PENNSYLVANIA
VEGETABLE GROWERS

NEWS

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for the commercial vegetable, potato and berry grower

"[Farmers markets] create jobs, help drive the local economy, and allow farms and food artisans to retain a much higher portion of the food dollar," says a Penn State Extension expert. Credit: Michael Houtz, College of Agricultural Sciences. All Rights Reserved.

Research Finds Farmers Markets Vital to Local Food Economy

Pennsylvania farmers markets generate an estimated $100 million in sales each year, according to a new Penn State Extension analysis that provides a snapshot of farmers markets' contribution to the local food economy in the commonwealth.

Using 2021 data collected from 15% of the farmers markets in Pennsylvania, the researchers found that these markets generated gross sales of about $18 million. The researchers then extrapolated these sales figures to take into account the more than 330 open-air community farmers markets in the state. Their analysis indicated that these markets generated, conservatively, $100 million of direct economic activity over the six-month market season.

"Open-air farmers markets, on-farm markets and public markets are essential businesses that provide more than fresh food," said Brian Moyer, Penn State Extension education program associate in business and community vitality. "They create jobs, help drive the local economy, and allow farms and food artisans to retain a much higher portion of the food dollar."

This research was initiated at the end of 2020, when Penn State Extension received $10,000 from the Pennsylvania Department of Agriculture's PA Preferred program to support a data collection project during the 2021 market season. The project was aimed at creating a culture of data collection within markets and communicating the value of these businesses across the commonwealth.

"It is not unusual for farmers markets to collect data and share the results with local community stakeholders," Moyer said. "What makes this project unique is that this is the first time any data collection project has been done on these markets on a statewide level.

"It's also worth noting," he said, "that this data represents only the regular market season of June through October. Many winter markets that were not part of this project generate revenue during our colder months."

At the beginning of the project, market managers filled out a form with the market name, day of the week the market is open,

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NEWS

Game Commission Approves Red Tag Changes, Antlerless Allocations

The Pennsylvania Board of Game Commissioners met on April 9, 2022, in Harrisburg, finalizing revisions to the Red Tag Program and the antlerless deer and elk license allocations for 2022-23 along with considering other business.

Changes to Red Tag Program Approved

The Commissioners gave final approval to a host of changes that will improve the efficiency and effectiveness of the Agricultural Deer Control Program, better known as the Red Tag Program, which helps farmers address crop-damage issues through the hunting of antlerless deer.

The changes, which were recommended to the Game Commission by PVGA, Pennsylvania Farm Bureau, and other stakeholder groups will become effective in November 2022.

Changes include:

- An individual hunter no longer would be limited to obtaining one permit for a Red Tag property; they could get up to four. The higher limit is consistent with that used in the Deer Management Assistance Program (DMAP), which also helps landowners meet deer-management goals through antlerless deer hunting. Hunters would be able to keep all deer they harvest.
- The summer period during which Red Tag hunting is closed (currently May 16 – June 30) would be expanded to April 16 – July 31. Permits would be valid from Aug. 1 through Sept. 15, then from Feb. 1 through April 15. Permits would be issued for the license year that begins July 1 and runs through June 30.
- Landowners no longer would be required to report Red Tag harvests. Instead, similar to DMAP, hunters would report for each permit regardless of harvest success.
- All licensed hunters, not just hunters who are Pennsylvania residents, would qualify for Red Tag permits.
- The red snap tags that are the namesake of the Red Tag Program, would be replaced with standard harvest tags issued through HuntFishPA.
- Landowners no longer would need to enroll in the Game Commission's Hunter Access program before using the Red Tag program, and Red Tag properties no longer would need to be posted with signs.

"The Agricultural Deer Control Program is designed to allow farmers to manage the deer populations on their property," said Game Commission Bureau of Wildlife Management Director Matthew Schnupp. "The changes adopted today make it easier for landowners to enroll in the program, while making it more convenient for hunters to participate through an expanded season and increased number of tags."

Board Increases Antlerless Deer Licenses

The Board also voted to allocate 948,000 antlerless deer licenses statewide, which is up from the 925,000 licenses allocated for 2021-21.

Allocations by WMU are as follows, with the allocation from the previous license year appearing in parentheses:

WMU 1A – 43,000 (40,000)	WMU 3C – 37,000 (33,000)
WMU 1B – 34,000 (32,000)	WMU 3D – 41,000 (36,000)
WMU 2A – 39,000 (39,000)	WMU 4A – 50,000 (50,000)
WMU 2B – 49,000 (49,000)	WMU 4B – 34,000 (34,000)
WMU 2C – 67,000 (67,000)	WMU 4C – 31,000 (29,000)
WMU 2D – 74,000 (74,000)	WMU 4D – 55,000 (55,000)
WMU 2E – 42,000 (42,000)	WMU 4E – 42,000 (42,000)
WMU 2F – 37,000 (32,000)	WMU 5A – 31,000 (31,000)
WMU 2G – 25,000 (23,000)	WMU 5B – 60,000 (60,000)
WMU 2H – 6,000 (9,000)	WMU 5C – 70,000 (70,000)
WMU 3A – 19,000 (19,000)	WMU 5D – 29,000 (29,000)
WMU 3B – 33,000 (30,000)	

Hunting licenses for 2022-23 go on sale in mid-June and become effective July 1. After hunters purchase a general hunting license, they may apply for antlerless deer licenses based on staggered timelines, which will be outlined in the 2022-23 Pennsylvania Hunting & Trapping Digest, to be given free to all license buyers.

PVGA submitted the following comments to the Commissioners regarding antlerless allocations:

As the Commission prepares to set the antlerless allocations for the next season, we wish to emphasize that our members continue to suffer significant crop losses to deer each year. For the past seven years we have been asking our members on our annual membership survey several questions related to wildlife crop damage. Of the 162 persons responding to the question "Did you have crop damage from deer this year?" 43% reported major damage, 41% minor damage and only 16% no damage. Sweet corn, pumpkins, strawberries and tree fruit were the major crops that suffered damage. About 40% of the growers reported the damage was worse than last year and 49% the same. As noted above, we have been asking our growers the same questions for the past seven years and the percentage of growers reporting major damage increased each year until last year – from 30% in 2015 to 49% in 2019 and dropping to 48% last year and 43% this year. While the number of growers reporting major damage has dropped, the number reporting minor damage increased from 34% last year to 41% this year.

These survey results show that many of our growers continue to suffer significant crop damage on their farms. While there appears to be some improvement, it remains a very real problem and a major loss for these growers. We ask the Commission to consider this when setting the antlerless allocations. Deer populations must be able to be supported by the available non-agricultural habitat.

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county location, zip code, Supplemental Nutrition Assistance Program information, and any additional matching dollars program.

Each week, market managers entered their customer counts, the number of SNAP transactions, SNAP dollars distributed and redeemed, and SNAP bonus or matching dollars distributed and redeemed. Market managers also asked their anchor produce and meat vendors for their number of daily transactions and whether gross sales were higher, lower or the same as the previous week.

Penn State Extension researchers will continue data collection in the 2022 market season.

"Farmers markets are more than nice events in our communities," Moyer said. "They are essential to our local food economy. Markets provide a common space for farms and food businesses to offer their products and incubate new businesses."

For more information about the data collection project or the postseason survey, contact Moyer at bfm3@psu.edu or 484-269-0229.

NEWS

National News Briefs

USDA Announces Plan for $250 Million Investment to Support American-Made Fertilizer

The US Department of Agriculture (USDA) announced last week that it will support additional fertilizer production for American farmers to address rising costs and spur competition.

The USDA will make available $250 million through a new grant program this summer that supports independent, innovative and sustainable American fertilizer production to supply American farmers. Additionally, to address growing competition concerns in the agricultural supply chain, USDA will launch a public inquiry seeking information regarding seeds and agricultural inputs, fertilizer and retail markets.

Fertilizer prices continue to be on the rise and have more than doubled in the past year due to many factors, including the war in Ukraine, a limited supply of the relevant minerals and high energy costs, high global demand and agricultural commodity prices, reliance on fertilizer imports and lack of competition in the industry.

The United States is a major importer and is largely dependent on foreign fertilizer. The US is the second or third top importer for each of the three major components of fertilizer. The top producers of the major components of fertilizer include China, Russia, Canada and Morocco, with Belarus also providing a significant share of potash.

The USDA will use funds from the Commodity Credit Corporation (CCC) set aside in September for market disruptions to develop a grant program that provides financing to bring new, independent domestic production capacity on-line – similar to the recently announced meat and poultry grants that are designed to promote competition and resilience in that sector.

The new program will support fertilizer production that is independent, made in America, innovative, sustainable and farmer focused. Details on the application process will be announced this summer, with the first awards expected before the end of 2022.

For more information, click here.

*From the **Penna. Agricultural Alliance Issues Update**, Penna. Farm Bureau, March 2022.*

State News Briefs

DEP Extends Energy Efficiency Rebate Program for Farmers

The Pennsylvania Department of Environmental Protection has extended the deadline for its rebate program for farmers that assists with the cost of energy efficiency projects.

The Agriculture Energy Efficiency Rebate Program is offering rebates to defray the costs of installing LED lighting or variable frequency drives on the farm, which can save energy while saving money on utility bills.

The rebate program has expanded its list of eligible equipment to now include all energy efficient ventilation equipment (including fans, motors, and controls such as variable frequency drives) and milk pumping equipment (including pumps, motors, and controls such as variable frequency drives).

Applications will be accepted through June 30, 2022, on a first-come, first-served basis as long as funding is available. The available rebates will pay for 50% of the equipment costs, up to $2,000. Total funding to any one applicant will not exceed $5,000. Interested ag producers should apply for a rebate voucher prior to purchasing and installing the equipment.

DEP has up to $10,000 available for this program through State Energy Program funding from the U.S. Department of Energy.

All applications must be submitted online through the Electronic Single Application system. For complete program guidelines and application instructions, visit the DEP agriculture and farming energy webpage.

*From the **Penna. Agricultural Alliance Issues Update**, Penna. Farm Bureau, March 2022.*

*The **Pennsylvania Vegetable Growers News** is the official monthly publication of the Pennsylvania Vegetable Growers Association, Inc.,*
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Our Mission:
The Pennsylvania Vegetable Growers Association serves Pennsylvania's commercial vegetable, potato and berry growers through education, research, advocacy and promotion.

