PENNSYLVANIA
VEGETABLE GROWERS

NEWS

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for the commercial vegetable, potato and berry grower

Governor Signs High Tunnel Bill

Governor Tom Wolf on April 18 signed into law Act 15, a bill exempting high tunnel structures from needing engineered storm water management plans. Rep. David Zimmerman of Lancaster County introduced the bill that was supported by various agricultural organizations including PVGA.

The bill does require high tunnels without storm water buffer or diversion systems to be at least 35 feet from streams, watercourses, public roads and property lines if they are on ground with a slope of 7% or less. If they are located on ground with more than a 7% slope they must be at least 100 feet from streams, watercourses, public roads and property lines unless they have appropriate storm water buffer or diversion systems.

The Pennsylvania Vegetable Growers Association is grateful to Rep. Zimmerman as well as Sens. Scott Martin, Ryan Aument and Gene Yaw for working to get this bill approved and is hopeful it will enable growers to proceed with the erection of many new planned high tunnels. PVGA is concerned that language in the bill may restrict the size of high tunnels that will be exempted. We understand the intention was to allow high tunnels to be exempted from storm water plans as long as the area under high tunnels is less than 25% of the total farm property. However, the way the bill was written could be interpreted to limit the exemption only to high tunnels that are less than 25% of the area currently under structures on the property. We are hopeful that the Department of Environmental Protection and municipalities will interpret the bill the way it was intended. PVGA would appreciate growers contacting us at 717-694-3596 or pvga@pvga.org if they (or growers they know) run into problems with this provision of the bill.

Limiting Liability for Agritourism Operators

As farm income declines, more and more farmers are turning to agritourism as a way to bring in extra revenue and keep farming. And with consumers growing more interested in learning where their food comes from, such operations are exploding in popularity.

But as Monroe County farmer Stuart Klingel has found, that can be a double-edged sword.

More customers at his corn maze and fall festival means a greater chance of somebody getting hurt. And as people grow more litigious, he said, insurance companies are getting more squeamish about covering the farm.

"It just seems the smallest of incidents can be potentially a big problem," Klingel said. "We have a very good safety record. But it seems the last several years, as soon as you have a twisted ankle or anything, one of the questions right away is: 'Are you well-insured.'"

That's why Klingel and other farmers with agritourism operations hope to see the state limit their exposure to lawsuits over incidents beyond their control. As he sees it, if someone gets hurt because he created unsafe conditions, shame on him. But he shouldn't be liable for a twisted ankle or skinned knee that came from the normal risks associated with being outdoors on a farm.

"When you come to a farm or you go somewhere where it's an outdoor activity where the terrain is uneven, you're around animals or equipment, you have to accept some of the responsibility," he said.

Farmers are backing a bill by state Sen. Ryan Aument of Lancaster County to grant agritourism operations what's called civil liability immunity. That legislation, Senate Bill 820, would protect agritourism operators from lawsuits over injuries related to participation in the activities as long as they post signs informing visitors that they assume some of the risk of participation.

It's not that there has been a rash of major incidents at agritourism operations, farmers said. But the threat of lawsuits has driven up insurance costs. Few insurers are willing to cover agritourism because of the liability involved, farmers said, and the coverage that is available is expensive.

"Some carriers get uncomfortable when you get over a certain level (of customers)," said Josh Grim, owner of Grim's Orchard and Family Farms in Lehigh County. "They're used to the small family farm and they don't mind that risk. But once you start putting tens of thousands of people through, they get uneasy."

Susan Bucknum, a Cumberland County attorney who specializes in agriculture, has been working with a group of agritourism operators to address their concerns. She said the proposed law could help alleviate those costs by reducing the liability associated with agritourism.

There is already a legal defense for businesses that are sued by people who were injured while engaged in activities they knew came with a risk, she said. For example, a baseball team may use that defense if sued by a fan who was hit by a foul ball. But she said, that defense is open to interpretation by

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Advocates Seek to Increase Funding for PASS Program

When Sterman Masser Potato Farms is left with misshapen or odd-looking potatoes that retailers won't take, the otherwise fine spuds often find a home at the Central Pennsylvania Food Bank. That way, families in need have access to fresh potatoes and the vegetables that would otherwise be waste are put to good use.

"That off grade is still usable food and completely safe to eat," said Julie Masser Ballay, a Farm Bureau member and Sterman Masser's Vice President and Chief Financial Officer. "So we're always looking at scenarios where we can either sell that or distribute that in some way so that it's not being given away as cattle feed...Knowing that this is central Pennsylvania, that we're helping families in need in the local area, that we're able to support that system, is really great."

Sterman Masser has been able to expand its relationship with the food bank through the Pennsylvania Agricultural Surplus System (PASS) program. The state Department of Agriculture initiative, first funded in 2015, helps cover the cost associated with getting surplus agricultural items into the state's food banks. The goal is two-fold. Farmers benefit by having an outlet for items they otherwise would not have a market for. And food banks are able to provide families in need with fresh items they otherwise would not be able to afford.

"This was an intentional program to get agriculture to think about the charitable food network," said Jane Clements-Smith, Executive Director of Feeding Pennsylvania, the advocacy group that represents the state's food banks. "It's valuable that we know the money is being spent with Pennsylvania farmers and processors and is being distributed to Pennsylvania families."

Since 2015, more than 6.5 million pounds of food have been distributed through the PASS program to families in all 67 counties. Agricultural products—including fresh produce, milk and dairy products, meat, eggs and more—have been sourced from nearly 100 farmers or processors in 35 counties.

Supporters of the program hope to see it expand and are calling on the General Assembly to triple its funding to at least $3 million per year. The increased funding would enable food banks to work with even more farms, accept more product and deliver fresh items to even more families.

"We would be begging farmers to join and trying to reach out," said Beth Hamilton, Director of Food Sourcing and Logistics for the Central Pennsylvania Food Bank. "Our goal is to work with a farm in each county that we serve but I don't have enough funds right now to be able to do that."

Hamilton said the program has enabled the food bank to expand relationships with farms and provide more variety and more nutritious food as a result of those relationships. PASS funds have helped add items that would usually be cost prohibitive, such as fresh meat and seasonal veggies, like broccoli and cauliflower.

When farmers contract with the food banks through the program, the food is essentially donated but PASS funds help farmers recoup the costs of preparing the items and getting them to the food bank. The money can also be used for processing, packaging items for distribution to families or making value-added products.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Limiting Liability... *(continued from page 1)*

a judge or jury and a farmer, if sued, would still have to argue his or her case in court. But if the law spells out clearly that agritourism operators aren't liable for injuries—as Aument's bill would do—then such lawsuits could be dismissed from the outset, saving the time and expense of going to court and reducing the risk of losing the case.

Many other states already offer similar protections for agritourism.

"Pennsylvania is a minority. The majority of states have it," said Jack Coleman, owner of Cherry Crest Adventure Farm in Lancaster County. "It's not like we're trying to do something different."

Growers in favor of this bill are urged to contact their state senators to let them know that they support SB 820.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

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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 furture 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 Secretary, at the above addresses.

National News Briefs

Agriculture Priorities Included in Spending Bill

There's good news for farmers in the $1.3 billion spending bill recently approved by Congress and signed by President Donald Trump.

In addition to exempting farmers for reporting routine livestock emissions and extending the deadline for agricultural haulers to comply with electronic logging requirements, the omnibus legislation tackles several issues that have been among farmers' priorities.

The bill creates a $625 million pilot program for rural broadband and increases funding for agriculture research. In addition, the plan prohibits the closing of Farm Service Agency (FSA) offices and increases funding for FSA programs and loan officers. The spending bill, which will fund the federal government through September, also fixes a provision (Section 199A) in the tax reform legislation enacted earlier this year that provided a tax advantage to farmers who sold their products to cooperatives, but not to private companies.

"The new provision allows farmers to take advantage of the tax break, regardless of whether they sell their agricultural goods to a cooperative or another food processing company," Pennsylvania Farm Bureau President Rick Ebert said.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Congress Takes First Steps on Farm Bill

The 2018 Farm Bill has cleared its first hurdle in Congress. The House Committee on Agriculture marked up and passed the legislation this week, which means the bill could be put to a vote by the full chamber in the coming month. Farm Bureau supports the bill and hopes to see it become law before the 2014 Farm Bill expires at the end of September. "This is great news for farmers and ranchers everywhere," American Farm Bureau Federation President Zippy Duvall said. "H.R. 2-The Agriculture and Nutrition Act of 2018-takes us one step closer to bringing certainty to families who face the toughest farm economy in more than a decade." The proposal protects current Farm Bill spending and keeps farm and nutrition programs unified in one bill. Under the legislation, the Dairy Margin Protection Program, which was recently updated by a federal spending bill, would be rebranded as the Dairy Risk Management Program and include additional changes such as lower Tier 1 premiums, additional coverage level options and measures to more accurately calculate feed costs. The bill also calls for maintaining and strengthening the Price Loss Coverage and Agricultural Risk Coverage programs and would give producers a chance to make a new election between the two. Also included in the bill are provisions designed to improve federal crop insurance, conservation programs, specialty crops, research, and rural development.

*From **Farm Bureau Express,** Penna. Farm Bureau, April 20, 2018.*

Tariffs Could Hurt Agriculture Exports

New tariffs on steel and aluminum are likely to hurt Pennsylvania farmers who rely on international trade to sell their goods, agricultural organizations say.

President Donald Trump recently signed executive orders increasing taxes on steel imports by 25 percent and those on aluminum imports by 10 percent.

Farm Bureau is concerned that affected nations will retaliate by placing new tariffs on U.S. agricultural products. That concern has already been realized with Chinese officials announcing tariffs on U.S. pork, wine and fruit. China is the second-largest recipient of U.S. agricultural goods, accounting for 15 percent of U.S. agricultural exports.

Chinese retaliation is especially bad news for Pennsylvania, a major pork-producing state. Exports of Pennsylvania pork generate $67.5 million per year.

"Higher tariffs make our products more expensive and less competitive, which opens the door for other countries to replace the U.S. as a supplier of food overseas," said Pennsylvania Farm Bureau President Rick Ebert.

Pennsylvania agriculture exports $2.2 billion in goods each year, with 59 percent of agricultural exports going to aluminum-producing countries and 17 percent of total agricultural exports going to steel-producing countries.

"Farm income across commodities has fallen by about 50 percent over the past four years," American Farm Bureau Federation President Zippy Duvall said. "Retaliation in the trade arena makes our outlook even worse. This could not be happening at a worse time for American agriculture."

On the upside, Trump's orders exempt Canada and Mexico from the new tariffs as the U.S. renegotiates the North American Free Trade Agreement. Those nations receive 60 percent of Pennsylvania's agricultural exports.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Syngenta Agrees to Settlement with Farmers in Corn Exports Case

Swiss seed company Syngenta has agreed to a $1.5 billion settlement in a class action lawsuit from grain producers and processors over the company's marketing of a genetically modified corn seed that had not yet been approved for import by China.

The settlement covers corn growers, grain-handling facilities and ethanol plants that sold corn priced after Sept. 15, 2013. Members of that class will have a limited time to submit a claim, opt out or object to the terms of the settlement before a federal judge decides whether to approve the settlement. If the settlement is approved, funds could be distributed next year.

The case stems from Syngenta's marketing of a strain of genetically engineered corn prior to China approving that strain for importing. That resulted in China halting U.S. corn for about a year and grain prices plunged as a result. Farmers and processors argued that Syngenta was negligent in putting the seeds to market before obtaining approvals from China, which is a major importer of U.S. corn. The company says it did nothing wrong.

*From **Pennsylvania Agricultural Alliance Issues Update,** Penna. Farm Bureau, April 2018.*

Electronic Logging Mandate Delayed Again for Agricultural Haulers

Commercial haulers of livestock and agricultural commodities will remain temporarily exempt from a mandate to use electronic logging devices as federal officials consider how to rectify the unique challenges the rule poses for agriculture.

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State News Briefs

Bill Extending Safe Harbor to Local Taxes Clears General Assembly

A Pennsylvania Farm Bureau-supported bill that would make it easier for farmers to estimate local tax payments has cleared the General Assembly. House Bill 866, sponsored by Rep. George Dunbar of Westmoreland County, passed the state Senate this week and now heads to Gov. Tom Wolf for his signature. The House passed the bill last June. Now, the state and federal governments allow farms and other businesses to estimate tax payments based on the previous year's tax liability. But local taxing bodies don't give those same "safe harbor" provisions. The legislation would extend those provisions to local taxes. PFB believes farmers should be allowed to estimate based on the previous tax year given the difficulty in predicting farm income, which varies widely from year to year and is influenced by market forces, commodity prices and input costs.

*From **Farm Bureau Express,** Penna. Farm Bureau, April 20, 2018.*

State House Passes Small Business Tax Overhaul Bills

The state House recently passed two Farm Bureau-supported bills that bring state laws governing small business taxation more in line with federal standards. The bills, which now head to the state Senate for consideration, are part of a tax reform package that would also help level the playing field between small businesses and corporations. House Bill 331, sponsored by Rep. Stephen Bloom of Cumberland County, would bring Pennsylvania tax laws in line with federal standards of "like-kind" exchanges. Federal law allows for a tax deferral when property is exchanged for similar property, but Pennsylvania does not have any such provisions. House Bill 333, sponsored by Rep. Eric Nelson of Westmoreland County, would bring state tax laws for Section 179 depreciation in line with federal standards. At the federal level, Section 179 allows small business owners to deduct the purchase of qualifying equipment up to $500,000 during the tax year. Currently, Pennsylvania limits deductions for small businesses under Section 179 to $25,000, while allowing businesses registered as C-corporations to use the full $500,000 deduction as allowed by IRS law.

*From **Farm Bureau Express,** Penna. Farm Bureau, April 20, 2018.*

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The U.S. Department of Transportation last month extended by an additional 90 days a previous exemption granted for agricultural haulers, which was due to expire March 18. Shortly after, a measure in a congressional spending bill gave an additional extension. Now, agricultural haulers are exempted from the electronic logging requirement through the end of September.

At the same time, the department is considering a request by Farm Bureau and other agricultural groups to provide livestock haulers a limited exemption from the regulation. Most farmers would be exempt from the mandate anyway because federal law exempts drivers of "covered farm vehicles" from logging requirements. But drivers for commercial trucking businesses who transport livestock, live fish and insects are likely to fall under the requirements.

