

PVGA to Fund 8 Vegetable and Small Fruit Research Projects

This year, the Pennsylvania Vegetable Growers Association will contribute \$30,000 towards vegetable research and \$4,869 for small fruit research. The Board of Directors budgeted \$30,000 from the Association's General Fund for vegetable research and \$7,000 for small fruit research.

Since 2021 the Association has also asked Pennsylvania PVGA members to consider making special donations to the Association to increase the amount of funding available for research. Members have responded by donating over \$11,700 for research since December 2020. In 2021, the Board voted to use \$8,021 of these donated funds to increase the amount available for vegetable research that year. That leaves about \$3,700 in the research donations funds - \$2,000 designated for vegetable research, \$847.50 for small fruit research and \$80.00 for potato research. These will be held an appropriate projects are identified or they are sufficient to cover an additional project.

This year's contributions put PVGA's funding for research over the past 35 years at \$1.4 million.

The following seven vegetable projects are being funded in conjunction with the Vegetable Marketing and Research Program, which will contribute \$26,000 towards the \$56,275 total cost of the projects. A total of 11 proposals were received but there were insufficient funds to fund them all. The projects approved for funding with their objectives are listed below.

Evaluation of Rapid On-Farm Monitoring Tools for the In-Season and Site-Specific Management of the Fertigation in High Tunnel Vegetable Production Systems

Francesco Di Gioia - The Pennsylvania State University and Leah Fronk, Karly Ragan, Glen Bupp, Thomas Ford - Penn State Extension
\$9,997

- To test the efficacy of buffer solutions that can correct the pH of the soil water extract and limit interferences of the NO₃-N ion-selective electrode readings. To this purpose soil samples will be collected by Extension Educators from different commercial farms characterized by different soil types. This will allow to validate and transfer the method to Extension Educators and growers.

Potential Residual Herbicide Programs in Pumpkin

Dwight Lingenfelter and John Wallace - Penn State and Lynn Sosnoskie, Cornell University

\$1,500

- To examine various pre and post herbicide programs in pumpkin (i.e., novel concepts vs. standards) to determine their effectiveness on weed control and to evaluate these herbicide programs on pumpkin injury and yield impact.

Evaluation of Fungicide Programs for Powdery Mildew Control in Pumpkins

Timothy Elkner - Penn State Extension and Beth Gugino - Penn State University

\$6,850

- To evaluate select fungicide programs for season-long powdery mildew compared to a standard commercial program as well as alternative programs that are developed based on cost. In addition, we will incorporate biorational materials such as Theia, Serifel, Aviv, etc where possible with the overall priority of maintaining yields, fruit quality and needed fungicide resistance management protocols.
- Develop and evaluate at least one organic powdery mildew management program using OMRI approved fungicides.
- Develop a breakdown of fungicide program costs for the season.

NEWS



*Pennsylvania
Vegetable Growers
Association*

*An association of
commercial vegetable,
potato and berry growers.*

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PVGA to Fund 8 Research Projects

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Evaluation of Pyridate as an Alternative to Atrazine to Enhance Postemergence Weed Control in Sweet Corn When Tank-Mixed with HPPD-Inhibiting Herbicides

Lynn Sosnoski, Cornell University

\$1,928

- Describe the weed control efficacy of an atrazine alternative (pyridate, Tough EC) applied in combination with key HPPD-inhibiting herbicides.
- Compare the performance of atrazine and atrazine alternatives applied in combination with key HPPD-inhibiting herbicides.
- Determine if reduced rates of atrazine and atrazine alternatives applied in combination with key HPPD-inhibiting herbicides can produce similar levels of weed control responses across diverse weed communities and environments (Rock Springs, PA, Geneva, NY, Georgetown, DE)

Keeping PA Vegetable Growers Profitable: Statewide Cultivar Trials on Tomatoes

Elsa Sánchez – Penn State University and Robert Pollock, Timothy Elkner, Thomas Butzler, and Megan Chawner – Penn State Extension

\$20,000

- To evaluate early maturing, determinate, large, red, slicing tomatoes in 2023. Up to 12 cultivars and selections of early maturing, determinate, large, red, slicing tomatoes will be evaluated in a conventional plasticulture system.

Breeding Fresh-Market Tomatoes for Production in PA

Majid R. Foolad - The Pennsylvania State University

\$8,000

- to evaluate 87 FM large-size F1 hybrids with EB resistance.
- to evaluate 106 FM large size F1 hybrids with EB + LB resistance.
- to evaluate 325 PSU-JSS FM large size F1 co-hybrids with EB +LB resistance.
- to evaluate 27 FM plum tomato hybrids with EB and/or EB + FB resistance.

- to evaluate 93 FM grape tomato hybrids with EB and/or EB + FB resistance.
- further evaluation of elite inbred lines of FM plum tomatoes.
- continuation of a project to identify and map genes for bacterial canker resistance to be used for breeding purposes.

Breeding Processing Tomatoes for Production in PA

Majid R. Foolad - The Pennsylvania State University

\$8,000

- to evaluate a total of 54 PROC tomato F1 hybrids with EB resistance.
- to evaluate 62 PROC tomato F1 hybrids with EB + LB resistance.
- commercial trialing of PSU PROC tomato F1 hybrids by tomato processing/canning companies.
- development and evaluation of new inbred lines of PROC tomato with EB resistance.
- identification of new sources of genetic resistance to tomato bacterial canker and genetic mapping of resistance genes.

The following berry research proposal was approved for funding by the Board of Directors:

Survey of Plant Parasitic Nematodes Associated with the Root Systems of Blueberry and Bramble Crops in Pennsylvania

Mihail Kantor and Kathleen Demchak, Penn State University

\$4,869

- to identify and quantify the plant-parasitic nematodes populations associated with blueberry and bramble root systems in grower plantings.

The following vegetable research proposals were not able to be funded:

Precision Cultivation using Camera Guidance Technology in Snap Bean

John Wallace and Tosh Mazzone, Penn State University and Lynn Sosnoskie, Cornell University

\$1,600

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The **Pennsylvania Vegetable Growers News** is the official monthly publication of the Pennsylvania Vegetable Growers Association, Inc.,
815 Middle Road, Richfield, PA 17086-9205

Phone and fax: 717-694-3596 • Email: pvga@pvga.org • Website: www.pvga.org

Our Mission:

The Pennsylvania Vegetable Growers Association serves Pennsylvania's commercial vegetable, potato and berry growers through education, research, advocacy and promotion.

Our Vision:

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

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

PVGA Directors Hold Spring Meeting in Harrisburg

The PVGA Board of Directors held their spring meeting at the Pennsylvania Department of Agriculture building in Harrisburg. While the Board normally tries to visit legislators in conjunction with their spring meeting, the General Assembly was not in session during most of the month of March, so the Board decided they needed to meet without doing legislative visits. The major topic of discussion was the transition of the Executive Director position. Two proposals from association management firms were reviewed.

The Association had interviewed and made preliminary offers last year to two individuals to replace Executive Director William Troxell, who will be retiring on December 15, 2023. However, final offers were not able to be agreed upon with either of these candidates. In early January the Association received a letter of interest from an association management firm in the Harrisburg area expressing interest in the Association's position. PVGA representatives met with them both at the Farm Show and at the Mid-Atlantic Fruit and Vegetable Convention. Since Mr. Troxell works for the Association with the assistance of his wife, Cheryl, and a part-time assistant whom they employ at their own expense, the Association has really had an association management firm for many years. After the Convention, this firm submitted a proposal but the required compensation was much more than the Executive Committee felt the Association could afford. The Executive Committee did move to develop a request for proposals (RFP) that was sent to several other association management firms.

At the March meeting, there was discussion on a proposal to pivot from a search for an Executive Director to a search for a General Manager who would maintain the Association's operations in the interim with the goal of hiring an Executive Director at some point in the future. However, the Board decided to consider two proposals from the association management firms received in response to the RFP and is hoping for several additional proposals to be received in the near future.

The Association's General Fund ended 2022 with \$419,017 in income and \$384,546 in expenses for a surplus \$34,471. At their meeting in January at the Convention, the Board had adopted a General Fund budget that anticipates \$540,700 in income and \$547,700 in expenses for a deficit of \$7,000. The increase in expected income for 2023 is largely due to the increase in Farm Show sales as well as an increase in Convention income.

The increase in expenses for 2023 are also due to increased Farm Show expenses as well as expected increased costs for administrative services. The failure to come to agreements with the three parties interested in the Executive Director position was primarily about the amount of compensation offered by the Association. Moreover, for 2023, it is anticipated that the Association will be paying both Mr. Troxell and the new entity during a transition period. The 2023 budget did cut vegetable research funding to \$30,000 and small fruit research funding to \$7,000 but did retain \$10,000 to contribute to Penn State for a start-up package for the new vegetable entomologist who will be replacing Dr. Shelby Fleischer who retired last year.

The Board is seeking to maintain Association activities and research funding at adequate or better levels but it is also mindful of maintaining a healthy reserve amount in the General Fund. The recent pandemic underscored the importance of the reserve funds that buffered a \$61,000 deficit and allowed the Association to retain normal services and adequate research funding in 2021. (The 2020 fiscal year was not as severely impacted by the pandemic because the majority of the Association's income was received in January from the Farm Show and Convention before the pandemic shutdown occurred.) With the surplus of \$34,000 in 2022, the Association was able to replenish over half of the reserves lost in 2021.

One of the major items of business at the spring meeting is renewing the contract with the Executive Director. With the avail-

ability of funds from increased sales at the Farm Show, the Board voted to pay Mr. Troxell/Troxell Administrative Services a 9% retroactive increase for the April 2022 to March 2023 contract year and to set the fee for 2023 at \$84,750.

On the basis of a recommendation from the Convention Planning Task Force, the Board voted to urge the Convention Joint Committee to set a uniform Convention-wide policy for paying honorariums and expenses for speakers. The Board favored a system that would pay university, extension, and grower speakers for their travel, lodging and meal expenses but would not pay honorariums. For grower speakers, expenses would be paid for making a full presentation and half of the expenses would be paid for participating in a panel. Grower speakers whose expenses are less than \$100 would receive a minimum amount of \$100 (or \$50 for panel members). Speakers representing companies that stand to benefit from the exposure at the Convention are not reimbursed for their expenses. All speakers receive free registration to the Convention.

Several members of the Board reported on a meeting with the organizers of the new Crop Growers Expo in Quarryville. It was agreed that it is important for the Association to be represented at this Expo that drew hundreds of growers from the plain community, many of whom have never attended the Mid-Atlantic Convention. The Association plans to have a booth at the 2024 Expo to promote membership and the Mid-Atlantic Convention. In turn, PVGA will advertise the Expo in the November special Convention newsletter that is mailed to over 3,000 growers. PVGA recognizes that if its mission is to serve the vegetable, potato and berry growers of Pennsylvania, it must reach out to include plain community growers who comprise an estimated 39% of the grower community but only about 13% of PVGA members. The Association has heard from several sources that the Pennsylvania Vegetable Growers News, the monthly newsletter, is highly valued by PVGA members from the plain community (and other members as well!). PVGA is committed to maintain this high-quality, hard-copy publication as a member benefit going forward as opposed to following a trend in some associations to move all member communications to email.

