. Sometimes a reddish color progressing to brown can occur on leaves. Deficiency is most common on acid, highly leached soils that are high in potassium or calcium.

Sulfur is cycled through soil in a very complex fashion, similar to nitrogen. Deficiency symptoms are not normally observed in the Northeast.

In general, micronutrients are not normally added. There may be specific conditions when plants would benefit from additions of micronutrients but in most cases, adjusting the pH to the optimum level will solve most micronutrient deficiencies. For pumpkins and squash, the fertilizer program in Table 2 is recommended.

Table 2. Fertility recommendations for pumpkins grown in the Northeast.

N (lbs/A)	P2O5 lbs/A Soil Phosphorus Level			K2O lbs/A Soil Potassium Level			Comments
	Low	Medium	High	Low	Medium	High	
80-100	**120**	**80**	**40**	**120**	**80**	**40**	**Total Recommended**
40	80	40	0	40	40	40	Broadcaset and disk in
20-30	40	40	40	40	40	40	Band place at planting
20-30	0	0	0	0	0	0	Sidedress when vines run

* If P2O5 and K2O levels are high, skip the broadcast application and apply 50 lbs/A P2O5 and K2O and 40 lbs/A of N in the band at planting and 60 pounds of N sidedressed.

When banding fertilizer on wide row spacing (6 feet or greater), avoid placing more than 40 lbs per acre of nitrogen and K2O combined, to avoid salt damage to the developing seedling. Remember, 40 pounds per acre at a 6-foot spacing is equivalent to 80 pounds per acre at a 3- foot spacing. Bands placed further away from the seed furrow than the two inch standard have less likelihood of burning plants. Some growers place one band two inches from the seed furrow, and a second band four inches from the seed furrow.

When sidedressing, most growers prefer using ammonium sulfate or urea. Both are efficient but care should be taken if sidedressed fertilizer remains on the soil surface and is not incorporated. Left on the surface, has a tendency to volatize and nitrogen will be lost. If the sidedressed fertilizer is incorporated into the soil, either with irrigation or mechanically, little will be lost.

Some growers fertilize vine crops through their trickle irrigation systems. If fertigation is to be used, it is recommended that growers apply 40 - 50 pounds per acre of N, P2O5, and K2O in a band at planting, at least 2 inches below and to the side of the seed. Nitrogen may then be applied once or twice through the season not exceeding 100 pounds total for the season. Sidedressings can occur as the vines begin to run and 2 to 3 weeks after the first application.

In pumpkin studies conducted in 2011 and 2012, yield was maximized with a total of 100 pounds of N per acre. Rates of 150 pounds showed no increase in yield. For pumpkins, there was no yield advantage by spoon-feeding crops weekly with small doses of nitrogen compared to traditional applications of banding and a single sidedress.

For more information see the Pumpkin and Winter Squash section of the 2019 Mid-Atlantic Commercial Vegetable Production Recommendations guide.

CUCURBIT DISEASES AND FUNGICIDE CONTROLS

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Managing diseases is an important component of a successful production program for cucurbit crops because there are several diseases that can reduce yield or fruit quality when not adequately managed. The mildews are among the most common. Fungicides are an important tool for managing diseases. Resistant varieties can be valuable components of an integrated management program, but typically when used without fungicides will not achieve sufficient control to avoid a reduction in yield or fruit quality. Fungicides recommended routinely change as new products are registered and pathogens develop resistance to fungicides that have been in use for several years. Modern fungicides because of their targeted mode of action typically have medium to high risk for resistance to develop in the pathogen. These need to be used in alternation to delay development of resistance, avoid control failure when resistance develops, and comply with label use restrictions.

Downy mildew is primarily managed with fungicides. Resistance has only been bred in cucumbers. Varieties with a new source of resistance are becoming available. Some suppression, albeit variable, can be obtained with varieties bred to be resistant to pathogen strains present before 2004. In a variety evaluation conducted on Long Island in 2017 under very high disease pressure, DMR 401 exhibited the highest level of resistance, Bristol and Citadel (pickling type suitable for fresh market) were moderately resistant but were not significantly less severely affected than SV3462CS, SV4719CS, and Diamondback. Marketmore 76 exhibited limited resistance while Speedway was not significantly less severely affected than Straight Eight, the susceptible check variety. In evaluations conducted in 2016 and 2017 at University of Massachusetts, NY264, DMR 401 (both sold at http://commonwealthseeds.com/), and Bristol exhibited good resistance with NY264 and Bristol performing best under high disease pressure.

An important tool for determining when fungicide application is warranted is the forecast web site for this disease at http://cdm.ipmpipe.org. Cucurbit plants are susceptible to downy mildew from emergence; however, this disease usually does not start to develop in the northeast until later in crop development when the pathogen is dispersed by wind into the region. The forecast program monitors where the disease occurs and predicts where the pathogen likely will be successfully spread. The pathogen needs living cucurbit crops to survive, thus it cannot survive where it is cold during winter. The risk of downy mildew occurring throughout the eastern USA is forecast and posted three times a week. Forecasts enable timely fungicide applications. Label directions for some fungicides state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. Growers can subscribe to receive customizable alerts by e-mail or text message. Information is also maintained at the forecast web site of cucurbit crop types being affected by downy mildew. This is important because the pathogen exists as two clades and pathotypes within each that differ in their ability to infect the various cucurbit crop types. Clade 1 pathotypes are A1

mating type and infect cucumber, pumpkin and cantaloupe. Clade 2 pathotypes are A2 mating type and infect squashes and watermelon. Success of the forecast system depends on knowledge of where downy mildew is occurring; therefore prompt reporting of outbreaks by growers is critical.

Scouting routinely for early symptoms is also important to ensure targeted fungicides are applied starting at the onset of disease development. While the forecast program has accurately predicted many outbreaks, a forecasted risk of infection may not result in infection if conditions are not as favorable as predicted, and the forecast program can miss predicting a risk in particular when downy mildew is not reported. The program is predicting movement of the pathogen from known sources of the disease. Photographs of symptoms are posted at: http://blogs.cornell.edu/livegpath/gallery/cucurbits/

http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cuc_Downy.htm

Alternate among targeted, mobile fungicides in different FRAC groups and apply with protectant fungicide (chlorothalonil and mancozeb are more effective than copper) to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions on number of consecutive and total applications allowed. Label directions for some fungicides state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. The pathogen has demonstrated ability to develop resistance to fungicides, thus a diversified fungicide program applied to resistant varieties when possible is critical for success. Resistance has been confirmed in the USA to FRAC Codes 4, 11, 28, 40, and 43. Frequency of resistance was higher in isolates from cucumber than other cucurbits in a study on Previcur Flex and Presidio, therefore these and Code 40 fungicides might be effective on other cucurbits; however, no or limited use is recommended for downy mildew on these crops to minimize selection pressure. FRAC Code 27 and 45 fungicides have exhibited poor control in some seedling bioassays suggesting resistance may also have developed to these chemistries. Most fungicides labeled for downy mildew are also labeled for Phytophthora blight, which is caused by a related (oomycete) pathogen. Table of fungicides for this and other main cucurbit diseases is at

http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cucurbit%20Fungicide%20List%202018-NY.pdf

Orondis (FRAC Code 49, previously U15). The novel active ingredient, oxathiapiprolin, has exhibited excellent activity in fungicide evaluations. It is formulated with mandipropamid (FRAC 40) as Orondis Ultra (REI is 4 hr) and with chlorothalonil (M5) as Orondis Opti (REI is 12 hr). PHI is 0 day. Make no more than 2 consecutive applications of either before rotating to a different fungicide. When at least 3 applications for downy mildew will be made, Orondis fungicides can be no more than 33% of the applications, or a maximum of 4 applications per planting, whichever is fewer. Orondis Opti is labeled for several other diseases because it contains chlorothalonil. It is only recommended used for these diseases when downy mildew is also present. Orondis Ultra is also labeled for Phytophthora blight. Another fungicide, Orondis Gold 200, is only labeled for application to soil for Phytophthora blight. Its use in a crop prohibits foliar application of Orondis fungicides for downy mildew.

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

Omega (29). REI is 12 hr. PHI is 7 days for squash/cucumber subgroup, which includes pumpkin, and 30 days for melons. Apply no more than 7.5 pts/A to a crop or 4 applications applied at highest label rate of 1.5 pts/A. Omega is more expensive than other fungicides.

Zing! or Gavel or Elumin (22). Zing! and Gavel are the only products that consist of a targeted fungicide and a protectant fungicide (chlorothalonil or mancozeb). REI is 12 hr and PHI is 0 days for Zing!; 48 hr and 5 days for Gavel; 12 hr and 2 day for Elumin. Apply no more than 8 times in a season; twice for Elumin. Some cantaloupe varieties are sensitive to Gavel (see label). Workers must be notified that a dermal sensitizer is applied both orally and by posting at entrance to treated area 24 hours before the scheduled application and for 4 days afterwards. The amount of chlorothalonil in Zing! is an intermediate rate (1.18 lb/A chlorothalonil) of the labeled rate range for downy mildew in products with just chlorothalonil (1.125-1.5 lb/A). Chlorothalonil is labeled for use at a higher rate (1.5-2.25) to manage several other diseases including powdery mildew. Growers trying to manage these diseases as well as downy mildew should apply additional Bravo to bring the amount of chlorothalonil up to the higher rate. To obtain an application rate of 1.5-2.25 lb/A chlorothalonil, tank mix Bravo WeatherStik at 0.43-1.43 pt/A with Zing!.

Ariston, Curzate or Tanos (27). These have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). They can be a good choice when it was not possible to apply fungicide at the start of a high risk period when temperature is below 80 F. Apply another targeted fungicide 3-5 days later. Both must be tank-mixed with a protectant. REI is 12 hr. PHI is 3 days. Apply no more than 4 times in a season (6-9 for Curzate depending on rate); no consecutive applications of Tanos are permitted. Tanos also has a FRAC Code 11 ingredient. It is recommended used only when this ingredient is needed for other diseases that are also occurring, such as Plectosporium blight. Tanos is the only one labeled for Phytophthora blight.

Zampro (40 + 45). Apply no more than 3 times in a season with no more than 2 consecutive applications before switching to a fungicide with different FRAC code. REI is 12 hr. PHI is 0 day.

Targeted fungicides no longer recommended. Resistance has been documented in the USA in the cucurbit downy mildew pathogen to the following fungicides. They have provided limited to no control of downy mildew when tested alone in recent university fungicide evaluations, in contrast with excellent control provided in the past. Seedling bioassays have also documented poor control presumed due to fungicide resistance. Poor control has also been reported in commercial cucumber crops. Research has almost exclusively been done with cucumber. In a study examining resistance in pathogen isolates from various cucurbit crops, most resistant isolates were from cucumber. Revus was effective for downy mildew in pumpkin but not cucumber in adjacent fungicide evaluations.

Previcur Flex (FRAC Code 28). Only labeled for downy mildew. REI is 12 hr. PHI is 2 day.

Presidio (43). Recommended used early in the season for Phytophthora blight when downy mildew is not a concern. Apply no more than 4 times in a season with no more than 2 consecutive applications. Must be applied with another fungicide.

Revus and Forum (40). Recommended used early in the season for Phytophthora blight when downy mildew is not a concern. Revus can be applied up to 4 times with no consecutive applications and Forum 5 times with at most 2 consecutive applications. REI is 12 hr and PHI is 0 day for both products. There is a different FRAC code 40 fungicide ingredient in Forum and Revus which may have slightly different mode of action, thus there may be benefit to using both in a fungicide program. Both must be applied as a tank mix with another non-Code 40 fungicide. A spreading/penetrating type adjuvant must be applied with Revus and is recommended for Forum.

Fungicides with mefenoxam and metalaxyl (FRAC 4), e.g. Ridomil, or a strobilurin active ingredient (FRAC 11), e.g. Cabrio, have not been recommended since 2004 as they have been ineffective due to resistance.

Powdery mildew. An integrated program with both management tools (resistant varieties and fungicides) is recommended to maximize likelihood of effective control and reduce selection pressure on the pathogen to overcome one of these tools. It has demonstrated ability to evolve and become less effectively controlled by both tools. Resistant cucumber varieties have an exceptional level of resistance and often develop no symptoms. Resistant melon varieties have race-specific resistance. Those with resistance to pathogen races 1 and 2 have not exhibited as high a level of powdery mildew suppression recently as in the past indicating presence of a new race. Resistant pumpkin varieties like Progress with a resistance gene from both parents (PMRR, homozygous) have been less severely affected by powdery mildew than varieties with a resistance gene from one parent which confers intermediate resistance. Later were less severely affected, but not significantly, than a variety with no resistance in recent trials.

Alternate among targeted, mobile fungicides in the 6 chemical groups below (principally the first 4; listed in recommended order) and apply with protectant fungicide to manage resistance development. Begin before or at start of disease development (one older leaf out of 50 with symptoms).

Vivando (FRAC Code U8) has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. It is recommended used with a silicon adjuvant. Do not mix with horticultural oils. Can be applied three times per year with no more than two consecutive applications. REI is 12 hr. PHI is 0 days.

Gatten (Code U13) is the newest fungicide; it was introduced in 2018. First cucurbit crops registered are cantaloupes, cucumbers, and squash. REI is 12 hr. PHI is 0 days. Five applications can be made.

DMI fungicides (Code 3) include Proline*, Procure, Luna Experience*, and Rhyme* (these considered most effective) plus Folicur, Aprovia Top*, Inspire Super*, Mettle, Rally, and Tebuzol. Resistance is quantitative. Highest label rate is recommended because the pathogen has become less sensitive to this chemistry. Efficacy has varied in fungicide evaluations. Proline is thought to have the greatest inherent activity. Procure applied at its highest label rate provides a higher dose of

active ingredient than the other Code 3 fungicides. Five applications can be made at this rate. REI is 12 hr for DMI fungicides. PHI is 0 days for some including Procure; 7 days for others including Proline. *Fungicides labeled for additional cucurbit diseases; see section on other diseases. TopGuard is labeled but not recommended because it has Code 11 ingredient plus same DMI ingredient in Rhyme.

Quintec (Code 13) has been consistently effective in fungicide evaluations; however, insensitivity to a high concentration of Quintec (similar to the dose when applied in the field) has been detected in some pathogen isolates collected from commercial fields and/or fungicide-treated research fields at the end of the growing season on Long Island since 2015. Resistant isolates evidently are sufficiently uncommon most of the season not to impact Quintec efficacy. Because resistance has developed, Quintec is now recommended to be used less than the label permits, which is a crop maximum of four applications. Aerial applications are not permitted and no more than two consecutive applications. Activity is limited to powdery mildew. It is the only mobile fungicide that does not move into leaves: it redistributes to foliage where spray was not directly deposited, including the underside of leaves, through diffusion and a continual process of absorption and desorption in the cuticular waxes of foliage. Labeled for use on non-edible peel crops: melons, pumpkin, and winter squash. REI is 12 hr. PHI is 3 days.

Carboxamide fungicides (Code 7) include Luna Experience, Miravis Prime, Fontelis, Endura, Pristine and Merivon. Powdery mildew pathogen strains resistant to boscalid, active ingredient in Endura and Pristine, have been detected since 2009 in NY and likely are the reason its efficacy has been poor in some fungicide evaluations. In laboratory assays boscalid-resistant strains exhibited sufficient cross resistance with Fontelis and Merivon that these are expected to be ineffective as well, but not with Luna fungicides. However, Luna Sensation failed in experiment at LIHREC in 2017. Luna Experience is the best choice because it also contains tebuconazole (Code 3), which needs to be considered when developing an alternation program. Luna Sensation is not recommended because it also contains trifloxystrobin (Code 11); resistance to this chemistry is very common. Limited use of Luna Experience is recommended. REI is 12 hr. PHI is 7. Maximum number of applications is 2-5, depending on rate used. Low rate is not recommended.

Torino (Code U6) exhibited excellent control in fungicide evaluations until recently. Resistant isolates have been detected on Long Island since 2017 when their existence was associated with control failure in a fungicide efficacy experiment. Activity is limited to powdery mildew. It can only be applied twice to a field in a 12-mo period. Consecutive applications are not recommended. REI is 4 hr. PHI is 0 days. One application at most is recommended.

Resistance continues to be very common to MBC fungicides (FRAC code 1; Topsin M) and QoI fungicides (Code 11; Quadris, Cabrio and Flint); therefore these are not recommended, nor combination products with an additional active ingredient.

Several protectants are labeled for powdery mildew. Chlorothalonil and sulfur are highly effective, especially on upper leaf surfaces. Oils also have exhibited good efficacy. There are several botanical and mineral oils. Numerous biopesticides now available have exhibited poor to good efficacy in university trials. Copper is moderately effective.

Fungicides Labeled for Other Diseases in Addition to Powdery Mildew.

Proline (FRAC 3). Fusarium blight and gummy stem blight.

Rhyme (FRAC 3). Gummy stem blight.

Luna Experience (FRAC 3 and 7). Alternaria leaf spot, anthracnose, gummy stem blight, and belly rot.

Aprovia Top (FRAC 3 and 7). Alternaria leaf blight, anthracnose, gummy stem blight, and Plectosporium blight.

Inspire Super (FRAC 3 and 9). Alternaria leaf blight, anthracnose, gummy stem blight, Plectosporium blight, and Septoria leaf spot.

Miravis Prime (FRAC 7 + 12). Alternaria leaf blight, gummy stem blight, and scab.

New Fungicides. Elumin (downy mildew and Phytophthora blight), Gatten (powdery mildew), and Miravis Prime (powdery mildew).

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede this infor-mation, if there is a conflict. Before purchase, make sure product is registered in your state. Any refer-ence to commercial products, trade or brand names is for information only; no endorsement is intended.

PUMPKIN INSECT IDENTIFICATION AND MANAGEMENT

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The list of significant insect pests in New Jersey pumpkin production is fairly limited. It is critical, however, to be able to identify these insects and understand their impact (or lack of same) on the crop because this affects management decisions.

