2024

MID-ATLANTIC
fruit & vegetable convention

PROCEEDINGS

for the vegetable, potato, greenhouse, small fruit & general sessions

Proceedings

for the

Vegetable, Potato, Greenhouse, Small Fruit and General Sessions

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Pennsylvania Vegetable Growers Association

An association of commercial vegetable, potato and berry growers

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MAKING AGRITOURISM ACCESSIBLE

Claudia Schmidt, Assistant Professor of Marketing and Local/Regional Food Systems, Department of Agricultural Economics, Sociology, and Education, Penn State

Ensuring that visitors of all abilities can enjoy your farm not only increases their satisfaction but also helps to enhance your reputation as an inclusive and accessible business. Operators have to ensure that visitors with disabilities have access to operations and events that are open to the public. The accommodations needed will depend on the operation and the activities offered. For more information, please see the Americans with Disabilities Act (ADA).

Helping Visitors Find Your Farm - Website and Social Media Accessibility

When creating content for your website and social media, it is essential to prioritize accessibility for all users, including those with disabilities. Using simple words and straightforward language can make your content more accessible to everyone, including individuals with disabilities. It also makes it easier for customers using assistive technology (e.g., screen and speech recognition software) to understand your content faster.

Regarding design elements, focus on easy to read fonts and color contrast. Your content should have high contrast between the text and background colors, and you should use legible fonts. Avoid using color combinations such as green and red and light colors with greys, which can be difficult for those with visual impairment to read or navigate websites. Verdana, Georgia, and Lucida Grande (Mac)/Lucida Sans (Win) are highly recommended fonts for web use. Other design elements include having a suggested 16-point font size and using a line spacing that is "at least 1.5 times the font size."

When using hashtags, adopt the Pascal Case, which involves capitalizing the first letter of each word (for example, #EasterOnTheFarm), or Camel case, which involves capitalizing each word after the first (#easterOnTheFarm). This makes them easier to read for everyone, not just those using screen readers. Limit your use of emojis as they can cause confusion for people using screen readers, which describe emojis literally. Another important part is using alternative text (Alt text) for images. Alt text allows people to visualize a picture when they can not see it. With Alt text you can briefly describe the picture or graphic that assistive technologies can read to visually impaired users. In addition, Alt text can also help with SEO (Search Engine Optimization), which relates to how easily website users can find your website among all the others that contain similar content - more descriptive words mean more people get to see your posts.

An important step in making your content accessible to deaf or hard-of-hearing users is to ensure your video content on social media or your website includes open or closed captioning. Captioning also helps users access your content in an environment where they have to be quiet. Make sure that you list all the accommodations you make, required and beyond, on your website so your visitors know what to expect.

Contact options

Have multiple communication options available for your customers. Besides providing a telephone number on your website, allow your visitors to text or email you and check these communication channels regularly when you offer them to ensure that messages are delivered. Additionally, having a website contact form that allows visitors to ask a question or provide a comment and then click submit further reduces the burden for consumers to reach you."Call for store hours" is a barrier for hearing-impaired customers.

Claudia Schmidt is an Assistant Professor of Marketing and Local/Regional Food Systems at The Pennsylvania State University. She researches small-scale agricultural producer and processor issues in the United States within the network of local food systems, focusing on agritourism and direct-to-consumer sales.
Kathy Kelley is a Professor of Horticultural Marketing and Business Management at The Pennsylvania State University. She teaches a Retail Horticultural Business Management course, and her research interests include studying consumers' wine consumption and purchasing attitudes and behaviors, wine tourism and what encourages tasting room visits, and related. She also has extension responsibilities that include developing business and marketing educational programs for wine brands and winery tasting rooms.

Providing Accessible Facilities and Amenities
Providing accessible facilities such as wheelchair ramps, accessible restrooms, designated parking spots for visitors with disabilities, and accessible seating areas are required. Make sure to provide information on your website and your property on where to find these facilities. A good way to check the accessibility of your farm is to rent or borrow a wheelchair and navigate through the property. The Blue Trunk Foundation suggests putting up a sign that lets customers know that they are welcome and how they can ask for assistance. If you have handouts or brochures, you may offer these in large printed fonts.

When designing pathways throughout your farm and to activities, ensure they are wide, and surfaces are flat and non-slip when wet so that visitors with mobility impairments can safely navigate them. Be sure to pretreat drive and walkways before any snowfall and remove snow and ice accumulating on these surfaces.

If you offer classes or sit-down events, The Blue Trunk Foundation recommends round tables instead of long rectangular tables, as these provide more space for wheelchairs, making it easier for deaf and hard of hearing customers to communicate with others at the table. Keep in mind that not all people with a hearing disability know sign language.

Asthma and Allergies
Under the ADA, asthma and allergies are typically classified as disabilities. If you offer consignments or food at your farm store or events make sure you label allergens clearly and/or have a list of allergens posted or available on request. According to the U.S. Food & Drug Administration, the nine major food allergies include peanuts, tree nuts (e.g., almonds, pecans), soybeans, sesame, wheat, eggs, milk, fish, and crustacean shellfish. Seek out guidance about steps you and your employees need to take to ensure an allergy-safe venue, including training, and what to do if a customer should have a reaction. While strong smells from animals, food preparation, fertilizers, etc., cannot be avoided on a farm, be aware that strong fragrances may be an issue for visitors with allergies and asthma.

Neurodivergence
The term neurodivergent is used as an umbrella descriptor for people with variations in their mental functions. It is important to note that being neurodivergent is not the same thing as having a disability, although some people who are neurodivergent may need accommodations at work or school. The Blue Trunk Foundation recommends having quiet areas available so visitors can recover from sensory stimuli and having materials available in easy-to-understand language.

Staff Training
For your farm to be truly accessible, all employees must be provided training and education regarding the needs of visitors and the accommodations and options that are in place. It is essential to train your staff on how to interact and engage with visitors with disabilities, including how to provide assistance and communicate effectively.

Resources:

5 Food Allergy Guidelines to Follow in Your Restaurant: www.unileverfoodsolutions.us
ADA-Compliant Snow and Ice Management Strategies: www.facilitiesnet.com

Asthma and Allergy Foundation of America: https://aafa.org/

Best Color Combinations for Visually Impaired Web Users: www.adaptainc.com

Easy, Actionable Ways to Make Your Content More Inclusive: www.accessliving.org

Food allergies: www.fda.gov

Is your content making the grade? Grade level is now a vital readability metric: www.visiblethread.com

The Americans with Disabilities Act (ADA): www.ada.gov/

PRICING AGRITOURISM ACTIVITIES AND EXPERIENCES

Sarah Cornelisse
Sr. Extension Associate
Dept. of Agricultural Economics, Sociology and Education
Penn State University, 206A Armsby Building, University Park, PA 16802
sar243@psu.edu

A national survey of agritourism operations found that more than half (66%) of the farms reported profit under $10,000 and 79% of farms reported challenges with cash flow management and availability of operating capital (Hollas et al., 2021). The survey also found that positive revenue and profitability are most strongly associated with on-farm sales and entertainment experiences (Hollas et al., 2021). For agritourism operations offering activities and experiences, pricing of those becomes key to having adequate cash flow, operating capital, and achieving profitability.

Beyond profitability, pricing contributes to the perception of your agritourism operation, that is, when consumers see your prices it sends signals to them about quality, match with them, the target consumer, expectations for the experience, and so forth.

Depending on the type of agritourism activities and experiences you offer, there are numerous opportunities to generate income. These include:

- Admission fee
- Activity fee (tour, tasting, craft table, etc.)
- Lodging
- Facility rental
- Food service
- Souvenir sales
- Sales of farm products
- Sales of value-added products

When determining how to price for your agritourism activities and experiences, it is important to keep in mind the three C's of pricing – costs, customers, and competition. Just as when setting prices for tangible products, your costs for providing activities and experiences need to be accounted for when setting agritourism prices. These costs include:

- Labor, supervision
- Products, inputs
- Facilities, infrastructure & maintenance
- Taxes and insurance
- Marketing
- Depreciation

Setting prices doesn't occur in a vacuum, however. Understanding current and potential customers is the second element to pricing. You should understand the motivations and the demand for the activities and experiences you offer. A 2014 study found that the top five motivations for visiting a farm were (1) view the scenic beauty, (2) do something with their family, (3) enjoy the smells and sounds of nature, (4) learn more about nature, and (5) have a change from their daily routine (Sotomayor et al., 2014). The ability to charge more is increased when what you

Sarah is a Senior Extension Associate and Specialist in agricultural entrepreneurship, marketing and business management at Penn State University in the Department of Agricultural Economics, Sociology, and Education. Sarah has expertise in direct marketing, agricultural and value-added dairy entrepreneurship and marketing, digital and social media marketing and commerce for agricultural farm and food businesses, and business and marketing planning and decision making.
Originally from New York state, she received a B.A in mathematics from the State University of New York at Geneseo, and M.S. degrees in Agricultural Economics and Animal Science both from Penn State University.

offer aligns with visitor motivation. Trends in agritourism activities and experiences can affect visitor demand for various activities and experiences. For instance, consider the rising popularity of activities such as apple cannons and sunflower mazes, and photographic opportunities.

In addition to understanding visitor motivations, an understanding of their spending habits and willingness to pay for various activities and experiences will also help with determining prices. Databases regarding consumer spending do exist and can be valuable, but accessing this information can be costly. Instead, surveying current and potential visitors about how much they would pay for different activities can be done. Depending on how a survey is carried out you may also gain insight as to visitors' perceived value of an activity or experience.

Competition, of course, plays a role in setting prices as well. Take the time to analyze the pricing of activities and experiences offered by other agritourism businesses. Look at operations that offer both similar and differing activities as well as businesses in your geographic area and in different parts of the country.

Agritourism operations that host numerous activities and experiences, particularly during a specified time period, such as a fall festival weekend event, may struggle with deciding whether to charge an admission fee or individual activity fees. In the publication Growing Agritourism in Kansas, several pros and cons are laid out for each strategy. For instance, an admission fee offers visitors the knowledge of exactly what they will spend during their time at your operation (Eckert and Kline, n.d). This can be vitally important for families with children or for those with limited disposable income. On the other hand, you will then be faced with marketing the value of the admission fee to visitors. They will want to know exactly what they can expect to receive by paying the fee.

Charging individual activity fees, rather than an admission fee can give visitors a sense of control since they will only pay for activities/experiences that they want to take part in. Two downsides of this pricing approach are that a transaction must occur at each activity (whether cash, credit, or ticket) and numerous transactions can leave visitors feeling "nickeled and dimed" (Eckert and Kline, n.d). Clearly posted and accessible prices are also crucial when charging by individual activity. Consider having signs at each activity showing the fee and having an activity list with prices on your website.

Additional considerations when pricing agritourism activities and experiences include:

- Adjustable pricing – e.g. higher prices on the weekends or no-school days
- Uniqueness of activity/experience – an activity/experience that is not available elsewhere can provide an opportunity for higher pricing.
- Using pricing strategies such as bundling of activities, group pricing, frequent visitor/loyalty rewards or discounts.

One way to assess the practicality of a proposed price, is by performing a simplified break-even analysis (Schilling et al., n.d.). This method will calculate a minimum of sales required for activity or experience using the formula:

$$BE = TFC / (P - VC),$$

where TFC = Total Fixed Costs, VC = Variable Costs, and P = Price.

The activity or experience would be profitable if you were able to sell more than the break-even (BE) calculated.

Finally, profitable pricing requires that you evaluate the pricing of your agritourism activities and experiences regularly. You should not be afraid to adjust prices. This requires that you maintain comprehensive and accurate records.

In summary, keys to setting profitable prices include:

- Knowing your costs - fixed and variable.
- Understanding opportunities for charging fees for activities, experiences.
- Performing a breakeven analysis to know breakeven price or quantity.

- Performing sensitivity analyses to understand how changes in sales quantities or changes in price impact profitability.
- Adjust based on product characteristics, a specific pricing strategy, customer price sensitivity, customer values, and other factors.

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BUILDING COMMUNITY WITH FARM EVENTS – GROWER PANEL
AGRITOURISM/ AGRI-EDUCATION IDEAS

Presented by Denise Bosworth
4th Generation Owner
Rohrbach's Farm
Catawissa, Pennsylvania
Rohrbacsh.farm.market@gmail.com

Community Connection and Partnership is Essential. Here are some of the key events Rohrbach's Farm participates in or hosts to foster the partnership and promote agriculture awareness and education.

Ag Awareness Day
Ag Awareness Day is hosted in partnership with local FFA Chapters, 4H, and Penn State Extension, hosted at the Bloomsburg Fairgrounds Industrial Arts Building.

Local farmers, growers, and community engaging organizations are invited to participate.
The event is free with a requested donation of canned food items that are donated to the local food pantry.

Traveling Library
On our farm we host key events with our local Traveling Library. The Traveling Library has two permanent sites but is essential in a rural community. This past year we hosted one of their story walks featuring my book, "Penelope Pumpkin" which is an agri-education based book. Children experienced walking and reading as well as visually seeing the farm in action.

Agriculture Camp
We kick off our summer with a week long agriculture camp. Funding is in partnership with our local Children's Museum and the Pennsylvania Farm Bureau as well as camp admission. The Mobile Agriculture Lab is the main education experience but we provide our own on farm education and invite guest speakers. The camp ends with a soil pit and a very hands on learning experience presented by the Columbia County Conservation District.

Thursday Summer Workshops
Thursday workshops are designed to give families an affordable summer fun learning experience. The target audience is a broad scope from ages 4 to 10 and we find it works very well. We host these outside with guest speakers who have agriculture related expertise and experience, or health and mental health aspects of education. We often

Denise (Rohrbach) Bosworth is the 4th generation owner of Rohrbach's Farm in Catawissa, Pennsylvania. Denise completed her Business and Communications degree from Houghton University in New York and her Master's work in Counseling from Cairn University.
Denise grew up on her family farm, but after college she pursued a career in Human Resources in Philadelphia. There she met and married her husband, Dan, and together they have three children. They returned to the farm in 2013, opening a BBQ restaurant in the barn and continuing a 67-year farming tradition in their community.

Abbie Spackman
Abbie Spackman is the owner and operator of The Heirloom Farmer, a family farm in Centre County, PA growing heirloom garden plants, pie pumpkins, potatoes and provides incredible on-farm experiences to bring joy and beauty to the community. Abbie is a 6th generation farmer, but the first generation to open the farm up to the public for events and agritourism. The largest on-farm event is the Spring Forward Homestead Day held on the farm each spring on the third Saturday in May. To learn more visit theheirloomfarmer.com or follow @theheirloomfarmer on Facebook and Instagram.

Anthony Leon, The Bubbly Goat Farm
My name is Anthony Leone. I grew up in a farming community and our family began a farm of our own in 2017. Our family owns and operates The Bubbly Goat in Stockton NJ. We raise several breeds of dairy goats and create products with their milk along with selling quality stock. We also provide a wide array of public ag experiences on our farm. I have a passion for cultivating vegetables, turf, ornamental bedding crops and sharing farm knowledge.

invite local youth to be guest presenters to foster opportunities for public speaking and gain confidence.

On-Site Field Trips
Traditionally, field trips are considered for elementary students and happen in the fall. We have been very intentional to broaden that exposure. We welcome homeschool groups, special needs and abilities groups as well as traditional classrooms of all ages. We adapt curriculum to be age and developmentally appropriate. We are constantly developing new curriculum because we see repeat groups attending.

Spring/ Summer Programs:
Strawberry Workshop; new in 2024: walking/ reading path with Denise's book, "Are They Ready Yet?" an Agri education book about strawberries in Pennsylvania.

How Sweet it Is: all about the different types of corn, how they grow and what they are used for.

Fuzzy, Sweet and Juicy, Peach Workshop: a workshop designed to help children understand about fruit trees throughout the season, how we care for them and what is so special about peaches.

Farm Scavenger Hunt: this program works best for groups of 30 or less. Students partner up with a clipboard and pencil and we do a walking tour of the farm on a learning scavenger hunt. This guided tour helps students look for and discover all the things we grow on our farm.

Our in-site field trips are very affordable at $1/ per child; minimum 15 students or $15 fee.

In addition we offer Add-On packages including making a dessert, picking your own fruit and even making strawberry jam!

Fall Programs:
Our fall tours are adapted to the age and developmental level of our groups. For a broad picture we show students how apple trees change through the season, how apples are harvested, and we emphasize the importance of supporting local farms and farm markets.

In addition, we talk about pumpkins, gourds and squash. We share with students what grows in the fall and what we can and can't eat. Talking to children about unique foods like spaghetti and carnival squash gains their interest and we hope their ambition to want to try new foods.

We also offer the option for students to play in our playland (corn pit, basketballs hoops, slides and more) for one hour, pick their own pumpkin, visit the corn maze and use our picnic tables if they'd like to bring their lunches.

We see a very high number of special needs and abilities groups visit us in the fall.

Winter programs:
We offer an inhouse gingerbread house assembly program in December. This continues our connection with our local groups, especially our smaller schools and our special needs classrooms.

EVALUATING HYDRANGEAS FOR LANDSCAPE AND CUT FLOWER USE

Becky Sideman, with Kaitlyn Orde, Cathy Neal, and Ella Lukacz
University of New Hampshire, 211 Kendall Hall, Durham NH 03824;
becky.sideman@unh.edu

Hydrangea *(Hydrangea spp.)* is a deciduous shrub native to Asia and the Americas, including Eastern North America. Its popularity has grown internationally in recent years (Kitamura et al., 2018) and it is sought after by florists and consumers for its' large size, texture, and range in colors. Florists most commonly source "big leaf" hydrangea *(H. macrophylla)*. However, this species is only winter hardy through USDA Zone 6 and winter injury and late spring freezes commonly reduce flowering even in zones 6 and 7.

Conversely, "panicle" *(H. paniculata)*, "smooth" *(H. arborescens)*, and "oakleaf" *(H. quercifolia)* hydrangeas are quite cold tolerant, with panicle and smooth hydrangea hardy through USDA Zone 4 and oakleaf through Zone 5. These species are available in a range of colors (white, green, magenta, light-pink, and purple), textures (lacey, loose, and dense), and bloom shape. These species are therefore promising for cut flower production in cold climates. New varieties are constantly being offered, but little or no performance experience is available to guide growers in selecting among the offerings.

With the support of two grants (from the Anna and Raymond Tuttle Foundation and the NH Specialty Crop Block Grant program), we established a replicated planting of sixteen hydrangea cultivars at Woodman Farm in summer 2020. Preliminary data from these young shrubs indicates that there are wide differences in flower production, stem quality, flowering time and duration, and postharvest floral quality – among other traits.

What we did: In one site (Durham NH – USDA hardiness zone 6a), we grew 16 hydrangea cultivars in a replicated trial with 4 plants of each cultivar using a randomized complete block design. Two-gallon nursery plants were planted in the field on 1 July 2020 in a full sun location. Plants were spaced 10 feet apart within two long rows spaced 15 feet apart on center, and were planted into holes cut in 6 foot wide landscape fabric for weed suppression. Plants were irrigated using drip irrigation with two emitters (2GPH each) per plant. After planting in 2020, plants were irrigated with 1.5 gallons per plant three times a week. In 2021, plants received 1 hour of irrigation twice a week, which equated to 3 gal/plant.

120 lbs/A of K2O using 0-0-60 was applied preplant. No nitrogen was applied preplant, but a slow release fertilizer was visible in all pots when planted. No additional fertility was applied in the year of planting (2020). On 14 Apr 2021, 1 lb per 1000 ft2 27-0-0 was applied to support early-season growth, as recommended by Neal (2018). An additional slow release fertilizer (Nutricote 18-6-8) was applied on 2 June 2021 at a rate of 1 lb N/1000 ft2. No additional supplemental fertility was provided throughout the experiment.

During the growing season of each year (2020-2023), we assessed vigor/survival in the early spring, and monitored plants weekly to record the bloom season. We also assessed plant size, stem length and bloom size, and evaluated vase life after 3 days of cooler storage after harvest.

Results:

Oakleaf hydrangea: Queen of Hearts and Gatsby Star suffered significant winter injury and for each, 2 of the 4 plants died. The remaining plants did not bloom in 2021 or 2022, though a few blooms were observed on the remaining living plants in 2023.

Smooth hydrangea: Invincibelle Spirit II suffered winter injury, with 2 out of 4 plants dead by 2023, and the remaining plants were small and weak. All Mini Mauvette plants survived, but they were small and lacked vigor. Both produced

Becky Sideman is a professor of horticulture with the University of New Hampshire. Her research and extension efforts include evaluation of new specialty crops, variety trials, seasons extension, and cover cropping systems. She chairs the Department of Agriculture, Nutrition & Food Systems at UNH. She lives with her husband on their small farm in Strafford NH. Dr. Sideman grew up on a diversified farm in Vermont. Prior to joining UNH in 2004, she worked as a plant breeder with the USDA Agricultural Research Service in Salinas, California.

blooms were beautiful with unique magenta/pink colors, but there were very few of them. In contrast, Lime Rickey was extremely vigorous, early, and a prolific producer of lime green blooms early in the season.

Panicle hydrangea: All cultivars of panicle hydrangea thrived and produced abundant blooms. For comparisons below, we include all panicle hydrangea cultivars, and Lime Rickey, the only smooth hydrangea cultivar to show reasonable vigor.

The earliest variety, Lime Rickey, first bloomed in mid-June, compared with late July for the latest variety, Confetti. Some varieties, such as Bobo, Flame, Flare, and Little Quick Fire, were excellent for landscape use, but produced flowers with relatively short stems, limiting their versatility for cut flower use. Some varieties, such as Diamond Rouge, Moonrock, Confetti, and Zinfin Doll, produced huge blooms, up to 12" tall, on stems longer than 2 feet, making them suitable as focal points or in very large arrangements.

A full report with photographs and additional details is available here: https://bit.ly/hydrangea22

Hydrangeas at a Glance

Variety - species	Vigor of plant at 3rd year	Early bloom color	Late bloom color	Cut flower life (fresh)*	Notes/ Comments
Lime Rickey *H. arborescens*	Excellent	Green-White	Green	10+ days, recutting increased vase life	very early blooming, mid-June
Invincibelle® Mini Mauvette *H. arborescens*	Poor	Deep purple	Pinkish-Green	did not flower in 2022	plants weak and/or dead
Invincibelle® Spirit II *H. arborescens*	Poor	Magenta	Pinkish-Green	10+ days	plants weak and/or dead
Bobo *H. paniculata*	Excellent (small plant)	Green-White	Deep pink	2-4 days, recutting increased vase life	stems very short for cutting
Confetti *H. paniculata*	Excellent	White	Dusky mauve	7-10 days	very late blooming, end of July
Diamond Rouge *H. paniculata*	Excellent	White	Deep rose pink	4 days	extremely large heads
Firelight *H. paniculata*	Excellent	White	Deep rose pink	4-7 days	some sepal browning reduced attractiveness
Flame *H. paniculata*	Excellent	White	Medium pink	2 days	extremely short stems

Flare *H. paniculata*	Excellent (small plant)	White	Deep rose pink	4 days	some brown spots on sepals, few sepals per head, somewhat short stems
Limelight *H. paniculata*	Excellent	Creamy-White	Pale Mauve	10+ days	one of the best for cut flowers
Little Lime *H. paniculata*	Excellent	Buttery-Yellow-Green	Dusty pink-magenta	7-10 days	unique green color
Little Quick Fire *H. paniculata*	Excellent	White	Pale Mauve	4-7 days	attractive red buds in spring; stems quite short
Moonrock *H. paniculata*	Excellent	White	Mauve	7+ days	unique flower shape, very attractive
Zinfin Doll *H. paniculata*	Excellent	Creamy-White	Magenta	4-7 days	gorgeous cut flower
Queen of Hearts *H. quercifolia*	Poor	White	Brown	did not flower in 2022	plants weak and/or dead
Gatsby Star *H. quercifolia*	Poor	White	Brown	did not flower in 2022	plants weak and/or dead

**Note that cut flower vase life data are based on a single years' only, and should be interpreted with caution.*

We thank the NH Agricultural Experiment Station, the Tuttle Horticultural Endowment, and the NH Specialty Crop Block Grants program for their support of this project.

MORE THAN ONE WAY TO SLING A FLOWER: CUT FLOWER FARM BUSINESS MODEL COMPARISON

Michelle Elston, Carlisle, PA
rootsflowerfarm@gmail.com
Laura Beth Resnick, White Hall, MD
butterbeefarm@gmail.com

Laura Beth Resnick, of Butterbee Farm, White Hall MD, and Michelle Elston, of Roots Cut Flower Farm, Carlisle PA, both operate successful, profitable cut flower farms with wildly different business models but similar profitability and sales volume. This comparative presentation by both farmers reviews their sales outlets, scale, and customer demographics to offer attendees insight on how to choose what business model is best for them. We also focus on our similarities and how they make our farms viable and our friendship exciting!

While new growers may be seeking "the best way" to sell their flowers, there is no one best way. Geography, personality, and growing preferences all contribute to choosing a sales model that works for a flower farmer. With 10 and 16 years under their belts (respectively), Laura Beth & Michelle have tried lots of flower farm models and honed in on the ones that work best for them. They both honor that change is the fun of business ownership and love the process of ever-evolving business goals, challenges and successes.

mers are hands-on leaders, participating in day-to-day labor as farm managers. They also both do their own bookkeeping and love the financial aspect of business. Neither do weekend sales (no design/weddings, no farmers market). Both have tried many other sales outlets and are now fairly narrowly focused on one customer type. Both choose our lifestyles and match our business outlets to what works for our lives and our families. Both love change, challenge, intensity (with breaks) and joy of pushing ourselves in farming.

The following chart offers our big differences:

	Butterbee	**Roots**
Biggest customer	Florist	Supermarket
Product offering	Straight stem bunches	Mixed bouquet
Region served	Urban DC, Baltimore	Rural Central PA; greater SEPA
Price point	High	Low
Post harvest labor	Low	High
Main growing season	Spring/fall/winter	Summer
Crew size	6, 2 core	15; 9 core
Main Selling season	12 weeks in spring, 12 weeks in fall/winter	12 weeks (July-Sept)
Growing area	1/2 acre annuals, 1/3 acre heat-ed greenhouse	7 acres; no heated space

Laura Beth Resnick, Butterbee Farm
Laura Beth Resnick is the founder and owner of Butterbee Farm, a five acre flower farm in northern Maryland. Following regenerative practices, Butterbee Farm provides locally grown flowers to florists and flower lovers from Baltimore to Washington, D.C. Growing in greenhouses, high tunnels, and fields, Butterbee Farm specializes in high quality cuts for use in design. Laura Beth has served as President of the MCFGA (Maryland Cut Flower Growers Association) and Secretary for the Board of the ASCFG (Association of Specialty Cut Flower Growers), and continues to write for their quarterly magazine. She speaks regularly at conferences, garden clubs, and arboretums, and mentors new growers through Future Harvest's Beginning Farmer Training Program.

Michelle Elston, Roots Flower Farm
Michelle Elston is owner and farmer of Roots Cut Flower Farm. She holds a B.S. in Plant Science from Cornell University. Prior to moving back home to her ROOTS in central PA, she operated a garden center and gift shop in Western Massachusetts with her husband Mike. She lives on the farm with Mike and her two children, Jake & Lucy. It is Michelle's purpose to celebrate each season's gifts and to share the beauty of nature with others.

There is more than one way to sling a flower! Michelle's way funds her kids going to college, several weekend vacations a year, and within this year, a new solar panel system on the barn and a new car. Laura Beth's way bought her a house and a farm, and a lifestyle that she has been wanting for a decade.

It sounds idyllic, but we're always dealing with new curve balls. Not only that, but our own goals change as we grow. Trusting ourselves and staying humble are two paradoxes that we always try to hold at once.

CUT FLOWER RESEARCH AT USU SMALL FARMS LAB: KEY FINDINGS FOR CROPS, PRODUCTION SYSTEMS, AND ENVIRONMENTAL SUSTAINABILITY

Dr. Melanie Stock
Utah State University, 4820 Old Main Hill, Logan, Utah 84322
melanie.stock@usu.edu | smallfarmslab.com

Cut flowers can be premium, high-value crops for small farms. To optimize and sustain production while balancing soil health, key management includes targeting crops and cultivars for local adaptation and markets, season extension to advance harvest and improve stem quality, and using resources efficiently. This presentation highlights research at Utah State University that improved outdoor production of cut flower crops across field to high tunnel systems, and emphasized environmental sustainability. Each management practice will be presented with specific cut flower crops as examples for optimization. This research was largely conducted at the Utah Agricultural Experiment Station in North Logan, UT (USDA Hardiness Zone 6a, Elevation: 4600 ft, Frost-free growing season: May 15-Sep 20).

Protected cultivation

High tunnels have the potential to advance and extend the growing season well beyond the frost dates. Research at USU has focused on using high tunnels as warming structures to advance cool-season cut flowers earlier in the spring, and then transitioning the tunnels into shade structures to alleviate heat load in summer. We will focus on four crops in this presentation to highlight these management approaches.

Snapdragons: We timed series/cultivar group numbers with 3-week transplant intervals and pruning to extend the harvest and improve stem length. From this, high tunnels produced snapdragons 5 to 8 weeks earlier than the field, and nearly doubled the number of marketable stems by increasing stem length, resulting in potential net returns that were five times greater than the field. 'Chantilly' (Group I) was best suited to early plantings, consistently blooming the earliest, while 'Rocket' (Group IV) tolerated heat and extended production into mid-summer. Pruning plants during the summer heat resulted in a fall flush, and thus the harvest season occurred from May through September.

Ranunculus and anemone: Protected cultivation was tested a step further with these two, cool-season cut flowers that were not rated as hardy enough for our winters (previous to the 2023 USDA Hardiness Zone release, North Logan, UT, was classified as Zone 4b to 5b). Industry recommendations to plant in spring resulted in bloom three months later, in summer conditions that were too hot and forced dormancy, resulting in minimal yield with net-negative returns. Using high tunnels, low tunnels, and mulch, we trialed several cultivars, pre-planting treatments, and transplant times. Planting ranunculus and anemone in a high tunnel between November and February resulted in blooms 4 to 5 weeks earlier than the field, and up to 7 marketable stems per plant. In the field, insulation was needed to prevent the soil temperatures from dropping too low, and the use of mulch or low tunnels increased the average soil temperature by over 4°F at a 2-inch depth. This resulted in greater than 95% winter survival, compared to 46-55% survival without, and harvest two to four weeks sooner.

Peony: As a perennial crop, peony requires chilling and then emerges in response to soil temperature. We tested the use of high tunnels, low tunnels, and soil heating with 'Coral Charm', an early variety that typically blooms around Memorial Day in North Logan, UT, in effort to advance production to meet the Mother's Day holiday market. Compared to natural field conditions, the high tunnel alone advanced harvest by 20 to 25 days. Adding low tunnels and soil heating advanced harvest up to another 16 days, depending on the date these were initiated each year. Without a high tunnel, the field could also be advanced with low tunnels and soil heating by seven days. By producing in both the high tunnel and field, production was extended and staggered across 38 days, reducing storage needs and prolonging the market. The total yield of the plants across these systems was consistent. The stem quality, however, can be reduced in the high tunnel, and

Dr. Melanie Stock is an Assistant Professor in the Plants, Soils, and Climate Department at Utah State University (USU) and USU Extension's Urban & Small Farms Specialist. Her research topics include high-value crop production and sustainable resource management. Over the last five years, her lab focused on soil fertility, irrigation, and season extension to optimize annual and perennial cut flower production. Her program now includes interdisciplinary collaborations in plant pathology and applied economics to study disease and profitability of cut flowers. Dr. Stock is originally from Wisconsin and graduated with her PhD in Soil Science at UW-Madison.

particularly with low tunnels and soil heating, if humidity, and pest and disease pressure are not managed.

Soil management

Long-term crop production and environmental sustainability start with careful stewardship of the soil. In the USU Small Farms Lab, we have focused on soils topics that include nutrient and irrigation recommendations for cut flowers, sustainable compost and manure use, and contaminants. Maintaining organic matter and fertility – without overapplication of nutrients – is key, but can be a challenge on small farms. This presentation overviews soil testing and sufficiency, assessing amendments, grouping cut flowers by nutrient demand, and fertility research with dahlias as the example crop.

EMBRACING BITTER BEAUTY: RADICCHIO VARIETIES AND THEIR PERFORMANCE IN THE NORTHEAST

Becky Sideman, Lilly Hartman and Ella Lukacz
University of New Hampshire, 211 Kendall Hall, Durham NH 03824
becky.sideman@unh.edu

Radicchio *(Cichorium intybus var. latifolium)* is grown widely throughout Europe, especially northern Italy. Within radicchio, there are several groups that differ in color and shape. The round heading Rossa di Chioggia type is the most widely grown. These bitter and colorful greens are commonly used as components of salad mixes or as the sole component of winter salads, and some types are more commonly braised or grilled. In addition to having interesting color and flavor profiles, they are rich in phenolics and other bioactive compounds. While increasingly popular as a niche vegetable in the region and some local growers have had good success growing and marketing this specialty crop, there is little research-based information to guide growers.

The New England growing climate is very different from that of major production regions, and it presents unique challenges. There is tremendous phenotypic variation among and within groups and cultivars. Many cultivars are extremely sensitive to bolting (premature flowering) under warm temperatures that are common in our summer months; it is common for fewer than 50% of radicchio plants to form marketable heads in our region. The availability of varieties to commercial growers in the U.S. has expanded greatly, but there remains a need for reliable regionally relevant information about performance of these varieties. Our work with radicchio is a collaboration with Peyton Ginakes and Mark Hutton at the University of Maine.

What we did: In two locations (Durham NH – USDA hardiness zone 6a, and Monmouth ME – zone 5b), we grew 30 (2022) and 34 (2023) cultivars of radicchio belonging to seven main groups (Chioggia, Castelfranco, Treviso, Sugarloaf, Verona, Rosa del Veneto, and Lusia). In both years, they were seeded on 20-21 June, and transplanted on 14-15 July. Plants were harvested and weighed as they reached market maturity. We also noted plants that were not marketable due to bolting, rot, or failure to head. We used standard cultural practices for the region: plants were grown in double rows on 30 inch wide raised beds covered with white-on-black plastic mulch with drip irrigation. Fertility was applied pre-plant: 110 lbs/acre of nitrogen and 150 lbs/acre of K2O. Plants were spaced 12 inches apart in each row, and each plot had 16 plants/plot.

We also performed two experiments in each site to evaluate the effects of planting date on harvest window, bolting, and crop marketability. For three typical round red Chioggia cultivars ('Sirio', 'Leonardo', and 'Perseo'), we planted them at four planting dates: seeding in early May, late May, late June, and mid-July. They were monitored twice a week until frost, and we noted when each head reached market maturity, when it stopped being marketable, and the reason for unmarketability. For these experiments, we used the practices described above, but plants were spaced 8 inches apart in each row, and each plot had 22 plants/plot.

\Results: The harvest season ranged from late August through early November in both years. There was great variability between varieties both within and between groups in percentage of plants that produced marketable heads (% marketable) and percentage of plants that bolted (% bolted). Harvest maturity dates roughly corresponded with days to harvest reported in seed catalogs, with some exceptions. We also observed differences in powdery mildew susceptibility.

A full report with additional details is available here: https://bit.ly/radicchioreport

Becky Sideman is a professor of horticulture with the University of New Hampshire. Her research and extension efforts include evaluation of new specialty crops, variety trials, seasons extension, and cover cropping systems. She chairs the Department of Agriculture, Nutrition & Food Systems at UNH. She lives with her husband on their small farm in Strafford NH. Dr. Sideman grew up on a diversified farm in Vermont. Prior to joining UNH in 2004, she worked as a plant breeder with the USDA Agricultural Research Service in Salinas, California.

EXTENDING LETTUCE PRODUCTION INTO THE SUMMER

Emmalea G. Ernest
University of Delaware Carvel Research and Education Center
16483 County Seat Hwy, Georgetown, DE 19947
emmalea@udel.edu

High temperatures can induce premature flowering (bolting) and development of bitter flavor in lettuce. This limits summer lettuce production in some parts of the Mid-Atlantic Region. Over several seasons, I have tested three strategies for maintaining quality lettuce for summer production: use of heat tolerant varieties, use of shade cloth and use of white and silver plastic mulch. I have also tested using these strategies in combination. All the trials were conducted at University of Delaware's research farm in Georgetown, Delaware.

Heat Tolerant Varieties

In all of the trials I have done, variety is the most significant factor determining premature bolting and development of bitter flavor. Some varieties are slow to bolt but still develop bitter flavor. In 2023 I tested 14 lettuce varieties that were reported to be heat tolerant for performance with early and late June planting dates. This trial was transplanted into white plastic mulch and shaded with 30% black shade cloth.

The bitterness ratings from the June 5 planting, which was harvested in early July are in Table 1. Bitterness was rated on a 1-4 scale with ratings of 1 and 2 considered marketable and ratings of 3 and 4 considered unmarketable. The varieties with the lowest bitterness ratings were Skyphos, Muir, Nevada, Jericho, Salanova Red Tango, and Sunland. In the June 22 planted trial, harvested in early August, only Muir and Nevada produced marketable lettuce.

Variety Name	Type	Average Flavor Rating*	
Skyphos	Butterhead, Red	1.04	a**
Muir	Batavia, Green	1.08	Ab
Nevada	Batavia, Green	1.13	Abc
Jericho	Romaine	1.17	Abc
Salnova Red Tango	One-Cut, Red	1.33	Abc
Sunland	Romaine	1.38	Abc
Salanova Red Butter	On-Cut, Red	1.42	Bcd
Verigo	One-Cut, Green	1.46	Cde
Rubygo	One-Cut, Red	1.75	Def
Salanova Green Oakleaf	One-Cut, Green	1.79	Efg
Adriana	Butterhead, Green	1.92	Fg
Starfighter	Leaf, Green	2.04	Fg
Salanova Green Butter	One-Cut, Green	2.13	G
Red Cross	Butterhead, Red	3.21	H

Flavor was rated on a 1-4 scale with ratings 1 and 2 having marketable flavor and 3 and 4 being un-marketable.

**Averages followed by the same letter are not statistically different from one another.

Emmalea Ernest is the Extension Fruit and Vegetable Specialist and an Assistant Professor at University of Delaware. Emmalea has been with UD Cooperative Extension since 2004. Her research is focused on abiotic stress tolerance, variety evaluation, and lima bean breeding and genetics. Emmalea is originally from southern Lancaster County, Pennsylvania. She earned a B.S. in Horticulture from Penn State University, an M.S. in Plant Breeding and Genetics from Michigan State University and a Ph.D. in Plant Science from University of Delaware. She and her husband Jeremy have two daughters.

Light Colored Mulch

In 2023 I tested the effect of silver and white plastic mulch on lettuce yield and quality. A bare ground treatment and a black plastic mulch treatment were included as controls. Silver mulch produced the largest lettuce plants and the least bitter lettuce. White mulch, especially with shade, also improved lettuce flavor. Silver or white mulch did not completely overcome the effect of variety, however. You cannot produce marketable lettuce under hot conditions if you are not also using a heat tolerant variety.

Shade Cloth

In trials planted in 2018 and 2019, use of 30% black shade cloth reduced bitterness in lettuce, however these trials were planted in early April and harvested in early June. In the 2023 trials, which were planted in June and harvested in July and August, 30% black shade cloth decreased lettuce plant size and had no effect on bitterness. In all of these trials, shade cloth was applied over low tunnels, which may have a heat trapping effect. Shade cloth might be more effectively used to reduce air temperatures for lettuce crops grown in high tunnels.

PEELING THE ROTTEN ONION: BACTERIAL DISEASES AND COPPER RESISTANCE

Ram Neupane and Beth K. Gugino
Department of Plant Pathology and Environmental Microbiology,
The Pennsylvania State University
204 Buckhout Lab, University Park, PA 16802
rcn5099@psu.edu | bkgugino@psu.edu

Bacterial diseases have been increasingly challenging to manage in Pennsylvania (PA) and New York (NY). They can cause yield losses of up to 60% in the mid-Atlantic region, even when recommended chemical and cultural management strategies are applied. However, the losses can vary significantly based on the season, farm, and even field. Warm and wet conditions favor bacterial disease development. The most common bacterial diseases observed in PA fields are leaf blight and bulb rot, also referred to as center rot, caused by *Pantoea agglomerans*, and soft rots, caused by *Pectobacterium carotovorum subsp. carotovorum*, and *Pseudomonas marginalis pv. marginalis*. Likewise, common bacterial diseases in NY are center rot (Pantoea ananatis), sour skin (Burkholderia cepacia), Enterobacter bulb decay (*Enterobacter cloacae*), bacterial soft rot (*Pectobacterium carotovorum subsp. carotovorum*), and bacterial leaf blight (*Xanthomonas axonopodis pv. allii*).

A **bacterial disease survey** was conducted from 2020 through 2023 across 30 onion fields in PA and NY to identify and evaluate the pathogenicity (ability to cause disease) of bacteria associated with diseased onion leaves and bulbs. Disease symptoms were commonly observed six to eight weeks after planting and disease incidence progressed throughout the growing season, reaching up to 30% in some sampled fields. Most sampled plants had necrotic and shriveled leaves as shown in Figure 1.

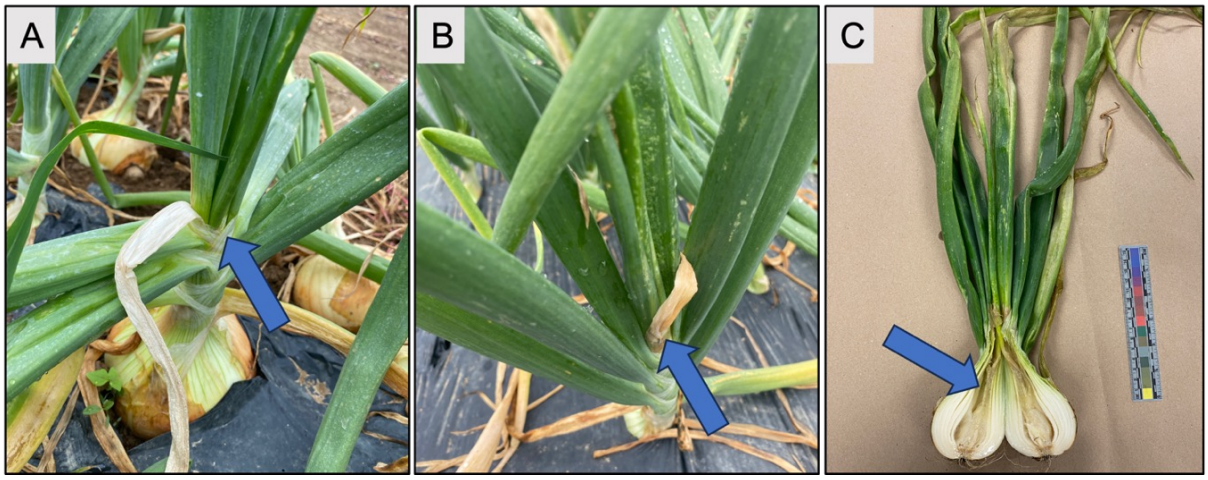

Figure 1: Symptoms of bacterial rots observed on onion fields across PA and NY. A and B: Necrotic and shriveled water-soaked inner leaves C: Decayed inner scales of the diseased onion bulb. (Photo credit: Ram Neupane).

In total across PA and NY, 1957 bacterial isolates were recovered from the collected samples, of which 1167 were identified to the genus level. Results indicated that *Burkholderia*, *Pantoea*, *Pseudomonas*, *Enterobacter*, *Acinetobacter, Kosakonia, Stenotrophomonas*, and *Rahnella* were the most common bacteria isolated from symptomatic plants in PA and NY onion fields. In NY, *Burkholderia* was the most prevalent, followed by *Pantoea*, *Pseudomonas*, and *Enterobacter*, whereas in PA, *Pantoea* was the most common, followed by *Burkholderia*, *Pseudomonas*, and *Enterobacte-*

Ram Neupane is a Ph.D. student in Plant Pathology with dual-degree in International Agriculture and Development at The Pennsylvania State University. His research focuses on the identification, diversity, pathogenicity, and copper resistance of bacteria associated with symptomatic onion plants and bulbs. Neupane is a Young Scientists Member of the World Food Forum (WFF) hosted by the Food and Agriculture Organization (FAO) and works closely with policy makers in global forums to enhance the involvement of youth in agriculture. He earned his B.S. degree in Agriculture from Agriculture and Forestry University (AFU), Nepal, and hails from Gorkha, Nepal.

ria. The higher incidence of *Burkholderia* in NY compared to PA may in part be attributed to the more limited crop rotations implemented in NY and the ability of Burkholderia to survive in the soil in the absence of a host.

Bacterial strains were also tested for their pathogenicity (ability to cause disease) in red onion scales, bulbs, and leaves. Of the 957 strains from 42 bacterial genera tested in the red scale necrosis (RSN) assay, 27.5% produced necrosis, meaning they can cause disease, in the onion bulb scales. A representative subset of strains that tested negative in RSN were subjected to bulb and foliar assay. Out of 189 strains tested in foliar and bulb assay, about 36% produced necrosis in either foliar assay, bulb assay, or both. This indicated that 36% of the strains that did not produce necrosis in the RSN assay were able to cause symptoms in the onion bulb and leaf assay and were characterized as weak pathogens. This survey demonstrated that there is a broad spectrum of bacterial genera associated with symptomatic onion bulbs and leaves, but a few bacterial genera (about one-fifth) are pathogenic. To the best of our knowledge, this is the first survey that indicates *Burkholderia* is more widespread in PA than previous recognized.

Surveys of this type are important for determining which bacterial pathogens are associated with symptomatic onion plants and thus enabling the development of more targeted diagnostic tools and management practices. The fact that not all isolates of a particular bacterial genus (and species) are pathogenic also indicates that diagnostic tools need to be able to distinguish between those that can and cannot cause disease. As we continue to probe this dataset, we will look more closely at the relationships between prevalence of certain bacterial genera within and between fields in PA and NY across the seasons to better characterize bacterial disease across this region.

Sensitivity of *Burkholderia* spp. to copper-based bactericides

In PA and NY, as well as in other onion production regions, growers use copper-based bactericides to prevent bacterial rot diseases. Copper compounds, applied to the leaf surface, are used as protectants, meaning they must be present on plant surfaces before pathogen infection. However, growers have reported reduced efficacy of copper treatments, leading to both the application of higher rates and more frequent applications. As has been documented with bacterial diseases of tomato, the over-reliance on copper bactericides may lead to the development of bacterial strains resistant to copper thus reducing their efficacy. Currently, the prevalence of copper resistance in *Burkholderia* is unknown in PA and NY.

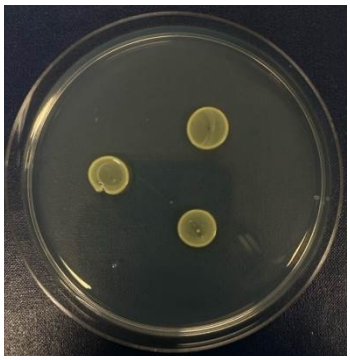

Figure 2: Confluent growth of a *Burkholderia* strain at 300 µg/ml of copper sulphate pentahydrate amended CYEG agar media. (Photo credit: Ram Neupane)

To investigate this, *Burkholderia* isolates collected as part of the previously described survey were screened for the copper resistance under laboratory conditions. These were screened against varying concentrations of copper sulfate pentahydrate at 0, 100, 200, 300, and 400 µg/ml diluted in casitone-yeast extract glycerol (CYEG) agar media plate. The strains were categorized as resistant or sensitive based on bacterial colony growth. Of the 14 *Burkholderia* strains from PA tested, 86% were copper resistant meaning that they were able to grow in the presence of copper. Likewise, of the 39 *Burkholderia* strains from NY tested, 82% were able to grow on plate amended with 300µgg/ml of copper sulfate pentahydrate. In this study, copper-resistant strains are those that survived and multiplied to produce confluent growth (bacterial cells are so densely packed that they merged into a continuous film, resembling a shiny, smooth surface as shown in Figure 2) at 300µgg/ml of copper sulfate pentahydrate. Although this is only a small subset of isolates and more testing is needed, this may in part explain some of the reduced efficacy of copper-based bactericides observed by growers in field and highlights the need for integrated disease management (IDM). Most importantly, with the greater prevalence of copper-resistant strains observed, evaluating alternatives to copper-based bactericides is necessary to reduce growers' reliance on copper-based bactericides.

PESTICIDE MIXING: HOW TO AVOID MIXING DISASTER

Jamie Kopco, Penn State

Tank-mixing multiple pesticides and/or fertilizers can save a grower time, labor, and money by allowing several products to be applied with a single application. However, not all products can be mixed into a single application, and products that can be mixed need to be mixed correctly. This presentation will discuss different types of product incompatibility, how pesticide labels can inform what can or cannot be mixed and how it should be mixed, typical mixing instructions for products with different formulations, and how to perform a jar test if you are unsure of whether two products can or cannot be mixed.

Jamie double-majored in Entomology and Natural Resources at Cornell University (BSc) and studied Entomology at North Dakota State University (PhD). He worked as an entomologist and pest manager in hydroponic greenhouses at Walt Disney World and built expertise in structural pest management by serving as technical director for Guardian Pest Solutions. Jamie also has professional teaching experiences ranging from merit badge counselor at a Boy Scout camp to Conservation Educator at Disney's Animal Kingdom to earning a college teaching certificate at North Dakota State University. Jamie is currently a Pesticide Education Specialist at Penn State University and a medical entomologist in the US Army Reserves. Jamie's combination of conservation and pest management experiences help him to maintain a balanced, science-based perspective on pesticides.

PRECAUTIONARY STATEMENTS AND WASHING OF PPE (JOINT CORE SESSION

Thomas Butzler, Penn State Extension

An analysis of nearly 2000 pesticide labels registered by the U.S. Environmental Protection Agency revealed that 85% mandated a long-sleeved shirt and long pants. Coveralls were required in different configurations: approximately 7% over a short-sleeved shirt and shorts, 8% over a long-sleeved shirt and long pants, and only 0.3% necessitated chemical-resistant suits (Shaw & Harned, 2013, Journal of Pesticide Safety Education, 15, 17–29).

Building upon the mandated requirements specified on pesticide labels, it is important to explore the actual choices made by pesticide applicators in terms of attire. A survey conducted by Shaw et al. in 2018 investigated the garment preferences of pesticide applicators, as reported in the Journal of Pesticide Safety Education (Vol. 20: 1–12). Results indicated that shirts and pants remained the most commonly worn attire, constituting 72% of respondents. Other options included reusable cloth coveralls (10%), disposable coveralls (15%), and rain suits (3%). These findings offer insights into the prevailing garment choices of pesticide applicators and their alignment with regulatory guidelines.

With the majority of pesticide applicators wearing long-sleeved shirt and long pants, the question is then how is this material laundered as these garments are not one-use products. Thia Walker, an Extension Specialist with Colorado State University Fort Collins, and several colleagues looked at removal of pesticide residue from clothing with different washing and drying methods.

Washing machine technology is changing as many units are evolving to high-efficiency front-loading washers, characterized by reduced water usage and absence of agitators from the more traditional full-fill washers featuring agitators. Their research in the Journal of Pesticide Safety Education (Vol. 23: 9-43) studied pesticide contamination of several products at different rates and removal processes on various types of clothing washed and dried in commonly used household appliances. Specifically, the study assessed the efficacy of a front-loading, high-efficiency washer without an agitator in comparison to a traditional full-fill washer with an agitator.

Results indicated that both full-fill agitator and high-efficiency washing machines effectively removed some products, but at varying rates. Blue jeans consistently retained more residues than other fabric types. Transference of pesticides to baby clothes occurred, emphasizing the need to launder pesticide-contaminated clothing separately.

