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The Garden State

NEW JERSEY DEPARTMENT OF AGRICULTURE

RUTGERS
New Jersey Agricultural Experiment Station

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Session Organizers

Tuesday, February 8

Morning Sessions

Agronomy – Steve Komar/William Bamka, RCE Agricultural Agents Sussex/Burlington Counties

Wine Grapes – Hemant Gohil, RCE Agricultral Agent, Gloucester County

Organic Production – Megan Muehlbauer, RCE Agricultural Agent Hunterdon County

General Vegetable I – Andy Wyenandt RCE Specialist in Vegetable Pathology, Rutgers NJAES

Nursery – William Errickson, RCE Agricultural Agent, Monmouth County

Tuesday, February 8

Mid-Day

Farmers Market Butrition Program (FMNP) Vendor Training – NJ Department of Health and NJ Dept. of Agriculture Representatives

Tuesday, February 8

Afternoon Sessions

Soil Health – Michelle Ingante-Casella, RCE Agricultural Agent, Gloucester County

Gazing in the Crystal Ball- Future of NJ Agriculture I – Rick VanVranken, RCE Agricultural Agent, Atlantic County

Agrivoltaics – A.J. Both, RCE Specialist in Ag Engineering, Rutgers NJAES

General Vegetables II – Robin Brumfield, RCE Specialist in Farm Management, Rutgers NJAES

Nursery II – Timothy Waller, RCE Agricultural Agent, Cumberland County

Wednesday, February 9

Morning Sessions

Blueberry – Gary Pavlis, RCE Agricultural Agent, Atlantic County

Small Fruit/Strawberry – Pete Nitzsche, RCE Agricultural Agent, Morris County

Gazing in the Crystal Ball – Future of NJ Agriculture – Rick VanVranken, RCE Agricultural Agent, Atlantic County

Specialty Crops – William Sciarappa, RCE Agricultural Agent

Wednesday, February 9

Mid-Day

Farmers Market Butrition Program (FMNP) Vendor Training – NJ Department of Health and NJ Dept. of Agriculture Representatives

VGANJ/NJDA Joint Session – NJDA's New Farmland Assessment Mapping Tool

Wednesday, February 9

Afternoon Sessions

Food Safety – Meredith Melendez, RCE Agricultural Agent, Mercer County

Integrated Pest Management – Kris Holkmstrom/Joe Ingerson-Mahar, RCE Vegetable IPM Program, Rutgers NJAES

New Crops & Innovative Marketing Ideas – Bill Hlubik, RCE Agricultural Agent, Middlesex County

Weed Management – Thierry Besançon, RCE Specialist in Weed Science, Rutgers NJAES

Thursday, February 10

Full Day Session

Produce Safety Alliance Training – Wes Kline & Meredith Melendez Agricultural Agents, Cumberland and Mercer Counties, Jennifer Matthews, RCE Senior Program Coordinator, Cumberland County

Beginner Farmers Training Session –

Part One – William Hlubik, Agricultural Agent, RCE Middlesex County, William Errickson, Agricultural Agent, RCE Monmouth County, Brendon Pearsall, Beginner Farm Program Coordinator RCE Middlesex County, Lauren Errickson, Community Farmers Market & Rutgers Garden, RCE New Brunswick

Part Two – Megan Muehlbauer, Agricultural Agent, RCE Hunterdon County

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Agronomy

ALTERNATIVE HAY SPECIES FOR THE EQUINE INDUSTRY

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The equine industry in New Jersey is one of the fastest growing agricultural sectors with nearly twenty-percent of the state's agricultural lands dedicated to equine operations (2007 Equine Industry Survey). The increased popularity of the equine industry in the state has provided hay producers a new market for their hay. Approximately 46,000 of the states 115,000 hay acres are dedicated to supplying the equine industry. While the steady increase of the equine industry offers a tremendous opportunity for hay producers, their demands are different compared to traditional animal operations. The hay market provides a tremendous opportunity for NJ agricultural producers. Limited research has been conducted to evaluate production practices, grass species and other inputs and their subsequent impacts on hay yield and quality. Research which focuses on yield and economic returns of alternatives to traditional hay species will help maintain the viability of the forage industry in NJ and potentially offer suitable alternatives for crop rotations.

The increased popularity of the equine industry in the state has provided hay producers a new market for their hay. This increased demand has resulted in a limited supply of high-quality hay. Field experiments started during the 2021 growing season to evaluate the effects of various treatments and cultural practices on the yield, quality and economic returns of three common cool season grasses and 2 warm-season annual crab grasses.

A split plot design was utilized for this experiment with forage species being the whole plot and fertility rates the sub plot. Treatments were monitored for yield, quality, and profitability. Whole plots of cool-season grasses have been planted in strips 50' wide X 100' long with 3 replications. 2 varieties of warm season grasses (crab grass) with 3

replications were planted in the summer of 2021. The replications were cut in half (treated with Nitrogen and untreated with nitrogen). Differences will be quantified by using the appropriate statistical tests. This presentation will discuss the results of study including the forage analyses done by Dairy One.

A REVIEW OF THE 2021 RUTGERS SNYDER FARM HEMP RESEARCH TRIAL

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The 2014 Farm Bill paved the way for production of hemp once again in the US. There is renewed interest and focus on hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. The passage of the NJ Farming Act legalized the production of hemp in the state in 2020. The NJDA has issued permits and authorized producers in the state to begin cultivation during the 2020 growing season. Producers are proceeding without the use of any New Jersey specific research or guidance developed by the NJ Agricultural Experiment Station. Hemp has not been legally produced in the United States since last produced in the WWII era for cordage. Currently, the newly created market demand and production practices center around production primarily of CBD. New Jersey has entered the hemp production arena rather late. Other states have been producing hemp since the 2014 Farm Bill passage. Using historically available production information and newly acquired data from surrounding states may be of some use to NJ Agriculture. However, it fails to provide highly valuable state specific data to help ensure that NJ hemp farmers can produce hemp viably and sustainably in a market they have entered late. Delay in providing reliable NJAES production practice and variety data will continue to place NJ producers at a disadvantage when compared to producers in competing locations with access to state specific information.

Field trials of hemp were continued in 2021 to enable Extension faculty to gain valuable hands-on production experience, collect data and acquire information for development of extension outreach materials. At the Rutgers Snyder farm a trial of 9 CBD varieties were planted in 2021 on raised plastic mulched beds. This builds on trials conducted in 2020 in which 8 separate varieties were evaluated. The Snyder Farm trials included a pilot study looking at plant THC content in relation to sampling location on individual plants. Also, rapid THC measurements were conducted with the aid of an Orange Photonics analyzer. These measurements will be evaluated against standard lab methods. Data and observations recorded during the trials included stand counts, plant height and vigor, flowering date, chlorophyll index (SPAD) assessment, total and % marketable bud yields. Data on weed pressure, disease incidence and insect damage were collected. Yield data was also collected and recorded. Qualitative analysis of the field grown hemp was conducted by the Rutgers hemp analytical research team where several parameters including Total THC, Delta 9 THC, CBG and CBD content were measured. These efforts will help with the development of production recommendations and help ensure the development of an economically viable industry in NJ. Results of the 2021 Rutgers trials will be reported as well as a focus on the status of the industry.

ALTERNATIVE SMALL GRAINS FOR NEW JERSEY PRODUCTION

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New Jersey producers are often looking for new crops to expand their marketing opportunities, to extend crop rotations and to maintain the economic viability of their agricultural operations. In recent years, Rutgers Cooperative Extension faculty have evaluated several potential new and emerging crops including malting barley, hops and other small grains. One crop that has garnered much attention from niche bakers and other value-added agricultural producers is hard red spring wheat. Red wheat is typically grown for its milling qualities and is often grown in the northwestern United States. Although the demand for artisan flours and specialty bread has increased substantially in recent years, limited studies have been conducted to evaluate wheat varieties for suitability for production in New Jersey. In 2021 an experiment was conducted to evaluate six hard red wheat varieties for suitability of production in the northeastern United States and New Jersey in particular.

Four hard red wheat varieties and 2 unreleased lines were evaluated in a conventional, Spring planted system. This presentation will report on the results of this study including yield, standability, grain and milling quality and other quality data.

As with many value-added crops produced in New Jersey, red spring wheat production will be challenging due to several insect pests, diseases, and other management challenges. For this crop to be a successful fit in New Jersey, management of these production challenges is essential and further variety trials are important to determine the best varieties for production in the region.

In addition, adequate milling and processing infrastructure will be crucial for large-scale production to be practical in the region. However, the opportunity for micro-milling and artisan flour production may be feasible options for New Jersey. Future research is needed to determine the best varieties for production in New Jersey and to quantify the impact of fertility regimes on the milling quality of selected lines.

Wine Grapes

GRAPEVINE TRUNK DISEASES AND THEIR MANAGEMENT

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Grapevine trunk diseases (GTD) are not new diseases of grapevine, records suggest they date back to the late 19th century. GTD vary in symptomology, fungal pathogens associated, and distribution worldwide. Grapevines affected by GTD often display dead fruiting positions, reductions in yield, and gradual decline of vines. In many cases, the fungi that cause GTD have extensive latent periods (5-8 years) meaning they can remain as inactive infections in the plant without showing symptoms of disease.

Eutypa dieback is caused by the fungus *Eutypa lata*. It has been identified in most grape growing regions and its occurrence is very dependent on rain events. The pathogen has a very broad host range including tree species in natural forest and horticultural trees. Symptoms of Eutypa dieback first appear in the spring during new shoot development. Affected shoots are often stunted and leaves are deformed, small, chlorotic, and cupped. Symptoms may take several years (3-8 years) to develop due to the slow growth of the fungus in the vascular tissue. *Eutypa lata* also produces a toxin that is translocated in the plant and results in the foliar symptoms described above; the fungus cannot be isolated from the leaves or green shoots. Infections typically occur at pruning wounds. Discoloration is visible under the bark as wedge-shaped cankers. Importantly, wedge-shaped cankers are not diagnostic of Eutypa specifically, as other dieback diseases like Botryosphaeria dieback result in similar vascular symptoms. Fungal spores of the pathogen spread by rain splash and wind. In places where winter temperatures drop below 0ºC like the Northeast and upper Midwest, spores do not spread until temperatures warm in the late winter and early spring.

Botryosphaeria dieback is caused by several species within the Botryosphaeriaceae fungal family. It is one of the most prevalent diseases of grapevine worldwide and can significantly reduce vineyard longevity and productivity. The pathogens are most common in warmer grape-growing regions. Symptoms of Botryosphaeria dieback include the absence of spring growth at affected spur positions. Vascular symptoms include perennial cankers, wood necrosis, brown streaking of the wood, and bud and pith necrosis. Vascular symptoms are often associated with pruning wounds, and can extend into the spurs, cordons, and trunks. This expansion of infection can take place over several years and ultimately result in death of the vine. Botryosphaeria dieback can occur on both mature and young vines, although it has traditionally been thought to be associated with more mature vineyards. Over 20 species of Botryosphaeriaceae fungi are associated with Botryosphaeria dieback, however only 5 or 6 of these species are

frequently isolated from symptomatic tissue and they represent some of the more aggressive species in this family. Further, fungi in this family have a very broad host range including many landscape and forest trees (dogwood, elm, oak, ash, maple, pine, spruce) and other fruit crops (cherry, almond, apple). Dispersal of fungal spores is strongly associated with precipitation events, and even overhead sprinkler irrigation can initiate the release of these fungal spores.

Phomopsis can cause both a cane and leaf spot, as well as a dieback disease. In the upper Midwest and Northeast, Phomopsis cane and leaf spot are more prevalent due to the humid environment. However, in more Mediterranean climates Phomopsis dieback is more prevalent. Phomopsis cane and leaf spot are favored by wet springs and result in black spots on the leaves and canes, these spots expand into lesions as the growing season progresses. Cane lesions do not cause severe damage to vines but do contribute to overwintering inoculum of the pathogen. Grape clusters are also susceptible to Phomopsis, and infections usually take place early in the season and remain inactive until the berries begin to ripen. Phomopsis dieback on the other hand displays symptoms like those of Botryosphaeria dieback, and typically infects via pruning wounds.

Esca is not a true dieback disease, as it affects the fruit ripening process, but it does cause a vascular discoloration like other grapevine trunk diseases. It is more common in Europe, although it has been reported in several grape production regions in the U.S. Several fungal species are associated with the disease. Symptoms of Esca are distinct with a tiger-stripe pattern on the leaves and superficial black spots on the fruits. The fungi associated with Esca infect through wounds and colonize the vascular tissue. Cross-sections of cordons and trunks display discoloration and streaking of the xylem tissues. Similar to *Eutypa lata*, the Esca pathogens produce toxins that are translocated to the leaves and berries.

Cytospora dieback is a more recently described dieback disease of grapevine. Canker diseases caused by Cytospora can affect various perennial crops. Infections occur via cracks or wounds. Much like the other dieback diseases the fungi that cause Cytospora dieback have a very broad host range. **Other trunk diseases of grapevines** include Petri disease which impacts the xylem vessels in the trunk and Black foot which mainly affects the roots and base of the trunk.

Management can be difficult due to the large number of wounds made on vines each year, the extensive period of wound susceptibility, and the diverse number of fungal species associated with dieback and canker diseases. However, several strategies have been identified to prevent and manage infections in grapevine.
***Mention of a fungicide product is not an endorsement. Few products are labeled for grapevine trunk disease management, and not all states have a label for these diseases - check with your states governing body for pesticide use and regulation laws.

Cultural management. Fungal fruiting bodies containing the spores of GTD fungi develop in the woody tissue of cordons, canes, and trunks. Removing the diseased

wood can significantly reduce disease pressure and prevent new infections. Remedial surgery is often relied on to remove infected tissue and prolong the life of the vine. Remedial surgery can be successful if all the infected wood is removed which includes removal of apparently healthy tissue 4-8 inches beyond the canker margins. Late pruning and/or double pruning are strategies widely used in California vineyards to reduce the incidence of Eutypa and Botryosphaeria dieback. The goal of these strategies is making pruning wounds at the end of the rainy season to avoid periods of high spore inoculum and increase chances of quicker wound healing as temperatures increase. Trunk renewal is another common practice, especially in colder climates where trunks may die from winter damage, where old trunks are replaced with new ones derived from suckers.

Chemical management. Pruning wounds are the main entry point for trunk disease fungi, so preventive strategies that aim to protect pruning wounds are critical for mitigating infections. Several active ingredients have been identified for protecting pruning wounds including some chemistries in the methyl benzimidazole carbamate, demethylation inhibitor, and quinone outside inhibitor mode of action groups. Fungicide sprays used in combination with late or double pruning methods can reduce the likelihood for infection. Depending on the period of susceptibility, more than one application of fungicide may be necessary to protect the wounds.

Biological management. Several studies have determined that biological products formulated with the biological control fungus *Trichoderma* are effective at protecting pruning wounds. Not all *Trichoderma*-based products work the same, and their efficacy is largely based on the ability of the active ingredient fungus to grow. Keep in mind that fungal biological control products are not usually compatible in systems where fungicides are used. Other biological control agents (fungi and bacteria) continue to be evaluated in lab and field studies.

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Gramaje, D., Úrbez-Torres, J.R., and Sosnowski, M. 2018. Managing Grapevine Trunk Diseases With Respect to Etiology and Epidemiology: Current Strategies and Future Prospects. *Plant Disease* 102:12-39.

Wilcox, W. F., Gubler, W. D., and Uyemoto, J. K. 2015. Compendium of Grape Diseases, Disorders, and Pests, 2nd Ed. American Phytopathological Society Press, St. Paul, MN.

Organic Production

ALTERNATIVE WEED MANAGEMENT 101

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The weed management toolbox is a treasure trove. Yet, since the discovery of herbicides, chemical weed management has become the favorite. The benefits of herbicides to the advancement of agriculture cannot be understated – herbicides have contributed to widespread adoption of soil building practices like no-till and reduced tillage farming and enabled more acres to be farmed with fewer people, all the while supporting higher per acre productivity. There can be too much of a good thing, however, and reliance on chemical weed management has resulted in the development of herbicide resistant weeds. In the United States alone, there have been 120+ unique cases of herbicide resistance (weed species x site of action); the most of any country. Worldwide, weeds have evolved resistance to 21 of the 31 known herbicide sites of action (http://www.weedscience.org/). These statistics highlight the need to diversify weed management strategies to preserve the viability of our cropping systems.

Part I: Overview of alternative weed management strategies and keys to successful implementation

Can you name the weeds present on your farm? Successful weed management starts with knowing your enemies, as ideal timing of management and the most effective strategies will be different for different types of weeds. For example, an early season tillage event may effectively control the first flush of annual weeds and provide sufficient time for the crop to get established. This same tillage event would fragment the rhizomes of a spreading perennial weed, resulting in more plants that develop from those fragments, and promote rapid regrowth. For the spreading perennials, several well-timed tillage events are necessary to deplete the storage organs.

Reliance on any one strategy puts selection pressure on the community of weeds, allowing the most resilient and, oftentimes troublesome, weeds to proliferate. Regardless of the cropping system, growers are encouraged to capitalize on the diversity of weed management strategies available to them. Some of these strategies and their “modes of action” are described below. Each of these will be discussed in further detail during the presentation.

Practice	Strategies, "Modes of Action"
Sanitation	Prevent introduction of weed seeds from manure, compost, mulches Clean equipment frequently to limit dispersal
Tillage/cultivation	Bury, uproot, cut Modify tillage timing, frequency, depth, and speed
Flame weeding	Termination of small weeds without soil disturbance Best in combination with stale seedbed
Mowing	Remove growing point, reduce vigor Prevent seed formation
Cover cropping	When actively growing – direct competition for space, resources As a mulch – prevents light from reaching soil surface, keeps soil cool, smothers, allelopathy
Crop rotation	Minimizes selective pressure on weeds Short season vs. late season; spring vs. fall crops; perennial vs. annual crops; fallow vs. cash crops
Stale/false seedbed	Reduces early season weed pressure for establishing crop Optimal when planting can be delayed Termination methods vary – flame, tarping, etc.
Using transplants	Competitive advantage to the crop More rapid canopy closure shades out weeds
Mulching	Physical barrier to weed growth Prevents light from reaching soil surface

Weed management strategies need to be tailored to the existing community of weeds, and tailored to the nature of those weeds. Weed populations change with time, so successful long-term weed management depends upon continual evaluation of the weed community. This presentation will feature many examples to help attendees find value in the diversity of the weed management toolbox.

Part II: Testing the utility of black plastic tarps as an alternative and complementary weed control tool for small-scale, direct-market vegetable operations

The use of black polyethylene tarps is an up-and-coming weed management practice for small-scale vegetable growers in the region. Research conducted at several land grant institutions in the Northeastern U.S. has demonstrated the utility of tarps for seedbed preparation or preservation as tarps can smother existing weeds, terminate cover crops, and conserve soil moisture. In New Jersey, tarping may be a particularly

useful practice on our pick-your-own farms where field proximity to parking often limits the use of crop rotation and fallowing. In New York, tarps applied for as little as 3 weeks reduced weed pressure in a study with table beets.

With funding from the Charles and Lena Maier Research Fund administered by the Vegetable Growers' Association of New Jersey, we conducted a small, one-year tarping study in sweet corn at the Burlington County Agricultural Center in Moorestown, NJ. Our objective was to test whether standard weed management strategies could be complemented by tarping. Our treatments were as follows:

- Tarping only
- Tarping + residual PRE-herbicide (Tarp + PRE)
- Pre-plant burndown herbicide only
- Pre-plant burndown + residual PRE-herbicide (Burndown + PRE)
- Weed-free check

Tarps (6-mil black polyethylene) were laid on the soil surface on April 7, 2021 and secured with sandbags. The pre-plant burndown herbicide was applied to the entire field (overtop of the tarps) on May 4, 2021 then tarps were removed on May 6, 2021. Sweet corn was planted on May 7, 2021 and the residual PRE-herbicide was applied to certain plots on May 9. Weed density was evaluated on June 8 (Figure 1) and weed biomass was collected on September 10, after sweet corn harvest (Figure 2).

Figure 1. Total weed density per square foot in sweet corn plots at the Burlington County Agricultural Center. Sweet corn was planted on May 6, 2021 and weed density data was collected on June 8, 2021.

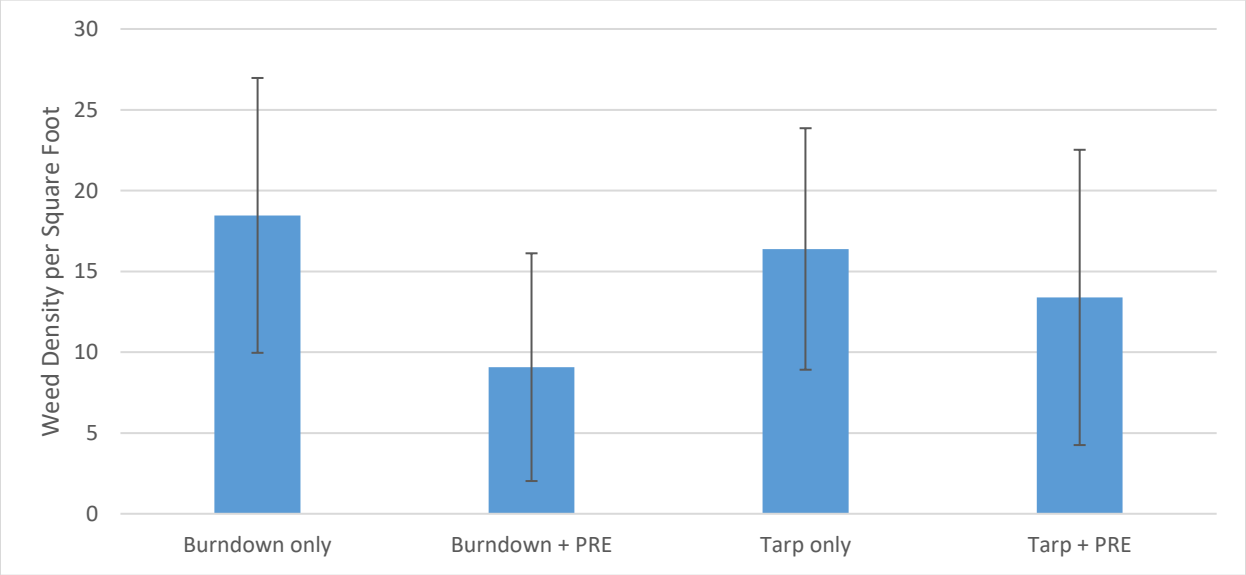
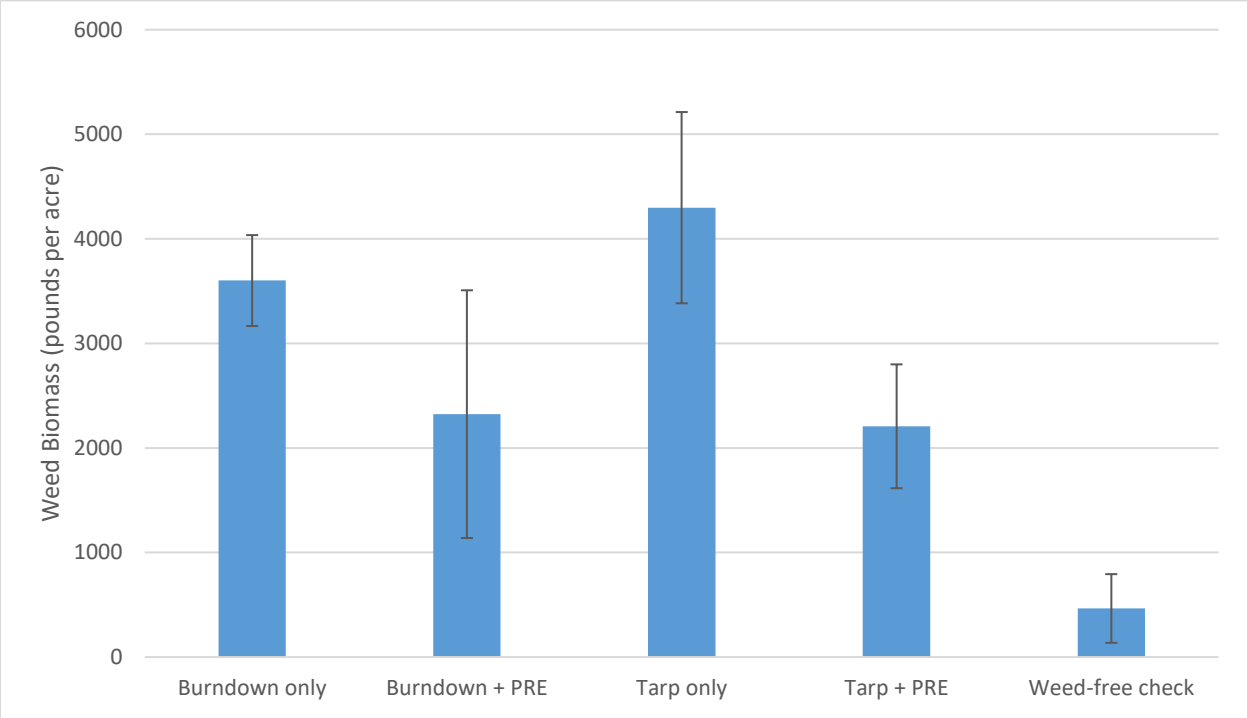


Figure 2. Total weed biomass per acre harvested from sweet corn plots at the Burlington County Agricultural Center. Sweet corn was planted on May 6, 2021 and biomass was harvested on September 10, 2021.



In our study, weed density was lowest in the standard treatment (burndown + PRE) but, due to the variability among samples, density in this treatment was not necessarily different from the other treatments (Figure 1). We observed a similar phenomenon when the weed biomass was harvested (Figure 2). Notably, tarping followed by a residual PRE-herbicide resulted in less weed biomass than tarping alone. Tarp + PRE also had similar weed biomass as the burndown + PRE. All treatments yielded greater weed biomass than the weed-free check.

Final Notes:

Weed pressure was very high in our field this year. Even where the standard pre-plant burndown and residual PRE-herbicides were applied, weed pressure was high and would not have been commercially acceptable. Additional years of study are needed, but tarping may be optimized:

- Where there is already lower weed pressure
- When allowed to remain on the soil for more time, or left on the soil longer into the growing season
- In shorter-season crops

ORGANIC LABELED HERBICIDE TRIAL

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Fruit and vegetable farmers in New Jersey have expressed their need for science based information to assist them in weed management decision making. This organic herbicide trial is part of a NJ Department of Agriculture, USDA SCBG, funded Ecological Weed Management project.

Certified organic farms and farms using organic practices in New Jersey were surveyed to gauge current weed management educational needs, discover their current weed management practices, and identify their biggest weed issues. Grasses, pigweed, galinsoga, yellow nutsedge, and Canada thistle are the weeds we focused on for organic herbicide efficacy based on the survey results.

The following Organic Materials Research Institute (OMRI) herbicides were used for this trial, with AIM as our conventional check herbicide:
- Supress – Caprylic acid and capric acid (fatty acid)
- Axxe – Ammonium nonanoate (soap of fatty acid/soap salts)
- Green Gobbler – 20% vinegar
- Avenger – d-Limonene (citrus oil)
- Burnout II – Clove oil, vinegar, lemon juices

A second spray on all plots was done on August 6th. Our observations show that the 20% vinegar and the ammonium nonanoate were more effective on the pigweed and galinsoga compared to the other OMRI approved products, particularly in the earliest sprayed plots. None of the products were effective against the thistle or nutsedge.

*Research conducted with funding from USDA SCBG G2018
**Co-PI on this project: Thierry Besancon, Rutgers Specialty Crop Weed Specialist

HIGH TUNNEL SOIL AND IRRIGATION WATER QUALITY

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Twenty-eight high tunnel farmers from 17 counties across Pennsylvania provided us soil and irrigation water samples. We had these samples analyzed and determined the most common issues. Since then, we have been working with farmers across Pennsylvania to improve soil and irrigation water quality issues in high tunnels.

The most common issues with soil quality have been phosphate, potash, calcium, and/or magnesium levels exceeding crop needs and high soluble salt levels.

Soil nutrient levels that exceed crop needs can be as bad as deficient levels. High levels might not only represent an economic loss, but may also result in crop, animal, or environmental problems. Applying phosphorus, potash, calcium, and magnesium based on recommendations on soil test reports and nitrogen recommendations will help avoid over application. Another place to get recommendations is the Mid-Atlantic Commercial Vegetable Production Recommendations guide. It's available as a free pdf here: Mid-Atlantic Commercial Vegetable Production Recommendations (Sections) (psu.edu) at https://extension.psu.edu/mid-atlantic-commercial-vegetable-production-recommendations-sections or for purchase as a hard copy through your local Extension office. Tissue testing can be used during the growing season to fine-tune fertility programs.

Over time, with crop growth, the phosphate, magnesium, and calcium levels should decrease. The process can be sped up by growing cover crops. The key with this method is to remove the cover crops from the tunnel (versus turning them in).

When salt levels are high, plants can have difficulty taking up water because of chemical-induced drought. However, even before problems with drought are seen, yield can be decreased.

Salts can be leached out of the soil. A general guideline for leaching out soluble salts from the top foot of soil is to apply 6 inches of water to leach about 50% of the salts, apply 12 inches to leach about 80% of the salts, and 24 inches to leach about 90% of the salts (California Fertilizer Association, Western Fertilizer Handbook, 8th Ed.). Another option is to leave the plastic off the tunnel for a while when it needs to be replaced. It would be useful to retest the soil after leaching the soil if you decide to do this.

The most frequent problems with irrigation water quality have been high pH, alkalinity, and/or hardness.

Sulfuric, nitric, phosphoric, and citric acid can be used to lower water pH. eGRO has an online calculator called the “AlkCalc” that determines how much sulfuric, nitric, or phosphoric acid to use based on the alkalinity and pH of the water and type and concentration of the acid. It can be found at: http://e-gro.org/alkcalc/.

Surface water with an algae problem can affect water quality. The pH of the water can vary by time of day based on the rate of photosynthesis or respiration of the algae. We would expect it to be lower at daybreak and higher at mid-day, for example. Algal growth can take hold because of an excess of nutrients in the water. Liming can help buffer the pH of the water. This website has a lot more information about pond management, including strategies to avoid excess nutrients in the water: https://extension.psu.edu/water/pond-management

ORGANIC LIVESTOCK PRODUCTION

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Below is the process of getting USDA Organic Certification for Livestock Production.

USDA Organic Certification

§ 205.100 What has to be certified

Under the USDA organic regulations, most operations or portions of operations that produce or handle agricultural products that are intended to be sold, labeled, or represented as organic must be certified. Producers who illegally represent their products as organic may be subject to prosecution and fines up to $11,000. During the application process, many certifiers will require farmers to sign an agreement that they will comply with the organic production and handling regulations in accordance with Title 7 Code of Federal Regulations Part 205 National Organic Program Rule.

§ 205.101 Exemptions and exclusions from certification

Producers who market less than $5,000 worth of organic products annually are not required to apply for organic certification. They must, however, comply with the organic production and handling requirements of the regulations, including recordkeeping (records must be kept for at least 3 years). The products from such noncertified operations cannot be used as organic ingredients in processed products produced by another operation; such noncertified products also are not allowed to display the USDA certified organic seal.

Where do organic livestock come from?

§205.236

Origin of livestock- Livestock products that are to be sold, labeled, or represented as organic must be from livestock under continuous organic management from the last third of gestation or hatching: except poultry. Poultry or edible poultry products must be from poultry that has been under continuous organic management beginning no later than the second day of life. Dairy animals-milk or milk products must be from animals that have been under continuous organic management beginning no later than 1 year prior to the production of the milk or milk products that are to be sold, labeled, or represented as organic, except crops and forage from land, included in the organic

system plan of a dairy farm, that is in the third year of organic management may be consumed by the dairy animals of the farm during the 12-month period immediately prior to the sale of organic milk and milk products.
The certification process:
1. The farmer submits an application to a certifier. Producers obtain certification from State or private certifiers who are accredited by the NOP. Farmers may apply to any accredited certification agency (ACA). The cost of organic certification is borne by the certified operations and is paid directly to the certifying agent.
2. The certifier reviews the application. The certifier reads the farm plan and determines whether the practices are described in sufficient detail and whether the farm appears to meet organic regulations. There are cases in which applications are denied or delayed.
3. The inspector visits the farm. One of the most important responsibilities of the inspector is to examine records that document your farming practices. The records the inspector will look at include, but are not limited to, the following:

- Land
    - Invoices for material purchases
    - Records of material applications
    - Records of yield, harvest, and organic sales of crops
- Livestock
- Organic certificates for purchased livestock
    - Sales and purchase records for livestock and products
    - Inventory list showing organic or conventional status
    - Breeding, birth, and health records
- Feeding records
    - Feeding plans for all species and all classes of animals
    - Harvest and storage records for feed grown on-farm
    - Feed-purchase records (invoices, tags, labels, and organic certificates)
- For ruminant livestock
    - Grazing records
    - Dry matter intake calculations and sources of dry matter intake values
    - Records of days on pasture, pasture management, among others

4. The certifier reviews the inspection report.
5. The certifier issues the organic certificate.

Organic management combines three types of approaches:

- Cultural- raising a breed of livestock adapted to the farm's climate
- Biological- maintaining a dense pasture to prevent weed growth and grazing cattle with sheep to reduce internal parasite problems
- Mechanical- clipping weeds before they can go to seed in pasture

Why organic livestock production?
Marketing:

- Access to 29 million people in a 100 radius in NJ with the potential of a higher dollar amount for products
- Increased marketing channels

Animal Husbandry

- Record keeping requirements
- Feeds and supplements
- Herd health management
- Handling Facilities
- Shelter
- Pasture Management

Processing and Harvesting

- USDA Certification
- USDA Organic Certification

Organic livestock production has many challenges and opportunities, but it is vital to understand the regulations associated with the certification process and to understand the market to be successful in this venture.
https://www.ams.usda.gov/sites/default/files/media/LivestockProducersGuide.pdf
https://www.ams.usda.gov/sites/default/files/media/Organic%20Livestock%20Requirements.pdf

General
Vegetables I

DISEASE CONTROL UPDATES IN VEGETABLE CROPS

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Pepper anthracnose caused by *Colletotrichum* spp. has become a significant problem on some farms in southern New Jersey. Unlike in tomato, where symptoms are only present in mature (red) fruit, pepper anthracnose can infect pepper fruit at any growth stage. Currently, there are no commercially available bell or non-bell peppers with known resistance to anthracnose. The pathogen overwinters, albeit, not very well on infected pepper fruit left in the field or on infected plant material at the end of the production season. Because pepper anthracnose does not overwinter very well, it always starts out as a 'hot spot' in the field and then fans out directionally with the prevailing direction of the wind and driving rain. Hot weather along isolated afternoon and evening showers are ideal conditions for anthracnose development.

On farms with a history of pepper anthracnose, precautions should to be taken each year. The first, if possible, is to rotate away from those areas of the farm with anthracnose for as long as possible. Remember, it can survive (although not very well) in the soil for many years. Importantly, the same pathogens that cause tomato anthracnose and strawberry anthracnose are the same species that infect pepper, so rotating away from fields heavily used in tomato and/or strawberry production is extremely important. Fields need to be scouted as soon as fruit start to develop to locate 'hot spots'. If 'hot spots' are found, all fruit from the immediate and surrounding area need to be strip-picked (or entire plants can also be removed). Growers who have adopted this practice have had success in reducing their losses by reducing the inoculum pressure before the pathogen begins to fan out across the field. Overhead irrigation should not be used in fields with anthracnose problems.