The agricultural groups argue that the hours of service requirements—which the electronic logs are intended to enforce—are problematic for haulers transporting live animals due to the requirement that drivers stop and take a minimum 10-hour break after reaching their service hour limit. The groups point out livestock haulers' specialized training and commitment to ensuring both the animals' well-being and the safety of other drivers.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Governor Rolls Out Broadband Initiative

Gov. Tom Wolf last month outlined his proposal for expanding access to high-speed internet in rural and underserved areas of the state.

The plan creates a Pennsylvania Office of Broadband Initiatives, tasked with developing and executing a plan to expand broadband access to every state resident by 2022. The governor's office estimates more than 800,000 Pennsylvanians still lack reliable access, more than 520,000 of them in rural areas. Mark Smith, a former Bradford County commissioner and Wolf's deputy chief of staff will lead the office.

The state also plans to offer $35 million in incentives for private companies to bid to expand internet service in Pennsylvania through the federal government's Connect America Fund Phase II Auction. That program provides nearly $2 billion nationally for expanding broadband.

The state funds would be used to spur investment in Pennsylvania by giving companies an incentive to bid to expand service in the state and leverage the state money to attract federal dollars.

"This is an opportunity to attract investment in many of Pennsylvania's rural areas and to provide service to many unserved residents, businesses, and farmers," Wolf said.

Money for the incentive program will come from PennDOT with the stipulation that PennDOT can then access that internet infrastructure to support the state's transportation system.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Pennsylvania Students Learn Agriculture's Story

Schools across Pennsylvania were once again host to farmers answering questions about wheat, blueberries, eggs, and buttermilk as part of the second annual Ag Literacy Week.

Spearheaded by the Pennsylvania Friends of Agriculture Foundation, a charitable organization supported by Pennsylvania Farm Bureau, Ag Literacy Week brought volunteer readers to more than 1,200 classrooms across the state, triple the number from last year's inaugural event. In addition to volunteers from county Farm Bureaus, the effort engaged organizations such as FFA, 4-H, Dairy Promotion, Pennsylvania Department of Agriculture and others.

Farmers and other volunteers read the book "Tyler Makes Pancakes," which tells the story of a boy named Tyler as he learns about the agricultural origins of each ingredient of his favorite pancake recipe as he prepares to make breakfast for his family. During the visits, volunteers led the kids through a bingo game in which each bingo square corresponds to a question about their favorite foods and what type of animal or plant each ingredient comes from, such as cows, chickens, trees, or other types of plants.

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The exercise helps the kids make the connection between the foods they eat at home and the farms the foods come from, and it gives farmers the opportunity to tell students about their own farms, and the work they do to put food on their tables.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Help Us Spread the Word: Educator's Ag Institute

The Pennsylvania Friends of Agriculture Foundation is committed to growing agriculture literacy. And one way the foundation achieves that goal is by helping educators develop lesson plans based on agriculture.

The foundation, a charitable organization supported by Pennsylvania Farm Bureau, is hosting the Educator's Ag Institute this summer at Penn State. This year's institute, planned for July 8-12, will give teachers an up close and personal look at farming practices, and how they can use agriculture as the basis for lesson plans.

While at the conference, educators will tour a number of Penn State's agriculture facilities, participate in hands-on lessons and leave with a host of materials for use in their classrooms.

The Educator's Ag Institute is open to new educators, along with those who have previously attended our Ag in the Classroom workshop. Participants will also tour several area farms and hear from farmers about how they grow food, care for and feed their animals, and how the farm is run. Educators will receive Act 48 credits and/or can register for continuing education credits through Penn State.

Please consider sharing information about this valuable workshop with educators in your area. For more information, contact the foundation at 717.731.3556 or www.pfb.com/aginstitute.

*From **Pennsylvania Agricultural Alliance Issues Update**, Penna. Farm Bureau, April 2018.*

Farm Bureau Opposes Bill to Cut State Legislative Seats, Reduce Rural Influence

Pennsylvania Farm Bureau is pushing against a plan that the organization believes would dilute the voice of rural families in state government by reducing the number of seats in the General Assembly.

The state House recently passed House Bill 253, which calls for cutting the number of House districts to 151 from 203 and reducing the number of Senate districts to 37 from 50. The legislation now heads to the Senate for consideration.

PFB believes that cutting legislative seats would result in more districts being concentrated in urban and suburban areas, reducing the influence of rural Pennsylvanians. That would weaken the ability of farmers and rural families to have their concerns and needs addressed in Harrisburg.

If the bill were to clear the General Assembly this year, it would be only the first step in a lengthy process. Changing the size of the General Assembly would require an amendment to the state Constitution. For that to happen, the House and Senate must each pass identical resolutions in back-to-back legislative sessions. Then, the proposed amendment would be put to a public vote in the form of a ballot question.

The Generally Assembly passed a resolution last session calling for the reduction in the House but not one calling for reducing the Senate or both chambers.

*From the **Pennsylvania Agricultural Alliance Issues Update,** Penna. Farm Bureau, March 2018.*

Application Deadline Looming for REAP Tax Credits

The Pennsylvania Department of Agriculture today reminded farmers of an impending June 30 deadline to apply for Resource Enhancement and Protection (REAP) program tax credits. The tax credits can help those in production agriculture offset the costs of implementing best management practices (BMPs) or purchasing on-farm conservation equipment. Producers should apply by June 1.

"Agriculture producers are facing tremendous market volatility and uncertainty today. At the same time, our farmers want to be good stewards of our natural resources, and they're being called on to help restore and protect the quality of our waterways," said Agriculture Secretary Russell Redding. "REAP is a way for farmers to make upgrades and improvements that increase their farm's bottom lines and clean up our waterways at the same time. If you're an agricultural producer thinking about purchasing new equipment or implementing a BMP and you want to take advantage of REAP, now is the time to act.."

REAP is a Pennsylvania tax credit program for agricultural producers who install BMPs or make equipment purchases that reduce nutrient and sediment runoff, which improves Pennsylvania's streams and watersheds. The program is administered by Pennsylvania's State Conservation Commission, which provides support and oversight to the state's 66 county conservation districts.

Farmers may receive tax credits of up to $150,000 per agricultural operation for 50 to 75 percent of the project's cost. The most commonly approved projects are for no-till planting and precision ag equipment, waste storage facilities, conservation plans, nutrient management plans, and protecting barnyards and other areas with animals. Cover crops and riparian stream buffers are also popular REAP-eligible practices. REAP can be used in conjunction with other funding sources, such as the Environmental Quality Incentive Program (EQIP) or the Chesapeake Bay Program to help install BMPs.

For projects that include the proposed purchase of equipment, the equipment must be delivered by June 30, 2018. For projects involving the implementation of structural BMPs, all BMPs and BMP components must be complete by June 30, 2019 to be eligible.

REAP applications are accepted on a first-come, first-served basis, up to the June 1 deadline for this year's funds. The longer producers wait, the less chance they have of securing funding from this year's allocation, Redding added.

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GENERAL

Understanding FSMA: The Produce Safety Rule

Luke La Borde

Editor's Note: This is the first in a series of articles on FSMA that will appear in the Penna. Vegetable Growers News. Dr. La Borde at the Department of Food Science at Penn State University prepared this summary which we have divided into segments to be published in the newsletter. The entire article is at https://extension.psu.edu/understanding-fsma-the-produce-safety-rule.

The Food Safety Modernization Act (FSMA) is considered to be the most sweeping reform of food safety laws in more than 70 years. Signed into law by President Obama on January 4, 2011, it directs the U.S. Food and Drug Administration (FDA) to shift the focus away from merely responding to contamination events toward establishing systems to prevent them from occurring. Seven regulations were written under the law, each of which will affect the vast and complex food production, processing, and distribution network that provides consumers with an uninterrupted supply of safe, nutritious, and affordable food. One of these regulations, "Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption," is of critical importance to growers of fresh produce. Known more simply as the "Produce Safety Rule," this regulation establishes, for the first time, science-based minimum food safety standards for growing, harvesting, packing, and holding fruits, vegetables, mushrooms, and sprouts intended for human consumption.

The following is a discussion of

(1) farming activities and types of produce that are covered under the rule,
(2) key requirements within the regulation,
(3) certain exemptions and modified requirements for which farms may be eligible, and
(4) deadlines for complying with the rule.

Coverage under the Produce Safety Rule

When we say that a type of produce, a produce-growing activity, or a farm or orchard is "covered" under the regulation, we mean that growers who meet the criteria for coverage will need to comply with the farm food safety standards written in the regulation. Not all produce or growing activities are covered. Retail establishments where produce is sold or served to consumers (e.g., farm stands, farmers markets, grocery stores, and restaurants) are not covered under the regulation, although they may be covered under other state or local regulations. Only commercial produce farms are affected. Home gardens are not regulated.

Criteria for determining which farms or types of produce are covered are based on the size of the farm in terms of annual sales and the inherent risk for some commodities to cause illness if they were to become contaminated.

Fruits, vegetables, sprouts, and mushrooms covered under the regulation are:

1. Grown on commercial farms with average annual produce sales of at least $25,000 calculated over the previous three years of production. Sales values in the regulation written

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in 2011 must be adjusted upward each year to account for inflation (i.e., $25,000 in 2011 is $27,199 in 2017 dollars).

2. Likely to be eaten raw (e.g., leafy greens, cucumbers, tomatoes, summer squash, and most fruits). Raw produce is considered riskier than cooked fruits and vegetables where any harmful microorganisms are likely to be destroyed.

Put another way, produce not covered under the regulation includes those commodities that are:

- Grown on farms with average annual produce sales less than $25,000 ($27,199).
- Rarely eaten raw (e.g., potatoes, winter squash, pumpkins, and some root crops). FDA has an exhaustive list of produce that is rarely consumed raw, and thus not covered under the regulation, at tinyurl.com/RarelyConsumedRaw.

Qualified and processing exemptions are available wherein all parts of the rule are not required and only certain modified requirements are in place. These will be discussed later in this article. Keep in mind that even if you think your produce is not covered, you are still required to do all that you can to prevent contamination with harmful microorganisms.

Key Requirements in the Produce Safety Rule

The Produce Safety Rule is divided into key requirements that are intended to prevent contamination of produce during production, harvesting, and after harvesting. Each of these will be discussed separately in detail:

1. Worker Health, Hygiene, and Training
2. Agricultural Water for Pre- and Postharvest Uses
3. Biological Soil Amendments
4. Domesticated and Wild Animals
5. Equipment, Tools, Buildings, and Sanitation
6. Required Records

Worker Health, Hygiene, and Training

FDA requires that all personnel who harvest or handle fresh produce covered under the regulation, and those who supervise them, receive food safety training that is appropriate to their assigned duties. Training must be offered upon hiring and periodically thereafter, and it must be presented in a language that all workers can understand.

Specific training outcomes required for harvesters and handlers include:

1. Recognizing the importance of health and personal hygiene for all personnel and visitors, including knowing symptoms of a health condition that is reasonably likely to result in contamination of produce or food-contact surfaces with harmful microorganisms.

2. Knowledge of appropriate hygienic practices when handling produce or food-contact surfaces. This includes washing and drying hands when necessary, especially after using the toilet, and removing or covering jewelry that could fall into the product.

3. The ability to recognize produce that should not be harvested because it is likely to be contaminated with harmful microorganisms.

4. Understanding the importance of inspecting harvest containers and equipment prior to harvest so that they are functioning properly, clean, and maintained.

In addition to these requirements, at least one supervisor or responsible person on a covered farm must have completed food safety training at least equivalent to that received under a standardized curriculum recognized by FDA. The Produce Safety Alliance (PSA), in association with FDA, has created a seven-hour training curriculum. Grower training courses are offered throughout the country and can be found on the Produce Safety Alliance website at producesafetyalliance.cornell.edu/training/grower-training-courses/upcoming-grower-trainings. In Pennsylvania, Penn State Extension offers regular produce safety certification courses. Visit the Penn State Extension FSMA website at extension.psu.edu/fsma for a list of upcoming courses in Pennsylvania.

To be continued next month.

Application Deadline... *(continued from page 6)*

"Governor Wolf and the General Assembly have made a commitment to continue funding the REAP program in this year's budget," Redding noted. "They see its value for our farms and waterways, and hear firsthand from farmers who have benefited from the program. I thank everyone who has a hand in this program's success."

Private investors may act as project sponsors by providing capital in exchange for tax credits. Any individual or business subject to taxation through personal income tax, corporate net income tax, the bank shares tax or others is eligible to participate in REAP.

Since the program began in 2007, REAP has awarded tax credits to more than 4,800 projects totaling more than $68 million. Public and private investments in REAP have contributed to the conservation projects, worth more than $165 million.

The 2017-18 REAP application packet, as well as other information about REAP, is available on the Pennsylvania Department of Agriculture's website, agriculture.pa.gov, or by contacting Joel Semke at 717-705-4032 or jsemke@pa.gov. Learn more information about WIP3, Pennsylvania's Chesapeake Bay strategy by visiting the WIP3 webpage.

Looking for Farm Labor?

In our membership and other grower surveys, farm labor is listed as a major concern facing growers. Besides the various rules and regulations regarding labor, simply finding enough good, reliable, skilled and legal farm workers is challenging for many growers. PVGA is exploring how we as an Association can help growers find that labor source. Currently the federal H-2A program is one way that some growers have successfully used to find workers. However, it does require considerable paperwork and expense. We are in contact with the Pennsylvania Department of Agriculture and other groups trying to develop a cooperative approach to working with the H-2A program that will make it less daunting and more cost-effective for smaller growers who may only be looking to hire a few H-2A workers. If you would be potentially interested in working with this cooperative effort, please contact PVGA at 717-694-3596 or pvga@pvga.org so we know of your interest and can keep you informed about the effort. We anticipate organizing an all-day session in early November to assist growers in filling out the H-2A application. It would be followed up by a subsequent session, perhaps at the 2019 Mid-Atlantic Convention, with further information. Again, please let us know if you would be interested in at least exploring this possibility.