It is important to recognize that washing work clothes and coveralls separately from other laundry is needed to minimize the risks associated with pesticide exposure. Pesticide applicators not only face threats to their health but to their families'. Pesticide residues can adhere to clothing through spills and drift during application, posing a potential risk to other family members if contaminated garments are laundered with regular laundry. Mixing contaminated workwear with other clothes may transfer pesticide residues, underscoring the need for strict laundering practices to prevent cross-contamination and ensure the safety of both the applicator and their household. Adherence to safety guidelines is imperative in pesticide-handling environments to safeguard the health of individuals involved.

Long pants – Most pesticide applications only require a long-sleeved shirt and long pants, along with PPE for hands and feet. Photo by Garo Goodrow, Multimedia Specialist Penn State Pesticide Education Program

Coveralls – Pesticide applicator showing the use of coveralls. Photo by Garo Goodrow, Multimedia Specialist Penn State Pesticide Education Program

Washer – Ideally, a separate washer should be used to wash pesticide contaminated clothing. Photo by Garo Goodrow, Multimedia Specialist Penn State Pesticide Education Program

Figure 1. Long Pants

Figure 2. Overalls

Figure 3. Washer

PROTECTING WATER RESOURCES FROM PESTICIDE CONTAMINATION

Jamie Kopco, Penn State

Pennsylvania has a variety of freshwater resources, including ponds, lakes, wetlands, rivers, streams, and groundwater. These resources are essential for drinking, agriculture, ecology, and many industrial purposes. Unfortunately, both surface and ground water can be contaminated by pesticides during transportation, mixing and loading, application, or disposal. The geology, geography, weather, and pesticide handling practices all affect the risks of contamination of water resources. This presentation will discuss which factors you can and cannot control regarding water contamination risks and how to minimize the risk that your pesticides will contaminate any water resources.

Jamie double-majored in Entomology and Natural Resources at Cornell University (BSc) and studied Entomology at North Dakota State University (PhD). He worked as an entomologist and pest manager in hydroponic greenhouses at Walt Disney World and built expertise in structural pest management by serving as technical director for Guardian Pest Solutions. Jamie also has professional teaching experiences ranging from merit badge counselor at a Boy Scout camp to Conservation Educator at Disney's Animal Kingdom to earning a college teaching certificate at North Dakota State University. Jamie is currently a Pesticide Education Specialist at Penn State University and a medical entomologist in the US Army Reserves. Jamie's combination of conservation and pest management experiences help him to maintain a balanced, science-based perspective on pesticides.

USE OF BIONEMATICIDES FOR NEMATODE MANAGEMENT

Caterina Roman and Beth K. Gugino
Department of Plant Pathology and Environmental Microbiology,
The Pennsylvania State University
219 Buckhout Lab, University Park, PA 16802
ccr5329@psu.edu | bkgugino@psu.edu

Root knot nematodes (*Meloidogyne spp.)* are a major agricultural pathogen that is becoming increasingly problematic for many growers in PA (Fig. 1). In a survey of tomato high tunnel soils conducted during 2019-2021, 31 out of 90 tunnels (34%) surveyed had actionable levels of root knot nematodes (Gugino, unpublished) meaning the populations were high enough to potentially cause crop yield loss if not managed. These microscopic worms spend most of their life cycle within plant roots, causing root galling, distortion, and stunting (Fig. 1). While aboveground symptoms are not readily visible, root knot nematodes can cause reduced yields, plant wilting, stunting, and nutrient deficiency-like symptoms. Populations within the soil can increase undetected season after season before causing noticeable yield losses. Similar to other soilborne pathogens, they often start as a hot spot and then spread as soil is moved around the tunnel through tillage operations. Management using cultural practices such as crop rotation can be challenging because root knot nematodes have a very wide host range containing hundreds of plant species including many vegetable crops and common weed species. Rotating with agronomic crops such as corn, wheat, and barley (all monocots) can help reduce populations but is often not practical for within high tunnels. Grafting onto nematode resistant rootstocks may be another management option but this comes at an increased cost per plant.

Historically chemical controls such as fumigants have been the primary management strategy relied upon, however, concerns about their effects on human and environmental health have severely restricted their use both geographically and the labelled crops. Biological controls are a potential alternative to chemical pesticides that could be used as part of an integrated pest management program. Previous research has demonstrated that the efficacy of biocontrols for root knot nematode management has been mixed. A greenhouse study was conducted using five commercially available bionematicides to evaluate their potential efficacy at reducing root knot nematode damage caused by our local nematode population. The products evaluated were selected from a range of companies and contained a variety of active ingredients.

Tomatoes (cv. Moneymaker) were grown for six weeks then transplanted into six-inch pots filled with 16:9 sand to pasteurized soil. Following transplanting, plants were inoculated with 25,000 root knot nematode eggs. Three days post-inoculation, the products Melocon LC, Neovo, Azaguard, Oxidate 5.0 and Monterey Nematode Control and a chemical control, Vydate, were applied as soil drenches using the rates and volumes described in table 1. Products were evaluated and compared to a non-inoculated control, an inoculated control and the chemical control (Vydate). The experiment was laid out in randomized complete block design with each treatment replicated 5 times for a total of 40 plants.

Fig. 1 Juvenile root knot nematode under the microscope (40X) (left) and root galling caused by root knot nematodes (right).

Caterina Roman is a current graduate student studying plant pathology at Pennsylvania State University under Dr. Beth Gugino. Her research focuses on biological soil-borne disease management strategies for high tunnel tomato growers, with a particular focus on root knot nematodes. Prior to Penn State, she completed her Bachelor of Science at the University of New Hampshire in sustainable agriculture and food systems, doing a mixture of horticultural research as well as working on an organic mixed vegetable farm. She aims to continue researching and promoting agricultural practices that are both sustainable and economically viable for growers.

Table 1. Description of products, active ingredients, dilution rates, volumes, and application frequencies. Rates and application frequencies are based on product label rates.

Product name	Active Ingredient	Company	Dilution rate (%)	Product volume (mL)	Water volume (mL)	Application frequency
Melocon LC	*Purpureocilium lilacinum strain 251*	Certis Biologicals	0.125	0.125	100	4 weeks
Neovo	*Burkholderia rinojensis* strain A396 and fermented media	ProFarm	0.033	0.033	100	2 weeks
Azaguard	Azadirachtin	BioSafe Systems	0.3	0.3	99.7	3 weeks
Oxidate 5.0	Hydrogen peroxide and peroxyacetic acid	BioSafe Systems	0.1	0.1	100	3 weeks
Monterey Nematode Control	*Quillaja saponaria* saponins	Monterey	1.56	1.56	98.44	2 weeks
Vydate	Oxamyl	Corteva	0.02	0.02	100	2 weeks

After six weeks, each plant was harvested, and the above ground fresh weight was recorded. The root systems were then gently washed before the root fresh weight and root galling severity was assessed. Nematode egg extractions and egg counting were then performed on each plant to calculate the number of eggs per gram of root. Preliminary results found that Melocon LC numerically reduced root galling and approved fresh weight, however, this was not statistically significant as compared to the inoculated control. Monterey Nematode Control, Oxidate, and Neovo did not reduce nematode galling as compared to the nontreated, inoculated control. Azaguard and Vydate were not included within this first study. A second experiment with all described products is underway, and the results will be presented.

VEGETABLE NEMATODE MANAGEMENT

George Bird, Professor Emeritus
Michigan State University

Nematodes are the most prominent animal on our planet. Most are microscopic. Some cause infectious diseases of plants, animals, and humans. Others are beneficial and make nutrients available for the growth and development of plants. In agriculture, both types require management.

Vegetable Nematode Management describes the basic types of plant-parasitic nematodes and how they cause infectious diseases of the Mid-Atlantic Vegetable Industry. This is followed by a brief description of nematode problem detection procedures and overviews of the management practices available for preventing and alleviating crop losses caused by nematodes. The types of beneficial nematodes and how they impact agriculture is explained. The conclusion is an overview of grower practices designed to enhance the activities of beneficial nematodes. This will be followed by the question; can a field have a fever? The answer will be provided

Plant Parasitic Nematode Types

Sedentary Endo-Parasitic Nematodes

This group includes root-knot and cyst nematodes. Juveniles penetrate root tissue with their stylet and migrate to a permanent feeding site. The nematode instructs the plant to form energy rich nurse cells to feed its young. This results in poor crop yield, foliar discoloration, and failure to fill in the rows in a timely manner. In addition, root-knot nematodes instruct the plant to form root-galls to protect the nematode eggs deposited in an egg mass. Cyst nematodes retain their eggs in the female body, which hardens upon death of the adult to form a protective cyst. Eggs in the cysts can remain viable for more than a decade in the absence of a suitable host plant. Both the southern root-knot and northern root-knot nematodes can be problems in Mid-Atlantic vegetable production. Most vegetables crops are susceptible to these two species. One exception is that corn is a host for the southern root-knot nematode, but not for the northern root-knot nematode. Beet and soybean cyst nematodes are known to be present in Mid-Atlantic states. Red beets, cabbage, cauliflower, broccoli, and Brussel sprouts are hosts of the beet cyst nematode. Snap beans and peas are host of the soybean cyst nematode. In Michigan, we have twelve different confirmed species of cyst nematodes.

Migratory Endo-Parasitic Nematodes

Some species of migratory endo-parasitic nematodes feed on root tissue, while others feed on shoot system tissues. In both cases, the nematode uses its stylet to penetrate the host tissue. It then migrates throughout the tissue depositing eggs and causing both chemical-induced and physical damage, plus crop yield loss. The root-lesion nematode is the most common endo-parasitic nematode in the Mid-Atlantic states. There are many species of root-lesion nematodes, each with their own host range. The bulb and stem nematode feeds on shoot system tissue, causing onion bloat and a current major issue in garlic production. The potato rot nematode is a regulatory species. While not currently a known issue in the U.S. foliar nematodes have been reported associated with vegetable production in South America.

Ecto-Parasitic Nematodes and Virus Vectors

There are many types of eco-parasitic nematodes. The sting, stunt, dagger, needle, pin, and stubby-root nematodes are examples. These nematodes insert their stylets into root tissue and fee while their body remaining outside the root. In addition to using yield loses and deformed root systems dagger, needle and stubby-root nematodes vector viruses that cause tomato ringspot, beet ringspot and corky ringspot of potato, respectively.

Nematode Problem Detection

In 2023, modern vegetable production requires records for each field. This should include crop yield and quality. If

George W. Bird is Professor Emeritus in the Department of Entomology at Michigan State University. He received his B.S. and M.S. degrees from Rutgers University and the Ph.D. from Cornell University. Before coming to Michigan State University in 1973, he was a Research Scientist with Agriculture Canada and an Associate Professor at the University of Georgia. At MSU, he conducts soil health research and teaches graduate and undergraduate courses. He is a Fellow of the American Phytopathological Society, and Fellow of the Society of Nematologists. Among George's honors are the MSU Distinguished Faculty and Michigan Vegetable Council Associate Farmer awards.

yield in a specific field is low or declining, nematodes may be the cause. In addition to root and shoot system symptom observation, testing soil and root tissue samples for plant-parasitic nematodes is imperative for proper nematode problem identification. Information about where to send soil and root tissue samples for nematode identification can be found at https://www.npdn.org. The results from the samples should be discussed with the farms consultant or local Land Grant System Extension agent.

Plant-Parasitic Nematode Management

Exclusion of plant parasitic nematodes from noon-infested vegetable field is an important strategy. This can be achieved by not planting nematode-infested transplants and other propagative materials. Cleaning equipment after it has been used in infested fields is also important. Once a field is infested with a phytopathogenic nematode it can be contained in the site, but not eradicated. Nematode population practices are required to prevent yield and crop quality losses. Crop rotations that include non-host cash and non-cash crops work well. This, however, requires a good understanding the target nematode and its biology. In some cases, nematode resistant crop varieties are available. If these are used too frequently, the nematode population may have the potential to increase through development of resistance to the host-crop.

Chemical nematicides are widely used for nematode management. In vegetable production. These include soil fumigants such as Telone ll or the low rate of metam. Chloropicrin is primarily a fungicide. When a product contains both Telone ll and Chloropicrin, it is essential to use the proper rate of nematode population reduction. Soil fumigants are expensive restricted use products that require unique buffer zones. Historically, non-fumigant nematodes have been organo-phosphate or organo-carbamate compounds. The most common one is Vydate (oamyl). In recent years there have been numerous new products registered for nematode management. Some of these are new chemistries, while others are bionematicides or living organism products. In each case, the vegetable grower should work closely with the company representative and local Land Grant Extension agent to determine the best product, rate, and application methodology for each nematode-site combination.

Beneficial Nematodes

Nematode that feed on bacteria or fungi mineralize nitrogen and other soil nutrients. This process is a key aspect of soil health. They are then excreted in the vegetable plant rhizosphere, taken up by the roots and used for the growth and development of the crop. In addition, entomopathogenic nematode product are available for management of specific crop damaging insects.

Beneficial Nematode Management

Beneficial nematode analysis can be part of a soil health indicator analysis. When soil health biology is poor, appropriate cover crops, high quality composts, reduced toxic chemical inputs and reduced tillage may be options for soil health and crop yield enhancement. Entomopathogenic nematodes are sensitive to light and inadequate moisture. This needs to be taken into consideration for the products to provide the intended results.

Summary

Agriculture is humankind's greatest innovation, and the U.S. Land Grant system is the envy of the world! Field vegetable production is a complex, open, nonlinear system. It cannot be controlled. It must be managed!

Question

Can a vegetable field have a fever? Thermal stability research has demonstrated that the answer is yes. This will be discussed in greater detail in the adjoining 2023 Pennsylvania Potato Association Conference.

Reference

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WATERMELON PRODUCTION – VARIETIES, IRRIGATION AND FERTILIZATION MANAGEMENT, AND GRAFTING

Wenjing Guan, Extension Specialist
Purdue University, Southwest Purdue Agricultural Center, Vincennes, IN, 47591
guan40@purdue.edu

Varieties

Watermelon fruit displays diverse characteristics in shape, size, rind pattern, flesh color. Seedless and seeded watermelons are both available. The mainstream market favors red-fleshed, blocky-shaped seedless watermelons with striped rind patterns. Fruit weight in the range of 14-18 lbs (45 count) is most preferred in the mainstream market. The long-standing popularity of Fascination persists among both farmers and consumers. However, recent years have seen increased attention on newer varieties, known for outstanding yields, improved disease resistance, and superior fruit quality.

Seeded watermelons are not commonly cultivate in large acreages in Indiana; instead, they are sometimes employed as pollenizer plants for growing seedless watermelons. The flower count of the edible seeded watermelon varieties nevertheless was significantly less compared to the non-edible pollenizer plants.

In watermelon-growing regions, Fusarium wilt poses a significant disease challenge. While no seedless watermelon cultivars are entirely resistant, there are varying tolerance levels toward this disease. Interestingly, the variety with the highest disease tolerance may not exhibit the best quality attributes, and vice versa.

In local food markets, farmers seek varieties with unique and attractive fruit characteristics, different from those found in large grocery stores. Varieties with solid dark-green rinds, mini watermelons, and yellow or orange-fleshed watermelons are promising. In our annual variety evaluations, we found some standouts with high sugar content, low flesh firmness, and thin rinds. Despite potential production issues like hollow heart or hail damage, these characteristics may be attractive in watermelons sold at local markets. Market studies are necessary to understand consumer perceptions toward watermelons of the different channels.

The results of the annual watermelon variety evaluation trials conducted since 2016 at the Southwest Purdue Agricultural Center, Vincennes, IN are available on the webstie.

Irrigation and Fertilization Management

In a recent survey of watermelon growers in Indiana, nearly half of the watermelon acreage was found to be non-irrigated. Among the irrigated lands, approximately two-thirds utilize drip irrigation, while one-third employs overhead irrigation. Despite the advantages of fertigation in drip irrigation, it was observed that it is used less than three times a season in most drip-irrigated lands, or not used at all. The current irrigation and fertilization practices in Indiana's watermelon production suggest a need for improvement to enhance water and fertilizer use efficiency. Notably, practices recommended in other watermelon-producing regions may not be directly applicable to the Midwest.

While precipitation is generally sufficient for watermelon production in Indiana, recent prolonged droughts pose an increased risk to production in non-irrigated lands. Drought during the fruit-setting period results in fewer fruits, and drought during the fruit-expanding stages leads to smaller fruit sizes. Consequently, irrigation is becoming essential in watermelon production. Drip irrigation stands out for its higher water use efficiency, allowing for fertigation and keeping foliage dry. However, it should be noted that wetting soil only in the bed area limits watermelon root expansion to a smaller soil profile, which may or may not be desirable. Irrigation schedules should consider not only crop water needs but also incoming heavy rainfalls, especially when the soil has less than optimal drainage, compacted, or has a high water table, to avoid potential waterlogging stress.

It is important to avoid fertilizer leaches during irrigation. Thus, prolonged irrigation events should be avoided. When there is a need to inject a substantial amount of nutrients in a single fertigation event, careful selection of fertilizers applied through the drip tape is crucial. Watermelons are highly sensitive to salt damage, and exposing a significant portion of the roots to high-salt fertilizer solutions may result in irreversible damage.

Wenjing Guan is an Extension specialist at Purdue University. She is stationed at Southwest Purdue Agricultural Center in Vincennes, IN. She works closely with melon growers, leading annual watermelon and cantaloupe variety trials in southern Indiana. Wenjing also works with diversified, smaller-scale vegetable and small-fruit growers across the state.

When possible, it is advisable to split nitrogen application rather than applying all nitrogen fertilizers at once. Foliar application of fertilizers can be considered when fertigation is not available. In the ongoing studies, we are also investigating the potential use of controlled-release fertilizers to enhance fertilizer use efficiency in the current watermelon production system.

Grafting

The primary motivation for employing grafted plants in Indiana watermelon production is the control of Fusarium wilt. The new rootstock 'Carolina Strongback' offers additional benefits, effectively controlling both Fusarium wilt and root-knot nematodes when both pathogens are present. Grafted plants also demonstrate improved tolerance to abiotic stresses, such as low temperatures, which is particularly beneficial in less-than-optimal environmental conditions.

To maximize economic benefits, it is crucial to adjust production practices when growing grafted plants. Given that a single grafted plant can be five times or more expensive than a regular plant, the current industry recommendation is to reduce the plant population by one-third when cultivating grafted watermelon plants. Growing grafted plants is anticipated for a higher yield and longer harvest. However, to meet these expectations, it is essential to ensure a consistent supply of nutrients and effective control of foliar diseases and insects throughout the season. It has been observed that grafted watermelons with hybrid squash rootstock slightly delayed harvest, and the fruit tends to have firmer flesh.

While more watermelon growers in Indiana are exploring the use of grafted plants in Indiana, the major barrier to wide adoption remains the cost of grafted plants.

WHAT'S WRONG WITH MY PLANTS? STRATEGIES FOR PLANT DIAGNOSIS

Jennie D. Mazzone
Penn State University, 216 Buckhout Lab, University Park, Pennsylvania 16802-1000

In order to prevent plant problems or minimize their impacts, it is important to accurately identify causal agents through the diagnostic process. The diagnostic process includes defining the problem, identifying symptoms and signs, looking for patterns, gathering site history information, synthesizing information, using diagnostic resources, and reviewing the likely culprits.

The path to accurately diagnosing the cause of a plant problem begins with first understanding what is normal and abnormal for a given plant. It is important to be familiar with variations in cultivars and common, nonparasitic organisms encountered in the environment, as these can be misidentified as pathogens, wasting time and resources. When a plant problem is encountered, the cause may be a biotic (living) organism, such as an insect or pathogen, or an abiotic (nonliving) disorder, such as drought or a nutrient imbalance. Abiotic and biotic problems are often co-occurring on the same plant and successful remediation depends on diagnosing both.

When a biotic organism or abiotic disorder disrupts essential plant functions, the plant's reaction is called a symptom. Symptoms include the external and internal reactions of a plant as a result of disease, insect damage, or abiotic disorders. Symptoms include leaf spots, chlorosis, necrosis, dieback, wilt, etc. Symptoms can occur quickly, within days or as long as years after damage. Signs are the visible structures of a biotic organism seen on or within the plant and can be used to differentiate between disease, insect damage, and abiotic disorders. Pathogen signs include fruiting bodies, mycelium, sclerotia, etc. Physical presence of an insect or the remnants they leave behind such as shed skins or frass also serve as signs. Pairing close examination of symptoms and signs with deductive logic leads to an accurate identification and therefore, a successful management plan.

Biotic pathogens and abiotic disorders have tendencies that help differentiate between them, but there are always exceptions. Using knowledge of the plant's horticultural requirements and site history in combination with careful examination for symptoms and signs can help distinguish between biotic and abiotic problems. Consider the pattern of symptom development and the amount of time it took for symptoms to appear. If the symptoms are uniform, occur over a large area, or developed suddenly, the cause may be abiotic. If the symptoms are irregular, localized, or spread over time, the cause may be biotic. To complicate matters, there are situations when biotic organisms and abiotic disorders do not follow these patterns. When diagnoses become complex like this, there are resources to help.

Not all plant health problems can be easily diagnosed, especially in the field. In some cases, you may need to seek additional diagnostic assistance. You can start with your local Extension office. Extension services can help identify the cause of the plant problem and share reputable resources that aid in identification and management. There are various factsheets, guides, and compendia available for plant diseases, insects, and abiotic disorders and each includes extensive information on management. When you need clinical diagnostic services, seek a diagnostic clinic. Most states in the United States have plant disease clinics and insect identification labs available to the public. These facilities are usually present at local Extension services, universities, or government laboratories. Most diagnostic clinics require a sample of the affected plant and information about the growing conditions. Keep in mind, the diagnosis you receive from a clinic is as only good as the sample submitted and the information provided, so be sure to collect and send the best plant sample possible.

Jennie Mazzone is a Research Technologist in Vegetable Pathology, Assistant Diagnostician in the Plant Disease Clinic, and Instructor at Penn State University. She has over a decade of professional experience as a Diagnostician at Penn State and the Bartlett Tree Research Laboratory. Jennie received her master's degree in Plant Pathology and baccalaureate degree in Horticulture from Penn State.

Many plant problems are caused by a complex of both abiotic and biotic factors. Identifying all the factors involved in a plant problem is vital to a successful management plan. Although the diagnostic process can be complex, the overall steps to narrowing down the possibilities are relatively consistent across different plant systems and will become second nature with regular use. Using the diagnostic process can lead to successful management, ultimately saving time and money.

PENN STATE FLOWER TRIALS BEST IN SHOW- 2023

Krystal Snyder, Penn State Extension, Interim Flower Trial Director
Kls6590@psu.edu

Alocasia 'Yucatan Princess' Plants Nouveau

Angelonia AngelDance™ 'Fuchsia Bicolor', Ball Floraplant
Angelonia AngelDance™ 'Violet Bicolor", Ball Floraplant
Angelonia Archangel™ 'Dark Purple', Ball Floraplant
Angelonia Archangel™ 'Purple IMP' Ball Floraplant

Aster Colonial™ 'Providence' GardenChoice

Begonia BabyWing® 'Red Bronze Leaf (seed)' PanAmerican Seed
Begonia Beauvilia® 'Red™' Beekenkamp
Begonia Beuvilia® 'BEBE 4689' Beekenkamp
Begonia BIG® 'Deep Pink Green Leaf (seed)' Benary
Begonia BK Collection® 'BEEL 4676' Beekenkamp
Begonia BK Collection® 'Frivola Pink™' Beekenkamp
Begonia BK Collection® 'Vermillion Hot Pink™' Beekenkamp
Begonia BK Collection® 'Vermillion Red™' Beekenkamp
Begonia Dragon Wing® 'Pink Bronze Leaf (seed)' PanAmerican Seed
Begonia Dragon Wing® 'Red Bronze Leaf (seed)' PanAmerican Seed
Begonia Dreams® Garden 'MacaRose™' Beekenkamp
Begonia Florencio™ 'Red' Syngenta Flowers
Begonia FlowerBall F1 'Pink (seed)' Cerny Seed
Begonia FlowerBall F1 'White (seed)' Cerny Seed
Begonia Hula™ Spreading 'Bicolor Red White (seed)' PanAmerican Seed
Begonia Hula™ Spreading 'Red (seed)' PanAmerican Seed
Begonia Limitless™ 'Dark Red (seed)' Syngenta Flowers
Begonia Megawatt™ 'Pink Bronze Leaf (seed)' PanAmerican Seed
Begonia Megawatt™ 'Rose Bronze Leaf IMP (seed)' PanAmerican Seed
Begonia Stonehedge™ 'Light Pink Bronzeleaf (seed)' Benary
Begonia Stonehedge™ 'Rose Bronzeleaf (seed)' Benary
Begonia Tophat™ 'Pink (seed)' Syngenta Flowers
Begonia Viking 'Coral Flame on Bronze (seed)' Sakata Seed America
Begonia Waterfall® 'BEEN 4690' Beekenkamp
Begonia Rex Spacestars® 'Avior™' Beekenkamp

Buddleja Chrysalis™ 'Blue' Darwin Perennials
Buddleja Summerbird 'Blue IMP Benary Plus
Buddleja Summerbird 'Raspberry' Benary Plus

Krystal Snyder is a Horticulture Extension educator based in Northeast PA focusing on greenhouse floriculture, hydroponics, green industry and industrial hemp. She joined Penn State Extension in March of 2019. Before joining Penn State Extension, Krystal worked in industry for JR Peters, as a technical specialist. She was also an adjunct professor at Delaware Valley University teaching Greenhouse Management and Introduction to Hydroponics. Krystal has a BS in Horticulture from Delaware Valley University and is an Environmental and Agricultural Plant Sciences Masters student at Penn State University. She lives in Easton, PA with her husband and two daughters.

Calibrachoa Cha-Cha™ 'Deep Blue' Ball Floraplant
Calibrachoa Cha-Cha™ 'Frosty Lemon' Ball Floraplant
Calibrachoa Cha-Cha™ 'Fuchsia' Ball Floraplant

Celosia Kelos® Fire 'Scarlet™' Beekenkamp

Coleus (Solenostemon) 'Solar Fire' Kientzler North America
Coleus (Solenostemon) 'Solar Flare' Ball Floraplant
Coleus (Solenostemon) Down Town 'Columbus' Dümmen Orange™
Coleus (Solenostemon) Down Town 'NYC NIghts' Dümmen Orange™
Coleus (Solenostemon) Trailblazer™ 'Glory Road' Ball Floraplant
Coleus (Solenostemon) Trailblazer™ 'Road Trip' Ball Floraplant

Combinations Confetti Garden® 'Summer Breeze' Dümmen Orange™
Combinations SuperCal® Premium Mix 'Petunia Mix 4' Sakata Seed America
Combinations SuperCal® Premium Mix 'Petunia Mix 6' Sakata Seed America

Dipladenia Flordenia 'Chocolate' Dümmen Orange™
Dipladenia Flordenia 'Neon' Dümmen Orange™

Echinacea Dark Shadows™ 'Mystic PPAF' Terra Nova Nurseries
Echinacea PollyNation 'Pink Shades (seed)' Benary
Echinacea SunMagic Vintage 'Mango' Bull Plant Genetics
Eupatorium 'Little-Pye' Dümmen Orange™
Eupatorium perfoliatum 'Blind Date PPAF' Intrinsic Perennial Gardens

Geranium - Zonal 'Super Moon Red' Selecta One

Hebe Sidekicks™ 'Robin' Selecta One

Impatiens - hybrida Solarscape™ 'Magenta Bliss (seed)' PanAmerican Seed
Impatiens - hybrida Solarscape™ 'Neon Purple (seed)' PanAmerican Seed
Impatiens - hybrida Solarscape™ 'Orange Burst (seed)' PanAmerican Seed
Impatiens - hybrida Spectra™ 'Bright Red' Syngenta Flowers
Impatiens - hybrida Spectra™ 'Orange IMP' Syngenta Flowers
Impatiens - hybrida SunPatiens® Compact 'Classic White' Sakata Seed America
Impatiens - hybrida SunPatiens® Vigorous 'Orange Imp' Sakata Seed America
Impatiens - hybrida SunPatiens® Vigorous 'Orchid' Sakata Seed America
Impatiens - hybrida SunPatiens® Vigorous 'Peach Candy' Sakata Seed America
Impatiens - New Guinea Paradise 'Red' Kientzler North America
Impatiens - New Guinea Rokoko 'Orange 2022' Kientzler North America
Impatiens - New Guinea Wild Romance 'Pink Dümmen Orange™

Ipomoea, Sweet Potato Sweet Caroline 'Red Hawk 2024' Proven Winners'
Ipomoea, Sweet Potato Sweet Caroline Sweetheart 'Mohogany™' Proven Winners
Ipomoea, Sweet Potato Sweet Caroline Upside 'Black Coffee' Proven Winners
Ipomoea, Sweet Potato Sweet Caroline Upside 'Key Lime' Proven Winners

Lantana Bloomify™ 'Pink' Ball Floraplant
Lantana Bloomify™ 'Rose' Ball Floraplant
Lantana Bloomify™ 'White' Ball Floraplant
Lantana Gem™ 'Citrine' Danziger Flower Farm
Lantana Landmark™ 'Gold IMP' Ball Floraplant
Lantana Shamrock™ 'Butterscotch Glow' Ball Floraplant
Lantana Shamrock™ 'Orange Flame IMP' Ball Floraplant
Lobelia Early Springs™ 'Lavender Pink' Ball Floraplant

Ornamental Grasses Carex 'Feather Falls' Pacific Plug and Liner
Ornamental Grasses Mulenbergia 'Rosy' Benary
Ornamental Grasses Mulenbergia 'Ruby' Benary
Ornamental Grasses Pennisetum 'Water to Wine' Must Have Perennials™
Ornamental Grasses Pennisetum alopecuroides 'Pure Energy PPAF' Intrinsic Perennial Gardens

Perovskia 'Bluesette (seed)' KieftSeed

Petchoa (Calibrachoa X Petunia) EnViva™ 'Pink' Selecta One

Petunia 'Burgundy Bliss' Ball Floraplant
Petunia Blanket® 'Silver Surprise' Green Fuse Botanicals
Petunia ColorRush™ 'Blueberries & Cream' Ball Floraplant
Petunia ColorRush™ 'Pink' Ball Floraplant
Petunia ColorRush™ 'White' Ball Floraplant
Petunia Headliner™ 'Violet Sky' Selecta One
Petunia Red Carpet 'RIMarkable™' Danziger Flower Farm
Petunia Supertunia Mini Vista® 'Indigo' Proven Winners
Petunia Supertunia Mini Vista® 'Sweet Sangria' Proven Winners
Petunia SureShot™ 'Hot Pink' Ball Floraplant

Plectranthus ColorBlaze® 'Chocolate Drop' Proven Winners
Plectranthus Talavera™ 'Moondust' Syngenta Flowers
Plectranthus Talavera™ 'Pink Tricolor' Syngenta Flowers

Salvia farinacea Cathedral® 'Blue Bicolor' Green Fuse Botanicals

Scaevola Abanico 'Rose IMP' Benary Plus
Scaevola Abanico 'White IMP'Benary Plus
Scaevola Scala 'Blue Bird' Dümmen Orange™

Sedum 'Conga Line' Terra Nova Nurseries

Veronica 'Seaside' GardenChoice

See all the trials results here: https://agsci.psu.edu/flower-trials

HERB GROWING QUICK REFERENCE GUIDE
CHERRY VALLEY ORGANICS

			Propagation								
Name	**Scientific Name**	**Preferred Varieties**	**Direct Seed in the Field**	**Seed started in Greenhouse**	**Cuttings**	**Field Spacing (in)**	**Fabric**	**Pinch**	**Corral**	**Light**	**Grown as**
Anise Hyssop	*Agastache foeniculum*			X		12	x			Full Sun	P Zone 5
Basil, Anise	*Ocimum basili-cum*	Persian		X		12	x			Full Sun	Annual
Basil, Lemon	*Ocimum basili-cum*	Mrs. Burns Lemon									
Sweet Dani Lemon		X		12	x			Full Sun	Annual		
Basil, Holy Kapoor	*Ocimum africanum*			X		12	x			Full Sun	Annual
Basil, Sweet	*Ocimum basili-cum*	Nufar		X		12	x			Full Sun	Annual
Basil, Sweet Thai	*Ocimum basili-cum*			X		9	x			Full Sun	Annual
Bee Balm	*Monarda didy-ma*			X	x	18		x	x	Full Sun/ Partial Shade	P Zone 4
Bergamot, Wild	*Monarda fistu-losa*			X	x	18		x	x	Full Sun/ Partial Shade	P Zone 4
Borage, Blue	*Borago officinalis*		x	X		12 to 18	x			Full Sun	Annual
Catnip	*Nepeta cataria*			X		18	x			Full Sun	P Zone 3
Celery, Cutting	*Apium graveo-lens*			X		12	x			Full Sun/ Partial Shade	Annual
Chamomile, German	*Matricaria recutita*		x	X		9				Full Sun	Annual
Chives, Com-mon	*Allium schoenoprasum*	Staro		X		9				Full Sun/ Partial Shade	P Zone 3
Cilantro	*Coriandrum sativum*	Santo	x			3				Full Sun/ Partial Shade	Annual
Comfrey	*Symphytum officinale*				x	24				Full Sun/ Partial Shade	P Zone 3
Dill	*Anethum grav-eolens*	Greensleeves	x			3				Full Sun	Annual
Geranium, Scented	*Pelargonium*	Attar of Rose			x	18	x	x		Full Sun	P Zone 10,11
Lavender	*Lavandula angustifolia*	Ellagance Purple Hidcote Munstead Vera		X	x	12 to 18	x	x		Full Sun	P Zone 5, Varies

			Propagation								
Name	**Scientific Name**	**Preferred Varieties**	**Direct Seed in the Field**	**Seed started in Greenhouse**	**Cuttings**	**Field Spacing (in)**	**Fabric**	**Pinch**	**Corral**	**Light**	**Grown as**
Lavender	*Lavandula x intermedia*	Hidcote Giant			x	18	x			Full Sun	P Zone 5
Lemon Balm	*Melissa officini-alis*			X		18				Full Sun	P Zone 4
Lemon Verbena	*Aloysia triphylla*				x	18	x			Full Sun	Annual
Lemongrass	*Cymbopogon flexuosus*	East Indian		x		9	x			Full Sun	Annual
Mint, Apple	*Mentha suaveo-lens*				x	12				Full Sun/ Partial Shade	P Zone 5
Mint, Choco-late	*Mentha piperita*				x	12				Full Sun/ Partial Shade	P Zone 5
Mint, Peppermint	*Mentha piperi-ta*				x	12				Full Sun/ Partial Shade	P Zone 5
Mint, Spearmint	*Mentha spicata*				x	12				Full Sun/ Partial Shade	P Zone 5
Oregano, Greek	*Origanum vul-gare*			x		12	x			Full Sun/ Partial Shade	P Zone 4
Parsley	*Petroselinum crispum*	Giant of ItalyKrausa		*x*		9	x			Full Sun/ Partial Shade	
Rosemary	*Rosmarinus officinalis*	Hardy Hill Barbeque Upright			x	12	x	x		Full Sun	Annual
Sage	*Salvia officinalis*	Fanni		x		12	x			Full Sun	P Zone 4
Sage, Pineapple	*Salvia elegans*				x	18	x		x	Full Sun	Annual
Stevia	*Stevia rebaudi-ana*				x	18	x	x	x	Full Sun	Annual
Thyme	*Thymus vulgaris*	German Winter Summer		x		9	x			Full Sun	Annual
Thyme, Lemon	*Thymus citriodorus*				x	9	x			Full Sun	P Zone 5

QUIET CREEK HERB FARM & SCHOOL OF COUNTRY LIVING: MAKING & SELLING VALUE-ADDED HERBAL PRODUCTS

Sylvia Rensel
Quiet Creek Herb Farm & School of Country Living

In this session Sylvia Rensel, one of the current Stewards at Quiet Creek Herb Farm, will be discussing how they make a profit growing, making, and selling value-added herbal products in their on-farm/online shop. As a farm just over 30 acres and run by 2-3 people plus volunteers, she will share how they use their limited resources to produce high quality herbal products and their method for marketing & selling said products.

Through on-farm workshops, school groups, public & private tours, events, community outreach, as well as an on-line & locally advertised presence they are able to have an economically viable herb shop in a rather remote location.

They make herbal teas, seasoning mixes, soaps, salves, tinctures, and massage oils as well as selling dried herbs by weight. Other items, such as books, locally made honey & maple syrup, and surplus fruits, veggies, and mushrooms grown on the farm are also sold in the shop.

Sylvia Rensel is an enthusiastic young farmer & community builder with holistic knowledge of regenerative agriculture/stewardship. She has experience networking, event planning, and developing/teaching educational programs for both non-profit & for-profit organizations such as Quiet Creek Herb Farm & School of Country Living where she currently works as a steward. A passion to make food systems more sustainable (environmentally sound, socially just & economically viable) and land stewardship more mindful is what drives her work and she is excited to share anything she knows with others to help them move towards the same goals.

CUCUMBER BAG CULTURE

Tom Childs
Twin Springs Fruit Farm, Inc., Orrtanna, PA 17353
717-642-8988

Any sort of greenhouse vegetable production starts with the manipulation of indoor climate and the ability to maintain target temperatures 24 hours a day. For indoor cucumbers, a basic controller or just thermostats may not be the answer. To maintain peak production, it is necessary that day/night differential of at least 8 degrees be targeted. So, a 68-degree night and a 76-degree day target is preferred. Obviously, day temperatures will exceed 76 degrees, but the night target should be as close as possible to 68 degrees. The transition period between night/day set points should be gradual, not just switch between one to the other at say 8:00 am. If the air temperature rises too quickly, the cooler leaf surface will condensate warm, moisture laden air, and a wet surface will bring a variety of fungal diseases. Most common in our greenhouse is powdery mildew, year-round. Downy mildew will occasionally show but usually limited to September/October. A controller with the ability to ramp between set points will be worth the money. Ours is limited to a 99-minute max but seems sufficient.

Media choices are also important. All our greenhouse vegetables, except cucumbers, are grown in coir/perlite/peat mix. For us, cucumbers didn't do well in any other media but coir bags. Bags we use are approximately 8" x 42" about 5" thick after hydration. They are shipped as compressed slabs in the bag. The bags lay in an 8" pipe cut in half and run unbroken the length of the house. Floors are graded to a one percent slope, so leachate drains to one end. Having a dry floor is not just desirable, but necessary. Wet floors are habitat for fungus gnats, and if left uncontrolled, will be an unnecessary future problem.

Anyone can grow cucumbers inside or outside in the summer, but to grow in the shoulder months, either side of summer requires more input and equipment. Winter production is a separate category. At a minimum, floor/root zone heating is required. If the roots aren't right – nothing else is either. We keep root zone at least 72 degrees and in colder weather go to 74 degrees. Consistency and accuracy here is necessary. Having a system that works most of the time just won't do and will cost you production when the prices are up.

Winter production – defined for this purpose, winter is mid-October to mid-February. Within this time period, supplemental light is required – no exceptions. Without lights, you can grow plants and pick into mid-October, and you can grow plants and start picking in mid-February. But to harvest cucumbers in this time frame, 20-22 moles of light per day – everyday, is required. Depending on your market, this can be profitable. But close examination of initial cost and operating cost matched with dependable sales price is a must. This also requires another level of environmental control, incorporating lighting control into the system. We just purchased a replacement controller for about $7000.00. Choices at this level are few.

Having a space other than the production space to start transplants is ideal. We seed into peat filled Jiffy Pots for germination. After germination, these are inserted into 3" rockwool cubes. Plants are grown out in the transplant house for about 2 weeks then placed in the production house at about 6" tall with roots at the bottom of cube. Holes are cut in the bags to fit the 3" blocks, 4 to a bag. Bags are laid end to end in the half pipe with no room for algae to grow. We always have 8 rows of various age plants, usually picking 6 rows at any given time. We seed a row every 2 weeks. The cycle allows plants to mature to about 110 days from seeding. Picking starts at about 50 days after seeding in average light. So, plants are harvested for about 60 days, then pulled, and replaced. We lean and lower a single stem much like tomatoes. This requires labor to pull leaves and lower. But all harvesting is done standing on the floor, not off ladders. This production house is 9' to the gutters. Because we pick 3-4 days a week and only lower

Tom is starting his 25th season as Production Manager at Twin Springs. The farm sells year-round at farmers markets in the Washington DC Metro area and has for over 40 years. He oversees 40 acres of vegetables, 32,000 SF greenhouse vegetables, and 10 acres of small fruits. Spare time finds him, with his wife, renovating an 1869 bank barn, part of a recent purchase of his wife's family farm. He enjoys spending time with the families of his 4 children which includes 4 rambunctious grandchildren.

occasionally, it is the better choice for us.

We grow Jawell from DeRuiter Seed. This is a seedless mid-Eastern type picked at 5”-6” long. These require no wrapping like European types and stay firm if customer places in a plastic bag in the refrigerator. We pick into wooden crates lined with butcher paper inside a large, crate-sized plastic bag that maintains moisture in the crop. We direct market only at farmers’ markets.

Using these production methods and incorporating supplemental light for year-round production we harvested 46,000 lbs. of cucumbers in 2022. Cucumbers are a customer favorite.

RESOURCE EFFICIENCY, YIELD AND QUALITY OF AMARANTH GROWN AS A SUMMER LEAF-CROP IN ALTERNATIVE SOILLESS SYSTEMS

Pradip Poudel and Francesco Di Gioia
Department of Plant Science, Pennsylvania State University

The growing demand of high-quality locally produced vegetables and the challenges associated with unpredictable weather patterns and the emergence of soilborne pest and pathogen issues are leading to the increased adoption of controlled environment agriculture (CEA) systems such as greenhouses and of soilless growing systems (SGS), which have great potential to enhance the resilience of regional food systems.

Soilless cultivation systems, combined with CEA systems are considered a promising solution for increasing food production, and are gaining momentum, particularly in densely populated areas where agricultural land, water resources, and nutrition security are limited. Recent studies comparing soil-based and soilless production systems have demonstrated the potential of SGS to outperform traditional soil-based cultivation systems in terms of yield and quality, while using significantly less water. The precise control over water and nutrient supply typical of SGS allows an efficient use of these resources and the opportunity to improve the nutritional quality of vegetable crops through the application of agronomic biofortification techniques. Additionally, SGS enable the year-round production of high-quality vegetables in spaces where traditional cultivation is impractical, reducing the consumption of land, optimizing space usage, and increasing resource use efficiency.

The various designs, components, input requirements, and nutrient solution management characterizing alternative SGS systems, influence crop yield, nutritional value, and resource use efficiency, and the optimal SGS may differ depending on crop, environmental conditions, and other factors. Soilless cultivation systems can be classified primarily in medium-based and water culture SGS. Medium-based growing systems employ a substrate alternative to soil which can be of organic or inorganic origin, and often a mix of different materials. The nutrient solution in this case can be distributed via drip irrigation or through subirrigation. Water culture or hydroponic systems are characterized by the absence of a growing medium, and the nutrient solution is either static like in deep water culture (DWC), and the Kratky method, or non-static like in the case of the nutrient film technique (NFT). The choice of the SGS can impact crop yield, nutritional profile, and the sustainability of the production process. It's noteworthy that SGS typically relies on electricity, which may be a limiting factor in areas with intermittent or expensive power supply. In such cases, options like the Kratky method or gravity-fed drip irrigation systems may prove more resilient and preferable. Limited knowledge is available on SGS that operate without electric power, and only a few studies have compared different SGS side-by-side for productivity, resource use efficiency, impact on crop quality, and overall sustainability. Selecting the most efficient and sustainable SGS is challenging considering that there are many variants, each with distinct requirements and initial investments, and crops may respond differently.

Pradip Poudel, currently pursuing a Ph.D. in the plant science department at Pennsylvania State University, specializes in controlled environment agriculture, soilless vegetable production, and agronomic biofortification, with a primary focus on zinc enrichment in various microgreen species using different agronomic approaches. He holds an M.S. degree in environmental studies from Kentucky State University and a B.S. degree in agriculture science from Agriculture and Forestry University in Chitwan, Nepal. He has experience working in saffron production in diverse growing systems such as inside high tunnels, green roof media, peat-perlite mix, and organic field production. He also has experience in fertilizer management in green roof vegetable production and its effect on the runoff water quality, and growing media properties.

Francesco Di Gioia is Assistant Professor of Vegetable Crop Science in the Department of Plant Science at The Pennsylvania State University. With a 50% research and 50% extension appointment, his integrated research and extension program focuses on developing sustainable vegetable production systems and enhancing vegetable quality. He received his B.S. and M.S. in Agricultural Science and Technology and his Ph.D. in Mediterranean Agronomy working on nutrient management of vegetable crops from the University of Bari in Italy. Before starting his position at Penn State in June 2018, he worked on vegetable crops as a post-doc at the University of Florida from 2015 to 2018 and at the University of Bari from 2012 to 2015.

By adopting SGS, vegetable growers can overcome the limitations of soil-based systems. They can diversify and extend production season conducting multiple crop cycles year-round, contributing to increase the resilience of the regional food system. As more growers contemplate the adoption of SGS, evaluating their performance in terms of crop yield, quality, resource use efficiency, production costs, and overall sustainability is of paramount importance. To this purpose, a study was conducted at the Penn State Greenhouse Facilities to assess the performance of five alternative SGS, in terms of yield, nutritional quality, and resource use efficiency using green and red amaranth as a test crop. Amaranth is an ethnic vegetable, typical of the Caribbean and could be an alternative crop to grow in a greenhouse over the summer as it can be grown at relatively high temperatures when other common greenhouse leafy greens like lettuce suffer high temperatures and are subject to bolting.

Green and red amaranth seedlings producing using small rockwool cubes were planted at the same stage, 23 days after sowing. A standard nutrient solution was used in all SGS tested, and the amount of nutrient solution added upon starting, during the experiments, and remaining at the end of the experiment were recorded to estimate water and nutrient consumption of each growing system. For drip irrigation, the total amount of nutrient solution used was calculated based on the emitter capacity (4L/h) and irrigation time. Nutrient solution pH, EC (electrical conductivity), and dissolved oxygen (DO) levels in the reservoir nutrient solution were recorded weekly, and pH was maintained between 5.5 and 6.5. Green and red amaranth were harvested 18 and 22 days after planting, respectively. The pH of the nutrient solution in the Kratky and NFT system generally tended to be low, but pH was not adjusted in the Kratky system. The Kratky system had the lowest DO level compared to other SGS. DWC and NFT were the growing systems that produced the highest leaf and stem fresh weight, while the Kratky system provided the lowest plant fresh biomass. Between cultivars, there was no clear difference in terms of the leaf fresh and dry weight, but green amaranth had higher stem fresh and dry weight than red amaranth. The dry matter content was not influenced by SGS, while red amaranth had higher dry matter content compared to green amaranth for both leaves and stem. In terms of the nutrient solution use per plant, the Kratky and DWC systems used less nutrient solution; 34.2% and 25.6% less than the ebb and flow growing system, which consumed more nutrient solution compared to the other systems. Water use efficiency (WUE), expressed as the dry biomass produced per liter of water used, was the highest with DWC. Among the two cultivars, the green cultivar had higher WUE for the stem dry weight, but no clear differences were observed for the leaf dry weight.

INNOVATIVE MARKETING IN HIGH VALUE NICHE CROPS

Selection of Hazelnut Cultivars and Pollinizers to Enhance Opportunities for Direct Marketing

David Hlubik, John Capik, and Thomas Molnar
Rutgers Department of Plant Biology, 59 Dudley Rd, New Brunswick, NJ 08901

Hazelnuts are a non-perishable, low input yet high value crop with a multitude of end-uses that offer substantial opportunities for direct marketing. Proper selection of cultivars and pollinizers is critical for the consistent production of high-quality nuts. World production has historically been centered in regions with Mediterranean-like climates including Turkey, Italy, and the Willamette Valley of Oregon, USA. However, due to recent breeding advances, hazelnut cultivars adapted to the Mid-Atlantic region (USDA Zones 6 and 7) are now available and are being planted. In the past, hazelnut production in the eastern United States was not possible due to the presence of the fungal stem canker disease Eastern Filbert Blight (EFB), which is endemic to the native hazelnut in this region, *Corylus americana*. The European hazelnut *(C. avellana)* is the primary species grown for consumption commercially due to its large nuts, but unfortunately most cultivars are highly susceptible to EFB. The Rutgers University hazelnut breeding program has been working for over 25 years on identifying resistance and developing new EFB-resistant cultivars adapted to New Jersey. The focus has also been on developing cultivars with very high-quality kernels so our growers can produce a premium product. In 2020, the breeding program released four cultivars: 'Raritan', 'Monmouth', 'Hunterdon', and 'Somerset', which are now available from nurseries. These cultivars produce high yields of nuts with round flavorful kernels desirable for the confectionary kernel market as well as for direct sales to consumers.

When orchards are properly designed with sufficient numbers of compatible production and pollinizer cultivars, mature plantings can yield well over 2000 lbs per acre. Fresh tree nut availability in this region is very limited, and a planting of hazelnuts may allow a grower to be one of the first in their area to have local nuts for sale at roadside stands and farmers' markets. Hazelnuts have a long shelf life —over one year in shell—offering many opportunities for sales throughout the fall/winter season (after a September harvest) and even throughout the following spring/summer when stored properly. Additionally, value added products such as shelled kernels (raw, roasted, or candied), nut butters, oil, and various confectionary products can be made on-farm and offer additional opportunities for direct sales. Thus, hazelnuts offer many opportunities for growers to diversify their farm operations and offer a unique, high-value product for sale.

Regarding production, hazelnuts are wind pollinated and self-incompatible, therefore proper selection of production and pollinizer cultivars is important when designing and planting an orchard. Due to genetic incompatibility alleles (S-alleles), the four cultivars mentioned above unfortunately do not inter-pollinate to the degree necessary for complete coverage and additional pollinizer trees are necessary within the orchard. Fortunately, additional pollinizer cultivars are available, such as OSU 541.147 "The Beast", Gene (NY 398), and Grand Traverse. These cultivars are "hybrids" with European hazelnuts and wild species and while they are not recommended as main production cultivars due to their lower yields or smaller nuts, they are EFB-resistant and have diverse incompatibility alleles and appropriate bloom timing, making them useful pollinizers for all four Rutgers cultivars (Table 1). Additionally, seedling trees (from germinated seeds) from resistant breeding lines including "hybrid" hazelnuts can be used to increase the diversity of pollen incompatibility alleles and time of pollen shed in orchards as complete compatible pollen coverage of the female blooms of the production cultivars is critical to achieving high yields. Male flowers (catkins) of European hazelnuts can occasionally get damaged from cold temperatures, especially following extended warm spells in winter, but hybrid pollinizers (including the clonal pollinizers listed above) tend to have more cold hardy catkins. Thus, including them can help ensure complete pollination during challenging winters. At standard 18'-20' spacing between rows and 10' between trees within the row, it is recommended for every 6th row to be made up of pollinizer trees, as well as planting

David Hlubik is a PhD candidate at Rutgers University under the direction of Dr. Thomas Molnar. His research topics focus on the investigation of interspecific hybrid hazelnuts as production and pollinizer cultivars. He has used the dynamic chilling model and growing degree hour model to study hazelnut dormancy and phenology. Additionally, he studies disease resistance to EFB, phenology, and nut characteristics of hybrid hazelnuts.

pollinizer trees at regular intervals within production rows. While pollinizer trees will also produce nuts, they will likely be smaller and/or lower yielding than 'Raritan', 'Monmouth', 'Hunterdon', and 'Somerset' so their incorporation should be closely considered on a case-by-case basis when designing orchards.