Seed Corn Maggot

The seed corn maggot is the larva of a nondescript fly, and growers are often alerted to infestations because of poor field germination or early death of emerging seedlings. Digging up seeds and examining collapsing seedlings will show the presence of these pale larvae if seed corn maggot was responsible for the problem. The adult is attracted to organic matter (manures, decaying vegetation, etc.) on the soil surface. Cool, moist conditions favor maggot survival and slow seedling development which enables greater seed/seedling destruction.
Most commercial seed producers will make pumpkins seed available pre-treated with a systemic neonicotinoid insecticide. The seedling takes up this material from the seed coat as it germinates and provides good protection against seed corn maggot. In cases where this treatment is unavailable or not compatible with production practices, growers should consider the following:
Incorporate surface organic material into the soil at least 4 weeks prior to planting.
Avoid planting when conditions are cool and wet if possible.
Plant shallower than normal to encourage faster emergence.
If an infestation is detected, delay replanting if maggots are small, but replant immediately if the infestation is dominated by large maggots or pupae (see photos above).

Cucumber Beetle

Striped cucumber beetles are one of the most serious insect pests of pumpkins because they cause significant injury to emerging plants, are vectors of bacterial wilt, and are capable of causing injury to the rinds of maturing fruit late in the season. Growers should monitor for cucumber beetle presence as soon as seedlings emerge because the yellow and black striped adults (photo at left) are highly attracted to chemicals found in all plant parts but particularly concentrated in seed leaves. At this growth stage, seedlings are unable to survive much injury and are very susceptible to bacterial wilt transmission.

Commercial seed treatments, as mentioned previously, significantly limit feeding and disease transmission during this vulnerable early stage. If no seed treatment is utilized, growers should consider treating if beetles are present in five or more sites in a ten site (5 plants per site) sample. As plants begin to run and develop flowers, the threat of bacterial wilt is much reduced. At this time, no insecticide treatment is necessary for cucumber beetle or the look-alike western corn rootworm beetle (photo at right) that commonly feeds in blossoms. Note that the abdomen of the western corn rootworm adult protrudes past the wing coverings, unlike the cucumber beetle whose abdomen is completely covered. Western corn rootworm beetles can be numerous in blossoms but do not significantly damage the plants.

As fruit begin to size and rinds are hardening in late summer, cucumber beetles again becoming an economic threat. They will often feed on rinds (photo at right), making the fruit unsaleable. With no systemic insecticide now present in plants, this damage can be widespread. Growers should scout fields weekly and consider treating for cucumber beetles as fruit mature if beetles are found at more than one site in a 10 site sample (5 plants per site) and damage is beginning to occur. Avoid foliar insecticide applications when bees are active in flowers. Evening applications can help reduce bee exposure.

The larval stage of the striped cucumber beetle lives in the soil, so repeated plantings in the same area can result in large local populations of this pest. Growers are encouraged to rotate fields with as much distance as possible to avoid this situation. On farms where a particular field must be utilized repeatedly (as with U-pick fields), systemic seed treatments are advised.

Squash Bug

Squash bugs are large true bugs that feed exclusively on cucurbit crops. They are capable of injuring plants in the 0-4 true leaf stage, but in New Jersey our typical pumpkin planting window is from the end of May through mid-June. This precedes the mid-summer adult stage of this insect. Therefore, this insect is rarely an economic threat to pumpkins in New Jersey. Adults are gray/brown and appx. 3/4'" long and lay clusters of copper colored eggs (see photo below at left) on the undersides of leaves in July. Newly emerged nymphs are green with black legs (photo below at center) and remain in groups for several molts. As they enlarge, nymphs go through several stages when they are gray in color (photo below at right) but do not develop wings until the final molt. All stages feed on foliage, but as vines decline through September, late stage nymphs will congregate on fruit as in the photo above. Although this looks like a serious problem, no fruit injury generally occurs. However, if the

field is to be utilized for U-pick, it may be necessary to treat in order to lower the population. Insecticides labeled for squash bug control will also be toxic to bees. Therefore it is advisable to treat in the evening to avoid bee contact.

Squash Vine Borer

Squash vine borer adults are brightly colored moths that resemble wasps in appearance (photo at left). The females lay eggs near the base of plants, and larvae bore into the main stems (see photo below), where they nutrient flow and weaken the rarely a problem in commercial disrupt water and stems. They are sized pumpkin and winter squash fields. However, in the typically smaller plantings of giant pumpkins, they can cause significant loss. Adults are actively laying eggs from late May through mid-June in New Jersey. Adult activity is best monitored using pheromone traps (available from most pest management suppliers). On small plantings, it may be useful to treat the base of plants weekly as long as adult borers are appearing in pheromone traps. For just a few plants, row covers may be sufficient to protect the crop, but covers must be removed as blossoms appear to allow bee entry.

Aphids

Aphids pose two main threats to pumpkins. Early to mid-season, prior to fruit set, winged aphids (see dark aphids in photo at right) that fly into the field may transmit mosaic viruses to growing plants. These aphids may have fed on infected plants outside the field, and enter the field with virus particles on their mouthparts. As they feed, the particles are rapidly shed into the pumpkin host. Resulting mosaic virus infections can lead to distorted foliage (lower photo at right) and disfigured fruit. While commercially available seeds treated with systemic insecticide will kill aphids feeding on young plants and prevent in-field spread, these mobile aphids are still capable of infecting the first plant on which they feed. As this movement of winged aphids into fields is highly unpredictable and because virus transmission is immediate, there is little value in insecticide applications beyond the initial seed treatment.

Later in the season, as fruit are maturing, melon aphids often enter fields and can build to extremely high population levels. These aphid colonies often contain pale yellow and darker green individuals (photo at left). Colony members will be wingless and reproduce clonally, allowing them to rapidly increase in numbers. Field monitoring for this pest situation should begin no later than mid-August. When colonies begin to form in more than one site in a ten site sample (5 consecutive plants per site), and the sticky droppings from the aphids are beginning to appear on fruit below,

growers should consider an insecticide treatment. Without management, the colonies will spread and the sticky droppings serve as a substrate on which sooty mold can grow (photo below at right). This non-pathogenic fungus is a cosmetic issue that lowers the economic viability of the crop. Additionally, affected fruit may need to be washed prior to sale, and aphid droppings (which are sugary) attract hornets. This last factor is a serious problem in U-pick situations. Should melon aphid require insecticidal treatment late in the season, there are several good choices that are much less toxic to bees. These include the Insecticide Resistance Action Committee (IRAC) code 9B product - Fulfill, and the 9C product – Beleaf, as well as the less toxic neonicotinoid 4A product – Assail.

Garden Flea Hopper

This true bug is not an economic threat to pumpkins in New Jersey, but is fairly common late in the summer and can build to high populations in the crop canopy. It's feeding results in pale areas on leaves that resemble symptoms of spider mite feeding. An obvious difference is that in the case of garden flea hopper, the tiny bugs (photo at right) will be plainly visible on the leaves. Additionally, flea hoppers leave lots of black droppings where they have fed. This is not a sign associated with mites. No treatment is necessary for garden flea hopper, but growers should familiarize themselves with this bug because it will likely appear late in the summer in some fields.

Session 13

Soil Health

SOIL HEALTH SURVEY IN NJ CROPS WITH THE SOLVITA® SYSTEM

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Introduction

Our expanding study on agricultural soil quality and health throughout New Jersey farmlands surveyed local soils from 2013 to 2018 has taken 1000+ samples from over 80 separate sites. The surface layer of most soils was classified as loamy sands, sandy loams or loams, while the sub-soils are mostly sandy loams and sandy clay loams. Soil quality is defined as the capacity of soil to function for different uses, such as a growing medium for plant production (commonly measured as yield), in the regulation of water flow in the environment, and in the recycling of organic residues. Soil quality has intrinsic and dynamic components. Soil mineralogy and soil texture (percentages of sand, silt, and clay) are intrinsic properties that affect a soil's ability to function and are not easily altered. Dynamic characteristics of soil quality, which respond to changes in management, include pH, nutrient status, density, organic matter, and soil biology.

Farmers and gardeners commonly manage specific soil amendments by incorporating limestone, humus, compost and cover crops. Maintenance of the chemical, physical, and biological "health" of the soil is a goal of sustainable soil management. Standard soil fertility assessments involve field sampling with soil probes and laboratory analysis of macro- and micro-nutrients as well as soil pH. Fertilizer recommendations are based upon current soil nutrient levels and estimated crop needs. The ability of farmland or garden soil to produce its own biological nutrients such as nitrogen over the growing season, typically has not been measured due to a lack of economical, practical and/or accurate testing equipment.

Fertilizer recommendations are typically based upon a chemical laboratory analysis and estimated crop needs over the growing season. What is not typically measured is the ability of farmland soils to biologically produce their own nutrients such as carbon and nitrogen through mineralization by soil microbes. Maintenance of the chemical and biological "health" of the soil is a goal of high yielding, sustainable land management.

Measurement of soil respiration CO_2 derived from micro and macro organisms is a potentially important tool to predict availability of nitrogen, the essential element not measured in routine soil tests. To be able to accurately credit nitrogen and other nutrients from dynamic natural organic matter mineralization against the suggested static total fertilizer recommendation would be a valuable contribution to economical and sustainable farming. A relatively new and novel method called the Solvita® Soil Test was used to gather such biological data.

Analytical Method - the Solvita® System

Solvita® is a patented environmental measurement system with applications for soil, compost, manure and grain. One type measures carbon dioxide (CO_2) in a low and high range, and the other type is for ammonia (NH_3) – (Haney and Brinton 2008). Thin-gel technology assesses a component of soil health by measuring CO_2 emissions from soil which are primarily due to microbial respiration. The level of microbial activity is indicative of the amount of active organic matter that is being broken down and nutrients being released. The CO_2-Burst Lab Method (Haney-Brinton Protocol) uses a drying-rewetting method to associate soil health with a soil's mineralization capacity to release nutrients (Solvita® Guidelines, 2013). (Figures 1 & 2). Soils with more biological activity may be considered healthier in terms of providing additional nutrients for plant growth.

Blue-Gray Color 0-1	1 – 2.5 Gray-Green	2.5 – 3.5 Green	3.5 – 4 Green-Yellow	4 – 5 Yellow
VERY LOW SOIL ACTIVITY Association with dry sandy soils, and little or no organic matter	MODERATELY LOW SOIL ACTIVITY Soil is marginal in terms of biological activity and organic matter	MEDIUM SOIL ACTIVITY Soil is in a moderately balanced condition and has been receiving organic matter additions	IDEAL SOIL ACTIVITY Soil is well supplied with organic matter and has an active population of microorganisms	UNUSUALLY HIGH SOIL ACTIVITY High/excessive organic matter additions
Carbon dioxide levels – PPM range				
0 – 5	6 – 12	13 – 30	31 – 70	71 – 160
Approximate quantity of nitrogen (N) release per year (average climate)				
<15 lbs/acre	15 – 25 lbs/acre	25 – 45 lbs/acre	45 – 75 lbs/acre	75 – 105 lbs/acre

Figure 1 – Solvita Index Color Scale, correlated CO_2 levels and predicted N contribution

Figure 2 – Color Reference Chart, Digital Color Reader, Beakers, Jars and Gel Paddles

Sampling Sites & Process

From 2013 – 2015, 18 representative soil sites were selected in Monmouth County, NJ; primarily farms having sandy loam soils with pH values ranging from approximately 5.1 to 6.3 and typical organic matter from 1.0 to 2.0%. Seventy-four crop fields were GPS/GIS mapped and sampled at the same location in spring, summer and fall. Six study groups of local horticulture were constructed with three replications each. These categories were artificial golf greens, annual crops, perennial fairways, residential lawns, perennial grass crops and organic blueberry. Representative types of plant production in the county included sweet corn, pepper, tomato, field corn, blueberry, equine pasture, bio-energy grass, residential lawns and golf courses – Figure 3.

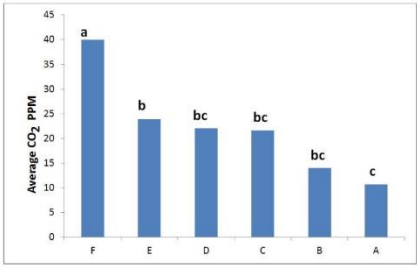


Figure 3 - Solvita® CO_2 analysis of six crop categories
Means with no letters in common are significantly different at 0.05 according to Fisher's Protected LSD
A= Golf Greens, B = Annual Crops, C = Golf Fairways, D= Home Lawns, E = Bioenergy Crop, F = Blueberry

From 2016 – 2018, 10 representative soil sites in Central NJ sampled mapped agronomic farm soils annually in the classic Soybean – Corn rotation sponsored by the NJ Soybean Council. Yearly information on crop varieties, plant populations, tillage, fertilizer, pesticides, farm soil chemistry and other variables was compiled including:

1. Testing for soil chemistry, fertility, texture and type.
2. Testing for biological soil health via microbial respiration.
3. Tissue testing for foliage analysis of nutritional levels of both crops.

In 2016-17, the Rutgers Marucci Cranbury and Blueberry Center served as a sample site for 4 blocks of highbush blueberry and the undisturbed surrounding pine forest of native berryland soils. The undisturbed native loam soils of Rutgers Hutcheson Memorial Forest in Somerset County, New Jersey also served a comparison to adjacent farm soils.

2017 – 2018. In over 70 blueberry blocks on 24 farms in the South Jersey Hammonton area served to assess soil chemistry and soil biology comparing conventional and organic operations.

Results

General Survey 2013 – 2015. The six categories of crops showed significant differences in increased respiration in both color value and carbon dioxide output. Little differences were noted between the visual reader scale of 0-5 for gel color versus using the expensive yet more accurate colorimeter measuring parts per million. There was a trend in most annual crop sites where early spring color values averaged approximately 2.0 with a small increase to 2.4 in the summer and to 2.7 in the fall. These initial values translate to low-moderate activity rising to medium activity by the season's end.

On the other hand, perennial crops with no tillage and more compost applications were significantly higher earlier and later in the season; ranging from an average of 2.61 to 3.10 (moderate to optimum activity). In comparing all 287 sample values in 18 separate farming systems, six replications had peak color ratings which indicated ideal microbial activity and soil health. These highest peak results were achieved in two organic blueberry farms, an equine pasture, a bio-energy demonstration and one residential lawn – 4.53 and 4.06, 4.37, 4.27, and 3.55 on the color scale, respectively. Correspondingly, six of these replications had the highest CO_2 – C production, ranging from 45.54 to 108.02 ppm. The main distinction of these six site categories was perennial cropping where no tillage was used leaving soil undisturbed along with standard practices of "feeding the soil" with composted amendments or mowing mulch on a regular basis.

These measures of CO_2 serve as a potential indicator of an unmeasured nutrient contribution in these sandy loam soils. With the estimated correlation of CO_2 carbon flux

to potential nitrogen contribution, additional N production predicted ranged from 10 to 15 lbs./acre for annual crops and 20 to 35 lbs./acre for perennial crops (Figure 3).

2016 – 2018 agronomic farm soils – Current Assessments Comparative results indicate that the NJ Soybean-Corn rotation fields are relatively healthy and generally better than similar NJ soils in other annual crops with different cultural practices, especially increased tillage.

1. Growers are applying agri-chemicals in appropriate amounts.
2. Tillage practices are reduced from previous norms.
3. Crop yields remain fairly strong given difficult growing seasons of 2016 and 2017.
4. The 2018 season may be much lower due to extremely difficult weather.
5. Soil fertility has been adequate to very good & correlated to crop tissue analysis.
6. Soil biology ranges fair to good and provides 20 to 35 lbs/A of free nitrogen.
7. The Solvita soil health system provides reliable data as to microbial populations.

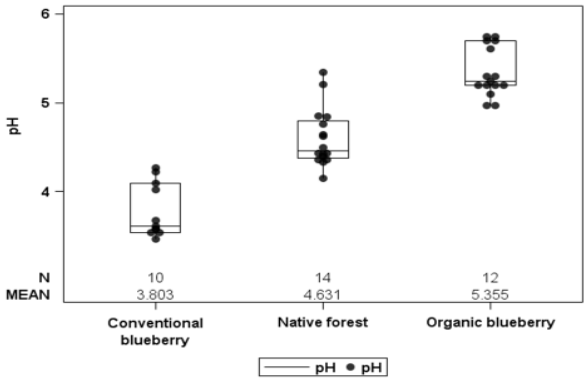
2016-18 Rutgers Marucci Farm & NJ Blueberry Surveys - South Jersey

Survey analysis of native and commercial blueberry soils

Site Description	# sites	0-5 scale	CO_2 ppm	pH	LRI[1]	SOM[2]
Pine Barren Forest	14	3.29 b	41.24 b	4.63 b	7.29 b	3.26 a
Organic Blocks	12	3.09 b	36.75 b	5.36 c	7.20 b	4.78 b
Conventional Blocks	10	1.22 a	6.08 a	3.80 a	7.01 a	2.36 a

[1]Lime Requirement Index
[2]Soil Organic Matter

Letters adjacent to table numbers means statistically significant differences at P>.05



Comments & Conclusion

Our wide-ranging soil surveys with the Solvita® soil respiration test in NJ has accurately measured active carbon and microbial biomass that have been correlated with potential nutrient release over the growing season. This low-cost, high-tech soil test provided a simple and quantitative means of evaluating an important component of soil health that can be used in conjunction with standard soil lab testing and tissue analysis. Seasonal sampling may be utilized to measure any changes in management practices over time; such as cover cropping, tillage systems, municipal leaves, compost applications, chemical fertilizers and organic soil amendments. Farmers, advisors, extension agents and agricultural specialists can add a new assessment method into their toolbox to refine fertilizer applications, tailor Nitrogen recommendations and build organic matter.

PRINCIPLES OF SOIL TESTING, INTERPRETATION, AND RECOMMENDATIONS FOR HEALTHY SOIL

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What is Healthy Soil? *"Soil health, also referred to as soil quality, is defined as the* ***continued*** *capacity of soil to* ***function*** *as a vital living ecosystem that sustains plants, animals, and humans"* (USDA-NRCS, my emphasis). Soil health is often used to specify the conditions of soil that are related to management practices, and so our focus is to manage soils so as to maintain favorable properties for the foreseeable future. Another important aspect is the understanding that a healthy soil serves many needs of the ecosystem, starting with plants but extending up the food chain. *"Only 'living' things can have health, so viewing soil as a living ecosystem reflects a fundamental shift in the way we care for our nation's soils"* (USDA-NRCS). We should strive to manage soils in ways that sustain (or improve) its functions as part of the whole ecosystem.