Update on Colored High Tunnel Peppers

Timothy Elkner

Introduction - Colored bell peppers are a high-value crop for vegetable growers. Producing these peppers in the field is risky because weather conditions can reduce marketable fruit. In addition, field production delays maturity of the crop. Earlier research showed that colored bell production was a good fit for high tunnel production because it helped overcome these two problems. The best red, yellow and orange varieties were identified in 2012 and recommended to growers. Since that trial was completed new pepper varieties have been introduced and this study was conducted to evaluate these new varieties compared to current standards.

Materials and Methods – Thirty-four bell pepper varieties varieties (named and advanced selections) were evaluated using plasticulture (narrow beds) and drip irrigation in a high tunnel. Mature fruit colors were red, orange and yellow. Plants were seeded on April 6 and transplants were set in the tunnel on May 16. There were three 4-plant replications per variety except for 'Dazzle' which only had one replication of 4 plants. Plants were set in the beds in a double row with an in-row spacing of 1.5 ft. No fertilizer was applied preplant based on soil test results and in season fertility was based on recommendations as found in the Commercial Vegetable Production Guide and adjusted based on tissue test results. Harvest started on August 2 and stopped on October 31. Fruit were graded into #1, #2 and cull and each group was counted and weighed. Pests were managed using biological controls most of the season.

Results and Discussion – Red varieties with the highest yields of #1 fruit by weight were Antebellum, Bocca, Karisma, Mercer, Ninja, Red Knight and Sprinter (Table 1). Varieties with the highest yields of marketable fruit (#1 & #2) were Antebellum, Karisma, Mercer, Ninja, PS 1819, Red Knight and Touchdown. CS 1730 and PS 1819 had the largest average fruit size for #1 fruit; Sprinter had the smallest and at 0.42 lbs. is most likely too small for most markets.

All orange varieties had similar yields of #1 fruit by weight except for Garfield which was lower (Table 2). Garfield had the greatest average fruit size at 0.62 lbs. while all other varieties were 0.50 lbs or lower. Average size for orange bell peppers in previous studies was similar to this season and in general this color tends to have smaller fruit. Varieties with the highest total marketable yield per plant were Delerio and Muscato.

Yellow varieties with the highest yields of #1 fruit by weight and good fruit size were Dazzle, Early Sunsation, and Sirius(Table 3). Catriona had good yields of #1 fruit but small fruit size; Galleon had good fruit size but poor yield. Varieties with the best marketable yields were Catriona, Dazzle, Early Sunsation and Sirius.

I would like to thank the PA Vegetable Marketing & Research Board and PVGA for funding this trial.

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Update on Colored... *(continued from page 9)*

Table 1. Number and weight of #1, #2 and cull fruit, total marketable weight and total harvested weight of fruit for 22 varieties of red bell peppers grown in a high tunnel in Lancaster County, PA in 2017. Values are for individual plants.

Variety	Number #1 Fruit	Weight #1 Fruit (lb)	Average Fruit Wt. #1 (lb)	Number #2 Fruit	Weight #2 Fruit (lb)	Total Marketable Weight (lb)	Number Culls	Weight Culls (lb)	Total Harvested Weight (lb)	Source**
Antebellum*	4.83	3.18	0.66	1.42	0.85	4.03	3.08	1.91	5.93	TW
Bocca	4.58	3.01	0.66	0.92	0.58	3.60	1.58	1.00	4.60	SW
Cherokee	3.33	2.30	0.69	2.17	1.43	3.72	1.92	1.24	4.97	SK
CS 1730	2.83	2.20	0.78	1.33	0.87	3.07	1.92	1.04	4.11	CS
Green Flash*	3.67	2.52	0.69	1.75	1.04	3.56	1.92	0.93	4.49	CS
Karisma	4.50	3.18	0.70	1.92	1.21	4.39	1.50	0.93	5.33	SW
Majestic Red	4.25	2.40	0.56	1.83	1.06	2.63	2.67	1.24	4.70	TW
Mariner*	1.83	1.15	0.63	1.58	0.94	2.10	2.75	1.48	3.58	CS
Mercer	5.17	3.23	0.62	2.00	1.25	4.48	1.92	1.06	5.54	SG
Mingun	3.50	2.44	0.70	1.75	1.12	3.56	2.67	1.57	5.13	SW
Ninja*	6.25	3.90	0.60	1.75	1.03	4.93	2.75	1.34	6.27	SK
Pepper #1	3.67	2.49	0.68	1.42	0.84	3.33	1.67	0.96	4.29	CS
Procraft	4.67	2.94	0.63	1.42	0.83	3.78	2.00	1.08	4.86	SW
PS 1819	3.67	2.81	0.77	2.25	1.68	4.49	1.58	1.09	5.51	SW
PS 8302	2.00	1.44	0.72	1.92	1.37	2.81	1.33	0.99	3.80	RP
PS 9325*	4.00	2.73	0.68	0.83	0.54	3.27	2.25	1.40	4.66	RP
Red Knight	6.42	3.65	0.57	2.00	1.08	4.74	2.50	1.23	5.96	SW
Samurai*	5.25	2.92	0.56	1.92	0.98	3.90	1.42	0.70	4.60	SK
Sprinter	6.50	3.01	0.46	1.42	0.69	3.72	1.92	0.75	4.47	SG
SV 3255*	3.83	2.54	0.66	1.50	0.90	3.44	2.33	1.38	4.82	RP
Touchdown	4.08	2.63	0.65	2.25	1.38	4.02	1.33	0.73	4.75	SK
Triology	4.00	2.76	0.69	1.25	0.79	3.54	1.42	0.71	4.25	SW

*X-10 variety
**CS = Clifton Seed; RP = Rupp Seed; SG = Siegers Seed; SK = Sakata Seed; SW = SeedWay; TW = Twilley Seed

Table 2. Number and weight of #1, #2 and cull fruit, total marketable weight and total harvested weight of fruit for 5 varieties of orange bell peppers grown in a high tunnel in Lancaster County, PA in 2017. Values are for individual plants.

Variety	Number #1 Fruit	Weight #1 Fruit (lb)	Average Fruit Wt. #1 (lb)	Number #2 Fruit	Weight #2 Fruit (lb)	Total Marketable Weight (lb)	Number Culls	Weight Culls (lb)	Total Harvested Weight (lb)	Source*
Delerio	8.25	3.83	0.46	1.42	0.58	4.42	2.67	0.84	5.26	SG
Garfield	4.25	2.64	0.62	1.42	0.93	3.57	1.92	1.05	4.62	TW
Milena	7.00	3.35	0.48	1.08	0.49	3.84	2.67	1.13	4.97	SG
Muscato	7.67	3.45	0.45	2.00	0.87	4.32	2.08	0.88	5.20	TW
Orenji	6.83	3.38	0.50	0.75	0.33	3.72	3.58	1.51	5.23	SK

*CS = Clifton Seed; RP = Rupp Seed; SG = Seigers Seed; SK = Sakata Seed; SW = SeedWay; TW = Twilley Seed

Table 3. Number and weight of #1, #2 and cull fruit, total marketable weight and total harvested weight of fruit for 7 varieties of yellow bell peppers grown in a high tunnel in Lancaster County, PA in 2017. Values are for individual plants.

Variety	Number #1 Fruit	Weight #1 Fruit (lb)	Average Fruit Wt. #1 (lb)	Number #2 Fruit	Weight #2 Fruit (lb)	Total Marketable Weight (lb)	Number Culls	Weight Culls (lb)	Total Harvested Weight (lb)	Source**
Abay	5.17	3.09	0.60	1.08	0.68	3.76	0.83	0.47	4.23	SW
Catriona	8.75	4.04	0.46	1.42	0.67	4.72	1.75	0.68	5.39	SG
Dazzle***	6.75	3.79	0.56	1.00	0.50	4.29	2.50	1.41	5.70	SW
Early Sunsation	6.17	3.74	0.61	0.75	0.48	4.22	1.83	1.08	5.30	SG
Flavorburst	6.83	3.03	0.44	1.92	0.81	3.83	3.42	1.05	4.89	SW
Galleon*	2.00	1.36	0.68	1.25	0.72	2.07	2.83	1.31	3.38	CS
Sirius	6.25	4.00	0.64	1.00	0.66	4.65	1.08	0.67	5.32	SG

*X-10 variety
**CS = Clifton Seed; RP = Rupp Seed; SG = Siegers Seed; SK = Sakata Seed; SW = SeedWay; TW = Twilley Seed
***Average of 4 plants

Dr. Elkner is with Penn State Extension in Lancaster Co.

New Herbicide Options for Weed Control in Sweet Corn

Mark J. VanGessel and Dwight D. Lingenfelter

Under heavy weed pressure, a full rate of residual herbicide followed by a postemergence application was needed for consistent weed control.

The newer herbicides (Acuron, Revulin Q, Solstice, Liberty, and Armezon Pro) performed comparable to Lumax, Accent, and Impact in terms of crop safety and yield.

Across two years, a trend was observed for more sweet corn injury and a negative effect on yield with Zidua and Verdict plus atrazine that needs further research.

Introduction:

Weed control continues to be a problem in sweet corn. However, over the past few years new herbicides have been labeled for use in sweet corn that could provide effective control of problem weed species. Products such as Acuron, Armezon PRO, Anthem, Liberty, Revulin Q, Solstice, Verdict, and Zidua now can be used in sweet corn production. These products have provided effective weed control and exhibited good crop safety in field corn, however there is limited research experience with them in sweet corn in Pennsylvania and the Mid-Atlantic region. In addition, with herbicide-resistant weeds spreading in the region, it is critical that growers use other effective modes of action to combat these weed problems. Some of these new products may help. While research was conducted on this project in 2016, more than one year is often necessary to provide confidence in its performance.

Newer GMO sweet corn varieties that are resistant to Roundup and Liberty are currently available for use. These varieties can be valuable since glyphosate and Liberty (glufosinate) provide broad-spectrum weed control with no soil residual issues that could interfere with rotational crops. However, due to the increasing number of glyphosate resistant weed species we did not use Roundup Ready sweet corn varieties in this study.

Objectives:

To examine various new herbicides in sweet corn to determine their effectiveness on weed control.

To evaluate these herbicide programs on sweet corn injury and yield impact.

Procedures:

Field studies were conducted in 2017 at the University of Delaware Research and Extension Center in Sussex County and Penn State's Russell E. Larson Agricultural Research Farm in Centre County. Studies were conducted were standard small-plot research techniques, arranged in a randomized complete block design with three replications for sites.

The sites were conventionally tilled and soil at UD the soil was a sandy loam with 0.7% organic matter and at PSU was a silt loam with over 2% organic matter. DE site was irrigated. Sweet corn 'BC0805' was planted on May 11 at 24,000 seeds/A at the DE site. At the PA site, 'Remedy' was planted May 22 at 22,000 seeds/A.

Preemergence (PRE) herbicides were applied at planting and postemergence (POST) treatments were applied 4 weeks after planting (4 WAP) on June 8 and June 22 at UD and PSU, respectively. UD treatments were applied in 20 g/A while PSU used 15 g/A.

Early-season evaluations for PRE applications.

At 4 WAP, stunting was observed with Verdict+atrazine and Zidua+atrazine at both locations, ranging from 8 to 15% stunting (Table 1). Injury was still observable 5 to 6 WAP, with up to 11% stunting with Zidua at UD and at PSU there was 16 and 20% stunting for Zidua+atrazine and Verdict+atrazine, respectively (Tables 2 and 3).

At UD, Palmer amaranth control was best with Lumax EZ, Acuron, Verdict+atrazine, and Zidua+atrazine (Table 1). Zidua alone and Anthem Maxx provided 85 to 91% control at 4 WAP. Morningglory control ranged from 79 to 89% control with all

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New Herbicide Options... (continued from page 11)

treatments. Fall panicum control was at least 95% for all treatments, except Lumax EZ and Verdict+atrazine. Note the low rate of Bicep II Magnum/Cinch ATZ was not rated at DE.

At PSU, common lambsquarters control was excellent (≥96%) for all treatments except the low rate of Bicep II Magnum (Table 1). All treatments provide at least 98% control of smooth pigweed, PA smartweed, and giant foxtail. There was no significant differences for velvetleaf, with all treatments providing at last 94% control.

Mid-season evaluations.

Palmer amaranth control at UD was best with POST applications of a HPPD-herbicide (Group 27) including Armezon, Impact, or Solstice (Table 2). However, treatments of Revulin Q and Accent Q plus Impact also contained a Group 27 herbicide, but control was reduced. In addition, Liberty POST only provided 85% control of Palmer amaranth. This reduced control can be attributed to poor or no early-season control with these treatments, which allowed Palmer amaranth to get too large for complete control.

Morningglory control was less than 88% for all treatments, with applications including Revulin Q, Solstice, and Accent Q plus Impact providing 79 to 88% control. Acuron applied PRE, was providing 86% control at 5 WAP. Armezon Pro and Impact provided 67 and 77% control, respectively.

Fall panicum control was at least 87% for all POST treatments except low rate of Bicep followed by Solstice. Zidua applied PRE provided excellent fall panicum control, with 95% control at 5 WAP.

At PSU, overall weed control was excellent for all species (Table 3). Smooth pigweed control was 99% for all treatments. Verdict+atrazine and Accent Q plus Impact provided at least 87% control of remaining species, but this was statistically lower than other treatments.

Yield.

Yield at UD was lowest for Verdict+atrazine and Zidua+atrazine (Table 2). Some of the reduced yield was due to weed competition, but Zidua+atrazine and Accent Q plus Impact had compared levels of weed control but yields (lbs./A and number of marketable ears) was significantly different. In terms of marketable ears per acre, the trends do not followed overall weed control. Treatments with only PRE applications had lower number of ears, but Verdict+atrazine and Zidua+atrazine were lower than Lumax EZ or Acuron. Zidua followed by Armezon Pro had lower yield than Anthem Maxx followed by Solstice.

Yield at PSU was quite variable and not differences were detected between treatments (Table 3). The third rep was not yielded due to damage. As a trend, the Verdict+atrazine and Zidua+atrazine had lower yields. However, when Zidua or Anthem Maxx (same active ingredient) was applied without atrazine, yields were higher.