Hazelnuts flower early compared to other orchard crops, with the majority of bloom and pollination occurring during late February and early March in central New Jersey (Zone 7a). As mentioned, C. avellana catkins can be sensitive to cold temperatures once dormancy is broken, but female flowers are quite cold hardy and can tolerate very cold temperatures once emerged without damage in this region. Recent work at Rutgers University has determined chilling portion/chilling hour requirements of trees. Hazelnuts are rare in that catkins, female flowers, and vegetative buds all respond separately in late winter/spring, therefore, chilling estimates for individual plant parts are shown (Table 2). Low chilling requirements of catkins and female flowers (12 to 26 chilling portions) explain early flowering, while vegetative bud chilling requirements (32 to 42 chilling portions) are higher and should be primarily considered when looking at adaptability for a particular region especially when considering southern states production. Fortunately, these chilling requirements are relatively low and are easily fulfilled in the Mid-Atlantic region and a wide area of the northeastern U.S.

Interested growers should contact Dr. Thomas Molnar at thomas.molnar@rutgers.edu.

			Pollen Source				
Female Parent	**R**	**M**	**H**	**S**	**B**	**Gene**	**GT**
Raritan S_3, S_{22}		Yes	No	No	Yes	Yes	Yes
Monmouth S_1, S_{12}	Yes		No	Yes	Yes	Yes	Yes
Hunterdon S_1, S_3	No	No		No	Yes	Yes	Yes
Somerset S_3, S_{10}	No	Yes	No		Yes	Yes	Yes
The Beast S_8, S_{23}	Yes	Yes	Yes	Yes		Yes	Yes
Gene (NY 398) S_{15}, S_{23}	Yes	Yes	Yes	Yes	Yes		Yes
Grand Traverse S_{11}, S_{25}	Yes	Yes	Yes	Yes	Yes	Yes	

Table 1: Compatibility table of recommended hazelnut cultivars/pollinizers for the Mid-Atlantic region. 'Yes' indicates that the pollen source cultivar has incompatibility alleles (S-alleles) that are compatible with the female parent. 'No' indicates that the pollen source cultivar is not compatible with the female parent. Note that hazelnuts exhibit a sporophytic self-incompatibility system with co-dominance in the female flower and dominance or co-dominance in the pollen.

	Catkins	Female Flowers	Vegetative Buds
Raritan	13 CP (186 CH)	19 CP (304 CH)	42 CP (739 CH)
Monmouth	20 CP (329 CH)	23 CP (350 CH)	33 CP (576 CH)
Somerset	12 CP (170 CH)	21 CP (312 CH)	35 CP (614 CH)
Hunterdon	21 CP (206 CH)	25 CP (371 CH)	34 CP (599 CH)
The Beast	26 CP (443 CH)	25 CP (391 CH)	32 CP (551 CH)

Table 2: Chilling requirements of hazelnut cultivars measured in chilling portions (CP) and chilling hours (CH).

WINTER WORK: PLANNING, IMPROVING AND SELLING IN THE OFF SEASON

James Klett
James@fairgrownfarm.com

Overview: Preparation is key to success, especially when headed into the unknown territory of growth. Fairgrown Farm has grown in size for 5 consecutive seasons, and doing so successfully is owed in large part to winter preparation for the coming season. This presentation outlines the steps – planning, improving, and selling - of how to invest in the off-season for success in the on-season.

Planning: Approaching the off-season with a goal. Setting summer up for success.

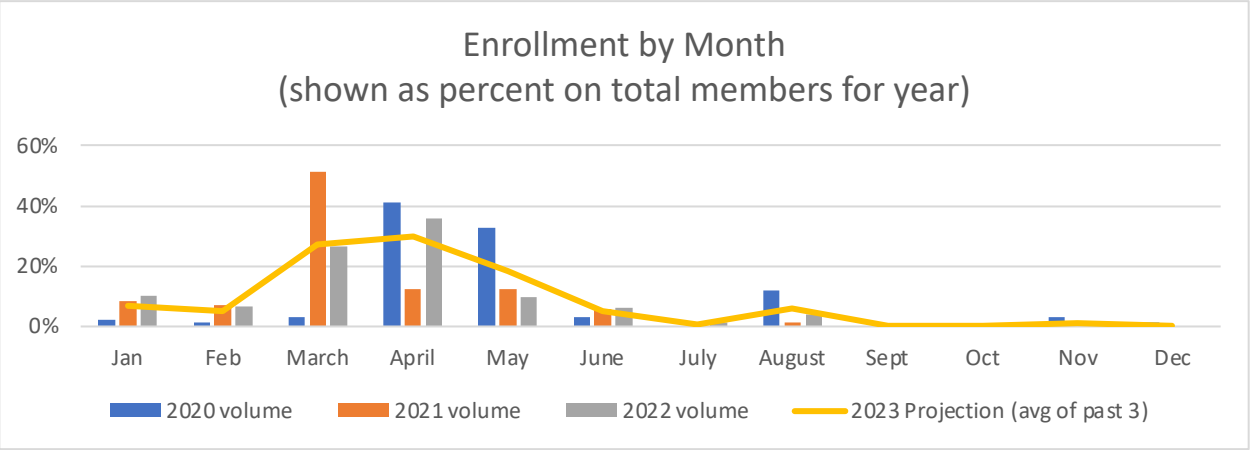
- Establish a farm vision. What do you WANT your farm to be? With the assets at your disposable, what actually CAN your farm be?
- Build a strategy. What general approach can you take to make your vision a reality?
- Set Goals. What can you do this year to work towards your vision?

Improving: Building capacity, implementing new systems, fixing old systems.

- Make your off-season as proactive as possible. Think about what you will need to achieve the goals you set and prepare accordingly.
- Setup new management systems and workflows, repair equipment, build new facilities.

Selling: Generate revenue through both pre-sales and winter crop sales.

Presales: CSA models can sell their programs in advance during the winter months. The graph below shows the importance of Jan-May as prime for enrollment. Wholesale and market operations should also build relationships (either directly with buyers or through advertisement) during this period.



Winter Crop Sales: Completely seasonal operations should consider growing and storing produce through the off-season for sale. Look at what your infrastructure and skillset will allow. Doing so comes with significant benefits, including employee retention and increased revenues.

Conclusion: Whether you're looking to rapidly expand your business or just improve your operation at its existing scale, being proactive in the off-season will be your key to success.

James Klett is Co-Owner of Fairgrown Farm in Hopewell, NJ, along with his brother Alex. James began farming at age 17 with no familial history. After graduating from Rutgers Business School (2019-mcl), he founded Fairgrown Farm and innovated the new "collaborative farm share" model. James differentiates himself with a unique skillset in business management, believing that profitable business is key to sustainable community farming. Fairgrown Farm's growth has doubled for 5 consecutive seasons under Klett's management, with the intent to continue expansion.

AUTOMATING YOUR IRRIGATION

Lee Fiocchi III
Lee Rain Inc., 2079 East Wheat Road, Vineland, New Jersey 08361
leef@leerain.com

Irrigation Automation has been available for use in Agriculture for many years now. It used to be limited to irrigation systems that used electric power for pumping operations and it also required proper wire sizing for long wire run lengths that are very common in agriculture operations. The traditional reasonings to automate irrigation used to be mostly for time/labor savings and to benefit from some energy and water efficiencies. In more recent years, combining automation with precision irrigation technologies like soil moisture monitoring have proven to not only benefit from the traditional reasons mentioned but also to accomplish other benefits such as yield, quality, plant health, soil health, fertilizer use just to mention a few.

Advances in Automation

In recent years, new advancements in equipment technology have helped increase the ease of implementation of automation on a farm. Wireless technology has made one of the biggest improvements by now not having to run wire to each device being controlled. Remote Telemetry Units, known as RTU's, have become the most used automation type equipment being implemented in new automation systems on the farm. Being able to control devices remotely from the base controller gives the farmer the ability to expand and/or scale the implementation of an automation system.

Conditioning programs have also become more popular in irrigation control systems. Conditioning program allows for more detail in automating the decision process not only to water but to be able to have the controller make the right decision you want to make when conflicts arise. Conflicts such as pump limit capacities, multiple pump operations, run of fertilizer programs on some zones but not others just to name a few. Conditioning program allows you to program the controller to operate as if you were standing there in front of the controller making the decision as you would.

The affordability of these types of systems has also made it possible to implement more on the farms. Just like any other technology, as time goes on and advancements are made the costs for these systems does not increase at the same rate as the advancements.

Automating Pumps

As mentioned before, electric powered pumps were a necessity to have if you were going to automate an irrigation system. Even with the advancements of VFD's for electric pumps the actual trigger/communication to the pump from the controller to turn on or off is the same. With the advancement of diesel engine control panels, it has allowed the adaptability of using diesel engines for automation systems to be more easily achievable. This is true whether it is a centrifugal pump or turbine pump. Just like an electric pump the controller sends a command to turn on or off but then the local engine control panel takes over to operate the pump and any ancillary equipment needed to make the diesel pump operate. This is an example of a typical operation of a engine panel on a diesel engine with a centrifugal pump that has a dc electric powered primer once it receives the signal to start. Engine starts at an idle for a programmed warm-up time, then there is a float wired in between the engine panel and the electric primer which tells the primer whether it is needed to run or not. If the primer is required to run, it will stop once the float is triggered to turn it off. Once that operation is complete the engine panel now knows to start to raise throttle to

Lee Fiocchi is the third generation President of Lee Rain, Inc. As a prominent thought leader and true agriculture visionary, he has been working to build a world-class company capable of discovering and delivering value in a bold new way for more than 25 years. In 2018 he received the distinguished 40 Under 40 Award from Farm Journal. Lee is acknowledged as the father of redefining the true value that agricultural analytics can bring to growers and society (i.e. profitability, manageability, sustainability and accountability), and his company has received several patents related to this methodology. It is through his life-long passion for uncovering water solutions for a growing world, Lee believes that global competitiveness requires continual investment in the future that will make innovations possible for decades to come.

increase RPM. The RPM is raised in specified increments until the pump reaches the set PSI that is required. Now the PSI takes over changing the RPM to maintain that set PSI. This action is repeated during the whole irrigation program as valves open and close.

Automating Valves/Devices

Typically, the valves that are automated are either simple On/Off DC latching solenoid hydraulic valves or Pressure Regulating Valves with the On/Off DC latching option. When an RTU is operating a valve, it outputs a pulse to energize the latching solenoid to turn on and then again it does the same thing to when it is time to turn it off. The RTU's get it command from the controller on when to do this task. Typical RTU's have multiple outputs that can connect to multiple valves that are close in proximity. RTU's can connect to other devices that the controller needs to control. Devices like fertilizer pumps and filtration valves to name a few.

Incorporating Technology

For some time now there has been many that are using technology devices like weather stations and soil moisture sensors to help in making decisions to operate irrigation and/or to monitor the effects of your irrigation decisions. In more recent years there has been many efforts in combing the data from these sensors to operate the controllers directly. This is sort of an AI (Artificial Intelligence) approach. The data that is interpreted from these sensors then tells the controller to start or not to start. This is a very high level of irrigation management. Some of the common results from this approach are reduction in water use and still increase yield and quality. Efficient fertilizer usage plays a big role in achieving the results. Even though using this technology in this approach it is not meant to be a "set it and forget it". A person is still needed to manage the irrigation. It is just managed in a different way than we are used to.

FOOD TRENDS 2024

Claudia Schmidt, Assistant Professor of Marketing and Local/Regional Food Systems,
Department of Agricultural Economics, Sociology, and Education, Penn State

Kathy Kelley, Professor of Horticultural Marketing and Business Management,
Department of Plant Science, Penn State

Every year, new food trends emerge. As in previous years, we provide an insider's view into trends highlighted by reputable publications, marketing firms, associations, and supermarkets. While certain ingredients or cuisines may gain attention, it's important to note that some trends last for multiple years.

Plant foods with … even more Plants!

- Whole Foods predicts the plant-based food trend to continue in 2024, with consumers preferring simpler meat substitutes and protein-rich plants like beans, mushrooms, walnuts, and tempeh (Whole Foods Market, 2023).
- Chickpeas are back in trend as a snack and baking ingredient following recovery from production shortages due to weather, production shifts, and pandemic-related supply issues (Food and Grain, 2023; The Takeout, 2023).
- Mushrooms are gaining popularity for their functional food properties, offering health benefits, caffeine substitution, relaxation, and skincare (Specialty Food Association, 2023c; PSU Extension, 2023c).
- Consumers are favoring all kinds of nuts, especially roasted and flavored ones. In 2024, spicier flavors such as hot honey, sweet heat, and mango habanero are expected to trend (Food Industry Executive, 2023).
- Peaches are predicted to regain popularity as condiments and paired with other plant flavors (Specialty Food Association, 2023b, 2023c).
- Lavender is forecasted to be a food and health trend in 2024, featured in honey, teas, preserves, baked goods, seasonings, and chocolates (Newsweek, 2023).
- Buckwheat, a gluten-free pseudocereal, is named one of the Top 10 Food Trends for 2024 by Whole Foods. It's high in fiber, resistant starch, quality protein, minerals, and antioxidants. It can be used as groats or flour in various dishes and processed foods (Daily Harvest, n.d.; Healthline, 2023; Specialty Food Association, 2023a). In Pennsylvania, buckwheat, a low-input crop suitable for organic cultivation, is popular as a cover crop and can thrive particularly well in the northern part (Björkman, 2009).

Gen Alpha and Gen Z

- It's not recommended to base a marketing plan solely on a consumer's generation; however, there are identifiable characteristics in how Gen Alpha (born after 2013) and Gen Z (born between 1997 and 2012) behave, gather information, and interact with others (Feger, 2023).
- Gen Alphas, who are just turning 10 in 2023, has a role in household food decisions. About 30% of Gen Alpha parents involve them in grocery purchasing decisions, and about 80% often or sometimes request specific snacks or food brands (Adams, 2023).

Kathy Kelley is a Professor of Horticultural Marketing and Business Management at The Pennsylvania State University. She teaches a Retail Horticultural Business Management course, and her research interests include studying consumers' wine consumption and purchasing attitudes and behaviors, wine tourism and what encourages tasting room visits, and related. She also has extension responsibilities that include developing business and marketing educational programs for wine brands and winery tasting rooms.

Claudia Schmidt is an Assistant Professor of Marketing and Local/Regional Food Systems at The Pennsylvania State University. She researches small-scale agricultural producer and processor issues in the United States within the network of local food systems, focusing on agritourism and direct-to-consumer sales.

- Despite children's requests, 66% of Gen Alpha parents prioritize buying fruits and vegetables for their kids (Beaton, 2023).
- Both Gen Alpha and Gen Z are influenced by online content. 55% of Gen Z use social media, particularly TikTok, to discover new foods and recipes (The Hartman Group, Inc., 2023a). For Gen Alpha with internet access, about half watch content on TikTok (Datassentials, 2023a).
- Gen Z consumers prioritize fresh, minimally processed food and beverages, with 52% wanting more meals with whole foods (The Hartman Group, Inc., 2023).
- Despite their healthy intentions, cost is a barrier for Gen Z, who are less willing than Millennials to pay extra for healthier options. Almost half choose less healthy options due to the high cost of healthier alternatives (Hartman Group, 2023b).

Trending ingredients and cuisines

- Korean cuisine and other Asian foods have been increasingly popular for years, according to sources like restaurant review sites and chef associations. This trend is driven by younger consumers who seek diverse food options and authentic flavors (Hamstra, 2023).
- Fermented, spicy, and fusion cuisine hold value across different food categories and are favored by multiple generations. Other trending fermented foods include those made from typically discarded items like spent grains and fruit peels (Food Beverage Insider, 2023).
- For younger consumers, lemon pepper and sriracha are gaining a presence on kids' menus. Global flavors that can be turned into dipping sauces, particularly those that pair with chicken, appeal to Gen Alpha (Datassentials, 2023b).
- Specialty peppers like Scorpion Peppers, Guajillo, and Hungarian Goathorn Peppers are expected to feature in various forms: fresh, ground, pickled, in oils and sauces, and in beverages (The Whole Foods Market, 2023). Calabrian chili peppers are used in products such as pasta sauce, hot sauce, cured meats, snacks, and relish (Specialty Food Association, 2023c).
- Fusion cuisine options are limitless and popular among Gen Zers, with around 38% enjoying mixing flavors to create new combinations (The Hartman Group, Inc., 2023c).

Snacking

- The boundary between "snacks" and "meals" is becoming less distinct in 2024 due to the increased need for convenience and limited time for meal preparation (Frito-Lay, 2023).
- Snacks account for 53% of Gen Z's total eating occasions (Des Jardins, n.d.).
- Gen Z primarily snacks for indulgence, while Millennials, Gen X, and Baby Boomers snack to satisfy cravings (Datassentials, 2023b).
- 35% of consumers reported eating more fruit in the past year, followed by salty, crunchy snacks (28%) and nuts (25%). Less than 22% reported eating more vegetables, snack bars, cheese, ice cream, and salads (Datassentials, 2023b).
- Specialty chips, pretzels, and snacks were the top specialty food category in 2022, up from 3rd place in 2020 and 2021 (Specialty Food Association, Summer 2023d).

"Litte Luxuries"

- Whole Foods Market (2023) predicts a trend of "little luxuries" in 2023. Examples mentioned are enjoying a beverage on the way home or adding a bath bomb to the cart when grocery shopping.

References available at: https://bit.ly/FoodTrends2024Ref

DEALING WITH HIGH SOLUBLE SALTS IN HIGH TUNNELS

Veronda T. Blue, M.S. Plant Science
The Pennsylvania State University
Vtb5045@psu.edu

We are investigating the problem of high soluble salts in high tunnels at The Pennsylvania State University alongside the University of Tennessee at Martin.

High tunnels, plastic-covered structures that are primarily used to extend the growing season (Knewtson et al., 2010a), are an important technology used on small-acreage diversified vegetable farms. Growing degree days accumulate faster in tunnels than outdoors because of higher soil and daytime air temperatures (Wein, 2009). This allows for planting earlier than the field and overwintering of some crops. In Pennsylvania alone, based on our experiences, about half or 2,000 vegetable farmers have one or more high tunnels on their farms. Farmers grow high-value crops in high tunnels. Tomatoes are the most grown, followed by leafy greens and peppers or cucumbers (Anonymous, 2016; Fitzgerald and Hutton, 2012).

The accumulation of soluble salts affects soil and plant health in high tunnels (Fitzgerald and Hutton, 2016; Knewtson et al., 2010a; Sánchez and Ford, 2019b). This problem can be overlooked because the whole high tunnel is uniformly affected. For example, a researcher worked with a farmer who did not realize that his tomato plants were suffering from high levels of soluble salts until the farmer extended his tunnel, and plants in the new area grew significantly better than in the old area. In a survey of 110 farmers in New England states, over 80% indicated that strategies to manage soluble salts levels in high tunnels would be "somewhat" or "very helpful" to improve crop fertility management (Sideman et al., 2016).

An analysis of the high tunnel soil from 27 farms across Pennsylvania also revealed issues with soil quality. Soluble salts levels averaged 1.48 mmhos/cm (1:2 soil:water method), which is well above levels where yields of salt-sensitive vegetables are reduced. These farmers were largely unsatisfied with yields, mostly of tomatoes, from their tunnels, and some had taken tunnels out of production. We are investigating the ability of cover crops for their ability to bioaccumulate excessive soluble salts in high tunnels to provide farmers with an environmentally sustainable solution for improving soil quality in high tunnels.

The studied cover crops include Bolder Beets, Winter Rye, Barley, Sorghum, Berseem Clover, and Sugar Beets. Each of these cover crops was planted in 3-gal planting bags in a high tunnel. After the planting, the bags were treated with 1 of 3 nutrient solutions (normal strength Hoagland's solution, double strength Hoagland's solution, triple strength Hoagland'ssolution) to determine how effective each crop is at absorbing/accumulating the salts from their environment. We are repeating the study during the early-season, mid-season, and late-season to determine which cover crops grow best in the different seasonal conditions and which plants were more effective at bioaccumulating salts. The seasonal conditions varied based on temperature, humidity, day length, and tunnel air movement/stagnation based on the different planting seasons. This is meant to emulate the different growing seasons and give farmers options to 'treat' their salt-affected fields when it best fits their schedules.

While each crop has the potential to bioaccumulate salts, some performed better than others in the three seasons. For example, while each plant was able to grow from start-to-finish in the early and mid-season trials, crops like

Veronda Blue is a first year Masters Student at The Pennsylvania State University (Penn State), earning a degree in Plant Science while working in Dr. Elsa Sanchez' Lab. Prior to attending Penn State, she earned a Bachelor of Science degree from North Carolina Agricultural and Technical State University in Agricultural and Environmental Systems concentrating in Sustainable Land and Food Systems. During undergraduate school, Veronda interned with the United States Department of Agriculture, Natural Resources Conservation Services agency (USDA NRCS) as a Soil Conservation Technician and accepted a full-time position as a Soil Conservationist.
She is originally from Leland, North Carolina and she graduated from North Brunswick High School in 2019 as the Valedictorian of her class. While she has no children of her own yet, she loves her nieces and nephews, and is ecstatic about welcoming a new Baby Girl Blue into the family next month!
After graduating, Veronda intends to further her education to earn a doctorate degree focusing on Horticulture and Plant Genetics while working with the USDA NRCS.

sorghum were not able to survive the frost and freezing temperatures, the berseem wilted from the frost, the beets did not produce large-to-any taproots, and each plant was exponentially smaller in the late-season when compared to the early and mid-season crops. While each of these differences are not directly indicative of salt bioaccumulation, it is noted and will be considered with tissue nutrient analyses and other plant growth parameters.

This is an ongoing research project, and further tests and analyses will be conducted on the plants to determine the amount of salts they were able to bioaccumulate, their tissue composition, and which plant is a more viable option in each of the growing seasons, especially when considering how much salt is present in the soils. Additionally, soil analysis tests are to be conducted to determine the soil composition after the addition and removal of solution salts, and they can also be compared to the original soil. This will help determine how well each cover crop performed in their environments, and how effective the crops were at accumulating soluble salts.

For additional questions or for follow up information on the crops and soluble salts bioaccumulation, please reach out to Veronda T. Blue or Elsa Sanchez at The Pennsylvania State University.

NUTRITIONAL COMPOSITION OF GREEN AND BLACK BEANS GROWN IN ORGANIC AND CONVENTIONAL SYSTEMS

Gladis Zinati, Ph.D.
Rodale Institute, 611 Siegfriedale Road, Kutztown, PA 19530
gladis.zinati@rodaleinstitute.org

Green snap beans, that grow in a more compact form, are the unripe, young fruit of various cultivars of the common bean *(Phaseolus vulgaris)*. They are a popular vegetable and are commonly enjoyed as a side dish in many cuisines around the world. Green beans are low in calories (31 calories/100g), sugar content (3.3g/100g), and rich in nutrients. They are a good source of vitamins A, C, and K, as well as folate (B9) and fiber. They also contain minerals such as manganese and potassium and contribute to overall health benefits such as improved digestion due to fiber content.

Snap beans rank as the second-largest vegetable crop in Pennsylvania, following sweet corn. The state ranks as the fifth-largest producer of processing snap beans nationwide. In Pennsylvania, snap beans are cultivated across 6,600 acres, with a total value of $6,271,000.00 for the fresh market and $4,437,000.00 for processing beans." (USDA, 2022).

Black beans are a popular legume known for their rich flavor, versatility, and nutritional benefits such as protein, fiber, vitamins, and minerals. Consumption of black beans provides 373 calories/100g, maintains blood sugar levels (0.4g/100g) and aids digestion. They are an excellent source of plant-based protein and low in fat. The beans contain antioxidants, which help combat oxidative stress.

Despite black beans production being largely concentrated in the Midwest and Great Plain regions of the United States, recently its production has expanded to the Mid-Atlantic region and New York. This is because black beans can be stored dry, providing a cash-flow at winter markets.

However, the nutrient composition of beans grown in organic and conventional systems can vary based on farming practices, specific type of bean, location, soil quality, and environmental conditions.

In organic farming, beans are grown with OMRI certified fertilizers and pesticides. Such practices may contribute to higher levels of certain nutrients and antioxidants in crops. On the other hand, conventional farming typically includes synthetic fertilizers and pesticides, and nutrient content may be influenced by fertilizers and overall management practices.

The objective of this study was to determine whether nutrient composition of green and black beans vary with cropping systems. With this objective, green and black beans were cultivated in the Vegetable Systems Trial (VST), a long-term study aimed at evaluating the variations in nutritional composition resulting from reduced tillage practices in both organic and conventional systems. The experimental design employed a randomized block design with four replications. Green beans, specifically the 'Provider' variety, and black Turtle beans were sown into cereal rye using the Monosem® seeder with a spacing of 32 inches between rows. In the organic system, beans were sown into a roll-crimped cereal rye cover crop, while in the conventional system, beans were sown into a burnt down cereal rye cover crop. Drip irrigation was used for watering the beans. Green beans were harvested between July 15 and August 3rd, while black beans were harvested in late August once the pods had dried on the plant.

For nutrient analyses, green beans underwent freeze-drying before the grinding process. Following this, ground subsamples of both green and black beans were analyzed for mineral nutrients, vitamin B6 and C, as well as crude protein.

Dr. Gladis Zinati, the Director of the Vegetable Systems Trial, serves as an Associate Research Scientist at Rodale Institute. Her research is focused on evaluating practices and cropping systems on soil health, crop nutrient densities and link those to human health. Her investigation involves assessing both chemical and biologically based methods that enhance soil carbon, bolster plant resilience against pests and climate change. With 35 years of experience, Dr. Zinati holds undergraduate degrees in General Agriculture and Agriculture Engineering, a Master's degree in Horticulture from the American University of Beirut, and a Ph.D. in Soil Fertility from Michigan State University.

Data collected from both years were subjected to analysis of variance (ANOVA) to assess the effect of cropping systems on nutrient concentrations in beans, using statistical software package SAS (version 9.3). Significant differences among treatments were compared using Tukey's Multiple Range Test at $P < 0.05$. Bars in figures represent means of treatments. Means followed by the same letter are not significantly different at P value <0.05.

Results

Mineral Nutrients:
The nitrogen (N) and potassium (K) concentrations in green beans were significantly elevated in the organic system compared to the conventional system (Figure 1). Furthermore, the nitrogen concentration in black beans was significantly greater in the organic than in the conventional system and was twice as high as that in organic green beans. While the potassium concentration in green beans was 65% higher than that in black beans in the organic system.

The phosphorus (P) concentrations in organic green beans were significantly higher than those in conventional green beans, while no significant difference was observed in calcium (Ca) levels (Figure 2). Black beans exhibited a 40% higher phosphorus concentration compared to green beans, whereas green beans had a calcium concentration 3.5 times greater than that in black beans.

Magnesium (Mg) levels in green beans (0.22%) did not differ significantly from those in black beans (0.19%) and were consistent across cropping systems. The sulfur (S) concentration in both organic green and black beans exceeded that in the conventional system, with black beans showing a higher S concentration (0.23%) compared to green beans (0.13%).

Mean manganese (Mn) concentrations in green beans (22 ppm) were slightly greater than those in black beans (16 ppm). Furthermore, organic black bean demonstrated significantly greater levels of Mn (17 ppm) than the conventional ones (15.7 ppm).

In green beans, concentration levels of iron (Fe), copper (Cu), and zinc (Zn) were significantly greater in the organic system (47.0 ppm, 5.1 ppm, and 22.3 ppm, respectively) compared to the conventional system (40.2 ppm, 4.5 ppm, and 17.4 ppm, respectively). Conversely, there was no significant difference in cropping systems for black bean Fe, Cu, and Zn concentrations, averaging 76.5 ppm, 10.15ppm, and 28.50 ppm, respectively. However, these levels were greater than those observed in green beans.

Vitamins and Crude Protein:
There was no significant difference in the levels of vitamin B6 in green beans between systems, averaging 0.59 mg/100g. However, the vitamin B6 level in black beans was significantly higher in the organic system (0.47 mg/100g) compared to the conventional system (0.42 mg/100g). While vitamin C concentrations in green and black beans showed no significant difference with cropping system, green beans exhibited a concentration 10 times higher (47.6 mg/100g) than that of black beans (0.43 mg/100g). Crude protein levels in both green and black beans were significantly higher in the organic system compared to the conventional system (Figure 3). Additionally, black beans exhibited higher protein levels than green beans.

In summary

Results from this study showed that cropping systems may influence nutrient concentrations in green and black beans. In addition, nutrient concentrations may vary with the type of beans. In short:

- Organic green beans exhibit significantly higher concentrations of N, P, K, S, Fe, Cu, Zn, and crude protein compared to their conventional counterparts.
- Organic black beans have significantly higher concentrations of N, S, Mn, vitamin B6, and crude protein compared to conventional black beans.
- Regardless of the cropping system, green beans are packed in mineral K, Ca, Mn, vitamin B6, and vitamin C. In contrast, black beans boast higher concentrations of N, P, S, Fe, Cu, Zn, and crude protein.
- Both green and black beans serve as excellent sources of dietary protein, mineral nutrients, and vitamins. They contribute to promoting healthy bones, reducing blood pressure, improving digestion, and maintaining body weight.

Figure 1. Nitrogen (N) and potassium (K) concentrations in green and black beans grown in organic (ORG) and conventional (CNV) systems of the Vegetable Systems Trial (VST) at Rodale Institute, 2021-2022.

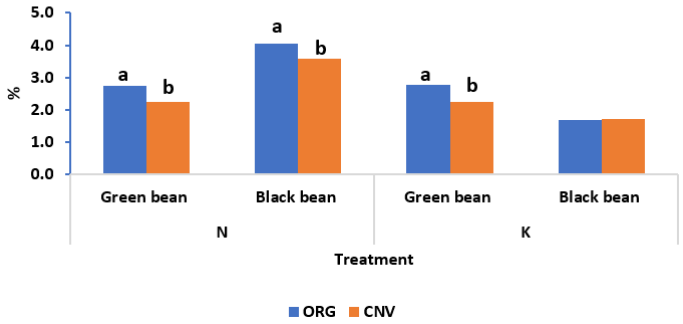


Figure 2. Phosphorus (P) and calcium (Ca) concentrations in green and black beans grown in organic (ORG) and conventional (CNV) systems in the Vegetable Systems Trial (VST) at Rodale Institute, 2021-2022.

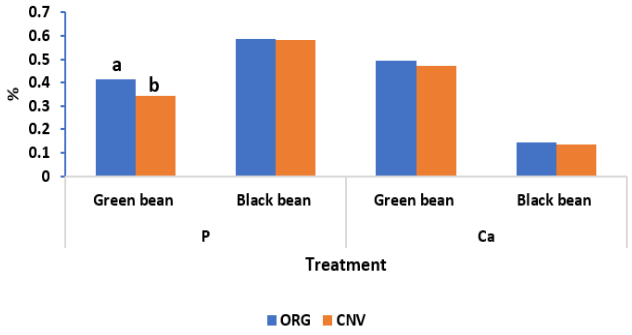
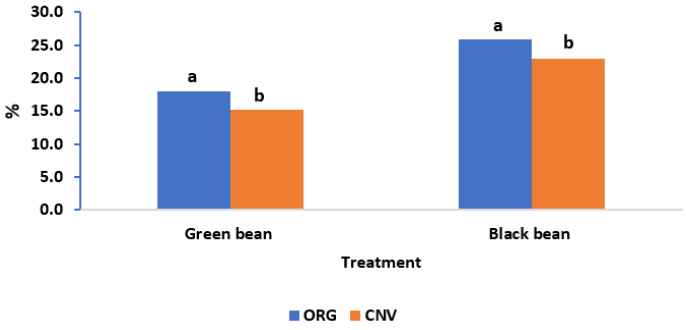


Figure 3. Crude protein levels in green and black beans grown in organic (ORG) and conventional (CNV) systems in the Vegetable Systems Trial (VST) at Rodale Institute, 2021-2022.



SOIL HEALTH AND FOOD SAFETY IN ORGANIC SPECIALTY CROP SYSTEMS – USE OF POULTRY LITTER IN CUCUMBER, MELON AND RADISH PRODUCTION

Ogutu Rose A. Ogutu
Delaware State University, 1200 N. DuPont Highway-19901 Dover, DE
rogutu@desu.edu

Organic specialty crop management practices in the Delmarva region face critical challenges such as soil health and food safety concerns from animal manure use. While green manures and composts can help maintain/improve soil health, supplemental nutrients may be needed to satisfy soil/crop requirements. Locally available stored stockpiles of animal manure are economical choices. However, they may contain less nitrogen than non-aged materials and harbor fecal indicator bacteria and pathogens, as well as insect larvae that vector the pathogens. In an organic farm system, it is essential that soil quality be sustained to give the plant its nutrients while improving quality and producing safe food. The major goal of this project was to evaluate the effects of customized poultry litter products and their soil application on soil microbial communities, including bacterial fecal pathogens and their survival, persistence, and transfer to fresh produce, and on soil health of high phosphorus soils in the Delmarva region.

A joint project carried out by University of Maryland Eastern Shore (UMES), Tuskegee University (TU), Delaware State University (DSU) and USDA-ARS. We used a multidisciplinary problem-solving approach that engaged, soil fertility, soil biochemistry, food safety, microbiology, horticulture, environmental science and extension expertise to address a nutrient problem faced by farmers on Delmarva.

Field experimental plots were established at DSU and UMES in fall 2017; cover crops: Hairy Vetch, HV and Forage Radish, FR were established on plots in a randomized complete block design (n=4 replicates); Poultry Litter (PL) and Heat-Treated PL pellets (PP)) were applied in spring (2018, 2019); creating four soil treatments, HVPL, FRPL, HVPP and FRPP. Poultry manure was applied in different crop fields using subsurface and banding methods for the cucumber and cantaloupe and Radish plots. A treatment simulating E coli contamination was included. Soil samples were collected aseptically before amendment and at the end of the production seasons using a composite sampling method for each field for soil health analysis. Post treatment data were compared to the base line levels that had been generated from a composite soil sample from the fields. Produce was analyzed for E coli contamination.

Neither of the application methods showed dominant effects over the other. Post-treated soils compared to the baseline levels showed differential responses among most of the treatment combinations. Soil macro and micronutrient content as assessed, showed improvements when compared to baseline assessment. This study indicates that there is potential for better soil health over a more extended period combined with acceptable farm practices.

PhD (Horticulture) Kansas State University, MS (Major-Horticulture; Minor-Marketing)-Cornell University. BS (Horticulture) University of Eastern Africa, Baraton
Rose has worked as a Horticulture Specialist with Small Farms Program at Delaware State University (DSU) since February 2011. She conducts applied research and develops and implements extension programs in horticultural crops with emphases on specialty crops, protected crop culture and organic production methodologies.
Dr. Ogutu is also the Delaware State coordinator of the Sustainable Agriculture Research and Education (SARE) Program. Dr. Ogutu is also part of the team working on DEIJ strategic plan for SARE.
As a member of the Northeast Climate Change Hub, Dr. Ogutu works with partners and stakeholders to develop and share science-based informational products that help managers of working lands (farms, forests) mitigate and adapt to the current and predicted impacts of climate change.
Dr. Ogutu also plays an important role in the Northeastern Integrated Pest Management (NEIPM) and helps administer IPM projects for small farms as part of the larger Delaware Extension Implementation of Projects team.
Dr Ogutu represents DSU extension at the Fruit and Vegetable Growers Association of Delaware Inc (FVGAD) board of directors meetings and in Delaware Soil Health partnership meetings.

POTATO INSECT UPDATE

Thomas P. Kuhar
Professor – Dept. of Entomology, Virginia Tech, Blacksburg, VA 24061-0319
tkuhar@vt.edu

Helene B. Doughty
Virginia Tech Eastern Shore AREC, Painter, VA 23420
hdoughty@vt.edu

Hannah Swarm
Graduate student - Dept. of Entomology, Virginia Tech, Blacksburg, VA 24061-0319
hannahswarm711@vt.edu

This presentation will discuss current work with managing two important insect pests of potatoes in the Mid-Atlantic U.S., wireworms and Colorado potato beetles.

Wireworms

Wireworms are the larval form of click beetles (Coleoptera: Elateridae) of which many species are persistent agricultural pests worldwide. They are particularly a problem for potato growers because they bore into tubers, which can lead to downgrades in the marketability of the crop, or load rejections. The loss of registrations of many soil insecticides (cyclodienes, organophosphates, and carbamates) has left few insecticide options remaining for wireworm control. Most potato growers control wireworms with at-planting applications of either Regent (fipronil), bifenthrin, Thimet (phorate), or Mocap (ethoprop). The latter two products are older organophosphates that are quite toxic. In addition, at-planting applications of neonicotinoids like Admire Pro (imidacloprid) or Platinum (thiamethoxam) for potato beetles also provide some control of wireworms. However, effective wireworm control in potatoes is not always achieved with any of the aforementioned insecticide options for wireworms.

Broflanilide and plinazolin are two novel insecticides with a new mode of action (meta-diamides – IRAC Group 30). In Canada and Europe, broflanilide has demonstrated great potential for wireworm control. Research has shown that wheat seed treated with Teraxxa (broflanilide) provides outstanding control against *Agriotes* spp. wireworms. Not only does broflanilide protect the wheat crop, but also suppresses wireworm populations in the field for subsequent crops. Broflanilide is registered in the grain seed treatment Teraxxa as well as a soil-applied liquid formulation (Nurizma). Plinazolin is not yet registered for use, but will be soon.

Because most of the efficacy work to date with these chemicals on wireworms has focused on *Agriotes* spp. and other European wireworm species, which are not found in the mid-Atlantic U.S., we need to evaluate their efficacy on *Melanotus* spp., which which are the primary pest species attacking potatoes in our area. In 2022 and 2023, we conducted both greenhouse container bioassays with field-collected wireworms and field trials in Virginia. These three experiments are summarized below.

Teraxxa corn seed treatment bioassay.

Container bioassays with corn seeds treated with Teraxxa (broflanilide) or fungicide only (control) seed treatments were planted in pots containing potting soil:sand mixture with 5 field-collected Melanotus wireworms added. Corn seed treated with Teraxxa resulted in >80% wireworm mortality and significant plant protection over untreated corn seed (Table 1).

Tom Kuhar is a Professor in the Department of Entomology at Virginia Tech. He has been a regular speaker at the MAFVC since the mid-2000s. Dr. Kuhar's research focuses on the integrated pest management of pests of potato and vegetable crops. He has trained over 40 graduate students and has published ~ 150 peer-reviewed papers and 6 book chapters on insect pest management in agricultural crops. A native of Baltimore, MD, he received his B.S. degree in biology from Towson, University, Towson, MD in 1992 and his Master's (1996) and Ph.D. (2000) degrees in entomology from Virginia Tech. He formerly worked as a postdoctoral research associate at Cornell University, Ithaca, NY researching alternative methods for managing vegetable pests.

Table 1. Efficacy of Teraxxa (broflanilide) seed treatment on Melanotus wireworms on corn planted in pots containing 5 wireworms; Painter, VA, 2022 and 2023.

2022	% emerged plants		Mean average height (in cm)		Fresh weight/10 plants (in g)	Root weight (in g)	% dead wireworms
Treatment	6-May	19-May	6-May	19-May			
UTC	80.0 b	80.0 b	12.7 b	24.7 b	14.5 b	30.8	15.0 d
Terraxa seed trt	100.0 a	100.0 a	14.1 a	39.1 a	44.5 a	51.3	82.5 a
P-value from Anova	<0.0001	<0.0001	0.0248	<0.0001	0.0002	ns	0.0005

2023	% emerged plants		Mean average height (in cm)		Fresh weight/[plant (in g)	Root weight (in g)	% dead wireworms
Treatment	10 April	2 May	13 April	2 May			
UTC	88 b	88 b	11.8 b	30.5 a	7.3 b	2.4 b	2.5 a
Terraxa seed trt	98 a	98 a	13.6 a	36.0 a	12.8 a	4.0 a	85.0 b
P-value from Anova	<0.007	<0.007	0.0006	NS	0.0002	0.0002	0.0001

Soil drench bioassay with broflanilide and plinazolin.
Knowing how well broflanilide performed as a corn seed treatment, we evaluated liquid formulations of the two Group 30 insecticides, Nurizma (broflanilide) and Plinazolin 300SC. Quart-sized containers were filled ¾ with top soil and each contained a small buried potato tuber plus 5 wireworms. The soil was drenched with the aforementioned insecticides. At 7 days after treatment, ~40% of wireworms were dead in the plinazolin and Nurizma treatments, but notably, 0% feeding injury to potato tubers occurred in these two treatments compared with 100% of tubers damaged in the water control. These data further support the potential for these insecticides for wireworm control and crop protection.

Field trials conducted in potatoes for wireworm control
Small plot field experiments were conducted in potatoes in Painter, VA (Eastern Shore) and Abingdon, VA (southwest) in 2023. We evaluated both Nurizma (broflanilide) and Plinazolin 300SC as at-planting in-furrow applications. Treatments were arranged in a RCBD with 4-6 replicates. At harvest, tubers were rated for damage from a subsample of 50 per plot. In Painter, there was no significant effect of treatment on any damage to tubers, although the untreated control had twice as mush wireworm damage as the Nurizma treatment (Table 2); too much variability in the data for statistical significance though. In Abingdon, there was a significant treatment effect. Both Nurizma and plinazolin reduced the percentage of wireworm damage similar to the commercial standard Regent SC. Further investigation with these novel insecticides for wireworm control is needed.

Table 2. Effects of in-furrow at-planting insecticide treatments on % damaged tubers (with holes) in small-plot field experiments in potatoes in Virginia, 2023.

		Painter, VA		Abingdon, VA	
Treatment (in-furrow)	**Rate / acre**	**% wireworm damaged tubers**	**% total damaged tubers (wireworms + white grubs)**	**% wireworm damaged tubers**	**% total damaged tubers (wireworms + white grubs)**
Untreated check		14.0	27.0	21.0 a	27.0 a
Nurizma	2.3 fl. oz	7.0	20.0	6.5 b	10.5 b
Plinazolin 300SC	3.43 fl. oz	11.0	16.0	7.0 b	7.0 b
Regent SC	3.2 fl oz	NA	NA	9.5 b	10.0 b
Platinum 75SG plus Regent SC	2.67 oz + 3.2 fl. oz	6.0	8.0	NA	NA
P-value from Anova		ns	ns	0.015	0.006

Colorado potato beetle

Colorado potato beetle is another major pest of potatoes across the U.S. including the mid-Atlantic Region. In Virginia, over 50% yield loss can occur if this pest is not managed effectively. Since the mid-1990s, systemic neonicotinoid insecticides such as Admire Pro, Platinum 75SG, Belay, or seed treatments such as Cruiser Maxx have provided excellent control of this pest. However, the inherent ability of this pest species to develop resistance to insecticides has led to reduced residual efficacy of these insecticides on CPB. Adult beetles that develop on volunteer potatoes in adjacent fields often move into potato fields after the residual efficacy of neonicotinoids is gone. Furthermore, some potato growers cannot use neonicotinoids on their crops for various regulatory and/or marketing reasons. This has created a greater need for foliar-applied insecticides to control CPB, and, as history has taught us, rotating modes of action is a wise strategy to prevent resistance development in CPB. Below are some recent small-plot field trials conducted on potatoes on the Eastern Shore of Virginia evaluating the efficacy of several newer foliar insecticide options.

Diamides insecticides (Coragen, Exirel, Verimark, Harvanta) and spinosyns (Blackhawk, Entrust, Radiant) are excellent IPM-compatible insecticide groups for lepidopteran pests. Our trials have also shown them to provide excellent control of CPB (Table 3).

Table 3. Potato foliar insecticide evaluation trial conducted in Painter, VA 2022. Potatoes (var. Envol) were planted 4 March 2022. Plots were sprayed twice in mid-May initiated at 50% CPB egg hatch. Coragen and Vantacor (each contain the same active ingredient, chlorantraniliprole, but Vantacor is a more concentrated formulation).

		# CPB per 10 stems				
Treatment	Rate/Acre	19 May small larvae	19 May large larvae	23 May small larvae	23 May large larvae	% defoliation 3 Jun
Untreated Check	-	122.5 a	8.0	77.3 a	171.8 a	80.0 a
Coragen 20SC	5 fl oz	n/a	n/a	0.0 b	0.0 b	3.3 b
Vantacor	1.7 fl oz	0.0 b	0.0	0.0 b	0.0 b	3.3 b
Blackhawk	3 oz	28.5 b	0.3	1.0 b	0.3 b	9.3 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).

In an effort to minimize nontarget effects of pesticide applications in the environment, one of the hottest new strategies for insecticide development is **RNA interference**, which is a biological process in which RNA molecules are involved in sequence-specific suppression of gene expression by double-stranded RNA, through translational or transcriptional repression. This strategy enables the development of compounds that are highly-specific to the pest species targeted, and thus, have zero to minimal effects on any other non-target species. Calantha is a novel RNAi insecticide recently registered for use on potatoes from Greenlight Biosciences. It has provided very good control of CPB larvae when sprayed at the right time (when larvae are small). Both Calantha and Coragen provided effective control of CPB reducing defoliation ≤5% compared to >68% in the untreated plots (Table 4).

Table 4. Potato foliar insecticide evaluation trial conducted in Painter, VA, where potatoes (var. Envol) were planted 4 March 2022. Plots were sprayed 2 or 3 times starting late April.

		No. CPB large larvae per 10 stems		
Treatment	Rate/Acre	23 May	31 May	% defoliation
Untreated Check		113.8 a	30.5 a	68.3 a
Calantha (3 apps2)	16 floz	5.8 b	7.3 b	5.0 b
Coragen (17 & 23 May)	5 floz	0.3 b	0.0 b	2.3 b

[2] 26 Apr, 3, 10 May.

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).

POTATO INSURANCE CHOICES FOR FCIC PROGRAMS

Jonathan Burcham
NAU Country, 4106 S. McDonald Lane, Spokane WA 99206
Jonathan.burcham@naucountry.com

Historical Perspective

USDA initially offered a multiple peril crop insurance (MPCI) program to potato growers in 1962. This initial program struggled to achieve actuarial sufficiency and was withdrawn after the 1969 crop year, after experiencing an overall 2.103 loss ratio. Potato growers continued to express interest in an MPCI program for their crop and in 1978 the Federal Crop Insurance Corporation (FCIC) reinstated the potato MPCI program to a limited area. In the mid 1980's USDA began expanding the MPCI potato program across the nation.

Insurance Program Complexities for Potatoes

Nationwide, the potato crop is marketed in a myriad of uses, e.g., table stock (fresh); processing as french fries, potato chips, dehydration; and seed. Some of the crop's utilization is regional in nature, and other uses may be more regionally universal. This poses an issue with policy design. To better accommodate the diverse insurance needs according to utilization, FCIC implemented two separate potato MPCI policies in 1986: 1) a Central / Southern policy providing basic coverage and, 2) a Northern policy with options / endorsements that better served its different and diverse markets. The Central / Southern policy is designed for growers that traditionally market their crop shortly after harvest and do not normally store their crop. In contrast, the Northern policy offers options / endorsements which enables the producer to fine tune their insurance protection according to their marketing intent, whether it be table stock with minimal storage, contracted for processing, or intended for seed. As a comparison, FCIC offers uses six different insurance policies to cover the different utilization of corn, but there are only two policy styles for potatoes.

Current State of Affairs –

USDA offers an MPCI potato program in thirty-eight states and for 2023, 1,616 producers insured approximately 768,000 acres. Current insurance experience shows the MPCI potato programs in the Northeast states are maintaining actuarial sufficiency with an overall loss ratio less than 1.00. In the past five years for the Northeast states, 97% of Maine's, 76% of New York's, and 45% of Pennsylvania's potato acres were insured with MPCI. In the same time period, 50% of Maine's, 57% of New York's, and 15% of Pennsylvania's growers chose the lowest level of coverage, i.e., Catastrophic (CAT) which equates to only 35%.

Recent Changes to the MPCI Potato Program (All States)

Enterprise Units are made available in 2024; this unit structure option has been previously well received by corn and soybean producers, so now offered to potato growers. All Northern Potato endorsements' premiums excluded from Prevented Planting coverage in 2022, recognizing an insured shouldn't pay premium on coverage not provided. Hurricane Insurance Protection – Wind Index (HIP-WI) added in select counties for 2020. Prevented Planting coverage level increased from 25% to 45% beginning 2019 (an optional 5% is also available). Supplemental Coverage Option (SCO) added in select counties for 2016. 80% and 85% Coverage Levels made available beginning in 2016, previously the maximum coverage level was 75%

Important Dates and Basic Insurability Requirements for Potato MPCI

Sales Closing – 03/15/2024; Final Planting Date – varies by county, see Actuarial Documents;

Jon is currently employed by an insurance company that services Multiple Peril Crop Insurance (MPCI) policies. Jon has been with this company since 2017 and currently serves as their Lead Perennial Crop Specialist. During his prior employment with FCIC / Risk Management Agency (1982 – 2014) Jon worked on the MPCI programs for numerous specialty crops besides perennials, including potatoes, onions, and seed crops. Jon is a native of Washington state, and resides in Spokane Washington with his wife, Stephanie. They have two adult children and three grandchildren. Jon attended Washington State University and acquired two collegiate degrees in Agronomy and Soils.

Production Reporting (used for establishing insurance guarantee) – 04/29/2024; Acreage Reporting (declaration of insurable acres) – 07/15/2024; Premium Billing Date – 08/15/2024; Calendar date for End of Insurance Period – Maine @ 10/20/2024 and All other NE states @ 10/31/2024.

In addition to the standard requirements of the Basic (Policy) Provisions, MPCI for Potatoes also requires:

1) Acreage must be planted with certified seed, and 2) No Potatoes grown in each of the preceding four crop years; New York counties have an exception allowing no rotation requirement for acreage recognized as 'muckland' soils.

Insurable Types and Practices

Maine and Suffolk County New York

Types – Russets & Shepody (076) and All Other (excluding fingerlings unless covered by written agreement) (093); Practices – Irrigated (002) & Nonirrigated (003) (including conventional & organic)

Pennsylvania and all other New York Counties

Types – All Types (excluding fingerlings unless covered by written agreement) (000); Practices – No Practice Specified (including conventional & organic) (997)

Universal Coverage Options

Hail & Fire Exclusion (HF); Extra 5 % prevented planting (PF); Yield Adjustment (YA); Yield Cup (YC); Yield Exclusion (YE) which is currently limited to NY Genesee, Monroe & Orleans counties; PA Columbia, Dauphin, Lehigh, Luzerne, Northumberland & Schuylkill counties; Contract Pricing (CP) – Contract Price Addendum (CPA) is an option providing price election enhancement for crop acreage grown under the organic practice(s).

Additional Options Available Under the Northern Policy – available to insureds without CAT

Certified Seed (CL); Quality Option #1 (QA) – can be used with PR & ST [available in Maine only]; Quality Option #2 (QB) – can be used with ST [available in PA, NY & ME]; Processing Option (PR) – can be used with QA, QD and ST; Storage Option (ST) – extends discovery time damage incurred in the field up to 60 days after harvest; can be used in conjunction with QA, QB, & PR. The Supplemental Coverage Option (SCO) with its area-based coverage beginning at the standard coverage level chosen continuing to 86 % is available in most counties (one of the few options also available to insureds choosing CAT). See Actuarial Documents for eligible counties; Hurricane Insurance Protection – Wind Index (HIP-WI) – See Actuarial Documents for eligible counties.

A few more specifics on the Northern Potato Policy's Options

Storage Endorsement – This option extends discovery time for damage assessment up to 60 days after harvest; applies to all insured acres except, Certified Seed Endorsement liability (built into this option) or contracted production required to be delivered within three (3) days of harvest.

'Standard' Quality Endorsement – This option offers a choice of U.S. #1 (QA) quality reference, or U.S. #2 or better (QB) quality reference when both contained in actuarial documents. These two quality reference standards can be selectively attached by type when more than one type is specified in actuarial documents – i.e., Maine. E.g., QA with All other (093) and QB with Russets & Shepody (076). Applies to all insured acres except any acreage grown for seed (regardless of whether insured under Certified Seed Endorsement or not).