Recognizing that soils can vary greatly across the landscape and continent (as a consequence of differences in geology, climate, prior organism activity, topography, and time), it's apparent that some will be "better" at performing specific functions – growing 250 bushel/acre-corn vs. 18,000 lb/acre-cranberries, for example. But for each soil, the goal of the soil health paradigm is to maximize its functions that support the specific ecosystem that exists or is desired there with a minimum of inputs.

So in evaluating soil health, we focus on soil properties that are affected by management. Traditional routine soil testing emphasizes the chemical aspects, such as soil pH and nutrient levels, which we can alter with amendments such as limestone and fertilizer. However, the life in the soil – that is, the activity of organisms - can itself be an indicator of soil health, especially since the microbe populations can provide a relatively rapid response to changes in their environment.

Organic matter or organic carbon is widely acknowledged as one of the most important factors linked to soil health (Soil Health Institute). Organic matter is composed primarily of carbon. Organic matter is linked to a number of other factors, such as nutrient levels, cation exchange capacity and buffering capacity (pH), carbon and nitrogen mineralization, water-holding capacity, and aggregate stability. Organic matter is also the "food" (carbon and energy source) for many millions of bacteria, fungi and other microbes that live in the soil,

Soil Health Institute "Tier 1" measures for assessment of Soil Health:

- organic carbon
- pH
- nitrogen
- phosphorus
- potassium
- micronutrients
- cation exchange capacity
- base saturation
- electrical conductivity
- C mineralization
- N mineralization
- crop yield
- texture
- bulk density
- penetration resistance
- water-stable aggregation
- erosion rating,
- infiltration rate

in addition to creating favorable physical conditions, and so has a close association with the biological aspects of soil health – populations, diversity, and processes.

Soil testing labs have responded to various degrees to the interest in soil health. At Rutgers Soil Testing Lab, we offer a wide range of “traditional” agronomic tests and also offer a test focusing on soil microbial activity: the Solvita® CO_2-burst test, to add a biological measure. The test measures potential carbon mineralization and predicts nitrogen mineralization that would occur under favorable environmental conditions.

Rutgers Soil Testing Laboratory’s reports usually will provide interpretation along with the test data. Assuming that a “crop” is indicated by the grower, a chart is included to indicate the optimum pH range (green) for comparison to the measured pH, with yellow and red ranges indicating increasing divergence from optimum.

Each nutrient measured has its specific “optimum” scale, and a bar graph is used to demonstrate how each macronutrient level is categorized in terms of deficiency/sufficiency: very low, low, medium, optimum (high), and very high. The category is what determines the fertilizer recommendation for that particular nutrient. Keep in mind that for cash crops, the maximum yield may not correspond to the most economic yield (profit), and higher levels of nutrients (above the critical value) result in wasted amendment and therefore low nutrient efficiency.

Table 1. Mehlich-3 Soil Test Values for Relative Level Categories

Macronutrients	Units	Very Low	Low	Medium	High	Very High
Phosphorus	pounds/acre	0-24	25-45	46-71	72-137	>137
Potassium	pounds/acre	0-40	41-81	82-145	146-277	>277
Magnesium	pounds/acre	0-45	46-83	84-143	144-295	>295
Calcium	pounds/acre	0-615	616-1007	1008-1400	1401-1790	>1790

Micronutrients, although “essential” for healthy productive crops, are needed in smaller amounts and are less well-defined, but are simply categorized as “low”, “adequate”, or “high”. Interpretive statements for each micronutrient provides further information: suggesting amendment sources, indicating pH effect, and referring to Rutgers Cooperative Extension fact sheets for details and more specific recommendations.

Organic matter content interpretation as a function of soil texture is provided based on an early Rutgers fact sheet generated by an anonymous New Jersey soil scientist. The

organic matter categories presumably compare the measured value to typical ("medium") New Jersey topsoil (A-horizon) ranges. Notice that greater percentages are expected in finer-textured soils, and that 5% organic matter content is considered very high for each soil texture listed. Although managed soils generally need higher levels of organic matter to improve soil health, excessive amounts may lead to problems such as excessive wetness, oxygen depletion in the root zone, and harboring pests.

Table 2. Interpretation of Organic Matter Levels in New Jersey Soils

Organic Matter	Soil Texture			
%	Loamy Sand	Sandy Loam	Loam	Silt Loam
Less than 0.5%	Very Low	Very Low	Very Low	Very Low
0.5 to 1.0%	Low	Very Low	Very Low	Very Low
1.0 to 1.5%	Medium	Low	Very Low	Very Low
1.5 to 2.0%	High	Medium	Low	Low
2.0 to 2.5%	Very High	High	Medium	Low
2.5 to 3.0%	Very High	Very High	Medium	Medium
3.0 to 3.5%	Very High	Very High	High	Medium
3.5 to 4.0%	Very High	Very High	High	Medium
4.0 to 5.0%	Very High	Very High	Very High	High
More than 5%	Very High	Very High	Very High	Very High

Recommendations to adjust nutrient levels and soil pH are always part of the standard fertility test report provided by Rutgers Cooperative Extension, assuming that a crop is indicated when the soil sample is received. Providing as much of the field history as possible with the soil sample will improve opportunity for customized recommendations.

If organic matter content is tested and the value is less than "medium", improvement in soil health can start with efforts to add sources of organic matter such as compost, manure, and/or cover crops. Contributions of organic matter build up the soil food web, which in turn promotes soil structure and water-related qualities. This reduces crop-related risks and assures opportunity for better yields and long-term resilience of the agro-ecosystem.

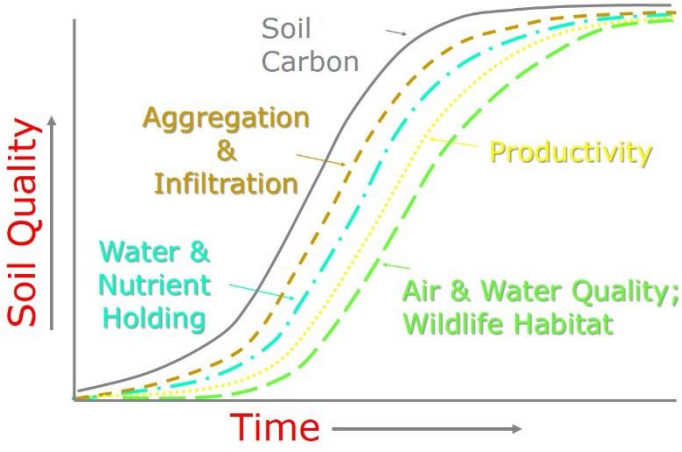
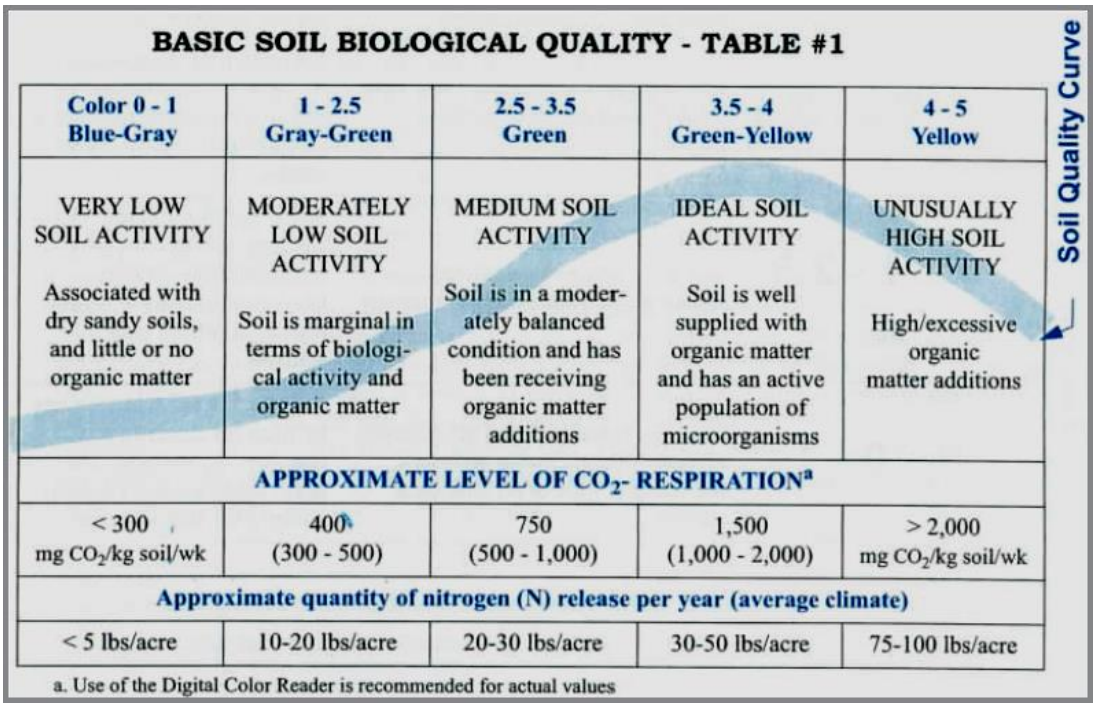


Figure 1. Theoretical sequence of soil quality improvement resulting from organic matter addition.

The Solvita® CO_2-burst test is often closely linked to organic matter content, since soil microbe populations, diversity, and metabolic activity depends in large part on organic

matter as nutrient and energy source. Poor fertility and other factors also contribute to the assessment. Increasing levels of active microorganisms are generally considered favorable, a sign of good soil quality/health. However, like with organic matter contents, there is a level of soil respiration that is considered “excessive”. Depletion of O_2 in the root zone and competition for plant nutrients are potential consequences of excessive microbial respiration.

Interpretation of microbe respiration rates (under laboratory conditions) relates not only to the resident microbial population, but also to potential release (recycling) of nutrients as organic matter is decomposed. Organic matter decomposition is an important, often overlooked, source of nitrogen to crops.



BASIC SOIL BIOLOGICAL QUALITY - TABLE #1

Soil Quality Curve

Color 0 - 1 Blue-Gray	1 - 2.5 Gray-Green	2.5 - 3.5 Green	3.5 - 4 Green-Yellow	4 - 5 Yellow
VERY LOW SOIL ACTIVITY Associated with dry sandy soils, and little or no organic matter	MODERATELY LOW SOIL ACTIVITY Soil is marginal in terms of biological activity and organic matter	MEDIUM SOIL ACTIVITY Soil is in a moderately balanced condition and has been receiving organic matter additions	IDEAL SOIL ACTIVITY Soil is well supplied with organic matter and has an active population of microorganisms	UNUSUALLY HIGH SOIL ACTIVITY High/excessive organic matter additions
APPROXIMATE LEVEL OF CO_2- RESPIRATION[a]				
< 300 mg CO_2/kg soil/wk	400 (300 - 500)	750 (500 - 1,000)	1,500 (1,000 - 2,000)	> 2,000 mg CO_2/kg soil/wk
Approximate quantity of nitrogen (N) release per year (average climate)				
< 5 lbs/acre	10-20 lbs/acre	20-30 lbs/acre	30-50 lbs/acre	75-100 lbs/acre

a. Use of the Digital Color Reader is recommended for actual values

Figure 2. Solvita(R) interpretation of soil respiration for soil quality and theoretical release of nitrogen resulting from mineralization.

In conclusion, there are a number of tests to consider when attempting to assess and monitor soil health. Routine fertility analysis along with organic matter content and microbial activity tests are good starts.

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USE OF COVER CROPS TO IMPROVE SOIL HEALTH

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http://gloucester.njaes.rutgers.edu

The importance of healthy soils is evident to all farmers. Maintaining healthy soil conditions can be a great challenge, especially in sandy soils where organic matter is quickly lost. Additionally, tillage adds to the loss of organic matter and in most vegetable crops multiple tillage operations are needed to create a planting bed for crop establishment. Increasing organic matter levels in soil can greatly improve soil health.

One of the most efficient methods of increasing soil organic matter levels is to use on-farm inputs. There are very few farm operations in this day and age that produce livestock and crops for human consumption (i.e. vegetables). Therefore, on-farm manure inputs may not be readily available to vegetable farmers. In the absence of manure, one of the best ways to obtain organic amendments for soil is to "*grow it yourself"*. This means planting and maintaining high biomass producing cover crops and green manures.

Some of the obvious reasons for using cover crops are to reduce soil from wind erosion. Additionally, water erosion from heavy rains or over irrigation can remove precious topsoil from fields. In the Northeast some fields can lose up to 2 tons of topsoil per year from erosion. Another obvious reason for planting cover crops is to increase soil organic matter. Some not so obvious reasons for implementing cover crops into a rotation are to reduce fertilizer and pesticide runoff into surface waters. Nearby ponds, streams, and rivers used for irrigation can possibly become contaminated from field runoff. By using cover crops this can be prevented. Also the planted cover crop can recycle the fertilizer left in a field by absorbing the nutrients during the growth and then releasing them when the cover crop is plowed down and decomposed. When cover crops are planted they also create an improved environment for beneficial microorganisms and insects. Some cover crops, like winter rye, can decrease weeds by giving off allelopathic chemicals that hinder weed seed germination. Additionally, cover crops can help reduce soil compaction, improve the soil structure, enhance percolation, and add aeration to the soil.

When choosing a cover crop to plant first investigate the purpose for this planting. If you would like to improve soil nitrogen choose legume crops. Those recommended in the Northeast include red clover, hairy vetch, berseem clover, and crimson clover. For building soil organic matter use winter rye, sweet clover, or sorghum-sudangrass hybrids. Cover crops that help reduce soil erosion best in rotations are winter rye, white clover, and cowpeas. If your aim is to loosen compacted subsoils you may want to try deeper rooted cover crops or those with large root systems, like sorghum-sudangrass hybrids, sweet clover, and alfalfa (if you intend on a longer rotation). Cover crops that combat weeds through natural plant inhibiting chemicals or competition include annual ryegrass, winter rye, oats, and buckwheat. Some cover crops have also been found to have soil disease suppression capabilities. Sorghum-sudangrass hybrids have been found to suppress some nematodes. However, one of the best results of planting cover crops

is the organic matter buildup of your soil. If managed correctly, cover crops can significantly raise the organic matter levels of soil. Raising organic matter levels in mineral soils will show great improvement in soils and in crop health. Healthy soils are one of the most important assets to successful crop production.

For more information on using sorghum-sudangrass hybrids for summer cover cropping go to http://www.rce.rutgers.edu/pubs/pdfs/fs994/pdf. This will bring you to a Rutgers Cooperative Extension fact sheet entitled "Sudangrass and Sorghum-Sudangrass Hybrids for Crop Rotations" authored by William Bamka, Agricultural Agent, Rutgers Cooperative Extension of Burlington County and Michelle Infante-Casella, Agricultural Agent Rutgers Cooperative Extension of Gloucester County. This fact sheet is a step by step guide to using sorghum-sudangrass as a cover crop for soil improvement and other rotational benefits.

Session 14

Direct Marketing

THE ART OF DIRECT MARKETING - CATCHING THE CUSTOMERS EYE

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The majority of what our brain processes is visual. If you were going to work on one aspect of your business from a marketing standpoint visuals would be the place to focus your efforts. Research suggests that 60% of buying decisions are based on color. Color not only of the item itself but of the display as well. When I re-started the family farm my mom asked what color I was going to paint the little farmstand she got for me. I said I'm thinking purple. She looked at me in horror and said, "How about red." Red, like every other farmstand in America? No way! People recognize the purple farmstand and it was a good way to separate myself from my neighbors. I also grow a large array of purple produce. Purple: Kohlrabi, potatoes, beans, cauliflower, etc. Essentially if it comes in purple I grow it to play into the brand.

Growing purple produce and other unusually colored vegetables plays into customer's decision to buy. It's a double edge sword because some people don't want vegetables in colors that are unfamiliar. They want red tomatoes, green peppers, and black eggplant. However at the farmers market customers are looking for new things. They are there for not just groceries but for the experience. By playing with color you are giving an experience. Whether people are opposed or interested it slows them down. It starts a conversation. The longer you have a shopper at your table or in your farm store the more likely they are to buy. You want to slow customers down as often as possible.

When thinking of display you want to accentuate what you're selling. If you distract the customer's eye it's harder for them to make buying decisions. Solid backgrounds are best. Classic patterned red and white check tablecloths that I often see at the markets are a poor choice for selling on. It takes the focus (mostly on a subconscious level) off what's on the table to what's covering the table. Black table clothes or black walls behind displays make colors pop.

White also works as well. I take a lot of photos on the purple farmstand as a backdrop and I've been shocked how the purple works with most things. So if you have a unique color scheme going on use it to make your branding fluid.

Signage should be concise, easy to read and professionally done. Ordering vinyl signs online is not very costly and they look great. Poorly written sings, spray painted signs, rushed painted signs are harder for customers to process and could cause confusion and loss of sale.

Embrace the diversity of your customers. If you have a large amount of customers from one county or region that come to your farm have signage be both in English and their native language. This helps customers feel celebrated and appreciated. These people are supporting you so you should make the effort to show them that you notice them, their culture and want them to feel welcome.

Digital signage works wonders! A local business in my town got a digital sign that actually drove me into the store to inquire about an event they were having. They told me that a lot of people

commented on the digital sign and how eye catching it is. There is a lot of evidence that digital signs are worth the investment.

Aside from visuals there are a few other things you can do to enhance customer experience, create loyalty and boost sales.

Talk tracks are critical so staff is educated and speak using your voice and rhetoric and not their own when representing your business. Answers to commonly asked questions should be written down with answers you would give as the business owner provided. All employees should memorize these answers so when asked they can give customers not only give correct information but give information in a clear manner that makes them seem knowledgeable. This is part of building trust with customers.

As the business owner it's important to be the face of your business. No matter how busy you are you need to be present some of the time. Pick 1 day a week to commit to being at your farmstand to greet customers and get to know them. Go to your tailgate markets once a month to drop in, say hi!, and cultivate relationships. No matter how busy or how long the line is you should still try to make a meaningful connection with each customer. Ask them how they are and take that moment to make eye contact. While you're making change comment on something they bought. For example you could say, "Oh you picked out my favorite heirloom tomato, Amana Orange! I love making tomato grilled cheeses with them. You'll have to let me know what you think of them next week." Always leave the door open to continue the conversation. Next week when you see them follow up. This makes the customer feel valued and noticed. From there the relationship will build and it will be less of just tidbits and more meaningful conversation.