Summary:

Weed control was good to excellent (≥87%) for all treatments at Rock Springs, PSU

Weed control at UD (where Palmer amaranth and fall panicum infestations were heavy) was generally best with Bicep followed by Revulin Q, Bicep followed by Impact+atrazine, Zidua followed by Armezon Pro, and Anthem Maxx followed by Solstice. Treatments with reduced rates of Bicep or no PRE herbicide were generally not as effective for Palmer amaranth control

Verdict+atrazine and Zidua+atrazine caused sweet corn stunting that persisted for at least 6 weeks after planting.

Yield loss at UD often corresponded with poor weed control, except Zidua+atrazine and Zidua followed by Armezon Pro where yield loss was observed even though weed control was acceptable.

In 2016, sweet corn injury from all treatments was minimal at both locations and no significant yield differences at UD. However, there was a trend towards lower yield with Zidua applied PRE.

Use of Zidua as PRE application for sweet corn needs further investigation. While significant difference in yield occurred only at one site, the consistent trend towards reduced yields with Zidua was observed across years and should be examined more closely.

Table 1. Early-season sweet corn injury and weed control at UD-REC and PSU Rock Springs in 2017. Ratings taken four weeks after planting.

					Delaware								Penn State					
TrtNo.	Herbicide	Rate[a]	Unit	Timing	Injury[x]		Palmer amrnth		Mrng-glory		Fall panicm		Injury		Lambs-quarter		Giant foxtail	
					%													
2	Lumax EZ	2.7	qt/A	PRE	8	b	100	a	89	a	94	bc	2	c	99	a	99	a
3	Acuron	2.5	qt/A	PRE	2	cd	96	ab	88	a	95	ab	3	bc	99	a	99	a
4	Verdict	10/15	fl oz/A	PRE	11.3	a	92	abc	81	bc	89	c	15	a	99	a	99	a
	+Atrazine	1	qt/A	PRE														
5	Zidua SC	2/2.5	fl oz/A	PRE	10.7	ab	95	ab	86	ab	97	ab	8	b	99	a	99	a
	+Atrazine	1	qt/A	PRE														
6-9	Bicep II Mag.	1	qt/A	PRE	0	d	--[y]		--		--		1	c	65	b	99	a
10	Zidua SC	2	fl oz/A	PRE	8.7	ab	85	c	80	bc	99	a	6	bc	96	a	98	a
11	Anthem Maxx[b]	3	fl oz/A	PRE	4.7	c	91	bc	79	c	95	ab	5	bc	99	a	99	a
	P[z]>*F*				0.0001		0.027		0.011		0.027		0.002		0.0001		0.468	

[a]If rates differed between the locations, the UD rates/PSU rates.
[b]Anthem Maxx at 3 fl oz is equivalent to Zidua SC at 1.9 fl oz.
[x]Means within a column followed by the same letter are not significantly different (p=0.05) according to Fisher's protected LSD test.
[y]—means ratings not taken.
[z]P values ≤0.05 indicate significant differences exist among treatments.

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New Herbicide Options... (continued from page 12)

Table 2. Sweet corn injury one week after POST applications and weed control three weeks after POST applications at UD-REC in 2017.

TrtNo	Herbicide	Rate	Unit	Timing	Injury[x]		Palmer amrnth		Morng-glory		Fall panicm		Yield lbs		Total ears		# ears market	
					%								per acre					
1	Untreated Chk												4,532	d	12,348	a	2,273	e
2	Lumax EZ	2.7	qt/A	PRE	7.3	ab	89	cd	64	d	69	e	8,585	ab	15,379	a	8,560	c
3	Acuron	2.5	qt/A	PRE	2.3	bc	85	de	68	cd	78	d	9,926	a	17,854	a	9,621	bc
4	Verdict	10*	fl oz/A	PRE	2.3	bc	57	g	86	a	63	e	6,168	cd	16,439	a	1,515	e
	+ Atrazine	1	qt/A	PRE														
5	Zidua SC	2*	fl oz/A	PRE	11.2	a	77	f	50	e	95	ab	7,098	bc	16,666	a	5,530	d
	+ Atrazine	1	qt/A	PRE														
6	Bicep II Mag.	1	qt/A	PRE	2.3	bc	93	bc	82	ab	96	a	10,656	a	18,182	a	10,606	abc
	Revulin Q	3.4*	oz wt/A	4 WAP														
	NIS + 30% UAN**																	
7	Bicep II Mag.	1	qt/A	PRE	2.3	bc	98	ab	82	ab	63	e	9,531	a	17,424	a	8,864	c
	Solstice	3[a]	fl oz/A	4 WAP														
	COC																	
8	Bicep II Mag.	1	qt/A	PRE	2.3	bc	97	ab	77	bc	88	bc	9,581	a	15,379	a	11,136	abc
	Impact	0.5*	fl oz/A	4 WAP														
	Atrazine	1	pt/A	4 WAP														
	COC + 30% UAN**																	
9	Bicep II Mag.	1	qt/A	PRE	0	c	85	de	77	b	92	abc	10,895	a	17,954	a	12,121	ab
	Liberty 280	20	fl oz/A	4 WAP														
	AMS																	
10	Zidua SC	2	fl oz/A	PRE	9.7	a	98	ab	67	d	96	a	9,269	ab	13,863	a	8,333	cd
	Armezon Pro	20*	fl oz/A	4 WAP														
	NIS + 30% UAN**																	
11	Anthem Maxx[b]	3	fl oz/A	PRE	9	a	99	a	88	a	96	ab	10,767	a	17,424	a	11,894	ab
	Solstice	3[a]	fl oz/A	4 WAP														
	COC																	
12	Accent Q	0.5	oz wt/A	4 WAP	8	a	82	ef	79	ab	87	c	10,700	a	16,439	a	12,651	a
	Impact	0.5*	fl oz/A	4 WAP														
	COC + 30% UAN**																	
	$P^z>F$				0.003		0.0001		0.0001		0.0001		0.0001		0.191		0.0001	

AMS= ammonium sulfate; COC= crop oil concentrate; NIS= nonionic surfactant.
[a]PSU treatments included 0.5 lbs ai of atrazine (1 pt/A).
[b]Anthem Maxx at 3 fl oz is equivalent to Zidua SC at 1.9 fl oz.
*Rates differ from PSU trials.
**Adjuvants differ from PSU trials.
[x]Means within a column followed by the same letter are not significantly different (p=0.05) according to Fisher's protected LSD test.
[z]P values ≤0.05 indicate significant differences exist among treatments.

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New Herbicide Options... (continued from page 13)

Table 3. Sweet corn injury and weed control two weeks after POST applications at Rock Springs, PSU in 2017.

TrtNo	Herbicide	Rate	Unit	Timing	Injury[x]		Lambs-quarter		Smooth pigwd		Velvet-leaf		Smart-weed		Giant foxtail		Yield lbs/A	
					%													
1	Untreated Chk																11,249	a
2	Lumax EZ	2.7	qt/A	PRE	5	de	99	a	99	a	99	a	99	a	99	a	16,905	a
3	Acuron	2.5	qt/A	PRE	3	e	99	a	99	a	99	a	99	a	98	a	20,554	a
4	Verdict	15*	fl oz/A	PRE	20	a	91	b	95	a	90	b	95	b	96	b	6,827	a
	+ Atrazine	1	qt/A	PRE														
5	Zidua SC	2.5*	fl oz/A	PRE	16	ab	97	a	99	a	99	a	99	a	99	a	12,483	a
	+ Atrazine	1	qt/A	PRE														
6	Bicep II Mag.	1	qt/A	PRE	2	e	98	a	99	a	99	a	99	a	99	a	19,947	a
	Revulin Q	4*	oz wt/A	4 WAP														
	COC**																	
7	Bicep II Mag.	1	qt/A	PRE	5	de	99	a	99	a	99	a	99	a	99	a	18,749	a
	Solstice	3	fl oz/A	4 WAP														
	Atrazine	1[a]	pt/A	4 WAP														
	COC																	
8	Bicep II Mag.	1	qt/A	PRE	2	e	99	a	99	a	99	a	99	a	99	a	19,041	a
	Impact	0.75*	fl oz/A	4 WAP														
	Atrazine	1	pt/A	4 WAP														
	MSO**																	
9	Bicep II Mag.	1	qt/A	PRE	1	e	93	b	99	a	98	a	99	a	99	a	17,348	a
	Liberty 280	20	fl oz/A	4 WAP														
	AMS																	
10	Zidua SC	2	fl oz/A	PRE	10	cd	99	a	99	a	98	a	99	a	99	a	18,950	a
	Armezon Pro	16*	fl oz/A	4 WAP														
	MSO**																	
11	Anthem Maxx[b]	3	fl oz/A	PRE	12	bc	99	a	99	a	99	a	99	a	99	a	15,407	a
	Solstice	3	fl oz/A	4 WAP														
	Atrazine	1[a]	pt/A															
	COC																	
12	Accent Q	0.5	oz wt/A	4 WAP	1	e	92	b	99	a	92	b	87	c	91	c	18,895	a
	Impact	0.75*	fl oz/A	4 WAP														
	MSO**																	
	P[z]>F				0.0001		0.0001		0.476		0.009		0.0001		0.0001		0.188	

AMS= ammonium sulfate; COC= crop oil concentrate; NIS= nonionic surfactant

[a]PSU treatments included 0.5 lbs ai of atrazine (1 pt/A).

[b]Anthem Maxx at 3 fl oz is equivalent to Zidua SC at 1.9 fl oz.

*Rates differ from UD trials.

**Adjuvants differ from UD trials.

[x]Means within a column followed by the same letter are not significantly different (p=0.05) according to Fisher's protected LSD test.

[z]P values ≤0.05 indicate significant differences exist among treatments.

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Dr. VanGessel is with the Univ. of Delaware and Mr. Lingenfelter is with Penn State Univ.

Authority MTZ: The Fit for Processing Tomatoes

Mark J. VanGessel and Dwight D. Lingenfelter

Authority MTZ is a pre-packaged herbicide of sulfentrazone and metribuzin, labeled for transplanted tomatoes. The labeled rate range for transplanted tomatoes ranges from 6 to 16 oz. There has been little research with this product in the Mid-Atlantic States to help provide guidance to farmers and crop advisors about the appropriate rates. The Authority MTZ label mentions control of eastern black nightshade, ivyleaf morning-glory, common lambsquarters, and pigweed species; all weeds that are difficult to control with current herbicide programs. The sulfentrazone portion of the product can help manage herbicide resistant weed biotypes. The Authority MTZ rate range for tomatoes is quite wide, for instance the rates for coarse textured soils with 1.5 to 3% organic matter ranges from 6 to 16 oz wt/A. Preliminary results at 8 oz/A, showed good crop safety, but this trial used only a single rate. Research is needed to determine optimum rate range for Mid-Atlantic growing conditions as well as our weed spectrum. In addition, it is important to evaluate Authority MTZ as part of a weed control program, not as single applications.

In order to obtain a wider range of weeds, soil types, and growing conditions, the studies were conducted at the Penn State research farm in Centre County and at the University of Delaware, Georgetown research farm. Benefits to state and regional processing tomato growers will include updated information effective rate range for our conditions and how best to integrate other effective herbicide modes of action into the program to reduce the potential for resistance. This information will be distributed through the vegetable production guides and other educational resources on how to more effectively control weeds with existing and new products.

Objectives:

Evaluate Authority MTZ for safety with processing tomatoes

Determine level of early-season weed control from Authority MTZ

Work Statement:

Experiments were conducted at two locations: the Russell E. Larson Agricultural Research Farm in Centre County and at the University of Delaware Research and Extension Center in Sussex County in 2017. Several rates of Authority MTZ with Dual were evaluated in transplanted tomato (Solanum lycopersicum, var. 'Heinz 3406') as pre-plant incorporated treatment (according to label) along with standard treatment of metribuzin plus Devrinol (Table 1) to determine impacts on crop injury and yield as well as effectiveness on annual weed control. The study was arragned as a randomized complete block design with three replications. The plots were 25-30 feet long. In order to obtain a wider range of weeds, soil types, and growing conditions, the studies were conducted at the Penn State research farm in Centre County and at the University of Delaware, Georgetown research farm.

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Authority MTZ... *(continued from page 15)*

Results

At Rock Springs (Centre Co.), PA, the Authority MTZ treatments (Table 2 & 3):

- Crop injury: 25, 27, 32, 52, and 58% respective to the rate from lowest to highest at 27 DAA (days after application)
- Crop injury dropped to 12, 15, 18, 24, and 27%, respectively, 68 DAA
- 92 to 94% large crabgrass (Digitaria sanguinalis) control;
- 88 to 95% common lambsquarters (Chenopodium album) control;
- 84 to 96% redroot pigweed (Amaranthus retroflexus) and common purslane (Portulaca oleracea) control; and
- 93 to 98% eastern black nightshade (Solanum phycanthum) control

Yield was not taken at the Pennsylvania location due to tomatoes not reaching maturity in a reasonable timeframe. In general, the growing season was not conducive for optimum tomato growth. It was cool and cloudy many days, and necessary heat units were lacking to produce desirable fruit.

In Delaware (Sussex Co.), the Authority MTZ treatments (Table 2 & 4):

- Crop injury: 17, 19, 25, 50, and 53% respective to the rate from lowest to highest at 27 DAA
- Crop injury dropped to 0, 5, 13, 14, and 21%, respectively, 50 DAA
- 83 to 87% large crabgrass (Digitaria sanguinalis) control and
- 85 to 97% control of Palmer amaranth (Amaranthus palmeri)
- Yield data ranged from 19.42 to 24.73 ton/A but did not correlate well with herbicide rate and injury.

Discussion and Summary

In summary, the Authority MTZ pre-packaged herbicide mix does have a fit in transplanted processing tomato production. However, the higher use rates might cause crop injury in certain soil types and under certain environmental conditions. The benefit of this herbicide product will be its ability to control certain difficult to control weeds such as eastern black nightshade, common lambsquarters, pigweed species, and likely annual morningglory that can be common in tomato crops. Also, the sulfentrazone portion of the product provides a unique herbicide mode of action (group 14) usually not used in tomato and can also help manage herbicide-resistant weed biotypes. Additional testing of this herbicide would be useful to get a better understanding of its utility in this crop. Furthermore, crop injury might possibly be decreased if the herbicide was not incorporated.

Table 1. Treatments for field trial. All Authority MTZ + Dual, and Devrinol + metribuzin were mechanically incorporated prior to transplanting.