Director Jeff Stoltzfus reported that there is work on a proposal to classify high tunnels that do not disturb the land as open-field production and thus not subject to stormwater management regulations. Pasa Sustainable Agriculture will be holding a virtual listening session on this issue on April 24.

The Association will be covering the costs to replace traps for the sweet corn insect pest monitoring network across the state. PVGA has budgeted funds to support this network for several years.

PVGA to Fund 8 Research Projects continued from page 2

Optimization of Hydroponic Lettuce Nutrition in Nutrient Flow Technique and Deep Water Culture Systems

*Krystal Snyder and Elsa Sanchez, Penn State University and
Carla Garzon, Delaware Valley University*
\$6,678

Study the Impacts of Soil Aggregate Stability on Crop Nutrient Uptake and Differences between Cropping Systems and Management Practices for Growing Vegetables

Dr. Gladis Zinati - Rodale Institute
\$7,580

Evaluation of Rootstock-Scion Interaction and Yield Performance in Fresh-Market Tomato Grown in High-Tunnels

Timothy Elkner - Penn State Extension and and Francesco Di Gioia - The Pennsylvania State University
\$9,889

NEWS

In Memory

**Herbert Clark Pollock**

Herbert Clark Pollock, 97, of Indiana, a PVGA Life Member and former Director, went into eternity with his Lord and Savior Jesus Christ on Sunday, April 16, 2023.

A son of Clark Craig Pollock and Mary Louise (Hopkins) Pollock, he was born in Indiana and raised on the Pollock farmstead in East Mahoning Township in Marion Center.

Herbert attended the Mahoning one room elementary school for seven years and graduated from Marion Center High School in 1944. He participated in both 4-H and FFA.

Herbert experienced the change from horsepower to tractor power! After having learned to drive horses in the field, he began driving a tractor doing fieldwork at age 13.

In 1938, Herbert joined his family church, the Covenant Presbyterian. This was the beginning of a long life of church activities, having been born into a family with a strong Christian faith.

In 1945, the military draft took him to Little Rock, Ark., for infantry basic training to go to Japan. By the end of his training, the war in Japan was over. After a month back on the farm milking cows and harvesting 5,000 bushels of potatoes, it was back to the Army, stationed in Bavaria, Germany, serving as a Jeep patrol driver in the 793rd Military Police Bn. 3rd Army. The next summer he was on Jeep patrol in Nuremberg, the war crimes trial year.

In 1947, Herbert attended Indiana State Teachers College as a Penn State University freshman then transferred to the main campus and graduated in 1951 with a degree in ag economics. Upon graduation, he applied to do volunteer agricultural work in a foreign country.

By early July, Herbert was on a ship for the two-week trip to Hafia, Israel. The goal of the Turan Village project was to improve their production and be a model village for others. The two-year assignment ended in July 1953, and before returning home, Herbert traveled to Cyprus, Turkey, Greece, Yugoslavia, Trieste and Italy by plane, bus and The Orient Express, visiting many early Christian locations.

Herbert also traveled over 2,000 miles through Europe on a Vespa motor scooter. In 1956, for a year and a half, Herbert substitute taught vocational agriculture at Marion Center High School.

On July 6, 1957, after dating six months, Herbert married the love of his life, Mary Nell Cribbs, in Calvary Presbyterian Church in Indiana and was an active member there the rest of his life.

He was a caring and nurturing family man. They opened their home to numerous foreign student/adult guests. They enjoyed square dancing and ballroom dancing, photography and traveling. Their travels took them to Hawaii twice and Europe five times, traveling by car in all continental states except Montana, Idaho and Utah.

Community service was important. Herbert worked for Eastern States Farmers' Cooperative and Agway for 34 years, retiring in 1990, and for 40 years enjoyed raising pick-your-own strawberries. Herbert served decades on the Conservation District, Kiwanis, County Fair Board and the Pennsylvania Vegetable Growers Board of Directors.

He is survived by a daughter, Marilyn Nisbet, and husband Dana; a son, Robert Pollock, and wife Annette; a sister, Laura (Pollock) Resener, and a brother-in-law, Clair Cribbs; four grandchildren, Matthew Pollock and wife Emma, Tyler Pollock and wife

Olivia, Gretchen Nisbet and Jocelyn Nisbet; seven great-grandchildren; and numerous nieces and nephews.

In addition to his parents, he was preceded in death by his wife of 53 years, Mary Nell Pollock; a brother and sister-in-law, H. Wallace Pollock and wife Ethel Grace; and a brother-in-law, the Rev. Carl Resener.

The funeral service was held at Calvary Presbyterian Church with interment in Oakland Cemetery.

The family would like to thank the staff of Maple Valley and Concordia/VNA Hospice for their compassionate and loving care.

The family kindly suggests memorial contributions be made to Calvary Presbyterian Church, 695 School St., Indiana, PA 15701, or Concordia — IRMC VNA, 850 Hospital Road, #3000, Indiana, PA 15701.

To view the online obituary, sign the guest registry or send condolences, please visit www.robinsonlytleshoemaker.com.

Adapted from the Indiana Gazette, April 18, 2023.

**Brian L. Reichart**

Brian L. Reichart, 55, passed away peacefully on Monday, April 3, 2023, following a courageous battle with cancer, at Hospice & Community Care in Mount Joy, Pennsylvania. He was the beloved husband of Lela S. (Mummert) Reichart for 27 years and loving father to Ryder L. Reichart and Artem T. Reichart. Born February 24, 1968, in Hanover, Brian was the son of Margaret A. (Miller) Reichart of New Oxford, and the late Thomas L. Reichart. He was a 1986 graduate of Delone Catholic High School, and a member of Immaculate Conception Catholic Church in New Oxford. Brian was a 1990 graduate of Millersville University where he participated in ROTC and played varsity football. He served in the U.S. Army at Ft. Benning, in the Mechanized Infantry Unit, served as an Army Ranger and Airborne, and was a Captain in the 3rd U.S. Infantry Regiment, The Old Guard at Arlington National Cemetery where he led more than 100 funeral processions. He was employed by Amazon where he spent nearly 18 years in leadership roles, exemplifying core principles and influencing the success of his various teams. He was also employed at Yellow Buttercup Farms, was a member of New Oxford Social & Athletic Club, and was a supporter of youth athletics and Delone Catholic sports. A mentor both professionally and personally, Brian seized every opportunity to teach and share practical guidance with his sons and the many young people fortunate to spend time on the family farm and surrounding woodland. An avid outdoorsman, he graciously shared his passion and knowledge of nature, wildlife, and stewardship. In addition to Brian's wife, two sons, and mother, he is survived by a sister, Carolyn R. Strickland and her husband Elliott of Williamsport, two brothers, Mark L. Reichart and his wife Christie McSherrystown, and Blane L. Reichart and his wife Michelle of Hanover, and numerous aunts, uncles, nieces, nephews and cousins. Burial, with military honors, was at Immaculate Conception Cemetery, New Oxford. Memorial contributions may be made to Roots For Boots, PO Box 213, New Oxford, PA 17350 at www.rootsforboots.com. Memories may be shared at www.feiserfuneralhome.com.

From The Evening Sun, Hanover, April 4, 2023

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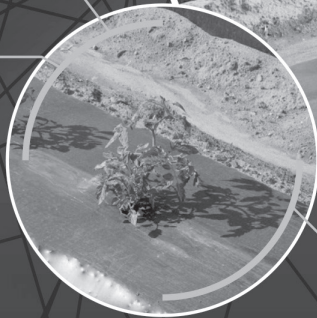
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GENERAL

Glyphosate (Roundup): Understanding Risks to Human Health

John Wallace, Dwight Lingenfelter, and Art Grover

A review of the risk assessment process for evaluating the potential of glyphosate to cause adverse effects on human health.

What is glyphosate?

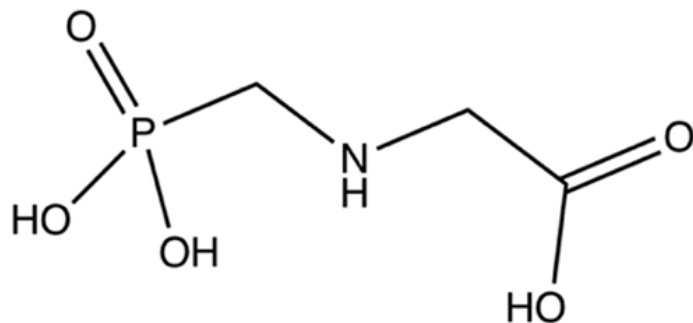
Glyphosate is a common herbicide ("weed-killer") used in crop and non-crop lands, including residential areas such as home lawns and gardens. Glyphosate was first registered in the United States in 1974 as the active ingredient in Roundup but is now available in many commercial herbicide products. There is currently increased concern about glyphosate impacts on human health, including risks of cancer. This article reviews the risk assessment process for evaluating the potential of glyphosate to cause adverse effects on human health and aims to improve understanding of recent studies on its carcinogenicity.

Hazard vs. risk.

All chemicals, including herbicides, are potentially hazardous to human health. However, a basic principle of toxicology is that "the dose makes the poison". Therefore, the risk of a hazardous effect to human health is a function of the toxicity of the chemical and the likelihood of exposure to a biologically relevant dose. A chemical can be toxic at very low doses (ex: dioxin) but present a low risk of hazardous effects if there is minimal likelihood of exposure to a biologically relevant dose.

Chemical properties.

The chemical properties of an herbicide are a primary determinant of toxicity and persistence in the environment. The glyphosate molecule (below) is unique among herbicides. Approximately 95% of registered herbicides are molecules made from aromatic ring structures. In comparison, glyphosate is a small molecule made of a linear carbon chain with weaker bonds, which makes glyphosate less persistent in the environment. In commercial products, glyphosate is formulated with salts to improve its water solubility and proprietary surfactants to improve plant uptake.



Glyphosate toxicity.

Acute toxicity describes the hazard associated with a single exposure to a chemical, such as dermal or oral exposure during the herbicide application process. Chronic toxicity describes the hazard associated with long term exposure to a chemical, such as repeated ingestion of low doses in food residues. Glyphosate has lower acute toxicity to humans than 94% of all herbicides¹ and many common household chemicals, including vinegar and table salt. Glyphosate also has lower chronic toxicity to humans than 90% of all herbicides¹.

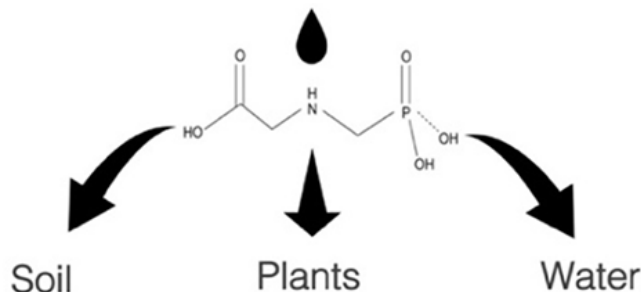
Likelihood of exposure.