I have a strong interest in language. I am also fortunate to have farmers markets where we have diverse clients. With my customers who speak English as their second language I always try to greet them in their native language and encourage them to teach me a new word each week at the market. If you take an interest in people they will take an interest in you.

Give to get is something so important. A great way to build followers and attract people who haven't visited is to give. Host a free class. Do informational videos that answer commonly asked questions about certain crops, give free chocolates, or water. If you give you will get.

Along that same thinking loyalty rewards are a nice perk for shoppers. This can easily be done with a punch card. I used to do "a bring your own bag" punch card. The 10th time the shopper used their own reusable bag they got a dollar off their purchase. Little things like this add up and build on a likable, personable image you want to convey.

Biography: Rose is the Owner of Robson's farm in Wrightstown, NJ. She has a degree from the University of South Carolina in Journalism and Mass Communication. After bouncing around to several sales jobs in pharmaceuticals and medical devices she came home to New Jersey and re-started her family's farm 6 years ago. She is a member of the NJ Ag Leadership program and the NJ Farm Bureau Young Farmers and Ranchers, as well a member of the National Young Farmers Coalition, American Specialty Cut Flowers Growers Association and Burlington Soil Conservation District.

Session 15

Peppers

HOT WATER SEED TREATMENT FOR REDUCING BACTERIAL DISEASES IN PEPPERS

Michelle Infante-Casella, Agricultural Agent and Associate Professor, Rutgers NJAES, Cooperative Extension Gloucester County

Hot water seed treatment is an excellent way to reduce seed borne pathogens in some specialty vegetable crops if done correctly. For pepper, the following diseases may be controlled with hot water seed treatment: Anthracnose, Bacterial leaf spot, Cucumber mosaic virus, Pepper mild mosaic virus, Tobacco mosaic virus, and Tomato mosaic virus. At Rutgers New Jersey Agricultural Experiment Station, Cooperative Extension, growers have cooperated with extension personnel for over 15 years to assist with hot water seed treatment with protocols adapted from Sally Miller, Plant Pathologist at The Ohio State University. Bacterial pathogens are particularly notorious for spreading via seed dissemination. Properly used hot water seed treatment will remove most disease causing organisms on or within the seed. Crops that may been hot water seed treated include: eggplant, pepper, tomato, carrot, spinach, lettuce, celery, parsley cabbage, collards, cauliflower, broccoli, rutabaga, kale, kohlrabi, Brussels sprouts, turnip, radish and other cruciferous crops. Hot water seed treatment begins with placing seed in some type of secure container or pouch that will enable the seed to soak in water. Care should be taken to not fill the pouch or container more than half way full to allow for water circulation and even temperature distribution. Seed that is able to not fall through screening can be placed into stapled pouches of household window screening. Pouches of seed should be labeled when treating multiple varieties and then placed in a warming bath for 10 minutes before being transferred into a precision hot water treatment bath. In the precision bath, seed is soaked for the specified length of time and temperature specific to individual crop groups. For pepper seed, seed is soaked in the precision bath at a temperature of 51 degrees Celsius for 30 minutes. Immediately after the precision hot water bath step is concluded, seed are run under cold water to stop the heating action. Seed can be left in screen to dry hung near fans or spread out on flat screening to dry. Hot water seed treatment is a proven tool that can assist growers by reducing seed borne pathogens.

UPDATE ON X10R AND PHYTOPHTHORA TOLERANT BELL PEPPER VARIETIES FOR USE IN NEW JERSEY

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Bacterial leaf spot (BLS) caused by the pathogens *Xanthomonas euvesicatoria* and *Xanthomonas campestris pv. Vesicatoria* is the second most important disease on peppers in New Jersey. Phytophthora blight caused by *Phytophthora capsici* is the number one disease. Phytophthora continues to be a concern among growers, but with proper management and tolerance varieties growers are learning to live with the disease.

BLS on the other hand has become more of a concern over the last ten years. The pathogen is favored by high humidity, hard driving rains, vigorous plant growth, infected stakes and working in the field when plants are wet. There are eleven (0-10) races of BLS identified in the United States. Most commercial bell pepper varieties grown in the Mid-Atlantic region are resistant to races 1-3 which have been the main races found in the Northern United States. Until recently growers in New Jersey have managed BLS with a combination of resistant varieties and chemical control. In 2004, growers reported that resistant varieties were being infected with BLS. A series of screening trials were carried out to determine if other races may be present in the state. It was determined that race four was found in Southern New Jersey, but not in the Northern part of the state. Since 2004 varieties e.g. 'Turnpike', 'PS0994-1819', 'Vanguard' and 'Tomcat' have been released with resistance to race 4. There are no recommended cherry, sweet frying, hot or banana type peppers resistant to race 4. Bell pepper growers should continue to use a combination of resistant varieties and chemical control while specialty pepper growers only have management and chemical control.

In 2013, growers again noticed BLS showing up on varieties which were resistant to races 0-5. Differential studies were established to determine if additional races were present in New Jersey. Plots were setup in the Southern and Northern parts of the state with a series of varieties with resistance to different races from no resistance to resistances to all known races. As in previous differential studies, it was determined that other races were prevalent in South Jersey, but not North Jersey. The only varieties that did not express any symptoms were those resistant to all races. Races 6 and 10 could not be distinguished from one another since they are closely related and if there is resistance to race 6 there is resistance to race 10. This screening trial has been repeated twice with similar results.

In 2016 we started screening varieties and advanced breeding line for resistance to all races of bacterial leaf spot. In 2018 the trial was carried out at the Rutgers Agricultural Research and Extension Center (RAREC) in Upper Deerfield. Plots were established on black plastic mulch with one drip line between double rows with distance between plants at 18 inches in double rows and 5 ft. between beds center to center. The plots were transplanted June 27. All cultural practices such as staking/tying, fertilization and pest management using recommended practices.

Based on seed company information, the entries '9325', 'Tracer', 'Raven', 'Antebellum', and 'Green Machine' had resistance or intermediate resistance to all known races; 'Paladin' no resistance; 'Turnpike' resistant to 0-5 and 7-9; 'Declaration' resistant to 1-3 and 5; 'Archimedes' resistance to 1-3, 7 and 8. The plots were rated on a weekly basis for BLS by counting plants. The results of the weekly counts will be discussed during the presentation.

The entries were harvested 3 times starting 62 days after transplanting from August 23 to September 26. Peppers were graded based on weight (extra-large >0.49 lbs., large 0.33 – 0.49 lbs., medium 0.25 – 0.32 lbs. culls >0.25 lbs.). Data is summarized in table 1 for all three harvests.

Table 1. Percent Marketable and Marketable Yield (28 lb. boxes) per Acre – 2018 – Upper Deerfield, NJ

Variety/Lines	X large	Large	Medium	% marketable	Total Marketable
Turnpike	608 a	295 ab	82 ab	99 ab	984 a
Archimedes	512 ab	282 a-c	106 a	99 ab	900 ab
Antebellum	358 bc	317 a	113 a	99 ab	788 a-c
Paladin	361 bc	321 a	83 ab	99 ab	765 a-c
Green Machine	370 bc	277 a-c	70 ab	99 ab	717 a-d
Declaration	345 bc	285 a-c	66 ab	99 ab	696 a-e
Raven	308 bc	233 a-d	41 b	98 b	581 b-e
Aristotle	277 c	105 d	34 b	100 a	415 c-e
9325	155 c	141 b-d	33 b	100 a	329 de
Tracer	151 c	132 cd	28 b	100 a	311 e
LSD	**221.8**	**158.0**	**62.3**	**1.7**	**400.7**

Note: The same letters in the same column are not statistically different from one another.

Yields were approximately 50% of a normal harvest. This is the results of a growth regulator inadvertently being applied during transplant production. 'Turnpike' had statistically more boxes of extra-large peppers and had the greatest number of total boxes per acre. This was the same result as the 2017 trial. However, for total boxes it was not statistically different from 'Archimedes', 'Antebellum', 'Paladin', 'Green Machine'

or ‘Declaration’. “Tracer” had the lowest marketable yield, but was not statistically different from ‘9325’, ‘Aristotle’, ‘Raven’ or ‘Declaration’.

In 2018, a differential study was carried out in Northern New Jersey looking at eleven varieties. All the following varieties showed symptoms of BLS in at least two replications: ‘Antebellum’, ‘Green Machine’, ‘Playmaker’, ‘Aristotle’, ‘9325’, ‘Paladin’, ‘Tracer’, ‘Raven’, ‘Turnpike’, ‘Declaration’ and ‘1819’. There were no fruit symptoms and most leaf symptoms were slight.

There are several varieties available that have resistance to BLS that could be evaluated by growers (see table 2). However, a grower can not rely on just a resistant variety but must have a complete management package including clean seed; disinfected stakes; not working in the field when wet and chemical applications. We have seen over the last ten years BLS strains involve thus a compete disease management program is needed to produce a quality pepper. If Phytophthora is a concern and last year’s varieties showed symptoms of BLS select varieties with BLS resistance and Phytophthora tolerance.

Hot Water Seed Treatment

Seed hot water heat treatment is a good management tool for growers who save their own seed or purchase non treated seed. Most seed that is purchased is treated with chlorine which will control BLS if it is on the seed coat, but does not if the BLS is in the seed coat. Seed companies normally do not hot water treat pepper seed.

If a grower plans to treat their own seed care is needed or the germination could be affected. Two water baths are required with one for preheating (100°F for 10 minutes) and the second (125°F for 30 minutes) to the effective temperature to kill the bacteria. Immediately after removing the seed from the second bath it needs to be rinsed in cool water and dry dried. The seed can then be treated with a fungicide if desired. It is not recommended to treat pelleted seed since the pellet will dissolve. If primed seed is purchased do not heat it or the germination will be lowered. Any hot water treated seed should be planted that year. There are good factsheets available that will explain the procedure for treating seed. Do not treat seed on a stove but infest in the right equipment! There are several locations in New Jersey where a grower can bring their seed to a Cooperative Extension office to have the seed treated.

Phytophthora Screenings

Table 2 lists all the varieties resistant or tolerant to Phytophthora blight which can be compared to the Bacterial Leaf Blight resistance by races. In 2018 a trial was carried out at RAREC where the following varieties were compared: ‘9325’, ‘Raven’, ‘Declaration’. ‘Camelot X3R’, ‘Revolution’, ‘Archimedes’, ‘Intruder’, ‘Paladin’, ‘Green Machine’ and ‘Antebellum”. The trial was not harvested due to the growth regulator

being applied to the transplants. Stand counts were carried out weekly and the results of those counts will be presented in the pepper session.

Table 2. Commercially Available Varieties with Resistance or Tolerance to Bacterial Leaf Spot or Phytophthora

Seed Company	Variety	BLS Race Resistance	Phytophthora Resist/Tolerant
Enza Zaden	Placepack	1-10	----
	Provider	1-10	----
Harris Moran	Skyhawk	1-10	----
	Raven	1-10	----
	Tracer	1-10	----
	Prowler	1-10	----
	Declaration	1-3, 5	Tolerant
	Revolution	1-3, 5	Tolerant
Sakata	Samurai	1-10	----
	Ninja	1-10	----
	Mercer	1-3, 7, 8	Tolerant
Seedway	Boca	1-10	----
Seminis	Autry	1-10	----
	Antebellum	1-10	----
	Green Machine	1-10	----
	Playmaker	1-10	Tolerant
	Archimedes	1-3, 7, 8	Tolerant
	Aristotle	1-3	Tolerant
	Turnpike	1-5, 7, 9	Tolerant
	1819	1-5	Tolerant
	9325	1-10	----
	3255	1-10	----
Syngenta	Standout	1-10	----
	Paladin	----	R/T
	Intruder	1-3	Tolerant
	Tomcat	1-5, 7, 9	-----
United Genetics USA	Green Flash	1-10	----
	Galleon	1-10	----
	Mariner	1-10	----

UPDATE ON DISEASE CONTROL IN PEPPER

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Controlling anthracnose fruit rot.

Anthracnose fruit rot has been an increasing problem in pepper production during the past few years. The pathogen, *Colletotrichum* spp., also causes a fruit rot in strawberries and tomatoes. The pathogen can infect pepper during all stages of fruit development resulting in serious losses if not controlled properly. Symptoms of anthracnose fruit rot include sunken (flat), circular lesions. In most cases, multiple lesions will develop on a single fruit. As lesions enlarge, diagnostic pinkish-orange spore masses develop in the center of lesions. During warm, wet weather spores are splashed onto healthy fruit through rainfall or overhead irrigation.

Managing anthracnose fruit rot begins with good cultural practices. The pathogen overwinters on infected plant debris and other susceptible hosts. The fungus does not survive for long periods without the presence of plant debris. Pepper fields should be thoroughly worked (i.e., disced, plowed under) after the season to help break down and bury old debris. Heavily infested fields should be rotated out of peppers for at least three years. Do not plant or rotate with strawberries, tomatoes, eggplant or other *solanaceous* crops. Once areas in fields become infested, management of the disease can be difficult. Prevention is critical to controlling anthracnose fruit rot.

Prevention is critical to controlling anthracnose fruit rot. Infected fruit left in the field during the production season will act as sources of inoculum for the remainder of the season, and therefore, should be removed accordingly. Thorough coverage (especially on fruit) is extremely important and high fertility programs may lead to thick, dense canopies reducing control. Growers have had success in reducing the spread of anthracnose by finding 'hot spots' early in the infection cycle and removing infected fruit and/or entire plants within and immediately around the hot spot.

Controlling Phytophthora crown and fruit rot.

Phytophthora blight (*Phytophthora capsici*) is one of the most destructive soil-borne diseases of pepper in the US. Without proper control measures, losses to Phytophthora blight can be extremely high. Heavy rains often lead to conditions which favor Phytophthora blight development in low, poorly drained areas of fields leading to the crown and stem rot phase of the disease. Infections often occur where water is slow to drain from the soil surface and/or where rainwater remains pooled for short periods of time after heavy rainfall. Always plant phytophthora-resistant/tolerant cultivars, such as Paladin, Aristotle, Turnpike, or Archimedes to help minimize losses to the crown rot phase of the disease. For an updated cultivar list please see the 2019 Commercial Vegetable Recommendations Guide.

Managing bacterial leaf spot in pepper.

Bacterial leaf spot (BLS) in pepper has increased in some areas of the mid-Atlantic region over the past few years. There are ~10 races of the pathogen and in the past few years races 1,2,3,4,5 and 6 have been detected in New Jersey. The pathogen can be seed-borne and can cause significant problems in the field if transplants are exposed to the pathogen during transplant production. Hot water seed treatment can be done to help mitigate potential problems due to BLS. Any seed suspected of carrying BLS should be hot water treated, this is especially important in heirloom varieties or organic seed where BLS problems have been suspected or an issue in the past. Some of the most commonly-grown commercial bell and non-bell pepper cultivars in the region carry resistance packages to different races of the pathogen. Many of the bell peppers grown in the region also have resistance/tolerance to phytophthora blight. Growers with past histories of BLS and/or phytophthora blight on their farm should only grow those cultivars that carry resistance/tolerance to both pathogens. For an updated cultivar list please see the 2019 Commercial Vegetable Recommendations Guide.

Session 16

IPM/Pest Control Updates

INTEGRATED WEED MANAGEMENT, OVERVIEW OF PRINCIPLES AND PRACTICAL APPLICATIONS

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Weeds remain a major challenge in any crop system and this is especially true with the development and spread of herbicides-resistant species. Overall, weeds have evolved resistance to 23 of the 26 known herbicide mechanisms of action, totaling 163 different herbicides and 255 weed species (148 dicots and 107 monocots) (Heap 2018). Farmers cannot anymore rely solely on herbicides for controlling weeds but need to develop and implement an integrated weed management approach to optimize weed control. Integrated weed management (IWM) combines various methods to reduce or eliminate the effect of weeds on crop production over time, using a **combination of practices** that are most effective for solving specific weed issues and placing the weeds at a competitive disadvantage over a wider range of environmental conditions. This presentation will cover the basics of a successful integrated weed management program from proper weed identification to the selection of appropriate tools to control weeds.

Weed Identification

Accurate weed identification is essential for developing successful weed management strategies. Identifying weed species present in a field will provide useful information on how to efficiently manage individual species and the weed population as a whole. Similarly, knowledge of weed biological and ecological characteristics allow growers to exploit weaknesses or avoid strengths of a weed, when making management decisions. It is important to have resources available to aid in weed identification. Guides and websites are available to help with identification of weed species in the Northeast:

- Weeds of the Northeast http://www.cornellpress.cornell.edu/book/
- Rutgers University http://njaes.rutgers.edu/weeds/
- Virginia Tech http://oak.ppws.vt.edu/~flessner/weedguide/
- Penn State http://plantscience.psu.edu/research/centers/turf/extension/plant-id

Weed Scouting and Mapping

Prevention is a necessary step but is not sufficient by itself. Weeds have generally to be targeted at the seedling stage since controlling fully developed weeds can be extremely difficult because of their size that prevent effective herbicide distribution on the plant or because of their ability to regrow following mechanical or chemical control. Surveying weeds will help you determine if a change in herbicides or cultural methods is needed. Fields should be scouted for weeds before planting, after herbicide applications, and at or after harvest time. When scouting, identify and record all weeds found, look for trends or new species and infestations, including suspected herbicide resistance. An efficient scouting program should also provide information on crop phenology as this may extremely important with regards to chemical weed control. The use of farm maps for weed scouting will provide data that can be used to define the control strategy but also assess its efficiency at controlling weeds over time.

Prevention of Weeds

The first step of any weed management program is to consider the steps that need to be taken to prevent introduction, establishment, and/or spread of a specified weed species into an area not currently infested with that species. The purchase of weed-free seeds, the necessity of cleaning equipment before moving from infested to non-infested fields, the use of weed-free irrigation water, the control of weeds on field borders and ditches, and prohibiting weeds already present from going to seeds are some of the key elements of an effective weed prevention program. Rotate crops and avoid fallows between crops will help preventing the build-up and domination of weeds common to a particular crop.