Our Vision:
The Pennsylvania Vegetable Growers Association will be the driving force in ensuring the future viability of the commercial vegetable, potato and berry industries in Pennsylvania.

Inquiries about membership, this publication or advertising rates should be directed to William Troxell, Executive Director, at the above address.

GENERAL

Why Should You Calibrate Your Sprayer Even If it has a Rate Controller?

Erdal Ozkan

Whenever I give a presentation about the need to calibrate a sprayer and how to do it, there is always someone asking me this same question: "I have a rate controller in the cab that regulates the flow rate of the sprayer regardless of the changes in sprayer ground speed. I just enter the gallons per acre application rate, and the controller does the rest, just like a cruise control in a car. So, should I still calibrate the sprayer? The answer is, Yes, a calibration should be done. Although the rate controllers do an excellent job with regulating the flow rate of nozzles to keep the application rate constant regardless of the changes in travel speed, a manual calibration at least once a year is needed for two reasons: 1) to ensure the rate controller is functioning properly, 2) the rate controller is not forced to operate outside the pressure operating range for the nozzles on the sprayer boom. Let me elaborate on both points I made and share with you the reasons why a manual calibration of a sprayer is a good idea.

If you are stopped by a police officer for speeding, telling the police officer that the car was in cruise control set to the speed limit will not get you out of getting a ticket. Cruise controls go bad, so will the rate controllers. That is why it is best to manually check the flow rate of nozzles to make sure the gallons per acre application rate you enter on the controller matches the gallons per acre rate provided by the nozzles.

Your controller may be in good shape, but if the ground speed sensor is giving inaccurate data to the controller, it will not work accurately. For example, if the speed sensor works based on revolutions of the tractor wheels, the ground speed determined may not be accurate, because of the slippage that may occur under some ground conditions. Even the tire pressure being off just a few psi may change the tire revolutions per minute leading to erroneous travel speed readings.

Unfortunately, most standard electronic controllers cannot detect flow rate changes on each nozzle on the boom. So, if a nozzle is plugged, or extremely worn out, the rate controller cannot warn us about these problems that happen all the time. It will still try to maintain the constant application rate by changing the system pressure and force other nozzles on the boom to spray less or more to overcome the problems with one or several nozzles on the spray boom.

Finally, controllers don't show changes in spray patterns that may happen when a nozzle is defective, plugged, or worn-out. If several of the nozzles are not maintaining the proper spray angle the proper overlap between adjacent spray patterns cannot be established. This will result in untreated areas and streaks under the boom, or some areas may receive excessive deposition of the pesticides applied. So, we will have to continue manually checking the flow rate of the nozzles, and visually observing the changes in spray patterns until the technology is developed to do these observations remotely, and on-the-go.

Measuring the flow rate of each nozzle is an important part of any calibration method you may use. Photo credit: Erdal Ozkan

As you know, to achieve best results from pesticides, the application rate, as well as the droplet size must remain relatively unchanged during the entire spraying. When sprayer speed goes up, to maintain the pre-set application rate, the controller requires the system pressure to go up to increase the nozzle flow rate. This, unfortunately, results in more drift-prone droplets coming out of the nozzle, especially if the nozzle used is designed for low application rates within the recommended pressure ranges. Conversely, when the sprayer slows down, the opposite happens: the controller forces the system to lower the pressure, in order to reduce flow rate of nozzles. This will result in production of larger than the desired size of droplets, leading to inadequate coverage. If you are spraying Dicamba or 2,4-D herbicides, you need to pay even more attention to operation of rate controllers. As you know, only a small number of nozzles at specific ranges of pressure can be used to spray these products. Significant changes in ground speed may force the rate controller to make significant changes in spray pressure that may be outside the allowable legal pressure range required to spray these herbicides. Without you realizing it, you may find yourself in violation of the label. Make sure the nozzle size selected will allow the controllers to make necessary changes in the flow rates while still staying within a safe, applicable, and allowable pressure range.

This is all you need to calibrate a sprayer. Photo credit: Erdal Ozkan

How to calibrate a sprayer?

It usually doesn't take more than 30 minutes to calibrate a sprayer, and only three things are needed: a watch or smart phone to record the time when measuring the nozzle flow rate or the travel speed, a measuring tape, and a jar graduated in ounces. Please look at the Ohio State University Extension publication FABE-520 for an easy method to calibrate a boom-type sprayer. Here is the URL for this publication: http:// ohioline.osu.edu/factsheet/fabe-520

Dr. Ozkan is Professor and Extension State Specialist at The Ohio State University. From VegNet Newsletter, The Ohio State Univ., https://u.osu.edu/vegnetnews/2022/04/12/why-should-you-calibrate-your-sprayer-even-if-it-has-a-rate-controller-erdal-ozkan/, April 12, 2022.

VEGETABLE PRODUCTION

Take-Homes for Practical Nutrient Management Planning

G. Higgins and S. Scheufele

Managing soil fertility is often overwhelming and expensive for farmers. This year especially, lots of growers are con-cerned about high fertilizer prices and are wondering if they really need to put down full rates of fertilizer this spring. The following are some take-home messages from a series of nutrient management workshops held by Becky Maden and Laura Johnson of UVM Extension in March 2020. We hope these messages will prevent you from getting bogged-down by stacks of soil tests, in-depth fertility recommendations, and sky-high fertilizer prices.

In addition to the concepts discussed in this article, you can consider saving on fertilizer costs in crops grown on mulched beds by applying fertilizer only to the bed tops. Here are two methods for calculating these fertilizer needs: the Mulched Acres model (at https://ag.umass.edu/sites/ag.umass.edu/files/newsletters/june_21_2018_vegetable_notes_1.pdf), and the Linear Bed Feet model (at https://edis.ifas.ufl.edu/pdffiles/ss/ss51600.pdf).

Pre-sidedress nitrate tests (PSNTs) are useful tools for dialing in your nitrogen rates every year, but especially this year if you want to try splitting fertilizer applications or applying less than you usually do. PSNTs measure the amount of plant-available N in the soil at the time of sampling. If PSNT levels are above 30ppm, generally, adding more N will not result in a yield increase. If you split your fertilizer applications this year (put down some at planting and plan to sidedress later), or if you want to try a reduced fertilizer rate, you can take PSNTs to inform your need for sidedressing and time those applications. PSNTs are also a great way to make sure you're not over-applying expensive N throughout the season—if a PSNT taken at the end of the season shows high N levels, you can consider lowering your fertilizer rates for next year. If you are relying primarily on organic forms of N (e.g. from compost, cover crops, soil organic matter, or organic soil amendments), this N is released slowly across many seasons. PSNTs taken monthly can help you evaluate whether this N is becoming available when your crops need it, or if you need to adjust.

Address the low-hanging fruit first: pH and macronutrients.

pH. Optimal pH for most vegetable crops is 6.5-6.8. Nutrients are most available at a neutral pH (7) and start to become unavailable as soil becomes more acidic. At a pH of 5.5, only 77% of N, 48% of P, and 77% of K in the soil is available to plants. Lime your fields to get your pH closer to 7 before you spend lots of money on fertilizers.

Macronutrients. Focus on reaching optimal levels of N, P, and K before addressing micronutrient concerns. Micronutrients are present in such small quantities in soils that they are hard to detect precisely with soil testing methods. Instead of trying to increase your soil zinc from 0.8 to 1.0 ppm, keep an eye out for nutrient deficiencies (see https://ipm.missouri.edu/cropPest/2016/7/Diagnosing_Nutrient_Deficiencies/) throughout the season and submit a tissue sample [to the Penn State Agricultural Analytical Services Laboratory if you suspect a specific micronutrient deficiency.

Base cation saturation ratios: The model of soil fertility that all state university soil labs use is based on the proven concept that nutrient levels can be defined for all crop nutrients and below those levels, you will see a yield response in your crop if you add more of that nutrient. This is known as the "sufficiency level of available nutrients" model. There are some private soil labs that use the "base cation saturation" (BCSR) model. The BCSR model focuses on fertilizing soils based on the ratios of calcium, magnesium, and potassium in the soil, with the goal of achieving "ideal" ratios that will result in a "balanced" soil and maximum crop quality and quantity. This idea of ideal ratios was first proposed in the late 1800s but became popular in the

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1970s after it was publicized by the soil scientist William Albrecht. However, the BCSR concept has since been disproved and it has been shown that maximum yields of many crops can be achieved across wide ranges of Ca:Mg and K:Mg ratios, if pH is maintained in an optimum range and sufficient macronutrients are supplied. While Mg and K deficiencies can certainly occur, it is much easier to address those deficiencies once the low-hanging fruit (pH and macronutrients) have been addressed. See the "Resources" list at the end of this article for more information about BCSR.

Prioritize problem fields and/or high-value crops. While we should strive to achieve the recommended fertility for every crop every year, it is not always realistic or even necessary. Crops respond to added nutrients logarithmically (Figure 1, right), meaning the initial response to added fertility is huge but there is a point of diminishing return, where adding more fertilizer leads to only small gains in growth or yield. Fertilizer is expensive! So spend your time and money wisely and get "close enough." Work on dialing in nutrients for fields where you see nutrient problems regularly and for high-value crops where you can't afford to get less-than-optimum yields. For other crops, you may be happy enough getting less-than-optimum yields and saving money on the fertilizer needed to get that last 5% yield.

Don't obsess over soil organic matter—work within the range of your soil type. Soil organic matter (SOM) includes living (e.g. insects, bacteria, fungi), dead (e.g. dead plants, insects, bacteria, fungi), and very dead (aka humus) material in soil. Organic matter is generally increased by incorporating cover crops or applying organic amendments like manure and compost, most of which have high phosphorous levels relative to crop need. Generally, 2-3% SOM is considered low, and 4-6% is considered good. But it's nearly impossible to maintain SOM above 3% in a sandy soil, and if you're adding enough compost that your SOM is increasing above 3%, your phosphorous levels are very likely well above optimum. If you have sandy soils, aim to maintain your SOM instead of increasing it. Across all soil types, look at the trend of your SOM and don't obsess over the value alone. If you're increasing your SOM without applying excessive phosphorous, great! If you're maintaining your SOM, great! If your SOM is decreasing, consider making a change.