Reducing the amount of inoculum in the field is critical for managing pepper anthracnose. Infected fruit left in the field during and after the production season have the potential to act as a source of inoculum. Therefore, it is critically important to take the appropriate steps to help reduce that chance. During the season, all infected fruit need to be removed from the field. After harvesting, all fields should immediately mowed or hit with gramoxone. All plant debris should be thoroughly worked back into the soil so it can start to break down as quickly as possible. Abandoned fields with plants still standing going into the fall/winter only act as an increased source for inoculum. It's a misnomer to think that the cold winter weather will help breakdown and reduce inoculum found on infected plant material left on the soil surface. It's much better if infected plant material is worked back into the soil where other soil microorganisms can help with the process.

Fungicide programs do work for controlling pepper anthracnose. Fungicide programs should begin as soon as plants start to flower. The key to controlling anthracnose is to get the fungicide to where it is needed the most, on the developing fruit. Planting peppers in a single or double-row fashion may greatly affect your ability to control the disease. Your fertility program may also affect your ability to control the disease. Fertility programs high in N that promote tall, lush, dense canopies will greatly impact how much fungicide gets to where it needs to be. Growers should apply high rates of chorothalonil or manzate in a weekly rotation; or tank mix either with azoxystrobin (11); Cabrio (pyraclostrobin, 11); Priaxor (fluxapyroxad + pyraclostrobin, 7 +11); Quadris Top (3 + 11); Aprovia Top (3 + 7); or Topguard (flutriafol + azoxystrobin, 3 + 11) with a high volume of water (50 gal/A +) to ensure adequate coverage. Organic growers need to be extremely diligent with proper crop rotations, regular scouting to detect 'hot spots' early and make sure to remove all potential sources of inoculum. Weekly OMRI-approved copper applications may help suppress anthracnose. Other organic products have shown little or no efficacy against pepper anthracnose.

Other important diseases of vegetable crops will be discussed.

For more information, please see the new 2022/2023 Mid-Atlantic Commercial Vegetable Production Guide.

UPDATES ON BASIL RESEARCH IN DEVELOPING DISEASE RESISTANCE AND IMPROVED NEW VARIETIES

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Over the past 20 years, Rutgers has been working on developing new basil (*Ocimum* spp.) lines. Originally, our team bred and developed new types of sweet, specialty lemon, and edible ornamental basils. In the early 2000s, our focus shifted to breeding for disease resistance when NJ growers informed us that fusarium wilt became a serious problem, resulting in major crop damage and economic losses. Most of the available sweet basil varieties were susceptible and control strategies were limited. The emergence of this disease on basil in the US led us to develop a family of genetic open pollinated fusarium wilt resistant sweet basils (FOB) including the release of 'Newton' that is now available to growers by seed companies.

About a decade later, basil downy mildew first arrived into New Jersey hitting growers hard and resulting in significant crop loss. This disease became the limiting factor in being able to grow sweet basil commercially with damage so severe that many growers

reduced their acreage or stopped growing sweet basil entirely. Once again, our program shifted focus to address growers' concerns. No disease resistant sweet basil varieties were available, and little was understood about controlling this new pathogen. Our Rutgers program established an initiative to improve understanding of the pathogen and develop new downy mildew resistant (DMR), sweet basils. Approximately seven years later, Rutgers introduced four DMR sweet basil varieties: Rutgers Obsession DMR, Rutgers Devotion DMR, Rutgers Thunderstruck DMR and two years later Rutgers Passion DMR. These lines exhibit traditional sweet basil aroma and leaf characteristics with downy mildew resistance supported by two genes. Our team has continued to search for more sources of DMR to stay ahead of potential breakdown of resistance in these lines and to continue to improve flavor and aroma profiles. Since these lines are not immune to BDM, proper management techniques like strict control spray programs and weed management are needed to achieve good control for most of the season. Newer DMR varieties from other breeding programs and seed companies are now entering the market and available also for growers to trial and test. In all cases, growers are urged to continue to use organic or conventional spray and management practices and never rely on genetic resistance or purported DMR as the only control strategy.

Currently, our team is breeding basil for classic and unique aromas, improved fusarium wilt resistance and more durable downy mildew resistance. Several crosses were made to improve RU Thai, lemon and sweet basil DMR breeding lines in 2019:

(1) RU breeding lines with licorice aroma and DMR were crossed with commercial Thai basil varieties to achieve ideal Thai morphology, aromatic profile and DMR.

(2) RU breeding lines with lemon aroma were crossed with an accession identified to have a new source of DMR.

(3) RU DMR varieties were crossed with commercial sweet basils to maintain DMR and improve aroma profiles.

The resulting hybrids were selfed and the F2 was screened for DMR in the NJAES greenhouse. The F3 were evaluated in field trials in the summer of 2020 at Snyder Research and Extension Farm and selected for DMR, desirable aroma profiles and characteristic morphology. F3 families were selected and advanced to F4, which were further evaluated in the summer of 2021 at Snyder Farm.

Our program is also currently breeding for improved cold tolerance in sweet basil as it is a large concern for growers and distributors due to cold damage during shipment. Crosses between commercial sweet basil, RU Obsession and a cold tolerant basil line with licorice aroma were made in 2020 to stack DMR, sweet basil aroma and cold tolerance. The resulting hybrid was selfed and the F2 were grown in pots in the NJAES greenhouse. The F2 were repeatedly screened for cold tolerance and the plant material was harvested for aroma profiling. Genetic linkage mapping is being conducted to identify genes for cold tolerance and aroma attributes. F3 from desirable lines will be screened for DMR.

For over a year we began to assemble and procure a massive array of basils across many species from around the world to expand and continue our search for new genes

of interest, and new sources of disease and chilling resistance. This past summer of 2021 in northern New Jersey we conducted the largest field trial ever performed on basil and evaluated 427 'types' of basil for DMR, 15 morphological attributes and aroma profiles. Replications of this study are planned for this winter of 2022 in southern Florida and then in southern New Jersey during the summer of 2022. This study has identified potential new sources of DMR that will be incorporated into our breeding program to continue to stack resistance genes and improve DMR. As part of a genome-wide association study (GWAS), our team is aiming to identify marker-trait associations responsible for those sources of resistance and other key characteristics of basil including leaf length, leaf width, leaf color intensity, leaf color distribution, leaf cupping, leaf blistering, leaf glossiness, leaf serration, leaf shape, flower corolla color, inflorescence color, flowering time, stem color, plant habit and plant height. These GWAS evaluations are also being used to characterize previously undescribed germplasm to serve as a source of information for researchers around the world.

For more information, please contact: **Jim Simon (jimsimon@rutgers.edu** and/or **Andy Wyenandt, wyenandt@njaes.rutges.edu)**

Follow us on **Instagram: https://www.instagram.com/rutgersbasil/?hl=en**

For tracking arrival of downy mildew in New Jersey use the Cornell University monitoring site developed by Dr. Meg McGrath: **https://basil.agpestmonitor.org/**

For some of our scientific and grower outreach materials see:

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UPDATE ON BACTERIAL LEAF SPOT POPULATIONS AND COPPER RESISTANCE IN VEGETABLE AND FRUIT CROPS IN NEW JERSEY

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Bacterial Leaf Spot (BLS) on vegetable and fruit crops caused by *Xanthomonas* species has posed a significant problem in New Jersey for decades. Early symptoms present as water-soaked lesions that progress to circular, necrotic spots. A ring of chlorotic tissue often surrounds the lesions. The primary method to control the disease is copper sprays as high concentrations of copper are highly toxic to living cells. However, with increased copper applications comes a higher probability of bacterial populations acquiring copper resistance. This is because copper resistance is conferred via plasmids that continually exist in a low frequency within a bacterial population. Once copper resistance is acquired by enough of the population, copper sprays become ineffective management tools. Although BLS and copper resistance within *Xanthomonas* populations are prevalent within the state, there have been no previous comprehensive surveys of the disease or copper resistance in New Jersey. As a result, we initiated a study at the beginning of the 2020 growing season to identify the *Xanthomonas* species causing BLS on vegetable and fruit crops and to assess the prevalence of copper resistance within the state. This study was continued for the 2021 growing season with the goals of expanding our sample size and conducting more robust genetic analysis of both the copper plasmid and the *Xanthomonas* species present as well.

Xanthomonas species were isolated from 31 samples of pepper and tomato. Pepper samples included bell, cubanelle, long hot, and shishito peppers as well as jalapeno. *X. euvesicatoria* and *X. perforans* were both isolated from tomato and pepper samples. This was consistent with our 2021 findings. In 2020, all *Xanthomonas* strains isolated from tomato and pepper samples collected from commercial fields were found to be copper resistant in laboratory assays. Of the 2021 isolates tested thus far, about 40% were found to be copper resistant, indicating that copper resistance in *Xanthomonas* species is not as common as the 2020 data suggested. Genetic analysis of copper resistance showed significant variation among resistant isolates. This may indicate that copper resistance did not originate from one source within the state.

Variation in 2020 and 2021 data underscores the need to continue a comprehensive survey of BLS on pepper and fruit crops and copper resistance in *Xanthomonas* populations. Continued assessment of 2021 isolates may help elucidate patterns in how copper resistance spreads throughout bacterial populations. This information is also useful to assess how growing and management practices affect the proliferation of copper resistance among bacterial pathogens.

X10R BELL PEPPER VARIETIES FOR NEW JERSEY

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Introduction:
Bacterial leaf spot (BLS) is caused by the pathogens, *Xanthomonas euvesicatoria*, *X. vesicatoria*, *X. perforans*, and *X. gardneri,* and is the second most important disease on bell and non-bell peppers in New Jersey. BLS has become more of a concern in New Jersey over the last ten to fifteen years. Early survey results from 2019 suggest *Xanthomonas euvesicatoria* is the most prevalent species found in pepper and tomato fields in the state. There are eleven (0-10) races of BLS identified in the United States; and past research has shown that all races are present in New Jersey. The pathogens are favored by high humidity, hard driving rains, vigorous plant growth, infested stakes, and working in the field when plants are wet.

Materials and Methods:
Since 2016, we have screened cultivars and advanced breeding lines with resistance to all races (often referred to as X10R resistance) of bacterial leaf spot. In 2021, One twenty-eight cell trays were seeded on March 17th, and the trial was established at the Rutgers Agricultural Research and Extension Center in Bridgeton, New Jersey on black plastic mulch with one drip line between double rows with a distance of 18 inches between plants and 80 inches between beds center to center. The plots (18 plants/plot) were transplanted June 9th. Plots were arranged in a randomized complete block design with four replications.

All cultural practices such as staking/tying, fertilization and pest management were carried out using standard recommendations except no fungicides were applied to control BLS. Plots were observed each week for presence of BLS and rated on October 22nd after the last harvest. Rating scale: 0=No symptom development, 1=Few leaf spots present, strong plant growth and canopy, 2=Major leaf spotting and marginal necrosis present, good growth, 3=Heavy leaf spotting and leaf drop, re-growth good and 4=Heavy defoliation, stunted growth with very little regrowth.

The entries were harvested 5 times starting 68 days after transplanting from August 17th to October 13th. Peppers were graded based on weight (extra-large >0.49 lbs., large 0.33 – 0.49 lbs., medium 0.25 – 0.32 lbs., commercials, and culls <0.25 lbs.).

Ten fruit were randomly selected from the four plots to assess fruit characteristics (fruit size, wall thickness and number of lobes) at the second harvest.

Table 1. Seed sources and disease resistance as reported by the company.

Variety	Company	Disease Resistance[1]
Revolution	Harris Moran	HR: Xcv: 1,2,3,5; IR: Pc; IR: CMV
Mercer	Sakata	HR: TMV:0; Xcv 0-3, 7-8; IR: Pc
Nitro S10	Sakata	HR: TMV:0, IR: Xcv 0-10
Shogun S10	Sakata	IR: Xcv; IR: TSWV; HR: TMV
HMC 1996	Seedway	HR: Xcv: 1-10
Labelle	Seedway	IR: Xcv 1-10
Sailfish	Seedway	IR: Xcv 1-10; HR: Tm:0; IR: Pc
1819	Seminis	HR: Xcv: 0-5; IR: Pc
3255	Seminis	HR: Tm: 0; IR: Xcv: 1-10
3964	Seminis	HR: Xcv: 0-4, 7-9; Tm: 0; IR: CMV
9325	Seminis	HR: Xcv: 0-10
Antebellum	Seminis	HR: Tm: 0, IR: TSWV, Xcv 1-10
Aristotle X3R	Seminis	HR: PVY: 0, Tm: 0; Xcv: 0-3, 7, 8
Camelot X3R	Seminis	Xcv 1-3
Playmaker	Seminis	HR: Xcv: 0-10; HR: Tm:0
Tarpon	Seminis	HR:Tm:0, Xcv: 0-10; Pc
Turnpike	Seminis	HR: Tm; Xcv: 0-5, 7-9; IR: Pc
RPP 52214	Syngenta	?
RPP 52243	Syngenta	?
RPP 52254	Syngenta	?
Intruder	Syngenta	HR: Xcv: 1-3; IR: Pc
Outsider	Syngenta	HR: TSWV; Xcv: 1-10
Paladin	Syngenta	HR: Pc

[1]PVY = Potato virus Y; TMV = Tobacco Mosaic Virus; TSWV = Tomato Spotted Wilt Virus; Tm = Tobamovirus; Xcv = Bacterial leaf spot race resistance; CMV = Cucumber mosaic virus; Pc = *Phytophthora capsici*, with HR = Highly resistant; IR = Intermediate resistance

Discussion:
Seed sources and disease resistance as reported by the seed companies are listed in Table1. The trial was evaluated weekly for BLS with the first observed BLS symptoms on July 14th in two plots of the variety (Paladin) and one plot of Camelot. By July 20 all plots of Paladin showed symptoms along with at least one plot of twelve other entries. The varieties that did not show symptoms were HMC 1996, Sailfish, La Belle, 3255, 8325, Antebellum, Tarpon, Aristotle and Playmaker. Plots were rated on October 22nd after the last harvest (Table2). Plots continued to be observed through November 6th with no changes to the varieties that were infected or the severity of the infections. The

entries that did not show any BLS symptoms when rated included Nitro, Shogun, Labelle, Sailfish, 3255, 9325, Antebellum, RPP 52214, RPP 52243 and Outsider. Note that these were plant not fruit symptoms. No fruit symptoms were observed during harvest. Plants were sampled for bacterial leaf spot and the laboratory identified the pathogen as *Xanthomonas euvesicatoria* which was also isolated from other pepper fields in South Jersey.

Fruit quality for length/diameter, wall thickness and number of lobes are presented in Table 2. All Harvest data is summarized in Table 3. Turnpike had the highest marketable yield (extra-large, large and medium) fruit, but was not statistically different from 3964, Paladin, Mercer, 1819, Aristotle, Playmaker, Antebellum, Revolution, or 9325. Turnpike, 3964 and 1819 had statistically more extra large fruit than the other entries.

Table 2. Bacterial Leaf Spot Rating, Fruit Size, Wall Thickness, and Number of Lobes. RAREC, 2021.

Variety	Seed Company	Rating[1]	L/W[2]	Wall Thickness (mm)	No. Lobes
Revolution	Harris Moran	4.00	0.94	6.36	4.0
Mercer	Sakata	3.75	1.01	6.37	3.6
Nitro S10	Sakata	0.00	0.92	6.41	4.1
Shogun S10	Sakata	0.00	1.00	6.25	4.3
HMC 1996	Seedway	1.00	0.96	6.39	4.1
Labelle	Seedway	0.00	0.96	6.45	3.8
Sailfish	Seedway	0.00	1.01	6.29	3.8
1819	Seminis	4.00	1.06	7.16	3.8
3255	Seminis	0.00	1.01	6.80	4.0
3964	Seminis	3.50	1.15	6.68	3.5
9325	Seminis	0.00	0.94	5.75	3.6
Antebellum	Seminis	0.00	1.12	6.58	3.7
Aristotle X3R	Seminis	2.50	1.05	6.94	4.0
Camelot X3R	Seminis	4.00	1.15	5.77	3.7
Playmaker	Seminis	0.25	1.05	6.45	3.6
Tarpon	Seminis	0.25	1.05	6.64	3.3
Turnpike	Seminis	4.00	1.05	7.17	4.0
RPP 52214	Syngenta	0.00	1.07	6.28	4.1
RPP 52243	Syngenta	0.00	1.11	5.52	3.8
RPP 52254	Syngenta	0.50	1.13	6.49	3.9
Intruder	Syngenta	3.75	1.09	7.00	3.7
Outsider	Syngenta	0.00	1.01	6.15	4.3
Paladin	Syngenta	3.50	1.14	6.61	3.8

[1]Rating Scale for BLS symptom development done on October 22:

0=No symptom development

1=Few leaf spots present, strong plant growth and canopy

2=Major leaf spotting and marginal necrosis present, good growth

3=Heavy leaf spotting and leaf drop due to BLS, re-growth good
4=Heavy defoliation due to BLS, stunted growth, very little regrowth
[2]Length/Diameter
Note Turnpike, 3964, Paladin, Mercer, 1819, Aristotle, and Revolution rated at least 2.50 for bacterial leaf spot on the plants yet had the highest yields.

Table 3. Extra-Large, Large, and Medium Sized Fruit (in 28 Lb. Boxes per Acre); Percent Marketable Yield, and Total Marketable (Boxes per Acre) for all Harvests in 2021 Upper Deerfield, NJ.

Variety/Line	XL[1]		L		M		% Marketable		Total Marketable	
Turnpike	268.13	a[2]	764.8	ab	97.04	i	95.3	cde	1129.9	a
3964	267.71	a	686.9	abc	112.30	i	93.2	c-f	1067.0	ab
Paladin	73.09	b-e	803.3	a	178.45	b-i	94.4	c-f	1054.8	ab
Mercer	75.13	b-e	791.2	ab	163.22	c-i	95.8	bcd	1029.6	abc
1819	215.69	a	711.3	abc	99.05	i	92.0	c-f	1026.1	abc
Aristotle	129.16	b	736.5	abc	154.05	d-i	93.8	c-f	1019.7	abc
Playmaker	85.63	b-e	677.2	a-d	215.50	b-f	94.6	c-f	978.3	abc
Antebellum	54.74	c-g	676.5	a-d	238.38	bc	96.0	abc	969.6	abc
Revolution	109.87	bc	652.4	a-d	143.45	f-i	87.8	ghi	905.7	abcd
9325	39.80	d-g	650.3	a-d	210.70	b-g	93.1	c-f	900.8	abcd
Shogun	73.41	b-e	675.1	a-d	127.05	hi	95.6	bcd	875.5	bcde
LaBelle	36.82	d-g	635.2	a-d	200.53	b-h	94.0	c-f	872.6	bcde
Nitro	35.87	d-g	677.6	a-d	154.92	d-i	96.4	abc	868.4	bcde
3255	5.70	fg	627.7	a-d	233.20	bcd	99.2	ab	866.6	bcde
Outsider	116.39	bc	592.9	a-d	151.42	e-i	87.8	hi	860.7	bcde
Tarpon	29.66	efg	564.2	a-e	216.54	b-f	95.1	c-f	810.4	cdef
Camelot	93.50	bcd	606.7	a-d	101.02	i	91.6	fgh	801.2	cdef
Intruder	65.15	c-f	604.3	a-d	128.80	hi	91.4	fgh	798.3	cdef
RPP 52243	30.92	d-g	448.1	de	251.93	b	93.8	c-f	730.9	def
1996	76.75	b-e	507.9	cde	131.00	hi	87.6	i	715.7	def
RPP 52214	28.85	efg	446.7	de	226.16	b-e	95.6	bcd	701.7	def
Salifish	0.00	g	189.8	f	465.00	a	99.7	a	654.8	ef
RPP 52254	26.38	efg	343.4	ef	231.80	b-e	95.5	bcd	601.6	f
LSD	**63.20**		**235.57**		**81.72**		**3.82**		**238.24**	

[1]XL = Extra-Large; L = Large; M = Medium
[2]Within columns, means followed by different letters are significantly different

Nursery I

NATIVE PLANTS FOR THE NEW JERSEY LANDSCAPE

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Incorporating native plants into the New Jersey landscape has emerged as a growing market trend as homeowners are becoming increasingly educated about the important ecosystem services that are provided by native plants. There are also a growing number of native plant nurseries and landscape professionals in New Jersey that are propagating native species. State-wide conservation efforts are encouraging the planting of low-maintenance native plants that encourage pollinators along roadways and coastal communities are developing plans to require green infrastructure plantings to mitigate stormwater. As such, there is a tremendous opportunity for New Jersey's nursery and landscape industry to sustainably produce and maintain the native plants that are making the Garden State a greener place to live.

A recent survey by the American Society of Landscape Architects ranked native plants and low-maintenance landscapes as the top landscape and garden design elements that are in high demand by consumers. Selecting native species that are well-adapted to the growing conditions in our region can greatly reduce pest and disease issues in the landscape, leading to a reduction in pesticide use, while enhancing the ecosystem services that are provided. There are many low-input, native ornamental plants that are suited to various site conditions, including challenges presented in urban and coastal areas. Focusing on the right native plant for the right location can lead to savings of time and money, while limiting the amount pesticides, fertilizers, and water required in the landscape.

Native Trees

Swamp White Oak (*Quercus bicolor*) is a very adaptable species that is good for urban sites. It tolerates soil compaction and wet sites but is also drought tolerant. Swamp white oak is a host tree for over 500 different of species native moths and butterflies, in addition to supporting populations of birds and other wildlife. There are over 400 swamp white oaks planted at the 9/11 Memorial in NYC.

American Hornbeam (*Carpinus caroliniana*) can thrive is shade to partial shade and medium wet to wet conditions, making it a viable option for some challenging sites. American hornbeam is deer resistant, attracts pollinators, and serves as a habitat for butterfly and moth larvae, which help to feed many species of birds.

Eastern Redbud (*Cercis canadensis*) is a drought tolerant native tree that produces abundant flowers in April and May. These flowers provide an important source of nectar and pollen for many pollinator species.

Sweet Bay Magnolia (*Magnolia virginiana*) is a deer resistant species that is good for coastal areas due to its tolerance to flooding and salt. Sweet bay magnolia thrives in partial shade to full sun and produces fragrant flowers from May through July. These flowers attract butterflies, and the fruit and seeds provide a food source for birds.

Tuliptree (*Liriodendron tulipifera*) is a large, fast growing species in the Magnolia family that produces yellow-orange blooms from May through June. The flowers attract hummingbirds, and the seeds can feed birds and other wildlife throughout the winter. The widely adapted tuliptree also displays good fall foliage, with several cultivars commercially available.

Tupelo Tree (*Nyssa sylvatica*) is tolerant of many soil conditions, including urban areas. It is generally drought tolerant and there are improved cultivars for growth habit, fall color, and leaf spot resistance. The flowers attract bees in the spring and the berries are a great food source for birds. It is important to note that some cultivars will not produce berries, reducing their value to wildlife.

Paw Paw (*Asimina triloba*) is a modestly sized tree that produces the largest native North American fruit. It is deer resistant and produces flowers in April or May that will develop into fruit that ripens in September or October. Two cultivars are required for pollination, but paw paw has minimal pest or disease issues. This native edible landscape specimen tree also has vibrant yellow fall foliage.

American Persimmon (*Diospyros virginiana)* is a deer resistant native species that is drought tolerant and has minimal pest and disease issues. American persimmon has small flowers that bloom in the spring and attract pollinators. A male and female tree are required for pollination, which leads to the development of edible fruit in October. The fall foliage is very good for this tree and any fruit that is not harvested will be eaten by wildlife.

Native Hedges

Inkberry Holly *(Ilex glabra*) is a native evergreen shrub that has excellent potential as an alternative to boxwood. Inkberry holly tolerates wet sites, demonstrates moderate deer resistance, and a high degree of wind resistance. This species has minimal pest and disease issues and produces small white flowers that attract beneficial insects and develop into fruits that feed birds throughout the winter months.

Northern Bayberry (*Morella pensylvanica*) is an excellent species for creating semi-evergreen hedges, especially in coastal areas. Northern bayberry is deer resistant and drought and salt tolerant. Its small flowers attract beneficial insects and its berries feed many bird species through the fall and winter.

American Holly (*Ilex opaca*) is a native tree species that can form evergreen hedges with high deer resistance. It is moderately salt and drought tolerant, with blooms from May through June that attract bees and butterflies. American holly's red berries persist through the winter months to feed birds and other wildlife.

Eastern Red Cedar (*Juniperus virginiana*) is a widely adapted species that is tolerant to drought, heat, wind, and salt. It can grow in many soil and site conditions, including urban environments. Its small flowers attract pollinators and wildlife feed on juniper "berries" of female trees, which are a type of modified cone.

Native Flowering Shrubs

Summersweet (*Clethra alnifolia*) is a native shrub that will bloom in the shade during the months of July and August. It attracts beneficial insects, hummingbirds, and other bird species, while demonstrating minimal pest and disease problems.

Mountain Laurel (*Kalmia latifolia*) is a shade tolerant broadleaf evergreen that is well-suited to woodland gardens. It attracts butterflies and birds and is a host plant for the laurel sphinx moth.

Buttonbush (*Cephalanthus occidentalis*) is a deer resistant native shrub that tolerates wet areas. Its fragrant flowers bloom July through August and attract pollinating insects and birds.

New Jersey Tea (*Ceanothus americanus*) is a low growing shrub with fragrant blooms from May through July that attract bees, butterflies, and hummingbirds. It is deer resistant and tolerant of drought and acidic soils.

Ninebark (*Physocarpus opulifolius*) is a shrub with unique bark that continues to provide visual interest throughout the winter. It is drought tolerant and adapted to poor soil conditions. Ninebark blooms May through June and provides a nectar source for native bees. The flowers will develop into red berries that feed birds and other wildlife into the winter.

Juneberry/Service Berry (*Amelanchier spp.*) is a low-maintenance shrub with moderate deer resistance. The early flowers will turn into edible fruit similar in size to a blueberry. Colorful, red fall foliage will develop on Juneberry as the season progresses.

Elderberry (*Sambucus nigra*) demonstrates moderate drought tolerance and is relatively low maintenance. It is easy to propagate and produces berries that are high in antioxidants.

Photinia (Chokeberry) (*Photinia melanocarpa*) is a very adaptable species that is resistant to drought, insects, pollution, and disease. This low-input shrub has early blooms that mature into berries that are high in antioxidants, supporting populations of pollinators, birds, and other wildlife.

Beach Plum (*Prunus maritima*) can be found growing throughout the coastal areas of NJ. It is drought and salt tolerant and produces early blooms that attract bees and butterflies. Beach plum will also produce edible fruits that can be consumed by humans or wildlife.

Flowering Herbaceous Perennial Plants

Blue Wild Indigo (*Baptisia australis*) is a nitrogen-fixing perennial species that grows in an herbaceous bush habit. It produces early blooms from May through June that attract pollinators. Blue wild indigo is also deer resistant and drought tolerant.

Lanceleaf Coreopsis (*Coreopsis lanceolata*) is a low-input clump forming species that is heat and drought tolerant and deer resistant. Its yellow flowers attract pollinators, and the seeds are an excellent food source for birds.

Seaside Goldenrod (*Solidago sempervirens*) is tolerant of salt, sand, and drought, making it an excellent option for coastal sites. Its golden flowers bloom from July through October, providing a food source for beneficial insects and birds late into the fall.

Cardinal Flower (*Lobelia cardinalis*) is native to the NJ Pine Barrens, where it can tolerate a range of site conditions. This species thrives in wet to moderately wet soil conditions, with acidic to neutral pH. It can grow in sun and shade and will produce vibrant red flowers that attract hummingbirds and butterflies.

Joe Pye Weed (*Eutrochium spp.*) is a deer resistant herbaceous perennial that can grow to eight feet tall. It thrives in wet conditions and produces large blooms from summer through fall. The flowers are an excellent nectar source for native insects and the seeds provide food for many bird species.

Additional Resources:

Incorporating Native Plants in Your Residential Landscape:
https://njaes.rutgers.edu/fs1140/

BUILDING MORE SUSTAINABLE LANDSCAPE DESIGNS WITH GRASSES AND SEDGES

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The incorporation of sustainable practices continues to increase in popularity with landscape designers, contractors and maintenance professionals. As customers request reduced pesticide use and more bio-rational approaches to pest management, as well as low maintenance demanding landscapes, new niches for landscape horticulture have evolved. One of the foundational approaches to low input and low maintenance design comes from the proper selection of well-suited plant materials for the particular site. Grasses and their grass-like relatives provide unique materials for building a more sustainable landscape.

Grasses (Poaceae) evolved approximately fifty-five million years ago when the continents of the earth were coming into an era of increasing dryness. Grass species used for ornamental purposes are well adapted to full sunlight and periods of droughty soil conditions. Unlike their cool-season turfgrass counterparts such as Kentucky bluegrass (*Poa pratensis*), many of the popular ornamental species are warm-season grasses, which consistently tolerate drought and heat and are more physiologically active in warm temperatures of mid to late summer. Due to ornamental grass species' low demand for water and nutrients, their reliably pest-free nature and minimal requirement for maintenance, they serve as excellent choices for landscapers seeking to reduce inputs and labor.

Sedges (*Carex* species) share many of the same attributes as grasses for being low-maintenance, but serve a different function in an environmentally sensitive design. Though the genus *Carex* contains nearly two-thousand species, it still remains relatively unknown to many landscapers and their clients. Though grass-like in appearance, sedges fill niches where grasses would not be appropriate. They thrive in moist, shady areas, in woodland settings and under trees. Upon establishment some may also tolerate dry conditions. Because of this cultural feature they can be easily substituted for overused and potentially invasive shade groundcover species, like Japanese pachysandra (*Pachysandra terminalis*), vinca (*Vinca minor*) and English ivy (*Hedera helix*). Sedges spread slowly forming effective groundcovers that block weeds, thereby reducing labor demands when maintaining residential and commercial sites.

This presentation will feature species of grasses and sedges that can be used to create attractive and functional landscapes that are mindful of current trends in sustainable landscape design.

MANAGING EMERGING INVASIVE SPECIES AND NATIVE ALTERNATIVES

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Invasive species are defined as species that are non-native to the ecosystem under consideration and, whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. This definition is from Executive Order 13112 which established the National Invasive Species Council (NISC) on Feb 3, 1999. Invasive species can be plants, animals, fungi, pathogens, or diseases. Here we will primarily focus on emerging invasive plants that are causing ecological harm to New Jersey's natural areas including forest ecosystems. Some of these emerging species are available in the nursery and landscaping trade. Due to heavy deer pressure and habitat fragmentation, these invasives are outcompeting native plant populations, and spreading quickly throughout New Jersey. Effective management options, knowing the invasive potential of horticultural plants, and providing native alternatives can help mitigate the spread of these invasive plants.

Unchecked invasive plants aggressively and rapidly invade natural areas, often forming monocultures, and outcompete diverse, native plant communities. For example, an upland Oak-Beech forest in southern New Jersey with an intact native plant community, can support dozens of species including early spring ephemerals (ie. Virginia Bluebells), understory shrubs (ie. Viburnums, Spicebush), and trees (ie. Black cherry, Red maple, Pignut hickory). These forests offer flowers, fruit, and seeds from different species throughout the year, which in turn provides food and habitat for wildlife including pollinators and birds. When that community is invaded by, for example, *Euonymous alata* (Burning Bush, a widespread invasive shrub), native plants are outcompeted and biodiversity decreases. There are no biological controls (predators or diseases) to keep the invasive population in check. Now one species dominates, which provides limited resources for wildlife during year.

Habitat fragmentation and disturbance is part of the reason for the invasive species problem. Another major cause is the increase in white-tailed deer populations which have skyrocketed in New Jersey from a normal average of 10-20/mi^2, to in some cases 100-150/mi^2. Deer do not eat the invasive, exotic plants which puts heavy browse pressure on their natural diet of native plants. Under normal circumstances, without deer pressure, native plants could compete with invasives for space and light. Few native plants can grow to maturity when continually browsed, giving invasives an added advantage.

Invasive plants are not a new problem impacting our natural resources. More common, invasives such as *Berberis thunbergii (*Japanese Barberry*)*, *Rosa multiflora* (Multiflora rose*),* and *Lythrum salicaria (*Purple loosestrife*)* have been present for decades. These species are considered widespread with little potential for eradication, but rather only local control and management where staff resources are available. Therefore, natural resource professionals have adopted an early detection/ rapid response (EDRR) approach to try and prevent new, emerging species from becoming widespread. This approach is supported by the invasion curve (Figure 1.) which indicates that eradication is still feasible the earlier a species is detected.

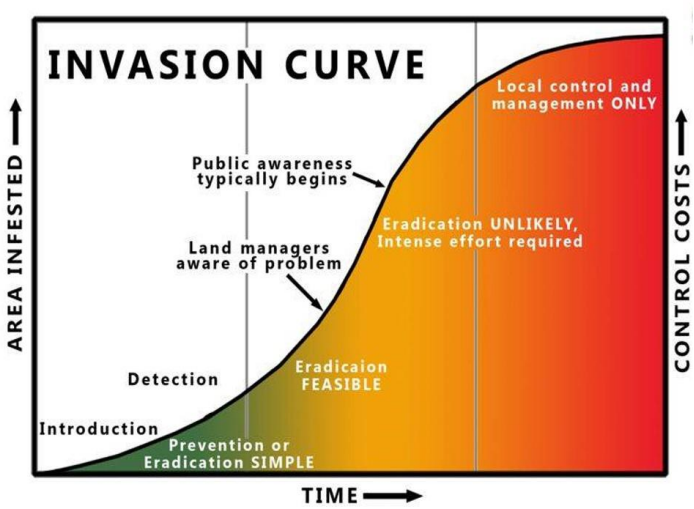

Figure 1. This invasion curve demonstrates that infestation and control costs are minimal the earlier a species is detected. Source: https://www.mipn.org/edrr/

Many of the attributes the public looks for in commercially available garden plants may also make them candidates for invasive species. Example attributes include adapting to many different site conditions, tolerance of poor soils, abundant flower and fruit, fast growing, and deer resistant. Many neighboring states including New York, Connecticut, Massachusetts, New Hampshire, and most recently Delaware have banned the cultivation and sale of certain invasive plants including more widespread species such as *Berberis thunbergii*, and *Euonymus alata*

A few of New Jersey's emerging species of concern, chemical management strategies, and native plant alternatives are listed below in Table 1. This list was generated based on the USDA 2018 report "New Invaders of the Northeast and Northcentral United States", the Mt. Cuba Center 2017 report "Native and Invasive Plants Sold by the Mid-Atlantic Nursery Industry", as well as data gathered by the New Jersey Invasive Species Strike Team (NJISST). NJISST, part of the Friends of Hopewell Valley Open Space, coordinates inter-state mapping of emerging invasive species of concern and works with local land managers to eradicate new populations using the EDRR approach. Chemical management is listed below but manual or mechanical removal is recommended for small populations when the entire root can be removed, or when an area can be repeatedly mowed to remove resprouts and deplete the plant's resources.