Glyphosate use has increased dramatically in the past 20 years due to its frequent use in Roundup Ready crops (corn, soybean, cotton). Consequently, the likelihood of glyphosate exposure has increased for pesticide applicators. However, the EPA has concluded that there is low potential for the general public or non-applicators to be exposed to a recurring biologically relevant dose of glyphosate based on models of glyphosate persistence in

the environment and dietary exposure.

Glyphosate fate in environment.

The chemical properties of glyphosate generally minimize off-target movement and promote dissipation in the environment.

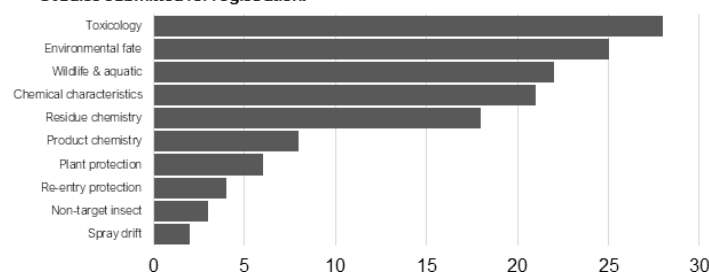


Glyphosate is degraded in soil and water by microbes and binds tightly to soil particles, which prevents leaching of glyphosate into ground water. Glyphosate does not degrade quickly in plants. As a result, it is possible that glyphosate residues can occur in food products. However, glyphosate is generally not applied to crops that are produced for direct human consumption. The vast majority of glyphosate is applied to fallow fields or in crops that are used for animal feed (corn, soybean), energy (corn) or fiber (cotton) and is applied early in the growing season to young vegetative crops many weeks before plants produce grain or are harvested.

Herbicide regulation.

The herbicide registration process requires EPA review of over 120 studies that focus on herbicide toxicological properties, environmental fate and the potential for non-target effects. These studies are used to conduct formal risk assessments that quantify the likelihood of adverse effects to humans using toxicological data and models of exposure. The Food Quality Protection Act (FQPA, passed in 1996) requires a "reasonable certainty that no harm will result from aggregate exposure" to pesticides and establishes enforceable residue standards based on models of food consumption. The USDA Food and Drug Administration actively monitors the level of glyphosate on foods in the marketplace.

Studies submitted for registration.



Cancer risks associated with glyphosate.

Several organizations have evaluated cancer risks associated with glyphosate in recent years. These assessments consider epidemiological, toxicology and genotoxicity studies. In 2015, the World Health Organization's International Agency for Research on Cancer (IARC) concluded that "Glyphosate is probably carcinogenic to humans". The IARC's study aimed to identify hazards that can result in cancer outcomes but did not consider the risk of exposure to doses that are likely to occur in the environment. Put another way, the IARC asked "Can glyphosate cause cancer under any circumstance?" Based on this criteria, other probable

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GENERAL

Improving Pollinator Habitat on the Farm

Hannah Whitehead Shell

Most of us are aware that pollinator populations are in decline. We also know that wild bees, butterflies, wasps, and flies provide critical pollination services for both food crops and native plants. (You can read more about pollinator declines in the February 2022 issue of Veg Notes). Through decades of research, we now know that the number one cause of pollinator decline is habitat loss – that is, not enough flowering plants for pollinators to eat and too few undisturbed areas where they can nest. It may seem like this problem is so sweeping and complex that there’s nothing we can do to help, but the good news is that preserving or establishing pollinator habitat is the most effective thing that individuals can do to support pollinators. There are several ways to do this on your farm.

Because farmers often manage large tracts of land, their actions are especially impactful. Protecting habitat on farms can not only help pollinators, but also boost pollination services to crops, support natural enemies that consume crop pests, and increase a farm’s environmental services and aesthetic value.

Here are some ways to improve pollinator habitat on your farm. They are ordered from easiest to hardest in terms of time and expense. We know that farming is already a lot of work. The good news is that “easier” habitat-improvement methods are not less impactful – ALL of these are valuable ways to support pollinators. So, if you’re inspired, do whatever is most feasible for you on your farm! At the end of the article, we’ve also included some key resources to help you get started.

Protect existing pollinator habitat...

1) Identify and preserve existing resources. Many diversified New England farms already contain pollinator habitat on



field edges or marginal/riparian areas. Any native flowering plants, shrubs or trees are excellent sources of food for pollinators, and any undisturbed soil provides a good location for nesting. By preserving these areas and protecting them from pesticide drift you are supporting many native pollinators and other beneficial insects. If you want to be methodical about assessing existing pollinator habitat on your land, you can use this [Pollinator Habitat Assessment Form and Guide for Farms](#).

2) Turn marginal areas into pollinator gardens. You know those spots by the high tunnel, or beside the barn, that always grow into a weedy mess? If they are already colonized with flowering native plants, celebrate them! If not, consider turning them into micro-pollinator-gardens. As a bonus, if these spots are close to your farm stand or CSA pick-up location, they will look great to

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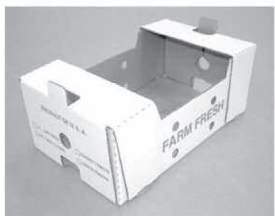
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GENERAL

Improving Pollinator Habitat on the Farm continued from page 7

customers. Check out this list of [Pollinator Plants for the Northeast](#) from the Xerces society for recommended native plants and planting tips. Or take a look at the Massachusetts Department of Agriculture's list of [Locally Available Pollinator-Friendly Native Plants](#).

Make pollinator habitat a part of your cropping plan...

3) Plant pollinator-friendly cover crops. Many flowering cover crops provide excellent food for bees and other beneficial insects. These include buckwheat, clovers, peas, phacelia, sunflower, alfalfa, and mustards. Many of these cover crops are multi-functional – for instance, buckwheat is also great at suppressing weeds, and clovers help to fix nitrogen. However, it is important to note that cover crops provide bees with a burst of resources during flowering, but not season-long food or nesting locations. You can read more about cover cropping for pollinators in SARE's [Cover Cropping for Pollinators and Beneficial Insects](#). You can also search for pollinator-friendly cover crops using the Northeast Cover Crop Council's [species selector tool](#).



*A field of flowering buckwheat.
Photo: UMass Vegetable Extension*

4) Consider adding cut flowers to your operation, and/or allow crops to flower. Many cut flowers, especially native perennial ones, provide excellent resources for pollinators. Some good examples are sunflower (and other asters), purple coneflower, foxglove, and yarrow. Food crops like brassicas, cilantro or dill are also great sources of nectar and pollen if left to flower.



*A few rows of cut flowers on a farm in Hampden County.
Photo: H Whitehead*

5) Practice IPM and bee-friendly pesticide use. It is not only important to preserve and/or establish flowering plants, but also to protect those flowers from pesticides. Reduce pesticide use through Integrated Pest Management (we know that most of you are already doing this!), choose pesticides with a lower hazard rating, and always apply pesticides in ways that reduce harm to beneficial insects (e.g. in the evening and when plants are not in full bloom). Read more about pollinator-friendly pesticide practices [here in the New England Vegetable Management Guide](#). You can also check the toxicity of pesticides for bees using this [University of California IPM tool](#).

Establish new perennial pollinator habitat...

(Note: you can often receive NRCS funding to install pollinator habitat - contact your local NRCS office to learn more)

6) Plant a hedgerow. Flowering shrubs and trees provide

amazing early-season resources for bees and other beneficial insects. They can also serve as a wind break or organic buffer, reduce erosion, or shield crops from a busy road. You can also consider boosting your hedgerow with native perennial herbaceous plants, which often flower later than trees and shrubs, providing pollinators with resources throughout the season. Check out this list of [MA Native Trees and Shrubs for Pollinator Conservation](#) as well as [Estimated Costs to Establish Pollinator Hedgerows](#) to get started.

7) Sow a pollinator meadow. Another powerful way to support bees and other beneficial insects is to install a pollinator meadow. Depending on meadow size, it usually is most economical to start a meadow from seed. However, it is important to follow instructions carefully, and be ready to invest significant time and energy into this endeavor. Meadows can be tricky and often become overrun with weeds. They can also take a significant amount of land out of production. But if done right, they can become a beautiful asset to your farm, and your local pollinators! To learn more about establishing a pollinator meadow, check out [Establishing Pollinator Meadows from Seed](#) and [Organic Site Preparation for Wildflower Establishment from the Xerces Society](#), as well as [Wildflower Meadows – Plant Selection and Establishment](#) from the University of New Hampshire. Also check out these videos on creating [Habitat for Bees](#) from Project Integrated Crop Pollination.



*A few rows of cut flowers on a farm in Hampden County.
Photo: H Whitehead*

To access the numerous additional pollinator habitat resource via hyperlinks, please see the online version of this article at https://ag.umass.edu/sites/ag.umass.edu/files/newsletters/april_vegetable_notes.pdf

Ms. Shell is with the Univ. of Massachusetts Vegetable Program. From [Vegetable Notes for Vegetable Farmers in Massachusetts](#), Univ. of Mass. Extension, Vol. 35, No. 4, April 13, 2023.

Glyphosate (Roundup) continued from page 6

human carcinogens included red meat, late-night work shifts and indoor emissions from burning wood. In 2016, the EPA evaluated the carcinogenic potential of glyphosate and concluded that glyphosate was "not likely to be carcinogenic to humans at doses relevant to human health risk assessments". In contrast, the EPA assessment accounted for the likelihood of exposure in order to quantify carcinogenic risks². Based on review of epidemiological studies, the EPA found no evidence of association between glyphosate exposure and numerous cancer outcomes but indicated more data was needed to determine association between glyphosate exposure and Non-Hodgkin Lymphoma².

¹Kniss, A (2017) Long term trends in the intensity and relative toxicity of herbicide use. Nature Comm.

²EPA (2016) Glyphosate issue paper: evaluation of carcinogenic potential. Office of Pesticide Programs

Dr. Wallace, Mr. Lingenfelter and Mr. Gover are with the Dept. of Plant Science at Penn State. From Penn State Extension, <https://extension.psu.edu/glyphosate-roundup-understanding-risks-to-human-health>, January 5, 2023.

GENERAL

Are Organic Herbicides Effective for Burndown Prior to Crop Establishment?

Dwight D. Lingenfelter and John M. Wallace



Introduction:

Weed management in organic cropping systems is extremely challenging. In most cases, it is accomplished with various tactics including tillage, cover crops, mulches, among others. Planting vegetable crops into an organic no-till

system provides its own set of unique challenges and significantly reduces the number of weed control options. However, some growers are always looking for ways to make this system work. One option is to apply OMRI-approved herbicide products such as HomePlate, Axxe, or Scythe during the burndown phase prior to crop planting. However, reliable information is limited on the overall weed control effectiveness of these types of products. Initial university data indicates that high product use rates and high spray volumes will likely be necessary for adequate burndown of existing weeds.

We propose to evaluate these products for burndown control especially on problem weeds such as marestalk. We will compare HomePlate, Axxe, and Scythe (each of these is a different type of chemical) at various use rates, spray volumes, and with certain OMRI listed adjuvants to determine their effectiveness on burndown weed control over a few-week period. As a comparison, conventional burndown herbicides such as glyphosate and Liberty will be included. The study will be conducted at the Penn State research farm near Rock Springs, Centre County. Benefits to state and regional organic vegetable growers will include updated information in vegetable production guides and other educational resources on how to control weeds more effectively.