Processing Quality Endorsement – This option provides additional quality protection due to: a) Inseparable internal disorders/damage, e.g., net necrosis; b) Specific Gravities less than 1.074; c) Fry Color of No. 3 or darker due to sugars > 10%, sugar ends > 19%; or d) Agtron rating lower than 58. Applicable only to acreage (and associated production) under contract with a Processor (e.g., Simplot, Lamb-Weston) or a Broker (e.g., supplier to Frito-Lay).

Certified Seed Endorsement – This option applies to insurable acreage entered into a state's seed certification program. Insured must provide at least the three previous years' records of seed potato acreage entered for state certification. The liability provided by this endorsement is capped at 125% when planted acreage exceeds 125 % of the most recent three-year average. This option creates a separate line of liability. One line for basic policy coverage plus

another constructed from APH guarantee times CSE price election. This option does not couple with the Storage Option for premium determination; however, the base policy's guarantee can be covered by the ST option.

Summary

This information is intended to help a potato grower better understand how the Northern Potato Policy and its options can be tailored to better meet the insurance needs of their particular operation. Growers are encouraged to visit with their insurance agent early. The brevity of this presentation prohibits all policy requirements being thoroughly covered; therefore, the policy and its associated handbooks take precedence despite any unintended omissions in this presentation.

SPUDS IN DEMAND: WHAT'S DRIVING THE POTATO MARKET

Kim Breshears, Chief Marketing Officer
Potatoes USA, 3675 Wynkoop Street, Denver, CO 80214
PotatoesUSA.com

Understanding the Potato Consumer

Nielsen IQ conducted a potato path-to-purchase study in October 2023 to gain a deeper understanding of the current state of the potato consumer.* Potatoes USA commissioned the study. Key insights from the study are summarized below:

Shopper Profiles

- Fresh potatoes
  - o Fresh potato shoppers are spread across age, urbanicity, and income. Shoppers are skewed toward females (53%), mainly Caucasian (78%).
  - o Consumption overlaps exist across Urban and Rural areas. In Rural areas, Russet potatoes are the most commonly purchased (34%). However, popular potato varieties (Russet, Red, and Yellow) are purchased more frequently, along with Purples and Fingerlings in urban areas.
  - o Russet potatoes are the most common type of fresh potatoes purchased. They are most often purchased at Mass Merch stores (56%), while Yellow (27%) and Red (18%) are purchased most often from specialty stores.
  - o Yellow and medley potatoes are the most considered alternatives.
  - o Shoppers have distinct beliefs toward different potato types and prefer to examine them before buying. They believe potatoes are versatile and a nutritious addition to their meals.
  - o Bagged potatoes are preferred by most (56%), and consumers find them more cost-effective per pound (47%).

- Frozen potatoes
  - o Frozen potato shoppers are mostly millennials (43%), mostly from urban/suburban regions (69%). They are primarily females (53%) and with kids at home (45%)
  - o Fries are the most common format of frozen potatoes purchased.
  - o Frozen potatoes hold a distinct value proposition in shopper's minds: prices come into play at the moment of choice, and shoppers are likely to have various varieties in their basket depending on meal or recipe.

Path to Purchase Insights

- Pre-store behaviors
  - o Eighty percent of shoppers plan their potato shopping trips. The most planned aspects include the type of potato they will purchase (61%) and the purpose of use (64%).
  - o The top pre-shop touchpoints are print (21%), social media (20%), and retailer-related content (20%).
  - o 10% of shoppers purchase online due to the convenience (65%) and quick deliveries (47%).
  - o Online shoppers who see online promotions, photos, recipes on the store's website and consumer ratings say they are the most impactful touchpoints.
  - o Consumers who don't shop online say they have quality concerns (47%) and prefer the in-store shopping experience (45%).

Kim Breshears is the Chief Marketing Officer at Potatoes USA. She is passionate about delivering results, effective communications, and financial stewardship. Her vast marketing experience includes various consumer products, food, technology, tourism, and home-building products. Kim has directed brand, marketing, and communications programs for organizations ranging from large corporations to small businesses, helping position them as recognized leaders in their respective industries. She's a proud graduate of the University of Colorado.

- In-store behaviors
  - o Most shoppers purchase habitually, going straight for the ones they typically purchase. When the type they want is unavailable, 57% of consumers are willing to change to another variety or type.
  - o The primary factors for in-store decisions are the potato size, physical appearance, and price.
  - o The items with the highest impact and reach during the shopping trip include fresh potato displays, the store's physical flyer, and signs placed above the product.

- Purchase decision factors
  - o Potato shoppers strongly believe that one type is better than another, which will likely influence how they approach their shopping.
  - o At the moment of choice, fresh potato shoppers say freshness and quality are most important, followed by price and quantity.
  - o For less frequently purchased varieties, such as white, purple/blue, and fingerling, occasions or usage recommendations are the primary reasons for purchasing.
  - o The potato category information most commonly referenced includes YouTube, recipe blogs/sites, Facebook, and Pinterest.
  - o Recipes are a strong motivator for purchasing the category.

- Consumption Insights
  - o Taste (78%) and convenience (68%) are the key drivers for choosing potatoes for meals. Health and nutritional benefits are also considered important when selecting potatoes.
  - o Top consumption occasions for potatoes (fresh and frozen) are as a side dish, at regular mealtime, and during dinner.
  - o Oven (69%) and stove top (64%) are the most common methods for cooking fresh potatoes.
  - o Consumers prefer oven tops (69%) and stove tops (56%) as cooking methods for frozen potatoes. Air fryers are gaining preference over microwaves.

- Value-added Potato Insights
  - o Value-added potatoes are mainly purchased for convenience (56%) and to shorten the preparation time (14%).
  - o Instant/dehydrated potatoes (48%) are the most purchased product in the value-added segment.
  - o Ease of cooking, convenience, time efficiency, affordability, taste, versatile ways of cooking, and as a side dish are the key themes for buying value-added potatoes.

The Consumer Path-to-Purchase study methodology: online quantitative study representative of the U.S. general population, fielded September 19-October 31, 2023. For a copy of the entire research report, contact Potatoes USA.

ARE THERE ANY NEW HERBICIDES FOR USE IN PUMPKINS?

Dwight Lingenfelter
Penn State University, Dept. of Plant Science, 116 ASI Building, University Park, PA 16802

Pumpkin farmers are continuously battling weeds in commercial production systems. Some common weeds include:
Annual grasses such as giant foxtail, large crabgrass, and fall panicum
Annual broadleaves: common lambsquarters, common ragweed, velvetleaf, pigweed species (including Palmer amaranth and waterhemp), cocklebur, eastern black nightshade, marestail, and common chickweed
Perennials: Canada thistle, horsenettle, bindweed, yellow nutsedge, quackgrass

The number of pumpkin herbicides (Table 1) is rather limited compared to other crops but with some creative thinking about using them, adequate weed control can be obtained. Since pumpkins are grown in a variety of ways (i.e., tilled seedbed, raised beds, no-till, on plastic, on rolled rye, direct-seeded, transplanted, etc.) not all these herbicides can be used effectively in all settings.

Table 1. Pumpkin herbicide efficacy

Weeds	Command (pre)	Curbit (pre)	Strategy (pre)	Prefar (pre)	Dual Mag. (pre)	Sandea (pre)	Sandea (post)	Aim (post)	Reflex (pre)	Select/ Poast (post)
Giant foxtail	G	-	G	G	G	N	N	N	P	G
Crabgrass	G	G	G	G	G	N	N	N	P	G
Yellow nutsedge	N	N	N	N	F-G	F	G	N	N	N
Lambsquarters	G	P-F	G	F-G	P	F-G	N	G	P	N
Nightshade	-	P	P	N	G	N	N	G	G	N
Pigweed	N-P	F	F	F	G	G	G	G	E	N
Common rag-weed	P-F	N	F	N	N	G	G	F	G	N
Smartweed	G	P	G	N	P	F	F	-	P	N
Velvetleaf	G	P	G	N	P	G	G	G	P	N
Cocklebur	N-F	N	N-F	N	N	G	G	P	N	N
Morningglory	P	P	P	N	N	F	F	F	P	N
Galinsoga	F	N	F	N	G	G	G	-	G	N
Purslane	G	F-G	G	F	F-G	F	P	-	E	N

Weed control rating scale: E= excellent; G = Good; F= Fair; P= Poor; N = no activity

There are not many potentially new herbicide options on the horizon for use in pumpkin. Reflex 2L is labeled for use in pumpkin in Pennsylvania and the DelMarVa states. Reflex controls eastern black nightshade, lambsquarters, pigweed, ragweed, and others. There are several potential herbicide candidates such as Chateau/BroadStar, Sharpen, Prowl, Spartan, Rely, Zidua, and a few others for row-middle and over-the-top weed control that are being tested. However, we are still working with IR-4 and the manufacturers to conduct appropriate research and if favorable crop tolerance is confirmed, the labels may be expanded to include use in pumpkin.

Dwight Lingenfelter is an extension agronomist/weed scientist in the Dept. of Plant Science at Penn State since 1994. He is responsible for developing various materials for Extension purposes, including revising portions of The Penn State Agronomy Guide, presenting practical information at county and statewide Extension meetings and field days, and generally contributing to other weed science Extension and research needs in mainly agronomic and some vegetable crops. He also coordinates the annual Penn State Agronomic Field Diagnostic Clinic and coaches the PSU collegiate weed science team and is a member of several professional societies and serves on various committees. He received BS and MS degrees in Agronomy from Penn State. He also worked for a period with a major ag chemical manufacturer and as a crop consultant.

Another approach to improve overall weed control is to apply a second residual herbicide over the top of the emerged crop, but before the weeds have begun to emerge. This approach is referred to as overlapping residuals. Dual Magnum is a common residual herbicide labeled for numerous crops, but not labeled preemergence in pumpkins. The current Dual Magnum label stipulates the following: "Apply as an inter-row or inter-hill application. Leave 1 foot of untreated area over the row, or 6 inches to each side of the planted hill and/or any emerged pumpkin foliage (inter-row or inter-hill means not directly over the planted seed or young pumpkin plants)." However, recent greenhouse and field studies have demonstrated good crop safety when using Dual Magnum over-the-top of pumpkin vines as an overlapping residual treatment. Dual Magnum will not control emerged weeds but weed control efficacy may be extended if it is applied sequentially, before the first herbicide dissipates. Dual Magnum provides residual control of several key annual small-seeded broadleaf and grassy weeds. Furthermore, weeds like Palmer amaranth and waterhemp are extremely aggressive and are spreading rapidly around the region and are on the PA Noxious Weed List. However, not many pumpkin herbicides are that effective on these noxious pigweeds. Here are some general comments:

- Command is not effective on these pigweeds
- Sandea has activity but does not control ALS-resistant (group 2) Palmer amaranth and it may cause stunting of the pumpkins
- Curbit will provide control, but its length of control is short
- Dual has activity but it cannot be used over the planted row currently. A sequential application made about 3 to 4 weeks after planting should provide adequate control of later emerging pigweeds allowing for cleaner fields at harvest.
- Shielded applications of Aim can control it but growers may not be willing to use this tactic
- Cereal rye can help suppress the weeds but then cultivation is no longer an option
- Choose the right field....don't plant where these noxious pigweeds have established

It is best to use an integrated weed management approach that includes some of the following: appropriate herbicides, crop rotation, hand-weeding, post-harvest control, cover crops, cultivation/tillage, and decreased row widths.

Over the past few years, nationwide field studies have been conducted, including here in Pennsylvania and the Mid-Atlantic region, on the utility of Dual Mangum applied postemergence to pumpkins. Thus far, the results look promising to potentially obtain a label for this use.

On another topic, the use of cover crops in vegetable systems, including pumpkins, has been on the rise. In recent years, an increasing number of growers are direct-seeding pumpkins in no-till systems, often into a cover crop (usually cereal rye) in order to reduce dirty pumpkins at harvest, provide some weed suppression, and reduce fruit rot. In no-till systems, growers cannot use tillage to give initial weed control or cultivation to provide in-season control, and therefore must rely on herbicides. Additionally, some weed control can occur in the rye prior to crop establishment. For example, spray 2,4-D (1 pt/A) in fall or early spring to kill marestail or other winter annual weeds. Than allow the rye to continue to grow and terminate it with glyphosate near planting. The rye can be rolled to make a nice surface and then plant directly into it. Also, as more farmers are using no-till, effective burndown herbicide programs are critical to the establishment of the crop.

UPDATE ON SOME NEW STRATEGIES AND INSECTICIDES FOR CONTROLLING CUCUMBER, BEETLE, SQUASH BUG, AND APHIDS

Thomas P. Kuhar and Demian Nunez
Dept. of Entomology, Virginia Tech, Blacksburg, VA 24061-0319
tkuhar@vt.edu

Cucurbit crops in the mid-Atlantic U.S. are attacked by several different insect species that can impact crop yield and quality. Cucumber beetles (Acalymma vittatum and Diabrotica undecimpunctata howardi) are usually the earliest to attack and most conspicuous pests. Adult beetles invade crops at all stages even at cotyledon, where large aggregations and their concomitant leaf feeding can kill seedling plants. Furthermore, beetles also can transmit disease pathogens including the bacterium Erwinia tracheiphila which causes bacterial wilt. The bacteria overwinter in the guts of cucumber beetles. The diseases can kill many susceptible cucurbit varieties. Cucumber beetles can also carry and transmit Squash mosaic virus, which can lead to stunted plants with distorted, blotchy-colored leaves. The virus can also reduce fruit yield and make fruits malformed and blotchy in color. If that's not enough reason for concern, cucumber beetles also may feed on the rinds of fruit, causing direct damage to crops. Consequently, these insects need to be controlled on cucurbit crops for many reasons.

The insecticide options for cucurbit growers are listed in Table 1. The effectiveness ratings are based on my 20-year experience conducting insecticide trials annually in Virginia. Most growers control cucumber beetles with neonicotinoids as either pretreatments on seeds such as such as Farmore F1400 (provides 3 weeks of protection) or transplant drench or drip chemigation or make foliar applications once beetles are seen on plants - usually pyrethroids (i.e., lambda-cyhalothrin, permethrin, bifenthrin, Baythroid XL, Mustang Max, Asana XL, etc.) are used for this as they are quite efficacious and relatively cheap. This pest management approach has worked well for a few decades, but there are now a few concerns including: 1. Environmental safety (particularly bee toxicity) of neonicotinoids; 2. Cancelation of neonicotinoid uses in certain states; 3. End-market acceptability of produce treated with neonicotinoids; 4. Non-target effects of pyrethroids – killing beneficial organisms; 5. Aphid and mite outbreaks as a result of pyrethroid sprays; and 6. Development of resistance to pyrethroids. With regards to the latter, there are increasing concerns of pyrethroids not working against cucumber beetles in Delaware (David Owens, University of Delaware, personal communication).

Thus, there is a great need to seek alternative insecticide chemistries and IPM approaches for cucumber beetle management. In this presentation, we discuss some current research in Virginia geared around this topic.

Tom Kuhar is a Professor in the Department of Entomology at Virginia Tech. He has been a regular speaker at the MAFVC since the mid-2000s. Dr. Kuhar's research focuses on the integrated pest management of pests of potato and vegetable crops. He has trained over 40 graduate students and has published ~ 150 peer-reviewed papers and 6 book chapters on insect pest management in agricultural crops. A native of Baltimore, MD, he received his B.S. degree in biology from Towson, University, Towson, MD in 1992 and his Master's (1996) and Ph.D. (2000) degrees in entomology from Virginia Tech. He formerly worked as a postdoctoral research associate at Cornell University, Ithaca, NY researching alternative methods for managing vegetable pests.

Demian Nunez is a PhD student working with Dr. Kuhar in the Department of Entomology at Virginia Tech where his research focuses on the integrated pest management of cucumber beetles. He received his dual B.S. degree in biology and environmental studies from Shepherd University in Shepherdstown, WV in 2017 and his Master's degree in entomology from University of Maryland in 2022.

Table 1. Insecticides registered for use on cucurbit crops in the Mid-Atlantic U.S.

Product Name (class)	Active Ingredient(s)	Effectiveness rating (E, G, F, P) on pest				PHI (d)	Bee Tox.
		Cucumber beetles	Squash bugs	Aphids	Pickleworm		
Carbamates (1A)							
Lannate LV	methomyl	F	G	G	G	3	H
Sevin XLR	carbaryl	G	G	F	G	3	H
Vydate L	oxamyl	F	F	G	P	1	H
Pyrethroids (3A)							
Asana XL	esfenvalerate	E	E	P	E	3	H
Baythroid XL	beta-cyfluthrin	E	E	P	E	0	H
Bifenthrin 2EC	bifenthrin	E	E	P	E	3	H
Danitol 2.4EC	fenpropathrin	E	E	P	E	7	H
Hero EC	zeta-cypermethrin + bifenthrin	E	E	P	E	3	H
Warrior 2, Lambda-cy	lambda-cyhalothrin	E	E	P	E	1	H
Mustang Maxx	zeta-cypermethrin	E	E	P	E	1	H
Perm-Up 3.2EC	permethrin	E	E	P	E	0	H
Tombstone	cyfluthrin	E	E	P	E	0	H
Neonicotinoids (4A)							
Admire PRO 4.6SC	imidacloprid	E	E	E	P	21	H
Assail 30SG	acetamiprid	G	E	E	P	0	M
Belay 2.13SC	clothianidin	E	E	E	P	21	H
Platinum 75SG	thiamethoxam	E	E	E	P	30	H
Actara 25WDG	thiamethoxam	E	E	E	P	0	H
Scorpion 35SL	dinotefuran	E	E	G	P	1	H
Venom 70SG	dinotefuran	E	E	G	P	1	H
Spinosyns (5)							
Entrust 2SC	spinosad	F	F	P	E	1	M
Radiant SC	spinetoram	F	F	P	E	1	M
Diamides (28)							
Coragen 1.67SC	chlorantraniliprole	F	P	P	E	1	L
Harvanta 50SL	cyclaniliprole	G	E	G	E	1	H
Other selective insecticides							
Intrepid 2F (18)	methoxyfenozide	P	P	P	G	3	L
Avaunt eVo (22A)	indoxacarb	F	F	P	E	3	H
Sivanto 200SL (4D)	flupyradifurone	G	G	E	P	1	M
Fulfill 50WDG (9B)	pymetrozine	P	P	E	P	0	L
Beleaf 50SG (29)	flonicamid	P	F	E	P	0	L
Combo products							
Endigo ZC	lambda-cy + thiamethoxam	E	E	E	E	1	H
Gladiator	zeta-cypermethrin + avermectin	E	E	P	E	7	H
Besiege	lambda-cy. + chlorantraniliprole	E	E	P	E	1	H
Durivo (28+4A)	thiamethox-am+chlorantra-niliprole	E	E	E	E	30	H
Minecto Pro (28+6)	cyantraniliprole + abamectin	G	G	G	E	7	H
Voliam flexi (28+4A)	thiamethox-am+chlorantra-niliprole	E	E	E	E	1	H

Is Assail (acetamiprid) a good option over other neonicotinoids?

Acetamiprid (active ingredient in Assail) is a different type of neonicotinoid. Unlike the more widespread nitro-group neonicotinoids on the market (such as imidacloprid, thiamethoxam, clothianidin), acetamiprid is a cyano-group neonicotinoid, which is only moderately toxic to pollinators (100-fold less toxic to bees than most other neonicotinoids). We know that Assail is excellent on aphids, which are often the target pest, but how well does it work on cucumber beetles?

In 2023, we conducted excised leaf bioassays with field-collected cucumber beetles from Virginia. Cucumber leaves were dipped in serial dilutions of Assail ranging from the equivalent of 1/10th to 1/32,000th the label application rate of 1.75 oz/acre and placed in large glass Petri dishes with 8 cucumber beetles over a 24-hour period. Assail proved to be incredibly potent, even at extremely low concentrations. Nearly 100% mortality was achieved at as low as 1/960th the labeled rate, and even at the lowest concentrations, beetles exhibited sublethal effects and ceased feeding on plant tissues after initial exposure. Bottomline, acetamiprid was extremely toxic to cucumber beetles despite having a reduced impact on bees. Further, in the field, Assail has performed well protecting plants against cucumber beetles. One well-timed application to galia melons in 2022 resulted in double the yield of melons over the untreated control by reducing defoliation damage and bacterial wilt incidence. That trial also provided good evidence that the organic insecticide Pyganic EC (natural pyrethrins) is not an efficacious option for cucumber beetle control. The insecticide probably breaks down too quickly.

Table 2. Summary of efficacy of Assail 30SG and Pyganic EC for the control of cucumber beetles on galia melons in Virginia – June & July 2022.

Treatment*	Rate per acre	Mean cumulative counts of cu-cumber beetles per 5 plants eve-ry 2-3 days for 3 weeks		% of plants w/ bacteri-al wilt symptoms	Yield (# mrktbl fruit per Acre)
		Live beetles	Dead beetles		
No insecticide control	12 fl oz	182.8 a	0.0 b	32.5	821.4
Assail 30SG	1.75 oz	53.5 b	120.0 a	10.0	1785.7
Pyganic EC	10 fl oz	150.0 a	1.0 b	35.0	464.3
p-value (trt)		0.01	0.05	NS	NS

*All plots were sprayed one time on June 21 and included Cide-Trak L cucurbitacin to enhance cucumber beetle attraction and feeding.

As most growers know, cucumber beetles aggregate in great numbers. This is the result of their highly acute response to semiochemicals such as the aggregation pheromone vittatalactone, which is emitted when overwintering male beetles encounter attractive cucurbit host plants to stimulate aggregation. This is most pronounced in the spring when and mass-attack on young cucurbit cotyledons can result in rapid destruction of plantings. Vittatatactone not only attracts conspecifics regardless of sex, but also other members of the cucurbit pest complex due to their long coevolutionary history in North America. Cucumber beetles are also attracted to certain floral kairomones (Indole, and TIC: combination of Trimethoxybenzene, Indole, and trans-Cinnamaldehyde).

The strong attraction of cucumber beetles to these compounds provides an opportunity for management strategies. Over a six-week period from May through June in Blacksburg, VA, sticky traps baited with vittatalactone, synthetic floral kairomones (Indole, and TIC: combination of Trimethoxybenzene, Indole, and trans-Cinnamaldehyde), and combinations thereof, were assessed for their early season attraction to striped cucumber beetles. Traps were located across 5 field sites at rerandomized positions every two weeks, with at least 115 feet between them. The objective was to assess which combination of compounds was most attractive and were checked weekly. Vittatalactone was highly attractive, drawing in high numbers of beetles (Fig. 1). Floral kairomones alone did not increase captures of beetles over un-baited traps, however, when combined with vittatalactone there was a possible synergistic effect that warrants additional investigation. It is believed that by using such chemicals in an early season trap-out or attract-and-kill strategy, beetle populations may be reduced through the remainder of the season, decreasing the need for additional insecticide interventions. Future work will explore an attract-and-kill trap plant approach where beetles are drawn to toxic plants early in the season.

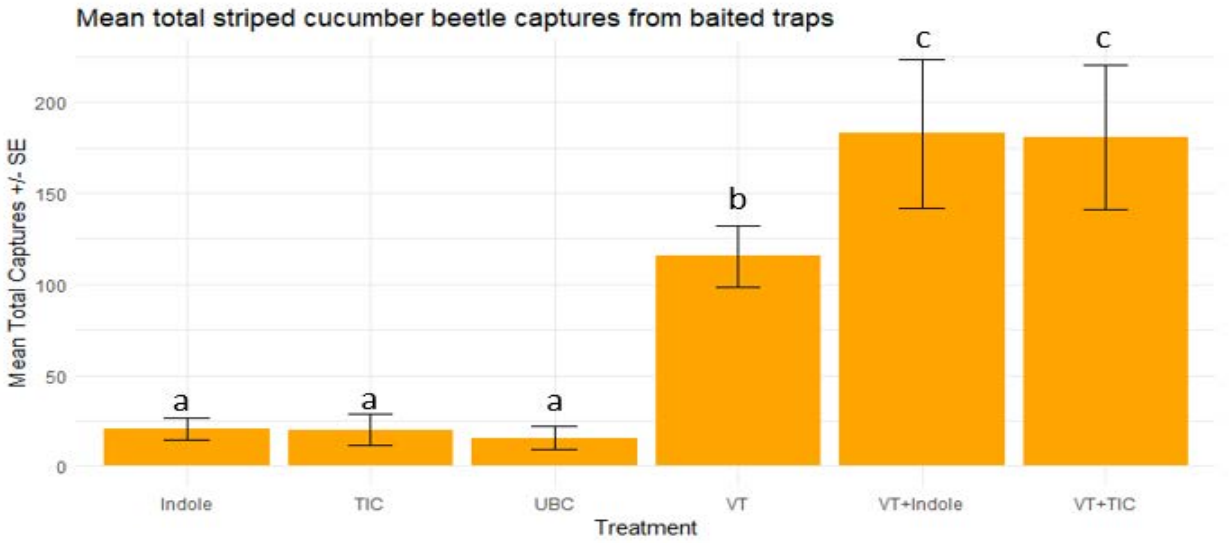


Fig. 1: Cumulative captures of cucumber beetles over 6-week period, May-June on sticky traps baited with various semiochemical lures (TIC = trimethoxybenzene, Indole, and trans-Cinnamaldehyde; UBC = unbaited control; VT = vittatalactone).

Cucurbit crops, especially pumpkins, squash, and zucchini, are also frequently attacked by squash bug (Anasa tristis), which injures plants with its piercing-sucking mouthparts by feeding on the vascular tissues of cucurbit leaves and injecting a toxic saliva. Leaves with numerous squash bug nymphs on them often wilt and die under heavy feeding. This is known as Anasa wilt. Squash bugs usually invade crops later in their development after the neonicotinoid seed treatments have run out. Thus, their control often requires mid-season insecticide sprays after eggs have hatched and young nymphs are present. These insecticides typically include either pyrethroids or carbamates, which are also highly toxic to pollinators, and natural enemies that attack pest insects. Frequent applications of these types of insecticides will result in outbreaks of melon aphids, which produce copious amounts of honeydew resulting in sticky fruit or fruit with sooty mold growth on them. Thus, my lab is continuously investigating the most IPM-compatible and pollinator-compatible insecticide options for control. The results of a recent insecticide efficacy test conducted on zucchini squash in Whitethorne, Virginia is presented below (Table 5). The treatments included insecticides: Transform (sulfoxaflor) and Sivanto (flupyradifurone), which both have a similar mode of action as neonicotinoids but are not technically grouped as such. We also evaluated the new aphicide Sefina (afidopyropen) Group 9D, which is registered for control of other hemipteran pests such as aphids, whiteflies and psyllids. We also included the diamide Harvanta (cyclaniliprole), which has shown promise for controlling hemipteran pests in addition to lepidopteran larvae. Untreated control plots averaged about 30 squash bug nymphs per 5 plants and there was no significant effect of insecticide treatments on squash bug densities 3, 9, and 17 days after treating; however, this was the result of one of the control plots lacking squash bugs. Looking at the data, there was noticeable control provided by Harvanta and the high rate of Transform, which is consistent with trials conducted on other heteropteran (bug) pests like harlequin bug, stink bugs, etc. We feel confident that a spray of Harvanta targeting lepidopteran or aphid pests will also reduce squash bug numbers.

Table 3. Efficacy of insecticides for the control of squash bug on zucchini; Kentland Farm, Whitethorne, VA.

		Squash bug nymphs per 5 plants		
Trt	Rate/A	Aug 6 (3 DAT)	Aug 12 (9 DAT)	Aug 20 (17 DAT)
Untreated Control		29.5	78.5	34.3
Transform WG	0.75 oz	26.3	49.5	9.8
Transform WG	1.0 oz	7.0	13.0	2.8
Sefina	3.0 fl oz	10.5	35.3	17.3
Sivanto Prime 200SL (soil)	28 fl oz	28.3	48.0	26.5
Sivanto HL 400SL (soil)	14 fl oz	30.3	22.8	29.0
Sivanto HL 400SL foliar)	10.5 fl oz	13.0	45.0	20.3
Harvanta 50SL	16.4 fl oz	12.3	5.0	2.0
P-value		0.5317	0.4276	0.4086

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

BLUEBERRY VARIETY TRIAL RESULTS FROM SOUTHERN DELAWARE

Emmalea G. Ernest
University of Delaware Carvel Research and Education Center
16483 County Seat Hwy, Georgetown, DE 19947
emmalea@udel.edu

Northern highbush blueberries (*Vaccinium corymbosum*) are typically recommended for production in USDA hardiness zones 4-7, including the southern Mid-Atlantic region. Southern highbush blueberries are derived from crosses between V. c*orymbosum* and other Vaccinium species that are native to the Southern US and were originally developed for production in regions with low chilling hours, but some Southern highbush cultivars may be adapted to production in the southern Mid-Atlantic region and would potentially offer more tolerance to heat and variable soil conditions. A trial of twenty-five blueberry varieties was established in 2011 in Georgetown, Delaware to evaluate the performance of fourteen Northern highbush and eleven Southern highbush cultivars. Plots consisted of three plants arranged in a randomized complete block design with four replications. After two establishment years, cultivars were evaluated for flowering window, susceptibility to winter damage, yield, harvest window and berry size for six years from 2013 to 2018.

'Darrow', 'Lenoir', 'Reka', 'Legacy' and 'Aurora' were the highest yielding varieties in the trial. 'Lenoir' is a Southern highbush cultivar and 'Legacy' is derived from a Northern x Southern highbush cross and has *V. darrowii* in its pedigree. 'Lenoir', 'Legacy' and 'Jubilee' are Southern highbush cultivars which showed little indication of winter injury to flower buds and produced good yields in the trial. Other Southern highbush cultivars, 'Misty', 'Star' and 'Arlen' grew vigorously but yielded poorly due to winter injury to flower buds each year. Flowering windows differed between the cultivars with Southern highbush varieties tending to flower earlier, possibly making them more susceptible to freeze damage. However, in 2016 when a late freeze occurred, all varieties in the trial had yields reduced by half, compared to the previous year except the very late flowering and maturing cultivar 'Aurora'. The earliest maturing cultivar was 'Reka', with harvest in mid-June and the latest was 'Aurora' with harvest in late July. Despite flowering earlier, the Southern highbush cultivars matured in the same late June time period as many of the Northern highbush cultivars.

All the Southern highbush cultivars grew vigorously, based on plant growth and pruning weight measured in the early years of the trial whereas certain Northern highbush cultivars, 'Toro' and 'Liberty' failed to establish well. Southern highbush blueberry cultivars may be adapted to a broader range of soil and summer temperature conditions than Northern highbush cultivars and some produce reliable yields when grown north of their typical recommended range.

Recommended Varieties

Chandler – Northern highbush variety with moderate yield. Berry size is very large and flavor is good. Ripens later in the season and over a long period. Plant tends toward woody growth and does not produce many shoots from the ground. Upright habit and large berry size could be desirable for pick-your-own.

Legacy – Northern/Southern highbush variety with good yields. Berry size is medium with good flavor. Late main season maturity.

Bluecrop – Northern highbush variety with moderate yields. This is a widely planted variety with familiar blueberry flavor which was included as a standard in the trial. Berries are medium in size. Fast and easy to prune. Early main season maturity.

Lenoir – Southern highbush variety with good yields. Berries are medium-sized with excellent flavor. This variety grows vigorously and we did not observe freeze damage to flower buds in any of the years we tested it although yields

Emmalea Ernest is the Extension Fruit and Vegetable Specialist and an Assistant Professor at University of Delaware. Emmalea has been with UD Cooperative Extension since 2004. Her research is focused on abiotic stress tolerance, variety evaluation, and lima bean breeding and genetics. Emmalea is originally from southern Lancaster County, Pennsylvania. She earned a B.S. in Horticulture from Penn State University, an M.S. in Plant Breeding and Genetics from Michigan State University and a Ph.D. in Plant Science from University of Delaware. She and her husband Jeremy have two daughters.

were reduced in 2016, the severe freeze year. Main season maturity.

Sweetheart – Northern highbush variety with vigorous growth and upright plant habit. Moderate early season yields. Flavor is good. Berries medium sized.

Recommended with Reservations

Reka – Northern highbush variety with good yield, and early fruiting. Berry size is medium to small. Flavor is good but tart. Berries are dark blue, almost black.

Bluegold – Northern highbush variety with good yields in some years. Medium size berry with good flavor. Tends to produce many short shoots, and over-flower. Requires lots of detail pruning to maintain berry size and limit over-production. Main season maturity.

Darrow – Northern highbush variety with very high yields. Berry size is very large. Flavor was not highly rated by tasters. Late main season maturity.

Draper – Northern highbush variety with moderate yield. Berries are large with good flavor. Plants were slow to get going but eventually produced good yields. Early main season maturity.

Aurora – Northern highbush variety with high yields. Berry size is medium to large. Matures late with peak harvest at the end of July and picking into August. Flavor was not highly rated

Jubilee – Southern highbush variety with good yields in most years. Freeze reduced yields in 2016. Berries are medium to small with good flavor. In most years we did not see freeze damage to this variety and it is very vigorous. The drawback of this variety is the tendency toward small berry size and tedious picking because of small clusters on very leafy canes. Early main season maturity.

Not Recommended

Toro – Northern highbush variety with good yields in 2013 and 2014 but declining plant health and yields starting in 2015. Berry size is large. Plant tends toward woody growth like Chandler but not as vigorous. Main season maturity.

Liberty – Northern highbush variety with low yields. Later maturing and similar to Aurora, but Aurora was later, higher yielding and more vigorous.

Bonus – Northern highbush variety with low yields. Berry size is very large. Plants did not establish well at the Georgetown site. Early main season maturity.

Star – Southern highbush variety with low yields in 2013 and 2014 and moderate yields in 2015, 2017 and 2018. Berries are large with excellent flavor. This is a very nice variety but we observed freeze damage to flower buds each year which results in yield loss. Early maturing.

Arlen – Southern highbush variety with low yields in 2013-15. Berries are very large with good flavor. This variety suffered significant yield loss from freeze damage to flower buds each year. Main season maturity.

Misty – Southern highbush variety with good yields in 2013-15. Berries are medium to small with good flavor. Berries have a lot of bloom and are light in color. We saw some freeze damage on this variety each year, which has reduced yields in several years. The plant grows very vigorously. Early main season maturity.

Hannah's Choice – Northern highbush variety with low vigor and yields in the trial. Flavor is good and berry size is medium to large.

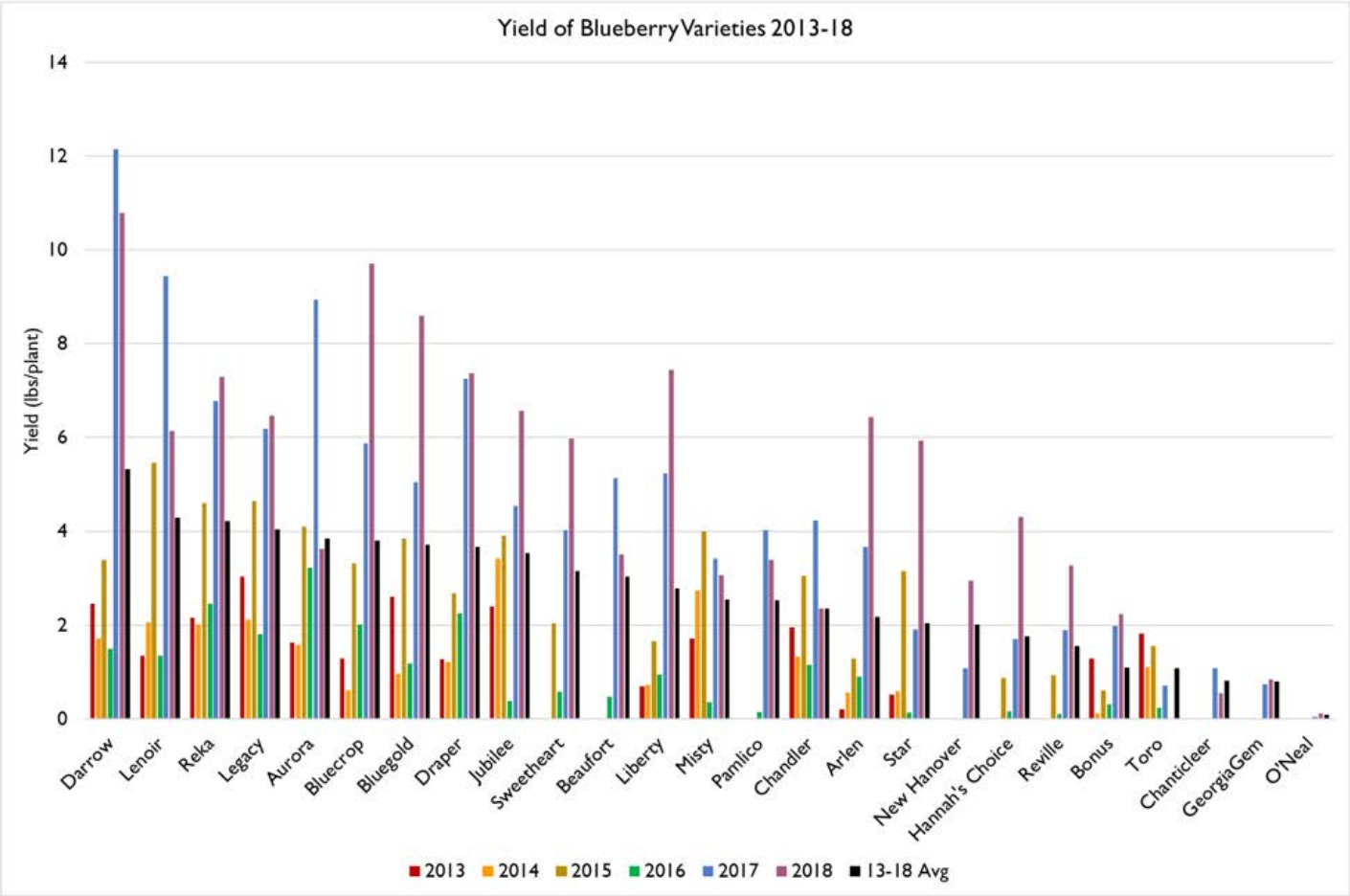
Varieties Added to the Trial Late

Southern Highbush

New Hanover - Moderate yields and flavor ratings
Pamlico – Good yield and flavor ratings, tentative recommendation.
Beaufort – Good yield and flavor ratings, tentative recommendation.

Reveille –Low yields and poor flavor ratings.
GeorgiaGem – Low yields and moderate flavor ratings
O'Neal – Low yields and poor to moderate flavor ratings

Northern Highbush
Chanticleer – moderate yields and flavor ratings, very early.



BIODEGRADABLE VS. NONBIODEGRADABLE PLASTIC MULCH: AN OVERVIEW

Robyn Underwood
PolyExpert
850 Munck, Laval (Qc) Canada H7S 1B1

In the North American fruit and vegetable industry, the significance of yield cannot be overstated. It serves as the linchpin for ensuring food security, bolstering the economy, enhancing global competitiveness, and promoting sustainable agricultural practices. Moreover, in today's economic context, where labor shortages pose significant challenges, there is a growing concern and interest in using biodegradable mulch films (BDM). These films, often misunderstood due to varying interpretations and certifications, have the potential to either complement or hinder the quest for higher yields and sustainability in fruit and vegetable production. This article delves into the pivotal role of yield in the North American context and untangles the complexities surrounding biodegradable mulch films, shedding light on their impact and implications for the industry's future, including their potential to alleviate labor challenges faced by growers.

The Biodegradable Mulch Film Dilemma

Biodegradable mulch films are a relatively recent innovation in agriculture. They are designed to break down naturally, reducing the environmental impact associated with traditional plastic mulch. However, the terminology surrounding these films can be confusing and is often misinterpreted:

Biodegradable vs. Compostable: Biodegradable mulch is designed to break down into natural substances over time. However, it may not meet the criteria for compostability, which requires the material to break down into non-toxic components in a specific timeframe, typically within industrial composting facilities.

Home vs. Soil vs. Industrial Facilities: Some biodegradable mulch films claim to be suitable for soil, some for home composting, while others require the controlled conditions of industrial composting facilities to degrade properly. This distinction is crucial, as home composting may not provide the necessary conditions for complete breakdown.

Certification Standards: To address these complexities, various certification standards, such as ASTM D6400 and EN 13432, have been established to distinguish between biodegradable and compostable materials. These standards outline specific criteria for the breakdown of materials and the absence of harmful residues. Consumers and farmers should look for these certifications to ensure they are using mulch films that meet the desired environmental goals.

Balancing Yield with Sustainability

While biodegradable mulch films hold promise for reducing the environmental impact of fruit and vegetable production, it's essential to recognize that not all these films are the same. They come in various versions, each with unique compositions and properties, which can lead to different certifications and effects. Farmers must be aware of the different interpretations of terms like "biodegradable" and "compostable" and should select products that align with their specific needs. Furthermore, it's crucial to recognize that the choice of mulch material can significantly affect both yield and sustainability.

In conclusion, the importance of yield in fruit and vegetable production in the North American context remains paramount. Mulch plays a vital role in achieving higher yields while reducing environmental impact. However, the use of biodegradable mulch films adds complexity due to varying interpretations, certifications, and material compositions. Farmers, consumers, and policymakers must stay informed about these nuances to make well-informed decisions. These informed decisions will lead to better yields while being sustainable. This will contribute to the long-term success of North American agriculture.

Gilles Mamane has been involved in the plastic packaging industry for over 25 years. He has worked at various packaging companies in North America and Europe. During the past four years at PolyExpert he has been crisscrossing the country meeting growers and agricultural distributors promoting plastic mulch – regular and biodegradable. He holds a steadfast belief that the agricultural producers of North America serve as the foundation of our society and merit our profound respect.

CRITICAL POINTS TO KNOW ABOUT PRUNING BLUEBERRIES

Gary C. Pavlis
Rutgers Cooperative Extension, 6260 Old Harding Highway, Mays Landing, NJ 08330
(609)625-0056
pavlis@njaes.rutgers.edu

New Jersey has approximately eight thousand acres of blueberries under cultivation which is the primary crop for which I have extension responsibilities. Pruning continues to be little understood and poorly executed throughout the industry. In fact, it is rare to find two growers who prune the same. I would like to clear up a few misconceptions and try to outline a simple method of pruning blueberries. The first place to start would be to discuss the importance of pruning. Growers often feel that pruning is of little value because the effects of the practice are not immediately apparent or dramatic. It should be noted that a well-known blueberry researcher, Phil Marucci, stated many years ago that there were a few factors which have greatly influenced the lack of increase in blueberry yield on a per acre basis over the last 30 years and pruning was the most significant factor.

More recent research has revealed that young canes are more efficient fruit producers than old canes. In fact, canes, which are 3 to 10 years old, allocate greater than 50% of applied water and fertilizer to fruit production. By the time a cane reaches 20 years of age, only 25% are allocated to fruit. (Water and fertilizer costs the grower money and there is no profit in the production of blueberry leaves.) Additional research compared three pruning types on yield and fruit size. Plants were 1) regularly pruned in a moderate manner such that one out of every six canes per cut out, 2) heavily pruned by removing 40% of all canes out every five years and 3) not pruned at all. The result was that the regular moderate pruning had the highest yield on the least number of canes. Research has also shown that as pruning increases, new cane production increases.

These studies show us that young canes outproduce old canes, the removal of one out of six canes produces the right number of new canes, and the highest yield and fruit weight is produced with regular moderate pruning.

It is also important to understand how a blueberry plant grows. Each year, canes are initiated from the base of the plant. Each succeeding year, the cane produces laterals, laterals produce laterals, and so on. Each year the lateral production on any individual cane decreases in diameter, or put in other words, the wood becomes progressively twiggy. It should be realized that as wood becomes smaller, fruit size decreases. This is why we detail prune to increase fruit size.

With this information under our belts we can address how to prune. There are really 5 basic steps to keep in mind when approaching a bush which is to be pruned. 1) Assess the plants overall vigor - is cane production adequate? 2) Prune out all dead wood. 3) Locate the oldest canes and prune out one of every six canes thus if the plant has twelve canes, remove two of the oldest. 4) Prune out all low branches, which will never be picked and are a source for disease. 5) Detail prune, i.e. remove as much twiggy wood as time allows.

Armed with these basics, we can now deal with the different plant situations that arise. First, pruning young plantings has primarily the objective of establishing the plant to obtain full production as soon as possible.

Thus, the first two years the procedure is to remove flower buds. Some growers cut off as much as the top half of the plant.

This is really quite drastic. Rubbing off lower buds would be sufficient; however, in a big operation it is usually less

Dr. Pavlis has been a professor and agricultural agent at Rutgers University for 38 years. His areas of expertise are blueberry and grape/wine production. His blueberry newsletter, 'The Blueberry Bulletin', has an international following and his research on blueberry fertilization has transformed the New Jersey industry. He has been instrumental in the expansion of the New Jersey wine industry by assisting would be grape growers through the production/marketing mine field.

labor intensive to cut the top 3-5 inches off each cane which will remove most flower buds. Any weak twiggy growth should also be removed.

In year three, a small crop is possible but not at the expense of stunting the plant. Usually 1-2 pints/bush is the optimum and fruit should only be on strong wood.

The fourth and fifth year twiggy growth must again be removed as well as any lateral canes which have developed. Fruit production can be increased but the amount is dependent on the number of new canes which were produced the preceding years; 3-5 canes/yr. is optimum.

The blueberry planting should be in full production by the sixth year though there are numerous variables which will influence this timing. The most important of these being proper pH and nutrition, water management and the crop to cane production balance.

I have found it is also helpful to growers to discuss blueberry pruning strategies based on plant status. I do not believe there is a strategy for each variety though any one variety may fall into one of the following categories most of the time. For example, the variety Blueray often has a spreading or open habit in which canes tend to bend down to the ground. Plants of this type must be thinned to the 1 of 6 rule; however, canes that are bent over also tend to produce an upright shoot. These canes should be pruned just above this upright shoot to produce a more erect plant. Other varieties that often fit into this category are Berkeley, Bluetta, Coville, Weymouth and Patriot.

Varieties such as Bluecrop, Collins, Darrow, Earliblue, Herbert, Jersey, Lateblue and Elliot often fall into the erect plant category. These plants become overly dense in the center which decease's fruit bud initiation. The pruning strategy for this category is to remove older central canes before all others.

When plants are overly vigorous, the primary strategy is to remove entire canes rather than spend time on detail pruning. This is done at least until the proper fruit to cane production balance can be established through nutrition and fruit production management. Varieties that are prone to this situation are Earliblue, Collins, Blueray, Herbert and Collins, though any variety can potentially be overly vigorous.

Weak plants are treated in the opposite manner. The primary procedure is to detail prune rather than whole cane elimination. Varieties that are classically put into this category are Weymouth and Bluetta. I should take a moment to address the method of pruning on a field that has been neglected for a long time and needs to be rejuvenated. This question often comes up when a grower has purchased one of these fields.

The most important step is to inspect the plants in their field for virus symptoms. Any plant showing these symptoms should be pulled out. The plant inspections must be done during the growing season because symptoms are most easily seen on the leaves. The next step is to completely prune everything down to the ground; a chain saw is the quickest and easiest method. This pruning is best done in late winter. An application of a 10-10-10 fertilizer should be made in early April, usually at a rate of 400 lbs. per acre. No crop will be harvested that year; however, the following winter the canes should be thinned to approximately 12-16 canes per plant. A full crop can be harvested that year.

In summary, pruning correctly can 1) increase yield, by producing more young canes, 2) increase fruit size by producing more strong wood, 3) decrease disease by removing dead wood and, 4) increase cane initiation because as pruning increases, cane number increases. Pruning costs money, but it will cost a grower more if it isn't done and it isn't done correctly.

CURRENT AND FUTURE ROBOTICS APPLICATIONS IN SMALL FRUIT

Long He
Fruit Research and Extension Center, The Pennsylvania State University
290 University Drive, Biglerville, PA 17307

In general, specialty crop industry including berry crops in the United State is facing two major challenges, one is the labor shortage and high associated cost due to its highly labor-intensive tasks, and the other one is the high operational cost and environmental impact due to the massive application of agricultural materials (water, fertilizers, and chemicals). Advanced agricultural technologies such as robotics and sensing have been showing promises on addressing these challenges at some extend. This presentation will discuss some of current robotic systems used in berry crop production, and some discussions on the future robotic technology development for berry crops are also included.

Robotic Harvesting

Harvesting is typically the most labor-intensive operation for many berry crops. Improving harvesting efficiency as well as reducing the dependence on the human workers have been a great interest of berry growers. So far, strawberry has attracted the most attention in terms of robotic harvesting. Due to the characteristics, strawberries typically have long stems, which can be an advantage for developing a robot to cut the stem without touch the fruit. Companies such as Tortuga Agtech developed a harvesting robot using camera vision and stem cutting mechanism; and the BERRY from Organifarms is an automated stem cutting strawberries harvesting robot with scans, picks, weighs, and packages. Both robots are mainly designed for greenhouse environment. There are some harvesters with multiple picking units onboard to scale up the harvesting efficiency, such as BetterPick strawberry harvester from Advanced Farm uses four or more mechanisms with vacuum cups to suck the fruit and then uses three fingers to hold and rotate to remove the berries from the plants, and Harvest CROO developed a robotic strawberry harvester with modular design. Agrobot SW 6010 Strawberry Harvester can offer up to 24 independent robotic arms for picking as a team. Research was also reported on robotic solutions for other berries, for example, a research team from Georgia Tech is working on developing a soft gripping robot to harvest raspberries.

In general, berry fruits are very fragile, and it is a challenge for a robot to grasp a berry without damage the fruit. Efforts have been made to improve the adaptability of robotic harvesting for berry fruits, such as using soft silicone gripper for harvesting berries, and using tactile sensing technique to detect gripping force to provide right amount of force for picking. Collecting fruits is another process that could damage berry fruits, so in many cases, berry fruits will need to be collected and packed into boxes right after picking. Besides harvesting robots, harvest-assist robots were also investigated in the past. These harvest-assist robots are typically used for transporting fruits in fields, which can reduce the transporting time for human pickers thus to improve the overall harvesting efficiency. Some harvest-assist robots are commercially available, such as StrawBot from AgPro Robotics for strawberry harvesting, and Burro robots from Augean Robotics, Inc. for blueberry harvesting.

Precision and robotic spraying systems

Sensor-guided precision sprayer technology has been developed and used in recent years. Three sensor types commonly used in pesticide sprayer development are ultrasonic sensors, digital cameras, and laser scanning sensors. For example, previous studies showed that chemical saving can be over 50% if a LiDAR sensor was used to detect tree canopy density, and then the sprayer nozzles were controlled to apply chemical rates based on the density of the canopy. This technology was recently commercialized by SmartApply, Inc, and mainly for air blast sprayers, but can be potentially expanded for other types of sprayers. Robot sprayers mainly refer to these autonomous ground or

Long He is an Assistant Professor and Extension Specialist in the Department of Agricultural and Biological Engineering, Fruit Research and Extension Center at The Pennsylvania State University. His research interest is precision agricultural technologies and agricultural robotics for specialty crops. Dr. He received his Ph.D. degree in Mechatronics Engineering from Yanshan University (China). Prior to Penn State, he was a postdoc scholar and research engineer at Washington State University and University of California, Davis. Long is originally from Hunan Province, China, and currently lives in Gettysburg, PA with his wife and three daughters.

aerial based spraying systems without an onboard operator. Sprayers such as autonomous sprayer from GUSS, and R150 unmanned ground sprayer from XAG, are in this type. It can be either operated by remote control or can be autonomously spraying with pre-set maps. With integrating sensing system, these robot sprayers can further provide precision and targeted spraying to save chemicals. Small fruit crops such as berry fruits are the ideal targets for using this type of robotic spraying system due to their diverse canopies, relatively low canopies, and dramatic canopy changes throughout the season.