Table 1. A selection of emerging invasive species in New Jersey available in the commercial horticultural trade. "Emerging" species are those with less then 1000 detections in the state.		
Emerging invasives	**Chemical Management***	**Native Alternative**
Shrubs		
Viburnum dilatatum (Linden viburnum) Invades understory forests. High shade tolerance.	FS1, BB1, CS1. Cut stump in winter only	*Viburnum prunifolium* (Blackhaw viburnum), *Viburnum opulus* var. *Americanum (*American cranberrybush); *Ilex verticillata (*Winterberry holly)
Ligustrum ovalifolium (California privet) Invades understory forests. High shade tolerance. Note: *L. obtusifolium* and *L. vulgare* are considered widespread invasives	FS-2, BB-1, CS-1	*Viburnum prunifolium* (Blackhaw viburnum), *Ilex glabra* (Inkberry holly), *Morella pensylvanica, (*Northern bayberry)
Frangula alnus (Glossy buckthorn) Invades open wetlands	FS-1, BB-1, CS-1, Cut stump only in winter	*Clethra alnifolia* (Sweet Pepperbush), *Ilex verticillata (*Winterberry holly*), (Cornus racemosa* (Grey Dogwood)
Rhamnus cathartica (Common or European buckthorn) Invades understory forests	FS-1, BB-1, CS-1 Strong re-sprouter. Cut stump only in winter	*Lindera benzoin* (Spicebush), *Hamamelis virginiana* (Witch Hazel), *Amelanchier arborea (*Common Serviceberry/ Shadbush)
Buddleja davidii (Butterflybush) Invades open upland habitat	FS-2, BB-1, CS-1	*Eutrochium purpureum* (Joe-Pye weed); *Asclepias tuberosa (*Butterfly weed); *Asclepias incarnata (*Swamp milkweed)
Rhodotypos scandens (Jetbead) Invades understory forests	FS-3	*Viburnum prunifolium* (Blackhaw viburnum), *Viburnum opulus* var. *Americanum (*American cranberrybush*); Ilex verticillata* (Winterberry holly*)*
Grass		
Miscanthus sinensis (Chinese slivergrass) Invades open upland habitat	FS-3	*Schizachyrium scoparium (*Little bluestem), *Panicum virgatum* (Switchgrass), *Eragrostis spectablis* (Purple Lovegrass),
Vine		
Akebia quinata (Chocolate vine) Invades understory forests and streambanks. High shade tolerance	FS-1, BB-1	*Lonicera sempervirens* (Trumpet or Coral Honeysuckle); *Wisteria frutescens, (*American Wisteria)
Tree		
Pyrus calleryana (Callery pear) Invades open upland habitat	FS-1, BB-1, CS-1 Strong re-sprouter. Cut stump only in winter	*Cercis canadensis* (Redbud), *Amelanchier arborea (*Common Serviceberry/ Shadbush)
Acer palmatum (Japanese maple) Invades forest edges and roadsides	FS-2, CS-1, BB-1	Cercis canadensis (Redbud), *Amelanchier arborea (*Common Serviceberry/ Shadbush)

*FS-1= Foliar spray of Glyphosate/ Triclopyr amine/ surfactant/ blue dye/ water mix
FS-2= Foliar spray of Glyphosate/ surfactant/ blue dye/ water mix
FS-3= Foliar spray of Glyphosate/ surfactant/ blue dye/ water mix
BB-1= Basal bark- Triclopyr ester/ red dye/ oil-based diluent mix
CS-1= Cut stump of Glyphosate/ blue dye/ water

For mixing quantities see Penn State Herbicide Selection and Use at https://plantscience.psu.edu/research/projects/wildland-weed-management/publications/natural-resource- management-factsheets/herbicide-selection-and-use and NJISST Species and Control Recommendations at https://www.fohvos.info/wp-content/uploads/2021/05/2021_Strike_Team_Species_and_Control_Recommendations_2021_05_21.pdf

How can a nursery or landscaping company make decisions about invasive plants? Knowing if the plant is invasive in the region is the first step. A few reliable resources are as follows:

The Invasive Plant Atlas of the United States at https://www.invasiveplantatlas.org/ is a collaborative project between the National Park Service, the University of Georgia Center for Invasive Species and Ecosystem Health, the Invasive Plant Atlas of New England and the Lady Bird Johnson Wildflower Center. This comprehensive website has distribution maps as well as identifies those states that list a species on their invasive species list or law.

USDA PLANTS Database at https://plants.usda.gov/home provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the US and its territories. It includes names, plant symbols, checklists, distributional data, species abstracts, and identifies those states that list a species on their invasive species list or law.

In our region the New Jersey Invasive Species Strike Team at https://www.fohvos.info/invasive-species-strike-team/ monitors emerging species and works cooperatively with state agencies and local environmental groups to list watch, target, and widespread invasive species in the state as well as control recommendations.

Sources:

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Coombs, G., Gilchrist D. Watson, P 2017. Native and Invasive Plants Sold by the Mid-Atlantic Nursery Industry. Mt. Cuba Center. Updated 2018. Available at https://mtcubacenter.org/wp-content/uploads/2018/03/Native-and-Invasive-Plants-Report-Public-Version.pdf

PLANT PHENOLOGY INDICATORS FOR SCOUTING AND CONTROLLING INSECTS

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Challenges of Pest Controls

Accurately timing a control tactic against the most vulnerable stage of an insect's development allows for the use of biorational pesticides as well as less use of traditional pesticides. Unfortunately, accurately timing controls is difficult because of the complex array of landscape plants and pests that can be present on any one site. IPM methods require knowledge of the pest's life cycle stages and when the vulnerable stage occurs for each pest. It requires knowledge of what pesticides will suppress the pest as well as their relative toxicities. This extensive amount of information can become overwhelming, especially to the less experienced landscaper or arborist.

Some landscape managers often resign to the easy, yet environmentally unsound practice of using four or more preventative cover sprays of pesticides each year. Studies have shown that typically only 2% of a blanket spray actually hits a targeted pest, with the remaining 98% contaminating the surrounding environment. Is there another way that pesticides can be applied more intelligently?

GDD vs. PPI

The concept of Growing Degree Days (GDD), or the daily accumulation of heat units to predict pest activity is used frequently within the Rutgers P&PA blogs. It can be a valuable tool to determine when a pest is active as well as its most vulnerable stage of development. However, most landscapers do not calculate the GDD units themselves (requires a Min-Max thermometer or a relatively expensive biophenometer) and many may not use the daily/weekly GDD information provided on internet websites. Therefore, without the access and constant updating of GDD information, the landscaper will find this useful tool to be of little practical value.

Another method is the possibility of timing pest activity via ornamental plant development. Using **Plant Phenological Indicators (PPI)** involves observing certain plants whose bloom time (flowers, leaves, fruit, etc.) coincides with a life stage event of a specific pest. As temperatures rise in the spring, both plants and insects/mites begin development and continue throughout the growing season in response to this accumulation of heat units or Growing Degree Days (GDD's). Therefore, the development of plants can be correlated to insect activity. A PPI that nearly all turf managers are familiar with states: "To control crabgrass, apply a pre-emergent herbicide when the forsythia blooms." (Actually, it is unfortunate that this PPI choice is not always dependable).

Timing Bronze Birch Borer Emergence Using PPI

Landscapers know that white-barked birches (especially European and Asian species) are sensitive to environmental stresses that make them susceptible to bronze birch borer infestations. For most practical situations, these trees should probably be allowed to die and then replaced with a more appropriate species. In some special situations, a client may have a valuable non-native white birch in a key location that may warrant protective sprays. If general cover sprays are applied based on the calendar (i.e., early June), the birch may still succumb to the bronze birch borer (BBB) because of inaccurate spray timing. Since insect pheromones are not available to time adult emergence, PPI can be especially valuable. Since the most vulnerable stage of this pest is the newly hatched larvae, it is necessary to apply an appropriate pesticide (e.g., pyrethroids) to the bark just prior to egg laying. Based upon many years of field observations, it has been determined that the first pesticide application should be sprayed when *Spirea X vanhouttei* (Bridal Wreath Spirea) finishes bloom. A few other alternative plant indicators for the first spray include:

- *Viburnum dentatum* (Arrowwood Viburnum) at beginning bloom stage-
- *Weigela florida* (Old-fashioned Weigela) at the blooming stage-
- *Aesculus hippocastanum* (Horse Chestnut) at the late bloom stage with some blossoms brown-

With the use of systemic neonicotinoid insecticides, the treatment timing has become less critical. However, there can still be times when it is valuable to know when the BBB is actively laying eggs by observing when certain plant species are in bloom.

Advantages & Best Use of PPI

Along with GDD information, the use of PPI replaces the general calendar recommendations for the timing of specific pest activity that are only based on averages. General calendar spray recommendations do not compensate for localized microclimates that can experience considerable variation from a regional average. These averages can often be too early or too late by two weeks or more, depending upon if the year is cooler or warmer than usual. Additional specific, localized conditions that generally will favor later & slower development of PPI & pests can include variations such as nearer the coast, further north, in the shade, under shady skies, on a north slope, and at higher elevations.

A possible advantage of using PPI over GDD is the direct observation of plant development at your landscape site. When using PPI, the observer is not dependent upon the need to constantly update GDD information. Plant indicators are an obvious signal, because you see them on site when inspecting for pest problems, or they literally “hit you in the face” during your regular scheduled maintenance. In fact, PPI are often superior to GDD for pest management timing when the GDD calculations are determined from an off-site location. Therefore, PPI can act as a refinement to improve the accuracy of GDD data when traveling from one landscape site to another during the day since microclimates are considered. The primary requirement for successfully using PPI is the ability to identify common landscape plants, usually to the species level. Remember, to use PPI practically the indicator plants must be readily available to be observed. The plant should be common, have a relatively short (well-defined) bloom

period that is easily recognized from a distance. Also, the plant should not be easily confused with other plants blooming. It is important to be aware that some biological uncertainty with PPI can still exist and the development of an individual plant will not always exactly coincide with temperature and pest emergence.

Conclusion:

The enclosed "Listing" at the end of this blog contains some Key Pests and a few of their corresponding Plant Phenological Indicators (PPI). (The months listed for each pest are averages for central NJ.) These plants bloom during the presence of the pest's most vulnerable stage. Although only a few pests and their plant indicators are identified here, all the common landscape pests have identifiable PPI that can be found in the literature. Furthermore, when plant managers observe the early emergence of specific pest species at various sites, they can take note of the stages of development of plants that are nearby. These coinciding insect & plant pairs should be written down for future reference. This kind of self-determined PPI can be the most accurate since the site-specific micro-climates are considered.

(Reference: Coincide: The Orton System of Pest Management, Donald A. Orton; 1989)

Examples of a Few Key Pests & Common Plant Phenological Indicators

SPRUCE SPIDER MITES (7-121 GDD)(April/May)

(Spring Sprays)

- –*Magnolia X soulangian* (Saucer Magnolia) = PINK BUD STAGE
- –*Acer saccharum* (Sugar Maple) = BEGINNING BLOOM
- –*Acer saccharinum* (Silver Maple) = LEAF BLADES ARE 1-2" LONG

(Fall Sprays)

- –*Acer saccharum* (Sugar Maple) = FOLIAGE BEGINNING TO COLOR
- –*Crataegus phaenopyrum* (Washington hawthorn) = FRUIT BEGINNING TO RIPEN

EUROPEAN PINE SAWFLY (35-145 GDD)(April/early May)

- –*Magnolia X soulangiana* (Saucer Magnolia) = DROPPING PETALS
- *-Amelanchier* (Serviceberry) = BLOOMING
- –*Acer platanoides* (Norway Maple) = LATE BLOOM; LEAFING OUT

BIRCH LEAF MINER (123-290 GDD)(May)

- *Spirea X vanhouttei* (Bridal Wreath Spirea) = EARLY BLOOM
- *Acer saccharinum* (Silver Maple) = DROPPING SEED
- *Pinus mugo* (Mugo Pine) = CANDLES 1-6" LONG; NEEDLES NOT EXTENDED

PINE NEEDLE SCALE (298-448 GDD)(late May/early June)

(1st generation crawlers)

- *Spirea X vanhouttei* (Bridal Wreath Spirea) = BLOOMING
- *Aesculus hippocastanum* (Horse chestnut) = BLOOMING

(2nd generation crawlers)

- *Daucus carota* (Queen Anne's Lace) = BLOOMING
- *Sorbus aucuparia* (European Mountain-ash) = FRUIT TURNING ORANGE

TWO-SPOTTED SPIDER MITES (437-997 GDD)(June)

(Begin summer spray period)

- *Hydrangea arborescens* 'Grandiflora' (Hills of Snow Hydrangea) = EARLY BLOOM
- *Daucus carota* (Queen Anne's Lace) = BLOOMING
- *Yucca filamentosa* (Adam's Needle) = BLOOMING

(End summer spray period)

- *Sorbus aucuparia* (European Mountain-ash) = FRUIT VERY ORANGE
- *Solidago* (Goldenrod) = SOME BLOOMING

EUONYMUS SCALE (533-820 GDD)(June)

(1st generation crawlers)

- *Syringa reticulata* (Japanese Tree Lilac) = EARLY BLOOM
- *Cornus kousa* (Kousa Dogwood) = BLOOM
- *Crategus crus-gali* (Cockspur Hawthorn) = BLOOMING

BAGWORM (600-900 GDD)(June)

- *Catalpa speciosa* (Northern Catalpa) = FULL BLOOM
- *Syringa reticulata* (Japanese Tree Lilac) = FULL BLOOM
- *Philadelphus* (Mock-orange) = BLOOMING

(Reference: Coincide: The Orton System of Pest Management, Donald A. Orton; 1989)

Soil Health

USING ANIMAL MANURE AND COMPOST TO MEET CROP NUTRIENT REQUIREMENTS

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Significant increases in fertilizer prices have reinvigorated interest in using manures and other organic materials as supplemental sources of nutrients for crop production. When used properly, these products can provide a cost-effective source of nutrients, while conserving natural resources and improving soil quality. However, if not used properly, the nutrients in manure can cause significant environmental concerns, reduce crop performance and result in odor and vermin concerns. Effective management of these concerns is achievable, by following best management practices. These practices are designed to maximize the benefits of manure applications while minimizing the potential for negative impacts.

Composting is a potential manure handling technique that has shown a great deal of promise for small livestock operations. It has been reported to provide many benefits including reduced haulage requirements and significant reductions in mass and greater concentrations of nutrients. Composting can also reduce the volume of material spread, making it a more economical way of spreading manure.

Manure management is a crucial component of any livestock operation, but can be particularly beneficial for small-scale producers, or in cases where the manure is used for crop fertility.

USING COVER CROPS FOR WATER QUALITY PROTECTION AND NUTRIENT RETENTION

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Introduction:
Many farmers plant both summer and winter cover crops to help improve soil health. Two benefits of cover crops are that they can directly impact water quality and soil nutrient retention. With attention being given to improving water quality and reducing nutrient loads going into waterways, farmers are encouraged to consider a multifaceted approach of management practices on farmland that includes the use of cover crops.

Cover crops, like other plants will absorb nutrients for their own growth. Cover crops are planted when a cash crop is not being grown in the field and although they are not usually harvested for sale, they can bring economic benefits back to the farm. Once a cover crop dies and decomposes, absorbed nutrients will return to the soil for use by other plants. Additional benefits of cover crops include increasing soil aggregate stability, competing with weeds for sunlight and nutrients to reduce weed populations, and many cover crop roots help alleviate soil compaction.

Besides helping prevent fertilizers and other chemicals from entering waterways via runoff, the use of cover crops will prevent soil particles from entering nearby surface waters. They do this by slowing the velocity of water moving off the field. Cover crop vegetation protects the soil from the impact of the rain drops and movement of soil particles in water on slopes. The roots of the cover crops, even those that become winter killed, can help to hold the soil in place, preventing the soil particles from reaching the waterways.

Soils void of cover crops can easily erode.

Soils with well-established cover crops can be protected from erosion.

Selection of cover crops is generally determined by soil needs and subsequent cash crop to be grown. If the next cash crop has high nitrogen (N) needs, like lettuces,

greens or corn, then a legume cover crop may be the best choice. Legume crops fix atmospheric nitrogen through a symbiotic relationship with rhizobium bacterium species. If excess fertility is presumed to be in soil after a cash crop, then a fast growing, high biomass, grass cover crop may be an option to absorb nutrients left in the soil (especially N) that may erode or be lost through nitrification. Through this system of recycling nutrients through constant cropping (cash crop/cover crop rotations) plant nutrients can be retained in soils. Economically, cover can decrease fertilizer costs by reducing the amount of fertilizer needed. With the spike in energy and fertilizer costs, farmers must look for alternatives in providing fertility to cash crops.

From: https://www.sare.org/wp-content/uploads/Managing-Cover-Crops-Profitably.pdf

Chart 2 **PERFORMANCE AND ROLES**

	Species	Legume N Source	Total N (lb./A)[1]	Dry Matter (lb./A/yr.)	N Scavenger[2]	Soil Builder[3]	Erosion Fighter[4]	Weed Fighter	Good Grazing[5]	Quick Growth
NONLEGUMES	Annual ryegrass *p. 74*			2,000–9,000	◕	◕	◕	◕	◕	◕
	Barley *p. 77*			2,000–10,000	◕	◕	●	◕	◕	◕
	Oats *p. 93*			2,000–10,000	◕	◑	◕	●	◑	●
	Rye *p. 98*			3,000–10,000	●	●	●	●	◑	●
	Wheat *p. 111*			3,000–8,000	◕	◕	◕	◕	◕	◕
	Buckwheat *p. 90*			2,000–4,000	○	◑	◔	●	○	●
	Sorghum-sudan. *p. 106*			8,000–10,000	●	●	●	◕	◕	●
BRASSICAS	Mustards *p.81*		30–120	3,000–9,000	◑	◕	◕	◕	◑	◕
	Radish *p. 81*		50–200	4,000–7,000	●	◕	◕	●	◑	◕
	Rapeseed *p. 81*		40–160	2,000–5,000	◕	◑	◕	◕	◑	◕
LEGUMES	Berseem clover *p. 118*	●	75–220	6,000–10,000	◕	◕	◕	●	●	●
	Cowpeas *p. 125*	●	100–150	2,500–4,500	◔	◑	●	●	◑	◕
	Crimson clover *p. 130*	◕	70–130	3,500–5,500	◑	◕	◕	◕	●	◑
	Field peas *p. 135*	●	90–150	4,000–5,000	◔	◑	◕	◑	◕	◕
	Hairy vetch *p. 142*	●	90–200	2,300–5,000	◔	◕	◑	◑	◑	◔
	Medics *p. 152*	◑	50–120	1,500–4,000	◔	◑	◑	◕	◕	●
	Red clover *p. 159*	◕	70–150	2,000–5,000	◑	◕	◑	◕	●	◔
	Subterranean clovers *p. 164*	●	75–200	3,000–8,500	◔	◕	◕	●	◕	◑
	Sweetclovers *p. 171*	●	90–170	3,000–5,000	◔	●	◕	◕	◕	◑
	White clover *p. 179*	●	80–200	2,000–6,000	◔	◑	◕	◕	●	◔
	Woollypod vetch *p. 185*	●	100–250	4,000–8,000	◑	●	◑	●	◑	◕

[1]**Total N**—Total N from all plant. Grasses not considered N source. [2]**N Scavenger**—Ability to take up/store excess nitrogen.
[3]**Soil Builder**—Organic matter yield and soil structure improvement. [4]**Erosion Fighter**—Soil-holding ability of roots and total plant.
[5]**Good Grazing**—Production, nutritional quality and palatability. Feeding pure legumes can cause bloat.

○=Poor; ◔=Fair; ◑=Good; ◕=Very Good; ●=Excellent

COMMUNITY SUPPORTED SOIL FERTILITY, FEEDING THE SOILS THAT FEED US

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Community Supported Agriculture (CSA) was an innovation that has served to connect and build fellowship between farms and customers. The late Robyn Van En introduced the concept of the CSA to North America, in 1985, beginning at her farm in the Berkshires region of Massachusetts. The idea quickly spread across the USA and Canada but was not entirely new as similar cooperative systems had existed in Europe and Japan. The CSA system is believed (Robyn Van En Center) to help “shift thinking about agriculture and its connection to our lives, to the land itself, and to our communities.” CSA members often visit the farms to pick up their food and, in some cases, help with farm activities such planting, weeding, and harvesting.

Community Supported Soil Fertility is a new twist on the CSA concept. It teaches CSA subscribers to return natural waste materials to the farm to feed the soil that feeds them. This practice is also not entirely new since the human role in conserving soil fertility was originally regarded as an “inherited instinct” in much of Asia. This was chronicled in the 1911 classic *Farmers of Forty Centuries, A Permanent Agriculture in China Korea and Japan* by American soil scientist F.H. King. This influential book was an inspiration to pioneers of the organic farming movement who were quick to advance composting and the Rule of Return concept of soil fertility.

By rebranding the practice of Composting and Rule of Return as Community Supported Soil Fertility – Feeding the Soil That Feeds Us, it is hoped that more people will feel connected to soils and sustainable farming. This community approach to soil fertility may help to engage customers at an emotional level with a commitment to Nature.

It is of course also intellectually based in science. Soils truly are living systems that metabolize organic residuals into the fertility that supports crops and food production. And nutrient contained within organic residuals become a renewable resource that can cycle in perpetual motion so long people commit the Rule of Return.

How to formally establish a system of Community Supported Soil Fertility is still a work in progress. Elements of such a system already exist in some communities that collect, compost, and distribute residuals from home kitchens and landscapes. The current high cost for commercial fertilizers gives incentive and urgency towards this effort.

Farmers accepting these materials also need information on best practices for utilization of urban derived nutrient stocks such as composts, shade tree leaves and grass clippings. Lab data on chemical composition and carbon to nitrogen ratio are keys to incorporating these materials into soils to benefit and sustain crop production. Soil fertility testing is also critical for managing nutrient applications and avoiding excesses that may impact water quality.

Gazing in the Crystal Ball – Future of NJ Agriculture I

NOTES

Agrivoltaics

AGRIVOLTAICS

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The state of New Jersey is planning to mitigate global warming by rapidly expanding the use of renewable energy sources. In particular, the use of solar and (offshore) wind energy will increase substantially over the next decades. Solar energy can be 'harvested' using photovoltaic (PV) panels that convert solar radiation into electricity. While PV panels are already a common sight across New Jersey, the number of installations will have to be increased substantially in order to meet the state's renewable energy goals. And one of the cheapest ways to expand our solar energy capacity is to install so-called solar farms. Often, solar farms are constructed on farmland that, as a result, is no longer available for regular farming operations over the life expectancy of the PV panels (typically 20-30 years). Therefore, installing a large number of solar farms across New Jersey, would substantially reduce the acreage available for agricultural activities.

Combining agriculture with the generation of electricity from PV panels is called agrivoltaics. The panels are raised or titled vertically in such a way that conventional farm equipment can be used for all the different crop production practices. Compared to a solar farm, the panel density for an agrivoltaic system is lower so as to minimize yield reductions due to resulting shading patterns. While some yield reduction is inevitable, the PV panels will generate additional income. The goal of an agrivoltaic system is to make the financial return of the sum of the two (agriculture and electricity generation) bigger than the return from either system separately. That would make it attractive for a farmer to keep using the land for agriculture instead of selling or leasing the land to a solar developer who will likely install a solar farm.

But do agrivoltaic systems make sense in New Jersey? Only careful research will be able to give a definitive answer. There are a few research projects in different states, but so far none are conducted here. A team of Rutgers University faculty and staff has been developing a comprehensive research plan and was successful in acquiring funding from the New Jersey Agricultural Experiment Station and from the State Legislature. The funding will allow the team to construct various agrivoltaic systems at different research and demonstration farms across the state. During this session, four team members will discuss various aspects of the Rutgers Agrivoltaics Program (RAP).

General Vegetable II

TURNING THOSE NEW CUSTOMERS INTO PERMANENT CUSTOMERS

Bridget Behe
Professor of Horticulture
Michigan State University

1

2

Five things that can help bring them back!

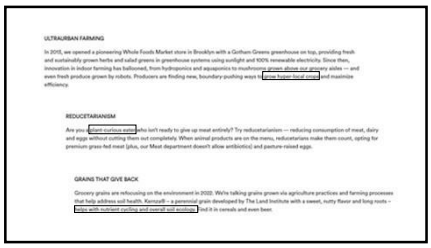
1. Work with the fact that people are busy (overwhelmed?) and not

3

4

5

6



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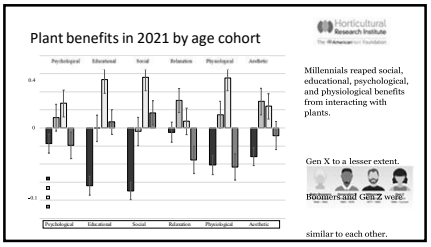

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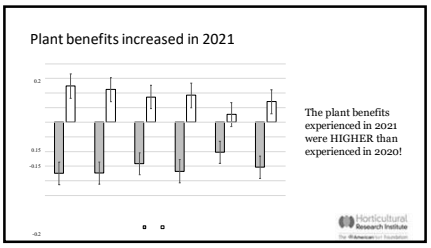

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Plant benefits motivate purchases!

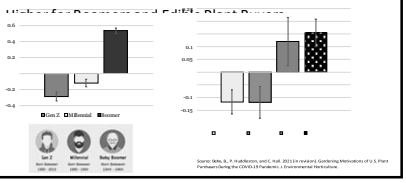
10

U.S. E-Commerce Habits Deepen

13

16

Food security:



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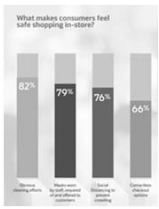

Consumers want to feel safe: Retailers must communicate that! Perceptions matter.

14

Keep them coming back by . . .

1. Meeting them where they are with your communications.
2. Emphasize the "whys" that are their priorities (mental and physical health, children, and the environment).
3. They are on social media; you should be too! 4.Offer solutions (and delivery) not just products (for an upcharge). Consider selling recipes (kits?) online through Instagram stories.

17

Good food security messages:

- With an interest in plant-based diets, the plant curious eater, you can have a lot of control over what you eat and where it comes from.
- We are your local source for fresh vegetableswith roots in your backyard.
- Great flavor and great nutrition start with us.
- Cultivate food independence at home.
- You can't get more local food than your backdoor

12

Online plant purchasers had greatest shopping anxiety

Source: Behe et al. (2020) HRI-funded online study of 1211 plant purchasers and non-purchasers in July-August

15

18

USDA'S PERISHABLE AGRICULTURAL COMMODITIES ACT (PACA): WHAT IS PACA AND HOW CAN IT HELP YOU GET PAID?

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Perishable Agricultural Commodities Act (PACA)

The Perishable Agricultural Commodities Act (PACA) is a Federal law that was enacted at the produce industry's request in 1930 to promote fair trade. The PACA protects businesses dealing in perishable produce, by ensuring a level playing field.

Services

The 1-800-495-7222 PACA customer service line is answered Monday through Friday from 7:00 am until 7:00 pm, Eastern Standard Time. PACA representatives provide guidance on problems unique to the industry, such as interpretation of inspection certificates, advice on contract disputes, and bankruptcy issues.

Dispute Resolution:

If a firm is involved in a dispute or has not been paid for produce, it can file an informal reparation complaint with PACA. The complaint must be in writing, accompanied by the $100 filing fee. Typically, 90 percent of PACA's informal complaints are resolved within 90 days. PACA staff can help resolve contract disputes, preserve business relationships, and keep the fruit and vegetable industry moving forward. PACA also offers mediation which is a low-cost alternative to expensive litigation. In the event informal efforts fail to settle a claim, the complainant firm can file a formal reparation complaint which may result USDA issuing an order for payment.

Investigative Enforcement:

PACA's enforcement program promotes compliance with the fair-trading provisions of the PACA by pursuing administrative actions against those firms or individuals that are not trading fairly, and by facilitating payment of past due produce transactions.

PACA Trust

Established in 1984, the PACA Trust provides produce sellers with financial protection if a customer files for bankruptcy or goes out of business. Since its inception, hundreds of millions of dollars have been paid to qualified produce creditors under the Trust provision. In the case of a business failure or bankruptcy, the debtor's trust assets are not available for general distribution to other creditors until all valid trust claims have been satisfied. To preserve Trust rights, it is important to remember that payment terms must not exceed 30 days, and the necessary Trust language must be conveyed to the customer.

Licensing
The law requires that produce dealers have a PACA license to operate a produce business. In general, any business that buys or sells wholesale quantities (2,000 lbs.) of fresh or frozen fruits and vegetables must have a PACA license. This includes shippers, wholesalers, brokers, retailers, processors, and many e-commerce firms. Growers or farmers are not required to have a PACA license unless they purchase wholesale quantities of produce from another grower or company.

ePACA Portal
The ePACA Portal is a centralized location for the produce industry to submit or renew a license application, search license status information, and file complaints. Please refer to https://www.ams.usda.gov/rules-regulations/paca/epacaportal for more information.

Contact PACA staff by phone at 1-800-495-7222, or visit the PACA website for additional information at http://www.ams.usda.gov/paca.

HOW YOU MANAGED YOUR FARM DURING THE PANDEMIC

Ashley Reese
Sales Manager
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Colts Neck, NJ

About Me

New Jersey Farm Bureau Women's Leadership Committee, First Vice Chair
New Jersey Horticultural Society, Director
Monmouth County Environmental Council, Chair
Leader's Association, External Vice President
Monmouth County Board of Agriculture, Associate Secretary
New Jersey Ag Society, Leadership and Development Program, Class 11

- I began working in agriculture in 2018 along side my husband.
- I have a business management degree and I spent my professional career up until this point focusing on sales, customer service, and account management.
- I have 2 young children, a 7-year-old son and a 5-year-old daughter. Both of whom needed extensive hands-on assistance with virtual learning in 2020.

About The Farm

- I run the sales, marketing, your name end of a 100-acre pick-your-own apple and peach orchard. We are open to the public from mid-July until the end of October.
- We are family owned, family run since 1923, and we mean that in every way.
    - We treat all our employees as if they are family and focus all our marketing efforts on a family friendly place to be.
- In 2020 we had over 125,000 people come to the farm between July 15th and October 24th.
- This year we had roughly the same amount from mid-July until the first week of November.

Today I'm going to talk about how I specifically managed the farm during the pandemic, and I'll touch on how COVID impacted specific risk areas of our business such as Finance, Personnel, Marketing, and Legal aspects.
I need you to remember several things as I go along:

- Just like many of you, during our season I work 70+ hours a week.
- I have 2 small children, and was the primary caretaker and teacher during this time
- This are my opinions, agree or disagree, they are mine.

Finance

- Make sure your pricing is competitive but know your worth.
- Always have a budget in place and plan for the worst.
- Take advantage of crop insurance, and state assistance programs (not loans).
    - The USDA has great programs that are super affordable and easy to sign up for.
- We moved towards contactless payments, and it was one of the best decisions we could have made.

Personnel

- You don't have to pay top dollar to get quality employees.
    - When it comes down to it, people want to be treated fairly and with respect.
    - We have agriculture minimum wage for a reason. Our business is already so variable, do feel the need to sink yourself with competitive wages.
        - Example Laird Vodka - $14 per hour, they are open 365 days per year and shipping their goods across the country. My business is not the same as theirs.
- You need to utilize social media, and signs in front of your business.
    - Spend Money wisely. Put signs out in front of your business or on main roads where people will see them. Start advertising help wanted on social media. You can run a help wanted ad for a week for $10 with a wide reach.
    - You can share your help wanted posts on your stories and keep adding them over and over for free. Make sure that you do this on peak times for the biggest success.
- Stay consistent with your policies and your message.
    - Not only do staff want you to treat them fairly and with respect, but they want your policies and your messages to be consistent. They want this not only for themselves and all the employees, but they want the rules and messages for customers to be clear and consistent as well.
    - Being able to stay on the same page with your employees helps significantly when with comes to dealing with customers or the public on the farm.
    - If your employees know what is and is not allowed, they are able to better handle customer interactions as they know what is expected of them and the customers while they are on the farm.
- I'm going to remind you that I explained that we are a family friendly place to work. That means that we treat each other with respect. It also means that we treat all our customer with respect, however: the customer is not always right, and make sure to back up your employees.
    - I'll touch more on this when I go over legal aspects of the business, but very seriously the customer is not always right.
    - We can listen, be respectful, patient, and understanding, but in the end they may not always be right. I find my employees have more respect for me when I listen to them, remove them from the situation, and then navigate with the customer on a clean slate.
    - It's also vital to follow up with your employees after difficult situations. What went well, what didn't. Is there anything we can improve on for the next time. Or even "man, that one was a nut job, and this is how I handled it.

Legal

- Stay consistent with your policies and your message.
    - This is important with your staff and your customers.

    - Make sure to post any rules you have clearly on every forum you have and repeat them often.
    - Make sure the most important rules are visible as customers are entering and make sure that employees know where they are.
        - No Pets Allowed, and Pay for what you pick
- Make sure to back up your employees as the customer is not always right.
    - I've gone through extensive training and done so much research on Service Animals. I know what my rights are as farmer and private business owner.
    - I also know that I'm able to make accommodations provided the customer works with us.
    - If a customer wants to bring their pet onto the farm and is unwilling to work with our food safety regulations, I DO NOT HAVE TO LET THEM ON THE FARM. The customer may be mad, but they are not right.
    - There are places on the farm where customers are not allowed to go.
    - If we are closed for the day, or closed for the season, and a customer comes onto the farm, they are trespassing. This is not a park.
        - Again, we can always be polite and respectful, but you need to know your rights and enforce your policies accordingly.
- Last year this was very difficult with mask mandates. Even though our operation is 100% outdoors, there were areas that customers were "unable to socially distance" such as our check out lines. We had to enforce masks on the farm in those areas.
    - Regardless how we or anyone felt about it. If you wanted people to wear them 100% of the time or none of it, we had to enforce it, and there was an incredible amount of backlash.
    - At the end of the day, you need to remember one thing. This is your business your success is dependent on staying open. This the executive rule we are following. There are the accommodations we can make for you, but this is what we are going to do. If not, then we'll see you again next year.
    - I know the executive orders. I know my rights. I take training classes. The customer does not. They are not always right.
- Stay informed (Rutgers, NJ.gov, Farm Bureau).
    - Have you joined your Local Board of Ag?
    - Do you follow Rutgers for relevant training seminars?
    - Are you a member of New Jersey Farm Bureau?
        - If you've said no to anything I mentioned, and you run a farm, own a farm, or are thinking of starting one begin today. All three are a wealth of information. People who are looking to help you and your business succeed.
- Know your rights and stay informed.
- The best advice someone gave me was to create incident report forms and keep them handy.

Marketing

- On a much lighter note, COVID was great for marketing. I stopped placing ads in newspapers and magazines. Our annual marketing budget was around $3,000 per year.
- In 2020 I was able to use that money to update our website, and make sure it was linked to both my Instagram and Facebook account.
    - When I post on Instagram, it automatically posts on Facebook and is then visible on our website.
    - The marketing Company we used help me update our website with relevant COIVD safety information, while at the same time creating a user-friendly page called Word Press that Allows me to make changes on the website without having to pay them by the hour.
    - I also began to advertise on Instagram and Facebook for $5-$10 per day based on what I was trying to accomplish.
        - My messages were more consistent, and were getting directly to my targeted customers (families, foodies, people looking to get outside for mental wellbeing)
        - Once I posted something on Instagram, I could run an ad on specific weekends to increase our sales numbers.
        - From here, I could add pictures to our stories.
        - If you aren't using Instagram start now.
            - If you aren't utilizing your stories, start now.
            - Once you have a picture or article in your stories, you can then add them to your Instagram Highlight Reels.
            - We use this specifically as families LOVE to post pictures while they are at the farm, and they tag us.
            - I had someone the other day tell me how excited they were that her picture was shared on stories, and that she knew that it was an exclusive thing.
                - Let me remind you that I keep my messages consistent. We don't allow children to ride in our wheelbarrows. We prefer paying customers come to the farm, and not just Instagram influencers (insert eyeroll). I don't repost anything that isn't family friendly or goes against our rules
    - In 2021 I only spent $200 on social media advertising.
        - I was able to funnel the budgeting advertising amount to reusable bags and t-shirts.
    - Helpful Hints, Take Ownership of your Google Account.
        - Add Content once or twice a year if not more.
        - If your business is weather or supply dependent, utilize Google to update your daily hours. The general population tends to use Google for your business hours more as they are more readily available than your website. You can update them on the fly.