Know your phosphorous levels and your environmental risk level before adding organic amendments. Phosphorous is an essential plant nutrient but can become an environmental pollutant if large quantities enter water sources. This is mainly an issue with large-scale growers who use manure or compost or who are growing on fields that historically had lots of manure put down. When P levels are high, there are no corrective actions except avoiding adding more phosphorous. Most organic amendments—composts and manures—are high in P. Cover crops are great ways to add organic matter without adding P. In high tunnels, where cover cropping is difficult, peat moss and coconut coir are two options for adding organic matter without adding extra P.

Optimal phosphorous ranges from a Modified Morgan soil test is 4-7ppm; above that, your phosphorous levels will be reported as "excessive". That means a P at 8ppm will look the same on the soil test report as one at 300ppm, even though 300ppm is much worse than 8ppm. Generally speaking, P levels above 50 ppm are alarming. We've heard some farmers say that excess P is not a big deal as long as your field is not next to a waterway—not so! There is a growing awareness that long-term over-application of manure and chemical fertilizer contributes to phosphorus movement into the groundwater system, resulting in a significant groundwater source of phosphorus to streams and lakes, as well as potential contamination of the groundwater resources. Further, excessive P can tie up zinc leading to deficiencies.

Updated high tunnel fertility and production recommendations. Research and surveying from several New England states in 2018 resulted in new high tunnel fertility recommendations, that are now included in the Greenhouse & High Tunnel Tomatoes section of the New England Vegetable Management Guide (see https://nevegetable.org/crops/tomato-greenhouse-and-high-tun-

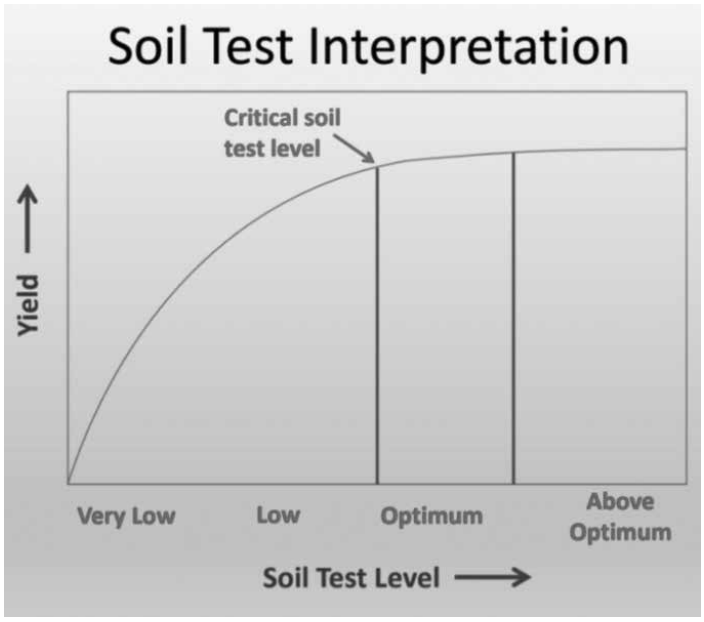

Figure 1. Crop yield response to soil nutrient levels. If a soil contains no nutrients, adding some nutrients will result in a large increase in yield. As soil nutrient levels approach optimum, each incremental addition of nutrients has less and less of an effect on crop yield. Figure: UVM Extension

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nel). The research is also summarized in this 2018 High Tunnel Survey Report (see https://ag.umass.edu/sites/ag.umass.edu/files/reports/2018_high_tunnel_survey_report.pdf). The take-home message from this research is that high tunnel tomatoes should be fertilized based on the potential yield of the production system: a heated tunnel of indeterminate, hybrid, disease-resistant, grafted tomatoes that are closely spaced and heavily pruned has the potential to produce much higher yields than an unheated tunnel of determinate heirloom tomatoes that will be harvested 3 times before they go down to leaf mold. The first scenario requires much more nutrients than the second. The Guide and fact sheet list nutrient recommendations for low, medium, good, and high yields, all of which refer to the potential yield of your high tunnel tomato production system.

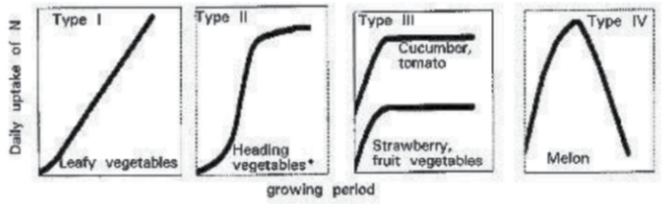

Figure 2. Uptake of nitrogen over the growing period of various crops. Figure: Redrawn from Kato 2000.

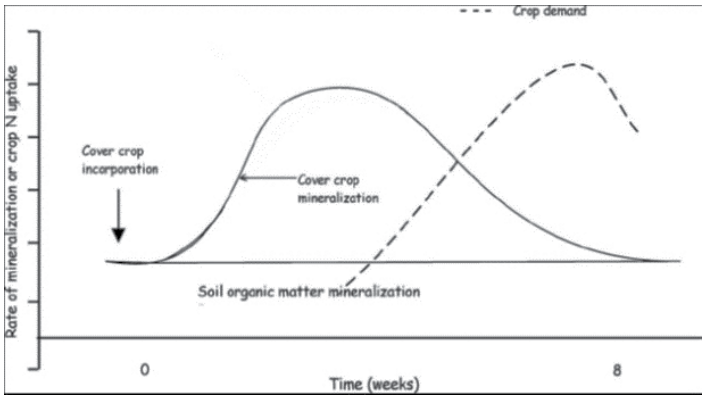

Figure 3. Timing of nitrogen (N) mineralization from soil organic matter, cover crop residues, and organic fertilizer in relation to crop N uptake (from Gaskell et al., 2006).

An important part of these new recommendations Salts can build up in the top two inches of high tunnel soil. Salts are wicked to the soil surface through evaporation and are not flushed back down because there's no rain. These salts are nutrients, so you don't want to remove them, but they can cause plant damage in high concentrations so take measures to mix or flush them deeper into the soil. Mix the soil by rototilling or plowing to a >6" depth and/or leave the tunnel plastic off for the winter every time you change it, to flush the salts back down.

In conclusion, when you get all 35 of your soil tests back and don't know where to start remember that you just need to get close enough, start with the low-hanging fruit, and feel free to contact any of us for help making a plan or going through some of the calculations.

Additional Resources:

- Becky Maden created a fertilizer calculator (see https://www.uvm.edu/vtvegandberry/NMPlinks.html) where you can enter nutrient levels, soil pH, and organic matter levels from a soil test, as well as cover crop information, and the spreadsheet will walk you through how much of a given amendment you should be applying to your field.
- Base Cation Saturation Ratio System, Building Soils for Better Crops. Magdoff, F., and van Es, H.
- A Review of the Use of the Basic Cation Saturation Ratio and the "Ideal" Soil. Kopittke, P., M., and Menzies, N. W.
- Phosphorous and Groundwater: Establishing Links Between Agricultural Use and Transport to Streams. Domagalski, J. L., and Johnson, H.
- The New England Vegetable Management Guide covers many of these topics:
- See the Plant Nutrients section for more information on both macro- and micronutrients
- See the Fundamentals of Soil Health and Fertility section for more information on soil organic matter and pH
- See the Fertilizer and Soil Amendments section for information on fertilizers as well as manure and compost.

Ms. Higgins and Ms. Scheufele are with the Univ. of Massachusetts Extension Vegetable Program. From Vegetable Notes for ***Vegetable Farmers in Mass., Univ. of Mass.*** *Extension, Vol. 34, No. 4, April 14, 2022.*

VEGETABLE PRODUCTION

Postemergence Herbicide Timing Effects on Snap Bean Development and Yield

Lynn Sosnoskie, John M. Wallace, Dwight D. Lingenfelter and Mark J. VanGessel

Research Funded by PA Growers
PA Veg. Growers Assn.
PA Veg. Mktg. & Research Prog.

Introduction: Pennsylvania, Delaware, Maryland, New Jersey, and New York grow over 46,000 acres of snap beans, combined (NASS, 2017). Because of the crop's short stature and the comparatively short window between planting and harvest, season-long weed control is necessary to maximize snap bean production. Weeds that compete with the crop can also reduce harvest efficiency, harbor pests and pathogens, and interfere with the deposition of other pesticides. Many weeds of concern (e.g. lambsquarters, smooth pigweed, common ragweed, nightshade, and velvetleaf) can emerge with the crop and must be rigorously managed to prevent direct and indirect impacts on crop yield. Postemergence (POST) applied herbicides are most effective when applied to small (typically < 2-3" in height) seedlings. However, application timings must also factor in crop development to minimize injury potential and subsequent impacts on crop maturity. For example, Basagran, Raptor, and Reflex applications must be made after the first trifoliate leaf is fully expanded. Growers may face decision challenges if uneven stand emergence impacts plant size throughout a field. *The objective of this study is to describe the impacts of 1) herbicide and 2) application timing on crop injury and yield to provide producers who may treat plants at less developed growth stages guidance about expected crop responses.*

Materials and Methods: In 2021, this multi-state trial was conducted at the Cornell AgriTech Experiment Station in Geneva (NY), the Penn State Horticultural Research Farm in Rock Springs (PA), and University of Delaware's Carvel Research and Education Center in Georgetown (DE). Snap beans were planted at commercial seeing rates (65,000 to 110,000 seed per acre) on 16 June in DE, 18 June in PA, and 25 June in NY. Field sites received applications of Dual Magnum at labeled rates to suppress weeds and permit observations of postemergence herbicide damage without confounding factors.

Herbicide treatments included: Basagran (1.5 pt/A), Reflex (0.75 pt/A), Basagran (1.5 pt/A) plus Reflex (0.75 pt/A) and Basagran (1.5 pt/A) plus Raptor (4 oz/A). All herbicide solutions included NIS at 0.25% v/v.