Robotic weed management

In robotic weed management, identifying weeds is the critical and first step for the whole process. Machine vision systems, using cameras or other sensors, have been investigated to detect and localize weeds in field. Different methods have been tested for removing weeds for various crops, such as mechanical blades, high voltage electricity, lasers, or flames. A robotic weeding system is the integration of machine vision system and weed removal system. To ensure that crops are not accidentally damaged, these robots need to be carefully designed. Some examples are listed here. Naio Technologies has developed an autonomous platform with mechanical weeding system to weed vineyards more efficiently. A French startup named Vitibot has developed an impressive autonomous robot called Bakus that is specifically designed to work in vineyards and control weeds, which is electrically powered vehicle with impressive battery life of up to 10 hours. GUSS Automation's latest product, the Herbicide GUSS, is another autonomous herbicide sprayer, which incorporates LIDAR (Light Detection and Ranging) sensors to detect and spot spray weeds in orchards. Overall, these new developments in weed management are exciting and promising, and we can expect more advancements in the future that will help us deal with weeds more effectively and efficiently in a complex berry crop field environment.

Other discussions

Many other tasks can also be operated with robots for berry fruits, such as crop monitoring and yield estimation. One good example is the autonomous tractors with embedded sensor systems for field data acquisition at various aspects including monitoring crop growth, crop health, and crop load. Automatic irrigation and nutrient management could be a great interest for berry growers as well. Other advanced technologies, such as internet of things (IoT) and artificial intelligence (AI) are also necessary components for future high performance robotic systems. IoT a combination of networked sensors and machines for capturing, transmitting, managing, and analyzing data. Artificial intelligence can provide fast and accurate information processing. By incorporating with these advanced technologies, the application of robotics could enable site-specific or even plant level management.

CURRENT STRAWBERRY DISEASE ISSUES: WHAT WE'RE LEARNING

Kathleen Demchak
Department of Plant Science, 102 Tyson Bldg., University Park, PA 16802
efz@psu.edu

What we understand about strawberry diseases is constantly changing as plant pathologists and those of us who work with them learn more. One new disease has arrived in the Mid-Atlantic region in the past few years while others were already familiar to us, but we've learned more about them recently.

Neopestalotiopsis update. Our most recently arrived strawberry disease is *Neopestalotiopsis*. Historically, fungi in this genus caused a disease known as "Pestalotia fruit rot" but that was caused by a different species that was mainly opportunistic. The newer disease is caused by a very aggressive strain of *Neopestalotiopsis* that hop-scotched from another species into strawberries down South. In 2020 it came into the Mid-Atlantic region on runner tips, based on testing done by Dr. Natalia Peres from the University of Florida. There have been major losses from this disease in Mexico and Florida, though according to Dr. Peres' further work, this may not be the same strain as has been causing problems in our region.

In the Mid-Atlantic region, this disease has been a problem only in the plasticulture system (so far). Symptoms are tan leaf and brown petiole lesions that grow rapidly, consuming entire leaves in a few days, and/or plants that collapse from a crown and root rot soon after planting. This fungus seems to need warm wet conditions, so if the plants are treated with fungicides and survive until the weather cools, symptom progression slows down greatly. This disease can cause a fruit rot as well, but this has only been seen in a few instances in the Mid-Atlantic, and so far we've been able to get through spring harvest without further losses.

There aren't any fungicides that are completely effective against this disease, though Thiram and Switch work relatively well. Thiram availability may be restricted greatly soon, as EPA is cancelling thiram uses except for seed treatments. Whether there will be a phase-out period is unclear as of this writing.

For control methods, we recommend close inspection of plug plants when they are first received, and applications of fungicides every two weeks or so if symptoms are seen. We do not recommend keeping plasticulture plantings for a second harvest year when plants are suspected of being infected. Plants and crowns should be pulled out and removed from the field to the extent possible before removing the plastic, because the fungus can survive in the crowns which are unlikely to decompose for several years. Avoid replanting strawberries into a field that previously had infected plants in it for as long as possible.

Botrytis (gray mold) resistance development. Recently, Dr. Mengjun Hu at the University of Maryland and others have been conducting a survey of strawberry fields to determine how widespread botrytis resistance to various fungicide active ingredients might be. Samples were collected from 8 farms and 19 cultivars in matted-row and plasticulture fields across PA, with many more samples collected from Maryland, New York, Virginia, and California. 179 botrytis isolates were obtained from PA samples alone, with even more from California, though fewer samples were obtained from the other states.

The single-site fungicides we've relied on the most as "gray mold" materials in the past 15 or so years have been products like Switch, which is a mixture of cyprodinil (FRAC code 9) and fludioxinil (FRAC code 12), and Elevate (fenhexamid, FRAC code 17). In the "old days", Topsin-M (thiophanate-methyl, FRAC code 1), Rovral (iprodione, FRAC code 2), and thiram were widely used. More recently FRAC code 7 fungicides have become available in products either alone or combined with active ingredients from other FRAC code groups. These include boscalid, one

Kathy Demchak has been at Penn State since 1983, and currently works in berry crop research and extension statewide. She earned a B.S. in Horticulture from Penn State and an M.S. in Horticulture from Virginia Tech. She lives in a rural area of Centre County with her husband Steve.

of the active ingredients in Pristine; penthiopyrad, found in Fontelis; isofetamid, the active ingredient in Kenja; and pydiflumetophen, found in Miravis products. PhD, aka OSO or Tavano (polyoxin D salt, FRAC code 19) is another option.

So how did these products fare in resistance screening? Nearly 80% of the botrytis isolates from PA had significant resistance to cyprodinil, one of the active ingredients in Switch, leaving the other active ingredient (fludioxinil) on its own to provide effectiveness. This puts Switch on shaky ground regarding resistance development. 65% of the isolates had resistance to fenhexamid (in Elevate), so performance of this product cannot be relied upon as much as it had been in the past, either. This was similar to the resistance frequency for thiophanate-methyl (Topsin M). Interestingly, "only" 40% of the PA botrytis isolates were resistant to iprodione (Rovral), another one of the oldest products. However, it cannot be used after first bloom or applied more than once per year, so its uses are limited. Products in the FRAC code 7 category are currently effective, but it is going to be important not to overuse them, because if resistance develop to them as it has to other active ingredients, growers will have few options. Products in FRAC code 19 also still appear to be effective, though resistance screening was not done for this group.

Anthracnose fruit rot weed hosts. Research by Leah Fronk, extension educator based in Juniata County, together with Sara May of Penn State's Plant Disease Clinic and Leah's advisor Rich Marini, has shown that weeds can host the anthracnose fruit rot organism. For more information on this topic, see the proceedings article by Leah. The bottom line from this work is that weed growth prevention may be even more important than we thought, and for reasons beyond just improving air flow in the planting.

It seems that a lot of new problems are knocking on the door of strawberry production these days. There are many reasons for this, including how plants are propagated in some instances, susceptible varieties being adopted, changes in production systems, reliance on single-site fungicides, and replanting of strawberries in the same fields multiple times, especially when the length of time that the field was out of strawberries is short. To help, we really need to adopt integrated approaches to management, and it's clear that using cultural methods of management are more important than ever.

What are the most important of these?

1) Lengthening out crop rotation cycles to the absolute maximum possible. Diseases build up over time, especially if the crowns did not have time to completely decompose before a new strawberry planting was established in the same field.
2) Making sure to follow label guidelines regarding the maximum number of times a fungicide category should be used, keeping in mind that plants may have been sprayed with the same fungicides before they got to your farm, especially when using the plasticulture system.
3) Improving air flow however you can. This might mean selecting different sites, trying to keep weeds under control, keeping rows narrow in matted-row fields, or perhaps increasing the plant spacing in plasticulture.
4) Protected culture, since rain-splashed diseases like *Neopestalotiopsis* and anthracnose seem to "disappear" in tunnels, even though they are still present in the plants. This might become more economically feasible for more people over time.
5) Obtaining the cleanest plants possible. The less time the plants spent in open-field production before they got to your farm, the better. Minimizing the number of farms that they were on before they got to yours is important, too, so ask your supplier about this.

Some words of hope are that work is continuing to address these problems. These include the above-mentioned work to understand the problems better, but also include breeding programs incorporating resistance, work on anaerobic soil disinfestation, and projects that help clean up the strawberry plant supply. It's going to take considerable effort on the part of everyone involved in the industry at every level, but hopefully the hard work will pay off in the end.

FINE TUNING FERTILIZER APPLICATIONS FOR SMALL FRUIT

Mary Concklin
Extension Educator Emerita, University of Connecticut,
163 N. Windham Rd, N. Windham, CT 06256

Developing a fertilizer program takes into account several factors including soil pH & nutrient levels, tissue analysis, existing mineral nutrients in the soil, available water, ground management, climatic conditions and crop load.

Soil pH is critical for availability of nutrients. Brambles and strawberries prefer a soil pH between 6.0 and 7.0. Grape soil pH is dependent on the type of grape: vinifera are from Europe where soil pH tends to be 6.5 to 7.0, natives are used to our acidic soils so prefer 5.5 to 6.0, while hybrids are in the middle at 6.0 to 6.5. Blueberries grow best in acid soils with a pH of 4.5 to 5.0 because iron is readily available in that range. However, if you look at a pH chart it appears that iron is readily available to pH 6.0. It is the form of iron that is critical – ferrous is the soluble form of Fe, most likely to exist in acid soils and most easily taken up by plants. The ferric form of iron most likely in pH 5-5.8 soils, and not soluble.

Tissue analysis indicates what and the amount of a nutrient that is in the plant. Combining these results with the soil test results provides a picture of what additional nutrient(s) is and is not needed. However, it is important to note that test results may not appear to line up. For example, there may be ample potassium in the soil while tissue results indicate a potassium deficiency. Relying on only the tissue analysis, you would want to add potassium. It is important to look at why there is ample in the soil but not in the plant. Reasons include a lack of water to move the potassium into and throughout the plant resulting in a deficiency. There could also be an over-abundance of another nutrient such as magnesium or phosphorus, that induces a potassium deficiency.

Ground management impacts nutrient availability: weeds and sod will out-compete small fruit for available nutrients. Most times the recommendation is for a weed free zone under and around the plants. An exception would be with grapes planted in very fertile soils where they are putting more energy into vegetative growth at the expense of fruiting. Allowing vegetative growth under the vines will help slow down vegetative growth. Just make sure the fruit doesn't suffer.

There are problems when guessing amounts and types of fertilizer to apply, without the data to back it up.

Misdiagnosis
Multiple deficiencies may exist
Guessing may result in

- Inadequate or excessive plant vigor
- Over or under nutrient applications
- Poor fruit set
- Reduced fruit quality
- Costs you $$$

Keep in mind, visual symptoms = damage already done

Mary Concklin retired as the Extension Fruit Specialist, UConn. She currently is working on two grant projects, one is a continuation of the fertilizer work begun in 2012, now examining the use of drones and models to detect nutrient deficiencies early in the season. Mary, with her husband Peter, owns and operates Raspberry Knoll Farm, a PYO berry and cut flower operation. She has a BS, University of Mass, MS, West Virginia University, and MS, College of Saint Rose. She formerly worked for PSU and Cornell.

Long term management decisions should include
Supplemental water during dry periods
Tissue analysis annually
Soil analysis every 3-4 years - same lab
Combine both for fine-tuned fertilizer programs while taking into account
- Crop load
- Your cultural practices
- Environmental conditions that season as well as the previous season

Your past experience – you know your fields and crops, and how they respond to your management practices

Comparing results from year to year will show a reliable trend making it possible to make decisions based on scientific data.

GREENHOUSE AND HIGH TUNNELS: OPTIONS IN STRAWBERRY SUBSTRATE PRODUCTION

Dr. Neil Mattson[1] and Kathy Demchak[2]
[1]School of Integrated Plant Science Horticulture Section, Cornell University, 624 Bradfield Hall, Ithaca, NY 14853
[2]Dept. of Plant Science, Penn State University, 102 Tyson Bldg., University Park, PA 16802
1nsm47@cornell.edu
2efz@psu.edu

Background

There are many reasons to consider soilless substrate production of strawberries. Avoidance of soil-borne diseases, ergonomics of harvesting/management at waist to chest height, and being able to grow the crop close to consumers are at the top of the list. Soil-borne diseases are a common issue with field production where land is too limited to allow sufficiently long crop rotations to minimize disease buildup and where fumigation may not be desirable or possible considering the layout of the farm and proximity to residential areas.

While substrate production can occur outdoors, the lack of environmental control is risky, as a high proportion of the fruit may be lost to rain-splashed diseases such as anthracnose fruit rot, or fruit splitting, and injury from insect pests such as tarnished plant bug. Thus, soilless production usually takes place under protection in greenhouses or high tunnels. Protected cultivation increases costs, incidences of powdery mildew and spider mites may be higher, and chemical management options are limited. However, the advantages generally outweigh the disadvantages of being outdoors.

Strawberry plants generally grow best under cool conditions, whether they are June-bearers or day-neutrals (aka everbearers, repeat-fruiters, or remontant or long-day plants). They also don't require excessively high supplemental light levels. Both factors among others affect the types of plants that may be grown, and how they are grown.

It should be noted that the information discussed here was based on work in the northeastern U.S. and the mid-Atlantic region, and while it may be applicable to other regions also, local sources of information should be consulted.

The Basics

Substrate strawberry producers typically use rooted plugs (propagated from runner tips) as their starting material. Plants can be purchased from specialty propagators where plug plants have a smaller substrate cell size (<100 mL) (3 oz.) and a single crown while larger tray plants are in 125-250 mL (4 to 8 oz.) cell sizes. Plants should have 3-5 true leaves and a 1-cm (0.5-inch) or greater crown diameter. Larger transplants will yield harvestable fruit more quickly.

Container type and spacing. Strawberries are sensitive to root diseases, thus good drainage/air porosity is important. There is more leeway in moisture levels if containers are deeper, as excess water can drain below the root system, and there is a greater reservoir if conditions are sunny/hot. Gutters and rigid pots with loose-fill substrate as well as growbags/slabs have all been used successfully. For tunnel/outdoor production it is best to use containers that are white to keep root temperatures as cool as possible during the summer. Typical spacing is 1 plant per square foot but practices vary. For example, gutters may be spaced 2.6 to 3 feet apart (center to center) with 3-4 plants for every foot of row length in greenhouses. Fruit trusses can become crimped on the narrow top edges of rigid pots/gutters,

Neil Mattson is Professor and greenhouse extension specialist having joined Cornell University in 2007. He earned a PhD from UC Davis and M.S. and B.A. degrees from the University of Minnesota. Neil and his family live just outside of Ithaca, NY where he enjoys backyard gardening and hiking.

Kathy Demchak has been at Penn State since 1983, and currently works in berry crop research and extension statewide. She earned a B.S. in Horticulture from Penn State and an M.S. in Horticulture from Virginia Tech. She lives in a rural area of Centre County with her husband Steve.

so growers often stretch tape raised a few inches above pot height to support trusses.

Media type. So far, research results have shown that high porosity mixes of various kinds all produced acceptable yields. However, some soilless mixes specifically developed and sold for strawberry production from major media suppliers resulted in the highest yields in recent Penn State trials. There may be other mixes that would perform just as well that haven't yet been trialed, so this is not meant to imply that these media types perform better than all other mixes.

Fertigation. Growers who are already familiar with growing greenhouse crops in soilless media using a constant-feed soluble fertilizer system may find it easier to make the transition to strawberry production in substrate than those who are not. The water source should be tested for pH and alkalinity levels. Water quality takes on added importance, as this will affect whether acid injection is needed, and whether any commercially available bagged fertilizers are an option. Strawberries are a lower fertilizer requiring plant with a nitrogen target of 80-120 ppm applied as a constant liquid feed (i.e. each irrigation event) and an electrical conductivity (EC) of 1.0 dS/m or less (see Ohio State website for fertilizer recipes). Maintain the root-zone pH at 5.5-6.0. It is also extremely important to have a reliable injector functioning as soon as the plants are planted. Injectors can malfunction at any time, so the dilution ratio should be verified periodically by checking the proportion of fertilizer concentrate being taken up relative to the total solution being delivered. If using an EC meter, be sure to subtract the background EC of the water source. Drip irrigation (using emitters or drip tape, depending on the container type) is used to deliver water/fertilizer to plants. Frequency will depend on media, container type, and environmental conditions. A 20% leaching fraction (20% excess water applied at each irrigation event) is typically recommended to avoid salt accumulation. Larger operations may use soil moisture sensors or solar radiation sum to trigger irrigation events.

Greenhouse Options

Hanging gutters or raised troughs are usually used to support containers/grow-bags. Strawberries require pollination and the majority of greenhouse growers use bumblebee colonies available from beneficial insect supply companies.

Production schedule. June bearing (short-day) plants can be used if the grower is interested in a shorter harvest window with a more intense flush. For June bearing cultivars runner plugs should be conditioned under low temperatures and short days for flower bud initiation (see the Ohio State website). Day-neutral plants are currently most common in U.S. greenhouses. 'Albion' is commonly used and very sweet. 'Cabrillo' and 'Portola' are higher yielders than 'Albion' but not as sweet. In a typical off-season greenhouse production cycle, plugs are transplanted mid-August to September and may start bearing in November and bear continuously until May. By this point high night temperatures (above 60 °F) reduce fruit quality (small size and too acidic). Good yields for the September-May production cycle are two pounds per square foot ('Albion') and can be higher for some cultivars. High-tech greenhouses in the Netherlands with year-round production have achieved yields up to 4.5 pounds per square foot.

Greenhouse environmental conditions. Average daily temperature drives crop development rate and is maintained at 60-65 °F. Day temperature is maintained between 68-75 °F and night temperature between 50-54 °F. Low night temperatures are required for larger fruit size and better flavor (sweetness). Strawberries require moderate light (minimum of 12 mol·m-2·d-1 daily light integral) and produce higher yields with more light up to 20+ mol·m-2·d-1). Many northern growers use supplemental lighting. Greenhouse strawberries benefit from carbon dioxide enrichment up to 700-1,000 ppm to improve productivity. Relative humidity (RH) should be maintained at 40 to 60% during the day. Strawberries are sensitive to leaf/calyx tipburn which is a physiological disorder due to poor calcium supply (symptoms are brown edges of leaf/calyx). High nighttime humidity (3 hours at 95% RH) significantly alleviates symptoms, and the Ohio State website describes an under-gutter misting system that can be used to raise humidity at night.

Primary greenhouse pests include spider mites and thrips. Aphids are sometimes a problem as well. Many growers use beneficial insects to manage all three. Powdery mildew is the primary foliar disease issue. Occasionally botrytis

will be an issue if over-ripe fruit are not removed.

High Tunnel Options

For soilless production in high tunnels, gutters, grow-bags, or rigid pots have been used in various configurations to maximize how the space is used. Because the tunnel sides are open for the period while the plants are in bloom, pollinators can enter and leave as they wish, though they may become trapped in the tunnel peak during mid-day.

Production schedule. Typically, dormant bare-root plants are planted in early April. When growing in substrate in tunnels, there is little to be gained by planting in the fall and trying to overwinter the plants, as the plants' roots and crowns are then exposed to widely fluctuating temperatures during the winter. Low temperatures will be similar to those outside, which are likely to be low enough to kill the crown during the winter in northern locations. Further, the plants' leaves and crowns can be highly attractive to voles seeking shelter inside. The first fruit will ripen two to three months after planting depending on how long you remove the first flower blossoms as the plants become established. The highest yields will be produced during the fall when plants are large, and temperatures are cool. Day-neutral cultivars are grown. A grower survey conducted over 10 years ago very clearly showed that growers who grew day-neutrals rather than June-bearers (aka short-day plants) in high tunnels were much more likely to continue with production. Greater economic viability was the main reason given, which can be a challenge with strawberries when compared to growing other crops like tomatoes in high tunnels. Currently 'Albion' is the day-neutral cultivar of choice. However, this cultivar will stop producing flowers and fruit when temperatures are hot in mid-summer. As with greenhouses during the winter season, it is reasonable to expect two pounds of fruit per plant. The harvest season typically lasts from mid-June through early November.

High tunnel environmental conditions. Unlike in greenhouses, with high tunnels there is no real option for cooling the environment beyond venting the tunnel sides to the maximum height and possibly installing gable-end vents or having open end walls. While growers will need to work within this limitation, some choices can be made that affect the temperatures the plants experience. Likewise, there is a limit to how much heat can be retained within the structure. While having containers high enough to ease harvest is appealing, temperatures are warmer if plants are raised, so most growers have opted for a height in tunnels where the plants experience cooler temperatures and breezes through the vented tunnel sides, while still keeping the plants off of the ground. A system that prevents pots from blowing over will be needed; this can be as simple as a string being run alone the sides of the rows to give the plants some support.

The main pest encountered has been two-spotted spider mites. In many cases, natural enemies have established on their own in a high tunnel environment, providing significant pest control. However, if they don't, predatory mites can be released.

Useful resources:

Kubota, C. and M. Kroggel. Ohio State University Controlled Environment Berry Production Information. Available online: https://u.osu.edu/indoorberry/

GROWING AND MARKETING SMALL FRUIT AT RASPBERRY KNOLL FARM

Mary Concklin
Owner & operator – Raspberry Knoll Farm, 163 N. Windham Rd, N. Windham, CT 06256

In 2009 we bought the land that Raspberry Knoll Farm now resides on. It was previously used for cattle grazing and hay production. During the fall of 2009, we soil tested, limed and installed deer fencing; planted primocane and floricane brambles in spring 2010 and opened for PYO summer 2011. Blueberries were added in 2011 followed by strawberries in 2015.

Vegetables were part of our operation from 2011 through 2021. At that point we decided to drop vegetables and focus more on the fruit which was the driver of our business. Another reason was that labor has been harder to find and the minimum wage increased, presently at $15/hour. There is more money in fruit than vegetables. Now we grow vegetables for friends and family. Any extra we sell in the farmstand.

Cut flowers and herbs were planted in 2011 and have continued to be a popular part of our business. Wedding parties cut their own flowers and make their own bouquets. We provide cutters and baskets, as well as water if someone brings a bucket or plastic bag. Every year we try new flowers while keeping the popular ones, including zinnias, lisianthus, snaps, celosia, calendula, salvia, strawflowers and more. In addition to cut-your-own, we sell bouquets. We have never run out of flowers, enjoy making folks smile, so we also have vases of cut flowers on the check out table with a sign "Enjoy a free flower'.

In addition to PYO and pre-picked berries available in the farmstand, we offer value added products – our popular jams, herbal vinegars, and dried flowers.

In the beginning we advertised in local newspapers, Facebook and our website. We dropped print ads because we asked folks how they heard about us and no one said through the ads. Responses included our website, Facebook, friends and driving by. We also send out emails through Mailchimp to over 2200 folks.

For 2011 and 2012, our 'farmstand' was a tent. In 2013 we closed in an equipment shed, poured a concrete floor, added a couple of doors and windows – a more comfortable farmstand. Our walk-in cooler and store cooler were now under cover as well.

In spring 2024 we are removing about 1/3 of our summer brambles – production has gone down. For a couple of years, we'll plant flowers for the summer and then cover crop the area in the fall. We'll rotate to strawberries in that area in 2026.

Mary Concklin retired as the UConn Extension Fruit Specialist. She, with her husband Peter, owns and operates Raspberry Knoll Farm, a PYO berry and cut flower operation. They purchased the farm in 2009 which was previously used for cattle and hay production. She has a BS, University of Mass, MS, West Virginia University, and MS, College of Saint Rose. She formerly worked for PSU and Cornell.

LIVING WITH EXTREMISM - NO, I MEAN THE WEATHER

Tom Childs
Twin Springs Fruit Farm, Inc., Orrtanna, PA 17353
717-642-8988

Roughly 15 years ago I sat in a session at Hershey presented by a man with lots of statistical data from the last 150 years. The premise of his session was that weather patterns were changing, and we were likely entering a time of wide fluctuations of temperature and rainfall. The patterns he saw then are apparently upon us. As I write this in mid-December, a wide swath of tornadoes just ripped through Tennessee, one was an F3, again this mid-December. It would seem his research was spot on. I see myself as conservative, not an alarmist, not a climate change promotor, and I don't claim to know why it appears the weather is changing.

This is what I know. In late December 2022 we planted a cover crop of Triticale thinking it was then a waste of time, too late. By the end of February 2023, the ground was fully covered with new growth. In February we had open bloom on apricot. The temperature at Twin Springs Fruit Farm was above 80 degrees four times in April 2023. Two consecutive days hit 86 degrees, one of these days another record high. These temperatures coincided with the fish spawn at Marburg Lake in York County and contributed to a large-scale fish kill. The water temperature rose 15 degrees over 4 days. Fish kills happen occasionally there during the spawning season with the fish under natural stress during spawn, but the rapid 15-degree temperature rise made the stress worse. Not your backyard pond, this 1275-acre lake which today set about 20 feet below normal, still not recovered from the summer drought. In August 2023 we ran 2 of our 6 irrigation wells dry, this was temporary, but never happened before. In early September about 1 week after planting Chandler plugs, we received 5 consecutive days above 94 degrees, 2 new record highs (almost 3) with one day at 97 degrees. I feel if we had not taken measures to reduce the stress, we would have lost many plugs, still not fully rooted.

My goal is to provide some proven, workable options quickly deployable to offset plant stresses from high temperatures in strawberries. We began using a variety of reflective materials after incorporating bare root eastern varieties five years ago. We briefly considered moving to matted row production but declined primarily due to weed control issues. Keeping the plasticulture model required taking measures to ensure plant survival in mid-summer conditions. Bare root dormant plants are planted on plastic 1 month before plug plants are planted. For Adams County, that is the 3rd week in July. We still use black plastic and plants are root pruned(shortened) to allow planting with a water wheel. Our first year we hand planted, as is recommended by bare root suppliers. For us, this time-consuming process did not fit into our mid-summer busy season. Close attention must be paid to this process, as our crew was always inclined to plant too shallow, never too deep.

The real challenge here is to moderate what is always a hostile environment for plant establishment. Plants start to grow the day they are planted, so all must be in place and ready before planting. We added a paint product in 2023 that avoided re-application of products previously used and covered normal July/August conditions satisfactorily. We applied greenhouse shade paint to plastic mulch about 2 days before planting. This product is made to adhere to plastic and lasted the summer season. Some remain even now; however, it has faded, revealing more black plastic and seems about right. I used 2 gallons of shade paint diluted in 70 gallons of water on 3 planted acres, only spraying the plastic. This was applied with the weed sprayer.

Tom is starting his 25th season as Production Manager at Twin Springs. The farm sells year-round at farmers markets in the Washington DC Metro area and has for over 40 years. He oversees 40 acres of vegetables, 32,000 SF of greenhouse vegetables, and 10 acres of small fruits. Spare time finds him, with his wife, renovating an 1869 bank barn, part of a recent purchase of his wife's family farm. He enjoys spending time with the families of his 4 children which includes 4 rambunctious grandchildren.

About 3 days after planting, weather dependent, we apply Reflections from Miller Chemical at 2 gallons per acre with Vapor Guard at 1 gallon per acre. The Reflections product is calcium acetate and calcium carbonate. The Reflections product lowers both plant canopy and soil temperatures. The Vapor Guard slows transpiration from leaves and reduces desiccation of the plant while rooting is developed. It also helps to adhere the Reflections to plant and plastic. We applied Reflections and Vapor Guard several times during establishment.

For temperatures above 90 degrees, we apply one or several coats of Surround WP from NovaSource. This is Kaolin clay. We apply this and the Reflections with a Penns Creek crop sprayer, covering all but the drive rows. The number of coats would depend on how high temperatures get and duration of spike. This product, like Reflections, washes off easily in moderate rain and is gone in a hard rain. Do not attempt to use Surround in a sprayer that does not have mechanical or otherwise excellent agitation. Agitation is required to keep product in suspension. Surround is applied at 25 lbs./acre and has its own sticker in the product. Measured results of 6–8-degree soil temperature reductions at 4" depth was observed compared to untreated area. By using these methods, we consistently see survival rates of bare root summer plantings at 95% or better. We used both as needed on plug plants too.

Winter row cover management will be discussed in this session with focus on decision making in unseasonable weather. The prospect of using straw as another option will also be discussed. In my opinion, neither is perfect, but I prefer straw. We will discuss the pros & cons of each as it pertains to shifts in recent weather patterns. Everything changes eventually. Perhaps a change to your production system is coming.

PRUNING RASPBERRIES TO MINIMIZE DISEASE AND INSECT PRESSURE

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

In order to keep a raspberry planting producing good crops of berries over the long term, the canes should be pruned every year in order to prevent the plants from becoming overcrowded. To properly prune raspberries you should have an understanding of the plant growth habit. The ground parts of a raspberry plant, the roots and crown, are perennial and can live for many years. The above ground shoots of the plant are called canes. Canes are biennial, meaning that they live for two years. In their first year of growth canes emerge as green shoots from buds on the roots or crowns and may grow up to six feet or more during the summer. These first year canes are called "primocanes". They remain green until the fall and don't produce fruit. As the canes grow, buds develop at every joint where a leaf attaches to the cane, known as leaf axils. These buds are called axillary buds and typically remain dormant during their first season. As fall leads into winter, the primocanes will drop their leaves and develop a thin brown bark. In the spring of their second year the canes are called "floricanes". The axillary buds that developed the previous year grow into short branches called fruiting laterals that will bear the raspberry flowers and fruit. As the fruit ripen in the summer, the floricanes begin to senesce, the leaves turning red or yellow and the canes dying as the fall approaches. Meanwhile, new primocanes have been growing to provide a crop for next year. To summarize: primocanes emerge as green shoots and form fruiting buds for the next season. In the second year the floricanes produce fruiting shoots from the budsand die after the fruit ripens. The exception to this is everbearing raspberries. With everbearing canes, the axillary buds that form on the tips of the primocanes don't remain dormant until the following spring. Instead, they break in the summer, resulting in a small crop in the fall. This is why everbearing raspberries are also called "primocane fruiting" raspberries. Buds lower down on the canes over winter and bear a typical floricane summer crop the following year. Like summer bearing varieties, everbearing raspberry canes are biennial, bearing a fall crop on the tips of the primocanes, and a summer crop on the floricanes.

Why Prune?

Left unpruned, or inadequately pruned, raspberries essentially become their own worst weed, competing for light, nutrients and water. Overcrowded canes shade each other to the point that many of the leaves don't receive adequate sunlight and die, especially on the lower portion of the canes. When this happens the axillary buds associated with those leaves also die, resulting in fewer fruiting laterals and a much smaller crop the following year. In addition, heavy competition for nutrients and water often results in small fruit size and poor eating quality. Finally, the dark, moist conditions around overcrowded canes are ideal for the development and spread of fungal diseases such as gray mold, spur blight and anthracnose, which infect the canes and buds, weakening the plants and causing much of the fruit to rot as soon as it ripens. The most effective way to deal with all of the issues caused by over crowding is to properly prune the plants each year to reduce the cane density and to keep the plant rows narrow, only 1 ½ to 2 feet wide at the base, allowing lots of sunlight and air to penetrate the rows throughout the growing season.

When, How and What to Prune

During the summer months the only pruning that should be done is to cut away any new canes or "suckers" that emerge outside of the desired plant row width of 1 ½ to 2 feet. This can be done by just trimming away any of the green shoots that emerge along the outer edges of the row two or three times over the growing season. The new

David T. Handley is the Extension Vegetable and Small Fruit Specialist and a Cooperating Professor of Horticulture for the University of Maine. Dr. Handley received a Bachelor's degree from the University of Massachusetts, and his Masters and Ph.D. degrees from the University of New Hampshire. He has been based at Highmoor Farm, the Agricultural and Forestry Experiment Station in Monmouth, Maine, since 1983, where he carries out applied research regarding berry and vegetable variety evaluation, production techniques and pest management strategies. He coordinates statewide integrated pest management (IPM) programs for strawberries and sweet corn. Dr. Handley is the author of numerous Extension fact sheets, articles and newsletters, and co-editor of two regional small fruit production guides.

shoots growing within the prescribed row width should be left in place. The majority of the pruning effort should be made during the winter months when the plants are dormant. Pruning can usually start any time after the New Year, but often has to wait until February or March when the snow has receded enough to be able to cut the unwanted canes to the ground.

Cutting out the floricanes that fruited during the summer can also be done in the fall, but research has shown that these canes are sending carbohydrates down to the crowns and roots of the plant even into the early winter to help the plant survive the dormant period, so it is best to leave the spent canes in place until all of the canes are fully dormant.

The first step of the dormant pruning process is to remove all of last year's spent floricanes. These are dead, and need to be removed to open up the row and prevent any disease spores overwintering on them from spreading to the new canes. These canes will have gray, peeling bark and the old fruiting lateral branches on them and most were attached to the trellis wires. Cut these and all the canes to be removed right to the ground.

Next, cut out any canes that are beyond the recommended 1 ½ to 2 foot row width. It doesn't matter how nice the cane might look; if it's out of bounds, cut it off. Keeping the rows narrow is critical for preventing disease problems and make harvesting much easier.

Now go into the plant row and cut out any canes that appear weak, spindly, short, or that are showing obvious symptoms of insect injury or disease.

Once you have completed these steps you'll find most of the work is done. The final cuts are thinning cuts. The only canes left standing in the row should be the tallest, thickest and healthiest looking canes. Keep cut away the less vigorous canes to create space between the canes that are being left. Don't worry about the canes being evenly spaced within the row; raspberries tend to grow clumps. Just make sure that the canes aren't so close together that they will be crowding and shading each other. A well-pruned raspberry planting should only have three to five canes per linear foot of row (remember, your rows should only be 1 ½ to 2 feet wide). So, as you walk down the row you should only see, at most, five canes for every foot of row length.

The remaining canes should be attached to the trellis wires with string or twine, twist ties, tomato ties, rubber bands, etc. Use whatever works well for you and holds the canes securely to the wire. Tie the canes such that roughly half of them are on one side of the row and half are on the other side. Because the row width is only 1 ½ to 2 feet wide at the base, and you are spreading the canes out to three feet wide on the trellis wires, when you look down the row from the end, the canes should have a "V" shaped look. This opens up the center of the row to improve light penetration and air movement through the planting, inhibiting the growth of fungal diseases and encouraging the new canes to come up in the center of the row rather than along the outside edges. Further, this puts the fruiting canes on the outside and will keep most of the new canes on the inside of the row, making harvest much easier, with less fruit going to waste.

Finally, remove all of the canes that you pruned out from the planting. These may harbor disease and/or over-wintering insects that could threaten the canes remaining in the planting. The prunings can be ground up and composted, thrown on a burn pile or taken to the dump.

Mowing Everbearing Raspberries

Because everbearing or primocane fruiting raspberries bear a crop on the first year canes during the late summer and fall, the canes can simply be mowed down late in the winter, eliminating the need for selective pruning. However, since you mow the floricanes, this practice will also eliminate the conventional second year (summer) crop, so you will only get the smaller fall crop. This might be a good option if you are growing summer bearing raspberries for an early crop and just want the everbearing type to extend the season with a fall crop.

RE-TOOLING YOUR SPRAYER FOR BETTER INSECT AND DISEASE MANAGEMENT

George W. Hamilton
UNH Cooperative Extension, Extension Field Specialist, Food and Agriculture,
emeritus Specializing in Fruit and Vegetable Production
Home Address: 173 Comstock Drive, Milford, NH 03055
Email: hillsidemeadowsagconsulting@gmail.com

As stated on the pesticide label – the sprayer needs to be calibrated before you spray!

Each season, blueberry growers may apply spray materials worth $100's or more an acre when using sprayers. Many of the materials applied can potentially protect the crops and plants from pests, supply nutrition, or regulate plant growth. However, the failure to apply a spray evenly to its target can cost growers much more than the original price of the material and the $35/acre application costs. Poor spray coverage is the primary cause of reduced spray product performance.

Growers must often adjust sprayer outputs and vary application speeds throughout the growing season to account for variations in crop structure, the time of season and the purpose of the spray. Unfortunately, some growers often bypass these adjustments because sprayer calibration is considered difficult and time consuming. Sprayer calibration adjustments are worth the time and effort.

The precise application of pesticides is important. Problems with inadequate pesticide efficacy and phytotoxicity are often due to inaccurate sprayer calibration and pesticide dosage. Off-target spray drift has a measurable economic impact, including the loss of chemicals that should have been applied to the crop, and potential damage to adjoining crops and property. Off-target spray drift may also contaminate surface, ground water supplies, and pose health risks to animals and people. Additionally, rising legal liability costs have made added attention to properly calibrated and operated spraying equipment vital for operations of all sizes.

Reasons for Calibrating

Chemicals should be applied at the proper rate to be effective and safe. The calibration test tells us the application rate for our selected nozzles, pressure, sprayer design and travel speed.

The operator must know the application rate. This is available on the chemical label and can determine the proper amount of chemicals to add to the sprayer tank. Once the actual application rate is known, it is easy to decide the acreage that a tankful can cover. The proper amount of chemicals to add to the tank can then be decided.

Chemicals must be applied at the correct rate. Too little will reduce the effectiveness, and money will have been wasted on the material and its application. Pest injury may also result. Small fruit growers forget how a mis-calibrated sprayer could cause phytotoxic damage to the crop and/or the bushes. This can affect a farm's profitability, and proper calibration and spray deposition can prevent it.

Actual application rates in the field may vary from nozzle catalog values because of pressure gauge error, wheel slip, speedometer error and friction loss in the plumbing. A catalog is satisfactory for selecting the correct nozzles, but the sprayer must be checked under actual operating conditions to adjust the pressure and/or speed for the required application rate. In addition, on some machines, the spray pattern on the left side of the sprayer is different from that on the

George W. Hamilton is a retired Extension Field Specialist in Food & Agriculture for the University of New Hampshire Cooperative Extension and received emeritus status when he retired in June 2021. George joined UNH Cooperative Extension in 1989 and had direct responsibilities working with commercial farm operations, both full and part-time, in the areas of vegetables, fruit, IPM, pesticide safety education and farm business management. Prior to working for UNH Cooperative Extension, he was an education instructor for three years in the tree fruit program at Wenatchee Valley College in Wenatchee, Washington. He began his career as a high school vocational agriculture teacher and adult farm instructional advisor for ten years at the Upper Adams School District, Biglerville, PA. He received both a BS degree in Agricultural Education in 1976 and MS degree in Agricultural Education in 1982 from The Pennsylvania State University. George is a native of North East, PA. He and his wife Leann currently reside in Milford, NH.

right. This is difficult to detect without special apparatus.

Spray Deposition or Spray Coverage

Before checking the spray pattern, check your sprayer and all its components. Make sure that it is set up correctly, the pressure is correct; the nozzles are at the correct height for the crop being treated, the distances between the nozzles are correct, and that the nozzles are not plugged. Evaluate the sprayer at the same speed (RPM, gear, and throttle setting) you plan to use when treating your intended crop or area. Put clean water in the tank when testing.

The sprayer's nozzle orientation affects the spray pattern that is emitted. With an air blast sprayer, nozzles are positioned radially around the sprayer's air outlet. On a counterclockwise fan rotation, the air blast carries the droplets upwards over the canopy on the right-hand side of the sprayer, and downwards on the left-hand side.

A vertical patternator is used to simulate the canopy of a crop that is more than two feet tall. This specialized equipment supplies an accurate method for checking two-dimensional spray distribution. Equipment availability may be limited, and an experienced technician is needed for set up. Several passes with a patternator will help decide how much material is reaching different coverage heights. The sprayer is stationary. Turn on the sprayer and spray clean water out of the nozzles, with the fan turned on. As you evaluate, select different nozzle configurations (number and orientation). Water is collected in the graduated cylinders. The results show the vertical distribution pattern.

Results from the patternator show great variability in spray patterns produced according to nozzle orientation and which side of the sprayer they are on. Remember, the rotation of the sprayer fan can affect air and spray coverage.

Vertical spray patternators are used in Europe for inspecting and calibrating air blast sprayers. A vertical spray patternator can aid in adjusting nozzle position and orientation if changes are made according to crop canopy size and geometry.

Water Sensitive Cards can be used as an alternative. These one- use cards are available from some pesticide suppliers and spray equipment dealers. They are yellow and turn blue when a drop of water or oil touches them.

To evaluate, set up a series of cards on the crop you intend to spray. Clothespins can be used to clip cards to plants. For a highbush blueberry planting, set cards at the top of the canopy (on a pole, for example) in the interior, and low in the canopy. Mark the position on each card with a pen. Run the sprayer once by the row or block. Retrieve the cards. The blue dots will show your sprayer's coverage. If necessary, you can replace the used cards with new cards, adjust your sprayer settings, and perform a second test.

By calibrating the sprayer, the rate sprayed per acre and spray coverage can be confirmed. There are several changes that sprayer operators can make to retool their sprayer to maximize application efficiency:

- Operation speed.
- Spray pressure setting.
- Type of spray tip nozzle to used (you can have different spray tips on the manifold).
- The spray tip orifice size (you can have different spray tip orifice sizes on the manifold).
- Location of different spray tip orifice sizes or types of spray tips on the maniform.
- Direction of spray tip nozzle bodies and tips.
- With some sprayers, you can alter fan speed or fan angle to adjust air flow.
- Use air deflector to direct air flow.
- Turn off some spray tip nozzles.

SWD MANAGEMENT: ADJUVANTS, BIOCONTROLS, REPELLENTS, AND INSECTICIDES

Dr. Cesar Rodriguez-Saona, Robert Holdcraft, Dr. Beth Ferguson
P. E. Marucci Center, Rutgers University, 125A Lake Oswego Rd., Chatsworth, NJ 08019
Dr. Alice Axtell
IR-4 Project Headquarters, NC State University, 1730 Varsity Drive, Venture IV, Suite 210, Raleigh, NC 27606

Spotted-wing drosophila (SWD), Drosophila suzukii (Matsumura), is currently managed through multiple calendar-based applications of insecticides. Losses are reported in a wide variety of fruit crops, estimated to exceed $718 million annually in the United States. Improved management strategies are crucial to address this issue and to reduce the reliance on insecticide use for SWD control. The objective of this study was to test behavior-based management strategies for SWD, aiming to reduce dependency on insecticides across various farm management types, including conventional, organic, and U-pick systems. To achieve this goal, we evaluated the efficacy of Combi-protec (Andermatt USA), a novel insect bait used as an adjuvant, to enhance the uptake of insecticides by SWD. Also, we will discuss other behavior-based strategies as well as current biological and chemical control efforts at the presentation.

What Was Done?

An on-farm field experiment was conducted in highbush blueberries (cv. "Elliott") at a commercial farm in Hammonton, New Jersey. The experiment was a complete block design with three blocks containing three treatments: 1) a full-rate insecticide program (Full-Rate), 2) a full-rate insecticide program + Combi-protec (Full-Rate + Cp), and 3) a half-rate insecticide program + Combi-protec (Half-Rate + Cp). The insecticide program followed is listed in Table 1. Treatments began in July 2023.

Table 1. Insecticide application program

Week	Product (EPA Reg. No.)	A.I.	Rate		GPA	Application Method	Adjuvant (Product & Rate)	Date Applied	Crop Growth Stage
1	10163-169	Phosmet	Full-Rate	1.33 lb/ac	40	Ground-overhead Boom		7/11	10-20% blue
1	10163-169	Phosmet	Full-Rate + Cp Half-Rate + Cp	1..33 lb/ac & 0.665 lb/ac			Combi-protec 1 lb/ac	7/11	10-20% blue
2	279-3426	Zeta-cypermethrin	Full-Rate	4 fl oz/ac	40	Ground-overhead Boom		7/18	50% blue
2	279-3426	Zeta-cypermethrin	Full-Rate + Cp Half-Rate + Cp	4 fl oz/ac & 2 fl oz/ac			Combi-protec 1 lb/ac	7/18	50% blue
3	4-99	Malathion	Full-Rate	2 pt/ac	40	Ground-overhead Boom		7/27	75% blue
3	4-99	Malathion	Full-Rate + Cp Half-Rate + Cp	2 pt/ac & 1 pt/ac			Combi-protec 1 lb/ac	7/27	75% blue
4	62719-541	Spinetoram	Full-Rate	6 oz/ac	40	Ground-overhead Boom		8/4	100% blue
4	62719-541	Spinetoram	Full-Rate + Cp Half-Rate + Cp	6 oz/ac & 3 oz/ac			Combi-protec 1 lb/ac	8/4	100% blue
5	10163-169	Phosmet	Full-Rate	1.33 lb/ac	40	Ground-overhead Boom		8/11	100% blue
5	10163-169	Phosmet	Full-Rate + Cp Half-Rate + Cp	1.33 lb/ac & 0.665 lb/ac			Combi-protec 1 lb/ac	8/11	100% blue

Cesar Rodriguez-Saona is a Professor and Extension Specialist in the Department of Entomology at Rutgers University, where he conducts basic and applied research on the development and implementation of sustainable insect pest management practices and delivers educational information to growers. He received his M.S. from Oregon State University and his Ph.D. from the University of California, Riverside.

Robert Holdcraft is a research technician and graduate student at Rutgers University. He conducts insecticide efficacy trials and helps with research projects. His master's thesis is on behavior-based approaches for oriental beetle control.

Beth Ferguson is a post-doctoral researcher at Rutgers University, where she is conducting studies on behavior-based strategies for managing SWD and on pollinator-blueberry interactions. She obtained her Ph.D. from the University of Arkansas and worked as a post-doctoral fellow at the USDA ARS Northern Crop Science Lab in Fargo, North Dakota.

Alice Axtell is the Biology Team Lead & Principal Entomologist at The IR-4 Project, a federal organization that generates data necessary to pursue pesticide registration for specialty crop growers.

Larval Infestation. A random collection of 20 berries was taken from the center of each plot on Week 1: 10 July (pre-spray) and 14 July (post-spray); Week 2: 17 July (pre-spray) and 21 July (post-spray); Week 3: 26 July (pre-spray) and 30 July (post-spray); Week 4: 3 August (pre-spray) and 7 August (post-spray); and Week 5: 13 August (pre-spray) and 17 August 17 (post-spray). Berries were stored in 16-oz deli cups under ambient laboratory temperature of 25±2°C and 16:8 L:D for three days after collection. At that time, salt extraction method was used to bring larvae out of the berries which were then counted.

Adult Mortality. From the center rows of each plot, 45 berries were collected. Additionally, three terminals with 5-7 leaves were collected from each plot. Assay containers were comprised of a 64-oz deli cup with a perforated lid to allow for airflow. A water pick was inserted into the bottom of the deli container and a single terminal was placed so it was held securely with no gaps. In each assay, n=15 berries were placed in the bottom along with 3-5 cm long dental wick moistened with deionized water. Ten adult SWD (1:1 M:F) were added to each assay. Mortality counts were taken 24hr and 72hr after flies were placed into containers.

What was found?

Larval Infestation. Larval infestation did not differ among treatments for weeks 1-4 for either the pre- or post-treatment samples (Table 2). In week 5, there was significantly lower larval infestation in the full-rate insecticide program (Full-Rate) and the full-rate insecticide + Combi-protec program (Full-Rate + Cp) compared to the half-rate insecticide + Combi-protec program (Half-Rate + Cp) (Table 2).

Adult Mortality. There were no significant differences in adult SWD mortality for weeks 2-4 among the treatments in either the pre- or post-treatment samples (Table 3). Female and male SWD mortality did vary in week 5, 72hrs after exposure, with significantly lower mortality in the half-rate insecticide + Combi-protec program (Half-Rate + Cp) compared to the full-rate insecticide, with (Full-Rate + Cp) and without (Full-Rate) Combi-protec, programs (Table 3).

Table 2. Larval counts per 20 berries when sampled pre- and post-treatment

Week	Chemical	Treatment	Pre	Post[1]
			Mean ± SE	Mean ± SE
1	Phosmet	Full-Rate	0.00 ± 0.00	0.00 ± 0.00
		Full-Rate + Cp	0.50 ± 0.30	0.05 ± 0.05
		Half-Rate + Cp	0.11 ± 0.07	0.00 ± 0.00
2	Zeta-cypermethrin	Full-Rate	0.00 ± 0.00	0.00 ± 0.00
		Full-Rate + Cp	0.00 ± 0.00	0.00 ± 0.00
		Half-Rate + Cp	0.00 ± 0.00	0.00 ± 0.00
3	Malathion	Full-Rate	0.19 ± 0.14	0.00 ± 0.00
		Full-Rate + Cp	1.13 ± 0.65	0.12 ± 0.08
		Half-Rate + Cp	0.19 ± 0.09	0.06 ± 0.06
4	Spinetoram	Full-Rate	0.82 ± 0.51	1.19 ± 0.52
		Full-Rate + Cp	1.41 ± 0.53	0.73 ± 0.48
		Half-Rate + Cp	0.88 ± 0.36	0.81 ± 0.30
5	Phosmet	Full-Rate	2.86 ± 1.69b	0.12 ± 0.12b
		Full-Rate + Cp	3.38 ± 0.58b	0.51 ± 0.24b
		Half-Rate + Cp	4.48 ± 1.80a	1.37 ± 0.59a

[1]**Different letters indicate significant differences among treatments.**

Conclusions

Larval infestation remained low throughout the trial apart from the final week. In the first four weeks, the absence of larvae in fruit led to no discernible differences among the treatments counts, indicating that the half-rate insecticide + Combi-protec program was as effective as the full-rate insecticide program. However, during the last week, larval counts in the half-rate insecticide + Combi-protec program surpassed those in the full-rate insecticide program, suggesting a loss of efficacy under higher SWD pressure.

Table 3. Proportion of dead SWD

Week	Chemical	Treatment	Female		Male	
			24hr	72hr[1]	24hr	72hr[1]
2	Zeta-cypermethrin	Full-Rate	0.02 ± 0.02	0.18 ± 0.11	0.00 ± 0.00	0.11 ± 0.11
		Full-Rate + Cp	0.00 ± 0.00	0.04 ± 0.03	0.04 ± 0.03	0.09 ± 0.04
		Half-Rate + Cp	0.00 ± 0.00	0.02 ± 0.02	0.04 ± 0.03	0.04 ± 0.03
3	Malathion	Full-Rate	0.04 ± 0.03	0.13 ± 0.07	0.07 ± 0.05	0.13 ± 0.07
		Full-Rate + Cp	0.00 ± 0.00	0.09 ± 0.09	0.02 ± 0.02	0.02 ± 0.02
		Half-Rate + Cp	0.02 ± 0.02	0.04 ± 0.04	0.00 ± 0.00	0.04 ± 0.03
4	Spinetoram	Full-Rate	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.07 ± 0.03
		Full-Rate + Cp	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.11 ± 0.05
		Half-Rate + Cp	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.09 ± 0.05
5	Phosmet	Full-Rate	0.29 ± 0.07	1.00 ± 0.00 a	0.38 ± 0.08	1.00 ± 0.00 a
		Full-Rate + Cp	0.29 ± 0.09	0.98 ± 0.02 a	0.40 ± 0.07	0.98 ± 0.02 a
		Half-Rate + Cp	0.22 ± 0.06	0.84 ± 0.07 b	0.22 ± 0.08	0.78 ± 0.09 b

[1]**Different letters indicate significant differences among treatments.**

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UNDERSTANDING NEMATODES AND MANAGEMENT OPTIONS IN BRAMBLES AND BLUEBERRIES

Dr. Mihail Kantor[1] and Kathleen Demchak[2]
[1]Department of Plant Pathology and Environmental Science, Penn State University
[2]Department of Plant Science, Penn State University

Very little information is available regarding plant-parasitic nematodes' (PPNs') impact on blueberry and bramble crops in PA. These PPNs, often patchily distributed, can harm berry crops by directly feeding on plant roots, or by transmitting viruses. In 2023, a survey was conducted to assess PPN populations in Pennsylvania's commercial blueberry and bramble crops. This involved collecting 69 soil samples from 13 farms in 10 counties: Adams, Allegheny, Butler, Clearfield, Centre, Dauphin, Erie, Lancaster, Lycoming, and Tioga. The majority - about two-thirds of the samples - were from blueberry plantings, which could have been likely to harbor larger PPN populations given the longevity of the plants. The remaining samples included 5 from black raspberry, 8 from red raspberry, 5 from blackberry, 1 from gold raspberry, and though not part of the original plan, 1 from strawberry.