- My business is variable, and I need my marketing to be flexible. I also don't want to spend a lot of money. Utilizing social media is the most inexpensive and effective way to handle direct marketing.
- To those of you who don't have time or money. Here is my unpopular opinion for Marketing. That's just an excuse and I use it all the time.
    - I never used Word Press, before I learned how. I never knew how to use Instagram, Instagram Stories, or Highlights, until I learned how.
        - My suggestions for you would be to come from a place that you understand that this will save you money help you control your business and then either take a class or better yet talk to someone who is on their phone all the time (like young people).
        - I ask the kids at work all the time suggestions about social media like hash tags and lingo. I swear they keep me young.
        - Additionally in the swell of your season you are going to feel overwhelmed and overworked and you aren't going to want to spend another minute advertising. THIS IS WHEN YOU NEED IT THE MOST.
            - Have a plan in place. Take some time this month to create a file or a favorites album on your phone that you can dive into when you don't have the time or the energy to post something.
    - Anyone I know can attest to this. If I can do it, you most certainly can do it, and I find 5 minutes every day (not that I want to) but I find the time to post every day during the season. The more I post the better our sales number are.
    - Create your content and culture.

Overall Takeaways

- Farmers are resourceful, be resourceful in other areas of your business (social media/ marketing). There is no reason to spend more money than you need to.
- The pandemic gave us a chance to try new things without the fear of failing because we knew that if we did nothing different, we were going to fail.

INSECT CONTROL UPDATE FOR VEGETABLES

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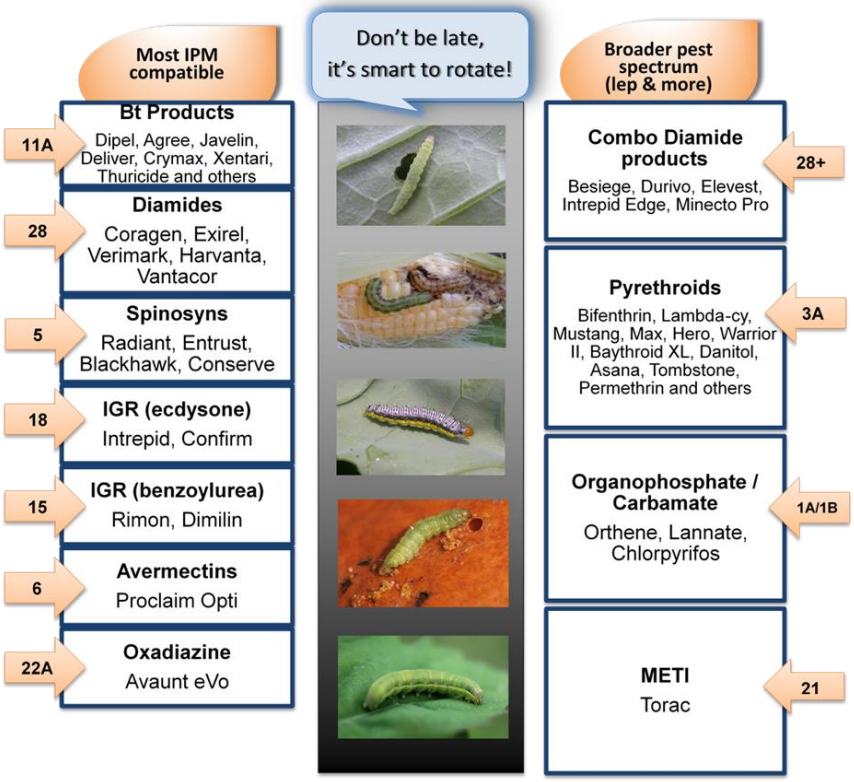
Vegetable crops in the mid-Atlantic U.S. are attacked by a wide range of damaging insect pests including different species lepidopteran larvae like armyworms, corn earworm, cabbageworms etc., as well as species of aphids, beetles, and stink bugs. Insect control is getting challenging as new invasive species have established in the region, resistance to insecticides has developed in some species, and insecticides have become more selective in their pest spectrum in order to reduce non-target impacts. Fig. 1 shows the broad selection of insecticides available for lepidopteran pests.

Fig. 1. Lepidopteran Insecticide Menu for Vegetable Growers (Grouped by insecticide MOA class) – Adapted from Kuhar and Doughty 2020. Virginia Coop. Ext. Publ. ENTO-395NP



Insecticide Evaluations

We conduct numerous insecticide trials on vegetables each year in Virginia. Below are two recent trials on two particularly difficult pests, Colorado potato beetle and stink bugs.

Efficacy of Labeled Foliar Insecticides for the Control of Colorado Potato Beetles

Colorado potato beetle is a major pest of potatoes and eggplant and can be difficult to control due to insecticide resistance development, most recently to neonicotinoids. In 2021, we evaluated most of the labeled non-neonicotinoid insecticides registered on potatoes. The trial was conducted in Painter, VA and two foliar applications were made 21 and 28 May. Treatments included: Sivanto (with similar MOA as neonicotinoids), the diamide products Harvanta, Exirel, Coragen, Vantacor, and Besiege; the spinosyn insecticides Blackhawk 36WG, Radiant, and Delegate; Torac, a mitochondrial poison; Agri-Mek (abamectin), the insect growth regulator Trigard 75WP; and Minecto Pro (a combo insecticide with the diamide cyantraniliprole + abamectin). All insecticide treatments provided excellent control of CPB larvae (Table 1).

Table 1. Numbers of CPB larvae per 10 potato stems after applications of different labeled insecticides on potatoes planted in Painter, VA 2021.

Treatment	Rate / acre	24-May (3 DAT)		2-Jun (6 DAT2)	
		Small larvae	Large larvae	Small larvae	Large larvae
Untreated check		54.3 a	96.0 a	63.0 a	100.8 a
Sivanto Prime	14 fl oz	3.3 b	0.0 c	6.5 b	2.0 b
Sivanto HL	7 fl oz	5.0 b	0.8 c	8.3 b	3.5 b
Harvanta	16.4 fl oz	2.0 b	0.0 c	0.0 b	0.0 b
Exirel	13.5 fl oz	9.8 b	0.0 c	0.0 b	0.0 b
Coragen	7.5 fl oz	2.0 b	0.0 c	0.0 b	0.0 b
Vantacor	7 fl oz	4.0 b	0.0 c	0.3 b	0.0 b
Besiege	9 fl oz	1.3 b	0.0 c	0.0 b	0.0 b
Torac + PBO	14 fl oz	0.0 b	0.0 c	0.3 b	0.0 b
Agri-Mek	3.5 fl oz	9.3 b	1.3 c	5.0 b	3.8 b
Blackhawk 36WG	3.3 oz	0.5 b	0.3 c	0.0 b	0.0 b
Radiant	8 fl oz	0.0 b	0.0 c	0.0 b	1.0 b
Delegate	4 oz	5.5 b	2.0 c	0.0 b	0.0 b
Trigard 75WP	5.32 fl oz	46.0 a	46.0 b	9.8 b	6.0 b
Minecto Pro	10 fl oz	7.8 b	0.0 c	0.0 b	0.0 b

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

Efficacy of Insecticides for the Control of stink bugs on tomatoes

A number of stink bug species can attack the fruiting stages of vegetables. Tomatoes and peppers are particularly vulnerable. In Virginia, in the invasive brown marmorated stink bug as well as the southern green stink bug have become prominent pests in addition to the native brown stink bug and green stink bug. All of these pests have piercing sucking stylets that can liquefy plant tissue and leave behind unsightly feeding marks on fruit. Pyrethroids such as bifenthrin have become the standard for stink bug control, but frequent applications of pyrethroids are not IPM compatible and can lead to

outbreaks of secondary pests such as aphids or spider mites. In 2021, we evaluated several other insecticide options for stink bugs on tomatoes planted in Painter, VA. Treatments included: bifenthrin, the neonicotinoids Belay Actara, Venom, and Assail, as well as Transform, which has a (similar MOA as neonicotinoids) and the older organophosphate Malathion. All insecticide treatments provided excellent control of CPB larvae (Table 1). The best reduction in stink bug damage to fruit was achieved with Venom and bifenthrin. Assail, Belay, and Malathion provided the least reduction in stink bug damage among the insecticides. All treatments reduced thrips damage to fruit.

Table 2. Summary of efficacy of select foliar insecticides for the control of stink bugs in tomatoes; ESAREC, Painter, VA 2021. Four insecticide applications: 24 Jun, 1, 9, 15 Jul.

		Mean no. stink bugs (adults/nymphs) per 2mn visual count					
Treatment	**Rate / acre**	**15 Jul (7 DAT2)**	**1 Jul (7 DAT1)**	**Total Stink bugs**	**% stink bug damaged fruit**	**% lepidopteran damaged fruit**	**% thrips damaged fruit**
Untreated check		4.25	0.00	4.25	56.5 a	9.0	10.0 a
Bifenthrin 2EC	6.4 fl. oz	0.00	0.00	0.00	11.5 d	6.5	0.0 b
Belay 2.13SC	4 fl. oz	0.00	0.00	0.00	33.0 bc	6.5	0.5 b
Actara	5.5 oz then 3 oz	0.25	0.00	0.25	28.0 c	8.5	2.0 b
Transform	2.25 oz	0.25	0.25	0.50	25.0 c	10.5	0.5 b
Malathion Aquamul	12.48 fl. 0z	0.25	0.25	0.50	45.5 ab	2.0	3.5 b
Venom 70SG	4 oz	0.25	0.25	0.50	3.0 d	6.5	0.0 b
Assail 30SG	4 oz	0.00	0.50	0.50	44.5 ab	6.0	2.0 b
P-Value from Anova		ns	ns	ns	<0.0001	ns	0.0009

All data were analyzed using analysis of variance procedures. Means were separated using Fisher's LSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

Nursery II

MANAGING RED-HEADED FLEA BEETLE LARVAE AND ADULTS

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Red-headed flea beetle (RHFB) adults, *Systena frontalis*, feed on container nursery ornamentals making plants unmarketable due to skeletonizing or holes in leaves. I know of grower concerns with this insect in the Southeast, Northeast, Ohio, and Michigan. It is native to the majority of the United States, from the east coast to the Rocky Mountains. RHFB seems to have become an issue during or following the Great Recession of December 2007 through June 2009.

Holes in leaves decrease marketability.

Traditional management has consisted of repeated adult foliar sprays. In 2017 I surveyed eastern North Carolina (NC) growers and found that acephate, bifenthrin, carbaryl, and chlorpyrifos were most commonly used to manage adult populations by making weekly to monthly applications depending on pressure. Growers indicated managing RHFB was their greatest production concern and that guided me to search for more information and conduct nursery research and demonstrations.

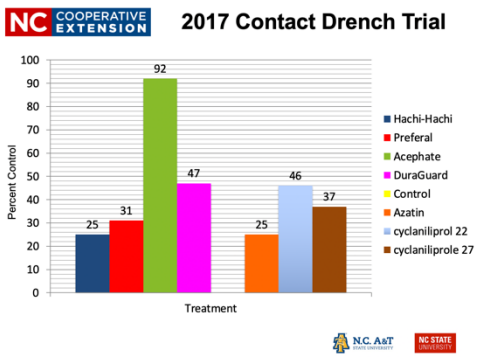
In nature and soil-based systems, this insect has one generation per year (egg, larva, pupa, adult) and is not of concern except in North American cranberry production in the Northern US and Canada and possibly in other small fruit production. In container nursery production, RHFB may have up to 4 generations per year. I am confident that in eastern NC container nurseries there are 3 to 4. RHFB overwinters as eggs in soil and substrate. In eastern NC, eggs hatch and larvae emerge in container substrate around 400 GDD_{50} (Growing Degree Days with a base temperature of 50 degrees) in plants overwintered outdoors (300 GDD_{50} for plants overwintered in structures). Plants overwintered in structures can result in first-generation larvae detection as early as 240 GDD_{50} (Brian Kunkel, 2013). Larvae don't seem to cause injury to plant root systems. Following a period of pupation, adults emerge beginning at 500 GDD_{50} from

Early larva size.

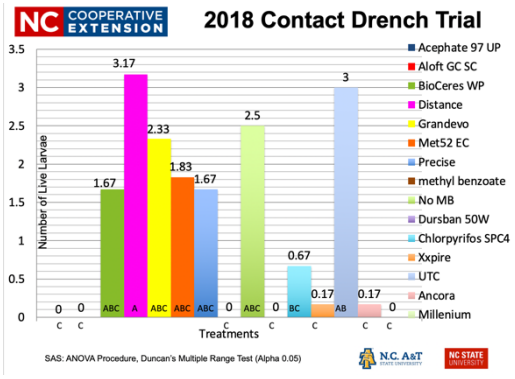
plants overwintered in structures (Brian Kunkel, 2013) and as late as 900-1000 GDD_{50} if overwintered outdoors in NC. Generations seem to overlap starting with the 2nd.

Research conducted for the IR-4 program from 2012-2019 by Braman, Frank, Kunkel, and Gilrein showed that foliar-applied active ingredients acetamiprid, bifenthrin, cyantraniliprole, cyclaniliprole, cyfluthrin + imidacloprid, dinotefuran, imidacloprid (granular applied exception), lambda-cyhalothrin, sulfoxaflor + spinetoram, thiamethoxam, and tolfenpyrad resulted in less RHFB damage over a 7 to 49 day period (depending on rates, varying levels of insect population and number of applications) when compared to untreated controls.
Following extensive discussions with Dr. Brian Kunkel from the University of Delaware and reviewing his research targeting larvae with drenches of entomopathogenic fungi (*Beauveria bassiana* and *Metarhizium anisopliae*), several products as drenches directed at active larvae in containers (dinotefuran, imidacloprid, thiamethoxam, cyantraniliprole, azadiractin, bifenthrin), and drenches with beneficial nematodes (Steinernema carpocapsae found to be most effective), I decided to conduct my own drench research targeting larvae.

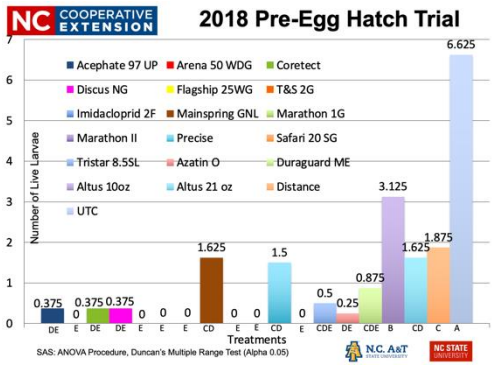
My first replicated nursery trial targeting active larvae in 2017 showed that while azadirachtin (Azatin O), chlorpyrifos (Duraguard ME), cyclaniliprole (Sarisa), *Isaria fumosorosea (*Preferal at the time, now Ancora*)*, and tolfenpyrad (Hachi Hachi) provided 25 to 47% control, acephate (Acephate 97UP) applied at a mix rate of 12 oz./100 gallons and drench volume of 12 fl. oz. per 3 gallon container provided 92% control of RHFB larvae.



A replicated nursery trial I conducted in 2018 targeting larvae with drenches showed acephate (Acephate 97UP at 12 oz./100 gallons), chlorpyrifos (Dursban 50W at 16 lb/100 gallons- max label rate for beetles), and *Steinernema carpocapsae* nematodes (Millenium at 250 million nematodes/100 gallons) applied at a drench volume of 8 fl. oz. per full 1 gallon container provided 100% control of RHFB larvae. *Isaria fumosorosea* (Ancora), provided 94% control.



Another 2018 replicated nursery trial showed that many labeled neonicotinoid insecticides applied at their recommended rates prior to egg hatch/larvae emergence (212 GDD_{50}) provided the best control (most 100%) and all other products significantly reduced numbers of larvae compared to the untreated control (UTC).



With heavy adult pressure, monthly foliar application of neonicotinoids or biweekly application (once every two weeks) of contact insecticides is not enough to maintain marketable plants (< 10% injury). Foliar contact insecticides often must be applied weekly to maintain marketable plants. The challenge is that many insecticide labels restrict the number of applications a year (for example carbaryl is 6) or have a maximum total rate per growing season or generation of insect. This is an opportunity to implement insecticide rotations that work within label restrictions and prevent insect resistance.

Neonicotinoids applied as drenches at potting or to existing plants prior to RHFB egg hatch/larvae emergence (approximately 200 to 300 GDD_{50}), as granular topdress, or by granular incorporation can provide at least 60 to 90 days of adult control with less than 10% foliar injury without using foliar insecticides (depending on rate). It is important to note (due to concern of neonicotinoid use and pollinators) that many newly spring potted plants (like *Itea virginica*) do not typically flower during their first growing season. Many modified varieties of Hydrangea with double flowers or sterile sepals attract few bees (Mach, 2018). Also, spring or summer flowering plants that are potted in the fall will not be attractive to pollinators at the time of application.

In the Eastern US RHFB Survey (Joseph et. al., 2021), we found 72% of growers had recurring infestations over the past 10 years and species most affected were *Hydrangea paniculata, Itea virginica, Weigela florida, Ilex crenata, Ilex glabra, Rosa spp., Rhododenron* spp. (azaleas), *Osmanthus fragrans, Cornus* spp. (shrub dogwoods like silky, red-twig, and yellow-twig), *Sedum* spp., and *Salvia* spp. Growers in eastern NC have also reported damage on *Viburnum* spp., *Loropetalum chinense*, *Forsythia* spp., *Lagerstroemia* spp., *Buddleija* spp., *Abelia* spp., *Gardenia* spp., *Guara* spp., *Illicium* spp., *Pyracantha* spp., and *Myrica cerifera.* Growers spend an average of $662/nursery Acre/yr. on RHFB management. 89% of growers apply insecticides against adults, 47% target larvae, 48% target adults and larvae, 11% were using *Steinernema carpocapsae* nematodes, and 2% were using entomopathogenic fungi. Among the growers surveyed, 36% use neonicotinoids, 23% carbaryl, 21% pyrethroids, 15% organophosphates, and 6% diamides. 54% of growers surveyed indicated they need more effective insecticides.

To improve management of RHFB, start by following GDD_{50} in your area based on the closest weather station or record and calculate on-site. Keep a list of plant flowering at the nursery based on GGD_{50}. This will guide scouting for first-generation larvae and

adults. In eastern NC I start scouting containers for larvae in plants overwintered in protection structures around 200-300 GDD_{50} (redbuds in full bloom, when flowering dogwoods start blooms open), for larvae in plants overwintered outdoors around 350-450 GDD_{50} when *Itea virginica* flower buds swell, and for adults when older *Itea virginica* are in full bloom and Magnolia grandiflora start bloom around 800-1000 GDD_{50} (possibly earlier in plants overwintered in protection structures).

Scouting for larvae, adults, and keeping records will help determine application timing for: -Pre-egg hatch with neonicotinoids (drench or granular topdress available in several formulations), azadirachtin (from numerous suppliers), or cyantraniliprole (Mainspring GNL). Neonicotinoids provide the best control of larvae and adults and the longest protection from foliar injury if applied to rooted cuttings, liners prior to potting, are incorporated in the substrate, or are applied as a drench or topdress after potting. -After egg hatch target larvae with acephate (various formulations), chlorpyrifos (various formulations), *Isaria fumosorosea* (Ancora) or beneficial nematodes (*Steinernema carpocapsae* from numerous suppliers). -Make applications of adult foliar insecticides just prior to historical first-generation adult emergence or based on scouting susceptible crops. -Many foliar insecticides kill adults short-term but don't break the life cycle. Repeat applications are needed during the summer to control newly emerging adults. Make sure to follow label instructions for rate and a limited number of applications per acre and/or year, growing season, or generation of insect. Use a rotation of products based on their IRAC (Insect Resistance Action Committee) classification to avoid resistance.

Active ingredient	Ex. Trade Name	REI (hr)	IRAC MOA Group
acephate*	Orthene 97UP	24	1A
acetamiprid*	Tristar 8.5 SL	12	4A
bifenthrin*	Bifenthrin 7.9F	12	3
carbaryl*	Sevin SL	12	1A
chlorpyrifos*	DuraGuard ME	24	1B
cyantraniliprol*	Mainspring GNL	4	28
cyclaniliprole*	Sarisa	4	28
cyclaniliprole+flonicamid*	Pradia	12	28 + 29
cyfluthrin*	Decathlon 20WP	12	3
cyfluthrin + imidacloprid*	Discus L	12	3 + 4A
diazinon	Diazinon AG500	12	1B
dinotefuran*	Safari 20SG	12	4A
tau-fluvalinate	Mavrik Aquaflow	12	3A
imidacloprid*	Marathon II	12	4A
lamba-cyhalothrin*	Scimitar GC	24	3A
sulfoxaflor + spinetoram*	Xxpire	12	4C + 5
spinosad	Conserve SC	4	5
thiamethoxam*	Flagship 25WG	12	4A
tolfenpyrad*	Hachi-Hachi SC	12	21A

*Foliar applied insecticides labeled for beetles or flea beetles. Active ingredients with an * have been proven to provide control in IR-4 trials, nursery demonstrations, and nursery research trials.*

In my experience, growers with greater numbers of susceptible plants held over from year to year have the greatest problems with RHFB. Know the most susceptible plants and manage production and inventory closely. Growers will have fewer problems with RHFB (and other pests or production issues) if plants are sold long before they have a birthday at the nursery. Consider split potting crops to fill plant sales demands throughout the year. This also provides the benefit of smaller crop blocks, lower pressure, less injury, fewer holds on sales, fewer sales credits, and prevents extra labor costs to prune and flush injured plants.

Finally, consider rotating the location of commonly susceptible plant species. Growers often put all deciduous plants in the same location year after year. Rotate those with conifer production to avoid population build-ups. This will also help with the prevention of conifer diseases, insects, and mites.

DETECTION & MANAGEMENT OF PHYTOPHTHORA IN CONIFERS

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Rutgers University Cooperative Extension agents Timothy Waller and Bill Errickson, and student intern Devan Gladden have been cooperating with commercial conifer nurseries throughout the state during the summer of 2021 to assess the impact of Phytophthora to this industry. Through this USDA-Specialty Crop Block Grant (SCBG) funded project we aim to identify the Phytophthora species limiting conifer production in New Jersey, and how best to manage this disease moving forward. During year-1, twenty, of the planned thirty nurseries by the end of this project, have been sampled for this devastating plant disease. Although the focus of this project is Christmas trees and other economically important conifer species, crop types such as deciduous, ericaceous, and broadleaf evergreens have been, or will be, evaluated. The goal of this project is to support a comprehensive and innovative disease management program; Provide recommendations on site selection, sources of *Phytophthora spp.* contamination into the operation, conifer variety selection for specific site types, and material (conventional and biological) treatment options to protect and guard from disease. This seminar serves as the first of many updates pertaining to this project.

Biology: "Phytophthora root rot" is caused by a fungus-like Oomycete plant pathogen, which, contrary to popular shorthand is not a true fungus. The difference may seem trivial; however, this detail fundamentally impacts material selection when targeting this pathogen and closely related Pythium species. Oomycetes, often referred to as "water-molds", lends some insight into the favored habitats and means of disease dispersal for this water-loving pathogen. Phytophthora inhabits soils and waterways (natural or man-made) and specific pathogen species can infect the roots, shoots, flowers, and leaves of varying plant species. Some have very narrow host ranges that they can infect, while others, unfortunately are known as cosmopolitan plant pathogens, meaning they are able to infect a very wide host range. Phytophthora can produce a multitude of potential infection structures including motile zoospores (able to 'swim' towards root chemicals) and non-motile mycelium and sporangia that can directly infect plant parts or release zoospores, and oospores and chlamydospores that are able to lay dormant for years. This ability to remain dormant in the soil is one of the main factors limiting conifer production throughout all conifer growing regions of the world. When conditions are ideal for Phytophthora development (warming soils and stagnant saturated soil conditions), resting Phytophthora propagules either free in the soil or within decaying roots from previously infected plants can become explosive and lead to rapid visual decline of conifers. We are working towards better understanding the impacts of certain cultural practices, such as not removing cut Christmas tree stumps, and seedling

treatments prior to planting to guard plants destined for known Phytophthora positive sites.

Symptoms and Sampling: During the first year of this project, we sampled symptomatic and non-symptomatic plants for the presence of Phytophthora. Typically, Phytophthora symptomology is twofold, above- and below-ground visual cues. The above-ground symptoms consist of yellowing to pale brown discoloration at a whole plant or partial plant level. Infected plants often appear drought-stressed, and their growth is typically stunted, with the whole tree or individual branches dying off. In some cases, 'bleeding' cankers can be observed on the main trunk, large branches, and near the crown. The below-ground symptoms are focused on the root system and subterranean crown area. The roots will appear darker than expected, often dark browns to black and will lack obvious healthy feeder roots and white tips. A simple diagnostic cue is the presence of 'root sloughing', where the outer root sheath can be easily pulled away, leaving an exposed core. In the crown area, slices into the bark and woody tissues often reveals zones of obvious patterns of wood discoloration. If these infected plant parts are left in the soil they can act as inoculum reservoirs for later infections as Phytophthora's propensity for persisting in the soil has already been discussed. During the first wave of the project, we looked for or were directed to obviously symptomatic conifers and nursery crops to sample, with additional samples taken from nearby yet symptomless plants. Once selected, we dug the plants (or removed them from their containers) and searched through the root systems to find darker than normal roots that 'sloughed off' when pulled. We also gathered symptomatic branches, inner bark or crown slices, a took soil samples for further study. These were then transported back to the laboratory and kept at 4˚C (refrigerated) until isolations were conducted. Samples were washed free of soil particles and symptomatic tissues were plated onto a Phytophthora selective media (CMA-PARPH; which contains antibiotics and fungicides within a cornmeal agar base – (CMA)) that disallows most other plant pathogens from growing within the media. Often subsequent rounds of transfer to PARPH were required to obtain pure cultures. These cultures were then stored on CMA slants until later identification to species level can take place. Morphological characteristics were utilized to generate primary groups prior to genetic identification, which will rely on amplification of two gene loci regions, ITS and COX2.

Water: Given that Phytophthora is very capable of destroying conifer root systems, the outward sign of drought-stress can be worse than misleading. In this situation if the plants are continually given 'extra' water, the situation can be greatly exacerbated as the pathogen is now given a means of spreading throughout the planting via the steady stream of water (whereby the zoospores are able sense and swim to new roots via a process known as chemotaxis). In many cases, a calling card of Phytophthora infection is the movement of symptoms either downhill or downstream from previously diseased plants. Additionally, Phytophthora can thrive in irrigation systems, living within biofilms in retention basins, plumbing, and other irrigation system components. Routine maintenance (cleaning and sanitizing) of these systems where applicable can positively benefit stopping the spread of this pathogen. Although originally slated for year-1 of the project, water baiting techniques will be implemented in year-2 and will act as a

continuing outreach tool as well as a deliverable diagnostic test that can be deployed by growers. The water baiting techniques refers to using 'baits' such as newly germinated lupine seedlings, pears, and rhododendron leaves to draw aquatic Phytophthora zoospores into causing symptoms, thus giving indication of the presence of Phytophthora in irrigation water sources. This tool will also aid in our ability to adequately understand which Phytophthora species are present versus which species are actively limiting conifer and nursery production in NJ. These water-collected species will be evaluated against the soil-collected Phytophthora species and their identity sought if morphologically different, via the previously described genetic regions.

Varieties: Most conifers and plants for that matter, are susceptible to one or more species of Phytophthora. That said, plant species and variety selection can greatly influence whether growers have marketable products in their respective seasons. Some commercially important conifers are known to be extremely susceptible to Phytophthora, such as Douglas fir (*Pseudotsuga menziesii*) and many of the true firs / *Abies spp*.: Noble (*Abies procera*), Fraser (*Abies fraseri*), and White (*Abies concolor*). Whereas others are thought to be more tolerant, such as Nordmann (*Abies nordmanniana*), Turkish (*Abies bornmuelleriana*), and Trojan (*Abies nordmanniana* subsp. *equi-trojani*). Spruces (*Picea spp.*) are thought to be more tolerant than many firs, yet through our sampling efforts Phytophthora was identified in the two most common spruce varieties; Blue (*Picea pungens*) and Norway (*Picea abies*). Pines, like all conifers, can be susceptible to Phytophthora, however in multiple instances this year we observed Scotch pines (*Pinus sylvestris*) growing within areas surrounded by dead or dying firs and spruces. Furthermore, we observed Phytophthora from both the highly susceptible and more tolerant conifer groups, thus begging to question which Phytophthora species are really causing these diseases and are there management options we could better utilize to safeguard this crop's marketability. It should be noted that the best defense we have regardless of conifer species is to obtain quality seedlings from trusted sources, that have been sufficiently quarantined in seed beds prior to planting out into the plantation. In 2022 we will be growing a large selection of commercially available confers including multiple *Pinus spp. (including Scotch),* many *Abies spp.* (considered very susceptible through tolerant, plus Douglas fir), and some of the economically important *Picea spp.* We will be evaluating these varieties with Phytophthora isolate combinations introduced at varying developmental stages such as dormancy, prior to planting, incorporation with media, etc. These variety and Phytophthora combinations will also be evaluated with established and experimental biological and conventional chemistry treatments to better hone or initiate disease recommendations relevant to our specific needs in NJ and regionally. In-vitro 96-well fungicide screening attempts will be made utilizing Phytophthora zoospores and combinations of materials plus stimulatory root signals in order to better inform field trials, a system that has only very recently been utilized to any real degree. Pre-planting treatments of fungicides or otherwise protective materials will also be conducted.

Material selection: Before beginning this section, the best way to manage Phytophthora is to obtain and plant only clean and robust seedlings from reputable sources, manage over-irrigation and promote drainage, understand which varieties grow

best at any given location, and deploy a balanced IPM approach as other stressors and pests often give Phytophthora an opportunity to take hold. If the Christmas trees in any given area appear as though they are beginning to succumb to Phytophthora and can be sold that year as CUT trees, only at a smaller size and price, this is a much better scenario than taking an outright loss. It should also be noted that fungicides must be *suitable for Oomycetes* and that they do NOT cure infected plants of Phytophthora infections, however they may be able to safeguard the plant from primary infections or reduce the symptom expression to market-acceptable levels. Materials most historically used for Phytophthora include mefenoxam (FRAC Group 4), mono- and di- potassium salts of phosphorous acid (P07), and etridiazole (14). It is important to check all labels prior to use as they provide detailed use pattern instructions, however many cite early spring, bud break and/or fall applications (with rouging plants in the fall if treatment results were inadequate). However, there have been cases of localized resistance / diminishing control to/by these products if the materials were not regularly rotated between the modes of action grouped by the Fungicide Resistance Action Committee (FRAC). Some of the other chemical treatment options available are cyazofamid (21), oxathiapiprolin (U15), fenamidone (11), and dimethomorph (40) *(chemical classes listed do not imply endorsement).* As with all plant diseases, adjusting the cultural practices known to exacerbate pathogen development in combination with a well-rounded chemical or biological rotation is key to preventing new infections and stabilizing losses caused by current infections. Additionally, there is mounting evidence that biological controls have a real place in the tool kit for managing Phytophthora diseases and often deploy strains of *Bacillus subtilis* and *Streptomyces griseoviridis.* In our SCBG field trials we will be examining how chemical and biological controls may be best used to guard against and delay Phytophthora symptoms.

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Blueberry

A MULTI-STAGE APPROACH TO MANAGE PLUM CURCULIO

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Plum curculio, *Conotrachelus nenuphar*, is a major pest of highbush blueberries in New Jersey where the standard management practice involves application of insecticides post-bloom. This approach relies on targeting mainly the adult stage. Alternatively, entomopathogenic (= insect-killing) nematodes (EPNs) can be used to target plum curculio larvae and pupae in the soil. The development of management programs that impact multiple life stages, such as using EPNs against the larvae and pupae in combination with insecticide applications to control the adults, is expected to decrease plum curculio population pressure.

Over the past decade, research in apples and peaches has characterized the efficacy of various EPN species on plum curculio larvae in both laboratory and field studies; however, no studies have been done on their efficacy in highbush blueberries. When application timing is in accordance with pest phenology and environmental conditions, EPNs can be very effective at controlling plum curculio by killing larvae that have emerged from fruit and dropped to the soil. For example, the EPN *Steinernema riobrave* caused 78-97% control in peach orchards, showing great promise as a management tool for plum curculio (Shapiro-Ilan, D.I., Mizell III, R.F., Cottrell, T.E., and Horton, D.L. 2004. Measuring field efficacy of *Steinernema feltiae* and *Steinernema riobrave* for suppression of plum curculio, *Conotrachelus nenuphar*, larvae, Biological Control 30: 496-503). Thus, it is important to test the efficacy of *S. riobrave*, and other EPNs, against plum curculio larvae under the conditions common to blueberry soils (i.e., acidic soils).

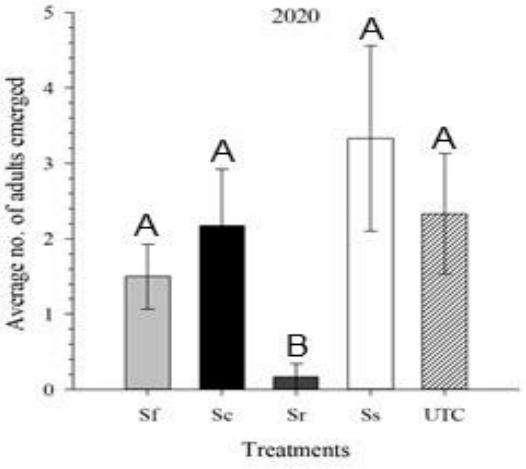
Field Experiments

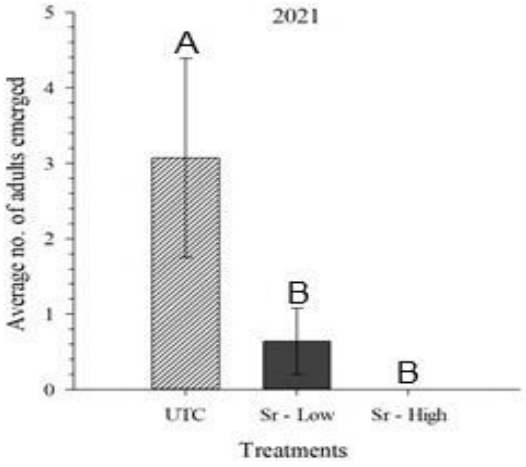
Two experiments were conducted in unsprayed blueberry fields at the Rutgers P.E. Marucci Center (Chatsworth, NJ).