Timing treatments included: cotyledon (23 June-DE and 1 July-NY), unifoliate (29 June-DE, 28 June-PA, and 4 July-NY), first trifoliate (6 July-DE, 6 July-PA, and 10 July-NY), and first flower (21 July-PA and 27 July-NY) stages of development.

Applications were made with CO2-pressurized backpack sprayers calibrated to deliver 20 GPA to plots that were two rows wide and 20 to 30 feet in length. Untreated bean plots (no postemergence herbicides applied) were included as a reference for injury ratings. All treatments were replicated three to four times at each site. Injury ratings (stunting and necrosis) on a scale of 0% (no injury) to 100% (complete plant death) were made throughout the season at each location. Yield data was collected in PA and NY.

Results: Injury (%) in snap beans at 10 to 14 days after treatment (DAT) and maximum observed injury (%) during the season were affected by herbicide, application timing, and state (Tables 1 to 4). In general, the greatest amount of crop injury was observed with Basagran plus Reflex, particularly when the mixture was applied at the cotyledon and unifoliate stages of bean development. Reflex applied alone and Basagran plus Raptor were the next most injurious treatments. Averaged over application timings and states, mean percent (%) injury at 10 to 14 DAT was 11% for Basagran, 15% for Reflex, 26% for Basagran plus Reflex, and 16% for Basagran plus Raptor; mean maximum percent (%) injury observed during the season was 13%, 19%, 30% and 22% for Basagran, Reflex, Basagran plus Reflex, and Basagran plus Raptor, respectively.

Younger, less developed plants were more severely injured by herbicide applications than older/larger ones. Averaged across herbicides and states, mean percent (%) injury at 10 to 14 DAT was 24%, 29%, 12% and 1% for applications made at the cotyledon, unifoliate, trifoliate, first flower stages of development, respectively. Mean maximum percent (%) injury observed during the season was 31% (cotyledon), 31% (unifoliate), 17% (trifoliate), and 2% (first flower). Although first flower is not a recommended application timing, it was included in this study to demonstrate how much crop maturity can influence herbicide injury potential.

Differences were also observed among states. Averaged over herbicides and timings, the least amount of crop damage was reported in PA, followed by DE. NY saw the most injury with maximum injury ratings up to 85% (Basagran plus Reflex at

		Injury (%) 10 to 14 DAT			Maximum Observed Injury (%) In Season		
Herbicide	Timing	DE	PA	NY	DE	PA	NY
Untreated	.	0	0	0	0	0	0
Basagran	Cotyledon	10	.	8	21	.	13
Reflex	Cotyledon	28	.	27	31	.	27
Basagran + Reflex	Cotyledon	46	.	37	55	.	37
Basagran + Raptor	Cotyledon	12	.	20	27	.	40
Basagran	Unifoliate	12	20	38	12	20	38
Reflex	Unifoliate	10	5	52	12	5	62
Basagran + Reflex	Unifoliate	22	20	78	22	20	85
Basagran + Raptor	Unifoliate	14	25	47	14	25	55
Basagran	Trifoliate	0	5	12	5	8	12
Reflex	Trifoliate	5	6	20	13	11	27
Basagran + Reflex	Trifoliate	12	11	30	27	13	32
Basagran + Raptor	Trifoliate	5	9	30	15	11	32
Basagran	First Flower	.	1	0	.	1	3
Reflex	First Flower	.	1	0	.	1	3
Basagran + Reflex	First Flower	.	2	0	.	2	3
Basagran + Raptor	First Flower	.	2	0	.	2	3

Table 1. Mean Injury (%) at 10 to 14 Days After Treatment and Maximum Observed Injury (%) for Each Herbicide by Timing Combination in Each State in 2021. Basagran (1.5 pt/A), Reflex (0.75 pt/A), Basagran (1.5 pt/A) plus Reflex (0.75 pt/A) and Basagran (1.5 pt/A) plus Raptor (4 oz/A).

Postemergence Herbicide Timing Effects on Snap Bean Development and Yield

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unifoliate leaf stage). The significant weather that the NY site experienced in 2021 likely accounted for the disparity. Geneva received 6 inches of rainfall in July, which resulted in waterlogged soils. Snap beans at Cornell AgriTech were unable to recover from the combined stress effects (e.g. herbicides and standing water). This also influenced bean yields. While no differences were observed in bean weights across all treatments in PA (1324 g/10 ft2), NY's were substantially impacted by herbicide injury. For example, Basagran plus Reflex or Raptor applied at the unifoliate stage reduced yields 22 to 36% relative to the control plots (984 g/10 ft2).

		Percent (%) Crop Injury (0 = No injury, 100 = Plant death)			
Herbicide	Timing	7/7/2021	7/16/2021	7/26/2021	Max. Percent (%) Injury
Basagran	UNI	18.3	20.0	13.3	20.0
Reflex	UNI	5.0	5.0	4.3	5.0
Basagran + Reflex	UNI	20.0	20.0	13.3	20.0
Basagran + Raptor	UNI	18.3	25.0	21.7	25.0
Basagran	TRI	7.0	8.0	5.7	8.0
Reflex	TRI	11.3	10.7	6.3	11.3
Basagran + Reflex	TRI	12.3	13.0	11.3	13.0
Basagran + Raptor	TRI	9.7	11.3	9.0	11.3
Basagran	R1	0.0	0.0	1.0	1.0
Reflex	R1	0.0	0.0	1.0	1.0
Basagran + Reflex	R1	0.0	0.0	2.0	2.0
Basagran + Raptor	R1	0.0	0.0	2.0	2.0

Table 2. Mean Injury (%) and Maximum Observed Injury (%) for Each Herbicide by Timing Combination in Pennsylvania in 2021. UNI = Unifoliate, TRI = Trifoliate, R1 = First Flower. Basagran (1.5 pt/A), Reflex (0.75 pt/A), Basagran (1.5 pt/A) plus Reflex (0.75 pt/A) and Basagran (1.5 pt/A) plus Raptor (4 oz/A).

Summary and Outreach: Postemergence herbicides applied in snap beans can cause significant damage to the crop depending on the active ingredient and the time of application. While there was some variability across states, Basagran applied alone was typically the least injurious herbicide evaluated while tank mixes resulted in more visual damage. Results from this study also indicate that early (cotyledon, unifoliate) applications of registered postemergence herbicides can result in significant crop injury and yield reductions, compared to applications made according to label recommendations (e.g. first fully expanded trifoliate leaf for the herbicides included in the trial). Injury symptoms can persist across time (Tables 2, 3, 4), particularly if additional/external stressors (e.g.

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Postemergence Herbicide Timing Effects on Snap Bean Development and Yield

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weather extremes) occur during the growing season. Crop plants that "get behind" early may not be able to "catch up". Results from these trials were presented at the Mid-Atlantic Fruit and Vegetable convention on February 1st ("*Impact of Herbicide Timing for Postemergence Weed Control in Snap Beans – Snap Beans" Mid-Atlantic-Convention-Program-22-website.pdf* (pvga.org)) and at the 2022 Empire State Producers Expo in the session "Snap Beans: Stress Mitigation" on March 1st (*Virtual-Session-Schedule-JANUARY-19.pdf* (nysvga.org)).

Take Home Points:

- Registered herbicides can cause injury to snap beans; the degree of injury varies among active ingredients/combinations of active ingredients
- Applications made to beans at the cotyledon and unifoliate growth stages resulted in increased injury, as compared to the recommended 1st trifoliate leaf, although this was affected by location and additional stresses
- Local environmental conditions can enhance injury symptoms across time (and reduce yields)
- Balancing weed control with crop safety can be difficult, but growers should be aware that early applications are not advised

Dr. Sosnoskie is with Cornell AgriTech, Dr. Wallace and Mr. Lingenfelter are with Penn State Univ. and Dr. VanGessel is with the Univ. of Delaware. *This research was funded by PVGA and the Pennsylvania Vegetable Marketing and Research Program.*

		Percent (%) Crop Injury (0 = No injury, 100 = Plant death)				
Herbicide	Timing	6/28/2021	7/6/2021	7/15/2021	7/22/2021	Max. Percent (%) Injury
Basagran	COT	21.0	10.0	7.3	0.0	21.0
Reflex	COT	31.0	28.3	28.3	14.3	31.0
Basagran + Reflex	COT	55.0	46.0	45.0	17.3	55.0
Basagran + Raptor	COT	26.7	11.7	19.3	8.0	26.7
Basagran	UNI	0.0	7.3	12.3	8.7	12.3
Reflex	UNI	0.0	11.7	10.0	0.0	11.7
Basagran + Reflex	UNI	0.0	14.7	21.7	10.0	21.7
Basagran + Raptor	UNI	0.0	6.7	14.3	5.0	14.3
Basagran	TRI	0.0	0.0	5.0	0.0	5.0
Reflex	TRI	0.0	0.0	12.7	5.0	12.7
Basagran + Reflex	TRI	0.0	0.0	26.7	12.3	26.7
Basagran + Raptor	TRI	0.0	0.0	15.3	5.0	15.3

Table 3. Mean Injury (%) and Maximum Observed Injury (%) for Each Herbicide by Timing Combination in Delaware in 2021. COT = Cotyledon, UNI = Unifoliate, TRI = Trifoliate. Basagran (1.5 pt/A), Reflex (0.75 pt/A), Basagran (1.5 pt/A) plus Reflex (0.75 pt/A) and Basagran (1.5 pt/A) plus Raptor (4 oz/A).