Weed Control before Planting and during Crop Development

- Biological control (biocontrol) tools for weeds include insects, mites, nematodes, pathogens, and grazing animals. Grazing animals and insects can directly impact weeds and reduce their growth and competitiveness. Other biocontrol organisms will feed on weed seeds and reduce seed return to the soil seedbank.
- Cover crops can help suppressing weeds when actively growing by outcompeting weeds for essential resources (light, nutrients, water, and space). Cover crops affect weed germination and emergence by reducing light at the soil surface, lowering soil temperatures, and providing a physical mulch or barrier after they have been terminated. Cereal cover crops can also, tie-up nitrogen (immobilize), making it less available for weeds. Furthermore, cover crops can release phytotoxic compounds (allelopathic effect) that affect small seeded weeds. Species selection and management is crucial to optimize the effectiveness of cover crops in weed suppression.
- Cultural control such as crop rotation, variety selection, soil fertility, planting date, seeding rate, row spacing, leaf architecture, and disease and insect management are considered good agronomic practices for helping to manage weeds. These methods are used to produce a healthy crop that can efficiently compete with weeds.
- Mechanical control is an important component of integrated weed management. Tillage can kill weed seedlings and bury weed seeds. However, it also can stimulate weed seed germination or bring weed seeds closer to the soil surface where they may be more likely to emerge. Mechanical weed control used after planting the crop controls germinated weed seeds or weeds that have already emerged. The types of tools employed generally kill weed seedlings or small weeds before they are well established and competitive with the crop. The goal is to incorporate mechanical weed control tactics that diversify the cropping system and reduce the potential for herbicide resistance while keeping soil conservation and productivity on the forefront. Mowing is a mechanical tactic that can suppress/control annuals and biennials broadleaf weeds that are beginning to flower or deplete carbohydrate reserves of perennial weeds at the vegetative stage when used repeatedly.
- Chemical control will use herbicides to kill weedy plants or interrupt normal plant growth, and can provide a convenient, economical, and effective way to help manage weeds. In most cases, they can be the backbone of many weed management programs. However, they should not be used alone but integrated with other effective nonchemical tactics. The perfect herbicide does not exist. No

single herbicide is capable of controlling all weeds that can develop in a crop or planting. Since every herbicide has advantages and disadvantages, selecting the correct herbicide(s) is crucial for implementing an integrated weed management strategy. By exerting intense selection pressure on weed populations, repeated overuse of certain herbicides has allowed for herbicide-resistant plants to survive and their densities to increase over time. Understanding the mechanisms of herbicide resistance development and spread gives farmers the tools to detect the early warning signs of resistance, take appropriate actions to control suspected resistant plants, and implement strategies to avoid or delay herbicide resistance.

Weed Control at Harvest

Failure to control weeds early in the season leads to “escaped” weeds that drop seeds, often in the fall, and contribute to the soil seedbank. Harvest weed seed control is a new method to kill or remove weed seeds during harvest-time and is most successful when harvest occurs as soon as possible and target weeds are small seeded and short-lived in the seedbank.

- Chaff cart: this cart travels behind the combine during harvest and collects weed seed-containing chaff.
- Narrow windrow burning: forming rows of chaff during harvest and then burning them to kill weed seeds.
- Harrington Seed Destructor: a motorized grinding mill that pulverizes weed seeds contained in the chaff.

Coordination of Integrated Weed Management

Integrating a variety of tactics and technics that can have direct or indirect impact on weeds might be challenging. Over-reliance on any one tactic that allows one species to increase more than other species should be avoided. Each farmer has to evaluate what is feasible for a particular field, possibly prioritizing fields that may need a more comprehensive approach to IWM (or higher level of IWM utilization). Then determining appropriate mechanical, cultural, chemical, and biological tactics, and evaluating the ability to implement these tactics.

For further details on technics and strategies discussed in this presentation, please refer to the following guide:

Integrated Weed Management Guide for Mid-Atlantic Grain Crops

A collaboration among Penn State, Rutgers University, University of Delaware, University of Maryland, USDA-Beltsville, Virginia Tech, West Virginia University

https://cdn.extension.udel.edu/wp-content/uploads/2018/07/09065231/Integrated-Weed-Management-Manual-rv2-for-IPM.pdf

ALLIUM LEAF MINER UPDATE 2018

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Preliminary companion studies were undertaken at the Rutgers Vegetable Research Station in Bridgeton, Cumberland County and at the Snyder Research and Extension Farm in Pittstown, Hunterdon County, examining host preference in the invasive allium leaf miner (ALM) as well as the effect of insecticide applications and one cultural control on infestation rates in scallions. Because no infestation occurred at the Bridgeton site, this report will focus on preliminary results from the Pittstown, Hunterdon County site.

ALM is an invasive pest that has caused significant injury to onions, leeks, garlic, scallions and other related crops in Pennsylvania over the past 3 years. There have been instances of serious injury to leeks and scallions in New Jersey as well; primarily to organic operations in central NJ counties. ALM has two adult generations per year in our area. The initial adult flight generally occurs from late March through April, with larval damage occurring through the spring. Larvae pupate and remain dormant through the hot summer months. Adults emerge in September and are mainly active in October, when they lay eggs on fall crops and weed hosts. At the request of, and in consultation with organic growers in the region, RCE Vegetable IPM program staff began investigating the primary questions of 1) host preference among economically important allium species and 2) the potential efficacy of an OMRI approved insecticide as well as a cultural technique in managing ALM infestations.

Methods

The study had two parts (see photo at right). The first (host preference) consisted of three rows of raised, black plastic with leek, onion and scallion replicated four times in a randomized complete block design. The leek variety was ‘Varna’, onion was ‘Patterson’ and scallion was ‘Nabechan’. The second part (control methods) consisted of two rows of scallions, variety ‘Nabechan’. One row was raised black plastic, and the other row was raised silver metallized mulch. All plots (both parts of study) were double row with drip irrigation. In-row spacing was 12” for leeks and onions and 6” for scallions. The crops were transplanted on 4/13/18, and straw mulch was applied between the beds to suppress weed growth on 4/20/18. The full study consisted of five beds. All beds were 65’ long with individual

reps 10’ long. There were four reps per bed. 12 yellow sticky cards were deployed at transplanting such that each treatment had two cards.

In the control methods portion, the black plastic bed consisted of four reps of scallion where two reps received the OMRI approved spinosyn insecticide Entrust at the 2 oz/A rate, three times at seven day intervals beginning with the first sign of ALM activity. The other two reps were untreated. The second bed was four reps of scallions on silver mulch.

Cards were checked weekly, and plants were sampled for signs of ALM feeding/egg laying (see photos at right – egg laying and feeding scars at top, and larval mine at bottom). The plant samples consisted of all plants in the same 10 holes per rep each week so that damage could be accumulated over time. Prior to the first sample, an initial plant count of each sample site was conducted so that damage could be presented as a percentage of total plants. Weekly Entrust applications were initiated on 5/4/18 at the appearance of the first ALM adult on any sticky card and ceased after 5/18/18.

A final sample site plant count and destructive harvest was conducted between 6/29 and 7/2/18, with 1106 total plants harvested and dissected to determine the level of ALM injury and presence of ALM pupae. Feeding/egg laying occurrence was analyzed as a percentage of plants sampled for each treatment in both portions of the study using SAS software. Tukey’s Studentized Range Test was used to separate mean average feeding by treatment.

Results

The first (and only) ALM adult was caught on a sticky card on 5/4/18. The first signs of injury in any plot occurred on 5/11/18 and the last new injury occurred on 5/23/18. The occurrence of injury was later than usual due to the exceptionally cold conditions during the early spring. Overall feeding was low, and no statistical differences were found among treatments in host preference (leek v. onion v. scallion) (see figure 1) nor among management method treatments (control v. Entrust applications v. silver mulch) (see figure 2), although the silver mulch treatment performed numerically better in limiting feeding in this preliminary study. During the final destructive samples, only 2 ALM pupae were found and no bulb/neck injury was detected. As a result, only feeding from the initial sample periods was analyzed. Initial and final plant counts were not significantly different, indicating no loss of plants due to infestation.

Conclusions

Infestation levels were very low overall, and the foliar injury that did occur did not translate to crop injury or plant loss at harvest. At the low infestation levels in this study, no clear host preference among leeks, onions and scallions was detected. Although differences in feeding/egg laying among management techniques (control, Entrust insecticide and silver mulch) were not statistically significant, there was enough difference numerically to indicate that silver mulch as a deterrent is a technique worthy of further investigation.

Growers had requested a spring study, as they have more allium crops in the field at this time and felt that it was more economically important to them. However, given the absence of injury at harvest, it is possible that these crops (particularly long season ones like leek and onion) can outgrow initial damage as they add layers. It may be that all crops that are exposed to the later flight and harvested in the same season could have greater injury/larval presence at harvest. This too, should be investigated further.

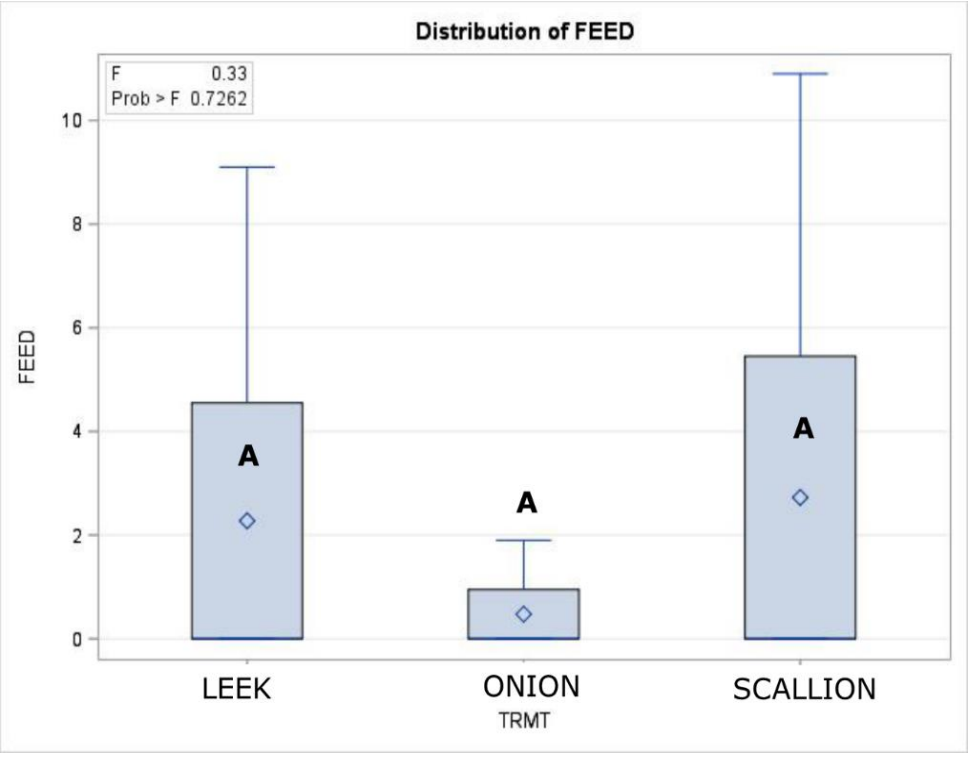

Fig. 1. Percent feeding/egg laying injury - Host preference

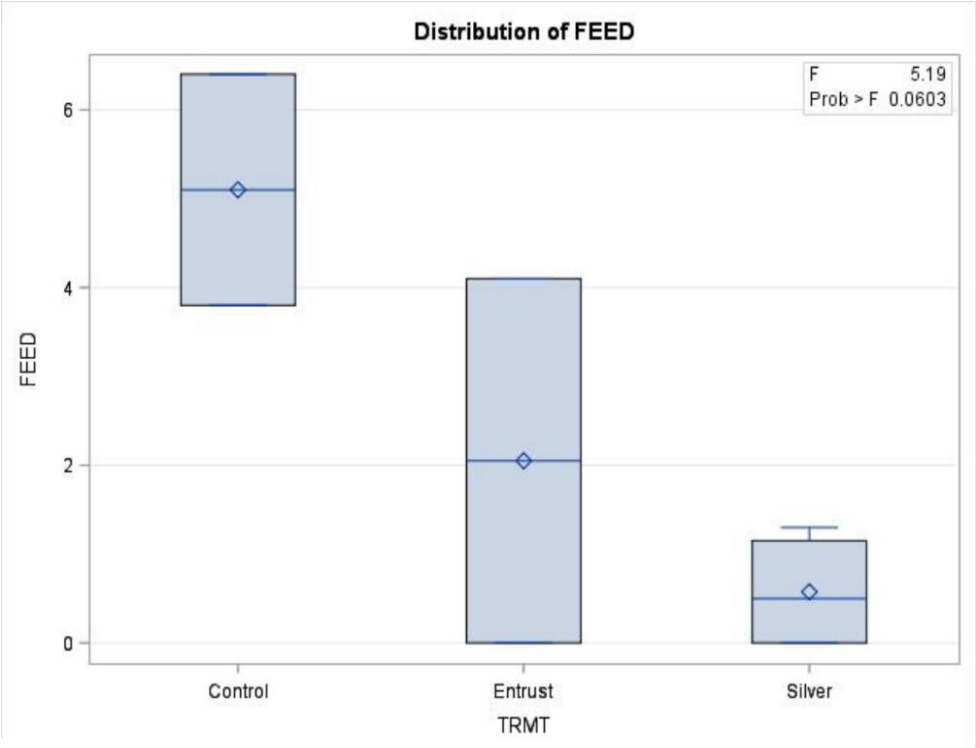

Fig. 2. Percent feeding/egg laying injury – Management technique. Control – black plastic mulch, Entrust – insecticide, Silver mulch

CORN EARWORM THRU THE ROOF IN SWEET CORN, TOMATOES, AND PEPPERS IN 2018

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Corn earworm, *Helicoverpa zea*, is a major pest of many crops in the Mid-Atlantic region, including, sweet corn, field corn, tomatoes and peppers. With the advent of GMO crops where the toxic protein of Bacillus thuringiensis was incorporated into the DNA of many crops, the annual earworm abundance has declined. We have been able to demonstrate this through the use of blacklight traps and pheromone traps at different farm locations around the state. See Fig. 1.

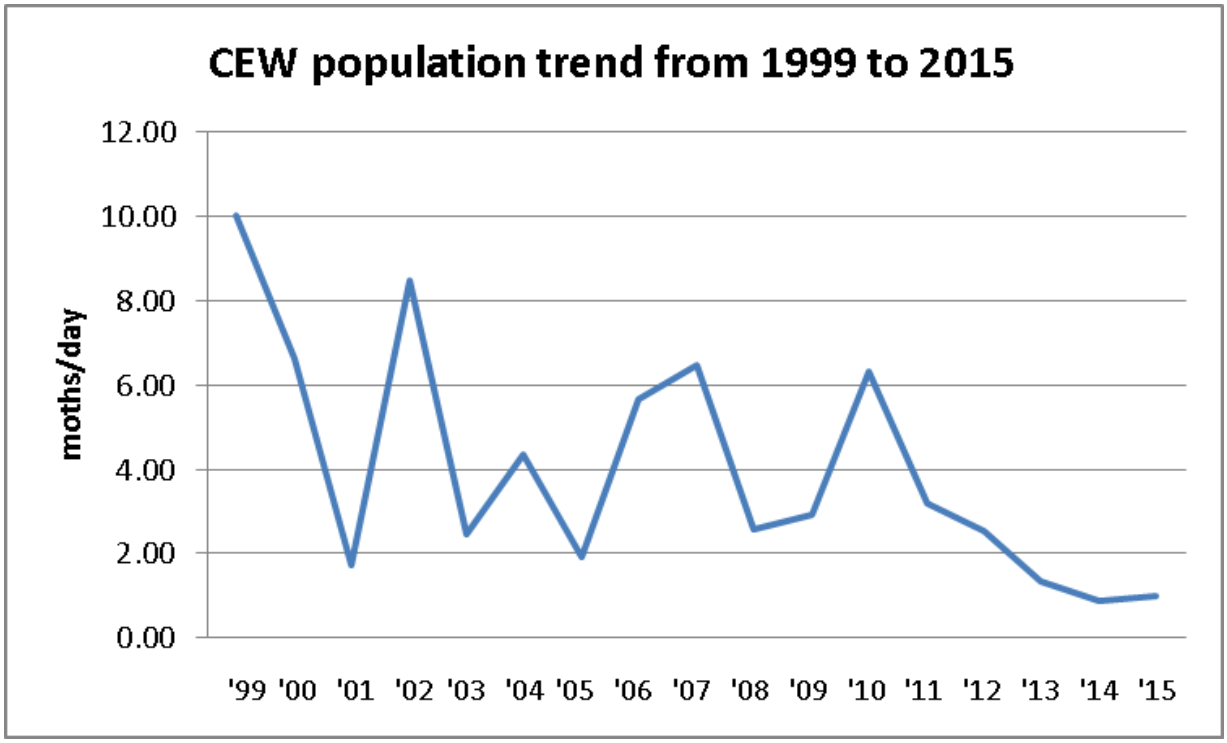
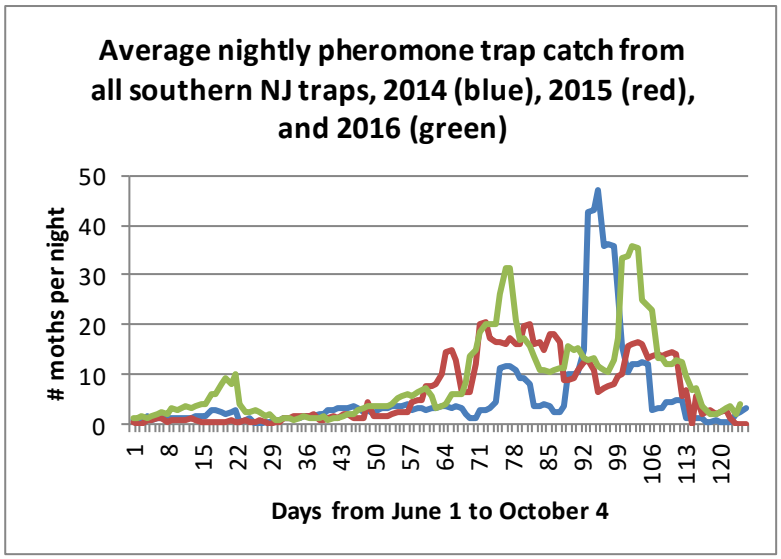


Fig.1. This graph is the average of the blacklight count of corn earworm (CEW) at nine farms across the state, from 1999 to 2015. While there are peaks and valleys in the averages the general trend has been a decline in numbers.