Herbicide*	Rate / A	As needed
Untreated	0	+ POST
Authority MTZ + Dual	6 oz wt + 1.25 pt	+ POST
Authority MTZ + Dual	8 oz wt + 1.25 pt	+ POST
Authority MTZ + Dual	10 oz wt + 1.25 pt	+ POST
Authority MTZ + Dual	12 oz wt + 1.25 pt	+ POST
Authority MTZ + Dual	16 oz wt + 1.25 pt	+ POST
Devrinol + metribuzin	2 qt + 4 oz wt	+ POST

*POST: Matrix (2 oz wt) + metribuzin (3 oz wt) + NIS (1 qt/100 gal)

(continued on page 17)

Authority MTZ... *(continued from page 16)*

Table 2. Effect of herbicides on tomato (% injury and yield), 2017

Herbicide (rate)*	PA 27 DAA	PA 68 DAA	DE 27 DAA	DE 50 DAA	DE Yield tons/A (total fruit; green and red)	DE Yield tons/A (mature red fruit only)**
Untreated	0	0	0	0	19.68	3.72
Authority MTZ (6 oz)	25	12	17	0	24.73	3.27
Authority MTZ (8 oz)	27	15	19	5	23.90	4.33
Authority MTZ (10 oz)	32	18	25	13	19.42	3.12
Authority MTZ (12 oz)	52	24	50	14	19.16	1.87
Authority MTZ (16 oz)	58	27	53	21	22.42	2.29
Devrinol (2 qt) + metribuzin (4 oz)	0	0	3	0	23.96	3.78
LSD (P=0.05)	12	6	12	6	6.72	2.36

*All Authority MTZ treatments were tank-mixed with Dual Magnum (1.25 pt/A)

**Harvested when 25% of total fruits were mature (red)

(continued on page 18)

Authority MTZ... *(continued from page 17)*

Table 3. Effect of herbicides on weed control (%) in tomato at Centre Co., PA, 2017

Herbicide (rate)*	Large crabgrass	Lambs-quarters	Rr pig-weed	Purslane	E. black Night-shade
Untreated	0	0	0	0	0
Authority MTZ (6 oz)	92	88	84	88	93
Authority MTZ (8 oz)	94	92	95	96	95
Authority MTZ (10 oz)	93	93	92	93	95
Authority MTZ (12 oz)	93	95	96	95	96
Authority MTZ (16 oz)	92	94	94	93	98
Devrinol (2 qt) + metribuzin (4 oz)	86	83	83	89	60
LSD (P=0.05)	5	7	9	6	9

*All Authority MTZ treatments were tank-mixed with Dual Magnum (1.25 pt/A)

Ratings taken 7/7/2017

Table 4. Effect of herbicides on weed control (%) in tomato at Sussex Co., DE, 2017

Herbicide (rate)*	Large crabgrass	Palmer amaranth
Untreated	0	0
Authority MTZ (6 oz)	85	89
Authority MTZ (8 oz)	84	87
Authority MTZ (10 oz)	89	85
Authority MTZ (12 oz)	83	97
Authority MTZ (16 oz)	87	97
Devrinol (2 qt) + metribuzin (4 oz)	77	91
LSD (P=0.05)	14	9

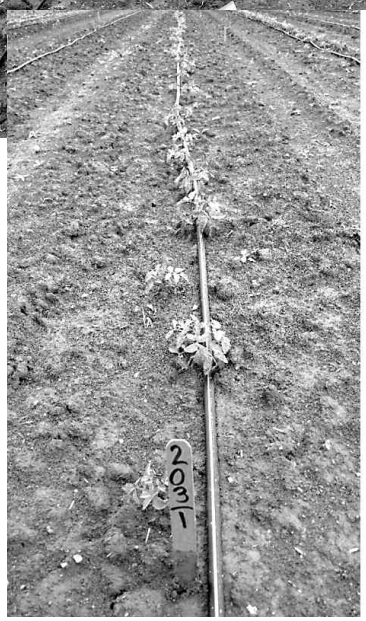
All Authority MTZ treatments were tank-mixed with Dual Magnum (1.25 pt/A)

Ratings taken 6/27/2017

Pictures from the study at Rock Springs.

(continued on page 19)

Overview of plots 3 weeks after planting (WAP); notice middle plots in foreground with herbicide injury



Check plot (3WAP)

Authority MTZ 16 oz (3WAP)

Authority MTZ 16 oz (14WAP)

Authority MTZ... *(continued from page 18)*

Pictures from the study at Delaware

Check plot after Matrix + metribuzin application

(Both images were taken mid-season)

Authority MTZ 16 oz fb Matrix + metribuzin

This research was supported by PVGA and the Pennsylvania Vegetable Marketing and Research Program. *Dr. VanGessel is with the Univ. of Delaware and Mr. Lingenfelter is with Penn State Univ.*

VEGETABLE PRODUCTION

Efficacy of Organic Biopesticides for Managing While Mold in Snap Beans

Sarah J. Pethybridge and Beth Gugino

A replicated small plot trial was conducted to quantify the efficacy of biofungicides and OMRI-listed products for the control of white mold in snap bean in Pennsylvania. Application of all products led to significant reductions in white mold incidence on plants and pods following inoculation with *Sclerotinia sclerotiorum* ascospores. All products significantly reduced white mold incidence compared to nontreated control plots. The conventional fungicides (Cercobin and Rovral) included in the trial for comparative purposes, were highly efficacious and resulted in disease control not significantly different between each other. Products that resulted in excellent white mold control with potential for use in organic snap bean production were Double Nickel, MBI-110 (undergoing EPA review), Nutrimag, F9110-9, and Naturall. The control of white mold resulting from these products was not sensitive to rates within the ranges tested. These products may provide additional options for the control of white mold within organic snap bean production.

Introduction

White mold, caused by the fungus *Sclerotinia sclerotiorum*, is one of the most devastating and problematic diseases of snap bean. The disease is difficult to control due to the: 1) long-lived sclerotia (resting structure of the fungus) produced on diseased plants; 2) wide host range of the pathogen which includes many of the cash crops, cover crops and weeds in typical vegetable rotations; and 3) absence of commercial bean varieties with resistance to *S. sclerotiorum*. In general, agronomic factors associated with high yields also exacerbate white mold by promoting canopy development and an ideal environment for disease development. Direct losses from white mold occur from reductions in the number of marketable pods. Indirect losses result when the disease causes lodging. Diseased pods also contribute to the perpetuation and increase of *S. sclerotiorum* inoculum for future susceptible crops.

Fungicides are one of the most critical control measures for white mold in snap bean and management is strongly reliant upon their well-timed use according to flower phenological development. Historically, major changes in the most commonly used fungicides have occurred due to the withdrawal of some products from the market (e.g. Ronilan®) due to health and environmental concerns. Diversity in efficacious products for use in conventional and organic production is therefore important for rotational purposes to adhere to best management guidelines.

More than 200 biopesticide active ingredients have been registered in the United States and some are certified by the Organic Materials Review Institute (OMRI). These biorational products are valuable tools because they generally have shorter restricted-entry and preharvest intervals. Earlier sponsored by PVMRP identified one biopesticide (Double Nickel) that provided similar control of white mold to conventional fungicides. The objective of this study was to support and facilitate organic production of snap beans by quantifying the efficacy of OMRI-listed products available to growers for white mold control in Pennsylvania.

Materials and Methods

The trial was planted at The New York State Agricultural Experiment Station in Geneva, New York, in a Honeoye silt loam soil (Research North field 25) on 14 June 2017. Seed (var. 'Huntington') was planted with a Monosem planter at a rate of 9 seeds/ft. Fertilizer (300 lb/A 15 N: 5 P: 10 K) was banded at planting and the pre-emergent herbicide, Dual Magnum® (1.8 pt/A) was applied on the same day. On 18 July, at 34 days after planting (DAP) and growth stage (GS) V3, additional nitrogen (50 lb/A) was applied by hand within the rows. Plant density within each plot was assessed on 25 July by counting the number of plants in a 4 foot section in each of two rows. The trial received supplementary irrigation using overhead sprinklers for optimal plant growth and disease development. Growth stage of the snap beans at critical points was recorded.

The trial design was a completely randomized block with four replications of each of the 13 treatments and a nontreated control (Table 1). Each plot was 10 feet long × 2 rows wide. Two noninoculated and nontreated rows separated plots between blocks, and 4-feet sections separated plots within rows. Fungicides were applied with a carbon dioxide-pressurized backpack sprayer with a volume of 26 gallons/A using a 38 inch long boom using four flat fan TJ 8002VS nozzles spaced 19 inches apart. Products were applied with a hand-held pump sprayer with a single flat fan TJ 8002VS nozzle on 26 July (~ 10% of plants with at least one open flower [GS = R1]; 42 DAP) and 1 August (~ 100% of plants with at least one open flower [GS = R2]; 48 DAP).

Plots were inoculated with *S. sclerotiorum* ascospores at 26 (43 DAP [GS = R1]), and 28 (44 DAP [GS = R1]) at concentrations of 5.6 × 103, and 3.2 × 103/ml using a backpack sprayer. The germination efficiency of ascospores was at least 99%. Carpogenic germination was induced and ascospores were collected (Fig. 1).

The efficacy of products was assessed on plants from two 3.2-feet sections within each plot on 16 August (63 DAP [GS = RH]) and removing marketable pods by hand. Pods and plants were separated into diseased (white mold symptoms) or healthy, and the number in each category counted to calculate the incidence of white mold on pods and plants (%). Plants with white mold had necrotic lesions on stems and often had signs of *S. sclerotiorum* (mycelia and sclerotia on diseased plant parts). The weight of the healthy pods was recorded to calculate the average weight of individual healthy pods. The efficacy of fungicides on white mold incidence (%) on pod and plants and yield (weight of healthy pods, and average individual weight of healthy pods) was quantified using generalized linear modelling (Genstat Version 17.1).

Results

Plant density was not significantly different according across the trial (P = 0.057). Disease incidence in the nontreated plots was high with 44.7% and 18% of plants and pods, respectively (Table 2; Fig. 2). The incidence of plants with white mold was significantly reduced by all treatments, but was significantly reduced in plots receiving Rovral and Naturall (foliar drench) compared to those receiving F9110-9. All products also significantly reduced the incidence of white mold in pods but MBI-110, Rovral, Naturall (soil drench), and Naturall (foliar drench) were more efficacious than F9110-9. No significant differences in white mold control was observed between the rates

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Efficacy of Organic... *(continued from page 20)*

Table 1. Products and rates tested for white mold control in snap bean in 2017 at Geneva, New York.

Fungicide (Company)	Active ingredient	FRAC group	Product rate (/A)
OMRI-listed			
DoubleNickel LC (Certis USA)	*Bacillus amyloliquefaciens* D747 strain	44	1 & 2 quarts
Nutrimag (Innovative Surface Solutions)	Magnesium chloride	-	2 gall
MBI-110 (Marrone Bio Innovations)	*Bacillus amyloliquefaciens*	44	2, 3 & 4 quarts
F9110-9 (FMC Agricultural Solutions)	*Banda de Lupinus albus doce* (BLAD)	BM 01	32 oz
Naturall for Vegetables (ABM)	*Trichoderma harzianum, T. virens,* and *T. atroviride*	BM 02	0.5 fl oz (soil) @ 18 days after planting 3 ml/L (foliar)
Conventional (for comparison)			
Rovral (FMC Agricultural Solutions)	Iprodione	2	24 oz
Cercobin (FMC Agricultural Solutions)	Thiophanate-methyl	1	22 oz

Fig 1. Sclerotinia sclerotiorum *apothecia and sclerotia in the growth chamber. Ascospores are collected throughout the year and stored at -20°C until rehydrated for field inoculations.*

tested of Double Nickel, and MBI-110 (Table 2). Treatments had no significant effect on marketable pod yield. However, the average weight of a healthy pod was significantly increased in plots treated with Cercobin, MBI-110 (2 and 4 quarts/A), and Nutrimag compared to nontreated plots (Table 2).

Discussion

Inoculation with *S. sclerotiorum* ascospores led to a high incidence of white mold in nontreated plots providing optimal conditions to quantify product efficacy. The 'standard' program for pod disease control in conventional snap bean production is one application of thiophanate methyl (aka. Cercobin in this trial) or Endura at early bloom (10% flowering) followed by an additional application at 100% flowering approximately 7 to 10 days thereafter if conditions are conducive to disease development. In this study, Rovral also provided excellent control of white mold and was not significantly different from Cercobin. Applications of Double Nickel at either rate tested (1 and 2 quarts/A) again resulted in significant control of white mold on plants and pods compared to nontreated plots. Analogous disease control was also obtained from all rates tested of MBI-110. This product is also a microbial biopesticide containing the bacterium, *Bacillus amyloliquefaciens* but a different strain to that within Double Nickel. MBI-110 is expected to soon be approved by the EPA and registered for white mold control in a broad range of field and specialty crops with OMRI certification. Nutrimag produced some transient bronzing phytotoxicity to the upper leaves but provided white mold control and significant increases in the average weight of a healthy pod. Similar benefits have also been reported for white mold control in dry

(continued on page 22)

Efficacy of Organic... *(continued from page 21)*

beans in New York in 2016 (Pethybridge, unpublished data). F9110-9 is the formulation of BLAD that will soon be OMRI-listed by FMC Agricultural Solutions. When applied alone, F9110-9 provided moderate white mold control and no benefits were observed when tank-mixed with the conventional fungicide, Rovral. Naturall is microbial biopesticide containing a mixture of *Trichoderma* species approved for organic production by the National Organic Program and for use in certified organic vegetable production by the Organic Materials Review Institute. Naturall provided excellent white mold control when applied as either a soil drench soon after establishment or as a foliar drench applied at the same phenological developmental stages as the other products tested. Naturall is currently registered only for application as a soil drench but registration for use as a foliar application is expected.

This research was supported by PVGA and the Pennsylvania Vegetable Marketing and Research Program.

Dr. Pethybridge is with Cornell Univ. at The New York Agricultural Experiment Station in Geneva and Dr. Gugino is with the Department of Plant Pathology and Environmental Microbiology at Penn State Univ.

Table 2. Effect of conventional and OMRI-listed products on white mold, marketable yield, and the average weight of a healthy pod in a small plot replicated trial at Geneva in 2017.