		Percent (%) Crop Injury (0 = No injury, 100 = Plant death)						
Herbicide	Timing	7/4/2021	7/10/2021	7/17/2021	7/24/2021	8/1/2021	8/16/2021	Max Percent (%) Injury
UTC	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Basagran	COT	13.3	8.3	1.7	0.0	0.0	0.0	13.3
Reflex	COT	23.3	26.7	20.0	23.3	21.7	10.0	26.7
Basagran + Reflex	COT	33.3	36.7	25.0	25.0	26.7	15.0	36.7
Basagran + Raptor	COT	13.3	20.0	28.3	40.0	36.7	16.7	40.0
Basagran	UNI	0.0	38.3	38.3	33.3	36.7	10.0	38.3
Reflex	UNI	0.0	61.7	51.7	46.7	33.3	20.0	61.7
Basagran + Reflex	UNI	0.0	85.0	78.3	73.3	73.3	30.0	85.0
Basagran + Raptor	UNI	0.0	41.7	46.7	55.0	46.7	23.3	55.0
Basagran	TRI	0.0	0.0	10.0	11.7	11.7	3.3	11.7
Reflex	TRI	0.0	0.0	26.7	20.0	15.0	3.3	26.7
Basagran + Reflex	TRI	0.0	0.0	30.0	30.0	31.7	10.0	31.7
Basagran + Raptor	TRI	0.0	0.0	23.3	30.0	31.7	11.7	31.7
Basagran	R1	0.0	0.0	0.0	0.0	3.3	0.0	3.3
Reflex	R1	0.0	0.0	0.0	0.0	3.3	0.0	3.3
Basagran + Reflex	R1	0.0	0.0	0.0	0.0	3.3	0.0	3.3
Basagran + Raptor	R1	0.0	0.0	0.0	0.0	3.3	0.0	3.3

Table 4. Mean Injury (%) and Maximum Observed Injury (%) for Each Herbicide by Timing Combination in New York in 2021. COT = Cotyledon, UNI = Unifoliate, TRI = Trifoliate, R1 = First Flower. Basagran (1.5 pt/A), Reflex (0.75 pt/A), Basagran (1.5 pt/A) plus Reflex (0.75 pt/A) and Basagran (1.5 pt/A) plus Raptor (4 oz/A).

VEGETABLE PRODUCTION

Why Aren't My High Tunnel Tomato Plants Growing Faster

Matthew Kleinhenz

Beginning about now and lasting through mid-April, I am often asked by high tunnel tomato growers why their crop is not developing as rapidly as they expect. Troubleshooting covers a wide range of possible explanations. As various ones are considered and ruled out, the possibility they have overlooked the role of soil temperature becomes more important. The high tunnel may be heated, and the crop may have been irrigated and fertilized aggressively, but there is usually no record of the soil temperature, which greenhouse growers know is very important and work to optimize. After all, root growth significantly influences shoot growth and root growth is influenced by soil or root zone temperature.

In my view, we know far too little about soil temperatures in high tunnels — what the optimal ones are at any time and how to achieve them. Still, discussing this with people in Ohio and other states and having done some research on the topic, I was asked to summarize findings at the recent Mid-Atlantic Fruit and Vegetable Convention in Hershey. The subject of the presentation was "root zone heating and root zone temperatures for high tunnel growers" and what follows are a few messages from that presentation.

Root systems are rarely seen but their size, form, and function influence every aspect of the crop, including the size of the canopy and crop marketable yield and profit potential.

Root systems are hard-wired to follow general patterns as they develop. However, conditions surrounding root systems influence their development significantly. Further, those conditions include temperature and are partially set by the grower. So, growers are partially responsible for root system development and function. While a "strong" canopy is good evidence of an equally strong root system, without another canopy to compare it to, it is difficult to be sure it is as strong and productive as it could be. This indicates that a little on-farm experimentation can go a long way in helping optimize total crop management. It also reminds us that since we usually cannot see roots while experimenting or farming, we often need to rely on tracking factors we can measure and that are known to influence root system development and function.

Research findings suggest that tomato growth and production tend to be greatest at root zone temperatures of 65-70 degrees F. This begs two questions.

First, are root zone temperatures in your high tunnel in the optimal range as often as possible? Do you measure soil and irrigation water temperatures? We have recorded soil temperatures every fifteen minutes for various entire seasons in high tunnels and open fields at OSU-Wooster/OARDC and some of the data are shown below (click to enlarge, if needed). Notice the description of the situation in which the readings were taken and when soil temperature readings were in the optimal range. These readings may or may not represent your farm or crops. However, the data may give clues as to the potential temperatures in your fields and high tunnels and encourage you to record those temperatures directly. Reliable, easy to use, inexpensive instruments are available for doing that.

About irrigation water – much of it draws from wells and surface sources and can be very cold (from the crop's perspective) fall through spring. Although it has not been tested to my knowledge, passing well, surface, or municipal water through drip lines in a high tunnel, heated or not, may be unable to bring its temperature to 65-70 deg F. So, irrigation in the earliest part of the season may amount to bathing roots in water well below the optimal temperature for tomato and other crops and heating the air may overcome that issue only partially.

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Why Aren't My High Tunnel Tomato Plants Growing Faster

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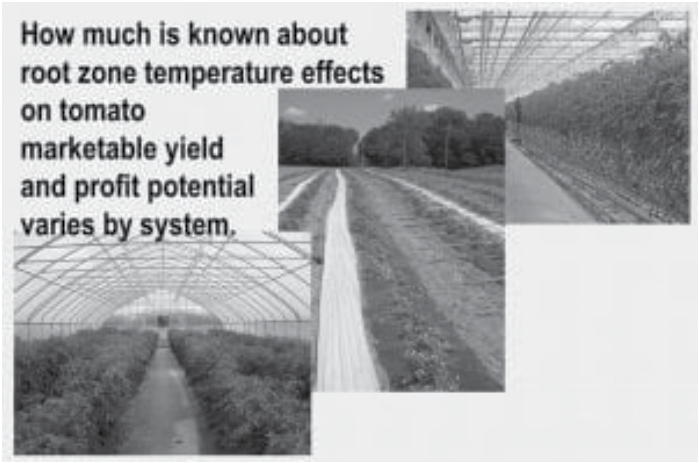
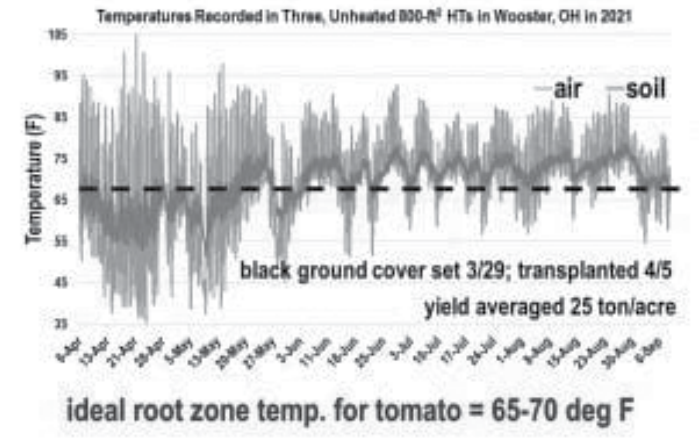
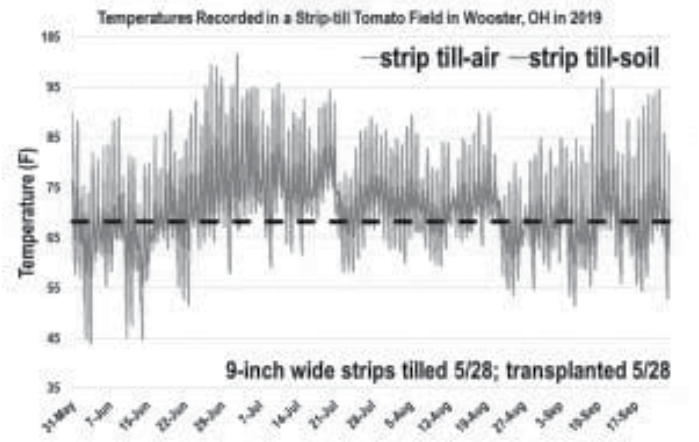
This brings us to Question 2. Are you convinced that your returns on investments in high tunnel heating, especially of the air for early season tomato production, are as high as possible? If the air temperature is high but soil temperature is low, are you getting as much from the relatively short photoperiods as you could? In early spring, crops may be more limited by a lack of sunlight than below-optimal air temperatures (and excessive heating during extended low-light periods may be counterproductive). We cannot change daylength or cloud cover, but we have some control over air and soil temperatures and may benefit from bringing investments in them into alignment with daylength. For example, should heating increase with daylength? What is the return on investment in aggressive air heating when daylength is very short soon after transplanting?

Addressing those questions opens doors to exploring the relative value of investments in air, soil, or combined heating. That is a subject for other discussions and articles, but it is worth asking if investments in air heating are returning as much as we expect based on the air temperature alone. The 11/6/21 issue of VegNet included an article on root and air heating in fall-time high tunnel leafy vegetable production (https://u.osu.edu/vegnetnews/2021/11/06/soil-heating-effects-on-days-to-harvest-quality-and-regrowth-of-three-high-tunnel-and-fall-grown-vegetable-crops/) and our previous research included spring season experiments, too. Individual crops respond differently to air and soil temperature due to biology and other reasons. For example, the growing tip of lettuce plants is closer to the soil surface than the growing tip of tomato plants and, therefore, may be more strongly impacted by root zone temperature and heating over brief periods.

The point here is that investments in high tunnel heating may be most effective when taking the whole cropping cycle and rotation into account. High tunnel management systems, including temperature, can be designed around one or a set of crops – i.e., around optimizing income from one crop or across the year. Of course, this would occur on a farm by farm, market by market basis. This spring and season, as you are able, consider taking a moment to examine your high tunnel temperature management practices and ask if they maximize your entire annual profit potential.