Experiment 1: In 2020, the efficacy of four EPNs (*Steinernema feltiae*, *S. carpocapsae*, *S. scarabaei*, and *S. riobrave*) was evaluated and compared to an untreated (water) control. Blueberry fruits were exposed to plum curculio adults for oviposition during mid- to late May, and 100 infested fruit were placed under each of 25 emergence cages (1 x 1 ft) (5 cages per treatment). Cages were placed between two adjacent bushes within a row in the blueberry field. EPNs were applied at a rate of 50 infective juveniles (IJs) per cm^2. After treatment application, the edges of the cages were buried in the soil to ensure any emerged adults would not escape. Cages were inspected twice weekly for 3 weeks

and the numbers of plum curculio adults that emerged inside the cages were compared among treatments.

Experiment 2: Based on our findings in 2020, we selected *S. riobrave* as the only EPN species for the 2021 field experiment. The experiment was conducted in two blueberry fields. The methodology used in 2021 was similar to that used in the 2020 experiment but had some modifications. In 2021, plum curculio larvae rather than infested berries as in 2020 were used to infest the plots. Treatments consisted of 0, 25, and 50 *S. riobrave* IJs/cm^2 with seven replicates per treatment in each field. Treatments were applied on 8 June 2021 in field 1 and on 16 June 2021 in field 2.





Results

In the 2020 experiment, *S. riobrave* provided higher levels of plum curculio suppression than *S. carpocapsae*, *S. feltiae* and *S. scarabaei*. There was no difference in plum curculio adult emergence among *S. carpocapsae*, *S. feltiae*, and *S. scarabaei* treatments and the untreated control (Figure 1).

In the 2021 experiment comparing *S. riobrave* rates, significantly more plum curculio adults emerged in the untreated control than at both *S. riobrave* rates. The low and high rates provided 80% and 100% control, respectively (Figure 1).

Conclusions

Our study demonstrates the superiority and great potential of the EPN *S. riobrave* for plum curculio management in highbush blueberries. Future research should examine optimal timing of EPN application and combination with other management tools to develop and implement a multi-stage integrated pest management program for plum curculio in highbush blueberries.

Figure 1. Number (mean ± SE) of adult plum curculio emerged from field plots following applications of the entomopathogenic nematodes *Steinernema feltiae* (Sf), *S. carpocapsae* (Sc), *S. riobrave* (Sr), and *S. scarabaei* (Ss) in 2020 and following applications of a high and low rate of *S. riobrave* in 2021. UTC = untreated control. Bars with the same letters are not statistically different ($P < 0.05$).

WHAT WE KNOW ABOUT HONEY BEE HEALTH DURING BLUEBERRY POLLINATION

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Honey Bee Background

The honey bee can be thought of as a “super organism” or colony which is divided into 3 castes: The single queen, the workers (all female) and the drones (males). Workers are divided into the young hive bees (up to 21 days old) that clean cells, keep the brood warm, feed the larvae (brood), produce wax, build the combs, and guard the hive entrance. The older workers (21-45 days old) are the foragers which locate and bring back nectar and pollen. Queens are produced in multiple queen cells in the hive, but only 1 queen will survive to service the colony, and takes 16 days to fully develop. Workers take 21 days to develop from egg to adult, while drones take 24 days to develop.

Honey bees are the most widely used pollination insects in the blueberry industry. They are easily managed, and with communication between the blueberry grower and the beekeeper, colonies can be placed in the fields at optimal timing during the start of blueberry bloom. The conventional wisdom is to place honey bee colonies in a blooming field when 10-20% of the flowers are open. This provides and abundant nectar and pollen source for the newly arrived bees which is thought to discourage the bees from foraging on alternative plants, and to stay in the blueberries. However, blueberry flowers are more likely to set large fruit if they are pollinated within 2-3 days of opening. After this time successful pollination becomes less likely. Depending on the weather and how fast the flowers open, this points to getting bees in the field at closer to 10% bloom. The total northern highbush blueberry pollination period usually lasts between 3 to 4 weeks, depending on the weather and temperature, and the varieties being produced. Therefore it is important to realize that the honey bee colony is trying to produce the equivalent of one entire generation during the pollination period, and expanding its growth at a critical time in the spring. A serious setback during this time can affect colony growth for the entire season.

Blueberry Pests Near and During Bloom

While the bloom is open, blueberry bushes are susceptible to several diseases. These include mummy berry, botrytis fruit rot and anthracnose. Management for mummy berry is usually first focused on the primary phase of the disease shortly before bloom, and botrytis is highly weather dependent, being more common during periods of cool wet weather during the bloom stage. However, anthracnose disease, also known as ripe rot

is more likely to infect the developing berries during bloom and fruit set. Overwintering spores on bud scales germinate on newly set (freshly pollinated) fruit. Depending on the variety, bud scales will drop at varying rates during bloom, and a variety like Bluecrop, which holds onto the scales and are slow to drop, is a more susceptible variety to the disease than Duke, which drops its bud scales earlier. This means that the bloom period is a critical time to control anthracnose.

Insect management during this time is largely focused on cranberry weevil about 1 week pre-bloom. During bloom there may be a need to manage gypsy moth, eastern tent caterpillar, spanworms, obliquebanded and redbanded leafroller larvae, as well as cherry fruitworm if numerous. If needed, gypsy moth and tent caterpillar control is usually only required near wooded areas when the larvae 'blow in' from the surrounding trees. Management is required for plum curculio and cranberry fruitworm if present, immediately after bloom as soon as the bees are removed from the fields.

Given a common pest management picture, both insecticides and fungicides are often used prebloom, followed by 2 to 4 fungicide applications during bloom, and both fungicide and insecticide applications shortly after bloom when the bees are removed.

Maximizing Honey Be Health During Bloom

Honey bee health can be thought of as minimizing the stress factors that the bees encounter. One of those stress factors is the exposure to pesticides. Given the current knowledge about toxicity of pesticides to bees, there are some easy rules to observe to avoid those detrimental effects. Most of this knowledge relates to insecticide toxicity, while new research is starting to also include the effects of fungicides on honey bees. Most insecticides that are used prebloom for weevils and other pests can be highly toxic to bees. These include all the pyrethroids (Asana, Brigade/Bifenture, Danitol, Hero, and Mustang) organophosphates (Imidan, Malathion, and Diazinon), carbamates (Carbaryl and Lannate), Indoxacarb (Avaunt), and most of the neonicotinoids (Actara, Imidacloprid, Platinum). Assail also has limited toxicity to foragers, but research is ongoing for its effect on brood development. In addition, some of the diamides (Exirel and Verdepryn) have been shown to be highly toxic to bees, and Altacor has been shown to be toxic when combined with certain other pesticides. All of these should be avoided during bloom and if used prebloom, then allow at least a 3 day buffer prior to bringing bees into the field. If insecticides need to be used during bloom for various Lepidopteran larvae or 'worms', then a B.t. product such as Dipel or Javelin will work on small worms. Therefor pest scouting is important to catch the presence of larvae in the younger, more susceptible stage. If the larvae are larger, then consider the insect growth regulators (IGRs) Confirm or Intrepid. However, recent research has implicated these IGR materials may have a negative effect on developing brood. The spinosyns (Entrust and Delegate) can also be used on larger larvae, and have shown low bee toxicity when dry, but moderate to high toxicity when wet. Therefor they should only be applied in the evening after foragers have returned to the hives. When insecticides are used shortly after bloom, honey bee colonies should have already been removed and transported at least 3 miles from the field. Removing bees from the field and placing the hives in a nearby holding yard still exposes the bees to insecticides, since some

foragers return to the blueberry field, or stop to feed on the extrafloral nectaries present at the base of blueberry leaves.

Recently, fungicide use is starting to get more attention. Recent and ongoing research is pointing to several sub-lethal effects, as well as combination and even some synergistic effects where some fungicides may contribute to honey bee mortality, especially with respect to brood development. Our work and others have shown that a few commonly used fungicides can contribute to larval/brood mortality when exposed at equivalent field rates. In addition, field observations and beekeeper reports have shown an increased queen loss, decreased brood production, and decreased food storage when bees are around intensive fungicide use. These observations have compared hives placed on farms where bees can encounter fresh fungicide sprays several times per week vs hives places on small, isolated farms where the bees may contact fungicide use only once every 10 – 14 days. Colony weights and survival have been better on the small, isolated farms. This seems to be improved when growers spray at night when foragers are not present, and the spray residue is dry in the morning by the time the foragers return.

Honey bee foragers readily collect blueberry nectar, but don't spend a lot of effort collecting the pollen. In fact there is some evidence that blueberry pollen alone is not a well balanced or nutritious food source. Honey bees are opportunistic, and pollen that is returned to the hive in blueberry fields is often a combination of pollen from various sources, including blueberries. Therefore the small farm with surrounding woodlands may also be providing a more nutritious diet as well as reduced pesticide exposure. While pesticides and an unbalanced diet can contribute to hive stress factors, other stress factors can include over-crowding and varroa mite load. If possible, beekeepers should be supplying as near a mite free hive as possible. Standard pollination recommendations have been to suggest 2+ hives per acre with each hive consisting of 8-10 frames of brood in all stages of development in a double deep box arrangement, often with a honey super on top. These hives are often migratory, and have recently arrived from Florida or California, already stressed from the trip. With an abundant food source a full hive can easily swarm into 2 smaller or weaker colonies. The weaker colony that remains in the box may now more negatively respond to pesticide and varroa stresses.

In summary:

1) Colonies should be placed in the field at close to 10% bloom.
2) At least a 3 day buffer should be allowed between the last prebloom insecticide and bloom or the arrival of honey bee colonies.
3) All bee toxic insecticides should be avoided during bloom, and pest scouting used to catch any young insect population that needs to be treated.
4) Hives should be removed immediately at the end of bloom and relocated at least 3 miles from the blueberry fields.
5) Make the first anthracnose fungicide application immediately before bringing bees in instead of just after they arrive.

6) Avoid the direct contact of fungicides and other freshly applied pesticides with foragers and hives by spraying in the evening after foragers have returned to the hive, and avoiding any over-spraying of the hives.
7) Do not mix pesticide types if possible. This decreases the likelihood of phytotoxic effects on the plant and can minimize the possibility toxic effect on the bees.

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ADVANCES IN BLUEBERRY 'OMICS

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The term 'omics (often used as a suffix) in biological research generally means 'the study of'. There are many fields of 'omics, but some basic examples are: 1) *genomics*- the branch of molecular biology concerned with the structure, function, evolution, and mapping of genomes (primarily the DNA of an organism), 2) *transcriptomics*- the study and function of the transcripts (primarily the RNA of an organism), 3) *proteomics*- the study and function of the proteins in an organism and 4) *metabolomics*- the study and function of the metabolites in an organism. Data collected from these 'omics are collectively being applied in modern plant breeding programs.

Researchers have made great strides in recent years in blueberry genomics and transcriptomics. This has, in large part, been due to advances in DNA sequencing technology. One bottleneck in the process of using these data for breeding purposes is collection and analyses of plant phenotypes. Phenomics is the study of phenotypes and phenotypes are basically the measurable physical and biochemical traits of an organism. Plant phenotypes include fruit size, fruit color, the amount of sugar in the fruit, leaf size and shape, yield, etc. Breeders have for decades collected phenotypic data, but the collection of these data tends to be laborious and time consuming. Application of modern technology is allowing more rapid collection of various types of phenotypic data.

The focus here is imaging and how imaging is being used for high-throughput phenomics. Imaging, using visible light, can be as simple as taking pictures with a standard camera. Cameras deployed on drones or ground-based machines can speed image capture. The next step is image analysis and this can be quite time consuming. Off-the shelf software packages are available that can measure simple traits (such as plant height or fruit size), but the measurement of more complex or less obvious traits can be facilitated using machine learning (ML). ML is the process of 'training' a computer system to recognize and measure the trait(s) of interest. For example, the system can be trained to detect certain nutrient deficiencies using subtle differences in plant color.

Imaging can be expanded beyond visible light. Imaging in the ultraviolet (UV) region can be used to non-destructively measure the levels of certain metabolites. Phenotyping using longer wavelengths [near-infrared (NIR) and infrared (IR)], often called hyperspectral imaging, is being used to measure a host of plant characteristics including nutrient and disease status.

We are applying hyperspectral imaging, coupled with ML, to phenotype blueberry plants in the field, greenhouse, and lab to measure traits rapidly and non-destructively. These phenomic data, coupled with genomic data, have great potential to speed up the breeding and selection process.

CULTIVATION METHODS FOR CONTAINER GROWN BLUEBERRIES

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Introduction

This presentation addresses recent innovations in above ground, high density, container production of highbush blueberry ("*Vaccinium corymbosum*"). We are seeking to document numerous aspects of plant growth related to a novel, containerized system and then assess economic feasibility and regional fit. Highbush blueberry production in the Northeast is plateauing in terms of total acreage and crop yield despite increasing consumer demand locally and globally. Current and future blueberry growers are stymied in expanding acreage.

Two key problems are a lack of suitable soils and reliance on traditional production methods. A good example is New Jersey where the total 8,000 acres of essential low pH, high organic matter farmlands are already used in blueberry production with little other farmland of this type available. Commercial highbush blueberry production requires unique and uncommon soil types known as spodisols; primarily in NJ. The soil substrate and amendments in standard blueberry ground are quite different from current container media used in greenhouses, nurseries and high tunnels. Blueberry requires unique soils with 4.0-5.3 pH, high organic matter and good drainage. By creating suitable soils in a 20 gallon container placed upon unsuitable soils, growers can diversify their operations into a new high-value, early season crop that draws consumers to the farm.

Agents and advisors have little information on containerized blueberry systems to recommend such a novel, untested method which prohibits promotion and limits adoption. Primarily, the industry requires an as yet undetermined media mixes appropriate and customized for key cultivars and climate zones.

Nursery crop and homeowner media made for pots, bags, and containers is quite expensive. Replicated, science-based trials are necessary to bridge this knowledge gap and gain confidence to begin any educational outreach program. In creating suitable soils in a 20 gallon container placed upon unsuitable soils, growers can diversify their traditional operations into a new high-value, early season crop that draws consumers to the farm; promising greater farm and farmer sustainability in terms of land use, lifestyle and profitability. This requirement is essential to ratcheting up overall interest, moving technology forward and outreaching results to leading edge producers and market drivers.

This economic and environmental sustainability is aimed at established commercial practices in the cultivation of container grown blueberries for small and moderate sized farms of the Northeast. An estimated 750+ additional acres could be grown profitably by current blueberry growers throughout the northeast as well as another 250+ new acres by established blueberry, vegetable, nursery and new farmers adopting this novel, containerized approach.

While I and our commercial farm team have some preliminary experience with new media blends and high-density containerized growing of blueberries in South Africa, New York rooftops, a small NJ farm and Rutgers Fruit Research Farm; side-by-side comparisons in replicated, science-based trials are necessary to bridge this knowledge gap and this presentation begins an educational outreach program.

Materials and Methods

Over the last 5+ years, four blueberry cultivars have been tested in above ground containers positioned in replicated blocks totaling 10 acres at Indigo Farms in Ocean County, NJ. NJ owned and operated by Tiffany Bohlin and farm Manager Brian Bohlin. The cultivars evaluated are Bluecrop, Duke, Top Shelf and Top Hat and 7 other lines of new cultivars. These plants are selected for grower appeal, consumer market, phenology and morphological differences. Any growth differences may indicate a variety better suited to a combination of media, container and growth zone.

This multi-treatment, multi- culture applied experiment is overlain on a previous mining operation with an infertile gravely, cool soil. Crop rows are 10 feet apart for ease of measurement, equipment travel and grower tours. The media selections are based on 2 consumer blends, a farmer method and experimental treatment. Each cultivar is tested at 3220 plants per acre. Plastic containers and container bags for blueberries and other smallfruit are used under shadecloth. Adapting such technology to northeastern conditions could prove promising to farm and farmer sustainability in terms of land use, lifestyle and profitability.

Results in Progress

Multi-year data will be provided on soil fertility, microbial activity, irrigation management, IPM, chlorophyll analysis, crop growth, yield and other factors. Production practices and farm site overview will be provided in a short narrated video.

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Small Fruit and Strawberry

RUTGERS NJAES STRAWBERRY DEVELOPMENT AND RELEASE PROGRAM UPDATE & TIPS FOR PRODUCTION AND MARKETING STRAWBERRIES

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Strawberries are an important early season crop for many New Jersey farmers. They are often one of the first pick-your-own crops offered on farms that focus on direct marketing to consumers. Based on our past surveys at NJAES, strawberries provide a significant source of early season profits for growers producing small fruit. Most June bearing varieties will produce one to two pounds of berries per plant depending on soils, nutrition and overall management of the crop. High quality fruit can often bring a premium price for direct market growers.

Many small fruit growers are producing strawberries on a high density plasticulture system with raised beds and drip irrigation. This allows for proper drainage and provides weed control and warming of soils in the early spring. Some strawberry growers will extend the annual production system into a second year before rotating into an alternative crop. In extending the season, mowing and thinning of crowns can be used for weed control and to invigorate the second year's crop. Proper removal of diseased plants and foliage can help to reduce problems in the second season. Crop yields typically decrease during the second year of production when using this system. This can be due to crown density, so thinning may be required.

The NJAES Strawberry Breeding program team has produced 'Rutgers Scarlet' and 'Rutgers D'Light' which will be available from a commercial plug producer in the Midwest in 2022 and beyond. This strawberry production nursery is expected to have limited release in 2022 and greater availability by 2023. Both of these varieties were developed for superior flavor as direct market strawberries and not intended for shipping. In review of our research at NJAES and together with scientists from nearby states, we have received encouraging feedback on the flavor of our strawberries and yields have been comparable to other commercial varieties that are grown in the northeast. Our focus throughout the program has been on flavor and fruit quality. Based on formal and informal taste tests, that goal appears to have been reached by the team.

In our 2021 strawberry research trial at the Rutgers Specialty Crop Research and Extension Center in Cream Ridge, NJ, our team recorded some of the highest yields to date. The fruit quality and post-harvest characteristics were notably high. The combination of soils, nutrition, proper irrigation and optimal environmental conditions resulted in an outstanding crop for 2021 June bearing strawberries. Marketable yield,

culls and brix data were collected during the trial. The harvest season was notably longer this past year. Strawberry plugs were planted the previous September at a density of 15,000 plants per acre. Plots were replicated four times regularly scheduled harvests encouraged continuous production.
Harvesting fruit early in the day in shallow containers and removing field heat as soon as possible was important to maintain fruit quality.

Some of the factors examined in the past five years include utilizing different colored plastics, modifying specific nutrients during the growth cycle and the use of row covers for winter protection.

Proper harvesting and storage of strawberries is paramount for retaining flavor and quality for consumers. Postharvest losses of strawberries and raspberries is estimated to be as high as 25% due to disease, dehydration, and over ripeness, all of which results in economic losses to farmers and consumer dissatisfaction. To solve this problem, Dr. Gianfagna and team at NJAES SEBS Rutgers demonstrated that when soft skinned fruits such as raspberries and strawberries are placed in clamshells fitted with sachets containing thyme oil (TO) encapsulated into cyclodextrin (CD), and then wrapped in modified atmosphere (MAP) bags, disease and water loss is reduced. In addition, measurements of fruit color indicated that the reduction in water loss preserved the bright red color of these fruits, which usually darken during cold storage.

At the end of the presentation, the conversation will be opened up for attendees to share their own strawberry production stories and provide feedback on future research needs at NJAES.

AN INTRODUCTION TO FLOWER MAPPING

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Current recommendations for fall nitrogen application and row cover management in annual strawberry plasticulture are based on tradition and calendar date. Decisions regarding both practices would be more appropriately based on the floral status of plants in production. Pre-plant N normally provided plasticulture strawberries is unnecessary: it does not improve yield. However, targeted weekly pulses of N after floral initiation begins in the fall significantly can enhance subsequent yield. Row covers applied to strawberries in the fall at the appropriate time increase yield the following spring by increasing the number of flowers per plant and protecting plants from excessive cold during dormancy. Many growers fertilize with N and apply row covers based on tradition and calendar date without knowing the floral status of your plants. Flower mapping is used to evaluate a plants floral status. While widely used in Europe, flower mapping has not been developed for US growers and data illustrating its usefulness for North American production has not been generated.

I'll supply you with the science behind this project during this talk and we'll follow it up with a flower mapping workshop to teach you how to do it. Flower mapping is not difficult and you can easily learn the technique and interpret the results to make science-based decisions regarding production practices rather than relying on tradition or calendar date. Flower mapping will be your new management tool and it might even reduce stress associated with these fertilizing and row cover management decisions.

We will supply you with a dissecting kit and teach you how to flower map. Space is limited and pre-registration was required. However, if you didn't pre-register, you may still attend the workshop and watch, we won't however, be able to provide you with a dissecting kit.

If you are interested in trying to flower map but can't attend this presentation, e-mail me at durner@sebs.rutgers.edu for more information.

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Empowering Northeastern Strawberry Growers with Flower Mapping

Gazing in the Crystal Ball – Future of NJ Agriculture II

NOTES

Specialty Crops

AMARANTH AND ROSELLE: NOVEL LEAFY GREENS FOR NEW JERSEY AGRICULTURE

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This past summer, two variety trials were conducted: each on the potential of amaranth (*Amaranthus spp.)* and roselle (*Hibiscus sabdariffa*) to be produced as leafy greens in New Jersey. The purpose of these variety trials was to identify which cultivars would have the greatest field performance and success in New Jersey agriculture. Specialty crop production dominates New Jersey agriculture due to the economic advantage of providing specialty crops to nearby international communities (Cappellano, 2009). The growth of these two minor crops, amaranth and roselle, could provide economic opportunities for farmers to provide products to cultural groups that are underrepresented across the state. Prior work on each of these crops as leafy greens stemmed from market surveys in the East Coast showing that each of these were preferred by several cultural groups as their foods of preference. Our prior research work in introducing these new crops for income generation and diversification of fresh produce for small-scale farmers in the US and internationally was successful and now we sought to explore introducing such models here in New Jersey (Byrnes et al. 2017; Dinssa et al 2020; Juliani et al, 2009; Mataa et al., 2020; Sanders et al., 2020; Simon et al, 2021; Zhen et al., 2016).

The first objective of each variety trial was to capture the botanical diversity present in germplasm around the world. We evaluated 97 lines of amaranth for genetic diversity and field performance in Central New Jersey. Seeds were from commercial sources, the USDA germplasm bank, and previous Rutgers selections for iron accumulation and African Diaspora consumer preferences. Seeds came from East and South Asia, Africa, Mexico, the United States, and the Caribbean. Leaves were vibrant yellows, greens, reds, and purples. Amaranth flowers also showed a diversity of colors and shapes, as most commercial lines are marketed as ornamentals. Quantitative characteristics

include plant height, ranging from 12-149 cm, and leaf area, ranging from 10-450 cm^2. The fresh weight of harvested amaranth stems and leaves ranged from 33 grams to 1.5 kilograms.

A similar variety trial was completed for roselle, capturing botanical descriptor information along with its field performance. We evaluated 42 different lines of roselle, six of which were Rutgers selections for consumer preference to leaves and calyx, the plant's fruit. The rest of the lines were collected from the USDA germplasm bank, which gathered seeds from across Southeast Asia, Africa, and Latin America. Differences in leaf size, shape and texture determined each lines likelihood as a leafy green. Red pigments were seen both in the calyx and leaves, which is due to the antioxidant anthocyanin. Plant height ranged from 25-80 cm. Leaf area ranged from 30-150 cm^2 and plant fresh weight ranged from 1.5-5 kg.

The second objective was to evaluate market interest in the two crops. Buyers and growers from New Jersey came to the field and placed flags on plants of interest. This allowed us to go from 97 lines of amaranth to 25 that were of interest in the consumer market. The same was done with roselle, identifying 10 plants out of the 42 that were of interest to be further investigated. Plants were evaluated based on appearance, taste, and cultural preferences. It was important to bring in growers that represented the different cultural groups that prefer these as leafy greens. This will allow us to continue with more centered variety trials in the future, focusing on nutritional value of favored lines for each plant.

Seedlings of the 97 varieties of amaranth and the 42 varieties of roselle were sown on May 13, 2021 and kept in a mist chamber until seedlings emerged. Germination times varied from three to fifteen days in amaranth and were consistent at around five days for roselle. Seedlings were then left to mature in the greenhouse for one month before transplanting. Seedlings were taken outside to harden 3 days before transplanting. Roselle was transplanted on June 16, 2021, and amaranth on June 28, 2021. Both crops were planted at Rutgers Horticultural Farm III in raised beds with drip irrigation. Each variety trial was set up as a randomized complete block design, with three blocks containing a random order of plots with 10 plants of each cultivar per plot. The soil used for amaranth is defined by the U.S. National Cooperative Soil Survey as Nixon series. This is characterized by fine-loamy, mixed, semiactive, mesic type Hapludults ("Official Series Description - NIXON Series," 2021). The hibiscus was planted in Sassafras series soil, defined by the U.S. National Cooperative Soil Survey as fine-loamy, siliceous, semiactive, mesic-type Hapludults ("Official Series Description - SASSAFRAS Series," 2013). Pesticide was sprayed once on amaranth, 3 weeks after transplanting. No pesticide was sprayed on roselle.

Yield measurements of amaranth were taken 5-6 weeks after transplanting, ending in a harvest of the whole plant 10 nodes above the ground. Three plants per plot were harvested and weighed, then plants were dried for two weeks, and the dry weight was taken. Other yield measurements included plant height, stem base diameter, leaf length and width, petiole length, and number of nodes.

Yield measurements were taken for roselle in mid-August, 8-10 weeks after transplanting. Roselle plants were harvested 10 nodes above the base and dried for 2 weeks. Fresh and dry weight were taken. Stem diameter, plant height, and leaf area were also taken. Qualitative traits like leaf color, stem hairiness, and leaf shape were all assessed with the aim to create a botanical descriptor guide for the USDA germplasm that other researchers can use when exploring horticultural uses of these crops.

Given the success of the variety trials on amaranth and roselle this past summer, a replication of each one focusing on yield-related traits will allow for multiple paper submissions relating to the introduction of each crop to New Jersey agriculture. Variety trials in the future will be done at different sites in New Jersey, representing the conditions of the northern part of the state at Rutgers Snyder Farm in Pittstown, NJ and in the south at Rutgers Agricultural Research and Extension Center in Bridgeton, NJ. These variety trials will focus on similar traits, including stem diameter, leaf area, plant height, fresh and dry weight. Nutrition will also be a large component of the study, evaluating each line for minerals like iron and potassium, and other health benefits like antioxidants and vitamin A (Mataa et al., 2020; Sanders et al., 2020; Zhen et al., 2016; Villani et al., 2013). Consumer interest in the health benefits of leafy greens is rising, so an understanding of the nutritional benefits of the crops will expand consumer interest to those that are not culturally familiar with these leafy greens (Cappellano, 2009).

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BREEDING, GROWING AND MARKETING RUTGERS HABANERO PEPPERS

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Rutgers Pumpkin' Habanero Plant in the field (left) and harvested fruit of the 'Rutgers Pumpkin Habanero and the 'Rutgers Rosebell Red' Habanero (right).

Fresh and hot sauce market opportunities for habanero peppers have grown in New Jersey as demand by ethnic nationalities from Africa, the Americas, Asia, and the Caribbean continues to increase in the state and surrounding states in the Mid-Atlantic. New Jersey is the third most ethnically diverse state in the United States after California and New York; and the most rapidly growing ethnic groups are the Hispanic/Latino and Asian groups, two major consumers of habanero peppers. Middlesex County has the highest ethnic growth in New Jersey. With these demographic dynamics, fresh and hot sauce markets for habanero peppers present commercial opportunities for our growers, produce marketers and consumers in New Jersey and the Mid-Atlantic. Since 2009, the Exotic Pepper Project team at Rutgers/ NJAES has conducted intensive research in southern, central and northern New Jersey to develop habanero peppers that are well adapted to NJ growing conditions. From this initiative two unique habanero pepper varieties have been developed that fit expanding community demands for habanero peppers for the fresh and hot sauce markets. One of the varieties, 'Rutgers Pumpkin Habanero', was released to the public in 2017. The other variety, 'Rutgers Rosebell Red' was completed in 2020 and a Plant Variety Protection (PVP) application was submitted and awarded (Ayeni et al. 2021). The 'Rutgers Pumpkin Habanero' and 'Rutgers Rosebell Red' are hybrids of an African and a Latin American *Capsicum chinense* that were collected in ethnic markets in Northern and Central New Jersey and first evaluated during the summer 2010. The 'Rutgers Pumpkin Habanero' yields mild fruits with <50K Scoville Heat Units (SHU). The low heat level and distinct flavor make the pepper very attractive to populations with low heat threshold. In contrast our new

‘Rutgers Rosebell Red’ with fruit heat levels between180-200K SHU makes these fruits of greater interest to the processing and hot sauce industry. Our research work in the past decade has shown that New Jersey’s agroecosystems support the production of these, and other unique habanero peppers These two varieties needed to go through another grow-out season to ensure fruit uniformity and to produce sufficient plant breeders seed and foundation seed stock. Local production could create commercial opportunities for NJVGs, add economic value to the efforts of our growers and marketers; and meet the expanding demands of our increasingly diverse community for habanero peppers for both the fresh market and the rapidly growing hot sauce industry.

In this study, our specific objectives were to promote Rutgers-developed Habanero peppers --- Rutgers Pumpkin Habanero and the Rutgers Rosebell Red to the fresh and hot sauce markets as value-added products.

Materials/Methods: The Rutgers habanero varieties, Rosebell Red, and Pumpkin Habanero were first sown in the Rutgers greenhouses and then transplanted on June 16, 2021, into the field at Rutgers Horticultural Farm III, East Brunswick, New Jersey. Raised soil beds were prepared with drip irrigation tape and covered with black plastic mulch to retain moisture. A mechanical transplanter was used to transplant both varieties. Five rows of Pumpkin Habanero were planted, each plant spaced 24 inches apart in a single row. Two rows of Rosebell Red were planted in a similar fashion, spaced 24 inches apart as a single row. One row of Rosebells were planted in a double staggered row, 24 inches apart. A total of ten randomly selected plants of each variety were marked within the field using spray paint and flags, which would be later used to collect yield data. Each plant was assigned a code and number; RRR (Rosebell) 1 through 10, and RPH (pumpkin) 1 through 10. Fields were kept separate from each other to avoid any cross pollination.

Fruit from both varieties were harvested in mid-September by hand. Produce bins were cleaned by scrubbing with soapy water, and later sanitized with a 10% bleach solution and rinsed with water. These peppers were taken to local farmers markets and given to various local hot sauce producers for market analysis and consumer feedback. Continual harvests occurred bi-weekly, for use of market research.

In mid-October, the plants designated by flags and spray paint were harvested by hand for yield data. Ten plants of Pumpkin Habanero, and 10 of Rosebell Red were harvested. All fully ripe fruit were carefully picked and separated by individual plant. Any rotting fruit, or fruit that had not ripened were left on the plants, and not counted toward the marketable yield.

Results: The yields of the Pumpkin Habaneros and the Rosebell Red were 4.16 lbs. fruit/plant at a average weight of 0.04 lbs./fruit; and 3.77 lbs. fruit/plant with an average fruit weight of 0.03 lbs./fruit, respectively. Fruit shape variability of both varieties was higher than expected. Whole plants were selected for their fruit quality, preferred shape, and overall plant health, and cut to be dried. The plants and fruit were allowed to sun dry in a heated plastic greenhouse for several weeks, Seed is being collected for the

next generation of plants. While selecting the most preferable plants for seed harvest, several off-types were identified, separated, and collected for seed harvest as well. Off-types were selected based on unique shapes, and different coloration.

For pepper seed collection, flat seeding trays were sanitized with 10% bleach solution, rinsed with water, and allowed to dry before processing the peppers. Layers of paper towels were laid in the trays to absorb any excess moisture once seeds are separated. Nitrile gloves were worn while processing peppers to protect from the volatile oils. A knife was used to cut peppers in half, and separate seeds from the fruit. Excess placental tissue was removed, and seeds were laid on paper towels to dry. Rosebell Red and Pumpkin Habaneros, as well as off-types were separated prior to drying and seed collection. Use of a room with no moving air was an important factor to ensure seeds of different varieties do not mix.

As part of the outreach and science in action storytelling, a production field trial video was produced to share with growers. In addition, several field tours with commercial seed companies and growers were held to generate interest by the industry.

A survey sheet was also constructed to assess commercial interest in Rutgers habanero cultivars from various groups and levels. The main categories evaluated in 81 total surveys of fruit quality were color, skin texture, shape, size and marketability as well as general comments related to at tasting, culinary processes and consumption. A 0-5 rating scale was used with 5 being the best. Key group participants were supermarket managers (2x), farm markets (6x), farmers at auction (13x), hot sauce producers (4x), and habanero consumers (18x) – a current total survey response of 81x.

Current market results achieved in 2021 include:

- Two supermarket managers' average rating for both Rutgers cultivar were 5 in all categories except Marketability as a 4. Their 7 shoppers rated Rosebell Red averaging 4.9 in all categories better than Pumpkin Habanero averaging 4.6.
- Six farm market managers/vendors/shoppers – The Farm Market Manager at Specca Farms in Southern NJ rated both pepper cultivars as all 5s in each category while their 11 consumers were mixed in all evaluations of both peppers ranging from 3 to 5. At Rick's Farm Market and Joe's Farm market in central NJ, both managers rated both pepper cultivars as 5s while their 9 consumers were also mixed with mostly 4-5s and some 3s. The preference was for the 'Rutgers Rose Belle Red and main factors are marketability, size and shape. At two New Brunswick Community Farm Markets and Rutgers Cook Farm Market in Northern NJ, 12 vendors/consumers rated both cultivars highly at 4.2 - 4.8 in all categories with Rosebell being preferred.
- 13 full-time farmers selling/distributing at their auction center in Hightstown, NJ rated both cultivars 4 to 5 in all categories with an occasional 3. Marketability was a bit lower, and Rosebell Red was slightly preferred.
- Two restaurant chefs each rated both cultivars similarly as 5 in all categories except for marketability rated lower as 3-4. Pumpkin Habanero was deemed sweet and bland while Rosebell Red was spicy and similar to typical habaneros

used. Also, a local brewery made pumpkin habanero ale which was a seasonal hit during Halloween and Thanksgiving.

- Four small hot sauce producers were encouraging in their comments and ratings of 4-5. They preferred Rosebell Red for its higher capsaicin content/color and liked Pumpkin Habanero for its unique color and taste profile.
- 18 general consumers of Spanish, Indian, European and American backgrounds rated both cultivars favorably – 3-5 ratings averaging 4.1 over all categories with a slight preference for Rosebell Red for its color, size and shape.

These 81 preliminary positive responses from this marketing survey indicate that there is market interest for these new specialty varieties in a competitive hot pepper market. Vegetable growers became more aware of these new Rutgers habanero pepper varieties and potential markets by the field days, farm tours and market studies in New Jersey and the Mid-Atlantic. Hot sauce companies were introduced to these peppers as sources of their ingredients. These market introductions and visits by seed companies and growers to Hort Farm III to see the fruits in the field assisted in the development of connections with the marketplace to develop partnerships with seed companies' production and distribution of these new peppers. These lines are being evaluated by seed industry. Sufficient seed of each new variety was collected as a plant breeder's stock seed from which foundation stock could next be produced. Yet, another season of selfing is needed to ensure highest quality seed is needed. Seed of the sister lines are also being collected for grow-out. 'Rutgers Pumpkin Habanero' and Rutgers Rosebell Red' seed have also been made available to New Jersey vegetable growers upon request to ensure they have access to these new peppers.