Fungicide (/A)	Incidence of plants with white mold (%)	Incidence of pods with white mold (%)	Marketable pod yield (g/m)	Average weight of a healthy pod (g)
Double Nickel (1 q)	7.5 bc	4.8 bc	0.90	8.59 ab
Double Nickel (2 q)	16.7 bc	4.9 bc	1.04	8.14 abc
Nutrimag (2 gall)	7.2 bc	3.7 bc	0.99	8.79 a
MBI-110 (2 q)	7.6 bc	5.2 bc	1.04	8.71 a
MBI-110 (3 q)	6.4 bc	3.2 bc	1.09	8.43 ab
MBI-110 (4 q)	5.7 bc	0.6 c	1.29	8.82 a
F9110-9 (32 oz)	21.5 b	6.3 b	1.08	7.94 abc
Rovral (24 oz)	0 c	0.7 c	1.05	8.13 abc
Rovral (24 oz) + Cercobin (22 oz)	3.2 bc	3.9 bc	0.97	8.14 abc
Rovral (24 oz) + F9110-9 (32 oz)	8.0 bc	2.5 bc	0.82	7.80 abc
Cercobin (22 oz)	5.4 bc	3.3 bc	0.92	8.79 a
Naturall (soil)	3.6 bc	0.6 c	0.97	7.28 c
Naturall (foliar)	2.6 c	1.1 c	1.05	7.14 c
Nontreated	44.7 a	18 a	0.79	7.57 bc
Df		55		
LSD	18.3	4.9	-	1.11
P =	0.002	<0.001	0.479 (ns)	0.034
CV (%)	27.8	23.2	20.6	4.6

Augmented Nitrogen Fertigation and Cultivar Selection to Minimize Center Rot of Onions

Beth K. Gugino

At harvest and post-harvest losses due to bacterial diseases remains a challenge for Pennsylvania sweet onion growers. Since management options in-season are limited and the efficacy of bactericides variable, our primary management tools need to be preventative and integrated. One important tool is host resistance. Currently breeders at New Mexico State University and University of Wisconsin are working to improve thrips resistance though manipulation of the foliar waxy cuticle composition. In the long-term this could help with the management of bacterial diseases through the reduction of feeding damage that serves as entry points for the bacteria as well as direct transmission of the pathogens during feeding. In the meantime, the identification of less susceptible commercially available cultivars to the center rot pathogens *Pantoea agglomerans* and *Pantoea ananatis* could provide growers with another management tool. With funding leveraged from the Pennsylvania Department of Agriculture Specialty Crop Block Grant Program, a total of 12 cultivars were evaluated in three replicated research trials conducted at the Penn State Research Farms in Centre and Lancaster Counties over the past two years. Of these cultivars, Spanish Medallion showed the greatest potential in terms of reduced susceptibility to center rot while maintaining the yield potential as well as sugar and pungency characteristics of Candy. In 2017, we evaluated Spanish Medallion grown in three commercial fields as well as in one small replicated research trial to determine its production potential under Pennsylvania production conditions.

Another potential tool to integrated into a management program for bacterial diseases is the augmentation of nitrogen fer-

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Augmented Nitrogen... (continued from page 22)

tility. With funding from the same PDA SCBG, in 2015 and 2016, three replicated trials were conducted to determine the effect of nitrogen (N) rate in combination with application timing (half-season vs. full season) on bacterial disease losses at harvest and post-harvest. Not surprisingly, this relationship has proven to be complex depending on the level of disease pressure however, in all three small plot replicated trials, reducing the total amount of nitrogen applied by 35 and 68% did not significantly reduce marketable yields regardless of the influence on center rot foliar disease severity and bulb rots at harvest. In itself, this could lead to a significant reduction in input costs for growers. In 2017, we conducted a simplified version of this trial to gain better understanding about the interaction between nitrogen rate and disease pressure by eliminating the factor of application timing which had less of an effect on disease severity based on the three previous trials.

Methods

To further evaluate the susceptibility and yield potential of cv. Spanish Medallion compared to the commercial standard cv. Candy, four replicated trials were established, one at the Russell E. Larson Research and Education Center and three on commercial farms in Centre and Lancaster Counties (designated Centre 1, Lancaster 1 and 2, respectively). In each field, three or four replicate 30 ft plots were established of which15 ft was planted with approximately 10 week-old plug transplants (200-cell trays) of Spanish Medallion and 15 ft with Candy using standard four row, six inch spacing. The on-farm plots were managed following the standard practices of the growers and the research farm trial was managed using standard commercial practices. On-farm trials were rated on 6, 16, 28 Jun, 7 and 13 Jul, for visual foliar disease severity on a 0 to 7 scale with 0 = no lesion, asymptomatic; 1 = Local lesion (< 2.5 cm x 2.5 cm); 2 = Expanded lesion but less than ¼ leaf; 3 = ½ of leaf chlorotic or bleached; 4 = Entire leaf is bleached and wilting; 5 = One entire leaf and a portion of another leaf are bleached and wilted; 6 = Multiple fully symptomatic leaves; and 7 = ≥50% of leaves bleached and collapsed. For the on-farm trials, natural inoculum was relied upon. On the research farm to establish more uniform disease pressure, on 1 Jul the fourth leaves from the outside of each plant in 8ft of two rows (one outer, one inner) was toothpick inoculated with a bacterial suspension containing a mix of *Pantoea agglomerans* and *P. ananatis*, isolated approx. 6-in. from the base of the neck. The on-farm trials were harvested on 13 Jul and the onions graded for size (small, medium, jumbo, and colossal), marketability and weight in each class. The research farm trial was harvested on 24 Jul.

To further understand the effect of nitrogen application rate and bacterial disease pressure on incidence and severity at harvest, a replicated field trial will be established at the Russell E. Larson Research and Education Center at Rock Springs. Based on a soil test and following standard commercial production practices, soil nutrient levels other than N were adjusted prior to establishing the trial on standard black plastic raised beds with a double row of drip irrigation. Bare root transplants cv. Candy were sourced from Sunbelt in Buckeye, AZ. The trial was arranged as a split-plot with four replications with N rate [0, 50, 105 or 160 lb liquid urea ammonium nitrate/A) as the whole plot and inoculation status (uninoculated (low pressure), adjacent to inoculated (medium) and inoculated (high pressure)] as the subplot. Each whole plot was 26 ft in length and the nitrogen was applied using a modified fertigation system that allows for the application of multiple treatments simultaneously. The rates represent the total amount of nitrogen that was applied during the season. On 29 Jun, a third of the plants in each subplot were toothpick inoculated as previously described. All data was collected by sub-sub plot to represent a range of disease pressures. Foliar disease severity data and harvest data were collected using the same methods and on the same dates described for the research farm cultivar trial.

Results

Cultivar trials. Across all three on-farm trials there were no significant differences in total marketable yield (sum of medium, jumbo and colossal) between Candy and Spanish Medallion. At the Centre 1 location, there was a significantly higher proportion of marketable jumbo and colossal size Candy onions compared to Spanish Medallion (95.9 compared to 85.7% respectively; P = 0.0186). There was no difference in center rot disease incidence between the cultivars within each location or across the three locations within each cultivar. At the Lancaster 2 location, the majority of marketable onions across both cultivars were medium in size as a result of allium leafminer damage early in the season (Table 1) which explains the lack of jumbo and colossal-sized onions.

The higher disease pressure that resulted from toothpick inoculating a subset of plants in the trial at Rock Springs resulted in significantly higher center rot incidence compared to the plots characterized as having low or moderate disease pressure. However this trend was only significant for Candy and resulted in a significantly lower total marketable yield compared to Spanish Medallion plants also subjected to high disease pressure (Table 2).

Nitrogen trial. Not surprisingly, increasing the total amount of nitrogen applied up until early July during bulb initiation significantly increased the percent of marketable onions that graded as jumbo and colossal in size at harvest (P = 0.0035) although no significant differences were observed between the two higher nitrogen rates (105 and 160 lb/A). When the percent of medium sized onions was combine with the total marketable yield this affect was lost (P = 0.8074) due to a greater proportion of medium-sized onions being harvested from plots receiving lower rates of nitrogen.

In the high disease pressure plots, which were toothpick inoculated, center rot disease incidence at harvest ranged between 0 and 36% across all the plots with the four nitrogen treatments 0, 50,105 and 160 lb/A averaging 2.9, 11.1, 11.7 and 14.8%, respectively. Although foliar disease symptoms progressed and led to bulb rots in symptomatic inoculated plants, disease did not spread between plants in the plot as has been observed in previous seasons. Within the high disease pressure plots, however, there was a trend towards increased center rot at harvest with increasing nitrogen rate (Figure 1).

There was a significant positive correlation between the increase in foliar disease severity and the percent of incidence of bulb rot at harvest (Adj R2 = 0.5146; P = 0.0002). Foliar disease severity over the course of the season (calculated as the area under the disease progress curve; AUDPC) also increased significantly as the nitrogen rate increased (P = 0.0482). With foliar disease severity being 2.5 times higher in the plots receiving 160 lb/N during the season compared to those which did not receive any in-season nitrogen applications.

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Augmented Nitrogen... (continued from page 23)

Table 1. *Comparison of marketable yield and incidence of center rot incidence between cvs. Candy and Spanish Medallion at three commercial farm locations in Lancaster and Centre Co., Pennsylvania in 2017.*

Field location	Total # harvested (15 ft of bed)		Total marketable yield (%)		% Marketable jumbo/col. size		Center rot (%)	
	Candy	Spanish Medallion	Candy	Spanish Medallion	Candy [z]	Spanish Medallion	Candy	Spanish Medallion
Lancaster 1	108	104	90.5	89.2	60.5	65.4	5.6	5.9
Lancaster 2	97	89	77.8	72.4	2.9	0	3.9	0.6
Centre 1	108	101	94.3	91.7	95.9	85.7*	3.5	2.7

* Denotes a significant difference between Candy and Spanish Medallion within the data type (marketable yield of jumbo and colossal onions) and field location based on a two-sample t-test ($P \leq 0.05$).

Table 2. *Comparison of marketable yield and center rot incidence between cvs. Candy and Spanish Medallion in a replicated research trial at Rock Springs in 2017. The trial was toothpick inoculated to create varying levels of disease pressure across the plots. Data was collected separately from each subplot and averaged across four replications.*

Disease pressure (based on inoculation)	Total # harvested (7.5 ft of bed)		Total marketable yield (%)		Center rot (%)	
	Candy	Spanish Medallion	Candy [z]	Spanish Medallion	Candy	Spanish Medallion
Low	31	27	90.5 a	95.5	5.7 b	4.5
Moderate	29	29	92.4 a	94.9	6.0 b	4.1
High (inoculated)	29	30	73.4 b	85.3*	24.1 a	10.6*
Ave across plot	89	87	85.5 a	91.6	11.8 b	6.6 *
	---	---	P=0.0024	NS	P=0.0016	NS

[z] Values in the same column followed by the same letter are not significantly different from each other based on Fisher's LSD. NS = no significant differences were observed across the subplots with varying disease pressure for Spanish Medallion.

* Denotes a significant difference between Candy and Spanish Medallion within the data type (total marketable yield or center rot) and level of disease pressure based on a two-sample t-test ($P \leq 0.05$).

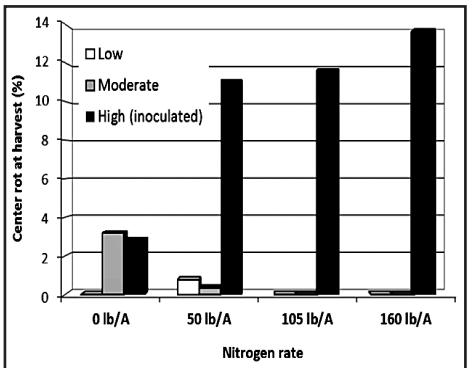


Figure 1. The percent center rot symptomatic onion bulbs at harvest from plots receiving four different rates of nitrogen and subjected to differing levels of disease pressure (low, moderate and high). All the plants in the high disease pressure subplots were toothpick inoculated with bacteria in late June.

Discussion/Conclusion:

Similar to bacterial diseases of other vegetable crops, managing center rot of onion requires an integrated approach. Reducing soil temperatures at bulbing through the use of alternative plastics such as reflective silver is one strategy. In cooler regions of the state, reflective silver with a heat strip (black stripe in the center) may be a compromise to maintain warmer early season soil temperatures but gain the benefits of silver later in the season at bulbing. Host resistance is an important disease management tool. Unfortunately, the cultivar Candy is very susceptible to the bacterial disease center rot. In the on-farm small plot trials conducted as part of this research, Spanish Medallion had marketable yields comparable to Candy under the relatively low disease pressure observed in the field. In the replicated research trial under high disease pressure, the inoculated Spanish Medallion plots had higher marketable yields and a lower incidence of bulb rot at harvest. In previous trials, Spanish Medallion also met the soluble solid and pungency requirements for inclusion in the Simply Sweet Onion program. Continued research into identifying less susceptible cultivars such as Spanish Medallion on a larger scale will provide growers with another potential tool.

Water soaking characteristic of an early stage center rot foliar lesion that can progress downward and lead to a bulb rot.

Managing nitrogen fertility is a balancing act. Not enough nitrogen and marketable yield can be compromised; however, too much nitrogen can exacerbate diseases such as center rot. In this trial, reducing the season-long nitrogen application rate from 160 to 105lb/A did not affect the percentage or total weight (data not shown) of marketable jumbo and colossal sized onions. Although this might not translate into reduced disease every season, it does reduce overall input costs thus saving the grower money.

A special thanks to PVGA and PVMRP for supporting this on-going research on understanding the biology, epidemiology and management of bacterial diseases of onion.

Dr. Gugino is with the Department of Plant Pathology and Environmental Microbiology at Penn State Univ.

Level of Susceptibility to the Black Rot Pathogen of Commercial Available Cabbage Varieties

Chris Smart and Holly Lange

There was varying susceptibility to black rot among cabbage varieties (left to right) Capture, Korsuma, Super Red 115

Caused by the bacterium *Xanthomonas campestris pv. campestris (Xcc),* black rot is a significant disease of cabbage, and other crucifer crops world-wide and is an annual problem here in NY. Currently the options for controlling the bacterial pathogen that causes black rot remain limited primarily to copper-based products. The goal of this project was to test cabbage varieties in a replicated and inoculated trial, for susceptibility to Xcc. These data will enable growers to evaluate the risk of using extremely susceptible varieties, and determine if there is a horticulturally similar variety available with some black rot tolerance.