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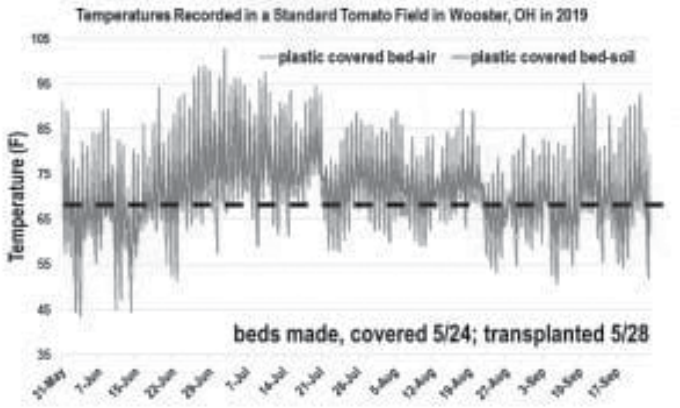

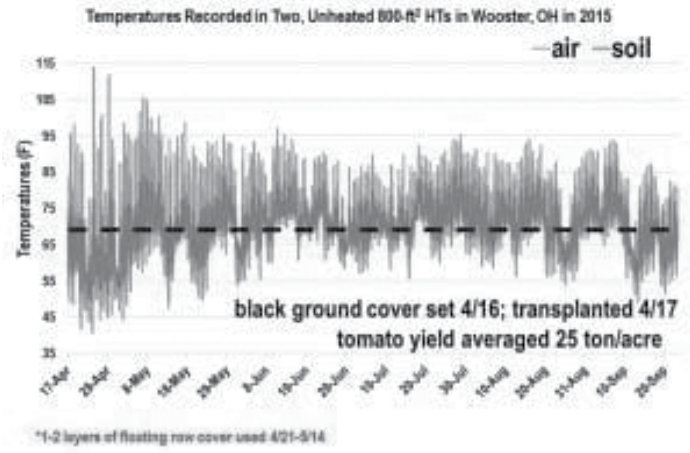

Dr. Klenheinz is with the Ohio State Univ. From the VegNet Newsletter, The Ohio State Univ. https://u.osu.edu/vegnetnews/2022/03/05/why-arent-my-high-tunnel-tomato-plants-growing-faster/, March 5, 2022.

VEGETABLE PRODUCTION

High Tunnel Spinach Crop with Significant Cucumber Mosaic Virus Infection

Karen Rane Alan Leslie and Jerry Brust

Winter crops of spinach, crucifers and other leafy produce have been growing nicely throughout most of this winter, but we came upon a high tunnel in which the spinach crop was not doing very well. We found that plants were infected with cucumber mosaic virus, CMV.

The first symptom of cucumber mosaic virus on spinach is a mild yellowing of younger leaves and a strapping or "puckered" appearance with margins of infected leaves rolling downwards (Fig. 1). As the disease progresses the foliage will show a yellow/green mottle (Fig. 2) with stunted and severely damaged crown leaves, and even death of the growing point. The earlier a plant becomes infected with the virus the more severe the symptoms and damage will be.

Figure 1. Yellowing and puckering of spinach leaves infected with CMV

Figure 2. Older CMV infected spinach with a greater mottled appearance and puckering

Cucumber mosaic virus is only one of more than 10 virus diseases of spinach, but it is one of the most common and economically important viruses of this crop. The virus is vectored by 75 different aphid species in a nonpersistent manner (meaning that the aphid acquires the virus within a minute of feeding on an infected plant but does not remain infective for very long). The virus can also be spread by cucumber beetles and by cultivating and handling plants. CMV can overwinter in many weed species and can survive the winter in the roots of a weed and move to the aerial parts in the spring, where it can then be transmitted by aphids to other plants. Some of the more important weed hosts include: bur- and wild-cucumber, catnip, chickweeds, clovers, curly dock, dandelions, fleabane, flowering spurge, groundcherries, horsenettle, Jimsonweed, milkweed, pigweed, pokeweeds, nightshades and white cockle. These infected weeds often show no virus symptoms. Vegetable hosts include carrot, celery, cucurbits, legumes, lettuce, onion, pepper, spinach and tomato.

The worst case scenario would be to have heavy weed pressure within a high tunnel along with a high aphid population and this is what we found in the HT with CMV infected spinach – there was a high population of green peach aphid (Fig. 3) and a lots of weeds, including chickweed, in the beds (Fig. 4). Winter annual weeds like chickweed need to be eliminated from the HT before planting and its management maintained throughout production of the crop. Growers also need to scout for aphids and manage this pest early, so that populations do not build to high levels. Beauveria bassiana can give good control of aphids when their populations are low but does not work as well in managing high populations. There are several aphicides that can be used to control aphids on spinach that can be found in the 2022-2023 Mid-Atlantic Commercial Vegetable Production Recommendations guide, but growers need to be sure how their state defines using pesticides in a high tunnel before using them. There are several commercial spinach varieties that are resistant to CMV that should be considered for use in a high tunnel: Avon, Renegade, Winter Bloomsdale, Melody F1, Menorca, Butterflay, Virginia Savoy, Bloomsdale Savoy, Early Hybrid #7, Marabu RZ, Unipak 151

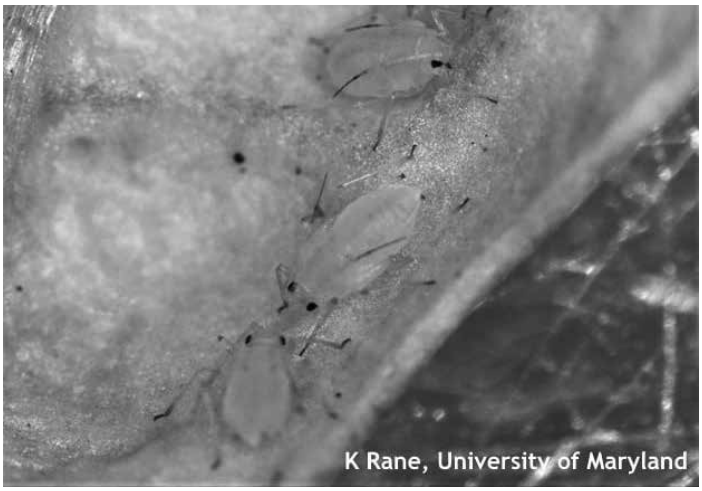

Figure 3. Green peach aphids on spinach

Figure 4. High population of chickweed alongside CMV infected spinach crop

Ms. Rane is a Plant Diagnostician with the Univ. of Maryland, Mr. Leslie is a Univ. of Maryland Extension Educator and Jerry Brust, IPM Vegetable Specialist, University of Maryland, jbrust@umd.edu
*From the **Weekly Crop Update**, Univ. of Delaware Extension, Vol. 30, Issue 1, March 4, 2022.*

VEGETABLE PRODUCTION

Sulfur Recommendations in the Mid-Atlantic Vegetable Guide

Gordon Johnson

Vegetable growers should note that sulfur (S) recommendations have been added to the 2022-23 Mid-Atlantic Commercial Vegetable Production Recommendations in the footnotes of the Recommended Nutrients section for each crop. For example, in the cole crop chapter below, 25-40 lbs. of sulfur are recommended.

Sulfur is one of the secondary macronutrients that vegetable crops require for growth. Sulfur is a component of four amino acids and is therefore critical for protein formation. It is also a component of certain glycosides that give pungency to mustard family crops (greens, cole crops) and allium crops (onions, garlic).

Recommended Nutrients Based on Soil Tests – continued

Cole Crops[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Kale, Collards	100-200	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50-100	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress after each cutting or stripping
Kohlrabi	25-50	0	0	0	0	0	0	0	0	Total nutrient recommended
	25-50	0	0	0	0	0	0	0	0	Sidedress if needed according to weather

[1]For broccoli, apply 1.5-3 lb/A of boron (B). For Brussels sprouts, cabbage and cauliflower, apply 1.5-3 lb/A of B and 0.2 lb molybdenum (Mo) applied as 0.5 lb/A sodium molybdate with broadcast fertilizer; see also Table B-7. in chapter B Soil and Nutrient Management.
[2]Include 25-40 lb/A of sulfur (S) in the fertilizer program for cole crops.
[3]In VA, crop replacement values of 25 lb/A of P_2O_5 and 25 lb/A of K_2O are recommended on soils testing Very High.

In the last 30 years, as industrial air pollution has been reduced (especially pollution from coal fired power plants) we have had less sulfur deposition from rainfall. Sulfur deficiencies are common and sulfur additions from fertilizer or manure are required for all vegetable crops to produce high yields.

Most of the sulfur in the upper part of the soil is held in organic matter. Upon mineralization, sulfur is found in the soil as the sulfate ion (SO42) which has two negative charges. The sulfate ion is subject to leaching, especially in sandy textured soils (loamy sands, sandy loams). It does accumulate in the subsoil but may not be available for shallow rooted vegetables.

In vegetable crops, sulfur removal is generally in the 10-25 lb/A range. Mustard family crops (cole crops such as cabbage and broccoli, mustard and turnip greens, radishes) remove between 30 and 45 lbs/A of sulfur. Research in our region has shown response to added sulfur for sweet corn and for watermelons. In Florida research it was shown that adding 25 pounds of sulfur per acre boosted yields by 1.7 tons per acre in tomatoes. Similar results were found with strawberries.

Our general recommendations are to apply 25-30 lbs of sulfur per acre for most vegetable crops. Remember to take credit for any sulfur being added with fertilizer sources such as ammonium sulfate (24% sulfur).

One vegetable where we want to limit sulfur is with sweet onions. Because sulfur increases onion pungency, and sweet onions are sold based on their low pungency, we limit sulfur applications to this crop.

*Dr. Johnson is the Extension Fruit and Vegetable Specialist at the Univ. of Delaware. From the **Weekly Crop Update**, Univ. of Delaware Extension, Vol. 30, Issue 4, April 15, 2022.*

VEGETABLE PRODUCTION

Edema Problem in High Tunnel Tomatoes

Gerald Brust

I recently received an inquiry from a high tunnel grower about unusual symptoms on tomato leaves. The tomatoes were planted in early March, and in the past few weeks developed blisters or callus-like growths along veins (Fig. 1 mild symptoms, Fig. 2 more severe symptoms). Leaves also showed unusual curling and other odd distortions as well as yellow spots on the upper side of the leaf (Fig. 3). Leaves with a great deal of this blistering were brittle with the leaf often cracking with any type of handling. These symptoms are edema (or sometimes spelled oedema).

Figure 1. Underside of tomato leaf showing mild symptoms (swollen tissue) of edema

Figure 2. Underside of tomato leaf with severe symptoms of edema

Figure 3. Top side of tomato leaf with edema

Edema is caused by the buildup of excess water in the root and conditions unfavorable for transpiration, usually caused by high humidity, low light and little air movement. When the tomato plant cells get too much water the cells will expand faster than they can get rid of the water leading to split and cracked tissue. Extensive edema can severely decrease the leaf's photosynthetic capability and lead to senescence. Other research has looked at poor or low light sources that affect the plant's ability to expel excess water. We have had cloudy cool weather in the last few weeks and these types of environmental conditions do not make it possible to roll up the sides of a high tunnel for good air circulation, which would help increase transpiration and reduce the likelihood of edema.