Objectives:

1. To examine various OMRI approved herbicides to determine their effectiveness on burndown weed control.
2. To evaluate these herbicides compared to competitive, non-OMRI approved products.

Work Statement:

An experiment was conducted at the Russell E. Larson Agricultural Research Farm in Centre County in 2022. Several herbicide treatments (Table 2) were evaluated in a randomized complete block design with three replications. Each plot was 5 x 30 feet and established in a fallow area with marestalk and other winter annual or perennial weeds. Treatments were applied on May 5 using the parameters specified in the treatment listing below (Table 1). Standard flat fan spray nozzles (TeeJet XR 11003) and two spray volumes (35 & 70 gallons/acre) were used to maximize coverage on the weed foliage. Nu-Film P (OMRI-approved) adjuvant was included in some treatments. Weed control for all species present was evaluated on May 9 and May 20.

Results (refer to Table 2)

- None of the “organic herbicide” treatments in this study provided effective burndown weed control. o In general, organic herbicides cause substantial leaf burning at first, but most weeds overcame this initial injury and thrived afterwards.
- Rating taken two (2) weeks after application showed that none of the organic treatments provided greater than 70% control of the weeds present, with a few exceptions. Most ranged from 20-60% control.
- In general, weed control with Liberty and Roundup continued to increase over time.
- Highest labeled use rates were necessary to get better weed suppression.
- High spray volumes (70 gallons/acre) provided better coverage of weed foliage and tended to cause more leaf injury.
- Certain OMRI-approved adjuvants (e.g., Nu-Film P) slightly improved weed control in this study.

continued on page 10

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GENERAL

Are Organic Herbicides Effective for Burndown?*continued from page 9***Discussion and summary****Table 2.** Effect of herbicides, use rate, spray volume, and adjuvant on burndown weed control at Centre Co., PA, 2022.

Treatment #	Herbicide(s)	Rate/A	Spray volume (GPA)	Marestail (May 9)	Marestail (May 20)	Dandelion (May 9)	Dandelion (May 20)	Mouseear chickweed (May 9)	Mouseear chickweed (May 20)
				% control					
1	Untreated	-	-	0	0	0	0	0	0
2	HomePlate	3% v/v (4.2 qt)	35	22	0	17	0	17	0
3	HomePlate	6% v/v (8.4 qt)	35	60	30	42	17	47	20
4	HomePlate	9% v/v (12.6 qt)	35	75	40	63	27	67	40
5	Axxe	8% v/v (11.2 qt)	35	47	28	37	23	47	23
6	Axxe	13% v/v (18.2 qt)	35	77	40	53	40	57	40
7	Scythe	5% v/v (7 qt)	35	82	70	60	38	53	35
8	Scythe	10% v/v (14 qt)	35	87	68	76	52	76	65
9	HomePlate	9% v/v (12.6 qt)	70	85	70	84	73	88	70
10	Axxe	13% v/v (18.2 qt)	70	85	63	83	61	86	63
11	Scythe	10% v/v (14 qt)	70	92	73	87	70	93	77
12	HomePlate + Nu-Film P	9% v/v (12.6 qt) + 8 fl oz	35	83	60	79	57	70	46
13	Axxe + Nu-Film P	13% v/v (18.2 qt) + 8 fl oz	35	84	65	81	50	68	52
14	Scythe + Nu-Film P	10% v/v (14 qt) + 8 fl oz	35	84	65	74	50	78	55
15	Roundup PM	22 fl oz	35	60	60	43	60	45	85
16	Liberty + AMS Liquid	32 fl oz + 2.5 %v/v	35	84	86	73	85	60	85
	LSD (P=0.05)			9	5	7	9	6	5

The quest for effective organic herbicides still remains elusive. Of the organic herbicides tested in this study, none of them provided adequate control of weeds when applied early in the season (refer to Table 2 and images and other comments below). As in other studies conducted at Penn State with organic products (e.g., vinegar, clove oil), initial weed control seems promising but over time, the weeds rebound and tend to make a full recovery. In some cases, products such as vinegar, clove oil, and the ones named above can provide fair to good control (80-90%) of small (<4" tall) annual broadleaves such as lambsquarters and redroot pigweed; but are less effective on waxy or hairy weeds and provide poor control of grasses. In general, a spray volume of at least 60 gal/acre tends to be necessary for adequate herbicide performance. Also, environmental conditions and application time are very important. For best results, apply when temperature and relative humidity are each above 70 (°F and %, respectively) and sunlight is bright and abundant. Therefore, best results are usually obtained in late spring or summer. Furthermore, organic herbicides might not make economic (or philosophical) sense in many organic cropping systems since they can be expensive (e.g., \$200 to 400/acre) and could be deemed an input substitution for other acceptable tactics of weed management. However, they might be used effectively and efficiently as a spot treatment. Also, some products such as Scythe are not OMRI approved, so they would be immediately disqualified for use in organic settings.

In general, the conventional burndown herbicides (Roundup PowerMax and Liberty) provided better control of most weeds.

Initial control rating showed that Roundup was much slower than the others but since it is a systemic herbicide it takes longer for symptoms and control to occur. Since lower than normal use rates of these products were used in this study, full effectiveness of these products was also limited. However, the marestail population at this study location was glyphosate-resistant so it would not be killed by Roundup. Liberty is more effective on marestail however, under cooler conditions in spring it tends to not be as effective as it would be when applied in the summer months.

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Table 1. Application parameters for organic herbicide burndown field study at Centre Co., PA 2022

Application parameters		Treatment #	Herbicide(s)	Rate/A	Spray volume (GPA)	Corn Speedwell (May 9)	Corn Speedwell (May 20)	Sulfur cinquefoil (May 9)	Sulfur cinquefoil (May 20)
Application date	May 5, 2022								
Air temperature*	67° F								
Relative humidity (%)	53%					% control			
Wind speed	1-3 MPH	1	Untreated	-	-	0	0	0	0
Cloud cover	10%; sunny	2	HomePlate	3% v/v (4.2 qt)	35	10	0	10	0
Nozzle type	TeeJet XR11003	3	HomePlate	6% v/v (8.4 qt)	35	43	17	43	10
		4	HomePlate	9% v/v (12.6 qt)	35	68	40	63	30
		5	Axxe	8% v/v (11.2 qt)	35	43	20	40	20
		6	Axxe	13% v/v (18.2 qt)	35	57	40	57	25
		7	Scythe	5% v/v (7 qt)	35	75	50	30	30
		8	Scythe	10% v/v (14 qt)	35	85	70	76	40
		9	HomePlate	9% v/v (12.6 qt)	70	86	65	87	73
		10	Axxe	13% v/v (18.2 qt)	70	85	63	80	60
		11	Scythe	10% v/v (14 qt)	70	92	85	87	62
		12	HomePlate + Nu-Film P	9% v/v (12.6 qt) + 8 fl oz	35	78	63	82	52
		13	Axxe + Nu-Film P	13% v/v (18.2 qt) + 8 fl oz	35	75	53	73	52
		14	Scythe + Nu-Film P	10% v/v (14 qt) + 8 fl oz	35	85	60	76	45
		15	Roundup PM	22 fl oz	35	57	85	45	80
		16	Liberty + AMS Liquid	32 fl oz + 2.5 %v/v	35	72	90	25	40
			LSD (P=0.05)			8	5	10	7

Weed species	Height at application (inches)
Marestail/horseweed	2-4"
Dandelion	6-10" diameter
Mouse-ear chickweed	5-10" diameter
Corn speedwell	3-5"
Sulfur cinquefoil	8-12" diameter

continued on page 12



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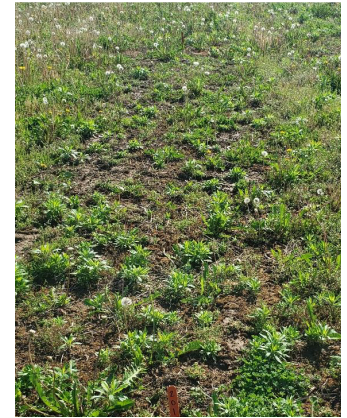
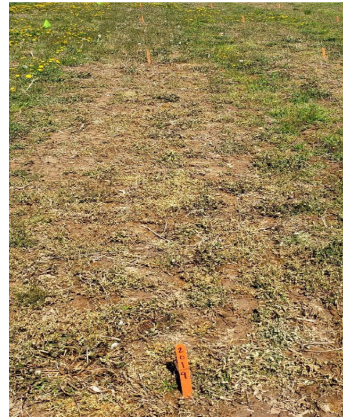
GENERAL

Are Organic Herbicides Effective for Burndown?*continued from page 11*

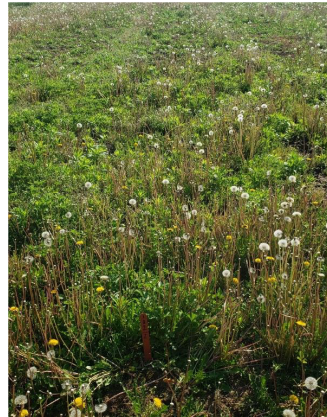
Pictures from the study at Rock Springs.



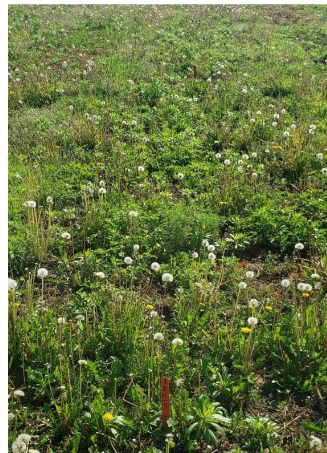
General overview of study area (May 5)



Treatment 9 HomePlate 9% 70 GPA (Photos May 5, left and May 21, right). The highest rate of HomePlate applied in 70 gallons/acre spray volume caused initial overall burning several hours after application (left) and provided some longer control of certain species a couple weeks later. However, weeds such as mar-estail and dandelion eventually recover. (Notice large dandelion plant in lower left corner, near orange stake, of each photo.)



Treatment 2 HomePlate 3% 35 GPA (Photos May 5, left and May 21, right). About two weeks after application treatment effects could not be seen.



Treatment 4 HomePlate 9% 35 GPA (Photos May 5, left and May 21, right). Symptoms were evident several hours after application (left); however, two weeks later many weeds recovered and were actively growing.

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Axxe 13% 70 GPA (Photo May 21) Scythe 10% 70 GPA (Photo May 21). These images show the effects of the high rates of Axxe and Scythe applied in 70 gallons per acre of spray volume two weeks after application. Notice regrowth of weeds.

Addendum: Below are images taken on June 10, 2022, from another field demo that contained HomePlate (6% v/v), Axxe (10% v/v), and Scythe (5% v/v). Treatments were applied in 35 and 70 gallons/acre spray volume on June 8. Annual broadleaf weeds were 1-3 inches tall and giant foxtail was 4-7" tall. Notice the speckling and burning on weeds. However, weeds were never killed even after a couple weeks, and they recovered soon after.