Thirty five commercially available cabbage varieties were seeded in 72 cell flats in a greenhouse at Cornell's NY State Ag Experiment Station. At 6 weeks of age plants were moved to a cold frame and hardened off for a week. They were then be planted into a research plot with 5 plants per plot and 4 replicate plots per treatment, in a randomized complete block design. Plants were fertilized and maintained according to standard grower practices, and the entire field was inoculated with a NY isolate of Xcc 2 weeks after transplanting. Plots were rated weekly for both disease incidence and severity beginning July 6, 2017. Two cabbage heads were harvested per plot for early, mid and late season cabbage (a total of 8 heads per variety). Each head was cut at the stump and visually rated for blackening of the veins on the core, and then each head was cut in half to check for ingress of the pathogen into the cabbage head.

Results: All 35 cabbage varieties included in the study showed black rot symptoms following inoculation with the bacterial pathogen Xcc. Typical V-shaped lesions were seen on all plants, and no varieties were completely resistant to the pathogen. Following disease progress over time (shown on next page) varieties Thunderhead, Excalibur, Viceroy and Capture had the least disease at the end of the study, while Korsuma and Surprise were most susceptible. These results are similar to those observed in 2016.

Results from harvesting mature heads show that mid and late season varieties have a greater chance of black rot inside the head than early season varieties (Figure 1). This is not surprising as all plants were inoculated at the same time and varieties with a longer date to harvest would enable the pathogen more time to move into the head. Additional results from cabbage harvest (Figure 2.):

- Three cultivars showed black rot inside every head (all mid or late season varieties)
- Five cultivars had 50%-87.5% infected heads (all mid or late season)
- 15 cultivars had 12.5%-33% infected heads
- 12 cultivars had no black rot inside the head even though they all had black rot symptoms on the leaves

By identifying the most black rot tolerant cabbage varieties available growers will have a guide as to the level of susceptibility of commonly grown cabbage varieties. This could be an economic benefit by either reducing copper sprays if a variety is known to be less susceptible, or starting copper sprays earlier if a variety is known to be highly susceptible. Of course, we would recommend that growers not plant those varieties that are highly susceptible.

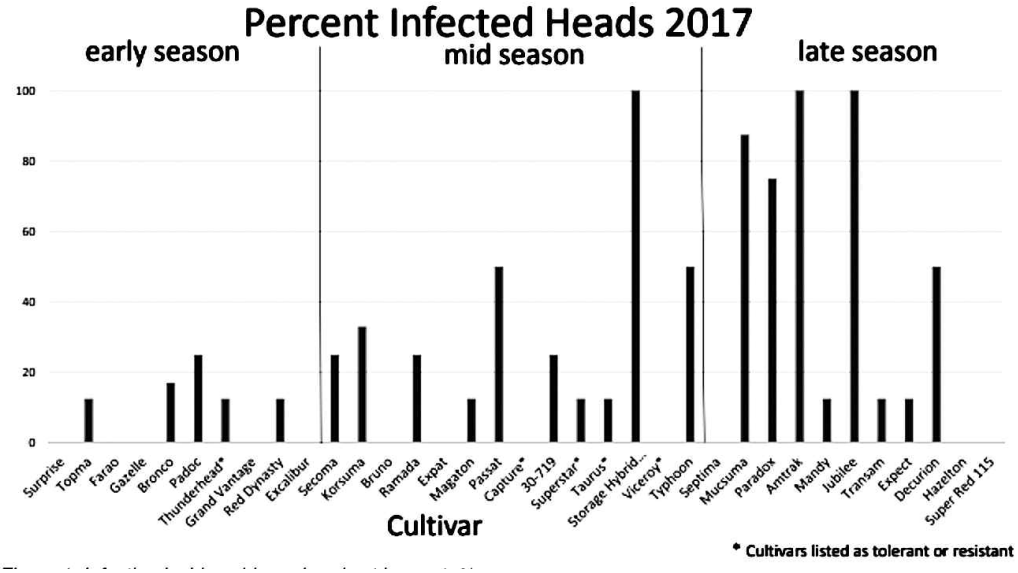


Figure 1. Infection inside cabbage heads at harvest. % infection on the 'x' axis

(continued on page 26)

VEGETABLE PRODUCTION

Strange Mite Pest Found in High Tunnel Vegetables

Gerald Brust

Over the last three months a few early season high tunnel operations on the Eastern Shore were having problems with some of their seedlings and leaf crops. Crops like spinach would have 'whitening' and then browning and eventually dead margins of their leaves while seedlings would collapse. We found the problem to be 'red legged winter mites' *Penthaleus dorsalis*, which is a new pest in vegetables and herbs for us (Fig. 1). This mite was identified by Dr. Ron Ochoa, USDA, Beltsville. Because these mites are such new pests some of the information presented here is based on other closely related earth mite pest species.

Red legged winter mites thrive in what we would normally consider conditions too cold for an arthropod to cause problems. This mite is cold adjusted and cannot stand hot dry soil conditions and will die as summer heat approaches. Eggs are laid in late spring and they over-summer in the soil. These are stress resistant eggs (i.e., they can withstand drying and heat as well as synthetic chemical applications). In the fall they will begin to hatch, and mites will be active throughout the fall and winter inside a high tunnel with crops. Damage appears as 'silvering' or 'whitening' of the attacked foliage. Mites are most damaging to newly emerging crops, greatly reducing seedling survival and development.

Red legged winter mites are difficult to control even when using synthetic chemicals. Foliar sprays of Pyrethroids (check label for the particular crops that are labeled as this will vary greatly) or Pyrethrum + Neem or Beauveria bassiana + Pyrethrum will reduce feeding, but if mite populations are high it will be difficult to eliminate the damage. Applications should start as soon as damage is noticed before mites have a chance to build their population. Foliage should be thoroughly covered with spray material as should the base of plants.

Figure 1. Penthaleus dorsalis

Cultural controls involve using transplants instead of direct seeding, as the mites would do less damage to larger plants. Using high levels of heat such as clear plastic mulch to heat the soil and kill mites and, if used in the summer, kill even their eggs. Steam heat used to control nematodes and soil pathogens can be used to greatly reduce mite numbers before next fall's planting. Many cultivations during the summer can significantly decrease the number of over-summering eggs that survive.

Dr. Brust is the IPM Specialist at the Univ. of Maryland. From the ***Weekly Crop Update****, Univ. of Delaware Extension, Issue 26:4, April 20, 2018.*

Level of Susceptibility... *(continued from page 25)*

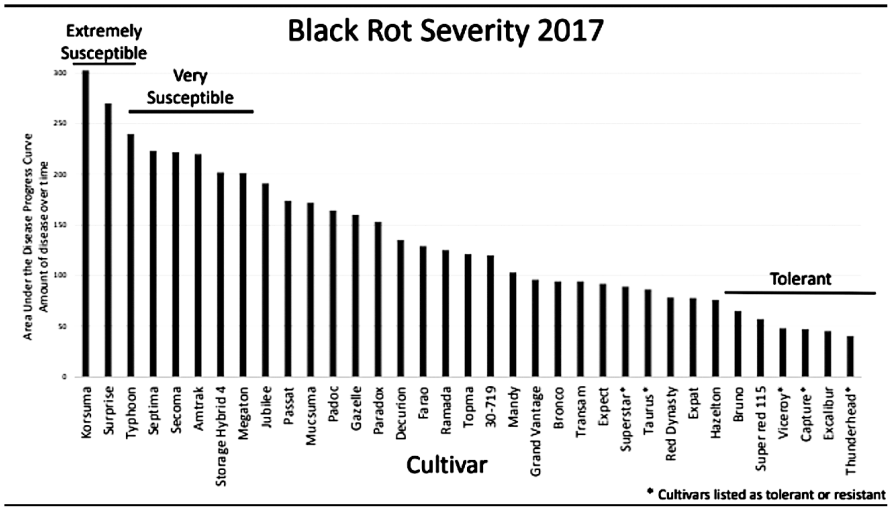


Figure 2. Black Rot severity on 35 cabbage varieties.

The authors are with the Plant Pathology and Plant-Microbe Biology Section at Cornell University, Geneva. From ***Vegetable Notes for Vegetable Farmers in Massachusetts,*** *Univ. of Mass. Ext., Vol. 30, No. 4, April 19, 2018.*

Figure 2. Black Rot severity on 35 cabbage varieties.

Improving Success with Early Planted Warm Season Vegetables

Gordon Johnson

Editor's Note: Please note that Dr. Johnson's primary audience is Delmarva growers, not Pennsylvania growers so that suggested dates will likely be later in most parts of Pennsylvania.

With the recent cold, windy weather as a reminder, it is important to understand the factors that affect success with transplanting early warm season vegetables. Remember that the average date of the last killing frost is around April 25 for most of the Delaware and cold weather events can occur well into the middle of May.

Earliest plantings of watermelons, cantaloupes, summer squash, and tomatoes will begin the last week in April. First transplanting of crops such as peppers and eggplant will begin in early May. One of the characteristics that all these crops have in common is that they are warm season vegetables that are sensitive to cold temperatures, both in the root zone and above ground. There has been a tendency to risk earlier and earlier plantings as growers try to hit the early market. Over the years, many of our early plantings of summer vegetables have suffered because of early cold damage and inadequate provisions to protect plants.

For early transplanted warm season vegetables, choose the lightest ground that warms up quickly. Plant higher sections in the field first. Avoid areas that receive any shade from woods or hedgerows. Early fields should be protected from extreme wind and should not have frost pockets. Rye windbreaks planted between each bed are desirable for early plantings because they limit heat transfer by wind. If no rye windbreaks have been planted, then consideration should be given to using row covers to protect the plants – either clear silted or perforated low tunnels or floating row covers. Even where windbreaks have been used, row covers may be necessary for extremely early plantings.

Lay plastic mulch well ahead of time to warm soil. Black plastic mulch should have excellent soil contact because beds with poor plastic to soil contact will not heat up effectively. Firm beds and tight mulch are much more effective in warming soils. Do not lay plastic on cloddy soils. Make sure that there is good soil moisture when forming beds and laying plastic because soil water will serve as the heat reservoir during cold nights.

When producing transplants, use larger cell sizes and grow plants so that they have well developed roots in those cells for the first plantings. Large cell sizes will perform better than small cells in early plantings.

Careful attention needs to be paid to hardening off warm season vegetable transplants that will be planted early. Gradual acclimation to colder temperatures will reduce transplant shock. Do not transplant tender, leggy plants or plants coming directly out of warm greenhouse conditions for these early plantings.

Watch extended weather forecasts and plant at the beginning of a predicted warming trend. Monitor soil temperatures in plastic beds and do not plant if they are below 60°F. Soil temperature in beds should be measured at the beginning of the day when at the coolest. When soil temperature conditions are not favorable, wait to plant. Avoid planting in extended cloudy periods, especially if plants have come out of the greenhouse after an overcast period. These plants will not perform well. Extra caution should be taken to minimize root injury during transplanting. When transplanting, make sure that there is good root to soil contact and there are few air pockets around roots.

In years with cold, cloudy, windy weather after transplanting, we have had large losses of transplants in the field, especially seedless watermelons. It is critical to have warm soil conditions after transplanting to allow roots to grow out into the bed quickly. In cold, cloudy conditions, plants shut down physiologically, little root growth occurs, and the existing roots on the transplant do not function well. If there is any wind, plants lose more water than they can take up and they die due to desiccation. This is accelerated when the sun does come out – the first sunny day after an extended cold, cloudy period is when you will see the most wilting of weakened transplants.

If cold weather occurs after transplanting, warm season vegetables vary in their ability to tolerate adverse weather after being set out. Tomatoes will stop growth but will grow out without much damage once warm weather returns. Summer squash and cucumber transplants may be temporarily stunted but generally grow out of the condition. Watermelons will hold if they have been hardened off properly. Cantaloupes can be stunted if exposed to excessively harsh early conditions. Peppers and eggplants will not put on any root growth until temperatures are warm enough. If stunting occurs on any of these warm season vegetables, you may lose the early advantage you were seeking. In addition, remember that these vegetables are susceptible to frost damage and will be killed by a late freeze. Long-term weather records show that there still is a 33% chance of freezing weather in parts of Delmarva up to the 30 of April and a 10% chance of freezing weather up to May 10.

Good windbreaks, tight mulch, and firm beds will lead to better success with early planted warm season vegetables.

Dr. Johnson is the Extension Vegetable and Fruit Specialist at the Univ. of Delaware. From the ***Weekly Crop Update****, Univ. of Delaware Extension, Issue 26:5, April 27, 2018.*

VEGETABLE PRODUCTION

Revisiting Compost for Vegetable Production

Gordon Johnson

Each year I field questions from vegetable growers on the use of compost for their production systems. The availability of commercial compost has fluctuated over the years based on the companies operating in the region. With the entry of Perdue AgriRecycle into the compost field another quality compost is now available for use by growers on Delmarva.

In the composting process, organic stock material sources such as yard wastes, manure and litter, wood waste, food scraps and garbage, paper, hatchery waste, or other waste materials are combined in a proper mix to create a carbon to nitrogen ratio that will promote the growth of microorganisms that then decompose the materials, producing a dark, humus-rich end-product. In addition, in the composting process, the compost piles will heat up to between 130-170° F, killing pathogens of concern in the materials. A properly produced compost can be used for vegetable production without concerns for transferring plant pathogens or human pathogens.

Compost will contain plant nutrients, the level of which depends largely upon the stock materials used. Nitrogen content may be significant; however, much of the nitrogen will be in organic form and will be slowly available over several years. Most of the potassium will be readily available while phosphorus availability is more variable.

While compost does contain plant nutrients, the more important benefit that it provides is stable organic matter. Because it has already been decomposed, the organic component contains humus-like materials that will decompose very slowly when added to the soil. This means that compost will immediately raise the organic matter of the soil. This in turn will increase the cation exchange capacity (CEC) of the soil, improve soil moisture holding capacity, and improve soil physical characteristics (reduced compaction, improved aeration, decreased crusting).