Basically overwatering, high humidity and low or poor light are the major causes for the development of edema in plants. Therefore, avoid overwatering plants especially during cool temperatures when they should be kept slightly on the dry side. Keep humidity levels below 70% by enhancing airflow around the plants and by spacing the plants farther apart. And finally, if possible though more complicated, research has shown that increasing light quality by providing a more "full-spectrum" of light output, with significantly more short-wavelength energy (i.e., UV light), will also decrease the occurrence of edema.

*Dr. Brust is the IPM Vegetable Specialist at the Univ. of Maryland. From the **Weekly Crop Update**, Univ. of Delaware Extension, Vol. 30, Issue 3, April 8, 2022.*

Getting Pole Lima Beans Started Right

Emmalea Ernest

Large-seeded pole lima beans are a unique crop produced by direct market growers and home gardeners in the Mid-Atlantic region. Unlike most legume crops, pole lima beans are usually transplanted into the field. This is because seed is expensive and sometimes hard to procure and because plants are spaced at 4 to 6 feet in the row. Here are some tips for successful production of pole lima transplants.

Quality Seed - Pole lima bean seed can be difficult to procure and consequently many growers save their own seed. Plant seeds that are free of obvious damage from fungi and insects. Fully dry seed should be stored in a sealed container (such as a lidded jar) in the refrigerator for maximum longevity and vigor.

Planting Date - Pole lima beans should be transplanted after the danger of frost. I aim for a mid-May planting in my research plots in Georgetown, Delaware. Because of their large seeds, which store lots of energy for the seedling, pole bean transplants grow quickly and the time from seeding to transplant is short, about three weeks. For mid-May planting, I seed the last week of April. It is not necessary to keep pole beans in pots longer than it takes for the seedlings to emerge and fully expand their primary leaves.

Pots and Media - Use pots with a diameter of 2.5-3 inches. I use the 2.5 inch square pots pictured below (Figure 1). Styrofoam cups can make a good pole bean seedling pot if you poke a hole in the bottom to provide drainage. Use pasteurized potting media to reduce incidence of seedling diseases. Avoid using potting media that is formulated for seed starting; this type of media is designed for germination of small-seeded crops and stays wetter than ideal for pole beans.

Figure 1. Pole lima seedlings in 2.5 inch pots.

Seeding, Water & Temp - Seeds should be planted 1.5 inches deep. I have been asked many times whether I plant my pole limas "eye up" or "eye down". I guess I am wishy-washy because I plant them laying flat on their sides! Maintaining proper moisture and temperature is probably more important than seed orientation. Transplants should be grown in a greenhouse or other warm, high light location. Water very well after seeding and keep media moist but not wet until plants have emerged. Maintain soil temperatures at ~80°F for quickest emergence. Heat mats are

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Getting Pole Lima Beans Started Right

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useful for this. If you provide ideal conditions for germination you will soon (4 days) see those green hypocotyls arching out of the potting media. After emergence, transplants can be moved off of heat mats if in a warm location.

Handle Gently & Harden Off - When seedlings have fully expanded their primary leaves (as in Figures 1 & 2) they should be moved to a protected outdoor location to harden-off for about 7 days. When handling transplants avoid breaking off the cotyledons (Figure 2) which store energy and nutrients for the growing seedling. Plants with missing cotyledons will be stunted and grow slowly. Do not keep transplants in pots longer than necessary, this too will stunt growth. Also, transplants that begin rapid shoot growth in the pot quickly become tangled with one another. At transplanting handle plants gently to avoid breaking off cotyledons or shoots.

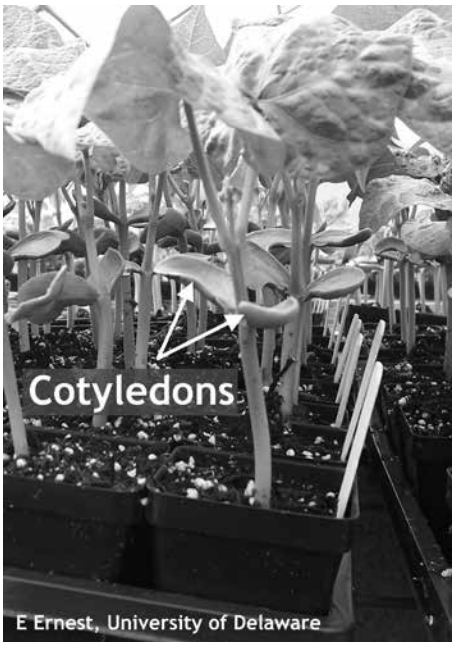

Figure 2. Be careful not to damage the cotyledons, they are providing nutrients to the growing plant.

Figure 3. Newly transplanted pole limas.

Ms. Ernest is Scientist for Vegetable and Fruit Crops at the Univ. of Delaware. From the ***Weekly Crop Update****, Univ. of Delaware Extension, Vol. 30, Issue 4, April 15, 2022.*

BERRY PRODUCTION

Strategies for Effective Management of Botrytis and Anthracnose Fruit Rot in Strawberries

Mengjun Hu and Kathleen Demchak

Managing gray mold (Botrytis) on strawberries is increasingly challenging because of fungicide resistance development, plus a new Botrytis species that is less susceptible to fungicides is becoming common in the mid-Atlantic region. Resistance to certain fungicides is also a problem in management of anthracnose fruit rot. This article describes disease management strategies designed to slow further resistance development, while also providing specifics for managing our two most common fruit rots.

First, what's new with Botrytis. There are at least 4 species of Botrytis that can infect strawberries, but only two of them have been commonly found in the region. *Botrytis cinerea*, the species traditionally infecting strawberries, is present nearly everywhere and affects many horticultural crops. Recently another species, *Botrytis fragariae*, has also been found and as its name indicates, is more specific to strawberry plants. It appears to overwinter on strawberry plant tissue, and preferentially colonizes blossoms early in the spring, causing them to "turn brown and dry up". While sometimes only one of these species is present, both can be present at the same time in a field and even in the same blossom. Using certain fungicides selects for resistant strains of either species, and also preferentially selects for one species over the other. This means that both species have resistance to multiple fungicide groups, and both species can survive in fungicide-treated fields.

How can you tell if the newer species of Botrytis might be present in your fields? While *B. cinerea* (the traditional species) is often isolated from both flowers and fruit, *B. fragariae* (the new one) is often isolated from flowers, and it has been shown that *B. fragariae* infection was much more aggressive on strawberry flowers than fruit. If you see larger-than-usual numbers of blossoms turning brown and shriveling (not to be confused with frost damage, which blackens the center of the flower), it may be prudent to choose fungicides as if *B. fragariae* presence had been confirmed in your field. If you see no more symptoms on the flowers or buds than usual, you may be able to assume that the new species isn't present, or at least not to a great extent.

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Which fungicides work for each botrytis species and which ones don't? Our traditional Botrytis species, (*B. cinerea*), is frequently resistant to iprodione (FRAC code 2, Rovral), fenhexamid (FRAC code 17, Elevate), boscalid (FRAC code 7, one of the active ingredients in Pristine), and cyprodinil (FRAC code 9, one of the active ingredients in Switch). Notably, *B. fragariae* seemed to be more tolerant/resistant to fludioxonil (FRAC code 12, the other active ingredient in Switch and also in Miravis Prime) and polyoxin D zinc salt (FRAC code 19, Ph-D or OSO), but it is less resistant to the above active ingredients with a high *B. cinerea* resistance frequency.

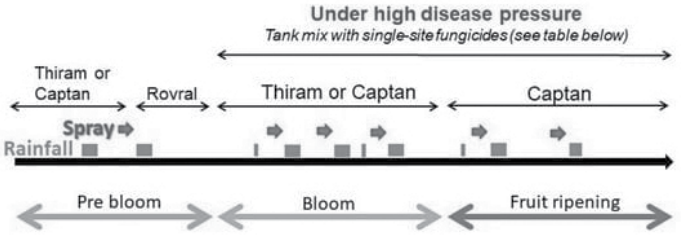
Thus far, no resistance to SDHI fungicides (active ingredients in FRAC code 7) has been detected in the newer Botrytis species *B. fragariae*. These include pydiflumetofen (the other active ingredient in Miravis Prime besides fludioxinil, which has little effect), isofetamid (Kenja), penthiopyrad (Fontelis), and fluopyram (Luna series). Boscalid, one of the active ingredients in Pristine has less intrinsic activity on botrytis species in general compared to other newer group 7 (SDHI) fungicides and as mentioned, resistance within *B. cinerea* is high. Strobilurins (FRAC code 11) and DMIs (FRAC code 3) are ineffective against Botrytis.

All of the active ingredients above are single-site fungicides, as indicated by a single number in their FRAC code, aka activity group, or simply "group" as they appear on labels. They target a single step in the fungus' processes, so simply put, the fungi find it rather easy to develop workarounds. Thiram, which works for Botrytis (and Captan) are multi-site fungicides as indicated by the "M" in their FRAC codes, so workarounds are less likely. Both play an important role in delaying resistance development to single-site fungicides. They are protectants, meaning that they form a protective layer on the surface of plant tissues, thus preventing diseases from growing into the plant. However, new growth that does not have this protective layer is vulnerable, and while the materials may simply be redistributed with light rains, heavy rains may wash the fungicides off.

More information related to fungicide resistance and categorization of products can be found at the Fungicide Resistance Action Committee web site (https://www.frac.info/).

What can you do to manage Botrytis and anthracnose? First, use all cultural methods that you can to minimize inoculum and maximize foliage drying. Having less inoculum around means less disease on your plants, and also fewer chances for resistance development. So, remove those dead and half-dead leaves from plasticulture strawberry plants in the spring, and if at all possible, remove the debris from the field. Keep weeds under control as much as possible. Weedy fields stay wet longer, and Botrytis of any type loves that moisture. The optimum temperature for growth of Botrytis is 65 to 72 degrees F – great temperatures for strawberry growth too, resulting in lots of tender easy-to-infect tissue. If foliage stays wet for 14 hours or longer, Botrytis infections are favored and spores are produced that easily waft around infecting blossoms, fruit, and leaves. Anthracnose is favored by wet conditions of 7 hours or longer, and its optimum temperatures for development are warmer (75 to 82 degrees F). Since its spores are produced in a liquid slime, it is primarily a rain-splashed disease that does not get spread over long distances unless extreme wind-driven rains occur, such as with hurricane events.