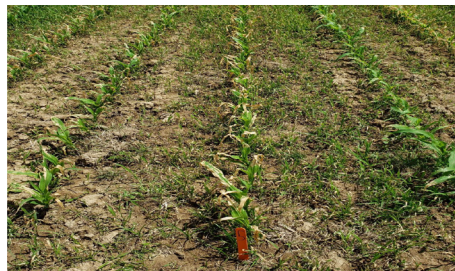


(left) Notice velvetleaf and foxtail injury. These weeds recovered several days later.

(right) Notice initial injury to common ragweed and foxtails but they recovered soon after.



Liberty 32 fl oz 35 GPA (Photo May 21). As a comparison, this is an image of a plot with a Liberty treatment. Overall control is much better than the other organic treatments two weeks after application.



This is an overview of a plot that was sprayed with Axxe 10% v/v at 70 GPA. The demo was conducted in a corn field with weeds. (Note: none of these types of herbicides are labeled for over-the-top applications in field corn, this was for demonstration purposes only.)

Mr. Lingenfelter and Dr. Wallace are with the Department of Plant Science at Penn State. This research project was funded by PVGA and the Pennsylvania Vegetable Marketing and Research Program.

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VEGETABLE PRODUCTION

2023 Allium Leafminer Emerging Earlier Than Recent Years

Karly Regan, Timothy Elkner, and Shelby Fleischer

Keep a lookout for Allium leafminer on any garlic or early-planted alliums you may have this season.



Figure 1. Allium leafminer on scallion leaf. Photo: T. Elkner / B. Lingbeek, Penn State provided some longer control of certain species a couple weeks later. However, weeds such as mar-estail and dandelion eventually recover. (Notice large dandelion plant in lower left corner, near orange stake, of each photo.)

The unusually mild weather we've had throughout this winter is leading to earlier emergence than we have seen in recent years. Evidence of leafminer activity has been seen in Maryland and southern New Jersey recently, which indicates it will not be much longer until this pest is seen in Pennsylvania.

Allium leafminer (ALM) is an invasive fly from Poland first detected in Lancaster Co., Pennsylvania, in December 2015 (Fig. 1). ALM attacks plants in the Allium genus, including onion, garlic, leek, scallions, shallots, and chives. It overwinters as a pupa in leaf tissue or adjacent soil, emerges in the spring, and adult flight occurs over a 5–7-week period. Females puncture leaves with their ovipositor, and both males and females feed on leaf sap. Oviposition results in a characteristic linear series of round wounds

(Fig. 2). Larval development progresses to the pupal stage but is then delayed as the pupa undergoes summer aestivation, and they do not emerge again until late September for another 5–7-week flight.



Figure 2. Oviposition and feeding scars. Photo: B. Lingbeek, Penn State

Knowing when adults start flying helps with management. You can protect crops by applying netting prior to flight and removing it after a flight period ends. In most of PA, now would be the time [this article was published March 10, 2023] to get the netting put on. If you're in the warmer portions of southeast PA, initial flight may have started, but netting would still protect the plants during the time most of the flight occurs. In past years, flight occurred over about 6–8 weeks. The flight period may be stretched out this year if we keep having intermixing of warm and cool (or near normal) weather.

Another option is to apply insecticides during the flight period, targeting adults and developing larvae. Systemics tend to

work best because the larvae are mining inside the leaf tissue. Since Allium leaves are very waxy, a nonionic surfactant is recommended whenever applying insecticides to allium crops. In trials conducted by researchers at Cornell University and Penn State, the highest and most consistent control of ALM occurred using foliar applications of dinotefuran (Scorpion), cyantraniliprole (Exirel), and spinetoram (Radiant). For OMRI-listed options, spinosad (Entrust) was the best performer. Those trials used weekly applications starting as soon as oviposition/feeding marks are detected. More recent trials suggest that very good control can be achieved by waiting about 2 weeks after the first detection.

That said, knowing when to start is an important question! With the support of PVGA and USDA, we developed a degree-day model. We estimate that ALM first emerge in the spring after 350° Celsius degree days above a threshold of 1°C, starting from January 1. This is a bit rougher than most phenology models, but it's the best we have and gives us a general idea of when to begin scouting (see Lingbeek et al 2021). In State College, this tended to coincide with when daffodils and forsythia had been blooming for a week, and ornamental pear was in bloom in urban areas.

You can use the Northeast Weather Associate (<https://newa.cornell.edu/>) to estimate when this occurs for select weather stations. Go to the NEWA website, click 'Weather Tools,' click 'Degree Day Calculator,' choose a site, set the start date to Jan 1 and end date to today, and select base of 1°C as the degree day type. This is important because you must accumulate in °C instead of °F for the 350° threshold. If you use °F, the conversion would mean we need ~650° dd. Once you make your model selections, the NEWA website will give you a table of accumulated GDD and forecasted predictions for the next week, as well as a cumulative graph to help visualize the trend. Graph 1 below is the graph for the Fruit Research and Extension Center in Biglerville on March 9, 2023. In this area, we are forecast to accumulate 287° by March 14th, which would put us on track for exceeding 350° around March 21st. In Philadelphia, we have already reached 366°, and in Hagerstown, MD, which is the closest NEWA site to the southern

portion of the Cumberland Valley, we are forecast to reach 350° around March 17th. This is slightly ahead of when the first emergence in PA occurred in the past (Table 1), which has ranged from the 17th of March to the 27th of April. In years with warm winters, we have seen some exceptionally early initial emergence, about 10 days before our prediction, but most

of the population emerged much closer to our prediction.

Now (in far southeast PA), and within a few weeks in cooler areas, is the time to start scouting your Allium crops and prepare for management. Finding adults is easiest in the cool temperatures of early morning and by looking at the tops of the leaves. Finding the feeding scars on leaves is often easier than finding adults, especially on onions and when scouting during windy conditions. Most of our first detections were in wild garlic or other weedy alliums along fence lines or forested borders of farms. Among Allium species, we tend to find more ALM in early spring scallions and green onions, so that is also a great place to search.

VEGETABLE PRODUCTION

Graph 1: Accumulated Celsius degree days above a base threshold of 1°C at Biglerville, PA. ALM emergence is predicted to start at 350°C GDD.



Citation for phenology:

Lingbeek, B., D. Roberts, T. Elkner, M. Gates, and S. J. Fleischer. 2021. Phenology, development, and parasitism of Allium Leafminer (Diptera: Agromyzidae), a recent invasive species in the US. *Environmental Entomology* 50(4): 878-887.

Citations for insecticide management:

Nault, B. A., L. E. Iglesias, R. S. Harding, E. A. Grundberg, T. Rusinek, T. Elkner, B. Lingbeek and S. J. Fleischer. 2020. Managing Allium leafminer (Diptera: Agromyzidae): an emerging pest of allium crops in North America. *J. Econ. Entomol.* 113 (5): 2300-2309.

Nault, B. A., K. R. Sandhi, R. S. Harding, E. A. Grundberg, and T. Rusinek. 2022. Optimizing Spinosyn Insecticide Applications for Allium Leafminer (Diptera: Agromyzidae) Management in Allium Crops. *J. Econ. Entomol.* doi.org/10.1093/jee/toac016

Table 1. Date of first detection of ALM adults or feeding/oviposition wounds in 2019 and 2020.

Year	State	Location	Date of First Detection
2020	PA	State College	13-Apr
		Landisville	17-Mar
		Landisburg	18-Mar
		York	17-Mar
		Hanover	17-Mar
		Rock Springs	14-Apr
		Millheim	14-Apr
		Aaronsburg	14-Apr
		Woodward	14-Apr
	NJ	Lawrenceville	24-Mar
		Milford	25-Mar
	NY	Hudson Valley	8-Apr
2019	PA	Landisville	18-Apr
		Pottstown	18-Apr
		Landisburg	16-Apr
		Millheim	27-Apr
		Woodward	27-Apr
		Aaronsburg	27-Apr
		Aaronsburg	27-Apr
		Huntington	24-Apr

Dr. Regan and Dr. Elkner are with Penn State Extension. Dr. Fleischer is retired from the Penn State Dept. of Entomology. From Penn State Extension, <https://extension.psu.edu/2023-allium-leafminer-emerging-earlier-than-recent-years?>, March 10, 2023.

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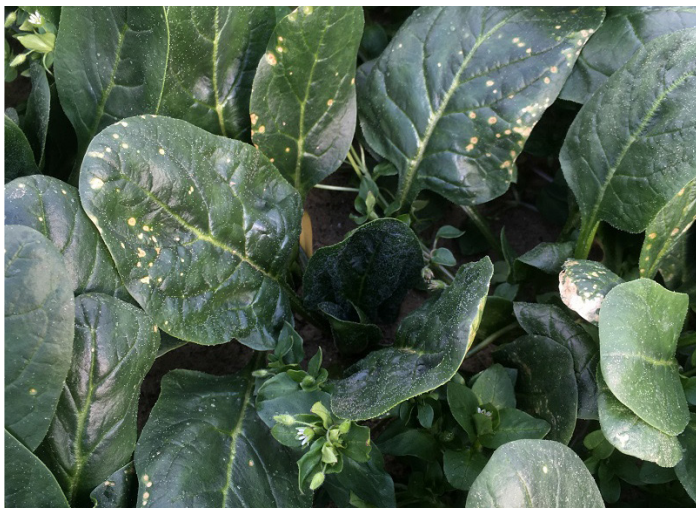
VEGETABLE PRODUCTION

Cladosporium Leaf Spot of Spinach

Genevieve Higgins

We are seeing *Cladosporium* leaf spot in our spinach variety trial – a common occurrence in late winter spinach. This disease is relatively unstudied in the Northeast but we've seen it every year for the last several years in our greenhouse trial spinach, and we receive reports from growers every winter.

Identification. *Cladosporium* leaf spot is caused by the fungal pathogen *Cladosporium variabile*. Early leaf spots are tan colored, and expand to 1-3 mm in diameter. Adjacent spots may coalesce, forming irregular lesions. As the disease develops, velvety dark green-brown sporulation develops within the lesions. In severe cases, older infected leaves may be killed.



Cladosporium leaf spot in spinach. Photo: G. Higgins

Life Cycle. Development of *Cladosporium* leaf spot is favored by cool, humid environmental conditions that often occur in the fall and in winter high tunnels in New England. Optimum conditions for infection are 59-68°F and relative humidity above 80%, but infection can occur at temperatures between 50 and 86°C and the fungus can continue growing at temperatures as low as 41°F.

In the absence of a spinach crop, *Cladosporium* may overwinter on crop residue, spinach volunteers, and weed hosts (although it has not been confirmed which weeds serve as hosts for this disease). Viable spores of *Cladosporium* have been isolated from dried spinach leaves and seed up to 8 years old. In the field, spores are spread by splashing water, wind, workers, and equipment.

Cladosporium can be seed-borne; in one 2006 study from Washington State University, *Cladosporium* was found infesting 37 out of 66 seed lots tested, with infestation levels ranging from 0-49%. Under the right environmental conditions, it's likely that seed contamination could lead to infected seedlings, although this hasn't yet been confirmed in the field, only in a controlled greenhouse environment.