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HEMP CROP MANAGEMENT FOR CBD-FLOWER PRODUCTION

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The NJ Department of Agriculture received approval to launch the industrial hemp program in December 2019, effectively starting production during the 2020 season. By legal definition, industrial hemp includes the production and processing of non-psychoactive cultivars of *Cannabis sativa* L., with a total delta-9 tetrahydrocannabinol (THC) concentration of not more than 0.3 percent on a dry weight basis (Johnson, 2019; Small, 2016). While hemp can be grown to produce fiber, grain and/or flowers, most of the hemp grown in NJ during 2020 and 2021 has been only for the later, namely production of flowers rich in cannabidiol (CBD), meant for processing (extraction) and smokable buds markets. Next are some highlights and observations made during 2020-2021 on the experimental field hemp plots grown at the Rutgers Agricultural Research & Extension Center (RAREC) in Bridgeton, NJ.

Field-grown hemp research

Several floral hemp (for cannabidiol, CBD and cannabigerol, CBG) cultivars were field-grown under plasticulture (6 ft. x 6 ft. spacing) and differentially irrigated (Figure 1). Rows of plants from several clonal cultivars (vegetatively–propagated: 'Cherry Wine', 'BaOx', 'Mango Mountain' and 'TrumpT1') and seedlings of others ('CBGenius', 'Triple Sour', 'Grape Juice' and 'Bay Mist') were subjected to either "wet" or "dry" irrigation treatments, tracked with soil tensiometers (at target soil tensions of 10-40 kPa and 40-70 kPa, respectively). All plants were fertigated with a complete water soluble fertilizer (15-5-15 Cal-Mag) providing a total (seasonal) nitrogen application of 95 to 120 lbs./acre. These crops were grown 15 weeks (mid-June to end of Sep.) for both years.

Figure 1. Overview of plasticulture plot of industrial hemp cultivars evaluated at RAREC. These cultivars were exposed to differential irrigation treatments ('wet' vs 'dry') managed through the use of soil tensiometers and reference evapotranspiration (from weather data).

A major observation made for both seasons mostly on the vegetatively–propagated cultivars was that a significant loss, as high as 20%, of plants to tip-over (i.e. lodging) and breakage of main branches with windy, gusty weather. This was more pronounced with the mini-tornado (89 mph winds for ~15 minutes) passing through the RAREC farms on August 7, 2020 (Figure 2). An inspection of the roots from clonal cultivars pointed out to a significant incidence of root-bound and root-circling conditions in the original small potted transplants (Figure 2), and which unfortunately were carried over to the field. This observation highlights the importance of carefully and, even destructively, inspecting the conditions of (already expensive) transplant roots at the time of purchase, to ensure the development of a good, strong, well-branched root system in the field.

Figure 2. Significant plant losses of hemp plants to lodging and breakage of stems and main branches under windy weather were observed mostly on vegetatively-propagated cultivars. Inspection of their roots, as well as on leftover transplants pointed a significant incidence of root-bound and root-circling conditions from the original small pots, and which carried over to poor root development in the field.

During the 2020 season most clonal CBD cultivars produced dry weight flower yields (trimmed buds + extractable biomass) comparable or higher than the industry standard of 1,500 lbs./acre, with ‘Mango Mountain’ and ‘Cherry Wine’ averaging 2,200 lbs./acre, and ‘TrumpT1’ the lowest at 1,260 lbs./acre. The seedling ‘CBGenius’ cultivar had the lowest overall yields, at 890 lbs./acre. The “dry” irrigation treatment reduced flower yields in most cultivars, by 9 to 34% with respect to the “wet” treatment, except for ‘Mango’.

While we still do not have the final numbers on the dry weight flower yields for the 2021 season, fresh weight flower data points out that the seed-propagated cultivars ‘Triple Sour’, ‘Grape Juice’ and ‘Bay Mist’ had yields that were about 25% higher than in the clonal (rooted cuttings) ‘Mango Mountain’ and ‘Cherry Wine’ cultivars. However, the “dry” irrigation treatment reduced flower yields more significantly in the seedling cultivars, with average flower yield losses of 32% versus 15% in the clonal cultivars.

Regulatory (NJ Dept. Agriculture) and in-house (Rutgers University) cannabinoid analyses were performed several times close to harvest. For the sampling done in August until the first week of September THC concentrations were below the 0.3% legal limit. However, only a week or two later (mid-September) most cultivars exceeded this limit, with averages ranging from 0.31 to 0.86%, except for ‘Mango Mountain’ and ‘CBGenius’ in 2020, and ‘Bay Mist’ in 2021. The average CBD concentrations at harvest ranged from 9.0% to 15.7% in 2020, and 7.2% to 10.6% in 2020.

The CBD:THC ratios in harvested flower tissues of clonal cultivars averaged 20:1 across all CBD cultivars during the 2020 season, and 25:1 for ‘Cherry Wine’, ‘Grape Juice’ and ’Triple Sour’ in 2021, confirming similar results from the NY state hemp growing region. Conversely, the CBG+CBD to THC ratios in ‘CBGenius’ exceeded 70:1 in 2020, and the CBD:THC ratios of ‘Bay Mist’ in 2021 were 37:1. Noticeable was the observation that these last two cultivars had total THC levels that were, at harvest, under the regulatory limit of 0.3%.

A recent study done at Cornell University has reported that hemp genetics (Toth et al., 2021), rather than environmental conditions and stresses (Lambers et al., 2018, Small, 2016; Roth et al., 2018) determine the total THC content and CBD:THC ratios in hemp. The Cornell researchers grew three CBD hemp cultivars of different genetic make-up under plasticulture conditions similar to our studies at RAREC. The stresses they imposed on those plants included flooding, powdery mildew disease, physical wounding, and applications of herbicide (Round-up) applications and ethylene (using the plant growth regulator ethephon), plus a standard non-stressed control. They found that the amounts of CBD and THC went up proportionately in all three cultivars and across all treatments. At harvest they found that nearly every plant (except those treated with Roundup, which almost killed them) produced a nearly fixed ratio of CBD:THC, with high levels of CBD corresponding to high levels of THC, above the 0.3% maximum legal threshold. They concluded that their results prove that genetics, rather than environment, determine the THC content and CBD:THC ratios in hemp.

Altogether, these results suggest that cultivars with CBD:THC ratios approaching 30:1 or higher, including CBG cultivars, should be strongly considered by growers to reduce potential to exceed regulatory THC limits at harvest, and maximize CBD and CBG contents. Whereas many (*or most*) commercially available CBD hemp cultivars over the past few years have been selected, and likely crossbred with recreational *Cannabis* cultivars (Rosenthal, 2010; Small, 2016) to enhance their CBD content, they have also raised significantly the potential to override the production of THC over the legal limit. It is expected that hemp breeders and plant (clone, seedlings, seed) purveyors will be

adjusting their future catalogues to provide hemp selections and cultivars with high CBD:THC ratios (> 30:1) and/or THC concentration at harvest.

For the 2021 season we plan to evaluate hemp cultivars with significantly different sources (genetics), paying particular attention to those with cannabinoid certificates showing CBD:THC ratios higher than 30:1.

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Food Safety

BRIDGING THE GAPS: APPROACHES FOR TREATING WATER ON-FARM

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Irrigation water has been linked to possible sources of contamination in several multi-state outbreaks. Given this linkage, growers, buyers, and marketing groups of some high-risk commodities, such as leafy greens and berries, have reevaluated their management of agricultural water to limit possible crop contamination by treating production water. At the same time, we are seeing movement the newly released proposed changes Produce Safety Rule (PSR) agricultural water requirements. In the proposed PSR agricultural water requirements treatment of production water is still highlighted as a risk mitigation strategy that farms may elect to use.

While testing for indicator organisms has been a standard approach for growers following Good Agricultural Practices or other audit requirements for quite some time, routinely quantifying generic *E. coli* using the current metrics may not indicate when a food safety risk is present, such as elevated populations of Shiga-toxigenic *E. coli* or *Salmonella.* Therefore, many growers and marketing groups are beginning to seriously consider the benefits of treating agricultural water. For example, in 2019, the California and Arizona Leafy Greens Marketing Agreements (LGMA) Technical Committee voted to approve revised water metrics, including the treatment of any surface water that contacts the harvestable portion of the crop within 21 days of harvest. The potential trickle down of these actions across the produce industry cannot be overstated. If water treatment is to be a more common approach for ensuring the safety of agricultural water applied to crops in the field, it is imperative that growers, irrigators, and other relevant industry stakeholders (e.g. educators, regulators, suppliers) receive training on how to approach water treatment successfully.

Development of a successful preharvest water treatment strategy requires a delicate balance between sometimes competing demands from food safety objectives, crop sensitivities, environmental concerns, and farm economics (Figure 1). Without this training, it is unlikely that water treatments will be consistently and correctly applied to achieve the desired water quality and food safety objectives, with the potential for ecological and crop damage resulting from over treatment. Our overall goal is to equip all stakeholders involved in irrigation (growers, irrigators, allied industries) with the knowledge to successfully implement, verify, and document water treatment systems on their farms. We will cover different approaches to water treatment on-farm, highlight results our team has observed with water treatment regiments (Table 1) and discuss how farms may implement water treatment in the field with practical considerations.

Figure 1. Considerations for selecting an agricultural water treatment method

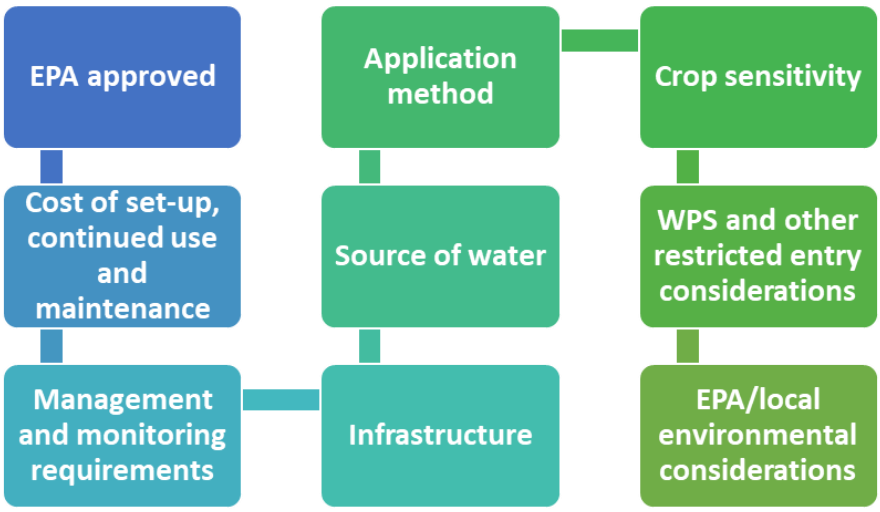

Table 1. Mean populations and standard deviation of coliforms (MPN/100 ml) for water samples collected at 0 (no treatment), and during treatment after the system had been operating for 5, 15, 30, 45 and 60 min (Krishnan et al., 2021)

	Treatment time (min)					
Treatments	**Untreated**	**5**	**15**	**30**	**45**	**60**
UV	1441·8 ± 802·1*,*^{Ab}	2·3 ± 4.0^{Ba}	1·3 ± 0·76^{Ba}	1·7 ± 2.5^{Ba}	1·4 ± 0.9^{Ba}	1·2 ± 0.6^{Ba}
Chlorine	1535·97 ± 799.6^{Ab}	1·9 ± 1.9^{Ba}	1·4 ± 0·88^{Ba}	1·9 ± 1.6^{Ba}	2·1 ± 2.3^{Ba}	1·7 ± 1.7^{Ba}
PAA	1796·01 ± 1070.4^{Ab}	7·2 ± 18.9^{Ba}	2·5 ± 3.4^{Ba}	1·3 ± 1.1^{Ba}	1·1 ± 0.5^{Ca}	2·3 ± 1.3^{BCa}
Chlorine + UV	1417·98 ± 825.5^{Ab}	0·9 ± 0.1^{Ba}	1·5 ± 1.6^{Ba}	1·3 ± 1.9^{Ba}	1·1 ± 0.5^{Ba}	0·9 ± 0.0^{Ba}
PAA + UV	1783·4 ± 1046.0^{Ab}	0·9 ± 0.2^{Ba}	1·6 ± 1.3^{Ba}	1·4 ± 1.0^{Ba}	1·4 ± 1.1^{Ba}	1·0 ± 1.4^{Ba}

Values followed by different uppercase letters indicate significant differences across rows. Values followed by different lowercase letters represent significant differences within a column.

* *n* = 16 replicates.

† Mean populations of coliforms expressed as MPN/100 ml from samples which had quantifiable populations above the limit of detection for the IDEXX Colilert/Quantitray 2000 assay. Samples which were below the limit of detection were assigned a value of 0·9 MPN/100 ml.

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WORKER TRAINING: MAKING PRODUCE SAFETY BEHAVIORS SECOND NATURE

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Trying to change a worker's behavior is hard. As a grower, you are asking workers to change from something they're comfortable with doing to something that is uncomfortable. You're not going to pay them any more to do it the uncomfortable way, and somebody else suffers the consequences if they go back to doing things the comfortable way.

Making these changes requires the right mindset and surroundings. People who study food safety call this mindset and surroundings "food safety culture". Food safety culture is the stuff we have, the things we do and the ideas we believe about food safety. A good food safety culture makes changing a worker's behavior easier. A bad food safety culture may make changing a worker's behavior impossible.

There are four tools suggested by Frank Yiannas, an expert in the field of food safety culture, that you can use to develop a good food safety culture. They are homophily, making a behavior the social norm, learning from the wrong way to do things, and commitment to consistency. When these tools are used, they can transform the food safety culture of a work crew for the better.

Homophily has to do with how similar the teacher and the student are. This similarity includes both physical similarity and behavioral similarity. We listen better and are more likely to use what we hear if the person who shares information with us dresses like us and speaks the same language. If they do the same things we do, that's important too. Farmers are more likely to listen to and make change from information presented by other farmers than non-farmers. This applies to harvest workers as well. Providing training from farm workers to farm workers will likely result in more change than if a person from off the farm delivers the training.

Social norms are very important. Lately, maybe we all have felt awkward about what to do when introducing ourselves to someone new, since some people are giving up the social norm of shaking hands. We all are hard wired to go with the herd to survive. We can use this tendency to our advantage when trying to change behaviors. If everyone is washing their hands, and I'm not in the habit of doing it, I might just wash my hands to fit in.

Learning from other peoples' mistakes is also a strong tool to use. By bringing up the consequences of poor produce safety behaviors, it can have a profound effect on the behaviors of the listeners.

Commitment to consistency has to do with people's tendency to follow through on larger investments once they have invested a little already. In other words, people will more often double down than cut their losses. If you get a worker to make a small investment in produce safety, they will likely be more willing to go bigger the next time. If you can get a supervisor to say one simple thing about produce safety at each morning meeting, they will be more willing to do a five-minute refresher once a month after a season of the daily reminders.

Once you are armed with these tools, it's time to put them to work. To change behaviors, you need to have a clear set of expected behaviors you want the farm workers to exhibit. Writing down that set of behaviors is a good thing, but not required. After you have a mental or written list, you need to observe the harvest workers to figure out how often they are actually doing the behaviors or which ones they need to be trained on. Again, writing this information down is a good thing, but if you can keep track of it in your head, that's fine too.

Once you know what the workers aren't doing or are doing poorly, design ways to teach them how to do better using the tools we talked about. After they've had a chance to work these behaviors into their routine. Observe the workers again and record, either on paper or mentally, how many times they do the right thing. This helps you figure out if you're doing the right things to influence behavior. Continue this process regularly and adjust your teaching to make sure you are teaching the right way and about the right stuff.

RISK BASED THINKING FOR AG FOOD SAFETY

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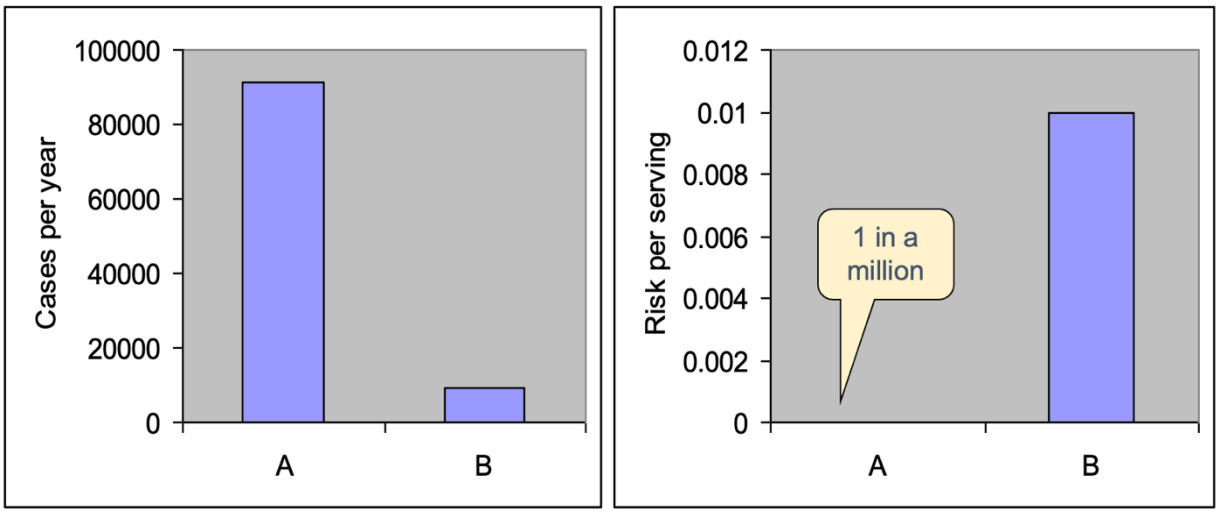
This talk will present an introduction to the science of microbial risk assessment. It will explain the difference between risk and hazard and will also explain the key differences between risk assessment and risk management. The second half of the talk will provide some different definitions of what we might mean by "high risk". The talk will conclude with a practical example of how we can use computer models for the growth of the foodborne pathogen *Listeria monocytogenes* to guide us in comparing different time temperature scenarios for storage of fresh produce.

A hazard is defined as a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect. Risk on the other hand, is a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food. Thinking about hazards leads to very black and white decision making. Either a hazard exists, or it does not exist. This is often not helpful because if we focus on preventing all occurrence of all hazards, under all circumstances, we will ultimately be unsuccessful. When we move to risk-based thinking, this can help set priorities and allocate resources, because we can focus on addressing the higher risks before moving onto lower risks. The one potential downside of risk-based thinking is that it is more complicated to think about risks versus hazards, and generally speaking we need use numerical, mathematical or statistical terms.

Risk Analysis is generally understood to have three components: risk assessment, communication, and risk management. This talk will only focus on the first one and the last one, although you can also view the entire talk has being an exercise in risk communication. Risk assessment tries to answer the questions, how big is the risk, and what factors control the risk. It is generally a scientific process, the people who carry out risk assessment are scientists, statisticians and mathematical modelers. Risk management deals with the much more practical question of what we can do about a given risk. Decisions about risk management often consider practical limitations, budgets, competing priorities and other non-scientific issues. Risk management may be informed by scientists and by the risk assessment process, but often those that are in charge of risk management are not scientists.

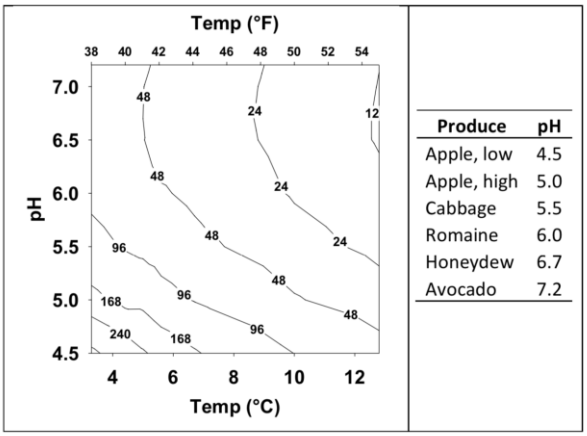
There are a variety of different ways of looking at risk, but for purposes of this talk we will consider two: Risk per serving vs. Risk per year. Let's imagine two foods. Food A is a very popular food that is consumed by many people but has a low risk of causing illness every time it's consumed. Food B is much less popular, most people don't

commonly eat this food, but it has a higher risk of causing illness every time is consumed. If we get very specific and we assign some numbers and probabilities, food A has a risk of 1 in a million per serving, and most people consume one serving per day on average. This means that 250 million people eat this food about 365 days per year. In contrast, food B has a risk of 1 in 100 per serving but is only consumed by a small fraction (0.0001%) of those people eating food A. The graph below compares Food A and Food B and answers the question "which is riskier". As is clear from the graph, which is riskier depends upon what we are comparing. The graph on the left illustrates the number of expected illnesses occurring in the population from Food A and Food B. In this case Food A is definitely riskier. The graph on the right shows the risk per serving, and here Food B is definitely much riskier. You can't even see the bar graph for Food A because it's only one in 1 million.



The next portion of the talk deals with predictive models for managing *Listeria* risk. This was part of a small project funded by the Center for Produce Safety seeking to answer the question under what conditions will *L. monocytogenes* increase and by how much? It also will help to identify which fresh produce items require time temperature control for safety, and what might be the appropriate time-temperature combinations for risk management. The project used microbial modeling techniques (not lab experiments) to determine the amount of time it takes to achieve a 1 log increase based on various temperatures. The project used the free software called ComBase to create the predictions.

The figure below shows the relationship between pH of the food (where some fresh produce examples are shown), and temperature of storage. The contour lines represent the number of hours needed before a one logarithm increase is predicted in the concentration of *Listeria*. Note that example assumes that the food in question has been chopped, cut, or otherwise damaged so that the organism has access to nutrients. The predictions tend to be quite fail safe, in other words they predict more risk than what would commonly be expected in the real world.



Produce	pH
Apple, low	4.5
Apple, high	5.0
Cabbage	5.5
Romaine	6.0
Honeydew	6.7
Avocado	7.2

The table below provides a different perspective on the same problem. The numbers are log increases. The pH was assumed to be 6 and real-world data on shelf life of Romaine lettuce (21 days at 38 °F or 17 days at 40°F) are used as the baseline predictions. From this baseline assumption we use 6.1 log increase as the starting point for comparison. This enables us to compare different time temperature conditions that have the same level of risk. They would also permit us to calculate risk for other time temperature conditions. This is of course a very simplistic scenario, but these models can also be applied to changing time temperature conditions and allow protections under those circumstances as well.

	Temp (°F)	38.0	40.0	41.0	42.0	44.0	45.0	50.0	55.0
	Temp (°C)	3.3	4.4	5.0	5.6	6.7	7.2	10.0	12.8
Time (d)	Time (h)								
0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	24	0.3	0.4	0.4	0.5	0.6	0.6	1.1	1.7
2	48	0.6	0.7	0.8	0.9	1.2	1.3	2.1	3.4
3	72	0.9	1.1	1.2	1.4	1.7	1.9	3.2	5.1
4	96	1.2	1.4	1.6	1.9	2.3	2.6	4.3	6.8
5	120	1.5	1.8	2.1	2.4	2.9	3.2	5.4	8.6
6	144	1.7	2.2	2.5	2.8	3.5	3.8	6.4	
7	168	2.0	2.5	2.9	3.3	4.1	4.5	7.5	
8	192	2.3	2.9	3.3	3.8	4.6	5.1	8.6	
9	216	2.6	3.2	3.7	4.2	5.2	5.8		
10	240	2.9	3.6	4.1	4.7	5.8	6.4		
11	264	3.2	4.0	4.5	5.2	6.4	7.0		
12	288	3.5	4.3	4.9	5.6	7.0	7.7		
13	312	3.8	4.7	5.3	6.1	7.5			
14	336	4.1	5.0	5.7	6.6	8.1			
15	360	4.4	5.4	6.2	7.1				
16	384	4.6	5.8	6.6	7.5				
17	408	4.9	6.1	7.0	8.0				
18	432	5.2	6.5	7.4					
19	456	5.5	6.8	7.8					
20	480	5.8	7.2						
21	504	6.1	7.6						
17 days	Green light	6.1							
21 days	Yellow light	7.6							

In summary, I hope that I have convinced you that risk-based thinking is more useful than hazard-based thinking. Using risk-based thinking can give focus and clarify priorities. Remember that risk assessment doesn't tell you what to do, but it can help risk managers make better (or at least more science and risk-based) decisions.

THIRD PARTY AUDIT AND FSMA UPDATE

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Third Party Audits are routinely performed on many farms and facilities in New Jersey. These audits are voluntary and are used to verify that fruits and vegetables are produced, packed, handled, and stored to minimize risks of microbial food safety hazards. Produce buyers often require growers to participate in Third Party Audit Programs to ensure that food safety standards have been met.

The New Jersey Department of Agriculture (NJDA) and our partners at Rutgers Cooperative Extension conduct USDA GAP/GHP and Harmonized Audit trainings. These trainings help new and current auditees stay up to date and meet training requirements of USDA audit standards.

NJDA Inspectors perform USDA Good Agricultural Practices (GAP) and Good Handling Practices (GHP), and Harmonized audits at produce farms, packing facilities, cold storages, and brokerage firms. Results from audits indicate that participants are doing very well meeting the USDA Audit Standards.

This presentation is an annual report of the most common inconsistencies observed during audits by NJDA Inspectors in 2021.

Integrated Pest Management

UPDATE ON CORN EARWORM CONTROL FOR CONVENTIONAL AND ORGANIC SWEET CORN SYSTEMS

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Corn earworm (CEW), *Helicoverpa zea*, is the primary pest that drives the majority of insecticide applications for sweet corn growers in the mid-Atlantic U.S. This noctuid moth pest feeds on many different crops but has a strong preference for depositing eggs on fresh sweet corn silks when available. Once eggs hatch; the tiny neonate larvae quickly make their way into the ear where they are protected against future insecticide sprays and most predators. Although some CEW pupae may survive the winters in the Mid-Atlantic emerging from cornfields in the late spring, a majority of the CEW pest pressure is driven by dispersing moths arriving from more southerly regions. As a result, greater CEW pest pressure occurs later in the summer and early fall.

Insecticide Evaluations

Because of their reliability and low cost, pyrethroid insecticides have been the tool of choice for corn earworm control for decades. Unfortunately, pyrethroids, which include bifenthrin, Warrior II and other formulations of lambda-cyhalothrin, Asana XL (esfenvalerate), permethrin, Tombstone (cyfluthrin), Baythroid XL (beta-cyfluthrin), Mustang Max (zeta cypermethrin), and Hero, which contains two pyrethroids zeta cypermethrin and bifenthrin are no longer providing effective control in some regions of the mid-Atlantic and southern U.S. because of resistance development in CEW populations. Based on recent testing of CEW larvae collected from five regions of Virginia, pyrethroid resistance is highly variable across farms and years. The concern has driven many growers to implement alternative mode of action insecticides into sweet corn rotations. In August 2021, we conducted an insecticide efficacy trial at the Virginia Tech ESAREC, Painter, VA, where pyrethroid resistance has been a problem. The experiment was arranged in a randomized complete block with four replications and 2-row by 20 ft plots. Insecticides were applied with a CO_2-powered backpack sprayer equipped with a single nozzle boom directed at the ear-zone. All sprays were initiated at first silking. Insecticide treatments included the following:

- Warrior II (lambda-cyhalothrin) – standard pyrethroid
- Lannate LV (methomyl) – older carbamate insecticide
- Harvanta (cyclaniliprole) – diamide insecticide
- Blackhawk (spinosad)
- Entrust (spinosad) – OMRI-certified formulation

- Radiant (spinetoram)
- Besiege (chlorantraniliprole + lambda-cyhalothrin) rotated with Warrior II
- Coragen (chlorantraniliprole) rotated with Warrior II
- Elevest* (chlorantraniliprole + bifenthrin) rotated with Warrior II

* Note that Elevest is a brand-new insecticide available to growers. It is comparable to Beseige in that is pairs the same diamide, chlorantranilprole, with a pyrethroid.

The most effective treatments that had the fewest numbers of CEW larvae in ears, the highest percentage of clean ears, and the lowest percentage of severely damaged ears (feeding injury > 2 inches beyond the tip) were the rotations of either Beseige, Coragen, or Elevest with Warrior II (Table 1).

Table 1. Summary of efficacy of common sweet corn insecticides for the control of lepidopteran larvae in sweet corn; Virginia Tech ESAREC, Painter, VA, August 2021. Six applications from 1st silking to harvest.

Treatment (spray application order)	Rate/Acre	# CEW larvae / 25 ears	% clean ears	% tip damaged ears only	% severely damaged ears
Untreated check		32.8 a	4.0 d	67.0 ab	29.0 a
Warrior II (abcdef)	1.28 fl oz	9.8 bcd	41.0 bc	45.0 bcd	14.0 b
Lannate LV (abcdef)	12 fl oz	26.5 a	7.0 d	87.0 a	6.0 bc
Harvanta (abcdef)	16.4 fl oz	8.8 bcd	57.0 ab	38.0 cd	5.0 bc
Blackhawk (abcdef)	2.2 oz	10.8 bc	37.0 bc	55.0 bc	8.0 bc
Entrust (abcdef)	2.4 fl oz	13.3 b	22.0 cd	69.0 ab	9.0 bc
Radiant (abcdef)	3 fl oz	3.8 d	75.0 a	21.0 d	4.0 bc
Besiege (abc) rotated with Warrior II (def)	6 fl oz 1.92 fl oz	4.5 cd	79.0 a	18.0 d	3.0 c
Coragen (abc) rotated with Warrior II (def)	3.5 fl oz 1.92 fl oz	3.3 d	74.0 a	21.0 d	5.0 bc
Elevest (ab) rotated with Warrior II (cdef)	5.6 fl oz 1.92 fl oz	5.0 cd	68.0 a	31.0 cd	1.0 c
P-value from Anova		<0.0001	<0.0001	<0.0001	0.0002

Also in August 2021, we conducted another insecticide efficacy trial in Painter, VA following the same protocol as described above. Treatments included Spear Lep, a novel spider venom-like peptide insecticide mixed with Leprotec (Bt kurstaki) and Vantacor, which is a more concentrated formulation of the diamide chlorantraniliprole, also found in the product Coragen. The trial also included rotations of different MOA insecticides such as Lannate LV and the insect growth regulator Rimon with pyrethroids.

Results (Table 2) indicated the following:

- The addition of three applications of Spear Lep + Leprotec to a rotation with 3 sprays of Beseige resulted in a little less CEW damage than the 3 sprays of

Beseige alone (Table 2). However, the addition of 3 sprays of Warrior II rotated with Beseige still provided the best control.

- Rotations of Lannate LV and Rimon with pyrethroids Bifenture 2EC + Lambda-cy (bc) can provide equal control as the standard Beseige with Warrior II rotations.
- Vantacor rotated with Warrior II also provides similar control as Beseige with Warrior II rotations.

Table 2. Summary of efficacy of insecticides for the control of lepidopteran larvae in sweet corn; Virginia Tech ESAREC, Painter, VA 2021

Treatment	Rate / acre	Mean no. corn earworm / 25 ears	% clean ears	% unmarketable ears	% tip damaged only ears
Untreated check		34.8 a	0.0 c	45.0 a	55.0 bcd
Besiege (bdf) only 3 sprays	7 fl. oz	12.3 b	19.0 bc	4.0 cd	77.0 ab
Spear Lep + Leprotec (aceg) rotated with Besiege (bdf)	16 fl. oz + 16 fl. oz fb 7 fl. oz	10.8 b	31.0 b	5.0 bcd	64.0 abc
Besiege (aceg) rotated with Warrior II (bdf)	7 fl. oz fb 1.92 fl. oz	7.0 b	64.0 a	3.0 cd	33.0 de
Lannate LV fb Bifenture 2EC + Lambda-cy (bc) fb Lannate LV + Rimon (d) fb Rimon (ef) fb Lannate LV (g)	24 fl oz fb 4.8 fl oz + 3.5 fl oz fb 24 fl oz + 12 fl oz fb 12 fl oz fb 24 fl oz	6.0 b	65.0 a	3.0 d	32.0 e
Lannate LV fb Rimon (bc) fb Lannate LV + Rimon (d) fb Bifenture 2EC plus Lambda-cy (ef) fb Lannate LV (g)	24 fl oz fb 12 fl oz fb 24 fl oz + 12 fl oz fb 4.8 fl oz + 3.5 fl oz fb 24 fl oz	29.3 b	1.0 c	16.0 b	83.0 a
Vantacor (soil applied)	2.5 fl oz	34.0 a	4.0 c	15.0 bc	81.0 a
Vantacor (abc) fb Warrior II (defg)	2.5 fl oz fb 1.92 fl oz	7.3 b	54.0 a	0.0 d	46.0 cde
P-value from Anova		<0.0001	<0.0001	<0.0001	0.0002

Evaluations of *Bt* sweet corn varieties

For the past four years, several entomologists in the mid-Atlantic and other locations in the U.S. have collaborated on a large multistate project evaluating the efficacy of *Bt* sweet corn varieties that contain different Bt proteins. We have detected complete resistance to certain Cry 1 proteins and shifts in susceptibility to other proteins (see Dively et al. 2020. Sweet Corn Sentinel Monitoring for Lepidopteran Field-Evolved Resistance to Bt Toxins. Journal of Economic Entomology 113(4): 1–13. doi: 10.1093/jee/toaa264).

In 2021, we again monitored the performance of Bt varieties at the Eastern Shore AREC in Painter, VA, the Tidewater AREC in Suffolk, VA working with Dr. Sally Taylor, Homefield Farm in Whitethorne, VA and the Virginia Cooperative Extension 4-H Center in Abingdon, VA working with Phil Blevins (VCE agent). Bt sweet corn seed for five varieties: Providence (non-Bt); BC0805 (Cry1Ab2); Obsession I (non-Bt); Obsession II (Cry1A.105 + Cry2Ab2); Remedy (Cry1Ab2 + Vip3A) was supplied by Galen Dively, University of Maryland, who maintains uniformity of sweet corn varietal evaluations across multiple locations in the U.S.

Results. As in recent years (Dively et al. 2020), we showed that the Bt proteins in the Cry1Ab2 or Cry1A.105 + Cry2Ab2 sweet corn varieties did not provide effective reduction in ear infestation by CEW (Table 3). Cry1Ab2 + Vip3A found in the variety Remedy provided excellent >99% control of CEW.

Table 3. Percentage of corn earworm damaged ears in small plot trials at four locations in Virginia in 2021.

Variety (Bt gene)	Painter, VA	Abingdon, VA	Whitethorne, VA	Suffolk, VA
Providence (non-Bt)	96	71	35	99
BC0805 (Cry1Ab2)	100	81	46	NA
Obsession I (non-Bt)	99	86	46	NA
Obsession II (Cry1A.105 + Cry2Ab2)	98	54	18	NA
Remedy (Cry1Ab2 + Vip3A)	2	0	0	0

Insect **control for organic sweet corn**

Organic sweet corn growers have fewer insecticide options and none that meet the control levels produced by the aforementioned synthetic insecticides. Products containing *Bacillus thuringiensis kurstaki* (such as Dipel) or *Bt aizawai* (such as Xentari or Agree) are terrific organic insecticides for many leaf-feeding lepidopteran pests, but unfortunately have not performed well at controlling CEW in sweet corn mostly due to the Bt resistance development in CEW populations. Popular organic insecticides like Pyganic, which contains natural pyrethrum, or azadirachtins, which are derived from the neem tree, also have not provided effective control against CEW in past trials. Most research has shown that the best organic insecticide for CEW control is Entrust (spinosad). However, sweet corn growers are only permitted to apply maybe 3 applications before the maximum load per crop is reached.