Populations of all nematodes varied widely from farm-to-farm, and sometimes by location on the same farm. The top three most commonly encountered genera/families identified were represented by lesion, stubby root, and spiral nematodes. Lesion nematodes, which historically are not considered a major pest in blueberries, may require further research on this crop. They can, however, cause a slow planting decline, reduced vigor, and yield losses in raspberries. Their feeding also results in entry points for fungal and bacterial diseases. Stubby root nematodes can cause yield losses in blueberries, but there is little data on spiral nematodes' effects on yield under field conditions for blueberries or brambles. Other identified PPNs included stunt, dagger, lance, pin, ring, and sheath nematodes. Our results indicated that blueberry and other bramble crops in Pennsylvania were hosts for dagger nematodes at levels over the threshold of concern. This occurred on 6 of the 13 farms sampled. This type of nematode transmits Tomato Ringspot and Tobacco Ringspot viruses.

It is useful to note that in some fields, crop plants were growing very well despite notable nematode populations. Good cultural practices can play an important role in allowing plants to tolerate nematode feeding without crop loss.

It is highly recommended to test fields for the presence of nematode populations years in advance of planting. This can inform growers regarding which cover crops or rotational crops are most suitable to grow or to avoid. Another important step involves choosing preceding crops with genetic resistance to certain nematodes. In fields with high nematode populations, fumigation may be necessary. Chemical treatments for established plantings are available but can be expensive. Anaerobic soil disinfestation is a promising new technique that has so far resulted in significant decreases in test nematode populations but, like fumigation, is only applicable before the planting is established. In conclusion, a combination of management practices will be required to manage nematodes in brambles and blueberry crops.

Our sincere appreciation is extended to the Pennsylvania Vegetable Growers Association for funding this research.

Mihail Kantor, Ph.D, is an Assistant Research Professor of Nematology in the Department of Plant Pathology and Environmental Microbiology at Penn State. Prior to joining Penn State, he worked at USDA ARS, Beltsville, MD under advisor Dr. Zafar Handoo (national APHIS nematode identifier). Kantor's research focus is on identification of plant-parasitic nematodes using systematics, morphology, and molecular techniques. At Penn State, Kantor applies integrated approaches for identification and classification of plant-parasitic nematodes of importance to Pennsylvania crops. Kantor has more than 16 years of experience in agricultural research, having spent the last 9 years studying the plant-parasitic nematodes.

UNDERSTANDING RUNNER FORMATION AND MANAGEMENT

Edward Durner
Associate Research Professor, Plant Biology, Rutgers Specialty Crop Research and Extension Center
283 Route 539, Cream Ridge, NJ 08514
durner@sebs.rutgers.edu

Runner production in strawberry is crucial for propagation, however, control of runner growth in many production systems is crucial for cropping success. Understanding runner growth in the cultivated strawberry begins with the fundamental understanding of their production and how it is regulated by genetics, light, temperature and fertility. This presentation will highlight runnering in strawberry, its physiological and genetic regulation and review applied aspects of runner management to maximize fruit production in field, high tunnel and greenhouse environments. A brief summary of basic runnering physiology is presented below while the applied aspects will be examined during the presentation.

The main stem of the strawberry plant is called the crown and consists of a single, lignified shoot with one terminal meristem and many axillary meristems, one in the axil of each leaf on the main shoot. A meristem is a region of cellular growth which has the potential to follow one of a number of developmental pathways. The developmental direction each meristem follows depends on the type (terminal or axillary) and environmental cues to which it is exposed. Shoot internodes of the main crown are very short producing a rosetted plant. The number of leaves on any individual crown varies and the number of axillary meristems per crown varies with this number.

The single terminal meristem of a strawberry crown remains dormant, produces leaves or transitions to an inflorescence depending on environmental cues and genetic composition. Axillary meristems are more complicated. An axillary meristem may remain dormant, produce a two-node shoot with highly elongated internodes with a new plantlet developing at the second node (a stolon or runner), or develop into a two-node shoot called a branch crown. When an axillary bud progresses into runner production, the first node has one axillary meristem which may elongate to form a runner, however, it normally remains dormant and is called a 'blind' node. A plantlet forms at the second node which is the propagule for commercial production.

Runner planlets may be allowed to root in the nursery and dug in the fall for direct planting in the production field as 'fresh dugs' (freshly dug plants immediately planted for fruit production) or 'cut-offs' (fresh-dugs with leaves removed). Nursery grown runner plants may also be dug in the fall and cold-stored at -0.5C until planting in the production field ('frigo' plants). Frigo plants are generally stored for 6 months or less, but may be stored for as many as 9 months. Survival rates for frigo plants decreases as storage length increases.

Specialized production systems have been developed for a relatively new form of propagation, plugs. Strawberry plugs are utilized extensively in many commercial production schemes including Florida winter production, cold-climate plasticulture and season extension in the US. Runner plants are harvested at the 'tip' stage (before rooting of the plantlet occurs) and planted in 50-cell trays where they are ready for planting for fruit production in 3 to 4 weeks. These plants are called plugs. Plantlets do not have to be harvested from mother plants as soon as they develop. Instead, runner plantlets may themselves produce runners, thus plantlets are labelled as first order, second order, etc. This sequential plantlet production from mother plant to first order to second to third and so on produces a runner chain. Runner chains rather than single plantlets are harvested, divided into plantlets, then rooted in plug trays as described above. At the 3 to 4-week stage plugs may be manipulated by photoperiod, temperature and nitrogen to enhance fruiting. Second order daughter plants are much more sensitive to conditioning than third order daughter plants.

When plug plants are conditioned and allowed to grow (often in larger cells) before planting for fruit production, they are called tray plants. Tray plants are well developed, multi-crowned plants with a complement of flowers ready for fruit production. Tray plant productivity varies depending on conditioning treatment, thus they are often flower mapped before production planting to verify their potential. Tray plants can be stored at -5oC for several months

prior to production planting, however, cold storage may alter flower and runner production as well as overall plant vigor.

When the axillary bud develops into a two-node shoot called a branch crown, it has a single terminal meristem and two axillary meristems. The terminal meristem of a branch crown behaves like the terminal meristem of the main crown and each axillary meristem behaves like the axillary meristems of the main crown. This process of axillary bud development produces multilayers of branching within a mature strawberry plant.

Terminal meristems exert apical dominance on the subtending axillary meristems on the same crown. Inflorescences are always formed terminally whether on the main crown or a branch crown and floral initiation always occurs in the terminal meristem of the main crown first. Once the terminal meristem of the main crown has transitioned to floral, the uppermost axillary meristem (two-node branch crown) begins developing as described above. In doing so, it appears to push the inflorescence of the main crown to the side, producing sympodial growth. The branch crown immediately subtending the terminal inflorescence is often called an extension crown, as it may continue growth of the central plant axis or main crown. Axillary buds furthest from the terminal may develop independently since the dominance of the terminal on the more basal axillaries is limited. These axillary meristems often form branch crowns with 2 to many internodes before floral initiation of their terminals, or they may follow the developmental pathway to produce a runner.

Runner formation is antagonistic to flowering and fruiting and is physiologically regulated by photoperiod and temperature. While runner production in short day cultivars is normally associated with long days or high temperature and runner production in long day cultivars is primarily a response to high temperature and short days, the categorization into cultivar classes based on runner production is not accurate.

Applied aspects of runner management will be discussed.

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USDA-ARS STRAWBERRY CULTIVARS FROM BELTSVILLE-2024

Kim Lewers
USDA-ARS Beltsville Agricultural Research Center, 10300 Baltimore Avenue, Beltsville, Maryland 20705,
Kim.Lewers@usda.gov

For over 100 years, the USDA strawberry breeding program in Beltsville, MD, has made major contributions to the development of the strawberry as a crop. From the start, the emphasis has been on fruit quality and natural disease resistance. Strawberry cultivars developed at Beltsville, MD, just north of Washington, DC, are evaluated in an annual plasticulture production system. Plug plants are planted in early August and fed 70 lbs/A nitrogen until mid-September. Fields have been overwintered using straw or row covers but now are unprotected. In spring, plants are fed 30 lbs/A nitrogen. Frost protection uses misters and impact sprinklers, which can support the development of botrytis fruit rot. To help eliminate seedlings or selections susceptible to disease, no fungicides are used. Cultivars from this program are resistant or tolerant of diseases present in Beltsville fields, especially anthracnose fruit rot.

Several short-day or June-bearing cultivars that perform well in the Mid-Atlantic are resistant to anthracnose fruit rot. Most are from the USDA program at Beltsville. In order of season, they are Sweet Charlie (University of Florida), Earliglow, Lumina, Galletta (North Carolina State University), Flavorfest, Keepsake, Allstar, and Cordial.

Early-season: 'Sweet Charlie' is earliest and can have a second flush of fruit towards the end of the traditional strawberry season. It is not as winter-hardy as the others. 'Earliglow' is known for its exceptional flavor, at times said to be "the gold standard around the world for flavor". 'Earliglow' fruits are smaller than is currently preferred. 'Lumina' is the newest of these cultivars. Like 'Earliglow', 'Lumina is early and has sweet fruit. But 'Lumina' produces larger fruit and does not flower through the winter. 'Lumina' was named for its exceptionally bright color and unusually high gloss. 'Galletta' produces large attractive fruit with good but variable flavor.


Lumina' fruits

Mid-season: 'Flavorfest' was released in 2013 and is well known in the Mid-Atlantic for high yields of large very plump-looking flavorful fruit. 'Keepsake' was patented in 2019, just before the pandemic. 'Keepsake' was the USDA's first cultivar resulting from efforts to improve shelf life. 'Keepsake' produces yields almost as great as 'Flavorfest' yields and slightly later. 'Keepsake' and 'Flavorfest' fruits are similarly large. 'Keepsake' fruits are more traditionally shaped, are sweeter, and last longer in storage than 'Flavorfest fruits. 'Allstar' also produces high yields of large, bright orange-red fruit. During exceptionally cool rainy weather, 'Allstar' fruits can suffer from bacterial angular leafspot disease and skin cracking.


'Flavorfest' fruits

Kim Lewers has been the strawberry breeder and geneticist with the USDA's Agricultural Research Service at Beltsville, Maryland, since 2001. She develops improved cultivars while studying inheritance of important traits. Dr. Lewers enjoys supporting the berry industry and other berry researchers as Chair of the North American Strawberry Growers Research Committee, member of the Small Fruits Crop Germplasm Committee, and member of the National Clean Plants Network (Berries) Tier II Executive Board of Directors. Kim was born in Pittsburgh, lived in Ohio and Georgia, got all three degrees at Iowa State University and is happy to return to the Mid-Atlantic.

'Keepsake' fruits

Late-season: 'Cordial' was patented in 2021, during the pandemic. 'Cordial' produces extremely high yields of very large fruits that tolerate heavy rains and have excellent shelf life. 'Cordial' fruits are very tough and firm but juicy, with a pleasant eating texture. 'Cordial' fruits are about as sweet as 'Flavorfest' fruits, and in some weather have pleasant overtones of cotton candy. 'Cordial' fruits are not tart, even in cool rainy weather. They don't bite back with tartness but are "friendly" or "cordial".

'Cordial' fruits

WEEDS AS HOSTS OF STRAWBERRY ANTHRACNOSEA: IMPLICATIONS FOR MANAGEMENT

Leah Fronk
Penn State Extension, 30 N. Main St, Mifflintown, PA 17059
Lxf339@psu.edu

Anthracnose, caused by fungi in the *Colletotrichum acutatum* and *C. gloeosporioides* species complexes, is responsible for significant economic losses in strawberry production worldwide in nursery and farm environments. Symptoms can be seen on fruit, petioles, leaves, and crowns. The presence of diseases caused by *Colletotrichum* in nursery transplants is of great concern to strawberry growers. The pathogen is often present without symptoms in transplants and may be further spread to soil, equipment, and other plants by water-splashed spores. It is also possible that some spores may be wind-blown into the planting from the surrounding environment. *Colletotrichum* can remain asymptomatic on strawberry and other plant material for some time until it causes lesions on fruit or other plant parts.

Since strawberry is often managed as a perennial crop or in fields with minimal crop rotation, weeds in strawberry fields are suspected to be another source of the disease. In other studies, *Colletotrichum* of the same species infecting strawberries was found on various weed species in strawberry fields. We hypothesized that common weeds in strawberry fields are hosts to Colletotrichum and thus could serve as reservoirs of disease inoculum either infecting disease-free plants or exacerbating disease problems. Funded by the Pennsylvania Vegetable Growers Association, the objectives of this 2-year study were to survey Pennsylvania strawberry fields to determine if weeds in strawberry fields are infected with Colletotrichum, and compare the species found on weeds to those infecting strawberry.

During 2021 and 2022, 144 weed plants were collected from 6 Pennsylvania strawberry production fields with active anthracnose infections. Fourteen of the 20 weed species were endophytically infected with Colletotrichum. From these weeds, 54 single-spore cultures of *C. acutatum* isolates were recovered. While detection frequency varied, all perennial weed species were infected with *Colletotrichum*. A total of 46 isolates were also recovered from infected strawberry plants. The predominant fungal species identified on both weeds and strawberries through PCR and phylogenetic analysis was C. nymphaeae, part of the *C. acutatum* species complex. To further test pathogenicity, detached strawberry fruit were inoculated with isolates from selected weed species. Strawberry fruit developed symptoms in almost every instance.

Strawberry growers should be aware that allowing weeds to persist in strawberry fields can allow *Colletotrichum* to hide. Whether weeds or strawberry plants are infected first is unknown, but the fact that *Colletotrichum nymphaeae* could persist on weeds means weed control takes on added importance. Much more work is needed, but for now, we have more answers on how clean plants may first become infected in nursery or grower fields.

Leah Fronk is a commercial horticulture educator for Penn State Extension based in Juniata County, PA. Her programming focuses on organic and conventional pest management for vegetable and small fruit crops, as well as assisting growers with issues related to pesticide certification and the Food Safety Modernization Act (FSMA). Leah earned her bachelors and masters degree in Horticulture from Temple University and Penn State, respectively. She lives in central PA with her husband and three children.

WEED MANAGEMENT STRATEGIES FOR STRAWBERRIES

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

Proper site and soil preparation for strawberries is critical for successful establishment of a new planting. Preventing weed problems in the planting year will be one of greatest challenges of getting the new bed established.

The first step in managing a weed problem is to prevent it from getting started. Select a site where the weed pressure, especially from perennial weeds, is low. Choose a site that has previously had cover crops and/or cash crops in which weeds were well-managed. Do not plant strawberries into recently plowed perennial grass sod. This can lead to devastating weed problems from species such as quack grass and clovers.

Planting new crowns late in the spring as opposed an earlier planting date can be used to manage an early flush of weeds in a new strawberry bed. Prepare the ground for planting in the fall or in the early spring, then allow the first flush of spring weeds to germinate before planting. You can then eliminate those early spring weeds with a light cultivation, a contact herbicide or flaming, and then plant the strawberries. By eliminating the first flush of weeds and planting into a warmer, drier soil, the need for early cultivation and hand weeding is greatly reduced. However, delaying planting by the four to six weeks needed for this practice can reduce the quality of your stored strawberry plants. Discuss any delayed planting plans with the nursery in advance so that they can store and ship the plants at the best time for you. Late planting also shortens the length of time the new plants have to develop and form runners to fill out the bed, but experience has shown that plant populations are usually adequate by season's end. Increasing the in-row crown spacing a few inches (e.g. 12" between plants) can also compensate for fewer runners where this is a concern.

Strawberry beds are typically planted on open ground following the incorporation of a cover crop. Weeds are then managed with a variety of cultivation methods such as tine cultivators, blind cultivators (e.g. Lely) and/or finger weeders (e.g. Buddingh, Regi). This can be effective early in the season, as long as it is combined with vigilant hand weeding within the plant rows where the cultivators can't reach. However cultivation becomes more challenging during the summer when the plants runners grow into the path of cultivators. Using sweep blades to push the runners out of the way in front of the cultivating tines can work, but generally the need for hand weeding will become more intense as the season progresses. Flaming weed seedlings between the rows may also be used in strawberries, but it is costly, and the burners must be well-shielded to prevent burning the strawberry plants. Flaming has the advantage of not disturbing the soil surface, and thus reduces further weed germination.

Tarping can also be used to eliminate the first flush of weed growth in a new planting. After soil preparation in the fall or early spring, plastic tarps laid over the soil surface for as little as four to six weeks can significantly reduce subsequent weed seed germination. The tarps must be well-anchored to prevent the wind from disturbing them. The size of the tarp available will limit the size of the area that can be treated. Planting following removal of the tarp should disturb the soil surface as little as possible to prevent bringing up more weed seeds.

Another strategy for managing weeds in the planting year is to use strip or zone tillage. A heavy cover crop of oats or winter rye is seeded during the late summer the year before planting strawberries. Oats will winter kill, but rye will need to be crimped, mowed or killed with a contact herbicide the following spring. The plant residue is left undisturbed on the soil surface except for narrow (8-12") strips or zones that are tilled for the strawberry plants. Leaving most of the soil surface untilled with a heavy plant residue prevents most weed seeds from germinating. The rye residue last longer than

David T. Handley is the Extension Vegetable and Small Fruit Specialist and a Cooperating Professor of Horticulture for the University of Maine. Dr. Handley received a Bachelor's degree from the University of Massachusetts, and his Masters and Ph.D. degrees from the University of New Hampshire. He has been based at Highmoor Farm, the Agricultural and Forestry Experiment Station in Monmouth, Maine, since 1983, where he carries out applied research regarding berry and vegetable variety evaluation, production techniques and pest management strategies. He coordinates statewide integrated pest management (IPM) programs for strawberries and sweet corn. Dr. Handley is the author of numerous Extension fact sheets, articles and newsletters, and co-editor of two regional small fruit production guides.

oats, but killing the rye can be problematic. Zone tillage requires specialized equipment to make the soil strips suitable for good plant growth. The equipment is both expensive and heavy, requiring a fair amount of horsepower, but it can be used for many crops on the farm. Toward the end of the season, as the residue breaks down, weeds can once again become an issue, and hand weeding will be required within the tilled strips of the plant rows. After harvest the following spring the planting is usually plowed down and the field put back into rotation crops for a minimum of three years.

Plastic mulches are also being used to reduce weed problems in strawberries. Planting strawberries through black plastic eliminates much of the weed pressure within the planting, but prevents the use of runner plants to fill out the row. Therefore, plasticulture systems require about two to three times as many plants as a matted row system at planting, and plants are initially spaced only 8 to 12 inches apart. Once again, specialized equipment for making beds and laying plastic mulch is required, but vegetable growers would likely have such equipment available. In a plasticulture system, strawberries are typically planted later in the spring or early summer to reduce runner production. Runners should be removed in this system, which is quite labor intensive. The plants are overwintered and harvested the next spring. After harvest the plastic is removed, and the planting is generally plowed down. Research is underway to evaluate the feasibility of cutting and removing the plastic in the second season and allowing the planting to become a matted row for harvest a second year. It is hoped that weed problems would be reduced from having the soil covered for the previous year.

Most organic strawberry growers using the matted row system have found that the beds should only be fruited one year then plowed down and put into rotation crops. Trying to renovate a bed and carry it over a second year inevitably leads to major weed infestations and increased insect and disease pressure. However, using a plasticulture system in the first year and converting it to a matted row for a second year with minimal soil disturbance could provide a workable two crop system that would significantly increase the profitability of the planting.

The one harvest year rotation is probably still the best option for most organic growers (plant year one, harvest year two, plow down and plant to rotation crops) to manage weed problems in strawberry beds. However, some of the new strategies being developed may allow growers to extend the productive life of strawberry beds and thus improve their profitability. With any new strategy, it is critical that strawberry growers maintain soil health and fertility and prevent the build up of pest organisms; therefore each new technique must be evaluated not only in terms of how it affects short-term yield, but also how it may impact the long term success of future crops.

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

1. Napropamide (Devrinol®): A pre-emergent herbicide that provides good control of annual grasses, volunteer grains and some broadleaf weeds. It is typically applied just before mulching in the fall. Split applications have become popular due to the loss of other pre-emergent herbicides, e.g. half maximum rate application after renovation or in late summer after desired daughter plants have rooted, and a second half rate application once the strawberry plants are dormant. Napropamide should be worked in by irrigation, rainfall or light cultivation within 24 hours of application.

2. Terbacil (Sinbar®): A pre-emergent herbicide with some post-emergent activity, which should be applied at renovation time – after mowing and tilling the beds, but before new growth begins. A second application can be made in late fall, after the plants are dormant. No more than 6 oz. may be applied in a single application, and no more than 8 oz. may be applied in one season. An example of one season's use could be 5 oz. applied at renovation and 3 oz. applied in the late fall, the latter in addition to napropamide or DCPA. Terbacil can cause plant injury. It is important to determine appropriate rates for each location.

3. Clopyralid (Spur®): One application is permitted per crop per year following harvest to emerged weeds. Apply uniformly in a minimum of 10 gallons of water per acre. Do not tank mix with other herbicides. Clopyralid offers control of clover, dandelion and thistle.

4. Sethoxydim (Poast®): A post-emergent herbicide for control of actively growing grasses. It will not control broadleaf weeds. It should not be applied when grasses are under stress, e.g. drought, or on unusually hot, humid days. Do not use sethoxydim within 6 weeks of terbacil (Sinbar®) applications, to avoid leaf injury. Sethoxydim should be used in combination with a crop oil concentrate. Do not tank mix with 2, 4-D.

5. Clethodim (Arrow®, Prism®, Select®): A post-emergent herbicide, similar in activity to Poast®, for control of actively growing grasses. It will not control broadleaf weeds. It should not be applied when grasses are under stress, e.g. drought, or on unusually hot, humid days. Clethodim should be used in combination with a crop oil concentrate.

6. Paraquat (Gramoxone Inteon®): A contact herbicide for post-emergent control of most annual weeds and suppression of many perennial weeds. Paraquat will injure or kill strawberries, so applications are made between rows only, with a sprayer shielded to protect the strawberries. It should be used in combination with a nonionic surfactant. Paraquat should not be applied within 21 days of harvest or more than three times in one season.

7. 2,4-D Amine (Formula 40®, Amine 4): A post-emergent herbicide effective on most broadleaf perennial weeds. It will not control grasses, nor offer any pre-emergent control. 2,4-D should be applied immediately after harvest is complete if emerged broadleaf weeds are a problem. After application, the bed should be left undisturbed for three to five days, before mowing the leaves off the plants. This allows time for the material to be taken in by the weeds. This material can also be used when the plants are dormant (late fall or early spring) to control winter annuals and biennials. Fall applications may result in injury to the strawberries if the plants are not completely dormant. Do not tank mix 2,4-D with sethoxydim (Poast®).

8. Flumloxazin (Chateau®): A pre-emergent herbicide for control of broadleaf weeds, including dandelion and shepherd's purse. For use in the fall when plants are dormant for control of weeds the following spring. If small boadleaf weeds are emerged, also apply a crop oil concentrate at 1% or a non-ionic surfactant at ¼% by volume. Chateau will control emerged chickweed, field pansy, and oxalis if sufficient contact is made with the weeds. Chateau can also be applied with a hood or shield to row middles of non-dormant strawberries prior to fruit set.

9. Pendimethalin (Prowl H20®, Satellite Hydrocap®): A pre-emergent herbicide that may be applied to the soil surface prior to planting. It may also be applied as a band with a shielded sprayer between the rows of strawberries up to 35 days before harvest. No weed control will be provided within the plant rows, and contact of this product on the strawberry plants will cause injury. Prowl provides excellent control of many annual grasses and several broadleaf species. Satellite Hydrocap® can be applied during the dormant season or at renovation prior to new growth emergence.

10. Sulfentrazone (Spartan 4F®): A pre-emergent herbicide that may be applied to the soil surface prior to planting or just after planting, but before new growth appears. May cause damage to new growth; varieties differ in sensitivity. Offers good control field pansy and nutsedge.

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

ROLE OF SM IN RESPONDING TO CRISES

Sarah Cornelisse
Sr. Extension Associate, Dept. of Agricultural Economics, Sociology and Education
Penn State University, 206A Armsby Building, University Park, PA 16802
sar243@psu.edu

What would you consider as a crisis for your business? Mislabeled product? A product recall? An employee injury? Death of an employee or customer? A claim regarding health or nutrition lacking scientific backing? Crises can take many forms. Dictionary.com defines a crisis as "a stage in a sequence of events at which the trend of all future events, especially for better or for worse, is determined." It's important to note that the definition does not identify the type of events, simply that events are occurring and that there is a point which defines the course of future events. And while it may be clear that some events are a crisis, others may not so clearly fit the category.

Types of crises in the agriculture and food industries can include contamination, recalls, and negative publicity. Crises may occur with more frequency than you might expect. For example, as of December 4, 2024, the United States Food and Drug Administration (US FDA) reports 6,536 recall events in the U.S. for fiscal years 2020 through 2024 with the greatest number (1809) occurring in fiscal year 2022 (FDA, n.d.). When you consider the other types of crises that may have occurred within all ag and food industries, the magnitude is staggering.

By now, most of us are familiar with social media. Platforms such as Facebook, X (formerly Twitter), Reddit, TikTok, and YouTube are all examples. Social media is a communication channel, but with the notable differentiating feature of 2-way communication when compared with traditional media such as newspaper, radio, or television. Due to the nature of communication on social media as well as the much shorter lifecycle of news and information, users have different expectations regarding openness and transparency for those with whom they interact, whether individuals or businesses.

Social media has progressed into a regularly used source for news by its users. In 2022, 50% of U.S. adults report sometimes or often getting their news from social media (Liedke and Matsa, 2022). This highlights the potential importance and value of social media for crisis management.

When it comes to crisis management, social media has altered the context and tactics used when responding to and managing a crisis, but the core principles remain the same. These include:

- **Identify a team** – Know who needs to, or should be, be involved. While some team members may be apparent (e.g. spokesperson, business owner/CEO, etc.), other team members may be less apparent and include individuals with responsibilities in areas such as product distribution or finance.
- **Have a plan** – Don't wait until a crisis occurs to figure out how to address one. Assign roles to team members and make sure each understands their responsibilities.
- **Practice your response** – Simulating a range of crisis types can provide teams valuable experience better preparing them for responding to a true crisis. Crisis drills provide a non-stressful environment for preparation and identifying aspects of the plan that need strengthening.

When considering the role of social media in crisis management, there are benefits including:

- **Real-time communication and information dissemination.** Social media allows businesses the ability to communicate with the public and stakeholders in real-time; no need to wait for the next publication of a

Sarah is a Senior Extension Associate and Specialist in agricultural entrepreneurship, marketing and business management at Penn State University in the Department of Agricultural Economics, Sociology, and Education. Sarah has expertise in direct marketing, agricultural and value-added dairy entrepreneurship and marketing, digital and social media marketing and commerce for agricultural farm and food businesses, and business and marketing planning and decision making.
Originally from New York state, she received a B.A in mathematics from the State University of New York at Geneseo, and M.S. degrees in Agricultural Economics and Animal Science both from Penn State University.

newspaper or news telecast.

- **Monitoring and tracking emerging issues.** The crisis management team can use social media to monitor online conversations and media coverage of the situation. This can aid in identifying important aspects that need to be addressed and help provide a sense of public and stakeholder sentiment.
- **Engaging with stakeholders and the public.** The two-way mode of communication allows businesses to directly engage with stakeholders on the social media platform(s), answering questions, addressing concerns, or providing specific information.
- **Convey transparency and build trust.** Appropriate use of social media and engagement through the platform can convey to stakeholders and the public that a business is being transparent in their efforts to share information and address the crisis, thus building and/or reinforcing trust between the public and the business. An analysis of existing research on crisis communication determined that "using social media significantly lessened consumers' perceived crisis responsibility" (Xu, 2020). That is, consumers' views of the business's responsibility for the crisis went down when businesses used social media.

A publication from Deloitte (Overlander, 2023) outlines five principles for thinking about social media in a crisis:

1. **Social media isn't always the right way to communicate in a crisis.** Crisis communications should be tailored to the specific incident and sometimes that may rule social media out as an appropriate tool.
2. **Great social media engagement in 'peace time' can be your downfall in a crisis.** Social media is often left to marketers, but during a crisis, the marketing individual or team may not be the appropriate lead for social media communications. Crisis planning should include a discussion about when social media responsibilities should be moved to someone in a different role. Consider also whether a process for approving social media crisis communications should be implemented.
3. **Inform, don't engage**. During and following a crisis, businesses will want to share relevant information with their audience and social media is a highly effective avenue. However, experienced social media users are also aware that the platforms don't often lend themselves to nuanced discussion. Details can easily be overlooked or left out. In a crisis therefore, it is important to discern when a conversation should be taken offline.
4. **Listen hard, ignore much.** What does this mean? As outlined previously, social media is an excellent tool for monitoring online conversations allowing businesses to assess sentiment and determine if there are issues that need to be addressed. However, there is also a lot of 'noise' on social media requiring the individual or team monitoring these conversations to be able to effectively sift through what is important and what is not.
5. **Protect your CEO: get them on social media.** This may seem counterintuitive given the principle about not engaging. In a crisis however, particularly serious crises, media will attempt to frame the situation and the business may fall victim to inaccurate reporting. Personal social media use during this time by the business leader(s) may be a way to counteract any inaccuracies while also displaying the human side to the business.

A vital point when considering the use of social media in crisis management is that someone on the team must be comfortable and experienced with the social media platform(s) used. A crisis is not the time to try to learn a new platform as differences exist between platforms when it comes to user demographics, style of use, and expectations.

The role of social media in crisis management continues to evolve as platforms and the public's use of social media

evolve. Businesses should regularly assess their planned use of social media as part of their crisis response plan. That said, food industry businesses should embrace social media as a vital tool for mitigating and managing crises.

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GROWING SOIL AT BRADDOCK FARM

Nick Lubecki
Grow Pittsburgh, Braddock Farm, Braddock, PA 15204

History of Braddock Farms

- Phase 1: Started in 2007 on 4/10 acre
- Phase 2: 2010 expansion brings farm to 8/10 acre total farm size
- Two high tunnels, one caterpillar tunnel and a heated greenhouse
- Roadside Farm Store and spring Plant Sale in Braddock
    - Open three days a week (Wednesday, Friday, Saturday)
    - Additional sales in: Pittsburgh Neighborhoods: Point Breeze, Homewood, and city of Wilkinsburg
- Events
    - Annual Zucchini Festival in July since 2019
    - Fall Festival in October since 2018
- Grower training and Education
    - On farm educational gardens
    - On Farm Outdoor Kitchen since 2022
    - Youth Education
        - UFIT summer program
        - Year round programming
    - Adult Education
        - On farm jobs
        - Worktrade program
        - Workshop series

Urban Soils are Brownfields

- Formally a building site
- Soil may have heavy metals or other toxins
- Site is heavily compacted
- Low water infiltration
- Low organic matter
- Soil has high percentage of rubble
- Some remaining foundations or tree stumps can conflict with farm use

Our Experience: Remediating Urban Soils

- Goals: Repair compaction, improve water infiltration, increase fertility and organic matter, remove rubble
- We use low-tech methods
    - Hand labor
    - Imported organic matter
    - Raised beds
    - Walk behind tiller
    - Cover crops
    - A lot of labor, money and Time
- Long Return on Investment interval: 3 – 5 years to productivity

Nick Lubecki oversees Braddock Farm for Grow Pittsburgh. He also co-owns Coldco Farm in Verona, PA. A native of Delaware County, PA. He lives in Pittsburgh, PA with his family.

Tools of soil remediation at Braddock Farms

- Not for profit status
  - Soil remediation is a huge job
  - Grant supported capital budget
  - Mission oriented not for profit: Low risk of going out of business while waiting for production to ramp up
  - Long term land access is key for this investment for a for-profit farm!
- Organic matter
  - Wood chips
  - Compost
  - Imported top soil
- Tillage and broad fork down to 6”
  - Breaks up compaction mechanically
  - Incorporates organic matter
- Cover cropping and irrigation supported plant growth
  - Breaks up subsoil compaction

Why Urban Farms? Its worthwhile!

- Bring Farms to where the People are
- Meet demand for fresh produce in communities
- Meet demand for local control over food system
- Education: improve garden skills and spark wonder
- Everyone deserves to know where their food comes from and connect with the natural world
- Urban farms are a community asset and green spaces
- Urban farms and farm stands are places for folks to connect

History of the Braddock Farm Soil

- Initial testing: no or low heavy metal contamination
- Heavily compacted soil with LOTS of rubble!
- Crop Yields were low to moderate for first 3 – 5 years
- **Phase 1 started in 2007: raised beds**
  - Raised bed garden
  - Wood chips in the paths
  - Drip irrigation
  - Annual application of wood chips in all aisles
  - Summer cover crops
  - Annual application of straw over entire growing area each fall, straw incorporated in the spring of the following year in lieu of cover crop

- **Phase 2 in 2010: in ground production**
  - New land. Building demo in 2009
  - Began with in ground production.
  - Farm 1 converted in 2012
  - Top dressed with a foot of compost
  - Crop aisles in wood chips
  - Twice annual tillage
  - Occasional cover crops, overwintered with fall straw application
- **Current Management Practices**
  - Annual soil nutrient test and application of amendments
  - Drip irrigation and fertigation

    - Reduced tillage
    - Over winter cover cropping with winter rye
    - Crop yields are good.
    - Challenges
- Farm soil is good in some areas. Patches of poor plant vigor remain.
- Ramping up soil biology

What we have learned

- Using low tech and human scale methods takes time!
- A not for profit can afford low productivity if it has other mission goals
- In ground production is better logistically than raised beds
- Wood chips work wonders
- Irrigation is very important
- Tillage can help repair compaction in the top 6" of top soil
- Subsoil repair takes years: cover crops and healthy plants key
    - Tractor with chisel plow is a great shortcut..

INTEGRATING COVER CROPS AND ANAEROBIC SOIL DISINFESTATION TO ENHANCE SOIL HEALTH IN AN ORGANIC TOMATO CROPPING SYSTEM

Joe Ono-Raphel[*1,2], Francisco Dini-Andreote[1,2], Gordon F. Custer[1,2], Kathleen Arrington3, Raymond Balaguer1, Jason Kaye[3], Erin Rosskopf[4], Francesco Di Gioia[1]

[1] Department of Plant Science, Pennsylvania State University, University Park, PA, USA; [2] Huck Institutes of Life Sciences, Pennsylvania State University, University Park, PA, USA; [3] Department of Ecosystem Science and Management, Pennsylvania State University, University Park, PA, USA; [4] USDA ARS, US Horticultural Research Laboratory, Fort Pierce, FL, USA.

* Presenting author

Anaerobic soil disinfestation (ASD) is a biological control strategy capable of managing several soilborne plant pathogens, plant-parasitic nematodes, and weeds across various climates and cropping systems. As an organic amendment-based approach, ASD not only controls soilborne pests and pathogens but also fosters soil health. This biological approach is employed in both high tunnels and open fields to tackle soilborne pathogens, offering an alternative to conventional soil fumigants. ASD is particularly well-suited for growers seeking to avoid the use of synthetic chemicals. The ASD process involves incorporating easily degradable organic materials into the soil. This is followed by saturating the soil with water until it reaches field capacity, and sealing it with a totally impermeable film for 3 to 4 weeks to establish an anaerobic environment. Typically, liquid and easily decomposable compounds, such as ethanol, molasses, and agricultural wastes (e.g., farm animal litter and wheat middlings), serve as carbon sources in ASD. Recently, plant residues like cover crops have proven to be affordable and easily integrated carbon sources for ASD, leading to improved soil health, reduced erosion, and the potential for enhanced crop yields.

The combination effect of the soil pores occupied with water, the impermeable plastic, and incorporated carbon sources that encourages the rapid growth and respiration of microorganisms depletes the available oxygen leading to a sharp decline in soil redox potential (a parameter indicating the level of oxygen in the soil). This depletion of oxygen induces a shift of microbial community towards facultative and obligate anaerobic microorganisms that are harmful to soilborne pests and pathogens. Predominant bacterial taxa associated with ASD-treated soils include Acidobacteria, Bacteroides, and Firmicutes which contribute to suppressing soilborne plant pests and pathogens through their physiological activities. Additionally, the re-assembly of the microbial community also contribute to sustaining the suppressive effect of ASD on soilborne pathogens throughout the cropping season. Importantly, the influence and degradability of various carbon sources in ASD are crucial factors shaping the soil microbial community and consequently the efficacy of ASD in controlling soilborne pests and pathogens. Therefore, using an organic fresh-market tomato crop as a test system, a study was conducted in central Pennsylvania to understand how cover crops combined with ASD can influence in-season dynamics of microbial community composition under conditions representative of the Northeastern region of the US.

The study was conducted in the spring of 2022 at the Penn State Russell E. Larson Agricultural Research Center and aimed to test the effectiveness of integrating cover crops characterized by different carbon to nitrogen content (C:N ratio) with ASD applied using wheat middlings as a carbon source within an organic tomato cropping system. The research carried out in central Pennsylvania, sought to evaluate the efficacy of large-scale ASD using different cover crops, such as crimson clover, triticale, and their combination, both as sole carbon sources and in conjunction with wheat middlings. Comparative analysis was performed against control plots, which included fallow conditions with and without irrigation, as well as with and without wheat middlings. Soil sampling occurred at various time points:

Joe Ono-Raphel earned his BSc in Microbiology at the University of Ibadan (Nigeria) and an MSc in Agrobiotechnology at Justus Liebig University (Germany). He is currently a second-year PhD Candidate in Plant Science and International Agriculture and Development at Penn State. Joe investigates the dynamics and role of the soil microbiome in anaerobic soil disinfestation. His academic achievements have earned him the Penn State College of Agricultural Sciences scholarships: the Frederick H. Brown Endowed Scholarship, the J. Franklin Styer Graduate Fellowship, and the James and Pamela Reese Arbuckle Scholarship. Joe is a member of the American Society for Horticultural Scientists.

day 0 (pre-ASD treatment), 2, 5, 7, 14, and 21 days after ASD treatment, and finally, 34 days post tomato-planting (equivalent to 55 days post-ASD). Molecular biology techniques, including total soil DNA extraction and 16S rRNA gene amplicon sequencing, were used to profile the soil bacterial communities in each treatment. The observed variations in bacterial communities were correlated with changes in soil redox potential, electrical conductivity, and pH during the initial ASD phase, indicating the influence of treatments on soil parameters. During this initial ASD stage, anaerobic conditions prevailed, leading to a reduction in alpha-diversity across treatments. Despite the initial decline in alpha-diversity, the study revealed a noteworthy rebound in diversity, returning to pre-treatment levels by 21 days after ASD. These findings suggest the transient nature of ASD impact on bacterial diversity, emphasizing the absence of long-lasting negative effects on soil health post-ASD. Our research contributes valuable evidence supporting the efficacy and soil-friendly nature of ASD practices, particularly in the context of cover crop variations.

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ROLE OF OM ON SOIL HEALTH AND NUTRIENT MANAGEMENT
ORGANIC MATTER, SOIL HEALTH, AND NUTRIENT MANAGEMENT

John T. Spargo
Associate Professor and Director, Agricultural Analytical Services Laboratory
Pennsylvania State University, University Park, PA 16802
jts29@psu.edu

Summary

Soil organic matter is generally recognized as the most important measure of soil health due to its strong positive influence on soil physical, chemical, and biological properties. Soil organic matter improves several soil functions including water holding capacity, soil structure, biological activity, and nutrient storage; each of these has a direct or indirect influence on soil fertility.

In coarse-textured soils, organic material bridges the gaps between sand grains, increasing water-holding capacity. In fine-textured soil, organic material helps maintain porosity by improving aggregate stability. These improvements in water holding capacity and soil structure improve soil-plant-water relations which enhance crop health and soil nutrient recovery.

Cation exchange capacity, a measure of a soils ability to retain positively charged ions (e.g., K+, Ca2+, Mg2+), is controlled by the clay and soil organic matter content; both materials supply negatively charged sites for adsorption of cations. On a mass basis, soil organic matter has much higher cation exchange capacity than clay. For example, the cation exchange capacity of soil organic matter is in the range of 100 to 300 meq/100 g, while the cation exchange capacity of common soil clay minerals is in the range of 10 to 100 meq/100 g. In coarse-textured soils, soil organic matter can account for the majority of the cation exchange capacity.

Soil organic matter also serves as an important source of essential plant nutrients. In cultivated soils, soil organic matter contains approximately 95% of the soil's supply of nitrogen, 80% of its sulfur, and 50% of its phosphorus. It is also an important soil pool of several micronutrients including boron and molybdenum. Soil organic matter supplies nutrients through the process of mineralization — the decomposition of organic compounds by microbial action into carbon dioxide and mineral constituents. Soil microbes are most active in warm soils (over 70°F) that are moist, but well aerated, with a pH between 6 and 7. Mineralization under these conditions occurs quickly.

The optimal range of soil organic matter for vegetable production or soil health varies across soil types. Native soil organic matter content of most mineral soils in the mid-Atlantic is typically in the range of 2 to 5%. Several factors control the amount of soil organic matter contained in soil, including soil texture, drainage, and climate. Well-drained, coarse textured soils naturally tend to have lower levels of soil organic matter; due, in part, to the rapid microbial decomposition rates favored by these soil conditions. In fact, it is difficult to maintain high levels of soil organic matter in coarse textured soils without drastic, and sometimes unsustainable, measures. Finer textured mineral soils will support higher levels of soil organic matter, but in our climate the upper limit of natural soil organic matter levels is generally around 5%. Higher levels can be achieved, but typically require significant inputs of compost and/or animal manure.

While our focus tends to be on the total quantity of soil organic matter, it is also important to consider its quality. Soil organic matter includes both active and stable fractions. The active fraction consists of root and microbial exudates as well as the fragmented remains of plant and animal residues in various stages of decomposition. The stable frac-

Dr. Spargo is Associate Professor and Director of the Pennsylvania State University Agricultural Analytical Services Laboratory. John has conducted applied research on soil fertility diagnostics and nutrient management of organic and sustainable cropping systems for over a decade. John received his B.S. in Agronomy from Texas A&M-Commerce (2002) and his Ph.D. in Soil Science from Virginia Tech (2008).

tion is principally humified soil organic matter or simply, soil humus. Each of these fractions, or types of soil organic matter plays a unique role in soil fertility. The active fraction is most important to nutrient turnover while humus contributes more to soil cation exchange capacity. As the name implies, the active fraction decomposes rapidly and typically makes up only 5 to 10% of the total soil organic matter. Management practices tend to have the largest impact on the active fraction of soil organic matter and can either enrich or deplete this critical pool of soil nutrients.

Soil organic matter is in a constant state of flux — additions and losses occur simultaneously. To maintain soil organic matter levels, additions and losses must be equal and to increase soil organic matter, additions must be greater than losses. Managing optimal soil organic matter involves reducing the rate of loss or increasing the rate of additions.

Soil organic matter can be lost by both wind and water erosion; however, the primary loss mechanism for soil organic matter is microbial decomposition. Soil microbes use soil organic matter as a source of energy, converting it into carbon dioxide and mineral elements. The rate of microbial decomposition of soil organic matter is controlled by a number of factors including: soil temperature, moisture, aeration (oxygen), and the quality or characteristics of the soil organic matter. Soil management can have a strong influence on the rate of decomposition. For example, aggressive tillage and cultivation increases aeration and destroys the soil aggregates that protect soil organic matter from microbial decomposition. Reducing tillage and cultivation is an effective management strategy to maintain, or even increase, soil organic matter content.

There are a number of ways to increase or maintain soil organic matter. Increasing the quantity of plant residues returned to the soil is one of the most sustainable methods of maintaining or increasing soil organic matter. Most vegetables leave little residue in the field and soil organic matter will usually decrease without addition inputs. Adding cover crops to the rotation can add significant amounts of biomass, but this generally just maintains levels of soil organic matter; it is difficult to increase soil organic matter with most cover crops. To increase soil organic matter, sod forming crops should be included in the rotation. Another more rapid and direct method of increasing soil organic matter is the application of organic amendments, such as compost. While the application of organic amendments is among the most effective methods of rapidly increasing soil organic matter, the implications for nutrient management and environmental quality must be considered. Over application of manure or compost can lead to excessive nitrogen and phosphorous in soil which can create problems with plant nutrition and pollute ground and surface waters.

Despite the low soil organic matter levels of many productive soils in the mid-Atlantic region, soil organic matter is an important component for improved water holding capacity, soil structure, and soil fertility. Soil organic matter is dynamic, with constant gains and losses. Producers can improve soil organic matter levels by reducing tillage, using crop rotations that include sod, planting cover crops, and the judicious use of compost and animal manure.

SOIL HEALTH FOR BERRY CROPS

Marvin Pritts, School of Integrative Plant Science, Horticulture Section
Cornell University, Ithaca, NY 14853

Farmers and researchers are learning that physical and biological characteristics of the soil are major contributors to plant performance, along with the chemical component that has received the most attention in the past. This integrated approach to assessing soils is termed "soil health." While the important role of physical and biological components on overall soil health is intuitive and has long been understood by organic farmers and those desiring to achieve more sustainable production, only recently have methods been developed to quantify the biological components of the soil. The reasoning of soil health practitioners is that cultural practices that positively enhance measurements of biological soil health should then also benefit berry productivity.

Berry growers face many difficulties in maintaining healthy fields. In addition to stress from cold and damp weather, soils may contain pathogens that can affect roots that are exposed to suboptimal conditions. Often pathogen levels are low that they are not detected or expressed in healthy plantings. High organic matter content (OM) is thought to help sustain biological soil activity by facilitating growth of beneficial organisms that compete and suppress pathogenic organisms. A large and diverse soil microbial community also is essential for nutrient cycling. Soil C and N are first immobilized in microbes then slowly released once the microorganisms are decomposed, freeing these nutrients in a plant-available form. Therefore, even though plants exude C from their roots, organic C pools in soil are important not only to increase the cation exchange capacity of the soil, but also for N cycling. Some microbes are also able to fix N2 gas from the air, providing another source of plant available N. The presence of microorganisms in the soil also increases soil aggregation through bacterial mucigel and fungal hyphae. Aggregation improves water infiltration, aeration, and reduces erosion. Without soil C these important microbial populations would decline.

Practices that detract from soil health: failure to rotate, repeated fumigation, repeated tillage, excessive driving of equipment over the field especially when the field is wet, overuse of preemergent herbicides, and poor fertility.

In the Northeast, most strawberries are grown using the matted row production system. Straw is used to protect the strawberry plants over winter, then in the spring, the straw is raked between the rows and incorporated. This straw is useful for suppressing weeds, improving water retention and decreasing fruit rot. In addition, strawberry fields are cultivated regularly since herbicides labeled for use are few. Cultivating for weeds is recommended up to every 10-14 days in new plantings. In this perennial production system, soils is cultivated frequently, straw is applied as mulch (recommendations range from 2-5 tons/acre/season), and is then incorporated into the soil over time. Straw contains high levels of C, which should fuel the biological health of the soil over the long term. However, repeated cultivation can be detrimental to soil health so a grower must balance cultivation, herbicide use, and weed pressure to find a balance so that soil health is not negatively impacted.

Seven strawberry fields in NY were given the Cornell Soil Health Test (CSHT, http://soilhealth.cals.cornell.edu/) and soil biological measurements from the CSHT were generally low. On a relative scale of 0-100, most tested biological indicators scored below 26. The CSHT measures soil biological activity with an OM test, an active carbon test, a potentially mineralizable nitrogen (PMN) test, and a root health rating. These tests indicate microbial abundance and root health in the soil. Therefore it was somewhat surprising that strawberry fields tested low for traditional indicators of soil health, particularly since large amounts of straw – a form of organic matter - are added each year.

Several cultural practices are known to impact soil health such as preplant cover cropping, composting, mulching and tillage practices. For example, in one study on strawberry, mulch significantly increased microbial biomass nitrogen (N) and carbon (C), soil extractable N, net N mineralization, and soil microbial respiration compared to bare soil – all of which should benefit berry plant growth. However, the quality of the mulch affected the amount of soil improvement. High C:N ratio mulch (such as straw) additions leads to N immobilization. Organic material with less than 15-17 g N/kg dry weight can temporarily immobilize soluble N, but annual applications of organic matter containing less than 10 g N/kg dry weight can enhance soluble N availability over long periods of time as it decomposes. The rate of mulch decomposition affects the longevity of the change in soil properties after mulching. Wood chips can sometimes immobilize N, damage crops when they are applied, and release leachates that are allelopathic to certain crops, but not all types of wood chips have that effect. Soil can compound an effect as soil mulched for the

Marvin P. Pritts is the berry crop specialist for Cornell University with an appointment in extension, research and teaching. He works primarily with production, season extension, and pest management systems in strawberries, raspberries, blackberries, and blueberries and has consulted with berry farmers throughout the world.

first time does not have a microbiome adapted to organic matter (OM) decomposition and therefore mulch decomposes more slowly than on a soil that is regularly mulched.

Berry fields are frequently tilled, first to break up the soil before planting, then to manage weeds. Tillage and cultivation practices have been found to increase runoff, decrease macro- and micro-porosity, form plow pans, and cause soil organic carbon (SOC) loss over time. Tilling exposes pockets of soil OM that can then be mineralized, causing a flush of plant available C and N in the short term. Microorganisms are stressed after the disturbance and may be unable to assimilate the nutrients effectively, so often C and N are leached away. Switching to a reduced-till system can increase soil and particulate OM. Limited compaction in the absence of pathogens can be tolerated by berry plants, but compaction in the presence of pathogens is detrimental.

In a mulched system such as strawberries and blueberries, the physical separation of the soil and the mulch slows decomposition, but tilling mixes the soil and OM together, making the OM more accessible to microorganisms in the soil. Consequently, the microorganisms can break the OM more easily. This leads to faster litter decomposition in tilled systems than untilled systems. Therefore, long-term substrate use efficiency is higher in systems with litter left on the soil surface than incorporated litter due partially to slower breakdown of litter.

In some situations with strawberry, long-term additions of straw have been shown to gradually improve soil productivity due to soil structure properties changes such as increased aggregation, water retention, and N supplying power. Large additions of straw to strawberry fields should therefore demonstrate these improvements. However, the biological indicators of the CSHT scored low in our study, highlighting a disconnect between expected outcomes and test results. It is possible that the detrimental effects of tilling offset the positive effects of organic matter addition in some cases.

In blueberries, fertilization reduces the amount of endomycorrhizal colonization of roots by fungi. Blueberry soils with the proper pH and high levels of organic matter often can supply sufficient phosphorus for good growth without adding P in the form of fertilizer, which reduces colonization.

Life beneath the surface is very complex and this not surprising considering that tens of thousands of species of microorganisms can be present in just a teaspoon of soil. There are a number of processes and interactions occurring there that make generalizations difficult. The table below summarizes what we think we know about organic matter and composts in relation to strawberry plant performance and soil health. And it demonstrates why conclusive generalized statements about cultural practices are difficult to make.