Cultural Controls & Prevention

- Till under crop residues promptly after harvest to speed up decomposition.
- Hot water seed treatment can effectively eliminate *Cladosporium* from spinach seed. Researchers at Washington State University found that treating infested seed at 40°C/104°F for 10 minutes sufficiently eliminated *Cladosporium* and did not decrease germination. See the January 13, 2022 issue of Veg Notes (https://ag.umass.edu/sites/ag.umass.edu/files/newsletters/january_13_2022_vegetable_notes_0.pdf) to learn about hot water treating your own seed.

- Chlorine seed treatment also effectively eliminates *Cladosporium* from spinach seed and does not reduce germination. Soak seed for 10 minutes in a 1.2% sodium hypochlorite (NaOCl) solution. NaOCl is the active ingredient in bleach; different bleach products have different percentages of NaOCl, with 5.25% being a common concentration. To make a 1.2% NaOCl solution from a common 5.25% NaOCl product, dilute bleach with water at a 1:3 ratio. There are many bleach solution calculators available online (here's an example). Note for dilution calculators: 1000ppm = 1%.
- Use drip irrigation or overhead irrigate early in the day on sunny days, when possible, so that crop foliage will dry quickly.
- Control weeds within your crop, as well as around the outside edge of high tunnels, both to increase air flow and eliminate possible weed hosts.
- Variation in susceptibility to *Cladosporium* between spinach varieties has been noted in the field, but resistance is not regularly evaluated for commercially available varieties.

Chemical Controls. Few products are labeled specifically for *Cladosporium* leaf spot in spinach and little research has been conducted on chemical control of this disease. QoI fungicides, commonly known as strobilurins, (FRAC Group 11) have been shown to effectively control this disease. Group 11 products that are labeled for spinach include Quadris (note: Quadris Top and Opti are not labeled for use on spinach), Reason, and Cabrio, and combination products including Merivon (groups 7 & 11) and Tanos (groups 27 & 11). In one University of Florida trial that evaluated several QoI products Cabrio and Merivon provided better control than Tanos, although all three significantly reduced the incidence of *Cladosporium* leaf spot. In the same trial, Switch (9 + 12) also significantly reduced *Cladosporium* incidence but performed worse than the QoI materials.

Because QoI fungicides have a single-site mode of action, pathogens frequently develop resistance to this group of fungicides. A few rules of thumb for using materials in FRAC group 11 are:

- Limit the total number of QoI applications. Product labels often provide information on maximum number of applications allowed per season. If no guidelines are given, make no more than three applications.
- Use a maximum of one QoI spray out of every three fungicide applications when using QoI alone (as opposed to a tank mix or combination product).
- Use a maximum of one QoI spray out of every three fungicide applications when using a tank mix or combination product.
- Do not make consecutive applications of QoI fungicides.
- Tank mix with a contact fungicide or use a combination product containing a contact fungicide (e.g. chlorothalonil, mancozeb, sulfur, oil).

Copper products are effective protectants for this disease but must be applied before the disease begins to develop.

No research has been conducted on control of *Cladosporium* with OMRI-listed products. Copper is the most effective OMRI-listed material for controlling foliar fungal diseases, in general. Adding a *Bacillus subtilis* (e.g. Serenade) or *Bacillus amyloliquifaciens* (e.g. Double Nickel, Stargus, Taegro, Triathlon) product to copper has a synergistic effect, meaning that applying copper + *Bacillus* provides better control than either product alone. Hydrogen dioxide products (e.g. Oxi-Date) will kill spores on contact but does not kill the fungus within the plant or offer any protection against future infections.

Ms. Higgins is with the Univ. of Massachusetts Vegetable Program. From the **Vegetable Notes for Vegetable Farmers in Massachusetts**, Univ. of Mass. Extension, Vol. 35, No. 2, February 16, 2023.

POTATO PRODUCTION

Potato Tuber Physiological Age, Sprouting and Emergence

Gordon Johnson

I have received questions in the past about variable potato sprouting in the field. While field and planting conditions, soil temperatures, seed piece handling all have an effect, another factor is seed age.

Potato tuber physiological age will determine seed piece sprouting. The physiological age is affected by harvest conditions, calendar (chronological) age, and storage conditions.

During seed tuber storage, the main influence on physiological aging is temperature. Higher storage temperatures cause greater physiological aging, colder storage keeps seed potatoes in a young stage.

In general seed potatoes can be divided into old and young physiological groups. Physiologically older aged seed emerges earlier, grows faster, yields higher early, and yields less later than physiologically young unaged seed. Physiologically young seed has more vigor, produces higher yields of larger tubers than old seed and is ideal under long production seasons.

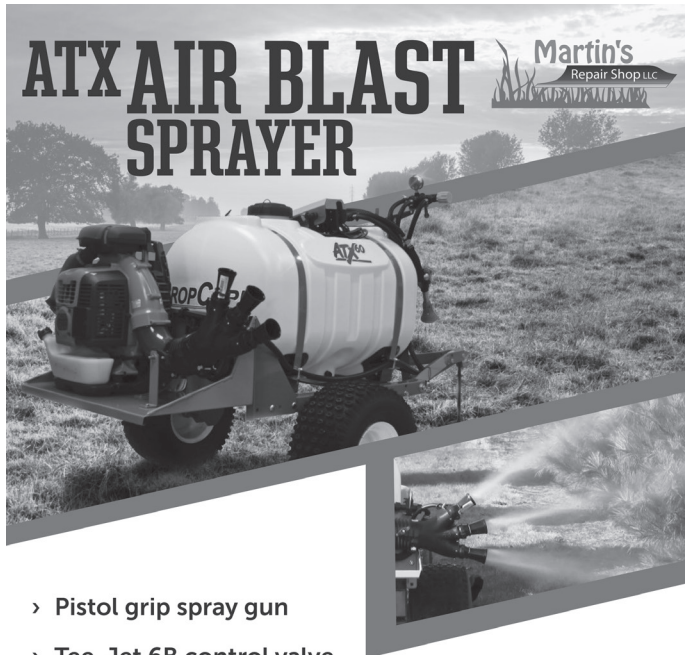
To age seed, store at 38°F then before planting store for 2 to 6 weeks at 55-60°F. To hold young seed, store at 38°F and warm to 45°F just before cutting and plant in soil about the same temperature as the tubers.

When large tubers are desired, young seed that produce few sprouts should be considered. For early fresh market, older seed may be more desirable to get a higher yield early and a quicker vine senescence. Older seed also may be more desirable where a smaller tuber is sought.

Field Characteristics of Physiologically Young and Old Seed

Characteristic	Young Seed	Old Seed
Emergence	slower	faster
Stand	greater	lesser
Early Vigor	greater	lesser
Foliage	more	less
Stems/Plant	less	more
Tuber Formation	later	earlier
Formation Period	longer	more uniform
Tuber Number	less	more
Tuber Bulking	longer	shorter
Tuber Sizing	larger	smaller
Senescence	later	sooner
Early Harvest Yield	lower	greater

Dr. Johnson is the Extension Vegetable and Fruit Specialist at the Univ. of Delaware. From the **Weekly Crop Update**, Univ. of Delaware Extension, Vol. 31, Issue 1, March 3, 2023.



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POTATO PRODUCTION

Growing Potatoes Using Plasticulture

William Lamont

The production of early potatoes for direct marketing or sale to consumers can be a very lucrative enterprise for many growers who only grow 3-5 acres of potatoes in Pennsylvania.

There are many excellent farm markets located throughout the Commonwealth that sell a wide variety of produce to consumers throughout the growing season. It is traditional here in Pennsylvania that in the late spring/early summer consumers are indeed anticipating the arrival of "new potatoes" or "B" size red potatoes at the local retail stands. These early potatoes command a high price and with the increasing popularity of specialty potatoes (different colored skins and flesh), growers are able to offer an increasing colorful display of potatoes to the consuming public.

In order to provide high quality, early potatoes for their markets, an increasing number of growers in Pennsylvania are using intensive production technology or plasticulture (plastic mulches, drip irrigation, fertigation, high tunnels, and row covers). Many growers are currently using this technology for other selected vegetable crops on their farms.

The use of plasticulture technology can provide:

- earlier production
- increase marketable yields
- improved quality of the product

In Pennsylvania we can have not only unpredictable growing conditions in the spring both in terms of temperatures and amount of precipitation, but also during the growing season, which can cause a delay in the maturity of the potato crop. The use of plasticulture helps ensure that a grower can have potatoes for the early market. The quality of the potatoes can also be affected by too much or too little water during the growing season.

Field Production

The benefits of using plastic mulch, drip irrigation, and row covers has been well documented in both the research literature and popular press, and is an accepted practice for the production of many vegetable crops, not only in Pennsylvania, but around the United States and the world. The primary benefit of using plasticulture for potatoes is earlier production, greater yields, and higher quality.

Obvious advantages of plasticulture are:

- plastic mulches warm the soil up earlier in the spring which in turn hastens the emergence and development of the potato plant and prevents weed growth in the row
- drip irrigation in conjunction with the plastic mulches offer excellent control of soil moisture and the ability to fertigate
- elimination of hilling
- the potential reduction in disease pressure as well as the opportunity for insect management

Soil temperatures taken in May using a hand held soil thermometer at noontime under a clear sky are typical of those experienced in constant monitoring. The ambient air temperature was 74oF. The soil temperature was measured at a 4-inch depth on the raised beds both with and without plastic mulch and with and without row covers.

The soil temperatures for the raised beds without row covers were:

- red mulch 72°F,
- black mulch 72°F
- metalized silver mulch 69°F
- no mulch 71°F.

Soil temperatures on raised beds under row covers were:

- red mulch 78°F,
- black mulch 80°F
- metalized silver mulch 73°F
- no mulch 77°F.

This was a consistent trend and will continue until the plant canopy covers the surface of the raised bed at which time the temperatures under the mulch even out. The addition of row covers clearly increased soil temperatures. Faster emergence and increased growth

of potato varieties grown under row covers has been observed each year. For potatoes grown without row covers, the growth of the potato plants on the red and black mulch were equal while the metalized silver mulch was slightly behind and no mulch was much further behind. Under row covers, emergence and growth of potatoes under red and black mulch were again equal, with silver mulch slightly behind and then even further behind no mulch.

The following potato varieties have been used in the plasticulture system:

- Keuka Gold (a light yellow flesh with white skin)
- Dark Red Norland (a white flesh with red skin)
- Eva (a white flesh with a bright white skin)
- Michigan Purple (a bright white flesh with a purple skin color)
- Red Pearl (a white flesh with a red skin producing 71% B size potatoes)
- Adirondack Blue (a blue flesh with a dark blue skin)

Dark Red Norland is a very early maturing variety with a relatively small plant canopy, Keuka Gold, Michigan Purple, Adirondack Blue, Red Pearl, and Eva are later maturing varieties and have larger plant canopies.

Small Plantings

The plastic mulch/drip tape applicator used in vegetable production is also used for potatoes. The raised beds are generally 4-inches high and 30-inches wide with the drip tape buried 3 inches deep in the center of the bed. The Drip tape used is 8 mil-thick, has a 12-inch spacing between the emitter openings and a flow rate of 0.450 GPM/100 feet of row. Seedpieces can be hand-planted using a bulb setter to make two rows of holes spaced 18 inches between the rows with the holes spaced 8-inches apart in the rows on the 30 inch wide raised beds. This would be for very small plantings.