Over the past two years, we have tested another organic insecticide for CEW control, Heligen (AgBiTech) and Gemstar (Certis USA), which are commercial products that contain Helicoverpa nucleopolyhedrovirus (H-NPV) particles (called virions). The NPV virion is eaten by the larvae to produce an infection, which is typically fatal to the insect. Because H-NPV must be ingested, they require a few days to actually kill the larva,

which has resulted in poor performance of Heligen so far in small plot sweet corn insecticide efficacy trials (Table 4). Please see the article by Kris Holmstrom (Rutgers IPM) for additional trials with Heligen in rotations with Entrust in sweet corn in New Jersey. Future research on improving the efficacy of Heligen with the use of feeding stimulants and other possible adjuvants and strategies will be investigated.

Table 4. Evaluation of Heligen for control of CEW in sweet corn – Painter, VA, August 2020. (7 applications beginning at first silk).

Treatment	Rate in fl. oz / Acre	% clean ears	No. CEW larvae per 25 ears
Untreated check		0.0 c	31.3 a
Heligen (HearNPV)	2.4	8.0 c	21.3 b
Warrior II (lambda-cyhalothrin)	1.5	29.0 b	7.8 c
Alternating: **Heligen** **Warrior II**	2.4 1.5	10.0 c	14.8 bc
Alternating: **Warrior II** **Lannate LV (methomyl)** **Coragen (chlorantraniliprole)**	1.5 16.0 3.5	65.0 a	7.0 c
P-value from Anova		<0.0001	0.011

UPDATE ON CONTROLLING FOLIAR AND FRUIT ROT PATHOGENS OF PUMPKIN

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In 2004, cucurbit downy mildew re-emerged in the US with a vengeance causing significant losses in cucurbit production. In most years prior to this, concern for CDM control was minimal, since the pathogen arrived late in the growing season (in more northern regions), or the pathogen caused little damage, or never appeared. After 2004, with significant losses at stake, and with very few fungicides labeled for its proper control, CDM became a serious threat to cucurbit production. Importantly, at the time, cucumber varieties with very good levels of CDM resistance were no longer resistant, suggesting a major shift in the pathogen population. Research done over the past 15 years has led to a better understanding of the pathogen. Recent research has determined that the CDM falls into two separate clades: Clade I and Clade II.

Some CDM (*Pseudoperonospora cubensis*) isolates fall into Clade I which predominately infect watermelon, pumpkin, and squash, where CDM isolates in Clade II predominately infect cucumber and cantaloupe. Research suggests that isolates in Clade II can quickly become resistant to specific fungicides (NCSU). Most cucumber varieties are resistant to Clade 1 isolates, but there is no resistance currently available for Clade 2 isolates. For pickling cucumber the varieties, Citadel and Peacemaker, are tolerant to clade 2 isolates. For slicing cucumbers, the varieties SV3462CS and SV4142CL are tolerant to Clade 2 isolates. All organic and greenhouse growers are encouraged to use tolerant varieties since chemical control options are very limited (NCSU). For the past decade, researchers from around the US have been closely monitoring and forecasting the progress of CDM through a website hosted by NCSU. The CDMpipe website is currently in the process of an upgrade and will now be hosted by Penn State University. All cucurbit growers are encouraged to sign up to the CDMpipe website to help them know what cucurbit crops are being infected (and where) and to follow the forecasting to know where the pathogen may move to next. As a note, in recent years, CDM control with certain fungicides has varied significantly depending on the cucurbit host and geographic region. This is extremely important since two clades of the pathogen are potentially present (affecting host range) as well as having a potential impact on control strategies. How do you know which clade may be present on your farm? Follow the reports. If CDM is mostly present in cucumber crops as it works its way up the east coast, then you are most likely to see it infect cucumber and cantaloupe on your farm first. Scout your fields regularly, especially if CDM is in the immediate region. Pay very close attention to symptom development and on what cucurbit crop(s) you see it on, this is especially important if you grow more than one cucurbit crop. Like cucurbit powdery mildew, once CDM arrives in the region preventative fungicide applications are necessary.

Fungicides for CDM control
Loss of efficacy in the control of CDM has also been documented in FRAC code 4 (mefenoxam), FRAC code 11 fungicides (azoxystrobin), FRAC code 28 (propamocarb HCL), and FRAC code 43 (fluopicolide) in the mid-Atlantic region and elsewhere. Insensitivity to fluopicolide (43) and propamocarb HCL (28) have been reported in multiple states (Thomas et al., 2018). In some cases, individual isolates of CDM were insensitive to both chemistries. Recent research in Michigan in a three year field study using pickling cucumber determined that cyazofamid (21), (ametoctradin, 45 + dimethomorph, 40), (zoxamide, 22 + mancozeb, M03), mancozeb (M03); chlorothalonil (M05), and oxathiapiprolin (49) alone or in a premix provided the best level of control (Goldenhar & Hausbeck, 2019). In a recent study evaluating different fungicide chemistries in field trials done in different states (OH, NY, & SC) determined that propamocarb HCL (28), cymoxanil + famoxadone (27 + 11), and fluopicolide (43) were ineffective in 1 or 2 states during both years of the trial (Keinath, Miller, & Smart, 2019). In one year of the study, famoxadone (11), dimethomorph (40), cymoxanil (21), and mancozeb (M03) were ineffective for CDM control (Keinath, Miller, & Smart, 2019). In bioassay studies done during this trial, cyazofamid (21), oxathiapiprolin (49) suppressed CDM >80%.

Most fungicides labeled for the control of CDM are at-risk for resistance development because of the specific modes of action. These include Ranman (cyazofamid, FRAC code 21), Gavel (zoxamide, 22 + mancozeb, M03), Zing! (zoxamide, 22 + chlorothalonil, M05); Curzate (cymoxanil, 27), Previcur Flex (propamocarb HCL, 28), Forum/Revus (dimethomorph, 40), Zampro (ametoctradin, 45 + dimethomorph, 40), Orondis Opti (oxathiapiprolin, 49 + chlorothalonil, M05), and Orondis Ultra (oxathiapiprolin, 49 + mandipropamid, 40). Importantly, just like with cucurbit powdery mildew control, there are a number of CDM fungicides with different modes of action from different FRAC codes to chose from. As noted in the paragraph above, the efficacy of individual fungicide chemistries may vary significantly by state or region. Thus, growers need to scout their cucurbit fields on a weekly basis, note the efficacy, or lack thereof, they are seeing in the field, and incorporate the use of as many different FRAC groups as possible to help mitigate fungicide resistance development.

Powdery mildew (*Podosphaera xanthii*) continues to be one of the most important foliar diseases of cucurbit crops in New Jersey. Symptoms of powdery mildew include white ‘fluffy’ colonies which develop on upper and lower leaf surfaces, vines and handles of fruit. Control of powdery mildew begins with planting powdery mildew resistant/tolerant cultivars and early detection of symptoms along preventative fungicide maintenance programs. Fungicide resistance to powdery mildew has been detected in NJ and growers need to follow fungicide labels and restrictions accordingly.

Plectosporium blight, also known as White speck, can cause significant problems in cucurbit production. Plectosporium blight is favored by cool, humid or rainy weather. The fungus can overwinter on crop residue and can persist in the soil for several years. No pumpkin or summer squash varieties are known to be resistant to the disease. Spores are spread by rain-splash and wind. Lesions are small (<1/4 inch) and white. On

vines, the lesions tend to be diamond shaped; and on fruit they are small, round and irregular. The lesions increase in number and coalesce until most of the vines and leaf petioles turn white and the foliage dies. Severely infected pumpkin vines become brittle. Early in the infection cycle, foliage tends to collapse in a circular pattern before damage becomes more universal throughout the field. These circular patterns can be easily detected when viewing an infected field from a distance. Fruit lesions produce a white russeting on the surface and stems that render the fruit unmarketable. The fruit lesions may allow for entry of soft rot pathogens that hasten the destruction of the crop (Boucher and Wick) (http://vegetablemdonline.ppath.cornell.edu).

The diagnosis and control of these diseases and other important diseases of cucurbit crops will be discussed. An update on the newest fungicide chemistries available for controlling important foliar and fruit rot pathogens in cucurbit crops will also be presented.

For more information, please see the new 2022/2023 Mid-Atlantic Commercial Vegetable Production Guide.

MANAGING DIAMONDBACK MOTH AND WHITEFLIES IN GEORGIA

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Insect pest control in Georgia vegetables continues to be a challenge, regardless of the many other factors affecting production. Unfortunately, insecticide resistance in key pests like whiteflies (WF), *Bemisia tabaci*, and the diamondback moth (DBM), *Plutella xylostella*, can reduce our confidence in traditional insecticide solutions. The best way to regain confidence in managing these pests with traditional control treatments is to have annual surveys of insecticide response and new efficacy data on new and alternative control tactics that can reduce reliance on any one treatment. Rotations of effective control treatments is the best way to keep insecticide resistance problems from developing. New products, alternative control options and current pest information are vital for sustainable vegetable insect pest management moving forward. In this talk, we briefly report and discuss some of the results of insect control experiments and insect bioassays in 2021. Insecticide resistance in DBM in Georgia continues to be a major problem, especially for certain diamide insecticides like chlorantraniliprole, but also for older chemistries like pyrethroids, carbamates, spinosyns and oxadiazines. A maximum-dose bioassay of multiple insecticide groups can alert a pest manager of a resistance problem before application for a heavily infested field. A new Baculovirus treatment for DBM from AgBiTech showed promise in 2021.

Whiteflies have been an increasing problem in fall vegetables in southern Georgia over the last decade. Neonics, like imidacloprid, have been losing efficacy over time and even some diamides, like cyantraniliprole, are not as strong a WF control at certain locations as they were a decade ago. We are developing a bioassay for WF to alert growers if certain products are beginning to fail at a given farm site. So far, dinotefuran, flupyradifurone, cyantraniliprole strongly control WF adults where they have been field tested in Georgia, with imidacloprid showing signs of weakness. Again, the goal is to recommend rotations of effective control treatments to reduce the carryover of resistant individuals from generation to generation.

Bonus information: recent results from control studies of pepper weevil suggest that pyrethroids continue not to provide very good control, thiamethoxam is intermediate and even oxamyl needs to be applied at the high rate to provide strong efficacy. Two new products, broflanilide and ISM-555 show great promise for pepper weevil control.

EVALUATING SILK SPRAY ROTATIONS OF AN OMRI APPROVED SPINOSYN AND NUCLEOPOLYHEDROVIRUS FOR MANAGING CORN EARWORM IN ORGANIC SWEET CORN

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Field evolved resistance to synthetic pyrethroids (and by extension, naturally derived pyrethrins) and the insecticidal toxins in *Bacillus thuringiensis (B.t.)* formulations has left organic sweet corn growers with few options for controlling corn earworm (CEW) during the silk stage of the crop. At present, only the OMRI approved spinosyn, Entrust (Corteva), is effective at managing this pest at this stage.

In order to remain in compliance with product labeling, Entrust may be applied no more than twice consecutively without switching to a product with another mode of action (MoA). Through much of the sweet corn growing season, and particularly August through September, CEW populations warrant up to seven silk applications to manage this pest, forcing growers to incorporate much less effective materials into their rotations.

This trial was designed to evaluate the efficacy of silk spray rotations that include the OMRI approved, CEW specific nucleopolyhedrovirus-based product, Heligen (AgBiTech) with Entrust such that product labeling on the spinosyn is not violated. A non-OMRI approved insecticide (Coragen (FMC)) was included as an industry standard check. CEW pressure, as indicated by nightly moth catch in the adjacent pheromone trap (30" Hartstack) was heavy **(Fig. 1)**, with highest activity around the arrival of a tropical storm system that deposited 4.5" of rain at Snyder Farm.

Location: Snyder Research and Extension Farm – Pittstown, Hunterdon County, NJ
Variety: Providence
Planting date: 6/18/21
Harvest date: 8/30/21
Sprayer: 4-row tractor mounted boom, 50 gal/A
Water: pH – Appx. 7.0 as per strip test administered at each spray
CEW pressure: Heavy
Spray schedule: Attempted 3-day (weather permitting), beginning at first silk
Sprays (6): 8/9, 8/13, 8/16, 8/19, 8/24, 8/27
Sample: 20 ears/rep, 4 reps/Trt

Treatments
1 – Untreated Check (UTC)
2 – Entrust SC @ 6 fl oz/A (spray-1,2,4,5) Heligen @ 2.4 fl/oz/A (3,6)
3 - Entrust SC @ 6 fl oz/A (spray-1,2,5,6) Heligen @ 2.4 fl/oz/A (3,4)
4 - Entrust SC @ 6 fl oz/A (spray-1,2,6) Heligen @ 2.4 fl/oz/A (3,4,5)
5 - Entrust SC @ 6 fl oz/A (spray-1,2) Heligen @ 2.4 fl/oz/A (3,4,5,6)
6 – Heligen @ 2.4 fl oz/A (spray-1-6)
7 – Entrust SC @ 6 fl oz/A (spray-1-6)
8 – Coragen @ 5 fl oz/A (spray-1-6)

Results

Treatments were evaluated at market maturity by examining twenty ears per plot (4 reps/treatment) for CEW presence and injury **(Fig. 2)**, total number of CEW/20 ears **(Fig. 3)**, and total number of late instar (stages 4-6) CEW/20 ears (not shown). Means separation by Tukey's Studentized Range Test.

Percentage of clean ears **(**(no CEW, no injury) **Fig. 2)** were greatest in treatments 7-8 (Entrust 6 sprays and Coragen 6 sprays), while statistically similar results were obtained in treatments 2 (Entrust sprays 1,2,4,5 and Heligen sprays 3,6) and 3 (Entrust sprays 1,2,5,6 and Heligen sprays 3,4). As more Heligen applications were substituted in the rotation, the percentage of clean ears became statistically inseparable from the untreated check. A consistent numerical improvement over the UTC was observed, even with a rotation of Heligen sprays alone (Trt 6). This phenomenon was also present in the evaluation of numbers of CEW/20 ears **(Fig. 3)**. Here, treatments 2,3, 7 and 8 were all statistically better than the UTC and treatments 4-6 at limiting overall numbers of CEW, with treatment 6 (Heligen alone) appearing to provide some improvement in CEW larval reduction.

Observations and Discussion

CEW pressure was heavy during this trial, with highest moth catches occurring during and just after the passing of a tropical storm that deposited 4.5" of rain on the site. Due to excessive soil moisture, a spray schedule that should have been conducted at 3-day intervals was stretched to 5 days. This delay in treatment is likely responsible for the sub-optimal control (66.25% clean ears-Fig. 2) in treatments 7-8, and lower efficacy than might have been achieved overall.

For growers of organic sweet corn, the level of control achieved relative to off-label use of Entrust (6 consecutive applications) by inserting limited numbers of Heligen sprays into the rotations is positive. By utilizing one Heligen treatment to separate two Entrust applications (Trts 2 and 3), a level of CEW control was achieved that was in range with treatments 7 and 8, despite the latter treatments being in violation of Entrust labeling (Trt 7) or not OMRI approved (Trt 8). Separating two Entrust applications with one Heligen application maintained adherence to Entrust label requirements. Heligen, a viral pathogen of CEW, must be ingested to kill larvae. Increasing the number of Heligen

applications reduced the overall efficacy of CEW control, most likely because of limited feeding done by larvae as they enter the ear, and because Heligen does not offer any residual activity. Heligen has performed better in trials on other crops such as hemp and soybeans, where treated foliage is consumed by CEW larvae.

Because product labelling requires switching insecticidal modes of action between a maximum of two spinosyn applications, organic growers have been forced to use alternate materials (pyrethrins and *B.t.* based insecticides) to which CEW has known resistance. Initial results from this trial indicate that a level of control may be achieved by inserting limited numbers of sprays of a CEW-specific viral pathogen, even under heavy pest pressure. The authors' intent is to repeat this trial in 2022.

The authors would like to thank the New Jersey Vegetable Growers Association for providing funding for this project, through the Charlie Maier Fund, and to Dr. Paula Marçon, of AgBiTech for supplying the Heligen.

Fig. 1. Snyder Farm corn earworm nightly catch with silk spray dates.

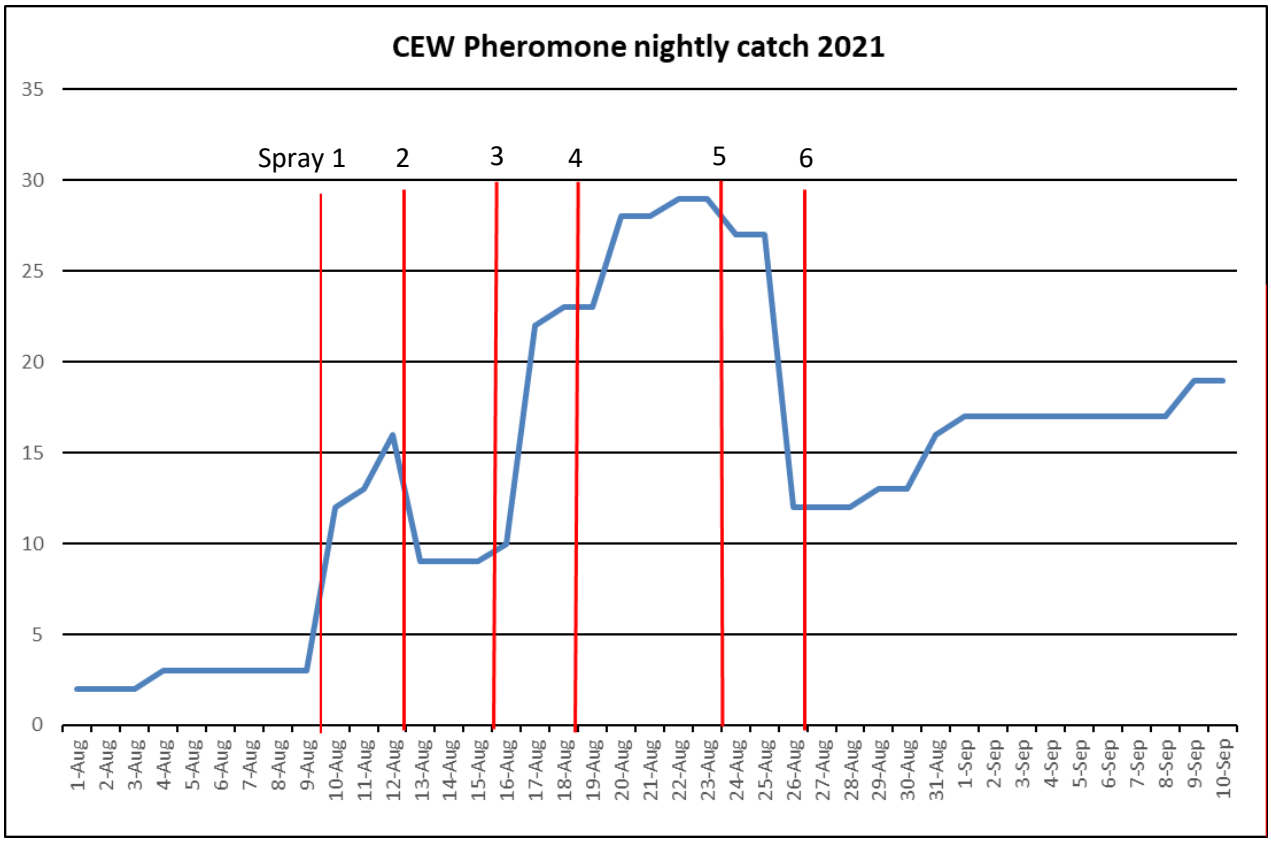


Fig. 2.

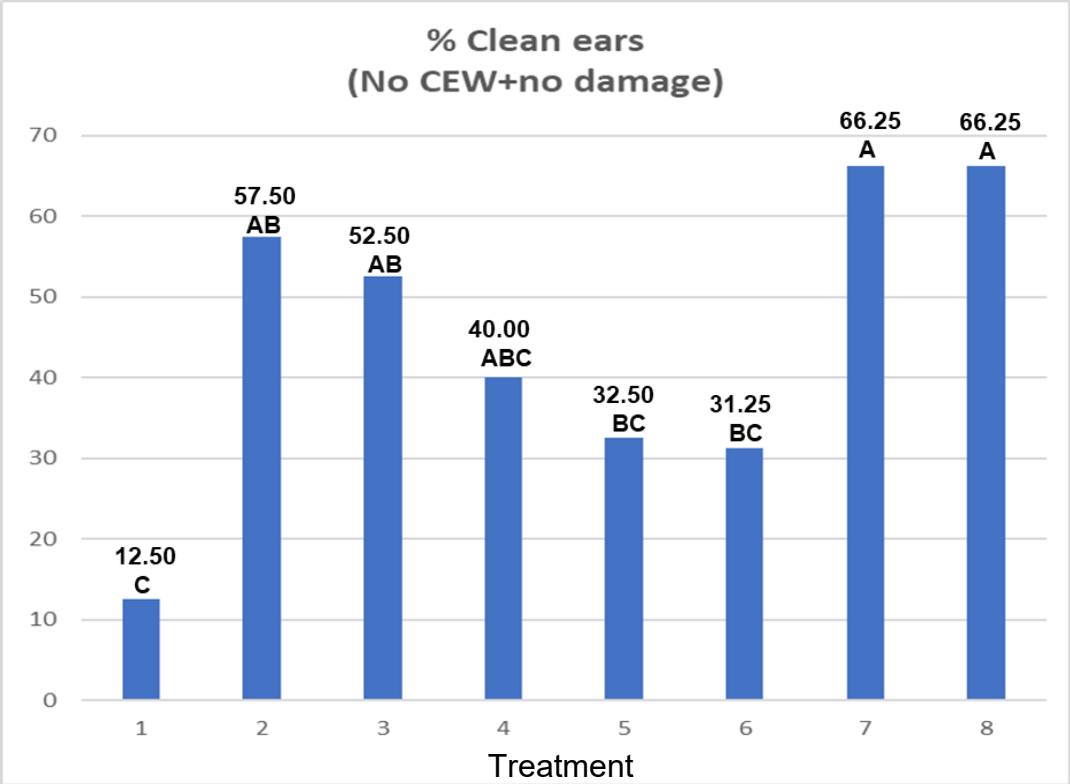
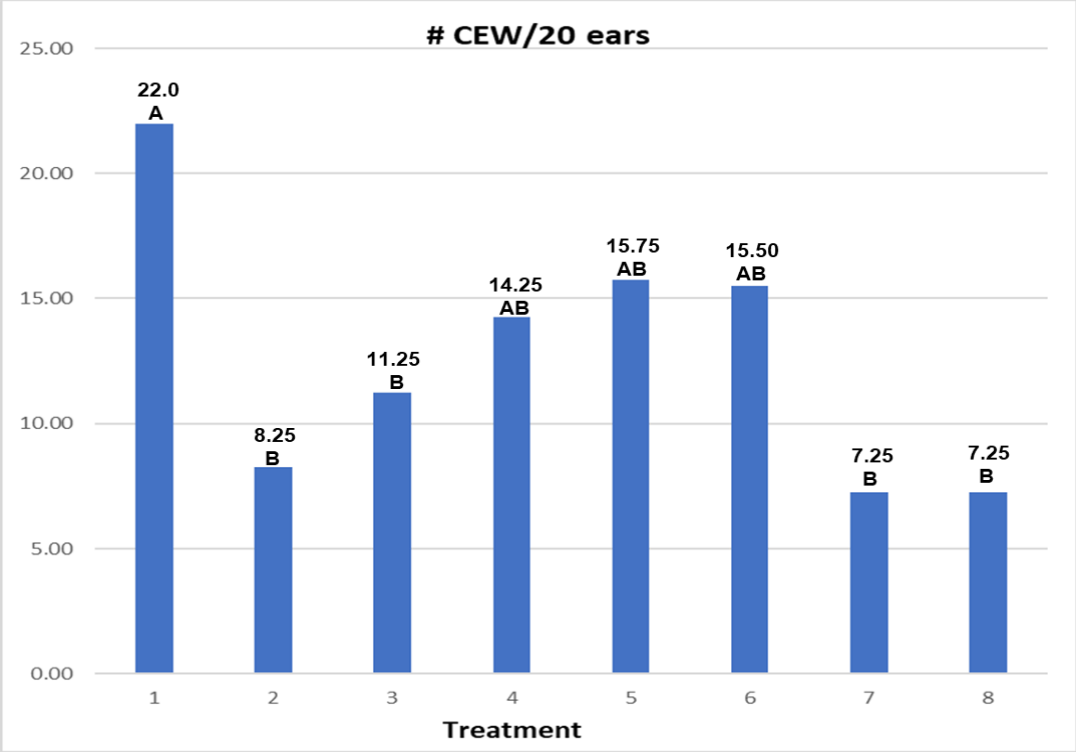

% Clean ears
(No CEW+no damage)
70
60
50
40
30
20
10
0
12.50
C
57.50
AB
52.50
AB
40.00
ABC
32.50
BC
31.25
BC
66.25
A
66.25
A
1
2
3
4
5
6
7
8
Treatment

Fig. 3.


CEW/20 ears
25.00
20.00
15.00
10.00
5.00
0.00
22.0
A
8.25
B
11.25
B
14.25
AB
15.75
AB
15.50
AB
7.25
B
7.25
B
1
2
3
4
5
6
7
8
Treatment

THE FUTURE OF PEPPER WEEVIL MANAGEMENT IN NEW JERSEY

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https://pestmanagement.rutgers.edu/ipm/vegetable/

Introduction:
Pepper weevil continues to be a major sporadic pest that frequently infests southern New Jersey pepper fields. Control options are limited and the best way to manage the weevil is to not allow them to enter pepper fields.

This means using pheromone traps to pick up the initial infestations before the weevil population becomes established. The threshold for spraying is one weevil caught in the traps or detected by field scouting. An insecticide application should be done as soon as possible after discovery of the weevil applying either thiamethoxam, imidacloprid, or oxymal. Since it is known that at least some weevil populations are resistant to pyrethroids it is better not to rely on them for management. Pepper fields that are near food processing facilities should also be sprayed at the beginning of flower bloom to reduce the odds of an early infestation.

Another option might be to have processors and repackers heat pepper refuse before disposing of it into on-site dumpsters or hauling away refuse to landfills. However, this does not seem likely to happen.

The Plan: three new management tools in addition to the current monitoring
A meeting of farmers, ag agents, agri-business personnel and extension entomologists was held in March of 2021, to discuss management options for pepper weevil. The results of that meeting are explained below.

Trap and kill:
Conducted by the Vegetable IPM Program, by placing mature pepper plants and pheromone traps next to dumpsters at processing and repacking disposal sites could significantly reduce the number of weevils escaping pepper residue from these facilities and other locations where weevils might be brought in. Potted, blooming peppers would attract the weevils to blossoms and ultimately be trapped on yellow sticky cards with pheromone lures. Lures would be replaced every two weeks and traps and plants maintained and monitored. The number of weevils trapped would be recorded and infested pepper fruit would be examined and destroyed. It is hoped that this arrangement will prevent the spread of weevils into the surrounding areas and fields, thus preventing field infestations.

The arrangement for trap and kill.

Farmers monitoring their own fields:
The benefit of farmers monitoring for pepper weevil on their own is to reduce the amount of off-farm traffic in the fields thereby reducing the likelihood of hitch-hiking weevils. With some training, farmers can learn how to recognize weevils on the pheromone traps and effect their own management. The following fact sheet, *FS 1330, Monitoring and Management of Pepper Weevil in New Jersey*, is available on-line, https://njaes.rutgers.edu/fs1330/ as an aide to farmers who want to monitor for pepper weevil on their own. Assistance in determining the number of traps and their placement and learning to recognize pepper weevils is available from the Vegetable IPM Program.

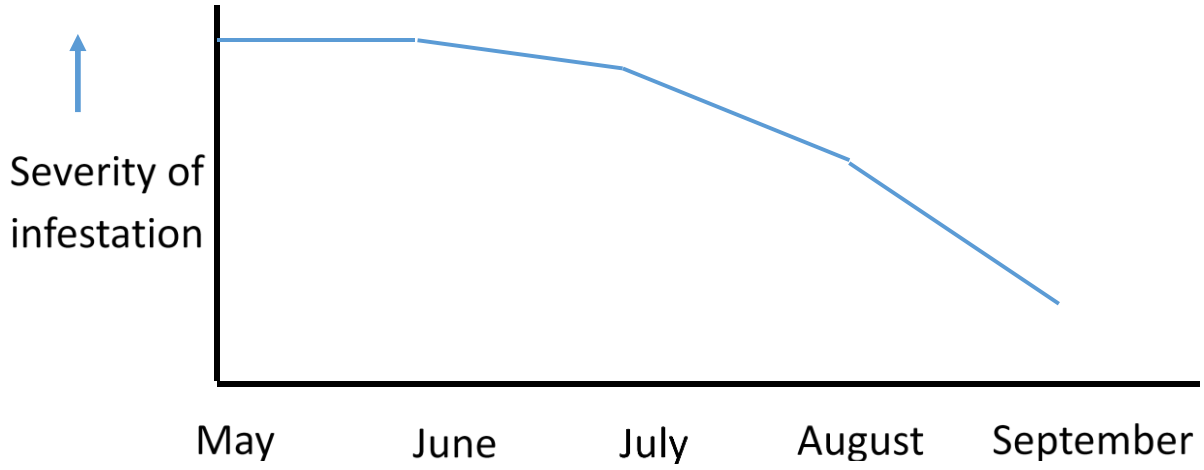
Insecticide assays:
The assays may be the only way to determine whether weevils infesting fields are resistant to insecticides. Work done in Georgia shows that all tested resident populations of pepper weevil are resistant to pyrethroids. Without genetic testing we cannot know where the weevils come from that we find in New Jersey. There may be resistant and non-resistant populations varying from farm to farm. Since multiple introductions of weevils to fields is possible there may be resistant/non-resistant weevils in the same field.

This testing would have to be done as quickly as possible once a field infestation is discovered, however there may be some delay as an adequate number of weevils for testing would be needed.

Current program:
The current IPM program will continue to be offered to farmers which includes setting and maintenance of traps, if desired.

Conclusions:
Even with these three options implemented, there is no guarantee of successfully keeping pepper weevils at bay. Over the years we have seen multiple ways weevils may be introduced into pepper fields. Pheromone traps aren't 100% effective in catching the first weevil arrivals in fields. However, if we can reduce the number of

introduced weevils and have diligent monitoring of traps and field scouting the threat of pepper weevil infestations will decline.
As the following graph shows, the longer weevil infestations are prevented during the growing season the less yield loss there will be.



New Crops & Innovative Marketing Ideas

GROWING FRESH BABY GINGER IN MOVEABLE HIGH TUNNELS

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Ginger (*Zingiber officinale*) is a perennial plant that is native to tropical regions of Asia and is grown commercially as an annual crop. Ginger is commonly used in many African, Asian, and Caribbean recipes or in herbal teas, and is sold fresh or dried and ground. What many people refer to as the "ginger root" is actually the "ginger rhizome," which refers to the underground stem of the plant. The continental United States imports most of its ginger from other countries, or from Hawaii, but ginger can also be grown locally right here in New Jersey. Recently, farmers throughout the Northeast have been having success growing baby ginger in high tunnels. Fresh baby ginger is a unique product that is different than the mature ginger that is sold in grocery stores and has potential as an excellent niche crop for farmers markets, restaurants, CSAs, and other direct marketing customers.

This project documented production practices for growing baby ginger (var. Peruvian Yellow) in Central New Jersey, at the Cream Ridge Specialty Crop Experiment Station using moveable high tunnels. After the ginger was harvested, samples of the crop were donated to local restaurants and breweries with a survey to complete, indicating their satisfaction with the crop and how likely they might be to purchase it from growers in the future.

Growing Methods

Pre-sprouting the Seed Pieces

Ginger requires a long growing season to produce a harvestable crop. In New Jersey, this involves pre-sprouting the ginger seed pieces in late February or early March in a heated greenhouse before they can be transplanted into the field. The seed pieces are sections of the rhizome, generally weighing 1 to 2 ounces each. Seed should only be obtained from a reputable supplier to minimize the potential for any disease issues on contaminated seed.

To pre-sprout the ginger, each seed piece was spread out in a single layer in flats and covered with 1-2" of potting mix. The temperature in the greenhouse was maintained at approximately 75^{o}F. The flats were then placed on heat mats set to 72^{o}F to maintain an even and consistent temperature in the root zone. The medium in the sprouting trays was supplied with adequate moisture but was never over-watered. Shoots emerged out of the medium and roots developed over an 8-week period.

Planting the Seed Pieces in the High Tunnel
When soil temperatures in the high tunnel are consistently 55ºF or higher, the sprouted seed pieces can be planted into the soil. This is likely to be in late April or early May, depending on the season. Ginger is a heavy feeder and grows best with compost additions and supplemental nitrogen (100 lbs. N/acre before planting plus two additional applications of 25 lbs. N/acre during the growing season). A neutral to slightly acidic pH (approximately 6.5) is recommended, and adequate calcium is important for the crop. Drip irrigation is also recommended to conserve water and reduce the leaf wetness period.

In this study, sprouted ginger seed pieces were planted 6 inches apart and 8 inches deep into trenches spaced 2 feet apart. They were then lightly covered with a few inches of soil so that the tip of the shoot was still showing. Each row was 20 feet long and was replicated four times across two moveable high tunnels. A second treatment group that received three applications of humic acid was also replicated four times to evaluate whether this product could encourage higher yields. Approximately 26 lbs. of seed planted 160 row feet in this trial. However, the initial size of the seed pieces will also influence how many row feet can be planted per pound of seed. The plants were hilled two times throughout the growing season as the shoots grew taller and the underground rhizomes began to develop.

Disease Management
Ginger is susceptible to bacterial wilt, bacterial soft rot, *Pythium*, and fusarium. Purchasing disease-free seed stock is the first line of defense against these problems. Soil-borne nematodes can also be a potential pest of ginger. It is important to avoid planting in areas where other crops that are susceptible to these pathogens have been recently grown to further minimize disease pressure. Growing the crop in a high tunnel not only provides necessary temperature modification, but also protects the crop from excessive rainfall events, which can lead to overly saturated soils and the development of disease problems. Moveable high tunnels allow the crop to be rotated from one section of the field to another each year, further helping to reduce the buildup of soil-borne pathogens.

Harvesting Ginger
Ginger is generally harvested from late September or early October through the beginning of November. The leaves will begin to turn brown as temperatures drop and frost begins to occur. Ginger plants can remain in the ground as long as there is at least one inch of green tissue still living above the rhizome, but many growers will harvest sooner. The plants are pulled from the ground using a digging fork and care should be taken not to damage the delicate skin of the rhizome. Baby ginger is perishable and will store for about two weeks in cold storage.

In this project, ginger was harvested and weighed over a 4-week period (October 13 to November 3) to determine if any significant increases in size occurred during this time. Each week, 5 feet of the 20-foot rows were harvested and weighed. The tops and roots were trimmed, and the rhizomes were washed free of soil. After the weights were

obtained, samples of the crop were donated to 18 local restaurants and breweries with a link to a survey about the crop.

Results

Harvested ginger yields by weight ranged from 2.1 to 2.7 lbs. per foot during the four-week harvest period (Figure 1). While trends of slight increases were observed over the course of the four weeks, these results were not statistically significant, suggesting that ginger can be harvested at any time during this four-week period without noticeable reductions in yield. Treatments with humic acid also demonstrated potential for slight yield increases, however these results were not statistically significant.