This trend seemed to continue and was reflected somewhat in the pheromone trap catch from 2014 to 2016. See Fig. 2. For most of these seasons the CEW population was below the 3 day spray schedule for silking sweet corn – 20 moths per night. Only in mid-August and later in September did the average nightly trap catch exceed 20.

Fig. 2. The average pheromone trap catches of all pheromone traps in southern NJ of 2014, 2015, and 2016

However, in 2018 we had an unexpected infestation in tomatoes, higher than anticipated moth numbers caught in Texas pheromone traps adjacent to pepper fields, and the highest numbers of moths caught in pheromone traps adjacent to sweet corn fields since we started to use them in 2007.

Beginning in 2017, there seemed to be a shift in the CEW population with higher numbers in early June and for longer periods of time in August and September. See Fig. 3. In 2018 this pattern persisted with a significant increase in numbers beginning in mid-July to mid-September. This increase contradicts the general decline that we were experiencing. This may be an anomaly dependent upon storm fronts and south to north airflows but this condition existed through much of the growing season and follows a pattern similar to 2017.

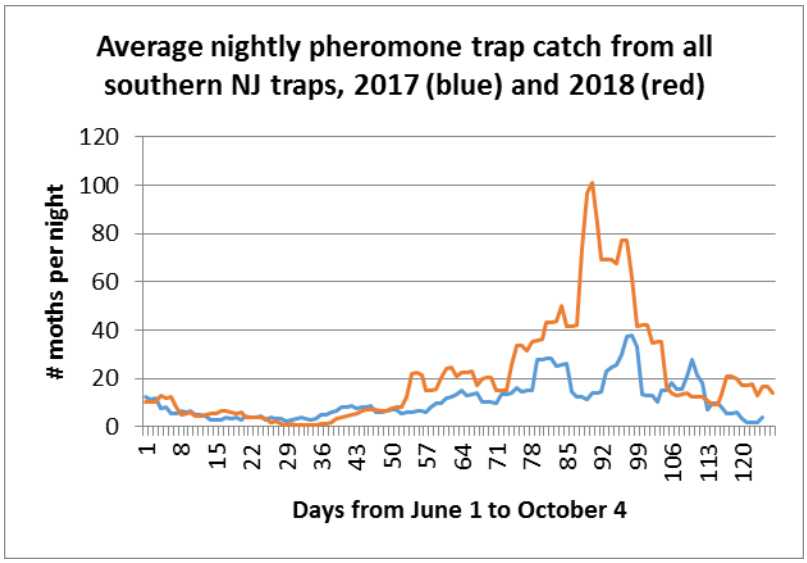


Fig. 3. The average pheromone trap catches of all pheromone traps in southern NJ of 2017 and 2018.

Based on data collected by Galen Dively, University of Maryland, and others in the Mid-Atlantic region, it has been shown that CEW has become resistant to the Cry 1 Bt gene. But in becoming resistant, it has cost the CEW population in reduced vigor, that is, in the number of eggs laid, viability of the caterpillars and so on. If that is the case then what does this sharp increase in CEW mean?

What do these numbers mean at the farm level? What are the thresholds for the differing spray schedules of silking sweet corn and other crops such as tomatoes and peppers. Even though trap catches for sweet corn often exceeded 100 moths per night and even when one trap site had nearly 300 moths per night, the amount of ear damage has been slight. I have not received complaints from farmers of excessive worm damage to the ear tips. Only one incident has occurred but it was deemed to be the result of missing a spray application. A survey will be conducted of the sweet corn growers in the vegetable IPM program to determine the extent of CEW damage. These results will be reported at a later time.

Session 17

Blueberries

BLUEBERRY WEED CONTROL AND WEED PROBLEMS IN GEORGIA

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There have been large increases in Georgia grown blueberries over the past twenty years. The two blueberry species grown are rabbiteye (*Vaccinium ashei*) and Southern highbush (*Vaccinium corymbosum*). The main stages of blueberry production are propagation, establishment (~2 years), and production management (3 year to plant removal). Weeds are problematic during all stages of blueberry production.

During propagation, rooted cuttings are generally grown in one gallon nursery containers in soilless media (9 months to a year). This phase of production is non-bearing, and most nursery herbicides labeled for containerized nursery production can be used. During rabbiteye blueberry establishment, growers will often utilize synthetic row mulches to control weeds. Unfortunately, weeds can grow in the planting hole of the row mulches creating a difficult control situation, as there is no selective postemergence labeled for over-the-top sprays. In highbush blueberry production, plantings are often grouped in tight plantings, and are established in 12 to 18 inches of bark mulch. With the lack of soil, weed control is unnecessary until the second year of establishment, and most preemergence herbicides labeled for blueberries will provide good control of most weeds. During production management, weeds are best controlled with preemergence herbicides. Although there has been much interest in organic production by our society, less than 5% of the acreage in Georgia is devoted to organic production. Some of the reasons for this are unreasonable pest and environmental pressures, lack of control options, strict organic production rules, and poor yields / profit.

Over the past several years many herbicides have been made available to growers. Products such as Chateau (flumioxazin), Alion (indaziflam), and Spartan (sulfentrazone) have the ability to provide reliable preemergence weed control for 12 weeks or more. Selective postemergence weed control in blueberries is often problematic. Weeds such as Alligator weed (*Alternanthera philoxeroides*), Dogfennal (Eupatorium capillifolium), and Smilax (Smilax spp.) are very difficult to control in blueberry fields as glyphosate is currently the only labeled herbicide to control these weeds.

Problems with poor herbicide performance are usually attributed to poor herbicide selection, application timing, and equipment calibration. These problems can easily be overcome with proper training.

SELF FERTILITY OF RECENTLY RELEASED BLUEBERRY CULTIVARS: EFFECT OF SELF VERSUS CROSS-POLLINATION ON FRUIT SET, SIZE AND RIPENING INTERVAL

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The Rutgers' New Jersey Agricultural Experiment Station highbush blueberry breeding program is focused on the development of machine-harvestable varieties for the fresh market. New Jersey growers have relied largely on available migrant hand-labor for harvest. Increasing restrictions on management options, e.g., labor availability, longer pesticide re-entry periods, etc., have placed additional burdens on farm sustainability, making machine-harvestable fresh fruit varieties highly desirable. Varieties with increased fruit firmness, ease of fruit disarticulation from the pedicel, small fruit scar, and tolerance to bruising are traits that are advantageous for machine-harvestability.

The development of new cultivars for machine-harvestability, as well as for adaptation to changing climate, disease and insect pressures, improved fruit quality continues in a number of public and private blueberry breeding programs. However, all blueberry breeding programs have productivity as an objective.

As for most fruit crops, blueberry requires to be pollinated to produce seeds in the ovary of the flower which promotes fruit set and development. The plant utilizes much of the photosynthetic energy to produce fruit to facilitate seed dispersal by animals, e.g., birds, providing the opportunity for blueberry species to evolve to changes in climate, diseases, etc. Thus, as a result of poor seed set, either from poor pollination or other factors, less energy is diverted to develop fruit. Thus, poor seed set usually results in poor crop productivity as well as affecting fruit quality such as fruit size and ripening to some extent in most if not all blueberry cultivars. Seed number and fruit size are positively correlated in many highbush blueberry cultivars.

Another biological, i.e., genetic, aspect of blueberry is that blueberry suffers from inbreeding depression. It is a general finding that blueberry seedlings derived from crosses are more vigorous than those derived from self-pollination resulting self fertilization. Thus, embryos, seeds, developing in the ovary during fruit development derived from cross pollination are more heterozygous than those from self pollination, and result in greater stimulus for fruit development. Another trait that could be useful in blueberry is parthenocarpy, that is, fruit development without fertilization of ovules. Parthenocarpy is also sometimes defined as seedless fruit, e.g. banana. Partial parthenocarpy has been observed in the Rutgers highbush blueberry breeding program. However, poor fruit quality was associated with this trait.

Thus, a desired trait in highbush blueberry is self-fruitfulness for adequate productivity where plantings are large blocks of a single cultivar. In New Jersey, highbush blueberry production typically relies on large plantings of a single cultivar. Unfortunately, due to the high varietal

diversity in blueberry breeding blocks, virtually all blueberry breeding programs measure fruitfulness in a fairly cross-pollinated environment. Since many new cultivars are being released by numerous highbush blueberry breeding programs a survey of self vs. cross fertility was evaluated in recently released cultivars.

USING DRONES TO DETECT AND MAP BLUEBERRY YIELD LOSS

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Drones are designed to collect data from a bird's eye view. This perspective can be very valuable for understanding variations, and therefore yields, over large areas such as individual fields or entire farms. Images provide confirmation of poor areas to help inform the practical grower of drainage issues, underlying soil problems and even topographic patterns that lead to erosion, unwanted fertilizer transport, and areas of insect, disease or weed infestations. Once the images are collected and compiled, the first question asked is usually, "What do I do with this information?"

To answer this question and investigate practical uses for drone imagery, we undertook a project in 2018 to examine spatial and temporal change in a blueberry farm from a "bird's eye view". Funding for the project was from iPiPE (http://www.ipipe.org/) and in-kind support from Downstown Airport, Buena, NJ. Images were collected using a DJI Matrice equipped with a RedEdge multispectral camera. The images were processed by creating an orthomosaic which involved stitching the individual images into a large single image that could be viewed at 5cm resolution. The images were georeferenced using 2015 NJ-DEP aerial photographs (https://njgin.state.nj.us/OGIS_IW/) as base maps, allowing multiple images to be layered and viewed as a temporal stack. Since the project included 12 flights during key times in the growing season from January through October, we were able to investigate changes across the farm during this time frame.

Our hypothesis was that we could detect changes over time on a blueberry farm such as plant growth (both crop and weed) and soil moisture. In other words, we should be able to detect bud break, bloom, and leaf growth by comparing images from different dates. Furthermore, we hypothesized that these changes would not be equal across the entire farm, and that some areas may exhibit a faster growth rate than others. To investigate these hypotheses, it was necessary to develop a method to quantify plant growth as well as other features such as soil properties, plant death and weed populations. Each orthomosaic image is made up of pixels which represent approximately 5cm (2 inches) of actual ground resolution. Each pixel contains five values representing the reflectance for blue, green, red, red edge and near infrared spectra. These values represent the subject within each pixel. So, for example, a pixel over a healthy plant leaf would reflect strongly in the green and near infrared zones and less so in the blue and red zones, whereas a dead or dying leaf would reflect more red and less near infrared. Using this information, we were able to calculate various vegetative indices using the reflectance data from each pixel.

Our data show that we are able to detect variations in plant development over time and within a single farm. Detection of disease and weed pressure as well as development of a soil map will be discussed in this presentation.

EFFICACY OF TRAPS FOR MONITORING SPOTTED WING DROSOPHILA

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Spotted wing drosophila (SWD), *Drosophila suzukii* Matsumura (Fig. 1), is an invasive vinegar fly that can damage many fruit crops including blueberry, cherry, raspberry, blackberry, and strawberry. Native to Southeast Asia, SWD was first detected in the continental USA in 2008. It has since established in many states across the country and was found in the Northeast USA in 2011 (Michel et al. 2015). Unlike most Drosophila, SWD females are equipped with a large serrated ovipositor which can saw through the soft skin of many ripening small fruits to lay eggs. In 2016-2017, a large-scale trapping network was implemented for SWD in blueberry farms in New Jersey to: a) determine the effectiveness of traps at predicting fruit infestation, b) evaluate management program efficacy based on trap counts, and c) investigate the effects of landscape features on SWD.

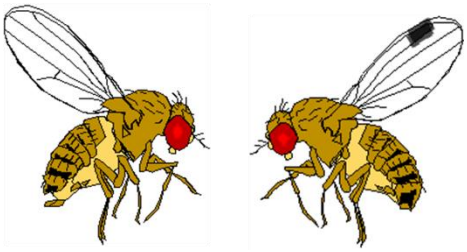

Fig. 1. Female (left) and male (right) SWD. Males have a distinctive black spot on each wing near the tip. Females are slightly larger than males and possess a large serrated

SWD Trapping Network

Eight farms were chosen based on their locations within the state, their surrounding habitats, and the management strategies they employ. A total of 147 baited SWD traps were deployed across those 8 farms. The number of traps employed at each farm was based on the acreage and traps were positioned along the exterior as well as the interior of the farms. Traps were equipped with commercial (Scentry) lures (Fig. 2), and were deployed throughout the summers (June-August) of 2016 and 2017 and monitored weekly for 12 weeks. Traps were made using 32 oz. clear deli cups. Ten holes were placed around the upper portion of the cup, evenly spaced two thirds of the way around the cup leaving a gap through which the trap contents could be poured out. Plastic coated paperclips were used to hang Scentry brand lures above a drowning solution. The drowning solution consisted of water with unscented soap (7th generation brand) at a rate of 4 ml of soap per gallon of water. Traps were hung directly on the blueberry bushes at mid-bush height. Lures were replaced every 4 weeks as recommended by the company. Total of SWD adults in traps

Fig. 2. SWD trap in a blueberry

were counted under a microscope. If needed, sub-sampling was employed in processing trap samples; 1/4th of the samples were processed by volume and SWD adult numbers estimated.

Fruit Sampling

To determine if trap counts correlate with levels of fruit infestation, fruit samples were taken of both 'Duke' and 'Bluecrop' varieties during a six week harvest period (June-July with 'Duke' samples beginning 2 weeks earlier than 'Bluecrop') of 2017. Fruit samples were taken from the same fields where the SWD traps were placed (total of 2 samples were taken from 40 fields of each variety across all farms; for a total of 960 samples), and SWD larval infestation was assessed using a salt test (Van Timmeren et al. 2017). Each sample was 8-oz by volume and taken from multiple bushes surrounding the trap area from all areas of the bush (top, middle, bottom). Two samples were taken from each field, an interior and an edge sample. Edge samples were taken from the exterior row of bushes bordering a wooded area. Interior samples were taken at least 10 bushes in from the edge. Fruit samples were placed in plastic bags and incubated at room temperature for 10 days to insure any eggs present in the fruit would develop into larvae that could easily be counted using the salt float method. Fruit samples were submerged in salt water (1 cup salt per gallon of warm water) for 24 hrs to extract any larvae present and then collected by filtering through a fine mesh screen and assessed under a stereomicroscope.

Our data showed that SWD trap counts accurately predict fruit infestation >90% of the time during the mid-season harvest period, i.e., when 'Duke' and 'Bluecrop' are fruiting (Fig. 3).

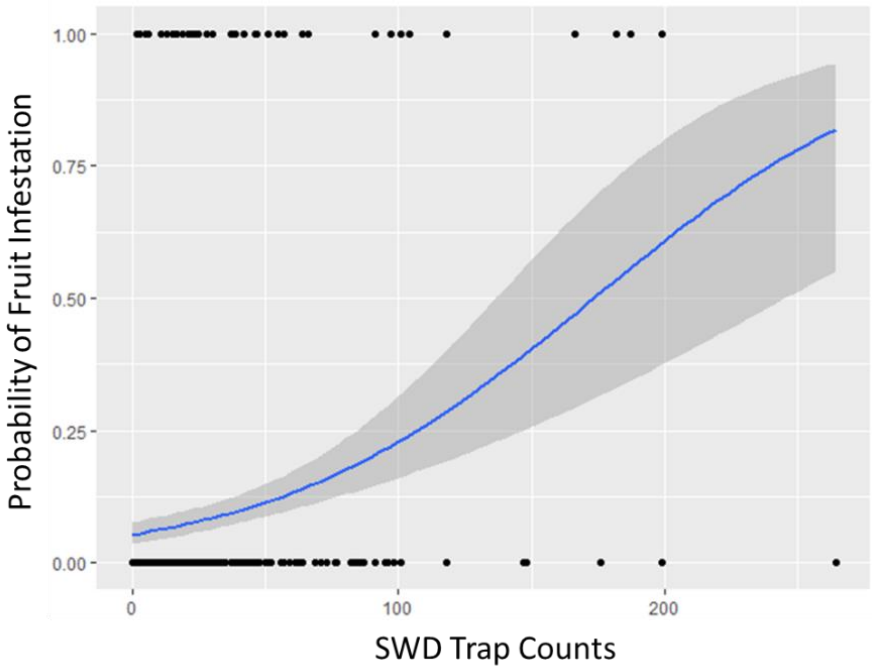

Fig. 3. Predictive power of SWD trap counts on fruit infestation.

Acknowledgments

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SPECIES SHIFT IN THE STEM BLIGHT PATHOGEN COMPLEX

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We have two major blueberry stem diseases in New Jersey. The first is called Stem Blight. This disease is particularly devasting in young plantings, where entire bushes can be killed. In older plantings, whole canes are killed and if the disease reaches the crown, even mature bushes can be killed. The pathogen enters through a wound and quickly spreads downward through the vascular tissue. The first symptoms are usually seen as reddening or yellowing of the leaves on one or more shoots of an otherwise healthy plant. The leaves and the infected shoot die later in the season. Stem Blight is thought to be caused by the fungus *Botryosphaeria dothidea*. The incidence and severity of this disease seems to be increasing in New Jersey

The second major stem disease is called Twig Blight. This disease is thought to be limited to shoot tips and appears in the spring shortly after bud break. The disease seems to enter the shoot tips that are freezing damaged. The tips of the fruiting twigs and the flowers on those shoot tips die, reducing yield. Twig Blight is reported to be caused by the fungus *Phomopsis vaccinii*. The incidence and severity of Twig Blight also seems to be increasing in New Jersey.