Larger Plantings

The potatoes are planted in double rows 18 inches apart with 12 inches in row, using a water wheel planter without water application at the time of planting the potato seedpiece, as is done with vegetable transplants. It is important to have adequate soil moisture prior to making the beds and applying the plastic mulch and drip irrigation tape, to ensure that the hole made by the waterwheel planter will not collapse before the seedpiece can be placed in the hole. We did develop in collaboration with colleagues in the Department of Agricultural and Biological Engineering a transplanter that utilizes cone-shaped dibbles that punch holes in the plastic bed, and can make holes 4 across, 2 across, or 1 depending on the crop, and in-row spacings (from 6 to 24 inches) depending on the crop.

Pre-plant Fertilizing

Prior to making the beds and applying the plastic mulch and drip irrigation tape, fertilizer can be broadcast on the field. An example used in our plantings is for 450 lbs/acre of 34-0-0, 500 lbs/acre of 0-10-10 and 500 lbs/acre of 0-20-10 to be broadcast evenly across the field.

Spacing

Spacing between the mulched beds is 6 feet. Though the distance between the mulched beds could be decreased to 5 feet apart, the plant canopies of the potatoes will quickly cover the space between the rows and can limit air circulation that is needed for disease control. Typar, a floating row cover material, is applied once the potato seedpieces are planted.

Pests

Admire can be injected through the drip irrigation system for control of some insect pests, such as the Colorado potato beetle and then standard pest management practices can be utilized the remainder of the growing season. On a side note of interest, counting was done on Colorado potato beetle adults found on the different plastic mulches and bare ground the end of May: black mulch-94 beetles, red mulch-54 beetles, no mulch-36 beetles and silver mulch- 13 beetles.

POTATO PRODUCTION

Harvest

The potatoes are routinely checked for development, and when the tubers are nearly marketable size, the vines are killed using Diquat. The potatoes are dug using a double row level bed digger and then picked up by hand. We have used a single row digger, but found it is too difficult to get the whole 30-inch wide bed up the digger. Potatoes will be set right out on the edge of the bed. Harvest begins with Dark Red Norlands, then Michigan Purple, Red Pearl, Adirondack Blue, Kueka Gold and Eva. Although the plastic mulch and drip irrigation tape will travel up the digger chain, it is easier to remove the plastic mulch prior to digging. This is best accomplished by mowing the dead potato vines as close to the plastic as possible with a rotary mower and then loosen the soil along the edges of the plastic, and either remove it by hand or use a small retrieval unit that will make a small round bale of plastic.

All plastic mulches significantly increased total and marketable yields for all varieties compared to bare ground. Marketable yields for potatoes grown with plastic mulch as compared to bare ground were:

Dark Red Norland:

- Black-271cwt.
- Red-249 cwt.
- Metallized Silver-246 cwt.
- no mulch-173 cwt.

For Eva:

- Black-325 cwt.
- Red-298 cwt.
- Metallized Silver-301 cwt.
- no mulch-182.

For Keuka Gold:

- Black-357 cwt.
- Red-372 cwt.
- Metallized Silver-364 cwt.
- no mulch 262 cwt.

The same holds true for Michigan Purple, Red Pearl, and Adirondack Blue.

The increased yields more than pays for the additional cost of the plastic mulch and drip irrigation tape. Although metalized silver mulch with or without a row cover had the coolest soil temperatures and slowest plant growth of the three colored mulches, the final yields are equal and sometimes better than the red and black mulch. There doesn't seem to be a corresponding increase in yield associated with an increase in plant growth. The positive effect of the red and black mulches covered or uncovered on the emergence of the potato is probably do to an increase in the soil temperature. This goes back to the fact that the rate of emergence and growth of sprouts from the seedpiece once it is planted is mostly a function of the soil temperature.

It is important to remember that the bare ground potatoes also received drip irrigation so the yield response is mainly a result of the plastic mulch. Plastic mulch and drip irrigation should be used together to get the maximum benefit from the system. It is recommended that a good strong black plastic mulch 1 to 1.25 mil thick be used for the production of potatoes, since, if a plastic mulch lets any light through, the potatoes that are on the surface or partially exposed will green up and be render unmarketable.

High Tunnel Production

High tunnels are part of plasticulture technology and are used worldwide for the production of a wide array of horticultural crops. In Pennsylvania the use of high tunnels permits the earlier production of a number of vegetable crops such as tomatoes, peppers, eggplant, and leafy greens. The use of high tunnels allows the production of early potatoes and is especially profitable if grown/ marketed in conjunction with fresh garden peas and pearl onions, which are used together for a tasty spring dish. The use of high tunnels can provide growers the opportunity to market early red potatoes or red, white, and blue for the 4th of July holiday.

The system of production is very similar to field production, except the equipment size is smaller. Plastic mulch, drip irrigation, and row covers are use inside the high tunnels. In a 17-foot wide high tunnel, 3-foot wide plastic mulch is used to make four small raised beds 18 inches wide and 3 inches high which are spaced 44 inches apart. A small 21 HP tractor and plastic laying machine is used to apply the 3-foot wide plastic mulch and drip irrigation tape.

Application of the plastic mulch and drip irrigation tape is similar to field production.

In the high tunnel black or red plastic mulch are good choices, since we want to really warm the soil up. If the plastic mulch and drip irrigation tape could be applied the preceding fall, it could then be ready for an early spring planting.

A note of caution, rodents may be a problem if plastic mulch and drip irrigation are applied in the fall. If fall application is not possible, then the plastic mulch and drip irrigation tape can be applied as soon as it is possible to enter the high tunnel in the early spring.

Fertilizer can be broadcast in the high tunnel and pulled into the row or some can be broadcast and then fertigated. The rates would be similar to the field situation, although lesser amounts can be used since in a high tunnel a grower has complete control over soil moisture and fertilizer.

Potato varieties commonly used in the high tunnels:

- Red Pearl - a red-skin/white flesh that makes 71% B size potatoes from the Wisconsin Potato Breeding Program
- Eva - a white skin/white flesh from the Cornell Potato Breeding Program
- Michigan Purple - a purple skin/white flesh from Michigan State Potato Breeding Program.

These were chosen in order to have some red, white, and blue skinned potatoes for a "Patriot Potato Salad" for the 4th of July. In central Pennsylvania, the potatoes can be hand-planted in April (soil temperature reaches 50oF) on double-rows 13 inches apart, with the potatoes spaced 8 inches apart in the row. The row cover is placed over the plastic covered beds.

Note: the row cover will provide some protection from an unexpected freeze event but it is recommended that some source of portable backup heat is available to prevent the tops of the potatoes from being killed off.

Potatoes are irrigated as needed and no pesticides applied to the crop. The potatoes should be dug by hand in June and ready for the 4th of July market.

- Red Pearl yielded 120 lbs. of potatoes
- Eva yielded 100 lbs.
- Michigan Purple yielded 139 lbs.

There were less than 10 tubers in the entire tunnel that had any defects.

- Red Pearl yielded 375 tubers/30 plants or 12.5 tubers per plant.
- Eva yielded 112 tubers/30 plants or 4 tubers per plant
- Michigan Purple yielded 90 tubers/30 plants or 3 tubers per plant.

The skin colors were excellent on all varieties. To take advantage of the skin colors of the potatoes and the 4th of July holiday, an American flag (3' wide by 5' long) made of the potatoes was constructed to show how they could be promoted in a retail market. These potatoes lend themselves to marketing in small woven baskets, in attractive displays, in polybags, or plastic clamshells and can command a high price.

If a grower had a 17' by 96' high tunnel and grew four rows at the 13" double-row, 8-inch in-row spacing, the yields should be:

- Red Pearl - 1,104 lbs. of potatoes,
- Eva - 920 lbs.
- Michigan Purple - 1,278 lbs.

The price of specialty potatoes at the food stores, according to a chart presented by the National Potato Promotion Board is 86/lb. If advertised and promoted at local retail markets, \$1.50 for 1.5lbs. could be a reasonable price to expect. If we use \$1.50 for 1.5 lb. then the gross return for each of the varieties would be

- Red Pearl- \$1,104,
- Eva- \$920
- Michigan Purple- \$1,278.

This is for an area of production that is only 0.037 of an acre.

Dr. Lamont is retired from the Department of Plant Science at Penn State. From Penn State Extension, <https://extension.psu.edu/growing-potatoes-using-plasticulture>, March 20, 2023

BERRY PRODUCTION

Tips on Managing Botrytis in Strawberry Plantings

Thomas Ford

Botrytis, also known as gray mold, is a more serious disease in strawberry fields.



Botrytis or gray mold is commonly observed on ripening strawberry fruit when rainfall is frequent. Photo by Thomas Ford, Penn State

When considering fungicides for the prevention of *Botrytis* spp. please note that there are reports of widespread resistance to some of the more commonly used strawberry fungicides. As strawberry plants, rooted tips, and plugs are moved into our area from propagators, there is the possibility that fungicide-resistant *Botrytis* spp. biotypes may be introduced onto your farm. In addition, a grower may inadvertently contribute to the development of *Botrytis* resistant strains or biotypes on their own farm when fungicides with different modes of action or FRAC codes are not rotated regularly.

Recently it was determined that two distinct *Botrytis* species are being observed in the Mid-Atlantic region at this time. *Botrytis cinerea* is the historical pathogen observed in area strawberry fields, but more recently, *Botrytis fragariae* has become quite common. *Botrytis fragariae* overwinters in strawberry fields on old leaves and plant debris, and it tends to be more readily observed during bloom because it will cause a noticeable browning or blighting of the strawberry flowers.

While fungicides are critical to preventing *Botrytis* spp. infection in strawberry plantings, growers should also utilize good cultural practices to reduce inoculum. *Botrytis* spp. can overwinter in plant debris, and the removal of dead leaves and plant debris from the field is the first step in preventing infection.

Botrytis spp. infects strawberry tissues when flowers or foliage are wet or moist for a period of 14 hours or more. Periods of wet, rainy weather are inevitable in the spring, but there are a few cultural practices that growers can employ to reduce infection. First, matted row growers should keep their rows narrow. When strawberry rows become too wide, air circulation is impeded, re-

sulting in longer drying times after rain events. Weeds in strawberry fields will compete for water and nutrient resources, but they also impede air movement in the planting, increasing foliage drying times after rain events. Growers cannot minimize *Botrytis* infections in strawberry plantings without first managing weeds effectively.

Nutrient management may also play a significant role in preventing *Botrytis* infection in strawberry plantings. Over-fertilization with nitrogenous fertilizers has become a recurring theme on some farms. When strawberry plants are overfertilized, excessive foliage growth may be noted, which impedes air circulation in the strawberry planting resulting in a higher incidence of disease.