Second, target Botrytis early in the season (i.e., during bloom) when applying fungicides and anthracnose later when temperatures are warmer using these strategies: 1) Use multi-site fungicides as the backbone of your spray program to minimize resistance development to the single-site fungicides mentioned above. Maintain continuous use of thiram (more effective for gray mold) and captan (more effective for anthracnose) during the critical disease control periods of bloom and fruit ripening. Use these products alone during drier spells when disease pressure is lower. Apply *before* rain events to have the material affixed onto the foliage before the rain occurs. 2) Add single-site fungicides only when disease pressure is high (extended periods of moisture). Recommended single-site fungicides during bloom for either Botrytis species are newer category 7 (SDHI) fungicides (Merivon, Kenja, Fontelis, and certain products in the Luna series). They can also be applied during ripening if needed. If conditions conducive to anthracnose development occur earlier than usual, products effective against anthracnose may be applied. 3) Save Switch or Miravis Prime for late-season *Botrytis* management since gray mold fruit rot is mainly caused by *B. cinerea* – and these products also have good effectiveness against fruit anthracnose. Other fungicides effective on anthracnose appear in the table below. Ph-D or OSO is another good choice for *B. cinerea* control during harvest. While strategies numbered 2 and 3 are helpful in targeting specific species/diseases, strategy 1 improves fungicide resistance management.



Here is a diagram of what these management strategies would look like for June-bearing cultivars. Diagram credit: G. Schnabel, Clemson Univ.; used with permission.

Overall, how you deploy these strategies will vary with your production system. Growers in plasticulture with anthracnose-susceptible varieties may need to focus more on anthracnose management, while growers using matted row production with anthracnose-resistant cultivars may need to focus on controlling Botrytis. Growers with anthracnose-susceptible day-neutral cultivars, which continually bloom and fruit over a long period, should try to focus on using the multi-site protectants thiram and captan prior to major or consecutive rain events.

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BERRY PRODUCTION

Strategies for Effective Management of Botrytis and Anthracnose Fruit Rot in Strawberries

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All growers should use single-site fungicides only when necessary, such as when protectant sprays were missed prior to rain events. Rotate chemistries carefully, and minimize fungicide use during warm dry spells when fungicides are less likely to be needed. Check individual product labels for rates, pre-harvest intervals, re-entry intervals, and any other restrictions before applying (for example, Fontelis may not be applied on 'Jewel', 'Clancy', or 'L'Amour') and make sure the products are registered for use in your state. Specimen labels can be found at CDMS (http://www.cdms.net/LabelsSDS/home) and Agrian (https://home.agrian.com/label-lookup/), in addition to company web sites.

Dr. Hu is a plant pathologist at the Univ. of Maryland and Ms. Demchak is with the Dept. of Plant Science at Penn State Univ. From the Univ. of Maryland Extension, https://blog.umd.edu/umefruitveg/2022/04/22/strategies-for-effective-management-of-botrytis-and-anthracnose-fruit-rot-in-strawberries/, April 22, 2022.

Early Bloom →		Late Bloom →	Green Fruit →	Early Harvest →		Late Harvest
Maintain continuous coverage with thiram (group M3) or captan (group M4)*						
thiram or captan	thiram or captan	thiram or captan	thiram or captan	captan	captan	captan
*If in matted row production and gray mold is the major concern, utilize thiram more and captan less. If in plasticulture and when growing anthracnose-susceptible varieties, captan may be needed to a greater extent.						
If weather is wet, add one of the following single-site fungicides to the above, making not more than 2 applications of any activity group over the season.						
Primarily for early season gray mold control				*Save for use during harvest*		
- Fontelis, group 7, or				*For gray mold and anthracnose fruit rot:*		
- Kenja, group 7, or				- Switch, group 9 + 12, or		
- Luna Tranquility, group 7 + 9, or				- Miravis Prime, group 7 + 12, or		
- Merivon Xemium, group 7 + 11**, or				- Luna Flex, group 7 + 3		
- Luna Sensation, group 7 + 11**						
**While these products can be used for gray mold, their use will increase selection pressure for anthracnose resistance to group 11 materials.				*For gray mold but not anthracnose fruit rot:*		
				- Ph-D or OSO, group 19		
				For anthracnose fruit rot but not gray mold:		
Alternatives to group 7 fungicides if needed:				- Tilt, group 3		
- Rovral, group 2 (pre-bloom only)***, or				- Inspire Super, group 3 + 9		
- Elevate, group 17***				- Cabrio, group 11***		
				- Pristine, group 7 + 11***		
				- Quadris Top, group 11 + 3***		
				- Quilt Xcel, group 3 + 11***		
***May be used once per season if resistance to active ingredients in these products is known to be low on your farm. Do not, however, make more than 2 applications of any activity group over the course of a season.						

The table above summarizes the information presented in this article with details on specific recommended fungicides, considerations for making the best use of them while minimizing resistance development, and their activity groups.

BERRY PRODUCTION

Would My Blueberries Benefit from More Nitrogen

Emmalea Ernest

It is soon time to apply nitrogen fertilizer to blueberries. Urea or ammonium sulfate are the recommended materials. Use urea if your soil pH is in the recommended range of 4.5 to 5.0 and use ammonium sulfate if pH is greater than 5.0 or if you have a history of rising pH because of soil properties, high pH irrigation water, mulch materials or other factors.

The nitrogen (N) fertilization recommendation for established blueberry plants in the Mid-Atlantic region is 65 lbs/acre (1.2 oz/plant) each year. The recommended application timing is to apply half of the N at bloom and the remaining half 6 weeks later. In other regions of the U.S. the N fertilization recommendation for blueberries is higher and recommended applications occur later in the season. For example, in Georgia and Mississippi the recommendation for bearing blueberries grown in soil is 80-120 lbs of N/year, split over 4-5 applications with final applications in July or August. The recommendations for Oregon growers are 100-165 lbs of N/year with applications at bloom, mid-May and mid-June. The vastly different N fertilization rates and application timings in other regions have prompted questions about whether the recommendations for the Mid-Atlantic are high enough and whether a later season N application would be beneficial to blueberry yield.

Blueberry Nitrogen Fertilization Study in Georgetown, Delaware

A blueberry nitrogen rate and timing study was undertaken in an established planting of 'Chandler' northern highbush blueberries at the Carvel Research and Education Center in Georgetown, Delaware. The planting was six years old at the time the study began and yield data was collected over a three year period. Six different rate/timing treatments were tested (Table 1.). Ammonium sulfate was applied to the mulched area, followed by overhead irrigation.

Table 1. Nitrogen Rate and Application Treatments Tested

Lbs of N over # Applications	Application Timing
65 over 2	Bloom, 6 wks post bloom
65 over 3	Bloom, 3 wks and 6 wks post bloom
85 over 2	Bloom, 6 wks post bloom
85 over 3	Bloom, 3 wks and 6 wks post bloom
85 over 4	Bloom, 3 wks, 6 wks and 10 wks post bloom
105 over 5	Bloom, 3 wks, 6 wks, 10 wks, and 14 wks post bloom

Plots consisted of three plants and there were four replications per treatment, resulting in 12 plants that received each nitrogen treatment. Yield was measured on an individual plant basis with harvest twice per week.

Over the three years of the study there were no statistically significant differences in yield between the six nitrogen fertilization treatments (Figure 1). In 2016 a late freeze damaged flowers and reduced yields in all treatments. The highest yields were obtained in 2017 followed by slightly lower yields in 2018.

Additionally, leaf tissue analysis of samples collected from each plot in early August of 2016 and 2017 did not reveal any statistically significant differences in N and all samples were in the sufficient range.

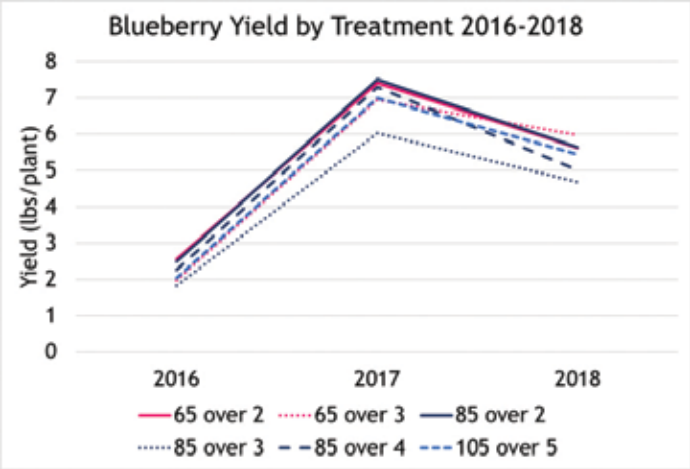

Figure 1. Blueberry yield in pounds/plant for each N fertilization treatment over the three years of the study. There were no statistically significant differences in yield between treatments in any of the three years.

Conclusions

Additional nitrogen, further splitting of nitrogen applications and later season nitrogen applications did not increase yield in Chandler highbush blueberries. Plants that received the current recommendation of 65 lbs/acre of N with half applied at bloom and half six weeks later yielded equivalently to treatments receiving more N, later N applications and more frequent N applications. The current Mid-Atlantic nitrogen recommendation for highbush blueberries provides adequate N, even in the southern part of the region. Mid-Atlantic blueberry growers should use the current N recommendation rate and timing for established plantings.

Growers should consider applying higher than the recommended rate of N in certain circumstances. If the material used to mulch blueberries is not well aged (<1 year) it will tie up N and additional N will be needed to ensure plant availability. If leaf tissue tests (sampling recommended in August) indicate N deficiency, additional N should be supplied in the spring of the following year. If plants are not producing adequate new growth, additional N might be warranted if other causes of poor vigor (soil pH, inadequate soil moisture, root disease, weed competition) are ruled out.

Ms. Ernest is Scientist for Vegetable and Fruit Crops at the Univ. of Delaware. From the ***Weekly Crop Update****, Univ. of Delaware Extension, Vol. 30, Issue 3, April 8, 2022.*

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