Both of these diseases are difficult to control with fungicides. Although inoculum levels can be reduced using proper fungicide application, once the fungi penetrate the stem tissue, they are not accessible to the fungicides and cannot be controlled. To help explain the increased incidence and severity of these diseases, we isolated fungi from canes with Stem Blight and Twig Blight symptoms in 2014, 2016 and 2018. The fungi were identified using DNA sequencing. Our data show that Stem Blight is caused by a complex of different fungal species, not just *B. dothidea* as reported in the literature. In fact, the frequency of *B. dothidea* isolation from infected tissue is decreasing, while those of *Neofusicoccum* species are increasing. Testing of the *Neofusicoccum* species isolates from our collection show that they quickly kill blueberry stem tissue. *Phomopsis vaccinii* was the only pathogen collected from plants with Twig Blight symptoms. Although *P. vaccinii* is reported to cause only cane tip dieback, inoculations on ‘Duke’ were severe, and symptoms were more like those of Stem Blight than Twig Blight.

Further study is warranted to develop better detection and control recommendations for both of these diseases.

Session 18

Workshop:

Developing a Recall System for Food Safety

FOOD SAFETY RECALL PROCEDURES

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What is a recall? “A voluntary or mandatory action taken by growers, packers, or produce distributors to remove potentially contaminated produce from the marketplace and consumers’ homes.” In other words, if you needed to remove all your product from the market place how would you do it. This is different than traceability which is “The ability to track a food product through the food production and distribution system. In the case of fruits and vegetables, this includes back to the field where it was grown and any subsequent handling, storage, and sale.” With traceability, it is the ability to identify each package, carton, master, or individual container from the field to where it was delivered. These both are part of a food safety plan a grower develops for a third-party audit.

What would you do if the Food and Drug Administration showed up and said your produce must be recalled? Who do you contact? How do you let all your buyers know? Can you trace all your product if necessary? These are just a few questions that should be answered prior to any recall. Also, all audits require a recall system to be in place and tested at least once a year.

Growers should maintain a contact list of buyers and develop lists of individuals inside/outside their organization that can be contacted (see attached list) at short notice. Identify the lead person in the organization who can be contacted seven days a week 24 hours a day. The number of team members will depend on the size of operation, but at a minimum the team should include the person who can make decisions; the person who will coordinate the recall; the point person to contact regulatory agencies; a media person to deal with any contacts with media and the public and a person to handle legal questions and insurance. Some of these can be the same individuals, but their responsibilities need to be clearly defined.

Recall Classifications:
Recalls are classified by the Food and Drug Administration by the likelihood of harm to humans or animals from the product.

Class I – There is a reasonable probability that the use of or exposure to the product will cause serious adverse health consequences or death. Examples include contamination from *E coli 0157:H7, Salmonella or Listeria monocytogenes*. The regulatory agency may issue a public alert prior to any traceback.

Class II – There is a reasonable likelihood that use of or exposure may cause temporary or medically reversible adverse health affect. An example is food adulterated with wood fragments. A public alert may be issued.

Class III – Use of or exposure to the product is not likely to cause adverse health consequences. An example is mouse hairs in a food, above allowable regulatory levels, but does not present health concerns. A public alert is usually not issued.

If a farm is going to voluntarily recall a product, make sure the right people are contracted prior to the recall including regulators. There may be steps which must be followed to not cause additional problems for the operation later. Delaying a recall when a foodborne illness outbreak is involved may lead to criminal consequences and/or increased civil damages. Do not ignore a recall notice of a foodborne illness outbreak or it may be considered intentional and open the operation for even more penalties and civil damages.

Steps in a recall plan

Before a recall:

- Create a customer/buyer contact list
- Create a recall team contact list
- Create an effective produce traceability plan and mock recall exercise

Once a problem is identified:

- Collect information and consider the health hazard evaluation factors
    - Document consumer complaints using a consumer complaint form
    - Consider the health hazard evaluation factors using a standard checklist
- Consult with the county health department if more than one consumer complaint about adverse health effects caused by a product.
- Consult with the New Jersey Department of Agriculture
- Consult with legal counsel
- Determine actionable items: Is this a recall? Are you conducting a market withdrawal or are you handling it internally by correction (repairing, relabeling, or other adjustments to product)?

Recall decision:

- Activate the recall team
- Contact the regulatory agencies and provide information
- Perform traceback procedures to determine the product(s), number of unites, unites of measure, farm, harvest date and lot numbers involved (one commodity, one day or all commodities.
- Collect pertinent documentation regarding the affect product.

    - Inputs and outputs of affected field associated with the lot number such as notes on harvesting, methods, wildlife activity, ill employees, manure applications, pesticide applications, water sources, etc.
- Work with regulatory agencies to initiate necessary recall notice, customer notifications and press releases.
- Record all communications related to the recall.
- Track, remove and dispose of recalled products.
- Determine the percent effectiveness of the recall.
- Determine if the recall is over/terminate.
- Update the recall plan if necessary.
- Restore operations.

Testing the recall plan

How do you test your recall plan? During the production season contact your buyers or receiving point and tell them you are doing a recall exercise. Ask them how much product they still have on hand and what has been moved to another receiver. They should be able to tell you that information over the telephone or at least be able to provide the information with two hours. If each carton has a tracing code make sure they provide you with that information.

References:

Ducharme, Diane 2016. Draft Recall Plan Workbook. North Carolina State University. Adapted for University of Vermont by Ginger Nickerson.

Ellixson, Ashley and Sarah Everhart. 2017. A Guide to Drafting a Recall Plan for Maryland Produce Growers EB-430. University of Maryland Agriculture Law Education Initiative.

Ellixson, Ashley and Sarah Everhart. 2017. Model Recall Plan EB-429. University of Maryland Agriculture Law Education Initiative.

Krasny, Leslie. 2012. Recall Manual. Western Growers. San Francisco, CA

New Jersey Recall Team Contact List

Role	Name	Business Phone	After Hours Phone	Responsibilities During Recall
On-Farm Recall Team Leader				• Serves as recall team leader • Makes final decisions on recovery of products • Reassigns team members
Recall Team Coordinator				• Oversees complaint investigation • Coordinates the recall team actions
Government liaison				• Communicates with regulatory agencies and works with legal counsel and provides information to regulatory agencies
Media/Customer Spokesperson				• Handles all media and customer communication • Works with regulatory agencies on press releases and customer letters
Legal Counsel				• Handles liability questions • Advises government liaison on regulatory responses
Insurance Agent				• Addresses insurance coverage issues
NJ Dept. of Ag.	Chris Kleinguenther	856-839-3388 609-292-5531	609-439-2203 609-439-2038	• Oversees recalls for food distributed intrastate
Rutgers Extension (South of I-195)	Dr. Wesley Kline	856-451-2800 Ext1	732-354-9128	• Provides technical assistance/guidance
Rutgers Extension (North of I-195)	Meredith Melendez	609-989-6830	732-354-9135	• Provides technical assistance/guidance
NJ Dept. of Health	Loel Muetter Alan Talarsky	609-826-4935 609-826-4935	609-947-8571 609-947-8595	• Oversees recalls for food distributed intrastate
FDA Voorhees District Office	Recall Coordinator	856-290-4020 856-290-4007	732-666-2592 973-452-8481	• Oversees all product recalls for FDA-regulated product within New Jersey
FDA Emergency		1-866-300-4374		• Connects producer to appropriate assistance
NJ Farm Bureau	Ben Casella	609-393-7163 609-320-6701		• Provides assistance to NJFB members
FDA Produce Safety Network	Cullen Wilson	207-221-0053 240-234-0879		• Provides technical assistance/outreach assistance

Session 19

Workshop: Food Safety Modernization Act (FSMA) Produce Safety Rule Training

Food Safety Modernization Act (FSMA) Produce Food Safety Training

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The Food Safety Modernization Act (FSMA) was signed into law January 2011. The final rule was published November 2015 after comment periods and public meetings. This is the biggest change to food safety that directly impacts fresh fruit and vegetable growers in over 70 years. The Act went into effect January 2018 and will be implemented over the next several years with compliance for growers with annual produce sales (previous three-year period) over $500,000 starting in January 2018, small operations ($250,000 – $500,000) in January 2019 and the very small operation ($25,000 – $250,000) in January 2020. All operations will have four additional years for the water component and some recordkeeping. Growers with produce sales less than $25,000 are not covered under this rule. If the operation produces fresh fruits and vegetables, this Act applies except if the produce is commercially processed, consumed on the farm or meets the qualified exemption.

If all food, including animal feed, sold from the farm is less than $500,000 averaged over the last three years (adjusted for inflation based on the most recent baseline values found at https://www.fda.gov/food/guidanceregulation/fsma/ucm554484.htm), goes directly to an end user (restaurant, roadside stand, supermarket, etc.) and it is sold within 275 miles or within the same state where it is grown then the operation meets the requirement for the qualified exemption. The operation must have receipts or other documents to show they meet this criterion, but there is no specific record which means it could be receipts, sale figures for CSA members, etc.

Growers should be aware that a buyer may still ask the operation to meet all the requirements for FSMA or to have a third-party food safety audit. The difference between FSMA and an audit is that FSMA is government regulation and inspection based while a third-party audit is voluntary that may be required by whom buys your produce.

Produce Safety Training:

. . The Produce Safety Alliance Grower Training Course is one way to satisfy the FSMA Produce Safety Rule requirement outlined in § 112.22(c) that requires '*At least one supervisor or responsible party for your farm must have successfully completed food safety training at least equivalent to that received under the standardized curriculum recognized as adequate by the Food and Drug Administration'.* This is the only training recognized by the FDA at this time!

Fruit and vegetables growers and others interested in learning about produce safety, the Food Safety Modernization Act (FSMA) Produce Safety Rule, Good Agricultural Practices (GAPs) and co-management of natural resources and food safety should also attend this training.

What to Expect at the PSA Grower Training Course?
This is approximately a seven-hour course to cover these seven modules:

- Introduction to Produce Safety
- Worker Health, Hygiene, and Training
- Soil Amendments
- Wildlife, Domesticated Animals, and Land Use
- Agricultural Water (Part I: Production Water; Part II: Postharvest Water)
- Postharvest Handling and Sanitation
- How to Develop a Farm Food Safety Plan

In addition to learning about produce safety best practices, parts of the FSMA Produce Safety Rule requirements are outlined within each module and are included in the grower manual provided. There is time for questions and discussion, so participants are encouraged to share their experiences and produce safety questions.

Benefits of Attending the Course
The course provides a foundation of Good Agricultural Practices (GAPs) and co-management information, FSMA Produce Safety Rule requirements, and details on how to develop a farm food safety plan. Individuals who participate in this course are expected to gain a basic understanding of:

- Microorganisms relevant to produce safety and where they may be found on the farm
- How to identify microbial risks, practices that reduce risks, and how to begin implementing produce safety practices on the farm
- Parts of a farm food safety plan and how to begin writing one
- Requirements in the FSMA Produce Safety Rule and how to meet them.

After attending the entire course, participants will be eligible to receive a certificate from the Association of Food and Drug Officials (AFDO) that verifies they have completed the training course. To receive an AFDO certificate, a participant must be present for the entire training and submit the appropriate paperwork to the trainers at the end of the course.

On-Farm Readiness Review:
As a follow-up to the produce safety training course, farm walkthroughs are available to review farming operations. The Food and Drug Administration is interested in helping growers with tools that they can use for a self-assessment prior to any inspections from NJDA. They want to educate before they regulate and work in a partnership with growers and the individual states. The Rutgers On Farm Food Safety Team has been working with the National Association of State Departments of Agriculture (NASDA) and four state departments of agriculture (Oregon, North Carolina, Florida and Vermont) the Food and Drug Administration (Produce Safety Office of Regulatory Affairs, Inspectors), United States Department of Agriculture (FDA liaison and GAP auditors), Cooperative Extension Organizations in Michigan, Florida, North Carolina and the Produce Safety

Alliance at Cornell University to develop materials for growers to help them prepare for an inspection.

An On-Farm Readiness Review manual has been developed to help simplify the Produce Rule for growers. This On-Farm Readiness Review (OFRR) is intended to be used by produce growers to help them prepare for farm inspections conducted under the Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR) and for OFRR reviewers to conduct on-farm assessments. The manual is intended to be adaptable to farms producing a wide range of covered commodities, using diverse production practices, and adaptable to a wide range of geographical production regions using unique growing and harvesting practices. Part of the OFRR is a farm visit where someone from Cooperative Extension and NJDA will team up to help growers assess their operations.

The purposes of the OFRR process and the farm visits are to:

- Prepare farmers for implementation of the FSMA PSR,
- Help OFRR reviewers better understand how the PSR gets translated on the farm
- Provide a conversational approach to help farmers assess their readiness for implementation of the FSMA PSR
- Provide the tools to help assess how prepared an individual farm is to implement the rule

There are numerous reasons why a grower might want to undertake an OFRR:

- It is voluntary, free and confidential
- It will help them align what they are doing with what is required in the rule.
- It will help them determine what they are missing.
- It provides a personalized discussion about their farm's food safety activities.
- Notes taken by the farmer remain the property of the farmer.
- It will improve the farmer's readiness for a PSR inspection.

The authors worked under the guiding principle that any farm inspection process should include "education before regulation." The hope, therefore, is that growers and extension and regulatory staff will use the manual to build their knowledge about the PSR and learn the most effective and consistent ways to apply that knowledge on the farm during production and inspection. For produce farmers, the manual provides a practical guide for assessing their on-farm food safety practices against the regulatory provisions of the PSR. Farmers are required to also complete PSA Grower Training or equivalent prior to having an OFRR, to maximize the value of that review. Exempt farms may choose to receive a full readiness review as an educational opportunity.
For extension and regulatory staff, the manual provides another resource to help understand the diversity and complexity of farming practices, equipment, and procedures used in the production of fruits and vegetables. The manual helps to identify critical food safety practices that need immediate attention and those that may be addressed in the future. It is meant to be a functional tool that can be used over time to assess practices and compliance, as farming operations or commodities change.

The manual is intended to be a useful and workable tool for growers, extension and inspection staff to use to improve food safety practices at the farm level. Every person stepping onto a farm, regardless of their role, bears responsibility to help ensure that the best food safety practices are understood and used when growing produce. Growers who go through the OFRR will receive a manual during the farm visit.

Inspections:
The New Jersey Department of Agriculture (NJDA) will be carrying out the inspections for the U.S. Food and Drug Administration (FDA). Originally the inspections were to start in January 2018, but inspections will be delayed until January 2019 for the largest operations (over 500,000 dollars). The other size operations will also be delayed by one year i.e. 2020 for small operations and 2021 for very small operations. The first inspections will be educational with the NJDA evaluating the farming operation. This will give the grower an opportunity to see what the NJDA considers area where improvement may be needed. After the inspection NJDA may do another inspection with possible enforcement in the future.

Session 20

Workshop:

RU Ready to Farm

USDA-NRCS FUNDING & PROGRAMS FOR BEGINNER FARMERS

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This session will cover three main areas: 1) Who is NRCS (history and background), 2) Services we provide, and 3) How to get help from NRCS.

Part of the United States Department of Agriculture, the Natural Resource Conservation Service (NRCS) is a federal agency that was created after the Dust Bowl in the 1930s. NRCS provides assistance to private land owners in the conservation and management of their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on our expertise. We deliver technical assistance based on sound science and suited to a customer's specific needs. NRCS works in cooperation with the New Jersey Association of Conservation District (NJACD) and New Jersey's Soil Conservation Districts and the State Soil Conservation Committee of the New Jersey Department of Agriculture.

Some of the services that would be of interest to Beginning Farmers include: Soil Survey data, technical assistance, conservation planning and funding assistance.

Soil survey data is available online through the Web Soil Survey. This information can be used to assess a piece of property a farmer is considering leasing or purchasing or to better understand the land already farmed. In addition to the soil survey information, NRCS has soil scientists that are available to come to the farm and conduct site specific evaluations and reports. If needed, these onsite evaluations can also analyze heavy metals in the soil at various depths within the soil profile.

Technical expertise within the agency or with partnering organizations includes: conservation planning, agronomy, grazing, forestry, wildlife, engineering, irrigation, pollinator, and wetlands. These technical experts are available free of charge to assist in the development and implementation of a farm conservation plan or just to assist with a single issue on the farm.

Our staff work with customers to develop a conservation plan that meets the specific farm objectives of the customer and helps to improve or protect the natural resources on the farm. Following a nine step Conservation Planning process, NRCS field staff will visit with the customer to identify what the problems and opportunities are on the farm. Available resources will be inventoried and analyzed. Next alternatives will be proposed and evaluated based on a number of factors including cost, regulations, how well the option works with the customers farm objectives. Lastly, the customer decides what options to include in the conservation plan and in many cases is eligible for financial assistance to implement the plan.

Our financial assistance programs offered change with each new federal Farm Bill that is passed. We encourage people to contact their local NRCS field office to discuss what programs are currently available to see what might be the best fit. Typically, we have programs that can share in the cost of implementing conservation practices that will:

- improve soil health: such as cover crop, no-till and prescribed grazing
- reduce soil erosion: such as grassed waterways, diversions and crop residue management
- improve water quality: such as stream buffers, fencing livestock out of waterways and practicing integrated pest management
- reduce water usage: such as drip or center pivot irrigation and following an irrigation water management plan
- reduce energy usage: such as lighting improvements, variable speed pumps and insulation
- improve wildlife habitat: such as creating pollinator plantings, delayed mowing for grassland bird habitat or forest thinning to create young forest habitat.

There is no minimum farm size or minimum farm income required to work with NRCS. Participation is voluntary and non-regulatory. A customer's conservation plan is protected by the Privacy Act and will not be shared with anyone without consent.

USDA FARM SERVICE AGENCY PROGRAMS AND LOANS AVAILABLE FOR BEGINNING FARMERS

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USDA Farm Service Agency, Farm Loan information for beginning farmers.

- Direct Farm Loan Programs
    - Farm Ownership Loans - May be used to purchase a farm, enlarge an existing farm, construct new farm buildings and/or improve structures.
    - Farm Operating Loans - May be used for normal operating expenses, machinery and equipment, minor real estate repairs or improvements, and refinancing debt.
    - Down Payment Program - A special loan program to assist socially disadvantaged and beginning farmers in purchasing a farm. Requires the applicant to make a cash-down payment of at least 5 percent of the purchase price.
    - Emergency Loans - To help farmers and ranchers who have suffered a loss caused by natural disasters that damaged their farming or ranching operation.
    - Microloans – A program to better serve the unique financial operating needs of new, niche and small to mid-sized family farm operations, with a simplified application process.
    - Youth Loans - Available to young persons between the ages of 10 and 20 years old, who are sponsored by a project advisor, such as a 4-H club, FFA, tribal youth organization or similar agriculture affiliated group.