Spring fertilization of strawberry plantings has also been implicated as the principal cause of soft berries in matted-row strawberry production systems. Soft fruit coupled with overly dense canopies of strawberry foliage fueled by the overzealous application of nitrogenous fertilizers can spell disaster when rain, heavy dew, or fog are prevalent. Strawberries grown in plasticulture systems, however, may require some supplemental nitrogen in the spring to maximize production. Strawberries grown in plasticulture systems appear to have a lower incidence of soft fruit when spring fertilization is properly practiced. When developing a fertility program for your strawberry planting, rely on your soil test recommendations from the Penn State Agricultural Analytical Laboratory (<https://agsci.psu.edu/aasl>).

When designing a disease management program for your strawberry crop, realize that you cannot trust your crop to just one or two fungicides because of pathogen resistance concerns. However, Thiram, a multi-site fungicide for which the risk of resistance development is low, can play an important role in tank mixes or be used alone when targeting *Botrytis*. Resistance management in the strawberry operation hinges on the grower's ability to select and rotate fungicides with different FRAC codes or modes of action. If a grower bases their disease management program on only a few chemistries, there will be a significant risk of developing pathogen resistance to the fungicides being applied to the strawberry crop.

Before purchasing crop protection chemistries, growers should carefully consider the efficacy of the fungicides on the market against the diseases the grower is trying to prevent/manage. Anthracnose is frequently observed in strawberry plantings in the Mid-Atlantic region alongside *Botrytis* spp. Because of the likelihood that Anthracnose and *Botrytis* spp. may be co-existing in the same strawberry field, growers need to keep both pathogens in mind when developing their disease management program. Dr. Mengjun Hu, University of Maryland, and Kathy Demchak, Senior Extension Associate with Pennsylvania State University, wrote an article on *Botrytis* and Anthracnose management entitled "Strategies for Effective Management of *Botrytis* and Anthracnose Fruit Rot in Strawberries" (<https://extension.psu.edu/strategies-for-effective-management-of-botrytis-and-anthracnose-fruit-rot-in-strawberries>) in April 2022. Please take the time to review this article before developing your strawberry disease management program.

For additional information on pest and disease issues in strawberry plantings, please contact any member of our Penn State Vegetable and Small Fruit team.

Mr. Ford is with Penn State Extension in Cambria Co. From Penn State Extension, <https://extension.psu.edu/tips-on-managing-botrytis-in-strawberry-plantings?>, April 6, 2023.

Prevent Algae in Transplants

Onions and leeks are some of the earliest crops to be seeded in the greenhouse. Every year we get calls about poor stands and green growth or crust forming on soil in transplant trays. The green growth is algae, which can grow on any greenhouse surface and comes in on dust or irrigation water. Algae thrives in sunny, wet areas with high organic matter, e.g. an overwatered tray full of potting media, especially if the media is compost-based or contains a lot of peat. Algae do not harm plants directly, but can slow gas exchange through media, thereby slowing root growth. Algae also attracts fungus gnats and shore flies, which not only feed on algae and other fungal growth in the growing medium, but also on plant roots, creating wounds where pathogens might gain entry into plant roots. Once you have algae it is hard to get rid of, so how can you prevent algae from growing?

Pre-season cleaning and managing moisture are key in preventing algae in greenhouses. Algae doesn't need potting soil to grow in a greenhouse – it can grow on any moist surface – so thoroughly cleaning and sanitizing your greenhouse benches, floors, trays, and any other surfaces in your greenhouse can help reduce algal "inoculum." Several algicides are currently registered for algae control in the greenhouse. Disinfectants can be used as part of pre-crop cleanup program and during the cropping cycle for routine algae management. Green-Shield, Physan 20, Triathlon (Quaternary ammonium compounds) can be applied to floors, walls, benches, tools, pots and flats as disinfectants. ZeroTol (Hydrogen Dioxide), is a sanitizer also labeled for use on greenhouse surfaces. Read and follow directions on these products.

Manage moisture and make sure that your transplants are able to quickly take up all the water you apply when irrigating.



Plant onions and leeks into small-celled trays to prevent algae from growing on constantly wet soil. Photo: S. Scheufele

Avoid overwatering, especially on cloudy days. Leeks and onions start out so small that if they are planted in a large cell their roots can't access all the water and the soil stays wet and algae begins to grow. Leeks and onions don't need big cells—you can use as small as 288-celled trays!—and they should transplant out well since they have big root systems. You can also achieve faster drying of soil by using lighter media and/or mixing in extra perlite to improve drainage.

From the Vegetable Notes for Vegetable Farmers in Massachusetts, Univ. of Massachusetts Extension, Vol. 35, No. 3, March 16, 2023.

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GREENHOUSE PRODUCTION

Water Quality for Crop Production – pH, Alkalinity and Soluble Salts

Irrigation water quality is a critical aspect of greenhouse crop production. Poor quality water can be responsible for slow growth, poor aesthetic quality of the crop, and in some cases can result in the gradual death of the plants. There are many factors which determine water quality. Among the most important are alkalinity, pH and soluble salts. High soluble salts can directly injure roots, interfering with water and nutrient uptake. Salts can accumulate in plant leaf margins, causing burning of the edges. Water with high alkalinity can adversely affect the pH of the growing medium, interfering with nutrient uptake and causing nutrient deficiencies which compromise plant health. To determine whether any of these conditions are occurring, water must be tested at a laboratory that is equipped to test water for agricultural irrigation purposes.

There are several other factors to consider, including whether your water contains hard water salts such as calcium and magnesium; heavy metals that can clog irrigation systems; or individual toxic ions. To read more about these contributors to water quality, see the full-length fact sheet *Water Quality for Crop Production* (<https://ag.umass.edu/greenhouse-floriculture/greenhouse-best-management-practices-bmp-manual/water-quality-for-crop#>). Additionally, if greenhouse irrigation water will contact the harvestable portion of a crop (e.g., if you're growing microgreens or herbs that will be harvested rather than planted into the field), consider adding a microbial water quality test for generic *E. coli*, and indicator of fecal contamination. For more on water testing for food safety, see the page on *Agricultural Water* on the 'UMass Food Safety for Farmers' webpage (<https://ag.umass.edu/resources/food-safety/for-farmers/agricultural-water>).

General Recommendations:

Get water tested to ensure it is acceptable for plant growth and to minimize the risk of discharging pollutants to surface or ground water. Irrigation water tests should always include pH and alkalinity.

Reclaimed water, runoff water, or recycled water may require reconditioning before use for irrigation since disease organisms, soluble salts and traces of organic chemicals may be present.

Use filters to remove suspended solids from water to prevent clogging of piping, valves, nozzles and emitters in an irrigation system. Suspended solids include sand, soil, leaves, organic matter, algae and weeds. Screen or disk filters work well for most applications. A 200-mesh filter is usually recommended for micro-irrigation. The filter should be sized so that the flow rate is large enough to handle the peak demand.

Maintain filters: Install pressure gauges on both sides of the filter to monitor for clogs. When the pressure variation between the two gauges exceeds about 10%, the filter should be cleaned.

Adjust water pH if needed before using for mixing some pesticides, floral preservatives, and growth regulators.

Adjust alkalinity if needed using an appropriate acid in order to treat irrigation water and also to help manage pH of irrigated high tunnel soils.

pH and Alkalinity

Alkalinity and pH are two important factors in determining the suitability of water for irrigating plants. *pH is a measure of the concentration of hydrogen ions (H+) in water or other liquids. Alkalinity is a measure of the water's ability to neutralize acidity.* In general, water for irrigation should have a pH between 5.0 and 7.0. Water with pH below 7.0 is termed "acidic" and water with pH above 7.0 is termed "basic"; pH 7.0 is "neutral". (Sometimes the term "alkaline" is used instead of "basic" and often "alkaline" is confused with "alkalinity".)

An alkalinity test measures the level of bicarbonates, carbonates, and hydroxides in water, and describes the ability of water to buffer against changes in pH. Water that helps to buffer against

pH changes is excellent, but too-high alkalinity will increase the incidence of dripper clogging and increase root zone pH over time. Test results are generally expressed as "ppm of calcium carbonate (CaCO₃)". The desirable range for irrigation water is 0 to 100 ppm calcium carbonate. Levels between 30 and 60 ppm are considered optimum for most plants.

Irrigation water tests should always include both pH and alkalinity tests. A pH test by itself is not an indication of alkalinity. Water with high alkalinity (i.e., high levels of bicarbonates or carbonates) often has a pH value of 7 or above, but water with high pH does not always have high alkalinity. This is important because high alkalinity, not pH, exerts the most significant effects on growing medium fertility and plant nutrition.

A UMass Extension greenhouse water study found that pH in the range of 7-8 is common in most water sources found in Massachusetts. These higher pH levels are typically not a problem unless the alkalinity exceeds the acceptable range.

High pH/high alkalinity water is common in Berkshire County and sometimes is found in other parts of the state.

Amending the alkalinity of your irrigation water is an important step in producing healthy transplants, and if you are also using this water to irrigate high tunnel soils, amending alkalinity is the fastest and most cost-effective method to manage high tunnel soil pH. This is accomplished by acid injection into irrigation water. A few sources of acid are available on the market: sulfuric acid (very affordable, also adds sulfur); phosphoric acid (can potentially add a lot of phosphorus); nitric acid (adds nitrate, is very acidic and has harmful fumes); and citric acid (approved for organic growers and the only acid source that does not supply additional nutrients). Exercise caution when handling and using any acids.

A handy tool to calculate how much acid is needed is ALK-CALC (https://extension.unh.edu/agric/AGGHFL/alk_calc.cfm). All you need to complete the form is the water's pH and alkalinity content, the type of acid you want to use, and your target alkalinity level.

Soluble Salts

Excess soluble salts impair root function, which can lead to reduced water uptake and nutrient deficiencies. These include calcium and magnesium (described as water "hardness"); sodium and chloride; potassium and phosphate; sulfate; and ammonium and nitrate. Soluble salts in water are measured by electrical conductivity (ECw) expressed as millimhos per centimeter (mmhos/cm), which is equivalent to milliSiemens per centimeter (mS/cm). Electrical conductivity is also referred to as specific conductance or salinity.

EC (electrical conductivity) measures the levels of natural salinity and salinity caused by fertilizer residues in water and soils. In Massachusetts, high EC water is not a common problem. However, high EC may occur in water from containment ponds rich in fertilizer residues, certain wastewaters used for irrigation, water contaminated by road salt, and, rarely, from saltwater intrusion in coastal wells. Irrigation water to which water-soluble fertilizer has been added has an EC of about 1.5-2.5 mS/cm, so, to avoid plant injury, the untreated water should have an EC no higher than the acceptable range of 0-1.5 mS/cm, although values of less than 1 are recommended for plugs.

Correcting Water Quality Problems

Alkalinity can be neutralized by addition of acids described in the alkalinity section above. Total dissolved solids, the soluble salts measured together as EC and individually in ppm of the element, can be removed by several water purification systems. Individual elements can be removed from the water if total dissolved solids are not high enough to warrant total salts removal. Before investing in any treatment system, however, it may be advisable to investigate the possibility of switching to an alternate water source, or mixing water sources, if it is an economical al-

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ternative for solving a water quality problem. Water purification methods are available and are summarized in table 5 of the full-length fact sheet on Water Quality for Crop Production (<https://ag.umass.edu/greenhouse-floriculture/greenhouse-best-management-practices-bmp-manual/water-quality-for-crop#>).

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