Research has also shown that certain composts can reduce the incidence of soil borne diseases and pests. This is most likely because the organic addition promotes more diversity in soil microorganisms that can compete with pathogens and the improved physical properties of the soil (such as reduced compaction) that limits the impact of certain pathogens. Newly finished compost also contains beneficial microorganisms that directly affect plant pathogens by antibiosis or hyperparasitism. Some composts have also been shown to induce resistance to pathogens in crop plants.

When using compost, growers should first receive an analysis of the material. From this analysis you should look at the following:

Compost Maturity and Stability – Only use mature compost that has finished the composting process and that is stable. Immature compost will continue to decompose, and can cause soil imbalances in some cases.

Nutrient Content – As previously stated, compost has a base nutrient content. You need to account for available nutrients in the nutrient management plan for the crop the compost will be used on. Much of the nitrogen will be in organic form and only a portion will be available for the growing season.

Electrical Conductivity (EC or salts levels) – Composts that use manure or poultry litter as part of the stock materials can accumulate salts (particularly potassium) at elevated levels. The elevated salt content must be accounted for when determining application rates so that salt injury does not occur with crops.

Calcium Carbonate Equivalent (lime value) – Lime is generally not added in the composting process; however, high pH materials such as hatchery waste sometimes are composted. This means that certain composts may have more liming value.

Moisture Content and Physical Condition – Compost will be partly water. With higher moisture composts, you will be paying for more water and less of the humus material and nutrients. In addition, higher moisture composts do not spread as well. Compost should be adequately screened so that the product spreads well.

In research at the University of Delaware with several compost materials, a rate of 5-7 tons per acre showed yield benefits on sandy soils in the first year with several vegetable crops. However, specific effects on a grower's farm will depend on soil type, existing organic matter, existing soil health, and compost source; therefore, rates should be adjusted accordingly.

The decision to use compost is also an economic one. Compost can cost anywhere from $15.00 to $50.00 per ton depending upon the source and distance for transport. Growers need to consider the soil improving and nutrient value of the compost and evaluate that against other soil improvement programs such as cover cropping and green manure crops.

*Dr. Johnson is the Extension Vegetable and Fruit Specialist at the Univ. of Delaware. From the **Weekly Crop Update**, Univ. of Delaware Extension, Issue 26:2, April 6, 2018.*

New Technology for Reducing Transplant Shock

Gordon Johnson

A new tool is available for reducing transplant shock. The chemical 1-methylcyclopropene (1-MCP) which is marketed as the product LandSpring by the AgroFresh company reduces ethylene production and stress on young plants. Ethylene in the plant hormone released when plants are injured or are under stress, as is common during transplanting. Excess ethylene can cause leaf drop and wilting and can increase transplant losses. The way 1-MCP works is that it has a similar molecular structure to ethylene but without the negative effects on the plant. It binds to ethylene receptors in the plant and thus blocks ethylene from causing damage.

LandSpring is labelled on broccoli, Brussels sprouts, cabbage, cantaloupe, cauliflower, cucumber, eggplant, muskmelon, bell pepper, non-bell pepper, summer squash, tomato and watermelon. According to the company "When applied to seedlings 1-5 days before transplanting, LandSpring WP helps decrease transplant shock enabling plants to more rapidly establish and grow. Observed benefits include increased crop biomass due to better root and shoot development when plants are subjected to stress.in the weeks following transplantation".

The label can be found at this site: https://agrofresh.octochemstore.com/wp-content/uploads/2017/04/LandSpring-_epa-approved-seedling-label.pdf

More information can be found at: http://www.landspring.info/

*Dr. Johnson is the Extension Vegetable and Fruit Specialist at the Univ. of Delaware. From the **Weekly Crop Update**, Univ. of Delaware Extension, Issue 26:5, April 27, 2018.*

Spring Strawberry Growth, or Lack Thereof

Kathleen Demchak

Strawberry growth can start out a little slow when the soil is cold. This year, we had a long cold winter, the spring warm-up just isn't happening yet in much of the state, and plant growth is nearly 2 weeks behind schedule. This can have a number of effects on the plants.

Temperature is a big driver of plant growth, so probably nothing will help growth quite as much as consistent warm temperatures (and sunshine). Plants in plasticulture plantings across the state are moving along faster than matted-row ones, as usual, from the combination of plastic mulch warming the soil and the use of row covers which allow in light. Plants in matted-row fields are still struggling to get going since they were covered with straw for a long period of time. As Marvin Pritts pointed out this morning in a conference call, matted row plants' carbohydrate reserves were probably depleted to a greater extent than usual this year due to the long winter, resulting in reduced remaining energy reserves to get them going.

Strawberry with mild winter injury (photo K. Demchak, Penn State Univ.)

In these cases, a light application of nitrogen (10 pounds per acre actual N) as a granular fertilizer or through the drip system should help spur some growth, depending on whether production is in matted row or plasticulture. Growers of June-bearers in plasticulture will normally be applying about 30 pounds of nitrogen per acre between now and the beginning of harvest, while growers of day-neutrals should be applying 1-2 pounds of nitrogen per acre per week all season, but might want to jump-start with a heavier dose as mentioned to help the plants get going.

There are other potential causes of poor spring growth. One is a rot such botrytis moving in and rotting out the growing point of the crown. This is more likely to occur especially if straw mulch was applied too heavily and conditions were wet. To diagnose, closely examine the growing point and look for green tissue right in the center of the strawberry crown. If firm green tissue is present, the plant is fine, but if the growing point is grayish and mushy, the plant won't be able to produce new growth from that area. Anthracnose crown rot can cause similar symptoms. An early fungicide spray may be needed to help curb either of these problems.

Winter injury is another potential cause of poor growth and can be diagnosed by cutting the crown lengthwise and looking for tan or brown discoloration towards the base of the crown tissue that would have been last year's crown growth. Crown tissue that is a mottled red or discolored in a wedge shape from the side, however, is likely an indication of a disease issue. If disease is suspected, submitting samples to Penn State's Plant Disease Clinic (if in PA – growers from other states should check for local services) may be in order for a definitive diagnosis.

Other causes of poor growth can include vole damage, or damage from mites such as cyclamen mites or two-spotted spider mites. With vole damage, plants are often chewed off right to the crown. Leaves on plants with cyclamen mites will appear distorted and off-color, but the mites are very tiny and not visible to the naked eye. If two-spotted mites are present, the adults should be visible on the leaf undersides and may appear reddish-orange early in the year. If populations are very high, which may occur under row covers if two-spotted mites multiplied over the winter, leaf stippling from feeding may be present. With either type of mite, a miticide application may need to be made.

Ms. Demchak is with the Department of Plant Science at Penn State Univ. From Penn State Extension, https://extension.psu.edu/spring-strawberry-growth-or-lack-thereof, April 25, 2018.

BERRY PRODUCTION

Damping-off: Identifying and Controlling Early-season Pathogens

Andrew Wyenandt

It is extremely important to know which pathogen is causing damping-off problems and which fungicide to properly apply. The key to controlling damping-off is being proactive instead of reactive. Always refer to the fungicide label for crop use, pathogens controlled, and application rates.

Damping-off is caused by a number of important vegetable pathogens and is very common during the spring. Damping-off can kill seedlings before they break the soil line (pre-emergent damping-off) or kill seedlings soon after they emerge (post-emergent damping-off). Common pathogens that cause damping-off include *Pythium, Phytophthora, Rhizoctonia* and *Fusarium* spp.

Control of damping-off depends on a number of factors. First, is recognizing the conditions which may be leading to the problem (i.e., weather/greenhouse growing conditions) and second, identifying the pathogen causing the problem.

Conditions Favoring Damping-off

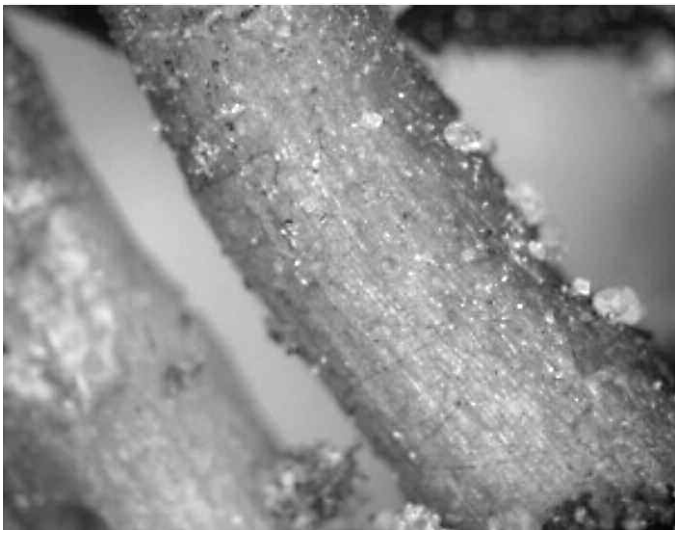
Although all four pathogens are associated with damping-off, the conditions which favor their development are very different. In general, *Phytophthora* and *Pythium* are more likely to cause damping-off in cool, wet or overwatered soils that aren't allowed to dry out due to cloudy weather or cooler temperatures. Conversely, *Rhizoctonia* and *Fusarium* are more likely to cause damping-off under warmer, drier conditions especially if plug trays are kept on the dry side to help reduce transplant growth.

The two root rots causing the most problems in New Jersey during transplant production are *Pythium* and *Rhizoctonia*. In general, *Pythium* tends to kill seedlings before or right after emergence where as *Rhizoctonia* tends to kill seedlings after emergence. If you are recycling old transplant flats with organic matter left on them from the previous season you may bring pathogens such as *Rhizoctonia* back into the operation. There are exceptions to the rules, but none the less, all damping-off pathogens can cause serious losses if not controlled properly.

Pathogen Identification

In root systems infected by *Pythium,* the outer cortex of the roots will slough-off if you pull the transplant out of the plug or if you simply pull on the roots with your fingers. If your soil has been excessively wet for extended periods of time because cool, cloudy weather hasn't allowed plug trays to dry out for extended periods (i.e. days) you may be dealing with a *Pythium* problem.

In root systems infected by *Rhizoctonia*, the outer cortex of the root system won't slough off. In many cases under ideal conditions, the mycelium of the fungus growing on the surface of infected roots can be seen with a 10x hand lens. *Rhizoctonia* produces distinct, brown hyphae that always branches at nearly 90 degree angles. This is a diagnostic feature of the fungus. Unlike with *Pythium*, the outer cortex of the root won't slough off.



Rhizoctonia: Note the brown "shoestrings" on the outside of the infected strawberry root

Pythium Root Rot. Photo: D.Groth, LSU

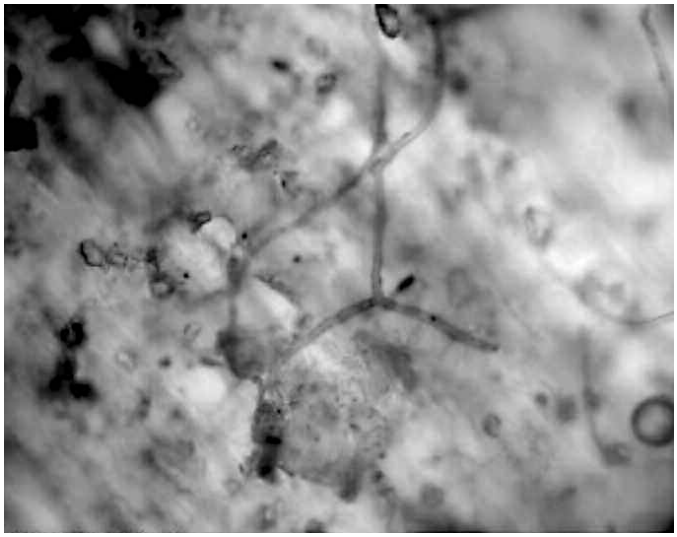
Treatment Options

Why is recognizing the different symptoms and diseases so important? The fungicides applied to prevent or control damping-off are specific in the pathogens they control. Fungicides used to control *Pythium* or *Phytophthora* won't control the other damping-off pathogens. Why is this? The biology of the fungus and the mode of action of the fungicide dictates fungicide efficacy.

For example, Ridomil Gold and Ultra Flourish (mefenoxam, FRAC code 4), MetaStar (metalaxyl, 4), Previcur Flex (propamocarb, 28), Ranman (cyazofamid, 21), Presidio (fluopicolide, 43), and Phosphites (33) help control the "water molds" (i.e., *Pythium* and *Phytophthora*). Terraclor or OLF (PCNB, 14) and azoxystrobin (Quadris, 11) help control damping-off caused by Rhizoctonia root rot. Ranman, Previcur Flex,

(continued on page 31)

Damping-off:.. (continued from page 30)



Rhizoctonia Root Rot on Strawberry Transplants

and phosphites have greenhouse use labels for *Pythium* control (see labels for specific crops and uses).

There are many organic options that can be used to suppress these pathogens in transplant media. These biologicals include *Bacillus subtillus* (Companion), *Streptomyces lydicus* (Actinovate), *Streptomyces griseoviridis* (Mycostop), *Trichoderma harzia-num* (PlantShield, Rootshield), and *Trichoderma virens* (SoilGard). These products can either be drenched on or incorporated into the media prior to seeding and/or transplanting. These products work by colonizing root surfaces and competing with the pathogen for space and resources. The mechanisms of control by biologicals include some form of antibiosis, parasitism, induction of host defense responses, and/or competition.

Disinfectant products such as Zerotol and Oxidate (hydrogen dioxide) may also be used to help suppress fungal pathogens in organic or conventional transplant production. It's important to understand that disinfectant products also kill biological agents, therefore caution should be used when using these in rotation with organic products. The same holds true for all conventional products. For a list of options for use in greenhouses on specific crops please see Table E-10 on pages 124-126 in 2018 Mid-Atlantic Commercial Vegetable Production Recommendations Guide. See individual crop section for of options in the field. Always refer to the fungicide label for crop use, pathogens controlled, and application rates.

Dr. Wyenandt is the Extension Plant Pathologist with Rutgers Cooperative Extension. From the ***Plant and Pest Advisory****, Rutgers Coop. Ext., April 24, 2018.*

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