USDA Farm Service Agency, Farm Program information for beginning farmers. Many programs are available for all types of farmers and ranchers. Some of the programs to be discussed include:

- Farm Storage Facility Loans (FSFL) – Low interest financing for farm storage and handling facilities.

- Disaster Programs
    - Noninsured Crop Disaster Assistance Program (NAP) - Provides financial assistance to producers of non-insurable crops when crop losses are from natural disasters.
    - Tree Assistance Program (TAP) - Provides financial assistance to qualifying orchardists and nursery tree growers to replant or rehabilitate eligible trees, bushes and vines damaged by natural disasters.

    - Emergency Livestock Assistance Program (ELAP) - Provides emergency assistance to producers of livestock, honeybees and farm-raised fish.

- Organic Certification Cost Share Program (OCCSP) - Provides cost share assistance to producers and handlers of agricultural products who are obtaining or renewing their certification under the National Organic Program.

- Market Facilitation Program (MFP) - Provides a direct payment to farmers to help soybean, sorghum, corn, wheat, cotton, dairy, hog, sweet fresh cherry, and shelled almonds producers. These payments help farmers adjust to disrupted markets, manage surplus commodities, and expand and develop new markets at home and abroad.

TIPS FOR SECURING CAPITAL FOR THE BEGINNING FARMER

Keith Dickinson, CFP®
Business Consultant, Farm Credit East, ACA

Any small business, including a farm business, requires adequate capital resources to be successful. A common challenge for the beginning farmer is securing sufficient capital early in the development of the business in order to generate sufficient profit. Capital, in layman's terms is 'stuff', with dollar signs associated with it. Inventory, supplies, equipment and land all require sufficient capital to obtain. Here are a few tips for securing capital for the beginning farmer when planning their new business.

- Have a plan, and put it in writing.

  The business plan is an essential component to any successful business, especially a new business. The writing of a business plan will force a business owner to think through the key aspects of their business, including capital needs, sources of funds, etc.

- Know where you stand.

  Have a realistic view of your financial position. What is your net worth? What is a realistic expectation of earnings from your business in the first few years? If you are planning to borrow funds, what is your potential lender looking for?

- Be Flexible.

  All too often a new business owner is so convinced that they have the 'perfect' plan for a business, that they become inflexible when barriers are placed in front of them. Look for alternative sources of capital when a loan falls through. Be strategic in your capital expenditures… only purchase what is absolutely necessary and be aware of the alternatives to securing an asset, such as leasing, sharing, borrowing, etc.

- Start slow and grow into your business.

  If you research the history of nearly any successful company, you are very unlikely to find an example of a business that started 'at the top'. You are much more likely to find that the business started very small, and grew into their current position over the course of several years, or even decades. Be patient, and do not try to run before you can walk.

CHALLENGES AND TIPS FOR NEW FARMERS

Jeff Tober and Jess Brandeisky Fernbrook farm CSA

Fernbrook Farm CSA has been hosting an Apprenticeship Program since 2008. Since that time 30 young farmers have come through the farm and 'graduated' from the Apprenticeship program. Jeff and Jess will talk about the program, the expectations for Apprentices and the rewards and challenges of hosting this program on the farm. The Apprenticeship program is intensive for both the farmers and the Apprentices and it may not be the right fit for every farm situation. The commitment for the farm manager is to be constantly teaching. This requires a level of patience, and a willingness to share a lot of information and be willing to handle learning curves. But the reward can be having highly motivated, bright, hard-working young people on the farm who can support your operation in many ways and be an asset to your farm and the farming community after they leave. So Apprenticeships have the potential to be a real asset to the farm, farmer and Apprentice.

We will also talk about the NJ CRAFT network - Collaborative Regional Alliance for Farmer Training. Roughly 30 farms in NJ and E. Pennsylvania have been involved in this network since 2013. It is modeled after the New England CRAFT program wherein farms who host Apprentices / young farmers agree to host a farm tour or workshop during the growing season. This allows new farmers to experience a variety of farm methods and approaches while networking with other young farmers.

Session 21

Workshop:

Basil

THE IR-4 PROJECT: PROGRESS GAINED IN NEW CHEMICAL REGISTRATIONS FOR THE CONTROL OF BASIL DOWNY MILDEW

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For 55 years, Rutgers University Interregional Research Project #4 (IR-4 Project) has been the leading resource in the United States to facilitate registrations of sustainable pest management technology including conventional, biopesticide and organic products on specialty food crops (fruits, vegetables, nuts, herbs). This is important, as the crop protection industry generally focuses on the registrations of crop protection products on major crops such as corn, soybeans and grains, which provide a greater financial incentive. To date, IR-4 has aided in obtaining over 45,000 crop registrations. Without the help of IR-4, specialty crops, which comprise approximately 40% of the total value of all crop production (~$83.1 billion) in the U.S., would encounter significant economic losses.

One recent example where the IR-4 Project is serving an integral role in supporting the specialty food crop industry is with the recent efficacy, crop safety and Magnitude of Residue (MOR) studies being conducted to support chemical product registrations on sweet basil (*Ocimum basilicum*) for control of basil downy mildew (BDM). Sweet basil is one of the most economically important herbs in the world that is favored for its flavor, fragrance, and culinary uses. However, since the 2007 introduction of the most economically devastating plant pathogen to affect sweet basil, *Peronospora belbahrii*, 100% of the sweet basil acreage in the U.S. has been at risk. Since the introduction of BDM, The IR-4 Project has received many Project Clearance Requests (PCRs) to conduct studies to support chemical product registrations.

Conventional product registrations obtained with the help of the IR-4 Project include oxathiapiprolin (Segovis® (greenhouse use); Orondis® Ultra (field use; premix of oxathiapiprolin + mandipropamid, FRAC Group U15 + 40), Syngenta Crop Protection), mandipropamid (Revus®, FRAC Group 40, Syngenta Crop Protection), fluopicolide (Presidio®, FRAC Group 43, Valent U.S.A. LLC Agricultural Products), fenamidone (Reason® 500 SC (field and greenhouse use), FRAC Group 11, Bayer CropScience) and cyazofamid (Ranman®, FRAC Group 21, ISK Biosciences Corporation). In the 2019 field season, the IR-4 Project in cooperation with Agriculture & Agri-Food Canada will initiate MOR and efficacy studies with the new active ingredient picarbutrazox (FRAC Code U17) on basil (field and greenhouse use).

Recent IR-4 Project biopesticide and organic efficacy work has focused on products including, but not limited to *Streptomyces lydicus* (Actinovate® AG, Novozymes BioAg Inc.), *Bacillus amyloliquefaciens* strain D747 (Double Nickel 55 and LC™, Certis U.S.A.), *Bacillus subtilis* strain IAB/BS03 (Aviv™, STK Bio-Ag Technologies) *Bacillus amyloliquefaciens* strain F727 (Stargus™, Marrone Bio Innovations), extract of *Reynoutria sachalinensis* (Regalia® CG, Marrone Bio Innovations), copper octanoate (Cueva®, Certis U.S.A.), neem oil (Trilogy®, Certis U.S.A.), potassium bicarbonate (Milstop®, BioWorks Inc.), hydrogen dioxide (Oxidate®, BioSafe Systems LLC), and hydrogen dioxide; peroxyacetic acid (Oxidate® 2.0, BioSafe Systems LLC), various phosphorous acid products, potassium bicarbonate (Carb-O-Nator™, Certis U.S.A.), hydrogen dioxide, peroxyacetic acid (ZeroTol® 2.0, BioSafe Systems, LLC), and hydrogen peroxide and peroxyacetic acid (Sanidate® 12.0, BioSafe Systems, LLC). In 2019, the IR-4 Project will begin testing select biopesticides, including various experimental products, for efficacy and crop safety on newly released downy mildew resistant / tolerant sweet basil varieties in hopes of developing a fungicide program for organic growers.

With the help of the IR-4 Project, these chemical registrations along with the eight recently developed Rutgers University BDM resistant / tolerant sweet basil lines that are now commercially available, will allow growers to have several options for battling this devastating disease.

FIELD STUDIES ON MANAGING BASIL DOWNY MILDEW IN NEW YORK

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Research has been conducted on managing naturally-occurring (not inoculated) downy mildew in field-grown basil at Cornell's facility on Long Island since 2010. Objectives are to evaluate conventional and organic fungicides used alone (to assess product efficacy) and combined in programs and to evaluate resistant varieties, experimentals, and breeding lines. What has been learned includes:

1. Onset of downy mildew development at LIHREC is very regular, with first symptoms found between 4 and 19 August since 2009; in contrast, first symptoms of downy mildew were found in cucumber from 17 July to 7 September over these ten years.

2. Downy mildew is difficult to manage, especially in crops grown organically. Inadequate control obtained with organic fungicides is at least partly due to the challenge of obtaining thorough spray deposition on the underside of basil leaves. Most organic fungicides have contact activity whereas most modern conventional fungicides are able to move inside leaves. Adding to the challenge of effectively managing downy mildew is the need for a very high level of control of leaf diseases for fresh-market herb crops to be salable.

   Organic fungicides evaluated singly in 2011-12 were Actinovate, BioGuard*, Companion*, Organocide*, Oxidate, Procidic, Regalia, Sporatec*, Sonata*, and Timorex Gold* (*product not registered or not labeled for this use). All provided little to no control based on percentage of leaves with symptoms, which is a rigorous assessment measure, but realistic reflecting the level of control needed to produce a marketable crop. All products tested singly were applied on a preventive, 7-day schedule with the exception of OxiDate, which was applied twice weekly in 2011. Applications were made with a hand-held single nozzle boom over the top of plants in 2010 and 2011, when the focus of evaluations was on products approved for organic production and other biopesticides. However, control of downy mildew was not achieved with the organic products tested singly in 2012 when the boom used had two drop nozzles plus one over the top of plants.

   Combination programs were tested in 2013, 2014, and 2015, which were all applied with a boom with three nozzles per plant. The combination program consisted of Regalia applied to soil starting at transplanting followed by Actinovate alternated with Trilogy applied to foliage in 2013 and 2014 or MilStop + Double Nickel alternated with Regalia + Double Nickel + Cueva and then Trilogy applied to foliage in 2015. The foliar sprays were made approximately twice weekly in 2014 and 2015, and

started at least 24 days before symptoms were found in the experiment. These combination programs were also tested on a moderately resistant variety, Eleonora; but using this integrated program (fungicides applied to a resistant variety) also did not result in successful control.

No treatments were effective in an experiment conducted in 2016 with organic products (Double Nickel, Double Nickel + Regalia,Oso, Procidic, and Sil-Matrix) applied weekly on a preventive schedule until downy mildew was found, then twice weekly in combination with Cueva applied every third application. Cueva used alone was effective based on defoliation ratings.

An experiment was conducted with potted plants dipped in fungicide solutions to obtain good coverage, then put next to affected plants outside for 3 days before returning them to a greenhouse. No symptoms were found on any plants treated with Sil-Matrix, Trilogy, Cueva, or the conventional standard fungicide, Revus. There were symptoms on only 1-3 out of 10 plants treated with MBI-110, Regalia, Procidic, and MilStop, 4 plants treated with Oso, while there were 6-8 affected plants for the nontreated control, Actinovate, and Double Nickel treatments. Among these treatments, severity on affected plants was lowest for MBI-110 and Regalia. No symptoms were found on plants treated with Sil-Matrix or Cueva at the second assessment 5 days later.

3. This disease can be effectively managed in basil with conventional fungicides applied weekly starting before symptoms are detected. However, control can be poor if applications start after disease detection or spray interval is extended due to rain.

   When tested singly, the most effective fungicides in the 2013 experiment were Zampro*, Revus, Orondis (pka Zorvec)*, and Ranman (*not registered yet). ProPhyt was effective in 2013 but not 2012 when another phosphorous acid fungicide, K-Phite, also was ineffective. Presidio was ineffective. Only Orondis and Zampro were effective in the 2012 experiment. Revus was ineffective in 2010 and 2011 when a single-nozzle boom was used. Limited efficacy detected in these experiments is at least partly due to the stringent assessment used: when assessing percent leaves affected, the severity of disease on the leaves is not taken into considered in the assessment. Best control (90-100%) was obtained with combination programs that were applied on a preventive, weekly schedule using a boom with drop nozzles in 2014 and also 2015. The two programs tested were: 1. Ridomil (soil drench), Quadris, Ranman, Revus, plus K-Phite and 2. Quadris, Ranman, Revus, and Orondis. K-Phite was applied at lowest label rate with all applications of the other fungicides based on the current opinion that this is the best use pattern for phosphorous acid fungicides. Many of these fungicides in different combinations in another experiment in 2015 provided poor control at least partly due to an unintended lapse in the spray schedule with 13 days between applications and rainfall 9 days after the previous application. In 2016 excellent control was obtained with 4 fungicide programs with Orondis, Revus, and Prophyt indicating this combination of chemistry was more important than specific timing for each fungicide. Ranman applied in alternation with Revus + K-Phite was not quite as effective (89% vs 99% control).

4. The first commercial resistant variety (Eleonora) has not provided sufficient suppression to be used as the sole management tool or in an integrated program with organic fungicides. Resistant varieties developed subsequently have exhibited better ability to suppress downy mildew. Experimental varieties from Enza Zaden USA, Inc. and PanAmerican Seed performed better than Eleonora in an evaluation conducted in 2015. M4828Z has been commercialized and named Everleaf Genovese and Pesto Party (marketing name for Burpee). Material developed at Rutgers University has been evaluated since 2013. Excellent suppression of downy mildew was achieved with some of the resistant experimental varieties which performed at least as well as resistant breeding lines and inherently resistant spice basil types, and better than Eleonora. No symptoms were observed on some in 2014. Experimental varieties evaluated in 2015 exhibited excellent resistance and good horticultural characteristics (leaf size, shape and flavor). In 2018 degree of control of downy mildew provided by four resistant varieties developed at Rutgers and being marketed by VanDrunen Specialty Seeds was 48% for Obsession, 64% for Devotion, 80% for Passion, and 81% for Thunderstruck, based on AUDPC values compared with Martina. No symptoms or signs of downy mildew were found on any plants of Amazel (Proven Winners) or Prospera (Genesis Seeds). Cultivar ranking based on average rating from 12 growers was Amazel (9.1 for appearance, 6.3 for taste, 8.6 for marketability), Passion (7.6, 6.8, 7.6), Prospera (7.5, 6.5, 6.6), Obsession (6.8, 6.2, 6.6), and Thunderstruck (5.9, 6.4, 5.2).

Research results and reports are posted at:
http://blogs.cornell.edu/livegpath/research/basil-downy-mildew/
New map-based monitoring program for basil downy mildew
https://basil.meas.ncsu.edu/
For more information about downy mildew of basil plus photographs, go to:
http://vegetablemdonline.ppath.cornell.edu/NewsArticles/BasilDowny.html
http://blogs.cornell.edu/livegpath/extension/basil-downy-mildew/

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

EVALUATION OF ORGANIC AND CONVENTIONAL FUNGICIDES USING RUTGERS DOWNY MILDEW RESISTANT SWEET BASIL VARIETIES

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Basil downy mildew (BDM) is the most destructive disease of sweet basil (*Ocimum basilicum*), and is caused by the oomycete pathogen *Peronospora belbahrii.* The pathogen was first characterized in 1932 in Uganda, but did not become a significant threat to basil production until 2001 when it was discovered in Switzerland. The pathogen continued to spread throughout Europe and reached the United States in 2007. Sweet basil is one of the most economically important herbs worldwide, but until recently, due to a lack of resistant basil varieties along with a lack of control options in organic production, global basil production has been under significant threat.

In 2018, Rutgers University released four BDM resistant sweet basil lines: Rutgers Obsession DMR, Rutgers Devotion DMR, Rutgers Thunderstruck DMR, and Rutgers Passion DMR. These four new lines are now available through VanDrunen Farm Specialty Seed for commercial use. Fungicide evaluations are being conducted in the field and greenhouse order to determine the best fungicide spray guide for growers. Two recent field studies were conducted during the 2018 growing season at the New Jersey Agricultural Research and Experiment Station (RAREC) in Bridgeton, NJ, which evaluated the efficacy of various fungicides used in conjunction with the DMR varieties to achieve BDM control. The first of these studies investigated one conventional (K-Phite 7LP) and organic (Stargus) fungicide with the three commercially-available Rutgers DMR basils (Obsession, Devotion, and Thunderstruck) and a susceptible control (Nufar). The conventional product used was K-phite, a pesticide composed of mono- and di-potassium salts of phosphoric acid, that has previously shown good efficacy in controlling BDM. The organic product used in the study was Stargus, a biofungicide containing *Bacillus amyloliquofaciens* strain F727 as its active ingredient. The results of this study demonstrated that, when combined with the resistant varieties, Stargus treated plants showed little to no variation in BDM control when compared to those treated with K-phite. In contrast, susceptible basils treated with Stargus showed no difference in disease progression compared to the untreated control, while K-phite was able to provide more effective control.

The second study investigated more diverse fungicide programs, including both conventional and organic products, in conjunction with the Rutgers Devotion DMR variety. The organic fungicides included were Stargus and Regalia (AIs: *Bacillus amyloliquofaciens* strain F727; Extract of *Reynoutria sachalinensis*), while the conventional products included Presidio

(fluopicolide), K-Phite 7LP, Ranman (cyazofamid), and Zampro (ametoctradin + dimethomorph). Fungicides were either used on their own, as part of an alternating spray program, or in tank mixtures. The results of this study showed that the organic fungicides did not reduce disease progression when compared to the untreated controls. However, when a organic product was alternated with a conventional product, efficacy increased. All conventional programs tested showed similar levels of BDM control when used with Rutgers Devotion DMR, with an alternating treatment of K-phite + Presidio and K-Phite + Ranman demonstrating slightly more control.

The use of the new Rutgers BDM resistant varieties in conjunction with proper fungicide programs offer organic and conventional sweet basil growers a valuable tool when producing sweet basil for both the fresh market and processing.

Session 22

Workshop:

Farm to School

Notes