Practice	**Expected response**	**Conditional response**
Cover cropping prior to planting	Increased soil organic matter and weed suppression	Certain cover crops can harbor dis-eases and nematodes that can transfer to strawberry plants. Some cover crops can become weeds in strawberry fields if not managed properly.
Compost incorporation prior to planting	Enhanced microbiological activity and increased water-holding capacity; decreased pathogen activity through competition.	May hold too much water and cre-ate conditions favorable for disease. May increase salt content of the soil.
Straw mulch incorporation	Enhanced soil biological activity and improved soil structure.	Strawberry plants may not perform well with preplant straw mulch in-corporation.
Tillage	Reduced weed pressure followed by quick release of nitrogen and active carbon from organic matter pools.	Nitrogen flush is short-lived and pools are eventually depleted. Soil structure can deteriorate and compaction increase under too much tillage.
Organic matter incorporation	Enhanced microbiological activity and increased water-holding capacity.	Soil may not contain the microorgan-isms at a sufficiently high level to rapidly decompose the organic matter, thereby tying up nitrogen and inhibiting crop growth particu-larly if the C:N ratio of the OM is high.
Soil health testing	Identifies indicators that are low and suggests cultural practices to improve those indicators.	Indicators developed for field crops may not be good indicators for per-ennial strawberries.

PRACTICAL USES OF COVER CROPS IN STRAWBERRY ROTATIONS PANEL DISCUSSION ON COVER CROPS FOR STRAWBERRY FIELDS

Not too long ago a grower told me that if you would like to know how to grow something, just ask someone who has done it for a year. The problem we are having is that we have grown strawberries on the same farm for 45 years. The difficulties seem to compile and when we think we have gotten ahead of one problem, a new one replaces it. So, the type of crops we grow in the fields between strawberry plantings has become even more important.

The goal is to break the cycle of soil diseases and insects, add organic matter to the soil, and suppress weeds. In the fields which will be replanted to strawberries, we try to avoid things like potatoes, tomatoes, peppers, or other crops which might host things like verticillium. Cereal rye over winter is almost always part of the rotation in years between strawberries because it is used for straw for mulching the berries. One thing we are working hard at is getting a dense stand of rye to allow little room for the winter annuals to get established. That begins with using at least 3 bushels of rye seed per acre and compost for good soil nutrition.

We have grown a number of things in the season preceding planting of strawberries. They have included mustard which was incorporated as a bio-fumigant and red clover for supplying nitrogen. The clover did not seem to help with soil disease issues and the last time we did that the strawberries did not do well although there may have been other issues. Currently, we are using the Sorghum- Sudan grass hybrids and adding cow peas to the mix for some nitrogen fixation. This is planted after harvesting the rye straw in late May. The Sorghum-Sudan was mowed in late summer to keep it from becoming too tall and allowed to regrow. We also did not want the cow peas to go to seed. This is not a problem with the Sudan grass hybrid because the seeds are sterile. In the fall, when it was killed by frost and became brittle, the field was disk harrowed to start the breakdown of the residue. We have tried no-till planting of strawberries into flattened Sudan grass to prevent erosion since the ground is bare for a long time after planting berries. This year the plan is to chisel plow and then lightly rototill.

One word of caution with using Sorghum Sudan grass is that it takes up a good amount of potassium and seems to retain it until broken down. We noticed this first when we followed the Sudan grass hybrid with Tomatoes and had persistent green shoulder: a symptom of potassium deficiency. This fall I took soil samples in the field to be planted in the spring and divided them in half. The top 4" went into one sample and the lower 4" went into another sample. It was evident that in this field which has not been moldboard plowed for perhaps 25 years, that there was a higher level of K closer to the surface. So, in order to try to get the strawberry plants to have deeper roots we hope for two things. One is that the deeply rooted Sorghum Sudan grass creates channels in the soil which we do not want to destroy and the second is to mix the potassium into the soil.

AUTOMATED DRIP IRRIGATION FOR PEPPER AND TOMATOES IRRIGATION AUTOMATION/TECHNOLOGY

Harlene Hatterman-Valenti, Ivymary Goodspeed, Sai Sri Sravya Vishnumolakala, and Xinhua Jia
Plant Sciences and Ag Biosystem Engineering, North Dakota State University
h.hatterman.valenti@ndsu.edu
Xinhua.jia@ndsu.edu

The use of high tunnels in specialty crop production has continually increased in the U.S., attributable to benefits such as extension of the growing season, yield amplification, enhanced crop quality, mitigation of risks associated with erratic weather, potential to reduce the dependency on crop insurance, and assurance of an economic advantage. Recent climatic changes, characterized by intensified soil erosion, enhanced pest and disease threats, and impacted specific growth requirements and yields of specialty crops due to their specific growth requirements and by affecting flowering and pollination have further increased the need for high tunnels. However, despite the growing popularity of high tunnels and other protected environment techniques, they come with their set of challenges. These include labor-intensive practices, complex pest management, and the need for precise irrigation to optimize crop growth and ensure sustainability.

The use of drip irrigation is prevalent in protected environments due to its high efficiency and suitability in controlled settings. Among the various irrigation methods, drip irrigation is the most efficient method, with efficiency surpassing 90%. In addition, drip irrigation provides minimal deep percolation losses, reduced soil evaporation, lower labor requirements, decreased incidence of leaf-related diseases, enhanced crop yield and quality, and the elimination of runoff, which all result in greater economic benefits. However, drip irrigation also has challenges such as high initial cost, requirement of good water quality, potential risk for salt accumulation near the edges of the wetting zone, and the need for skilled labor for operation and maintenance. Since the system is designed to deliver water at a minimal rate directly to the root zone, accurate irrigation scheduling is critical because even minor scheduling errors can significantly impact the system's efficacy and the associated benefits.

Irrigation scheduling plays a crucial role in optimizing water application by incorporating the application timing and amount applied, based on soil moisture levels or plant water consumption. The traditional irrigation scheduling methods are primarily based on intuitive soil water assessments and evapotranspiration (ET). However, a more scientific approach to irrigation scheduling considers variables like ET, soil conditions, and crop stages to make informed and data-driven irrigation decisions. Recent studies in North Dakota by Dr. Jia and her colleagues have focused on evaluating actual crop ET and reference crop ET, complemented by insights into crop coefficients. Such findings are central to understanding crop water requirements and when integrated with soil moisture, can further improve irrigation accuracy. These scientific approaches and technology have become the foundation of modern irrigation practices. The emergence of decision support systems, smartphone apps, and web-based software have been transformative in offering irrigation recommendations, especially for vegetable crops.

In the precisely calibrated high tunnel environment, conventional methods for irrigation scheduling rely on crop water consumption (or ET) estimations may not work. In contrast, the use of smart irrigation controllers, which depend on real-time weather data or soil moisture sensor (SMS) readings, offers both ease of use and dependability. Over the past two decades, this approach has been increasingly recognized as a crucial tool for water conservation by the US EPA and USDA NRCS. Smart irrigation practices have become either mandatory or incentivized in various US states. Using an SMS controller, they can save an average of 15,058 gallons of water annually for a household. If SMS controllers were to replace time-based controllers in residential irrigation systems across the U.S., a savings

Harlene Hatterman-Valenti is a Professor, Assistant Head, and High-value Crops Specialist in the Plant Sciences Department at North Dakota State University. Harlene joined NDSU in September 2000 and has 85/15% research/teaching responsibilities. She has sponsored three visiting scientists, trained two post-docs, three PhD, 30 MS students and currently has five PhD and nine MS students in her program. To date, Harlene has published 73 peer-reviewed manuscripts, authored/co-authored three book chapters, published 252 scientific abstracts/proceedings, authored/co-authored 42 extension publications, and published 287 research reports. Since joining NDSU, she has given 280 extension presentations.

of more than 3.9 trillion gallons of water could occur each year. In controlled settings like high tunnels, where SMS-driven controllers work the best, they have outperformed their ET-based and time-based counterparts, yielding water conservation efficiencies between 22-75%. Additionally, when integrated with Wi-Fi, these SMS controllers can be remotely managed without acquiring extra costs, allowing for real-time monitoring and adjustments to irrigation schedules from any location. While the principle behind SMS controllers appears straightforward, their efficacy can be hindered by human errors, such as incorrect installation, mis-programming, and a lack of user education.

Determining the optimal irrigation threshold is key for the effective use of SMS-controllers. This value fluctuates based on soil and crop types, as well as the specific controller in use. Recent research has showcased the utility of an SMS-controller in autonomously managed drip irrigation system for tomatoes and watermelons in eastern North Dakota, and how to determine an irrigation threshold. This threshold can either act as a directive for halting irrigation, irrespective of the pre-established irrigation timeframe or the threshold can be the trigger to administer water for a predetermined duration. While SMS-based automatic irrigation technology is primed for application in high tunnels, there's a need to calibrate parameters to determine irrigation thresholds that are specific to the specific soil and crop types within the high tunnels. This calibration allows for the division of the planting areas into distinct zones, facilitating precise irrigation scheduling tailored to the predominant crops in each high tunnel. Most controllers can manage 8 to 16 zones or even more, yet they rely on a singular soil moisture sensor to initiate irrigation. Thus, we have been conducting this research under various conditions to ensure their compatibility with unique soil and crop combinations, in order to enhance the precision and efficiency of irrigation in high tunnels.

The most recent example of this research was when we evaluated the growth, yield, and fruit quality of eight paste tomato cultivars and eight bell pepper cultivars under three irrigation schedules in the field and high tunnel at the Horticulture Research Farm near Absaraka, ND. The three irrigation schedules were: 1) 30% management allowable depletion (MAD), 10% MAD, and a time-based irrigation practice. The eight tomato cultivars were: 1) Amish Paste, 2) Big Mama, 3) Cauralina, 4) Gladiator, 5) Granadero, 6) Pozzano, 7) San Marzano, 8) Super Sauce. The eight bell pepper cultivars were: 1) Classic, 2) Early Sun, 3) Intruder, 4) King Arthur, 5) Ninja, 6) Olympus, 7) Orange Blaze, 8) X3R Red.

Seeds were germinated in a greenhouse approximately six weeks prior to transplanting. Plants in the high tunnel were started four weeks earlier than the field plants so that transplants were approximately the same size when transplanted into raised beds covered with black plastic and when there was less than a 10% chance of a late spring frost. Land preparation and fertilization were identical in the high tunnel and field and according to extension recommendations. Each environment was arranged as a split plot design with three replications. Data obtained was analyzed using PROC MIXED in SAS and appropriate means separated using LSD at $\alpha = 0.05$. Environments could not be statistically compared due to lack of replication. In the 2022 growing season, the tomato mosaic virus infected primarily the field tomato cultivars, where all plants were removed due to the infection except on cultivar.

Yield results for 2022 are presented graphically in Figures 1-3. Results for 2023 are still being analyzed at this time and will be presented at a future meeting. In 2022, high tunnel grown 'Intruder', 'Olympus', and 'Orange Blaze' had the highest yield under the 30% MAD irrigation treatment. 'Early Sun', 'King Arthur', and 'X3R Red' had the highest yield under the time-based irrigation treatment (Fig. 1). 'Classic' and 'Ninja' had similar yields under MAD and time-based irrigation. Field grown 'Early Sun' and 'King Arthur' had the highest yield under the 30% MAD irrigation treatment (Fig. 2). 'Classic', 'Intruder', 'Ninja', 'Olympus', 'Orange Blaze' and 'X3R Red' similar yields under MAD and time-based irrigation. High tunnel 'Super Sauce' had higher yields than any other cultivar when plants were grown under 10% or 30% MAD irrigation (Fig. 3). 'Cauralina', 'Gladiator', and 'Pozanno' had higher yields under timed-based irrigation. 'Amish Paste', 'Big Mama', 'Granadero', and 'San Marzano' had similar yields under MAD and timed-based irrigation.

Water use efficiency is the other critical factor in optimizing crop production, particularly in controlled environments such as high tunnels. It is a measure of how effectively plants utilize water to produce biomass or yield. It is typically expressed as the ratio of the amount of biomass or yield produced per unit of water consumed. For cultivat-

ing tomatoes and peppers inside the high tunnels, the integration of automatic irrigation controllers plays a pivotal role in enhancing water use efficiency. These controllers enable precise and automated management of irrigation schedules, ensuring that plants receive the right amount of water at the right time. The water use efficiency of tomatoes and peppers inside the high tunnel is very high when compared to the outside field in the year 2022. The results were shown graphically in figures 4 and 5.

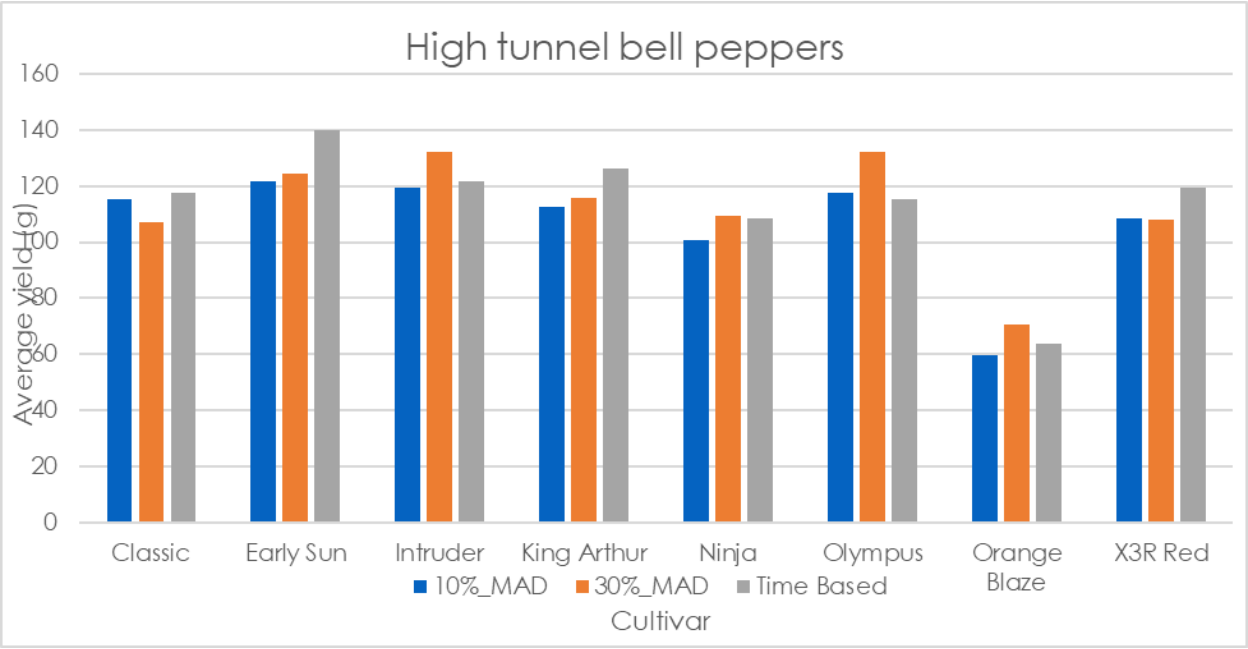

Figure 1. Influence of bell pepper cultivar and irrigation treatment on high tunnel yield in 2022 at the Horticulture Research Farm near Absaraka, ND.

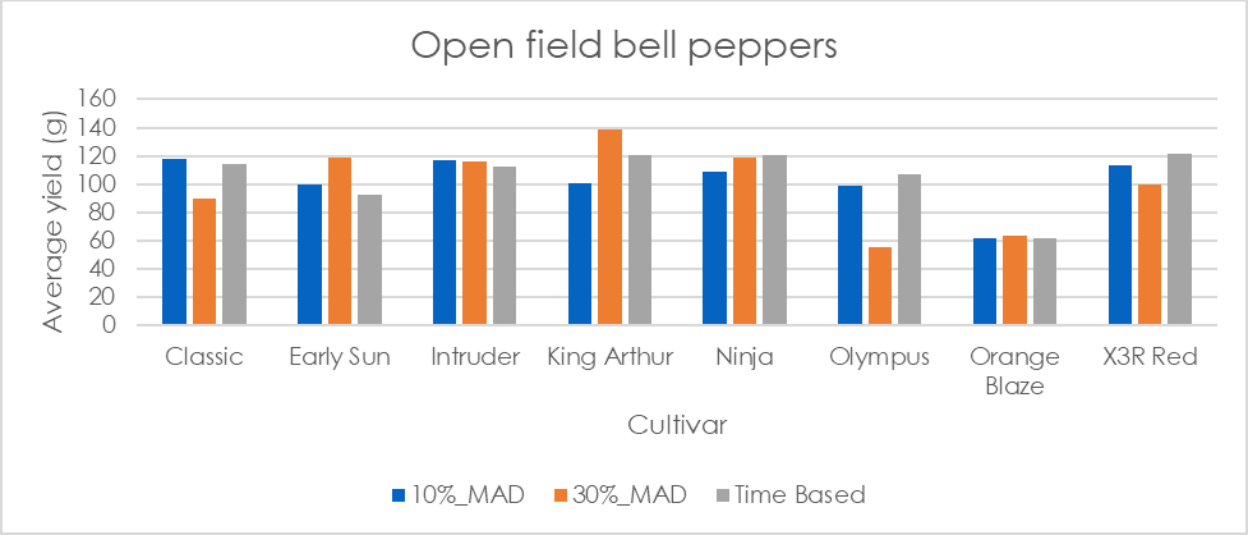

Figure 2. Influence of bell pepper cultivar and irrigation treatment on open field yield in 2022 at the Horticulture Research Farm near Absaraka, ND.

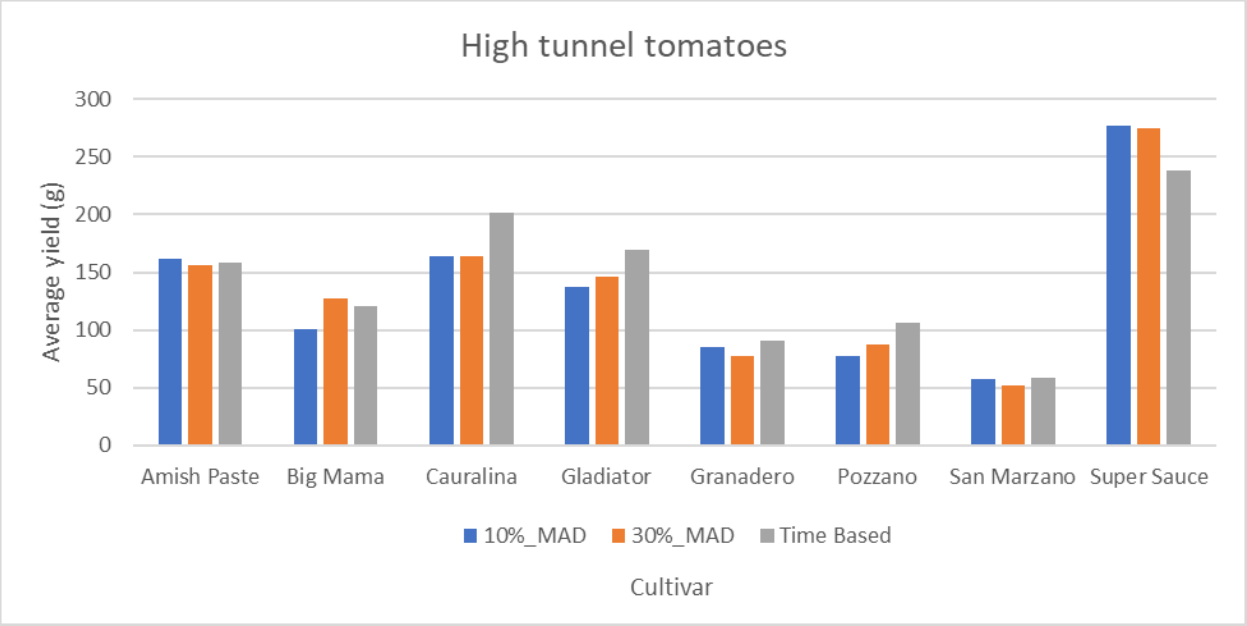

Figure 3. Influence of paste tomato cultivar and irrigation treatment on high tunnel yield in 2022 at the Horticulture Research Farm near Absaraka, ND

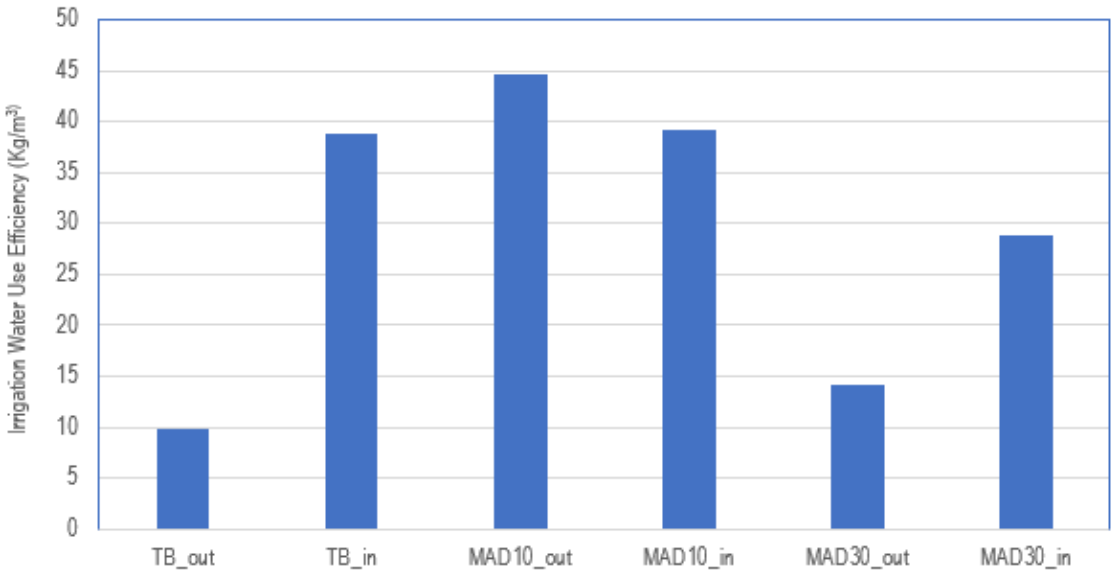

Figure 4. Bell pepper irrigation water use efficiency inside the high tunnel and outside the field in 2022 for time-based (TB), management allowable depletion (MAD) at 10%, and 30%. The yield was adjusted based on the number of green pepper plants harvested.

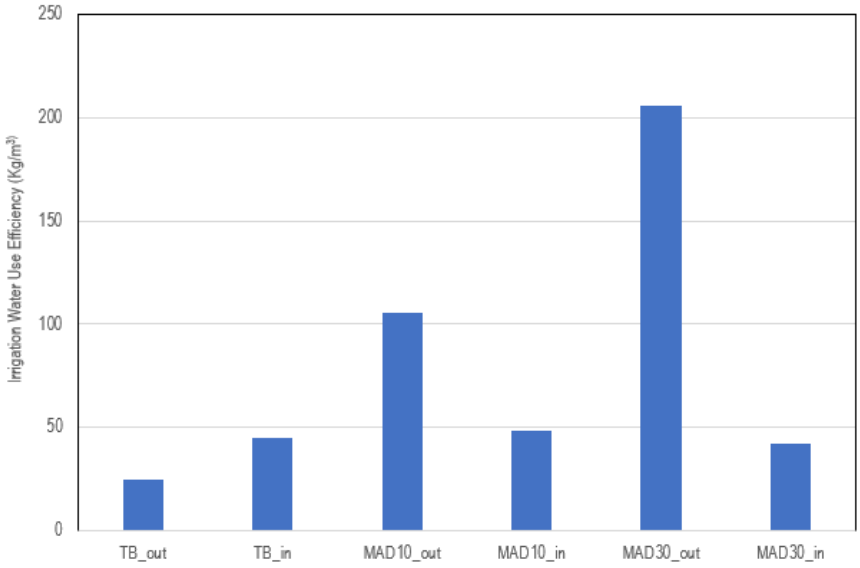

Figure 5. Tomato irrigation water use efficiency of tomatoes inside the high tunnel and outside the field in 2022 for time-based (TB), management allowable depletion (MAD) at 10%, and 30%. The yield was adjusted based on the number of tomato plants harvested.

USING PHOTO-SELECTIVE COVERING FILMS TO IMPROVE GREEN AND PURPLE BASIL YIELD AND QUALITY AND MANAGE DOWNY MILDEW

Francesco Di Gioia, Fritzner Pierre, Matthew Cooper, Myungjin Lee, and Kathleen Demchak
Department of Plant Science, Pennsylvania State University

High tunnels are becoming increasingly popular as a crop protection technology for the opportunity they offer to improve the cultivation environment, extend the growing season, potentially expand the variety of crops grown, and improve crop yield and quality. While high tunnels are considered a passive crop protection technology, the structural design and the covering material used play a key role in determining the microenvironmental conditions within the high tunnel, which in turn affect crop yield and quality performance and can also favor or limit the occurrence and severity of pests and pathogens.

Covering films are a sort of filter regulating the entry of solar radiation and determining which component (wavelengths) of the solar radiation is transmitted (passing through), absorbed, or reflected. The covering film can also determine how the transmitted radiation is distributed within the high tunnel environment and on the plants, having various levels of light diffusion. All these properties contribute to determine the amount and quality of the radiation level within the high tunnel and influence temperature and humidity levels, and all these factors contribute to determine the crop performance. Typically, high tunnels are covered with clear polyethylene films, but not all polyethylene films are the same. Recent advancements have led to the development of alternative covering films with particular properties, such as films capable of diffusing light and films with selective spectral properties, capable of selectively transmitting or excluding specific fractions of the solar radiation such as ultraviolet (UV) radiation or near infrared radiation.

Light diffusive films (films that scatter the radiation in multiple directions) tend to slightly reduce the transmittance of the fraction of solar radiation actively used by plants (photosynthetically active radiation, PAR), which corresponds to the visible radiation (400 – 700 nm range), but at the same time improves the light distribution within the high tunnel environment, penetrating more the crop canopy. Compared to direct sunlight, with diffuse light, portions of the crop vegetation typically shaded can be exposed to radiation, and the more uniform light distribution within the plant canopy can improve the crop radiation use efficiency. In fact, the photosynthetic activity of shaded leaves, typically limited by light availability, is rapidly increased with relatively small increases of the exposure to radiation. However, if light diffusive films are beneficial or not for our crop is determined by several factors, including the type of crop and the specific environmental conditions, which may also vary with the season. For these reasons, the effect of radiation diffusive films cannot be guessed and should be evaluated under various conditions.

Another interesting category of radiation selective (photo-selective) covering films, are those capable of regulating the transmittance of ultraviolet (UV) radiation, which include UV-transparent and UV-opaque (UV-blocking) films. UV-transmitting films allow most of the UV radiation to go through and reach the plants. Instead, UV-opaque films can limit or exclude the transmission of UV radiation. The UV radiation represents an essential component of sunlight and is classified in three subcategories based on the wavelength and energy range: 1) UV-A (320-400 nm), 2) UV-B (280-320 nm), and 3) UV-C (below 280 nm) radiation. Lower is the wavelength of the radiation measured in nanometer (nm) higher is the level of energy. Most of the UV radiation reaching the Earth's surface is UV-A radiation, while nearly all of the UV-C radiation and about 95% of the UV-B radiation is absorbed by the Earth's stratospheric ozone layer. Although the UV radiation or most of it is not considered relevant for the photosynthesis of the plants (is not considered part of the PAR), UV-A and the UV-B fraction reaching the Earth's surface affects several physiological processes of the plants, the plant growth and morphology and the production of secondary metabolites. The transmittance or blocking of the UV radiation can also affect the presence and activity of insects (beneficial and not) and the incidence and severity of plant pathogens.

A better understanding of how covering films characterized by different light diffusion levels or different UV-light transmission properties can affect microenvironmental conditions and crop yield and quality performance under environmental conditions typical of Pennsylvania is needed to provide solid recommendations and support high tunnel growers in the selection of the best covering film.

We hypothesized that different spectra-selective polyethylene covering films (light diffusive or not, UV transparent or UV opaque) would have different effects on the high tunnel microenvironmental conditions (radiation spectrum, tem-

perature, relative humidity), which in turn may affect the plant physiology, yield, and nutritional quality of fresh herbs such as basil.

To this purpose, a study was conducted at the Penn State High Tunnel Research Facility aimed to evaluate yield, physiological, and nutritional quality response of soilless-grown green 'Genovese Compact Improved' and purple 'Amethyst Improved' basil (Ocimum basilicum L.) to high-tunnel cultivation under alternative covering films characterized by different levels of light diffusion and transparency to UV radiation. Twelve research-size (17-ft × 36-ft) galvanized metal frame Gothic style high tunnels (Ledgewood Farms, Moultonboro, NH) were used for the study. Their fixed wood frame end walls were covered with the same covering materials used for the top and sides of the high tunnels. The tunnels were vented manually with roll-up sides opened to a maximum height of 1.2 m above the baseboard. The high tunnels were covered with four different polyethylene 6-mil films: TuffLite IV® (TIV; Berry Global, Inc., Evansville, IN), KoolLite® Plus (KLP; RKW Hyplast NV, Hoogstraten, Belgium), and two experimental films custom-manufactured that varied in their transparency to ultraviolet (UV) light, a UV transparent film (UVT) and a UV opaque (UVO) film (BPI-Visqueen, Stevenston, UK, subsequently available through Lightworks Poly, Lancashire, UK). TIV is a clear (non-diffusing) plastic covering marketed as having high levels of transmission of UV, visible, and IR wavelengths, while KLP is marketed as a diffusing "bee-friendly" plastic due to blocking mainly in the UV-A range. Both are commonly used by growers in the region. UVT and UVO are diffusing plastics different from each other in UV transmission. Treatments were arranged according to a split-plot experimental design with three replications.

Air temperature and solar radiation inside and outside the high tunnel were monitored over the entire growing period to evaluate the effect of the treatment on the microenvironmental conditions. Plant growth biometric assessments were conducted at 42 and 78 days after planting. Plant tissue samples collected at the 1st harvest were analyzed for their mineral profile (N, P, K, Ca, Mg, S, Na, Fe, Zn, Mn, B, Cu, Mo) and for their content of phytonutrients (chlorophyll, carotenoids, phenolics content, and antioxidant activity). At the 2nd harvest, basil downy mildew (Peronospora belbahrii) was observed, and a visual assessment was conducted to assess the severity of the foliar disease the day before the 2nd harvest by estimating the percentage of leaf area affected by the disease as an indication of severity.

The plastic covering film had a significant effect on the growth of both basil cultivars, with a significant interaction between the film and basil genotype. Green basil generally exhibited higher fresh yield and dry biomass compared to purple basil, and the film effect varied with basil genotype. Leaf area, stem, leaf, and total plant biomass were influenced by the plastic cover, with UVO and UVT films resulting in higher biomass production. The plastic covering films showed varying effects on the mineral content, total chlorophyll, carotenoids, total phenolic compounds, and antioxidant activity, with UVO and UVT films often resulting in improved nutritional quality compared to traditional films. Covering films also influenced the downy mildew severity on both cultivars and the UVT film consistently limited the severity of the foliar disease in both genotypes. Overall, this study highlights the importance of selecting appropriate plastic covering films and suggest that UV transparent films may enhance basil production and quality in high tunnel production systems.

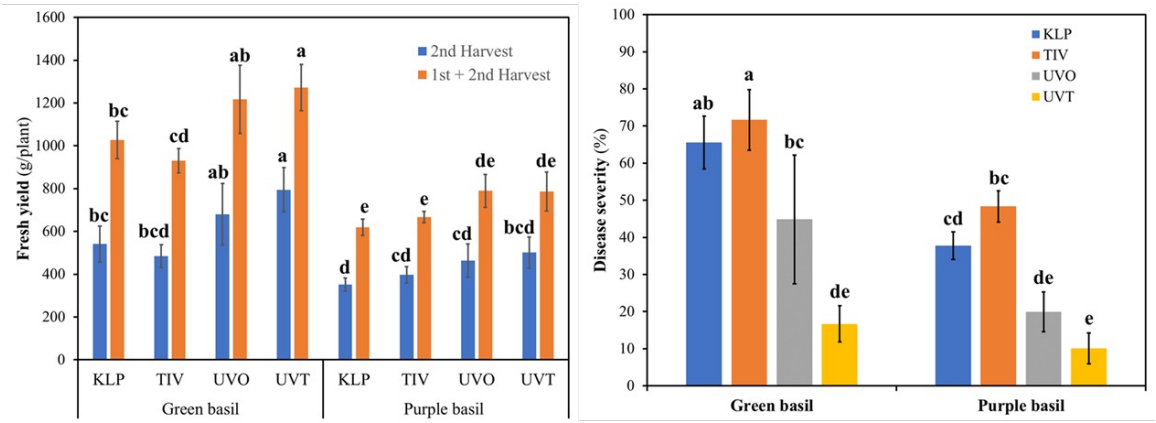

Figure 1. Effect of alternative high tunnel plastic covering films on green and purple basil fresh yield at the 2nd and 1st+2nd harvest and on downy mildew severity. Vertical bars indicate average values and standard error (n=3). Different letters indicate means that differ at the 5% level of significance by SLICEDIFF in GLIMMIX. KLP: KoolLite Plus; TIV: Tufflite IV; UVO: ultraviolet opaque; UVT: ultraviolet transparent.

CORN EARWORM IPM
UPDATE ON CORN EARWORM MANAGEMENT IN SWEET CORN

Thomas P. Kuhar1 Brian Currin1, and Hélène B. Doughty2
1Virginia Tech Dept. of Entomology, 170 Drillfield Drive, Blacksburg, VA 24061-0319 2Eastern Shore AREC, 33446 Research Drive, Painter, VA 23420
tkuhar@vt.edu; briancurrin@vt.edu
hdoughty@vt.edu

Of the many pests that can be found attacking corn, the 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. 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. Once eggs hatch on corn silks; the tiny neonate larvae quickly make their way into the ear where they are protected against future insecticide sprays and most predators. Most commercial sweet corn growers apply insecticides frequently from 1st silking to harvest (~ 3 to 8 sprays) and/or plant Bt transgenic sweet corn hybrids to protect their crop from CEW. Managing this pest has become a greater challenge in recent years because of higher overwintering survival of pupae further north than decades before, as well as insecticide resistance development to both pyrethroids and the Bt Cry toxins found in many of the Bt transgenic corn and cotton hybrids. In this talk, we summarize three experiments conducted in Virginia to help improve IPM of CEW in sweet corn.

Experiment 1. Using CEW moth catch data to guide spray intervals

One strategy to reduce the amount of insecticides applied to sweet corn is to monitor pest population levels and spray based on action thresholds. Because direct sampling for eggs and larvae of CEW during silking is not practical because of the short lead time and low tolerance levels of ear damage and because large numbers of plants or ears would have to be sampled to avoid estimation errors in decision making, this method is not used. Instead, the scheduling of insecticide applications during silking is based primarily on action thresholds of moth numbers caught in either blacklight or pheromone traps. The Scentry Heliothis mesh trap baited with a Hercon CEW pheromone lure has become the standard used by most producers. Although action thresholds may vary among states, silk spray decisions in the northeast are generally based on the following decision-making chart (Table 1).

Table 1. **Action thresholds** and insecticide spray intervals during silking based on pheromone trap catch of CEW moths using the Scentry nylon mesh trap and Hercon *Heliocoverpa zea* lure.

Average number of CEW moths captured per trap			Recommended control action or days between sprays
per day	per 5 days	per week	
less than 0.2	less than 1	less than 1.4	spray at green silk then reassess
0.2 - 0.5	1 - 2.5	1.4 - 3.5	6
0.5 - 1	2.5 - 5	3.5 - 7	5
1 - 13	5 - 65	7 - 91	4
>13	>65	>91	3

In 2017 and again in 2023, we conducted experiments at two locations in Virginia, Painter on the Eastern Shore (high CEW pest pressure) and Whitethorne in the southwestern portion of the state (moderate pest pressure). The experiment was conducted a total of 7 times. Sweet corn fields were arranged in randomized complete blocks with four replications of three treatments: 1. no insecticide control; 2. IPM; 3. regular insecticide applications every 2-3 days through reproductive development of the corn (6-7 sprays). The IPM treatment included an initial spray of Coragen at first silking, then subsequent sprays only if trap catches of CEW moths exceeded the threshold (Table 1). For the conventional spray treatment 3, lambda-cyhalothrin was sprayed every 2-3 days at the high rate through silking (6 sprays) in 2017. In 2023, we modified the insecticides to better match grower standards. The IPM treatment received Vantacor (low rate) at 1st silking, then a rotation with Radiant SC (spinetoram) only if trap catches of CEW moths exceeded the threshold. For the conventional spray treatment 3, bifenthrin was alternated with Besiege and sprayed every 2-3 days at the high rate through silking (6 sprays) in 2023. The addition of Beseige was due to pyrethroid resistance development in CEW populations.

Results

Overall, and in each experiment, the IPM treatment based on CEW trap catch performed as well as the conventional sprays applied every 2-3 days (Table 2). These two treatments averaged about 80% clean ears, which was significantly higher than the untreated control (<14% clean ears). However, the IPM treatments required an average of about 2.3 less spray applications per field (Table 2).

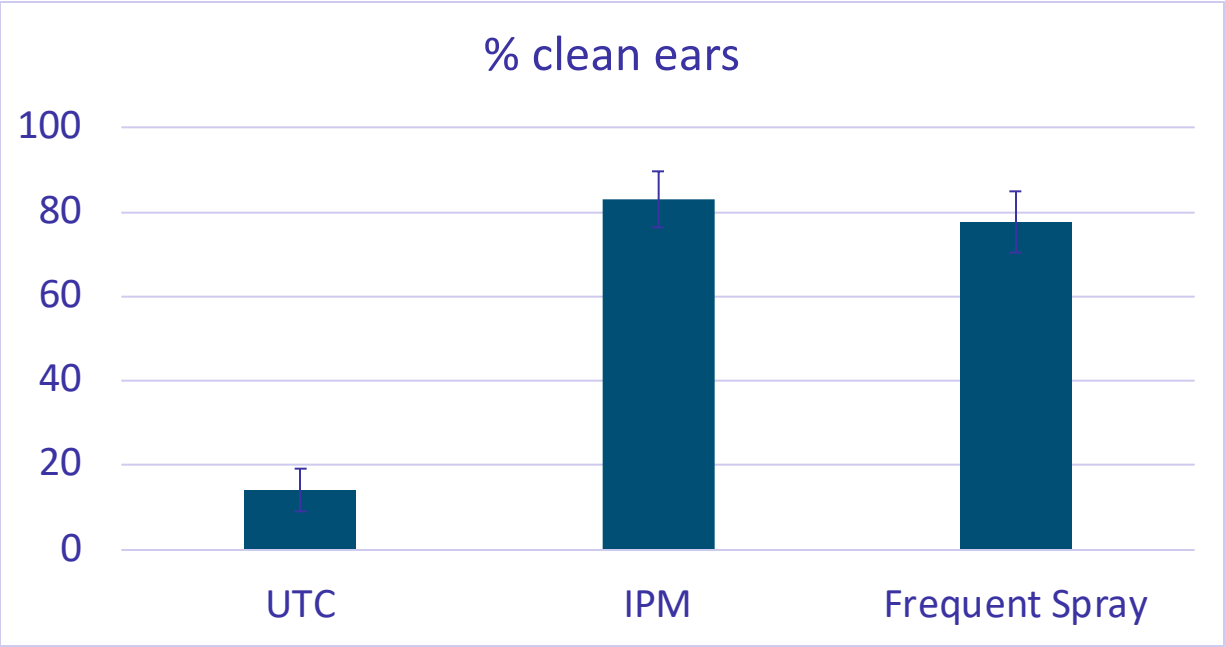

Table 2. Summary of 7 experiments conducted in either 2017 or 2023 in both Painter and Whitethorne, VA comparing an IPM strategy against no insecticide applications and routine insecticides applied every 2-3 days through silking. The IPM strategy included a first-silking application of the IPM-compatible insecticide chlorantraniliprole, then subsequent sprays of that or spinetoram (in 2023) only if pheromone trap catches of CEW moths exceeded threshold.

Experiment 2. Evaluating which insecticides work the best

Pyrethroid insecticides have been the tool of choice for CEW control for decades because they are relatively cheap and effective. 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 (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 2023, we conducted an insecticide efficacy trial at the Virginia Tech Homefield Farm in Whitethorne, VA. The experiment was arranged in a randomized complete block with four replications and 2-row by 20 ft plots. Insecticides were applied with a CO2-powered backpack sprayer equipped with a single nozzle boom directed at the ear-zone. All sprays were initiated at first silking and repeated every 2-3 days. Insecticide treatments included the following products labeled for sweet corn:

- Lannate LV (methomyl) – older carbamate insecticide
- Bifenthrin 2EC (standard pyrethroid)
- Shenzi 400 (34.2% chlorantraniliprole) * New insecticide similar to Coragen or Vantacor
- Besiege (9.3% chlorantraniliprole + 4.6% lambda-cyhalothrin)

All four insecticides doubled the % of clean ears compared with the untreated control (Table 3). Lannate LV performed extremely well despite being an older insecticide (carbamate). Although pyrethroid resistance is a problem with CEW in some areas, bifenthrin still provided very good efficacy in this trial, and actually slightly outperformed Besiege. The new diamide Shenzi, which has the same active ingredient as Coragen but at a much higher concentration, also performed well. Among the four insecticides, Shenzi is the safest and most IPM- and pollinator-compatible. It may not be the cheapest however. A rotation amongst the aforementioned products should be considered for resistance management.

Table 3. Efficacy of insecticides for the control of corn earworm in sweet corn (sprayed 7 times every 2-3 days), Whitethorne, VA, 2023.

Treatment (rate fl oz/A)	% clean ears	# CEW larvae per 25 ears
Untreated Check	42.6 b	8.5 a
Lannate LV (24)	93.6 a	0.8 b
Bifenthrin 2EC (4.8)	87.8 a	1.5 b
Shenzi 400 (1.7)	89.1 a	2.0 b
Besiege (6)	80.0 a	1.8 b

Experiment 3. Evaluating reduced risk insecticides paired with Bt sweet corn

Transgenic sweet corn producing Cry and Vip3Aa toxins derived from Bacillus thuringiensis (Bt) is widely planted in the United States to control CEW as well as other lepidopteran pests (Dively et al. 2016). In recent years, CEW has developed widespread resistance to three of the Bt Cry toxins Cry1Ab, Cry2Ab2, Cry1A.105 (Dively et al. 2016, 2021, 2023). While the Cry toxins no longer effectively kill CEW larvae, their larval development is often impeded particularly with the Cry1A.105 + Cry2Ab2 hybrids and sometimes higher numbers of small larvae may be found infesting Bt sweet corn ears versus non-Bt ears in field trials (Dively et al. 2023). This is the result of small larvae progressing normally to later instars in the non-Bt corn, but not in the Bt corn. Prolonging the development time of the early instars (small larvae) could make them more susceptible to certain insecticides that have not necessarily performed well against CEW (Little et al. 2017). Two such insecticides are the biological-based: 1. Helicoverpa zea Nuclear polyhedrosis virus (HzNPV), which is found in the products (Heligen, AgBitech and Gemstar, Certis USA); and 2. the peptide toxin GS-omega/kappa-Hxtx-Hv1a (Spear-Lep (Vestaron). The objective of this experiment was to assess the efficacy of these two biological-based insecticides, Heligen and Spear-Lep at controlling CEW in both Bt (Cry1A.105 + Cry2Ab2) and non-Bt sweet corn. The protocol, location, and timing for this experiment was the same as described in the previous trial (Experiment 2).

Results.

- Based on the mixed model ANOVA, there were no significant interactions between Bt corn treatment and insecticide on any of the variables measured. Thus, the main effects of Bt corn and insecticide application could be derived from the model.
- The main effect of Bt corn was significant with the Obession II sweet corn having less total kernel damage and fewer large CEW larvae compared with the non-Bt Providence.
- There was no main effect of insecticide treatment on damage or CEW larvae, which suggests that these two insecticides provided no benefit over the use of Bt corn alone.

Table 4. Percentage clean ears, kernel damage, and numbers of corn earworm larvae in non-Bt and Bt sweet corn treated with three different insecticides (six applications) Whitethorne, VA 2023

			Mean per 15 harvested ears		
Corn variety	Insecticide	% clean ears	Kernel damage (cm2)	No. small CEW larvae	No. large CEW larvae
Non-Bt (Providence)	None	25.0	87.5	2.5	6.5
Bt (Obsession II)	None	48.3	31.3	3.5	4.0
Non-Bt (Providence)	Heligen (2.5 fl oz/A)	15.0	103.5	2.0	9.0
Bt (Obsession II)	Heligen (2.5 fl oz/A)	16.7	46.8	5.8	7.0
Non-Bt (Providence)	Spear-Lep (32 fl oz/A)	18.3	99.3	1.5	9.8
Bt (Obsession II)	Spear-Lep (32 fl oz/A)	30.0	44.3	6.0	5.5

All data were analyzed using a mixed model 2-way ANOVA analysis of variance procedures

Table 5. Main effects of Bt

		Mean per 15 harvested ears		
Effect	% clean ears	Kernel damage (cm2)	No. small CEW larvae	No. large CEW larvae
Non-Bt (Providence)	19.4	96.8*	2.0	8.4*
Bt (Obsession II)	31.7	40.8	5.1*	5.5
P-value from Mixed model	0.2223 NS	0.0001	0.0219	0.0079

Table 6. Main effects of insecticide

		Mean per 15 harvested ears		
Effect	% clean ears	Kernel damage (cm2)	No. small CEW larvae	No. large CEW larvae
None	36.7	59.4	3.0	5.3
Spear-Lep	15.8	72.1	3.9	8.0
Heligen	24.2	71.8	3.8	7.6
P-value from Mixed model	NS	NS	NS	NS

New SCRI grant funded– "Addressing evolving corn earworm management challenges in sweet corn grown in the Eastern US

Kelly Hamby (Univ. MD), Michael Crossley (Univ. DE), Galen Dively (Univ. MD), James MacDonald (Univ. MD), Christophe Duplais (Cornell Univ.), Brian Nault (Cornell Univ.), Deb Grantham (NE IPM Center), Anders Huseth (NCSU), Thomas Kuhar (Virginia Tech), Anna Wallingford (USDA-ARS), Analena Bruce (Univ. NH), Dan Gilrein (Cornell Coop. Ext.), Jared Dyer (Cornell Coop. Ext.), Claris Jones (NCSU), Ross Meetenmeyer (NCSU), David Owens (Univ. DE), Joe LaForest (Southern IPM Center)

With some new funding from the USDA-NIFA Specialty Crop Research Initiative, we look forward to further researching CEW management in sweet corn in the eastern U.S.

Goals and Objectives. This project aims to improve our knowledge of CEW spatiotemporal population patterns, delivering risk maps and models that help to anticipate and avoid crop loss, and that look to future changes in population dynamics due to climate and resistance. We will develop best practices for monitoring, dynamic thresholds, and effective management programs that mitigate impacts to natural enemies and pollinators. Economic analyses, on-farm research and demonstrations, collaborations with stakeholders, and Extension efforts will ensure solutions are implementable and scalable in eastern U.S. sweet corn production systems (fresh market, processing, conventional, and organic). We will solicit feedback from the advisory panel and other stakeholders throughout the project to evaluate project deliverables and impact.

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CONDUCTING A SITE ASSESSMENT BEFORE A PESTICIDE APPLICATION

Jamie Kopco, Penn State Pesticide Education

Pesticides are used to manage a wide variety of pests and can be beneficial when applied to the right target at the right time. However, pesticides can also cause major problems if they work their way into groundwater, surface water, blossoms worked by pollinators, or contact other non-target organisms. One of the best ways to avoid these problems is to avoid applying pesticides in areas most vulnerable to contamination, which requires an analysis of the application site and surrounding areas. We will discuss some key things to consider, including how to read soil maps, soil types, geological features that access groundwater, and restrictions you may see on pesticide labels that should be considered when assessing an area prior to a pesticide application.

Jamie double-majored in Entomology and Natural Resources at Cornell University (BSc) and studied Entomology at North Dakota State University (PhD). He worked as an entomologist and pest manager in hydroponic greenhouses at Walt Disney World and built expertise in structural pest management by serving as technical director for Guardian Pest Solutions. Jamie also has professional teaching experiences ranging from merit badge counselor at a Boy Scout camp to Conservation Educator at Disney's Animal Kingdom to earning a college teaching certificate at North Dakota State University. Jamie is currently a Pesticide Education Specialist at Penn State University and a medical entomologist in the US Army Reserves. Jamie's combination of conservation and pest management experiences help him to maintain a balanced, science-based perspective on pesticides.

FOLIAR APPLICATIONS - HOW ARE THEY TAKEN UP IN THE PLANT?
FOLIAR APPLICATIONS, HOW ARE THEY TAKEN UP INTO THE PLANT?

Steve Bogash, NE TSM, ProFarm Group

Applying foliar nutrients to supplement soil / root applied nutrients has become common practice for many growers. Being sure that these treatments are effective and safe for plants is very important as phytotoxic reactions or an apparent lack of efficacy are commonplace among growers. We'll discuss what we know about foliar applications and how to make them safer and more effective.

The movement of nutrients into leaves from a foliar application is a passive process so is very distinct from how plants pull nutrients in through their roots. There are two primary variables that determine how effective an application will be: 1) the nutrient concentration gradient between the leaf surface and that of the leaf interior. and 2) Leaf surface permeability.

If the concentration of nutrients is high in the epidermal cells, then few nutrients will move across the barrier as the cuticle and epidermal leaf structure helps to protect plants and has little permeability. Only through tissue testing or sap testing can growers determine what their plants need. If nutrients cannot move across the barrier, then they will accumulate on plant surfaces which can increase the chances of phytotoxic reactions. This explains why we often use very low concentrations of nutrients in application equipment.

Most foliar application suggestions include 'Spray to completely wet, but not to the point of runoff'. This is to keep from increasing concentrations on lower leaves and leaf tips from accumulated nutrient salts. It's not unusual to see leaf margins with scorch from accumulated nutrients. In outdoor conditions, rainwater will generally keep nutrient salts from building on leaves, but indoors this can be more challenging to avoid.

There are two likely pathways for nutrients to move into leaves: 1) through aqueous cuticular pores, and 2) through stomata. We'll discuss these pathways in depth as particle size, chemistry, and leaf wetness / relative humidity all impact this flow.

In general, smaller particles such nano-particles and chelates have an easier time moving into leaves. As this flow is passive in nature, the combination of particle size, adjuvant, concentration, and relative humidity all impact successful foliar nutrient applications.

Steve retired as a Horticulture Educator and Researcher, PSU Cooperative Extension in June 2016. Since retiring, Steve joined Marrone Bio Innovations (now ProFarm Group) as their NE / Mid-Atlantic Product Development and Territory Business Manager. He now oversees university and private research company product trials and on-farm demos in the NE. "One of the most exciting things about this stage of my life and career is helping to usher in this next wave of safe, effective, biological pest management products". Steve is burnishing his wood working skills as he prepares for retirement as he plans to build small boats and smell like sawdust much more often.

MANAGING MITES, WORMS, AND STINK BUGS

David Owens, Extension Specialist Entomology
University of Delaware Carvel REC, 16483 County Seat Highway, Georgetown DE 19947, (302) 698-712
owensd@udel.edu;

As a general rule, sucking pests tend to be flared up by pesticide use and be frustrating to make recommendations for management. Mites are no exception. Fungicide use suppresses pathogens that might otherwise keep spider mites in check. High fertilizer use and heavy fruit load stress make the plant more susceptible to mites, and overuse of broad-spectrum insecticides further limit beneficial arthropod activity. This session will focus on spider mites but include a few general comments on other significant arthropod pests of tomato.