The total harvested yield for Peruvian Yellow baby ginger was 384.5 lbs. from 26 lbs. of seed planted in 160 row feet. This equates to 14.8 lbs. harvested for every 1 lb. planted and approximately 2.4 lbs. of ginger harvested per foot. Baby ginger retails for approximately $16 per pound at farmers markets and can wholesale for $10 per pound. At retail prices, baby ginger can gross over $38 per linear foot of bed space planted, making it a potentially very valuable crop for NJ growers who are involved in direct market sales.

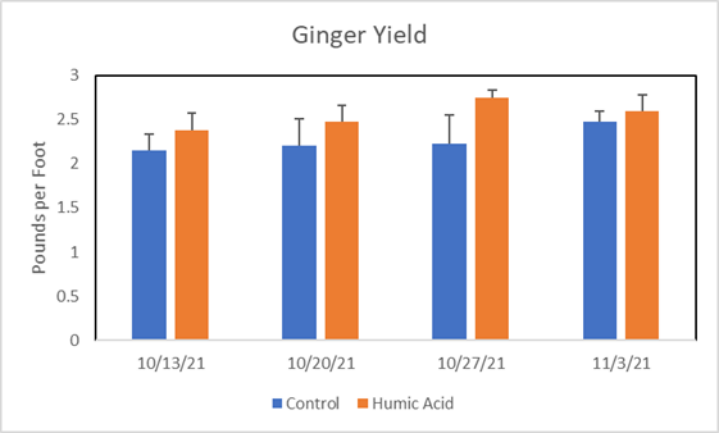

Figure 1: Ginger yields from control beds, and beds treated with humic acid over a 4-week period.

Restaurants and breweries indicated a high degree of satisfaction with the crop, with 100% of respondents (n=11) indicating that they were Very Satisfied with the crop overall. Additionally, 91% of respondents (n=11) indicated that they were Somewhat Likely or Very Likely to purchase baby ginger from local farmers in the future (Figure 2). Additional feedback from the respondents included: “The ginger had excellent flavor,” “The baby ginger was beautiful and tropical looking,” and “Very easy to peel and much more flavorful than any other ginger I’ve tried.”

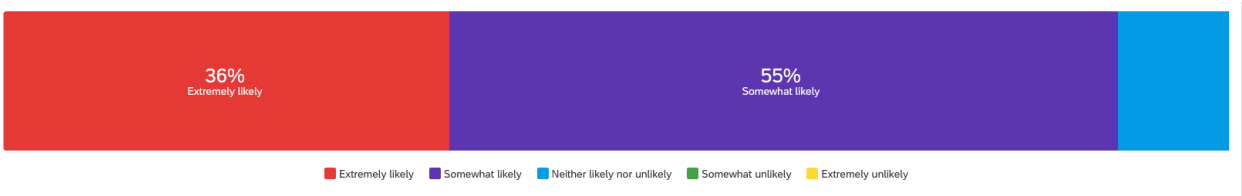

Figure 2: Responses from restaurants and breweries indicating how likely they would be to purchase baby ginger in the future (n=11).

The high level of satisfaction from local restaurants and breweries, combined with their willingness to purchase baby ginger from growers further indicate the potential for growing and marketing baby ginger as a niche crop in NJ.

Additional Resources

Ginger and Turmeric. University of Kentucky Cooperative Extension: https://www.uky.edu/ccd/sites/www.uky.edu.ccd/files/ginger_turmeric.pdf

Effects of early season heating, low tunnels, and harvest time on ginger yields in NH, 2017: https://extension.unh.edu/resources/files/Resource007161_Rep10344.pdf

GETTING STARTED GROWING HIGH-VALUE MUSHROOMS ON THE FARM

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Introduction

Mushroom production presents an interesting opportunity for growers who are looking to diversify their current production or are looking for a niche crop to get started with. This talk will discuss specialty mushrooms as a niche crop, addressing some of the reasons one might consider entering mushroom production, as well as the types of mushrooms to consider, and the systems involved in producing them. For those with little experience in mushroom production, starting small and scaling up is a safe bet, since mushrooms require a different skill set than plant-based agriculture. I will discuss specific techniques that can be implemented on a small scale to take your first steps into mushroom cultivation.

Important Terms

Mycelium – the "plant" of mushroom production, this is what you are growing inside of your substrate. It's the main body of the fungus.

Substrate – the "soil" of mushroom production, there are many types of substrate, including logs, sawdust, and straw.

Inoculate – the "planting" of mushroom production, properly inoculated spawn begins to grow mycelium.

Spawn – the "seeds" of mushroom production, you will use this to inoculate your substrate.

Bolt – a length of log that is to be inoculated with spawn. Preferred types are sugar maple, oak, ironwood, hop hornbeam, and birch.

Sterilize – to make something free from bacteria or other living microorganisms. Sterilization is achieved within a minimum of 15 min at 121°C (250 °F) or 3 min at 134°C (273°F).

Pasteurize – subject to a process of partial sterilization, especially one involving heat treatment or irradiation. Pasteurization takes place between 160 to 180 degrees Fahrenheit.

Why Mushrooms?
As a niche crop, specialty mushrooms can be a great addition to your farm business. Start up costs are relatively low for a small operation, production can be done in a concentrated area that doesn't take space from other crops, and the resulting product is high-value and in demand. Mushrooms can be produced outdoors in wooded or otherwise highly shaded areas that are not suitable for other crops, or indoors in a shed, barn, basement, or container. Average nationwide sale price of specialty mushrooms in 2021 was $3.21 per pound according to United States Department of Agriculture. This includes bulk sales to processors as well as direct retail sales.

The biggest challenge with growing mushrooms is cleanliness, particularly with indoor production. Sterilized or pasteurized spawn and substrate are essential depending on the techniques you are using. A mushroom producer who is interested in producing their own spawn will also need to create a clean room or area where they can carry out this process. Contamination of spawn or substrate can lead to crop loss and wasted labor.

Understanding what mushrooms are, and how they differ from plants, can help you understand how they are cultivated, and which ones can be viable. The body of a fungal organism is the mycelial network, which grows throughout the substrate, similar to roots, and releases enzymes that break down the substrate into usable nutrients. A mushroom is the fruit of the mycelial network. To fruit and produce harvestable mushrooms, the mycelium needs specific conditions, temperature, and humidity. As a mushroom farmer, your job is to consistently create those conditions, maintaining the health of the mycelium and triggering it to produce mushrooms.

Which Mushrooms?
The term "specialty" mushrooms refers to cultivatable mushrooms outside of the species *Agaricus bisporus.* The vast majority of commercial mushroom production involves *Agaricus bisporus,* which includes button, portabella, and cremini mushrooms. While these mushrooms are relatively straightforward to produce commercially, the high quantity of large-scale wholesale producers make this a very saturated market with low sale prices. Small growers entering into the *Agaricus bisporus* market will find it difficult to compete. A small grower looking to produce mushrooms profitably will have better luck growing one of the less common specialty varieties, with Shiitake, Oyster, Chestnut and Lions Mane being among the most commercially viable. High-quality specialty mushrooms are often sought after by restaurants and consumers, making direct market sale of these products highly profitable.

Techniques for Mushroom Cultivation
Mushrooms can be successfully cultivated indoors and outdoors depending on the variety. There are pros and cons to each approach and certain mushrooms produce better than others in different conditions.

Outdoor production is most commonly used for the cultivation of Shiitake mushrooms. This type of mushroom cultivate typically uses recently cut hardwood logs, called bolts, that have multiple holes drilled into them which are then filled with sawdust spawn or

plugs that have been inoculated with mycelium. These logs can be stacked in a well-shaded, humid area, such as a wood lot or tree line, and can be forced to fruit at regular intervals by soaking them in water, a process called “shocking”. Once the mycelium in the bolts has been established, they can continue to produce for several years before needing to be replaced. Setting up an outdoor growing area with several hundred or even thousand logs can produce a large quantity of high-quality Shiitake mushroom and provide a great return on investment. Some of the downsides of outdoor production include a limited growing season due to temperature, and less control over contaminants, this can result in some bolts needing to be replaced if other types of fungus colonize them.

Indoor production introduces additional levels of control for the mushroom grower, making it well suited to a wider range of varieties. Oyster, Lions Mane, and Chestnut mushrooms all grow well in indoor, climate-controlled spaces. Indoor cultivation opens up potential for year-round production, making it a stable income source. This type or production often uses sterilized sawdust or straw as a substrate, which is placed into specialized mushroom growing bags and inoculated with spawn. Cleanliness is key for indoor production, so growers often rely on either a pressure cooker or steam room to sterilize their substrate. Once the substrate bags have been inoculated, they are placed into a climate-controlled space for several weeks to give the mycelium a chance to colonize the entire block. When the bags are ready, they can be cut open and placed in a room with the correct temperature and humidity for the variety of mushrooms being produce. If conditions are correct, the blocks will fruit and produce harvestable mushrooms. The main downside of indoor production is the set-up cost associated with climate controlled areas.

Conclusion

Specialty mushroom production offers a unique opportunity to small farmers who are looking for a high-value niche crop that can be produced year-round in a compact space. There are plenty of budget and DIY options for getting started that can easily be scaled up or down, making this a very flexible enterprise. For those looking to minimize costs and maximize profits, there are advanced techniques that can be applied to reduce the need for purchased inputs. Propagating your own spawn and creating your own bulk substrate can result in a sustainable, low-cost, specialty crop production system.

HAZELNUTS: AN EXCITING NEW LOW-INPUT CROP TO EXTEND YOUR SEASON AND INCREASE PROFITS

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Hazelnuts are an exciting new crop for New Jersey and the Mid-Atlantic region and are one of the few tree nuts that can be grown commercially in the Eastern U.S. Breeders at Rutgers University have recently released four new cultivars, which include Monmouth, Raritan, Somerset, Hunterdon, along with The Beast, a hybrid hazelnut released by the collaborative Hybrid Hazelnut Consortium. In 2020, the first trees became available from nurseries for sale to growers and orchards have been established at dozens of locations across the region. Demand for hazelnut kernels in local markets appears to be high.

A major benefit of hazelnuts is their low input requirements compared to tree fruit and most other conventional crops. The Rutgers cultivars have been bred to be resistant to Eastern Filbert Blight, the main fungal pathogen of concern, and do not require fungicide sprays. In areas where bacterial blight has become a pathogen of concern, copper sprays have proven effective. Weed control is necessary around the base of the plants for both water conservation and facilitation of harvest and can be accomplished chemically or mechanically. Successful weed control is the main consideration for integration into organic systems. Additionally, irrigation is recommended when establishing orchards but becomes less critical as orchards mature.

Hazelnuts also offer opportunities for extending farm income into the fall and winter. Harvest takes place in early fall and the nuts require a short drying period before sale. However, the nuts remain fresh for up to one year in shell with proper storage, allowing for sale during the holiday season and well into the following year after harvest. Growers can direct market the nuts right on the farm, use the nuts to create value added products, or do small scale wholesaling to local bakeries or confectionaries.

ATTRACT NEW CUSTOMERS WITH INNOVATIVE FLOWER PRODUCTION AND MARKETING STRATEGIES

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Using Your Talents to Grow Your Business

- What are your hobbies and interests?
- What are your interests that you have not pursued?
- What areas are others encouraging you to move toward?
- What's nagging you to explore it further

I had always been interested in floral design and actually considered just growing flowers when I restarted the farm but at the time I pushed that interest aside and ran with vegetable production.Over the years I kept being drawn back to floral and finally a boyfriend said, "Hey, I think you should grow more flowers."
I said, "I think you're right."
And the rest is history, as they say! From there I dove into making flowers a big part of our business.

Wedding Floral
I started pursuing wedding floral by taking classes at Longwood gardens, through other farmer florists and online.
We also increased our flower production to offer bouquets.

- 16 weddings to 62 weddings
    - My first year 16 couples trusted me with their wedding flowers and I had 0employees
    - In 2021 we did flowers for 62 couples, had 11 freelancers work for us and hadwedding floral budgets range from a $3,000 minimum to $12,000
- Don't tell them, show them...but tell them too
    - In order to grow the flower business we did:
        - styled shoots, which are a collaborative effort among wedding professionals to create content and expand their portfolio (everyonedonates everything)
        - Sampling
            - Definitely gave a lot of stuff away for free (I do not recommend thisone! Trading is fine but free is a one way street and not nice!)
        - social media "influencers"
            - This could be a friend that lives near you that has 2K followers. Itdoes not have to be someone with a huge following but it does have to be someone who is followed by

people you'd like to be your clients (location is key here!)

- Use your base clients to build what's new

  When customers would shop at our farmstand they'd see us working onwedding flowers

  - In every email I sent out I'd have a small blurb about wedding flowers and a button to click to take them to the flower website
  - Used the farm instagram to promote the flower instagram andbusiness with Wedding Wednesday
    - Now they are completely separate and I don't post contentfrom the wedding side on the farm account anymore

Other Ways to Incorporate Floral

- People don't always buy what they need but they usually buy what they want
  - Flowers are a great add on sale and a great grab and go by check out
- Market bouquets
  - Single variety, fast easy and budget friendly for customers
  - Mixed bouquets, cost more but also are WAY more work
    - For mixed bouquets we write a "recipe" and pick based on the recipe
      - Recipe Example:
        1sunflower
        3 celosia
        3 zinnias
        5 strawflower
        3 butterfly bush
        3 marigolds

- U Pick flowers are a fun add on for U-pick farms
  - You have them at your farm so make a few extra dollars and create morephoto opportunities
- Teaching classes
  - Wreath classes
  - Centerpiece classes
  - Class focused on an individual flower like peonies, dahlias, etc.
  - Mommy and me bouquet or centerpiece classes

Using what you already have going to grow your current business and the new add ons

- Email Lists
  - We have had an email list from the beginning and it's a huge asset
    - People that sign up for your email are your biggest fans, giving your emailis a commitment so make it worth it

Growing an email list

- Make it easy for them to sign up
    - A sign up tab on your website
    - Pop up on your website prompting them to sign up

Encourage email list sign ups by giving something away

- Information
    - Dahlia planting guide, recipes, garden advice, etc.
- first to know
    - Lure them in with email list exclusives…if you're not on the list you miss out
- actual item
    - Do a give away for an actual item, anyone on the list is in the running to win
        - Free u-pick pass for the season
        - Pie for the holidays
        - Admission to an on farm class
- Run a Give to Get Promotion
    - Give your email and get 10% off every time

you shopEmail Writing Tips

- Keep them short and make them quickly
    - header in canva or just use your logo at the top
    - 1-2 additional images
- 1 topic per email
- Always include a call to action whether that is a sale right then, getting them toyour farm, getting them to your website

3 types of Emails

- Selling
    - This is the most direct shortest type of email
        - Tell them what you want them to buy and then invite them to buy it
- Inspiration
    - This is a great opportunity to share a video or tell a story
    - Builds a connection with your customer and inspires them to use yourproducts
    - Appeals to emotions
- Informational
    - Helps customers learn about you, your business or your products
        - A monthly round up of commonly asked questions would be a greatinformational email
        - Comparing varieties of apples
        - Talking about availability

Social Media vs. Email vs. Blogging vs. Collaboration

Social Media is really great for showing your personality and for video content

- Know what you're going to say and say it clearly and concisely
- Is a following putting money in your pocket
- selling posts vs. story telling posts
    - I'd argue that storytelling posts are more valuable (people buy from peoplethey know, like and trust)
    - We usually get better response to the story telling posts I do over thewinter than the hard sell posts of the summer

Email

- You own your list

Blogging

- Great for writers, recipes, story telling

Collaboration

- The absolute best way to grow your business
    - Helping others in a mutually beneficial way
    - Engaging your local community
    - Actually reaching people who are more likely to visit your business

Weed Management

NOTES

Produce Safety Alliance Training

PRODUCE SAFETY RULE GROWER TRAINING

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The Food Safety Modernization Act (FSMA) was signed into law January 2011. The final rule was published November 2015 and went into effect January 2018. This is the biggest change to food safety that directly impacts fresh fruit and vegetable growers in over 70 years. 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 and farm stand products, 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/food-safety-modernization-act-fsma/fsma-inflation-adjusted-cut-offs, 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, IRS schedule F, etc. There are requirements for signage or labeling if qualified exempt.

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 buyers.

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) and proposed changes to the regulations
- 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. 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 growers 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 growers 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 should 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 growers, 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 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. To signup for a Readiness Review email Charlotte Muetter at chalotte.muetter@ag.nj.gov.

Inspections:
As part of the rule The New Jersey Department of Agriculture have begun inspections for the U.S. Food and Drug Administration (FDA). They started with concentrating on operations over $500,000. They are now expanding the inspections to include smaller operations. The first inspection is 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.

Produce Safety Rule Proposed Agricultural Water Revisions to Subpart E
Subpart E of the Food Safety Modernization Act Produce Safety Rule has been under review for some time. On December 6, 2021, FDA published in the Federal Register the proposed final rule. There is a 120-day comment period which ends April 5, 2022. Once the FDA reviews comments and publishes the final rule it will go into effect 60 days later. The proposed rule applies to anyone who produces fresh fruits or vegetables and sales over $25,000 annually.

Federal Register: https://www.federalregister.gov/documents/2021/12/06/2021-26127/standards-for-the-growing-harvesting-packing-and-holding-of-produce-for-human-consumption-relating. The proposed rule is 35 pages – 69120 to 69155 (small print). The actual proposed rule starts on page 69130.

The current agricultural water compliance dates are set to begin in January 2022, but FDA intends to exercise enforcement discretion for the agricultural water requirements for covered produce (other than sprouts) while proposing to extend the compliance dates for ALL Subpart E provisions. More information about the proposed compliance dates will be announced in the Federal Register and we will publicize those dates when announced.

FDA is looking for comments that are thoughtful and substantive, containing real life examples and solutions will assist them in creating a document that better suits the needs of fresh produce farmers across the country.

The On-Farm Food Safety Team has started to review the proposed rule. We will be sending out more information with areas where you may want to comment in the next few weeks.

Following are the instructions for making comments:

Proposed Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption Relating to Agricultural Water: https://public-inspection.federalregister.gov/2021-26127.pdf

Submit electronic comments in the following way:

Comments submitted electronically, including attachments, to *https://www.regulations.gov* will be posted to the docket unchanged. Because your comment will be made public, you are solely responsible for ensuring that your comment does not include any confidential information that you or a third party may not wish to be posted, such as medical information, your or anyone else's Social Security number, or confidential business information, such as a manufacturing process. Please note that if you include your name, contact information, or other information that identifies you in the body of your comments, that information will be posted on *https://www.regulations.gov*. If you want to submit a comment with confidential information that you do not wish to be made available to the public, submit the comment as a written/paper submission and in the manner detailed (see "Written/Paper Submissions" and "Instructions.")

Mail/Hand Delivery/Courier (for written/paper submissions):
Dockets Management Staff (HFA-305), Food and Drug Administration, 5630 Fishers Lane, Rm. 1061, Rockville, MD 20852.

For written/paper comments submitted to the Dockets Management Staff, FDA will post your comment, as well as any attachments, except for information submitted, marked, and identified as confidential, if submitted as detailed in "Instructions."

Instructions: All submissions received must include the Docket No. FDA-2021-N-0471 for "Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption Relating to Agricultural Water." Received comments will be placed in the docket and, except for those submitted as "Confidential Submissions," publicly viewable at https://www.regulations.gov or at Dockets Management Staff between 9 a.m. and 4 p.m. Eastern Time, Monday through Friday, 240-402-7500.

Confidential Submissions—To submit a comment with confidential information that you do not wish to be made publicly available, submit your comments only as a written/paper submission. You should submit two copies total. One copy will include the information you claim to be confidential with a heading or cover note that states "THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION." The Agency will review this copy, including the claimed confidential information, in its consideration of comments. The second copy, which will have the claimed confidential information redacted/blacked out, will be available for public viewing and posted on https://www.regulations.gov. Submit both copies to the Dockets Management Staff. If you do not wish your name and contact information to be made publicly available, you can provide this information on the cover sheet and not in the body of your comments and you must identify this information as "confidential." Any information marked as "confidential" will not be disclosed except in accordance with 21 CFR 10.20 and other applicable disclosure law. For more information about FDA's posting of comments to public dockets, see 80 FR 56469, September 18, 2015, or access the information at: https://www.govinfo.gov/content/pkg/FR-2015-09-18/pdf/2015-23389.pdf.

Beginner Farmers Training Session

BEGINNER FARMERS TRAINING SESSION: PART ONE – GETTING STARTED

William Hlubik[1], William Errickson[2], Brendon Pearsall[3], Lauren Errickson[4]
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Introduction

The RU Ready to Farm Beginner Farmer Training Program is a multi-year educational and training program designed to help new and beginner farmers establish and grow a successful farm business. This program provides online education in many of the practical business concerns that should be taken into account by new farmers. This includes the selection and evaluation of farmland, choice of crops to produce, business planning, marketing, financial management, and more. Part one of this full day session highlights several of these topics and serves as a starting point for those interested in learning more about what it takes to be a successful farmer in New Jersey. The RU Ready to Farm Beginner Farmer Training Program is supported by Beginning Farmer and Rancher Development Program grant no. 2020-70017-32784 from the United States Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA).

Getting Started in Farming

Project Director and Middlesex County Agricultural Agent William (Bill) Hlubik will cover many of the considerations that should be taken into account by those who are interested in becoming farmers. Bill will discuss the importance of planning before planting by:

- Reviewing basic questions to consider before starting a small farm business.
- Developing a business plan with a clear vision and S.M.A.R.T. goals and objectives – Plan before you plant a seed in the ground.
- Using a SWOT (Strengths, Weaknesses, Opportunities, Threats) to make key decision for your new farm.
- Determining if you want to be a part-time or full time farmer – Many farmers have an outside income or benefits to provide the additional support they need to build their business.
- Starting off on a small scale to minimize risks and gain experience.
- Finding opportunities to gain experience working with experienced growers.
- Learning to work together with a community of experts to help you achieve your farm business goals.

Site Selection for Your Farm

Co-Program Director and Monmouth County Agricultural Agent William Errickson will discuss some of the most important things to consider before purchasing or leasing a farm property.

Important elements to consider for selecting your site include:

- Site History – Determining potentially hazardous industrial or agricultural activities that may have taken place on the site in the past and whether they could be a potential source of contamination for your crops.
- Water Availability – Assessing the quality, quantity, and availability of water on the site, including whether there are any contamination issues or environmental concerns.
- Soil type and Quality – Using the Natural Resources Conservation Service's (NRCS) Web Soil Survey to evaluate soil type, texture, slope, and quality to gain insight into whether or not the crops you want to grow will produce well on a given parcel of land.
- Other Concerns – Determining whether the land has (or needs) deer fencing, outbuildings, adequate sunlight, and access for equipment and/or customers.

Incorporating Niche Crops into Your Farm Business Plan

RU Ready to Farm's Program Coordinator, Brendon Pearsall will discuss several niche crops you may consider adding to your farm business plan. Niche crops offer a great opportunity for small farmers who are looking for a way to start making a good profit on a small scale. We define niche crops as high-value crops that can be profitable on 10 acres or less. They often have a high value per acre and don't require expensive or specialized equipment to start out. Some examples that will be discussed include:

- Cut Flowers – High intensity growing systems and great value-added options make flowers an ideal niche crop.
- Mushrooms – Specialty mushrooms can be produced indoors year-round with relatively low start up costs, making them a predictable revenue source for those who are willing to learn a new skill.
- Specialty Hot Peppers – These aren't your standard jalapenos. Habanero, Carolina Reaper, Ghost Peppers, and other high heat peppers can give you a great return if you can match up your supply with consistent demand.

Promoting and Marketing Your Farm

Good promotion and marketing are vital to the success of any small farm, regardless of what product you choose. With the tools offered by social media platforms, it has never been easier or more affordable to promote your products, but it does take some skill. Marketing Consultant Justine Gray will discuss some of the easy-to-use online options available to small farm businesses. This talk will cover:

- The importance of having an attractive and easy to navigate website.
- How to use social media to raise awareness of your business.
- How to find and use simple templates on sites like Canva to quickly create attractive advertisements.
- How building an email list and using email marketing can keep customers coming back to you.

Ag Agency Program and Support for New Farmers

Throughout this session we will feature speakers from various Ag Agencies that offer support and services to farmers. These agencies include:

- **Farm Services Agency (FSA) –** The FSA is a federal agency that administers various USDA farm loan and assistance programs. New farmers who struggle to find financing from traditional lenders can turn to the FSA for access to operating, purchasing, and micro loans.
- **NRCS –** The NRCS provides farmers access to a wide range of financial and technical assistance programs. NRCS grants can help farmers to improve water management, soil health, and can assist in the construction of high tunnels for season extension.
- **Farm Credit -** Farm Credit's mission is to support rural communities and agriculture with reliable, consistent credit and financial services. They are a lender that specializes in agricultural loans and understands the complexity of running a farm business in way that many other lenders do not.
- **Farm Bureau –** Farm Bureau is a nationwide advocacy group that represents farmers at all levels of government. They provide informational resources to farmers and work to educate the public on the importance of agriculture.

Beginner Farmer Panel
Co-Program Director and Director of Rutgers Gardens, Lauren Errickson, will facilitate a panel discussion of successful beginner farmers. This panel will give attendees a chance to learn from and network with farmers who are currently growing their farm businesses. They will discuss what has worked for them, and what they would do differently if they had the chance.

Part 1 of 2
This program is part one of a full day education session for beginner farmers. The afternoon session, New Orchards, is led by Hunterdon County Agricultural Agent Megan Muehlbauer and will provide new and beginner farmers in-depth information on starting and managing a tree fruit orchard.

Session Recording
If you are interested in obtaining the video recording of this session, reach out to us at beginnerfarmer@njaes.rutgers.edu.

Beginner Farmers
New Orchards

ORCHARD SPECIFIC SITE SELECTION, PREPARATION, AND NUTRIENT MANAGEMENT

Megan Muehlbauer
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Growing tree fruit is one of the most challenging horticultural endeavors. Thus, in order to maintain a healthy, fruitful and profitable orchard it is critical to select, prepare and manage an optimal site.

Site Selection:
Selecting a site for an orchard is unique from annual crops in that tree fruit are a 20+ year land investment. It is one of the very first considerations when establishing an orchard, and should be done so carefully as it is very difficult to move trees after planting them. This decision should also be made at least 2 years prior to planting trees to allow plenty of time to prepare the soil.

As part of the site selection process, growers should research the soil properties of their site illustrated on the Web Soil Survey: The Web Soil Survey developed by the USDA-NRCS (Natural Resource Conservation Service) provides an interactive map detailing a tremendous amount of information including the natural pH of soils, soil textural properties and soil slopes. All of which is information that may not be clear based upon an initial site visit.

Additional Site Considerations include:

Air drainage: Optimal orchard placement is along a slope, specifically in the middle section of the slope to aid in air drainage. Allowing for air drainage is an important way in which to prevent frost damage.
Water drainage: An additional reason to establish an orchard along a slope is to aid in water drainage. Water should not puddle in an orchard for more than 24 hours after a moderate spring rain.
Full sun: All fruit crops need unobstructed sunlight to produce fruit buds
Placement downwind from a hedgerow: The hedgerow provides a buffer from prevailing winds.

Site Preparation:

Soil/site preparation should begin two years prior to planting.
Fall (1): Soil test #1-A complete soil test should be taken to determine the pH and other major nutrient levels.
Spring (1): Adjust the soil pH to achieve a pH of 6-6.5, as well as potassium and phosphorous levels as detailed by the soil test. In addition, begin to spray herbicides and eliminate perennial weeds.

Summer: Plant a cover crop to improve soil structure, and organic matter while further reducing the weed population.
Fall (2): Perform a follow up soil test to ensure the pH and nutrient levels are adjusted appropriately, and apply additional amendments if necessary
Spring (2): Plant trees

Nutrient Management:
Early/short term management involves performing the two afore mentioned soil tests. The most important thing to achieve is to ensure that the pH has been adjusted to reach 6-6.5 prior to planting. Additional critical early nutrient management includes monitoring potassium, phosphorous, sulfur and boron levels.

Long term nutrient management involves consistent leaf tissue analysis. However, note that nitrogen levels are measured by both leaf tissue analysis and previous seasons shoot growth. If shoot growth is too extensive future nitrogen amendments should be reduced, if shoot growth is less extensive nitrogen amendments should be increased.

APPLE VARIETY AND ROOTSTOCK SELECTION

Megan Muehlbauer
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After many years of cultivation, hundreds of apple varieties are available to growers. A few of the most notable varieties best suited for beginner growers in New Jersey will be highlighted.

Apple Tree Anatomy

Apples are unique from several other fruit and nut crops, in that they are nearly always clonally propagated by grafting. In this process, the scion (variety of interest) is grafted onto a rootstock (root system of tree fruit). This ensures the trees are clonal, while allowing the root system to impart characteristics such as disease resistance and dwarfing.

It is important to note that apples are cross pollinated and thus require another tree of a different and compatible variety in to produce fruit.

Varieties

A number of apples have been bred specifically for NJ growing conditions, a few are described below.
Variety Choices and Characteristics:

Zester!™ ('State Fair' x advanced seedling): This is a popular summer apple among NJ growers. It is a yellow apple with an excellent sugar acid balance.

Crimsoncrisp™: This September ripening variety is a result of collaborative breeding efforts at Rutgers University. It is a deep red apple with yellow flesh and very sweet flavor. It is particularly well suited for new growers as it has apple scab resistance.

Suncrisp™: This variety ripens in late October and was also bred at Rutgers University. It is a golden apple with orange red blush, high sugar and acid and cream-colored flesh. This can be a slightly more challenging apple to grow because it lacks disease resistance however it has stand out flavor.

Evercrisp®: Evercrisp is one of the latest ripening apples. It has great sweet juicy flavor and a notable crunch due in part to its Honeycrisp parentage. Evercrisp is a standout apple because it has excellent storage potential.

Rootstocks

Most newly bred rootstocks have some degree of resistance to a number of different diseases (i.e. fireblight and crown rot). In choosing a rootstock it is important to consider the type of growing system they will be planted in. Growing systems range from low density where the trees are free standing with 10+ feet centers up to very high density systems where trees are grown on trellises with just a couple feet between trees. Trees grown in high density systems tend to be grown on rootstocks with highly dwarfing characteristics while trees grown in low density systems are grown on less dwarfing rootsystems.

Rootstock Choices and characteristics:

B.9: This is one of the most dwarfing rootstocks available. It is slightly more dwarfing than M.9 and a bit more productive. It is also very winter hardy and resistant to crown rot and fireblight

M.9: This rootstock is one of the most common dwarfing rootstocks available. It is very precocious, and tolerant to a number of different growing environments.

G.935: This rootstock has production that is about equivalent to that of M.9 but has resistance to fireblight and crown rot.

G.11: This rootstock is significantly more dwarfing than M.9 but noted as being more productive. It is also resistant to fireblight and crown rot.

2022 TREE FRUIT PEST AND DISEASE IPM OVERVIEW

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This talk highlighted potential key pests and diseases for tree fruit (pome and stone) producers in New Jersey in the upcoming field season. Special focus was provided for invasive insects of particular importance (Brown marmorated stink bug (BMSB) and Spotted lanternfly (SLF)). Integrated pest management (IPM) techniques for managing the various pests and diseases were provided, including pesticide recommendations. Special thanks to Drs. Greg Krawczyk and Kari Peter for their assistance with slide preparation.

Resources, such as NEWA (**N**etwork for **E**nvironment and **W**eather **A**pplications), which can be found at https://newa.cornell.edu/, for growers looking to better manage the insects and diseases within their orchard were discussed in depth. NEWA provides growers the opportunity to use weather data collected from local weather stations and track the infection risk from diseases such as apple scab and track insect development for appropriate trap deployment. The NEWA website also provides growers insight into potential apple thinning timings using the carbohydrate thinning model. Finally, it is also helpful for growers with berries, grapes, or any of the several vegetable crops that have models available.

Utilizing orchard scouting to time for orchard pheromone trap placement was highlighted as a good IPM practice. General timing guidelines for several orchard pests can be found in a table below. However, it is extremely important to note that these are guidelines, and orchard scouting is not optional when it comes to timeliness and efficacy of trap placement.

Table 1: Apple insect pest pheromone trap timing.

Insect	Trap Timing
Oriental fruit moth	First week of April
Codling moth	At pink
Tufted apple bud moth	At pink
Obliquebanded leafroller	After bloom
Apple maggot	Early June

Table 2: Peach insect pest pheromone trap timing.

Insect	Trap Timing
Oriental fruit moth	First week of April
Obliquebanded leafroller	Late May
Lesser peachtree borer	After bloom
Peach tree borer	Late May

Below is a table highlighting some insecticidal options available for petal fall control for common insect pests to be used in conjunction with other IPM practices. Important to note is that these are merely options. There are many products capable of controlling these pests, but these examples were chosen due to their common usage by Pennsylvania fruit growers.

Table 3: Orchard insect pests and insecticidal control measures.

Insect	Control Measure
Brown marmorated stink bug (BMSB)	Assail, Actara, imidacloprid
Spotted tentiform leafminer (STLM)	Actara, imidacloprid, Agri-Mek
Tarnished plant bug (TPB)	Assail, Avaunt, Imidan
Rosy apple aphid (RAA)	Assail, Actara, imidacloprid
Eastern apple sawfly (EAS)	Assail, Avaunt, Imidan
European red mite (ERM)	Agri-Mek
Plum curculio (PC)	Assial, Avaunt, Actara, imidacloprid, Imidan
Oriental fruit moth	Assail, Avaunt, Imidan

2021, for Pennsylvania growers, was a tough year for apple scab management. It is important to note that apple scab preventative sprays should be combined with orchard scouting to ensure efficacy of treatments. Spray recommendations were made available alongside proper scouting techniques. The chart below highlights some of the products available for apple scab control and their timings. Once again, it's important to note that these products were used as examples.

Table 4: Apple scab spray timings and materials.

Timing	Materials
Dormant	Copper
Green tip	Rainfast mancozeb + Syllit OR Captan OR potassium bicarbonate
Tight cluster	Rainfast Mancozeb + Syllit FRAC Groups 3 and/or 9 (Ceyva, Rally, Indar, Procure, Rhyme, Vanguard, Inspire Super) Sulfur Potassium bicarbonate
Pink, bloom, petal fall	Rainfast mancozeb + FRAC Group 7 (Aprovia, Fontelis, Excalia, Luna Tranquility, Luna Sensation, Merivon, Miravis, Pristine, Sercadis)
Cover sprays	Captan (alone) OR + TopsinM + Ziram
Preharvest	Merivon, Pristine, Luna Sensation

The table below highlights the temperature ranges and leaf wetness hours necessary for infection during the critical period between pink and petal fall. This chart helps growers determine when scouting can be done to determine spray efficacy.

Table 5: Calculating apple scab infection periods using the Revised Mills Table.

Average temperature (°F)	Wetness (hours)	Lesion appearance (days)
34	41	--
36	35	--
37	30	--
41	21	--
43	18	17
45	15	17
46	13	17
48	12	17
50	11	16
52	9	15
54-56	8	14
57-59	7	12-13
61-75	6	9-10
77	8	--
79	11	--

The take home message of the presentation is that for good, long-term management of orchard pests and diseases a well-balanced spray program must be utilized alongside other integrated pest management techniques, such as pheromone disruption and scouting. Timing sprays to historical dates is not enough to effectively manage an orchard since environmental changes will influence the life cycles of both insects and diseases.