Two spotted spider mites are major pests of tomato, especially, but not limited to high tunnel production. Mites often start building up once plants begin flowering and fruiting when the plants are diverting energy towards reproduction. Thresholds developed in North Carolina are 2-4 mites per upper canopy leaflet, but aggregated hot spots can occur and either require spot treatment or border applications. Scouting should focus on field edges, near in-field obstacles, or the edge closest to other early season, mite-susceptible crops such as strawberry. Infested fields can also become a source of infestation for other fields nearby on the same farm by mites hitching rides on persons or equipment.

During periods of hot dry weather, spider mite feeding and reproduction increases, sometimes resulting in more than a 10x increase per week. Miticide efficacy can be a challenge during such conditions, and miticides vary as to what life stage they target, residual control, whether they are translaminar or surface contact materials, and their impact on beneficials. In open field settings, one of the most important factors to reduce mite outbreaks is to decrease broad spectrum insecticides.

The biological control agent, Phytoseiulus persimilis, has some promise for spider mite management. Purchasing them can be expensive however, and it may take several weeks (3-5) for them to establish and begin controlling spider mites. Thus, if they are to be used, they need to be deployed early and care needs to be taken to select miticides or other pesticides that are compatible with them. The University of Delaware two spotted spider mite fact sheet is a helpful information source on spider mite biology, management, and predatory mites: https://www.udel.edu/academics/colleges/canr/cooperative-extension/fact-sheets/two-spotted-spider-mite/.

Two major pests to contend with that could also complicate mite management are stink bugs and corn earworm. There are several species of stink bug that affect tomatoes. Among the pyrethroids, bifenthrin is the best material for brown and brown marmorated stink bug but pyrethroids will impact spider mite management. The neonicotinoid dinotefuran is another potential stink bug management tool. Stink bug scouting should be done from green fruit to harvest. Stink bugs tend to be most severe in June, July and early August. By mid-August, corn earworm becomes the most important threat to tomatoes. There are multiple good, IPM-friendly materials currently and soon to be available for corn earworm.

Two other mites worth mentioning are russet mites and broad mites. These tend to be high tunnel pests. Symptoms can be easily confused with nutrient deficiency and includes bronzing, leaf dessication and deformation, and fruit russeting/abortion. Broad mites tend to feed in the upper canopy while russet mites tend to start near the base of the plant. Sulfur, abamectin, Oberon, and Portal are effective miticides. Greenhouse or high tunnel sanitation and host free periods is important to limit all mite species activity and prevent them from carrying over into a new planting.

David Owens is the University of Delaware's Agricultural Entomology Extension Specialist located at the Carvel Research and Education Center in Georgetown. Starting in 2017, he has been providing extension education and support for Delaware field and vegetable crops. He conducts pest surveys and IPM and efficacy trials in sweet corn, watermelon, cole crops, legumes, small grains, soybean, and sorghum. In-season updates and recommendations are primarily delivered through the UD Weekly Crop Update. He received his bachelor's and master's degree from Virginia Tech and his doctorate from University of Florida and worked as a postdoc with USDA-ARS in Florida working with avocado pests and at NC State working with tomato pest management. He and his wife, Beth, have two children, Hazel (7) and Jack (5) and keep bees.

AN INTEGRATED APPROACH OF EXPANDING URBAN AGRICULTURE TO ADVANCE FOOD SYSTEMS FOR URBAN AND SUBURBAN COMMUNITY

BENEFITS OF URBAN AGRICULTURE TO ADVANCE FOOD SYSTEMS FOR URBAN AND SUBURBAN COMMUNITIES

Dr. Kefeni Kejela,
Resource Soil Scientist and Urban Agriculture Conservationist
United States Department of Agriculture, Natural Resources Conservation Services.
1415 N Broad St, Philadelphia, PA 19122

BACKGROUND HISTORY OF URBAN AGRICULTURE.

Urban agriculture has a long history, dating back to at least 3,500 B.C. (according to the American Society of Landscape Architects' (ASLA). Some of the first evidence of urban agriculture comes from Mesopotamia, where farmers would set aside small plots of land for farming within the city's walls. In Persia's semi-desert towns, oases were fed through aqueducts carrying mountain water to support intensive food production, nurtured by wastes from the communities. Recent history dates back to British and European allotment gardens of the 19th century. Victory gardens were also a staple of World War II-era cityscapes.

The idea of supplemental food production beyond rural farming operations and distant imports is not new to United States as well. It was used during war and depression times when food shortage issues arose, as well as during times of relative abundance. In 1893, citizens of a depression-struck Detroit were asked to use vacant lots to grow vegetables.

Urban agriculture is the cultivation, processing, and distribution of agricultural products in urban and suburban areas which includes Community gardens, rooftop farms, hydroponic, aeroponic and aquaponic facilities. It also encompasses gardening in backyards, schools, public right-of-way, boulevards, vertical gardening; keeping micro livestock such as hens, rabbits, and bees; greenhouses; permaculture design in parks; edible landscaping; public orchards or food forests; and agricultural parks. It is an industry located within (intra urban) or on the fringe (peri-urban) of a town, a city, or a metropolis, which grows and raises, processes, and distributes a diversity of food and non-food products, reusing largely human and material resources, products and services found in and around that urban area. Urban agriculture is often part of the role of municipal planning departments.

IMPORTANCE OF URBAN AGRICULTURE

Urban Agriculture is the ability to secure a stable and accessible supply of food for a global population of 9.7 billion by 2050, whilst limiting contributions to climate change and conserving the world's limited water, land, and energy resources, is one of the most pressing and complex challenges facing the world today (FAO 2015; UN Department of Economic and Social Affairs 2019). At global level, an estimated 2 and 14 % of the world population lived in cities in 1800 and in 1900, respectively. Projections indicate that by 2025, 55% of the world population will live in the urban centers, and this percentage will rise up to 60 and 70 % in 2030 and 2050, respectively. By 2050, global population is projected to increase to around 9.8 billion. It's estimated that more than twice as many people in the world will be living in urban (6.7 billion) than in rural settings (3.1 billion) (UN Population Division, 2017). More than half of the

Dr Kefeni Kejela has served as Senior Soil Scientist in the Ministry of Agriculture - Ethiopia for over 12 years (1984 – 1996) conducting soil and water conservation research program and provided training for State and Federal Conservation Planners on soil Conservation and soil health management. From 2003 up to 2020, Dr Kejela served as Resource Soil Scientist, Soil Conservationist in different offices at different capacity and from 2020 up to 2023 as Urban Conservationist.
As Soil Health Cadre, Dr. Kejela provided soil health training for Federal, State and Local Conservation employees for the last 10 years. Currently, he is working with Urban Farmers in Philadelphia, Reading, Allentown, York, Harrisburg, Chester, Montgomery and Bucks counties on USDA program delivery and Urban Soils testing.
He is a winner of USDA/NRCS Individual National Civil Rights Award of 2022 for significant contribution to USDA/NRCS in civil rights program delivery for demonstrating honesty, integrity, impartiality, objectivity, unity, and diversity in his everyday working with customers including Mennonite farmers, limited resource or beginning urban farmers in Philadelphia and Pittsburgh, and traditional corn/soybean producers in Pennsylvania. From 2022 up to now, he works as Resource Soil Scientist and Urban Conservationist in Philadelphia NRCS, Urban Agriculture Office assisting Urban Farmers in Philadelphia and other cities in PA in Program delivery as well as provides Training and Outreach activities and Urban Soil Testing for Urban Producers.
Dr. Kejela holds a Ph.D. in Environmental Science from Oklahoma State University, USA, and MSc (honors degree) in Soil Science from Krasnodar Institute of Tropical and Subtropical Agriculture, former Soviet Union, and MSc in Resource Assessment for Development Planning from the University of East Anglia (England) United Kingdom. He is the author of a book entitled "Heavy Metal Leaching in different Environments, 2010.
Dr Kejela is originally from Ethiopia. He lives with his wife and two children, son, and daughter.

world population now lives in cities.

According to the USDA, 1 in 7 Americans suffers from food insecurity, including at least 6 million children. In addition, some neighborhoods in the United States, particularly those in low-income urban areas have been dubbed "food apartheids" because residents do not live near food retailers that carry affordable and nutritious food. Undeniably with land resources becoming more limited, extreme weather events occur more. frequently, and pandemics like COVID 19, disruption has occurred within the food supply chain. Urban farming can help reduce the food insecurities caused by the present-day environment. Current estimates suggest 15 percent of the world's food is grown in urban areas. The fast growth of urban agriculture comes with many advantages, including less worry about unpredictable weather conditions and seasonality. Supporting the organic trend is easier to facilitate with the control environment of an urban setting. Urban farming can conserve space, taking up 1/10th of conventional farm space and provide a shorter supply chain because of the local nature. Currently, urban Agriculture is an expanding industry in the United States, where it has grown by 30 % in the past 30 years. 79 % of Pennsylvania's population live in Urban areas.

The urbanization process goes along with increasing urban poverty and polluted environment. Many North American cities have obesogenic built environments that allow for access to low-quality, energy - dense food and little opportunity for active living. This is particularly evident in lower-income neighborhoods and results in growing health inequities that have resulted in the consumption of more processed food and simple carbohydrates, and fewer vegetables and fruits. Urban Agriculture has the power to increase local food production and to address the hunger and food apartheid, biodiversity loss, soil degradation, waste, and climate crisis. We can build the 21st – century local food system if we redistribute and invest long term resources to build sustainable infrastructure for agriculture in the city. Urban agriculture represents an opportunity for improving food supply, health conditions, local economy, social integration, and environmental sustainability altogether. Urban dwellers ranging 25–30 % are involved worldwide in the agro-food sector. Urban agriculture will gain recognition for its benefits and services because urban population and rural–urban migration is increasing. In light of Population increase, urban agriculture (UA) has emerged as one approach to contribute to local food security by increasing the availability and accessibility of fresh and healthy produce in food insecure areas in cities (FAO 2007). Urban agriculture is a means to improve community health and reduce health inequities. It encourages civic participation in food system governance and offers citizens opportunities to explore concepts of food sovereignty within an urban setting. The Strategy is to engage civic participation in developing an urban agriculture action plan for city and to identify the short- and long-term goals and the barriers and facilitators to growing more food in the city. Benefits to advance Integrated Urban Agriculture include:

1. URBAN AGRICULTURE AND PUBLIC/COMMUNITY ENGAGEMENT

Urban Agriculture Activities encourage public participation in food system governance and offer citizens opportunities to explore concepts of food sovereignty within an urban setting. Food sovereignty refers to a process of expanding democracy to regenerate local, autonomous, healthy, and ecologically sound food systems that respect the rights of people to decent working conditions and incomes. Urban agriculture provides opportunities for citizens to participate directly in their food system, while gaining a sense of power and control that can improve health. Urban Agriculture also described as a means for cultural preservation and crime prevention that contributes to public engagement in urban settings. Urban Agriculture also creates an environment that will contribute to a community-based food system, builds resilience against an unpredictable climate future, and benefits the local population through greater vegetable and fruit production. Public engagement is part of Community development that brings people together and building connections, and bridging available resources with the people who need them. Actionable items include connecting gardeners with unused gardening space, including links to local urban agriculture organizations on the city creating city-supported resources to help citizens begin urban agriculture projects, and expanding backyard gardening programs.

2. JOB OPPORTUNITIES: In areas where poverty and hunger are prevalent, urban farming can help address these issues in two ways: providing food and creating jobs. People working and volunteering at urban farms or running their own small farming operations develop marketable skills they might not have otherwise gotten. Urban agriculture is a growing industry that has the potential to create employment opportunities.

3. URBAN AGRICULTURE AND PUBLIC EDUCATION

Public education in urban agriculture provides public training on different types of urban agriculture and edible native plants to make it culturally acceptable to grow food. Urban Agriculture and Gardening Education helps local Urban Agriculture communities to expand academic and community gardening and farming skills, understanding of food systems and healthy eating, connection to nature, awareness of local problems, social food justice, leadership, teamwork, public speaking, and other aspects of positive youth development of sustainable farming techniques that improves Urban Agricultural production.

4. ENVIRONMENTAL BENEFITS OF URBA AGRICULTURE

Integrated approaches of Urban farming offer numerous environmental benefits that contribute to overall sustainability.

Reduction of Food Miles and Carbon emissions.

By promoting a more local production of the food we eat, urban farming can contribute greatly to the reduction of greenhouse gases. Indeed, a large part of the fruits and vegetables we consume has to travel long distances before arriving in our plates, which induce great amounts of pollution. By growing vegetables directly in cities, the distance between production and consumers is reduced and thus diminishes the greenhouses gas emitted through the transportation of food. Moreover, like their green fellows, vegetable plants act as air filters and sequester carbon and other polluting gases, which contributes to the improvement of ambient air in cities.

Mitigation of urban heat island effect.

Urban areas often suffer from the "heat island" effect, where the concentration of buildings and human activity can cause the city to be significantly warmer than surrounding rural areas. The green spaces created by urban farms can help to cool these areas down by absorbing heat and releasing oxygen, reducing the overall heat island effect.

Promotion of Biodiversity.

Urban farms can serve as sanctuaries for local wildlife and promote biodiversity. By offering habitats for various pollinators like bees, butterflies, and birds, they support local ecosystems. This biodiversity is important for ecosystem health and resilience.

Use of Native Plants.

Urban farming often involves the use of native plants, which are adapted to local conditions and require less care and resources compared to non-native species. This not only helps in reducing the use of resources but also supports local biodiversity and ecosystem health.

Reduction in Chemical use.

Organic urban farming practices minimize or eliminate the use of harmful synthetic fertilizers, pesticides, and herbicides. This results in fewer harmful chemicals entering our waterways and soil, and less exposure for people and wildlife, leading to a healthier environment.

Soil Erosion Prevention and Soil Health Improvement.

Urban Farming can prevent soil erosion in certain areas, which can be a common problem in cities. The practice of composting in urban farms also contributes to soil health by recycling organic waste into nutrient-rich soil, enhancing its productivity and fertility as well as from soil contamination with heavy metals such as Lead, Arsenic, chrome, Nickel, and cobalt by applying best management practices such as raised seedbeds.

Water Conservation.
Many Urban Farming techniques, such as vertical farming and hydroponics, use significantly less (up to 95%) water than traditional farming methods. By using water more efficiently, these methods contribute to conservation efforts in areas where water may be scarce.

Waste Reduction and Recycling.
Urban farming promotes the recycling of organic waste into compost, which is then used to enrich the soil. This practice reduces the amount of waste going to landfills, cuts greenhouse gas emissions, and creates a circular system where waste is turned into a valuable resource.

5. URBAN AGRICULTURE AND FOOD SYSTEM TRANSFORMATION

The deployment of urban agriculture initiatives enables the development of local, sustainable, and resilient food systems. **Urban Agriculture (UA) plays an important role in sustainable food systems** through a diverse array of potential benefits. Although Urban Agriculture is unlikely to provide most of the world's food, food systems that include some production in urban areas may help achieve society's health, economic, and conservation goals.

Transformation Framework includes Building a more resilient food supply chain that provides more and better market options for consumers and producers while reducing carbon pollution, creating a fairer food system that combats market dominance and helps producers and consumers gain more power in the marketplace by creating new, more, and better local market options and making nutritious food more accessible and affordable for consumers. By transforming unused and underutilized spaces into urban farms, we are transforming the landscape of our cities and giving it an edible value to pave the way to food self-sufficiency.

USDA/NRCS ROLES IN BUILDING LONG – TERM SUPPORT FOR URBAN AGRICULTURE INITIATIVES INTO THE CITY'S INFRASTRUCTURE, POLICIES AND PROGRAMS.

There are 13 Counties in Pennsylvania selected for urban agriculture to increase local food production, markets, and community gardens, and thus prioritize these locations, when possible, for NRCS assistance to Provide centralized support for growers, and coordinate with City agencies and partners to implement the plan and track progress.These counties are, Philadelphia, Chester, Buck, Montgomery, Delaware, Fayette, Washington, Westmoreland, Allegheny, Beaver, Butler, Armstrong, and Pike. USDA/NRCS also established an Office of Urban Agriculture in Philadelphia (Natural Resources Conservation Service and Farm Service Agency) to have the opportunity to assist private landowners with urban Agriculture to implement best management practices in urban areas in Pennsylvania for funding for High Tunnel, Cover crops, alley cropping, composting facility, field boarder, pollinator Habitats, Rain Harvest Barrel (Water Storage Tank) / Roof and Gutters, , Drip Irrigation, Raise Bed, & Soil Test as well as provides funding for programs such as Peoples Gardens Initiatives that support collaboration, education, and diversification of food networks in urban areas. Soil Health in urban areas focus on soil quality (including problems with urban debris, concrete and construction materials and trash), compaction, drainage, and contamination from previous land uses. Frequently, soil testing is needed in urban areas and testing for heavy metals is particularly important. Heavy metals can be transferred or absorbed by plants and food grown in soil that contain them. NRCS well equipped to help with soil issues in urban agriculture areas. Pennsylvania NRCS started using the PXRF (Portable X – Ray Florescence) in situ soils testing technology tool to assist urban agriculture producers in testing heavy metals. NRCS/FSA Philadelphia Urban Office also assists urban producers in:

- Providing centralized support for growers, and coordinate with City agencies and partners to implement the plan and track progress.
- Developing resources (e.g., guides, tools, and funding) to support community gardens and farms incorporating universal design techniques into their spaces to ensure that they are inclusive and accessible to people of all abilities.
- Increasing awareness of existing city and state Urban Agriculture programs and explore new programs to support gardeners & farmers with access to free or reduced cost resources for physical improvement.

- Developing a long-term Roadmap to explore safe and appropriate indoor gardening techniques such as hydroponic, aquaponics, use of available spaces like rooftops, balconies, and vacant lots, vertical farming, adapting crops to climate, space, and consumer demand. Common crops include leafy greens, herbs, microgreens, root vegetables, bell peppers, and fast-growing fruits like tomatoes and strawberries. It can be practiced at different scales, from individual households to community gardens, schools, and commercial enterprises.

CONCLUSIONS: Urban Agriculture (UA) has the potential to contribute to local food security by increasing the availability and access to fresh and healthy produce. In the future, the ability of cities to produce at least a portion of their own food supply will become important as climate change-driven natural disasters are expected to increase in frequency and severity, thus affecting the global supply chain. Urban agriculture is one way to promote sustainable livelihoods and improving health equity. If a city has appropriate financial and physical supports, and a willing citizenry, urban agriculture is an actionable way to promote food sovereignty and improve quality of life as well as to inevitably intertwin with the issues of sustainability, environmental health, water, food security, and ecological responsibility. The four most important areas to focus on will be public education to address the "knowledge gap" that exists between the older and younger generations, utilizing public spaces to make gardening both accessible and visible, community development to connect people to each other and to gardening resources and environmental sustainability. Additionally, by working on these practical steps, it will also work toward the cultural shift that will be required to make this system sustainable into the future. Creating Urban Agricultural Systems provides the producers and communities with background, expertise, and inspiration for designing with urban agriculture. It shows how to grow food in cities, operate growing systems, and integrate them with natural cycles and existing infrastructures. It teaches the essential environmental inputs and operational strategies of urban farms and inspires community and design tools for innovative operations and sustainable urban environments that produce fresh, local food. It is emphasized on nutrient, water and energy management, farm operation, community integration, and design approaches so that the community can see innovative strategies in action. "We're absolutely dependent on the oxygen, and the air, and the earth, and the six inches of topsoil, but we don't see that every day, and we start to live very disconnected." By normalizing urban agriculture, and making it more visible, Urban Agriculture producers can work toward bridging this disconnect from their food system and their environment and allow them to reap all of the health benefits that increased urban agriculture has to offer. Reconnecting Urban population with the food system and establishing food sovereignty will take time, but it is an achievable goal.

HIGH TUNNEL RAINWATER HARVESTING & SOLAR PUMP SYSTEM

Raymond Balaguer[1], Megan Chawner[2], María Gorgo-Simcox[2], and Beth Yount[2]
[1]University of Florida Institute of Food and Agriculture Sciences, Live Oak, FL 32064, USA
[2]The Pennsylvania State University, University Park, PA 16802, USA

Abstract
Rainwater harvesting (RWH) is a simple but underutilized technology that can increase the sustainability of farms in several valuable ways. These include more efficient water use and runoff management, reducing erosion and watering costs, as well as helping to slow down the buildup of salts inside protected growing spaces such as high tunnels. In the most basic form, a rainwater harvesting system needs a harvesting surface (usually a roof), a cistern, and a pipe or gutter connecting them. In the city setting there might be a relative abundance of containers such as food-grade intermediate bulk container (IBC) totes or 55-gallon barrels from food product shipping; however, there are limitations due to space, budget, and regulations that are unique to farmers in the urban setting.

A potential solution to these problems could be the use of high tunnels as a roofed structure for RWH. High tunnels are a farming tool that is already used in the Mid-Atlantic region to extend the growing season and mitigate the spread of diseases by excluding rain. They have become more common both in the rural and urban areas of the mid-Atlantic due in part to the benefits mentioned above but also through subsidies and cost-share programs such as the Environmental Quality Incentives Program (EQIP) from NRCS. Adding a rainwater harvesting system can save urban farmers money by not relying on municipal water as a source for irrigation (or lack of), and it allows all of the farming systems to be in one place.

Here we highlight the steps followed to use the high tunnel's plastic covering as an effective rainwater harvesting surface. A strip of polyethylene plastic was taped with greenhouse plastic patching tape along the lengths of the high tunnel to direct water into a gutter. Gutters were approximately 1" higher towards the middle of the high tunnel to allow water to flow in the gutter towards the ends of the high tunnel. The water collected would flow into four different types of cisterns: five white rain barrels connected in series (total volume of 275 gal), a white IBC tote (275 gal), a Black HDPE Vertical Water Storage Tank (220 gal), and a Norwesco white utility tank (200 gal). Once fully installed, water collected in each cistern was sampled to test for biological and chemical properties.

A rainwater harvesting system can only be considered successful if the water captured is used.

The solar pump system will transport water to an irrigation system as shown on the bottom of Figure 1. Although not installed yet at the site, it will include a 12V photovoltaic solar panel, 12V deep cycle gel battery, solar charge controller, a 12V direct current (DC) industrial diaphragm pump, and a 30-gallon pressure tank. It is advised to consult a licensed electrician when wiring the solar setup and the pump. However, we observed that there were diverse options on solar equipment and difference in opinions from different professionals we consulted.

Through this project, we confirmed that rainwater harvesting is a tool with much potential, but also learned that the materials supply is not streamlined and that there is limited availability from technical professionals like plumbers and electricians with experience in the installation of these systems. As perception of value for freshwater increases, we foresee that rainwater harvesting will become one of the essential parts of farms both in the urban and rural settings.

Raymond Balaguer is an Extension Agent working at Suwannee County, Florida with UF IFAS. His current focus includes general vegetable production and technologies for sustainable farming in diversified small farms.
He obtained his master's degree in the Plant Sciences Department at Penn State.
He is from Puerto Rico with a background is in biology and agroecology in tropical climates. He earned a bachelor's degree in general biology from the University of Puerto Rico.

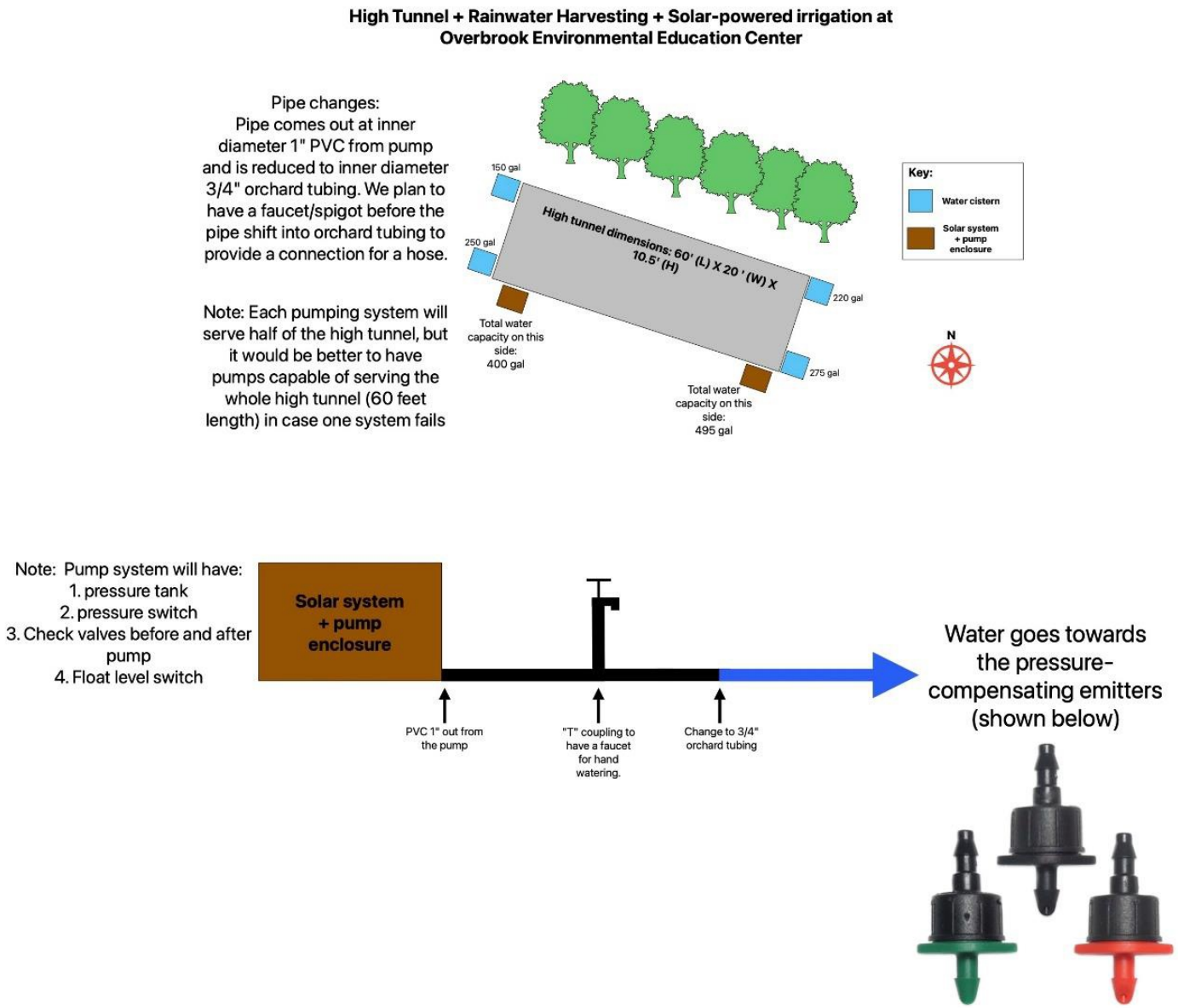

Figure 1. High tunnel top view sketch (top of the picture). Solar and pump systems enclosure with pipe diameter changes as water gets pumped out towards the irrigation system (bottom of picture).

THE PROS AND CONS OF URBAN BEEKEEPING

Jeffery Eckel
PA Department of Agriculture, Bureau of Plant Industry, Apiary and Pollinator Services,
2301 N Cameron St, Harrisburg, PA 17110

Beekeeping in urban areas presents unique challenges and rewards. Pros: Bees provide pollination services. Beekeeping is good for mental health and can serve to connect city dwellers to nature. Bees make honey! Cons: Hive placement can be challenging. Bees sting. Some areas are overpopulated by bees. Some areas do not have enough flowering plants for bees.

Jeff Eckel has been an apiary inspector since 2015, covering Berks, Bucks, Chester, Delaware, Montgomery and Philadelphia, PA counties. Jeff also keeps his own bees in the city of Philadelphia.

BEST MANAGEMENT PRACTICES FOR URBAN BEEKEEPING: KEEPING YOUR NEIGHBORS HAPPY

Robyn Underwood
Penn State Extension, Suite 100, 4184 Dorney Park Rd., Allentown, PA 18104

There are many things to consider when keeping bees in urban (and suburban) areas. Honey bee colony management must include keeping parasitic mite levels under control, as these parasites transmit viruses and can be passed from one colony to another. Keeping nearby humans safe is critical. Only gentle bees should be kept and disturbances to the hives should be kept to a minimum to avoid the possibility that people nearby may be stung. Preventing the bees from swarming is also very important. If swarming is allowed, the bees may end up taking up residence in cavities in nearby buildings, which will cost a lot of money to remove. There are practical ways to maintain bees in urban areas, while also keeping a happy relationship with your bee and human neighbors. These practices will be discussed in detail here.

Dr. Robyn Underwood was born and raised in Pennsylvania. She studied Entomology and Applied Ecology for her BSc from the University of Delaware, Newark, DE, where she fell in love with honey bees and beekeeping while taking a course in Apidology with Dewey Caron. She went on to study honey bees further by researching the use of formic acid to control parasitic mites in colonies kept indoors for the winter at the University of Manitoba in Winnipeg, Manitoba, Canada, where she obtained her PhD. She returned to PA and continued conducting applied research while working as an Assistant Professor of Biology at Kutztown University, and later as an Assistant Research Professor at Penn State University, University Park, PA. Her research and extension work has allowed her to interact with the large network of beekeepers from across the commonwealth, as stakeholders, advisors, and students. Robyn is very excited to have joined Penn State Extension in 2022, where she continues to engage with the beekeepers in PA and beyond while conducting applied research.

URBAN FARMING SITE HISTORY ASSESSMENT TOOLS
FREE TOOLS FOR URBAN GROWING SITE ASSESSMENT

Russell Thorsen they/he
Pasa Sustainable Agricultural

Proper site selection is crucial to ensuring an urban growing site's longevity and sustainability. Many sites struggle with physical contamination of rubble and compaction, as well as heavy metal contamination. Understanding a site's history helps inform the remediation process timeline. Free online databases and maps can quickly show growers what may be below the ground. Combined with on-site heavy metal testing, we can develop an informed site specific plan. In this session we will use a case study of Soil Sisters Plant Nursery's site selection process.

Urban agriculture practitioners must be mindful of the neighborhood's history they are working in. We will not have time to thoroughly address centuries of racism, classicism, and inequality. Because this session is focused on maps, I will touch on how intentionally racist mapmaking created conditions decades laters for vacant lots. Redlining is the practice of classifying black, brown, and immigrant communities as "poor financial risk" and refusing to issue loans and insurance to residents. Redlining was common practice of banks and financial institutions across the US. The systematic racism of this approach, as well as many other injustices, has lasting negative impacts on communities. It is with this context that we look at the Beltzhoover neighborhood in the hilltop area of Pittsburgh.

Community centered site selection is of utmost importance to the continued success of a growing project. Beltzhoover neighborhood meeting participants acknowledged wanting the lots 129,131, and 137 Beltzhoover Ave to be used for local food production. They also stated that Soil Sisters Plant Nursery, a local business, should manage the proposed farm. This is an ideal growing site selection process. Many businesses, non-profits, universities, churchs, and individuals, build growing space in communities of color without neighborhood buy-in. It is pivotal to note, these actors are historically white. These projects struggle and may even fail. Gardens and farms that started this way must do the slow process of building authentic trust. Interpersonal dynamics of a growing project and the surrounding community is the single greatest contributor to a site's longevity.

With this process in mind, we move to the bulk of this presentation, using free online tools to understand a site's history, and inform its future. Whether you are a prospective grower, or service provider, these tools will give you a holistic view of the site.

Google maps satellite imagery and street view can show what is currently on site. What plants are growing, slope, utility connection, where bulk delivery can go. Acknowledging these features lets us plan with those in mind. Notice the date of the imagery in the bottom right corner to ensure it is a recent image. Look for clues to what time of year it is, such as colors of the leaves on trees, how many layers pedestrians wear, etc. This is a great way to get a feel for a prospective site in moments. We want the site to tell us where features should go. Public records of property lines show site ownership. Allegheny County Real Estate Portal is our county owned public webpage where we can search and find ownership and tax records. In our case, we already know the owners of the property is the Urban Redevelopment Authority. In many cases, adjoining vacant lots can be owned by different people. Insecure land tenureship hinders prospective growers. It makes investing in more expensive infrastructure riskier. Land agreements are also needed for access to government, and local non-profit and foundation resources. Know your property lines. Once we know what the site presently looks like, and know who owns it, we can look at what was there historically. This is a map called Historic Pittsburgh GIS maps. It has map layers dating back to the late 1800's. In 200 year old, post industrial cities, truly anything could have been there. Many ravines are now filled in, and even mounded up. Industrial waste sites are now wooded parks. This lot was residential housing. We can see the initial property lines as the neighborhood developed, and subsequently houses being built. Many Pittsburgh homes in the 19th century were heated by coal, and painted with lead. Because the site is now an empty field, any and all of those potential contaminants can be in the soil. I'm also looking for the existence of garages. Pre-1970s gasoline storage is a probable site of elevated lead levels. If your municipality does not have a map like this, the Sanborn Fire Insurance Maps in the Library of Congress is a good database to search. Aerial photography replaces had drawn survey maps in the 30's.

Notice every building covered in soot. Somewhere pre 1967, most of the homes were demolished. Standard practices then were to knock the building into the basement, and use the industrial steel byproduct, slag, as fill. It is almost easier to assume most vacant lots have remnants of a building underneath. This is a great tool to also find sites that remained an open field, or park. Old ball fields are excellent sites for farms.

There are big gaps in the aerial photography that Google Earth can fill starting in the 90s, with the bulk of the 2000's well documented. Clicking on the timeline view, we can see that much of the site was some sort of drive way/lot. This means the site will most likely be difficult to pull soil samples from. This tells us that we should spend the next few years building soil. Many sites burn out too fast trying to remediate and grow for production and sale at the same time.

Building slowly and growing cover crop allows your site to build capacity as you scale. Allegheny County Conservation District provides free heavy metal soil screening. They make a 10'x10' grid for the whole site. They pull 5 soil cores per grid square, take 1 cup of that sample, and use a XRF machine to ID heavy metals. Though there are more accurate lab sampling methods for heavy metals, they are prohibitively expensive. The XRF is free to use, provides a great interaction point to share soil health safety education and resources. This initial heat map can be validated with lab testing for any problem areas. With this heat map, and our site history, we can build an informed site remediation plan with production goals.

URBAN SOILS PROJECT IN PHILADELPHIA

Patrick Drohan, Penn State University

Across many cities, a quiet revolution is taking root – urban farming and a greening of cities to adapt to climate change. As concrete landscapes stretch far and wide, the concept of cultivating food and greenspaces within city limits is becoming a beacon of hope and change. Greening cities, and urban farming, is not just about growing crops amidst skyscrapers; it's a dynamic solution to some of our most pressing urban challenges. Imagine strolling through a neighborhood where vacant lots transform into vibrant gardens, rooftops burst with greenery, and community spaces become hubs for shared agriculture. Urban farming isn't merely about plants and produce; it's about fostering resilience, reducing our environmental footprint, and creating a healthier, more connected urban experience. But how does one make sure a site to use for growing a crop is safe?

Can abandoned lots, spaces behind schools, community centers, or residential areas be effectively utilized for horticulture, such as cultivating flowers, vegetables, or fruit and nut trees? Before undertaking any gardening endeavors, it is crucial to address potential concerns related to soil quality and historical land use. Could there be buried materials in the soil that might pose risks to gardeners' health or contaminate the cultivated plants?

Answering these questions necessitates a comprehensive understanding of the soil through site assessment and soil testing. Site assessment involves adopting a detective-like approach to delve into the area's historical development as the community evolved over a significant span, possibly spanning more than three centuries. By conducting a meticulous site assessment, one can glean valuable insights into the land's past uses, which can aid in guiding subsequent soil testing. The assessment can identify potential risks and the need for specialized testing based on the site's history.

Soil testing plays a critical role in determining the soil's suitability for different purposes, such as cultivating vegetables, flowers, crops, or trees. It allows for an assessment of nutrient levels and potential hazardous characteristics, such as elevated levels of heavy metals, excessively high soil pH, or an abundance of base cations.

As part of a grant from the Pennsylvania Department of Agriculture, our team has developed a guide for "assessing and testing soils for urban gardening, food production and green infrastructure", which primarily focuses on three principal land uses and soil management practices. First, it addresses urban gardening aimed at aesthetic enhancement through the cultivation of flowers, trees, and other ornamental plants. Second, it explores food production for community building, where gardening initiatives bring people together and foster a sense of shared responsibility for food sources. Last, the guide delves into food production from a commercial perspective, where urban agriculture can contribute to local food supply chains.

Dr. Patrick Drohan has a 50/50 Research and Teaching split. He is a Professor of Pedology in the Department of Ecosystem Science and Management at Penn State and is Director of Graduate Studies. Dr. Drohan has worked in arid, wetland, forested, tropical and urban systems. His research examines people's use of landscapes and the accompanying changes in soil function across the larger ecosystem the soil supports. His group conducts soil and landscape analysis using field-based, laboratory, remotely sensed and geophysical techniques. He teaches courses in urban soils, soil genesis, and the co-evolution of land ownership, land management and civilization.

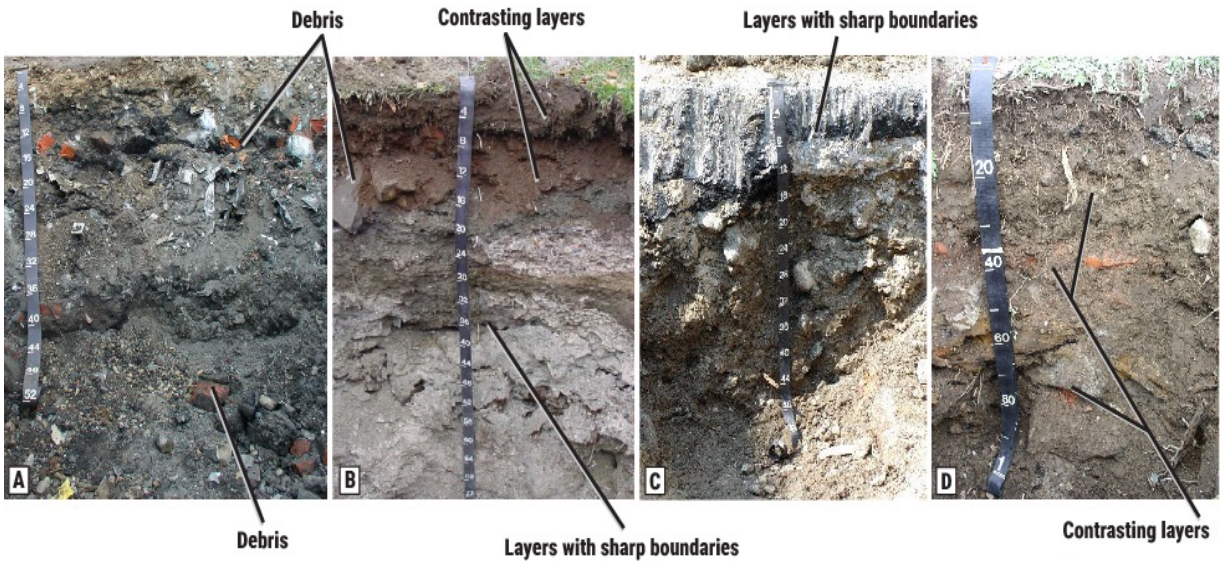

Figure 1. Example disturbed soils found in urban areas. Soils in urban areas that are disturbed may have: debris (bricks, garbage, metal, building wood, toys, broken ceramic); layers next to one another that look very different and that can have sharp boundaries or; layers made up of differing material from a variety of sources (compost, construction debris, clean soil dumped from elsewhere). Photos A, C, and D, Rich Shaw (USDA-NRCS) and photo B USDA-NRCS.

This guide is also applicable to those interested in implementing Green Infrastructure to promote stormwater control. Successful Green Infrastructure relies on the soil's ability to manage water flow and potentially remediate pollutants. However, it is essential to monitor pollutant accumulations within Green Infrastructure, as it may also accumulate harmful substances. Wildlife, which feeds off vegetation or its fruits, may hyperaccumulate pollutants in their bodies. Similarly, soil-dwelling organisms, such as earthworms and other soil fauna, can hyperaccumulate certain pollutants, including lead. Additionally, humans may forage for wild foods in urban habitats, including both wild and unmanaged areas or intentionally created ones like Green Infrastructure.

Evaluating the potential of abandoned or underutilized spaces for horticultural activities involves a thorough understanding of the soil's history and composition. By engaging in site assessment and soil testing, individuals can make informed decisions to create productive and safe gardening environments that contribute to urban sustainability and community well-being. Additionally, proper soil management practices play a vital role in the successful implementation of Green Infrastructure, ensuring its efficiency and minimal impact on the ecosystem.

The term 'urban soil' can be confusing, as it encompasses soil in areas that have been impacted by human activity in various ways. Urban areas, characterized by high population density and current or past development, can have soils with similar attributes to those found in suburban or rural regions, depending on their historical use.

Urban soil can display a wide range of characteristics, influenced by the varied history of land utilization (Figure 1). In some urban areas, soils remain relatively undisturbed, such as in city parks created from former forest land, municipal areas along major transit corridors, or historic graveyards. Conversely, certain parks in older cities may have been converted from former farmland or orchards, resulting in soils that exhibit signs of past agricultural practices like surface homogenization due to plowing while retaining the unaltered characteristics of the deeper soil layers. Orchards, on the other hand, may contain elevated levels of certain pollutants, such as arsenic (As), due to historical chemical usage in the orchard industry.

Urban soils can serve as a record of the past, potentially containing artifacts from previous structures and remnants of daily life, including bricks, ash, wood, coins, toys, nails, and waste products. These soils may consist of multiple layers of different 'fill' materials placed atop undisturbed 'native' soils. Additionally, urban, suburban, and even some

rural areas may experience surface additions of metals through various sources like dust, debris from vehicles, sprays, rain, fog, smoke, or snow. The presence of undesirable metals, such as lead (Pb), in significant quantities can pose challenges to the intended use of the soil.

Despite these complexities, many urban soils are safe and suitable for various purposes. Conducting a thorough site assessment is essential to determine the soil's safety for specific use goals. This assessment should consider factors such as the presence of pollutants, historical land use, and potential risks associated with the site.

In conclusion, understanding urban soil requires navigating a diverse range of characteristics and potential contaminations. By incorporating scientific evidence and conducting comprehensive site assessments, individuals can make informed decisions about the suitability of urban soil for their intended purposes.

When considering a site for gardening, it is important to conduct a thorough examination of its land use history. This includes not only the specific plot you intend to develop but also the surrounding lots. Start by consulting city records, available online or at city hall, to identify the property class, zoning information, and current and previous owners. Long-time neighbors can also be valuable sources of information.

If there are any doubts or concerns about the site's history, it is advisable to check with local and state agencies to determine if an environmental evaluation has been conducted. Certain sites require special attention due to their past or current land uses (Table 1):

- Abandoned railroad lots, chemical facilities, manufacturing and industrial sites, dry cleaners, and gas stations, any warehouse with chemical storage may carry risks associated with storage and leakage.
- Waste disposal locations like landfills or junkyards might contain inorganic and organic contaminants that have leached into the soils.
- Highways and the areas adjacent, parking lots, or older streets and streets that are heavily trafficked by trucks areas are commonly associated with high lead levels from vehicle emissions.
- Household or building sites may have lead due to paints (prior to 1978 manufacturing) and plumbing fixtures. Household areas may also have asbestos issues or other insulation issues (e.g. foam, fiberglass).
- Former farmland may have accumulated inorganic or organic contaminants from fertilizers and pesticides (apple orchard areas especially). Oftentimes, former farmland is generally good for gardening.

Taking the time to thoroughly assess the land use history of a potential gardening site will help you make informed decisions and ensure the safety and success of your gardening endeavor.

PRODUCE BUYER PANEL: INDUSTRY TRENDS

Jaci Daly, Regional Buyer for Sprouts Farmers Market

Retail Trends

- Basket size is down, trip frequency up, and fresh produce is the driver of trip frequency. Shoppers are reducing waste by buying less, more often.
- Convenience is king. Customers are looking for shortcuts - at mealtime, and in how they shop. Sales in convenience items like fresh cuts, meal kits, and grab & go packaging continue to grow as customers look for time savers in feeding their families.
- E-Commerce growth was driven by necessity, but sales remain 35% higher than pre-pandemic - another area where consumers have grown accustomed to paying a premium for convenience.
- Growth in e-commerce segment has increased the need for high quality marketing support - this means high resolution product images for online catalogs, attractive packaging, leveraging sponsorship opportunities offered by Instacart, etc.
- Packaging is an opportunity to do more than get a piece of fruit from A to B with a barcode, and good packaging is especially essential when launching something unique. Packaging should establish brand identity, uses/recipe suggestion, call out unique characteristics and health benefits, even if they seem obvious.

Produce Trends

- Pressure to deliver value - both in stretching dollars, but also in nutritional density. It's not a coincidence that bananas and potatoes are the top selling fruit and veg.
- Organic penetration continues to rise, particularly in the healthy living space. Customer research indicates that, when the quality and price is the same, a customer's first choice is produce that is local AND organic, but if they have to choose, most will pick organic over local. In order for locally grown conventional produce to be competitive against organics, it must be of superior quality, flavor, and value.

Challenges to Selling to Retailer

- Software requirements (iTrade, SPS Commerce, other proprietary systems) each with their own costs
- Logistics - delivering to distribution centers vs. DSD partners, challenges of working with third party logistics partners
- Higher insurance requirements than other sales channels

Jaci Daly is a Regional Buyer for Sprouts Farmers Market, focused on Eastern grown produce. She spent her formative years sometimes living, always working at Richfield Farm, her family's produce farm located in Manchester, MD. She remains involved in the farm, primarily through the ongoing organization and management of seasonal CSA box program. Prior to joining Sprouts, she gained additional experience in local food systems sourcing for the highly respected Foreman Wolf restaurant group, then as a buyer for Coastal Sunbelt Produce. While at Coastal Sunbelt, she organized the donation of over one million pounds of fresh produce for the Brighter Bites program in Washington, DC. Across all of these positions, Jaci has worked to promote diverse local food systems, and looks forward to continuing that commitment to responsible, sustainable sourcing practices as Sprouts Farmers Market expands its footprint on the East coast. Jaci proudly holds a history degree from the University of Baltimore and lives just outside the city with her spouse and small, useless dog.

WILDLIFE MITIGATION EFFORTS AND WILDLIFE CAMERAS

Steve Sample
Sample's Vegetable Farm
1 Faculty Road, Duncannon, Pennsylvania 17020

- SAMPLE'S VEGETABLE FARM SINCE 1978
- OVERCAME INSECTS, DISEASES & WEEDS, BUT WILDLIFE BECAME INCREASING PROBLEM

- **EQUIPMENT**
  - FENCING
    - POSTS AND GROUND RODS
    - WIRE 17 GUAGE ALUMINUM, 14 GUAGE ALUMINUM AND POLY WIRE
    - POST DRIVER AND STAKE PULLER FENCE
    - TIGHTENERS & INSULATORS
  - ZAREBA FENCER – BLINKIING LIGHT
  - PAR-MAK FENCER – GAUGE SHOWS BETTER ELECTRICAL STRENGTH
  - BALLOONS
  - SPRAYER
  - CAMERAS
    - MOULTRIE CAMERAS (BROWNING, BUSHNELL, STEALTH, SPYPOINT, WILDGAME, TACTACAM, KEEN) BROWNING DARK OPS USES 6 BATTERIES AND ADJUSTABLE VIDEO
    - 12V RECHARGABLE UNITS
    - 6V SOLAR UNITS
    - HME TRAIL CAMERA MOUNT (HAS THREADED MOUNT) BROWNING ALSO HAS ONE WITH 2 THREADED MOUNTS
    - USE
      - 45 DEGREE ANGLE
      - MAKE SURE IT ISN'T POINTED INTO THE SUNRISE OR SUNSET
      - BE CAREFUL OF VEGETATIVE MOVEMENT IN FRONT OF THE CAMERA
- **SWEET CORN**
  - DEER WIRE + FAWN WIRE AT PLANTING
    - TAKE DOWN EACH END TO SPRAY WITH BANDING NOZZLES
  - ADD GROUND WIRE AND 2 HOT WIRES FOR RACOONS AND GROUNDHOGS JUST BEFORE MATURITY
  - USE THE CAMERA TO MAKE ADJUSTMENTS WHEN WE SEE A BREACH
  - DOWNSIDES
    - DEER MAY STILL JUMP IT IN A DRY YEAR
    - RIBBON MAY BE BETTER
  - BIRD CONTROL
    - BALLOONS
    - MIGRATION JULY/AUGUST
    - USE AVIAN CONTROL 2 WEEKS BEFORE AND CLOSE TO HARVEST
    - SHOTGUN WITH BLANKS
- **CANTALOUPES AND WATERMELONS**
  - DEER WIRE AND FAWN WIRE UP AFTER MULCH IS LAID
  - GROUNDHOG WIRES UP AS SOON AS THE FIELD IS PLANTED
  - PERIMETER HAS TO BE WEED FREE BEFORE VINES RUN

Steve Sample and his wife own a 37 acre farm in Duncannon, Pennsylvania. They grow 7 acres of sweet corn, cantaloupes, seedless watermelons, tomatoes, peppers, blueberries and strawberries. All produce is sold at their roadside stand. Steve holds an associate degree in Forest Technology and a batchelor's degree in Business Administration from Penn State.

- **ZUCCHINI**
  - WHEN PLANTED AT THE END OF A CANTALOUP ROW EATEN BY DEER
  - USED CAMERA TO DETERMINE PERPETRATOR
  - WIRED BOTH SIDES
  - USED CAMERA TO VEIW RESULTS
- **TOMATOES**
  - CAMERA CAUGHT DEER EATING GREEN TOMATOES
  - PUT UP DEER WIRE AND FAWN WIRE WHEN MULCH IS LAID
- **PEPPERS**
  - DEER WIRE AND FAWN WIRE UP WHEN PLASTIC IS LAID
  - WIRES TAKEN DOWN WHEN PEPPERS ARE STAKED
- **STRAWBERRIES**
  - BIG PROBLEM FOR PLASTICULTURE STRAWBERRIES
  - MONITORED WITH CAMERAS
  - ADDED MORE WIRES AS NEEDED
  - ALTERNATED HOT AND GROUND WIRES
  - WOULD PROBABLY BE BETTER WITH TAPE
- **BLUEBERRIES**
  - PREVIOUS PLANTING USED MESUROL
  - USED 14’ BIRD NETTING ON SOME ROWS WITH SUCCESS
  - KESTREL BOXES
  - PUT UP DEER AND FAWN WIRE IN RESPONSE TO DAMAGE
  - PURCHASED BIRD NETTING TO COVER ENTIRE PLANTING
  - NEEDED BETTER BOTTOM TIE DOWN. USED TOMATO STAKES AND STAPLE
  - CAMERA SHOWED RACCOONS BORED HOLES AT BASE AND BIRDS SEARCHED THEM OUT
  - PUT UP 2 HOT AND ONE GROUND WIRE
  - ADJUSTED WIRES FOR A PERSISTANT SQUIRREL
  - SUGGESTIONS
    - LEAVE ROOM ON SIDES AND END FOR EQUIPMENT
    - THINK OF HOW YOU WILL ENTER AND EXIT
    - KEEP WEEDS DOWN IN THE PERIMETER OR NETTING WILL BE HARD TO PULL UP
    - WATCH OESCO PRESENTATION LATER FOR BETTER WAY
    - SEWING KIT – DON’T LEAVE HOME WITHOUT IT
- **HUNTING**
  - A LOT OF VEGETABLE AREA IN SAFETY ZONE OR PROXIMITY TO A ROAD
    - LIABILITY A CONCERN
  - ALLOWED HUNTING FOR THE FIRST TIME LAST YEAR
  - USING NEIGHBORS TO HARVEST DEER
- **MAGNET CROP**
- **TOTAL FENCING**

Mark Your Calendar!

2025 Mid-Atlantic Fruit and Vegetable Convention

JANUARY 28–30, 2025

Hershey Lodge
Hershey, PA