PENNSYLVANIA
VEGETABLE GROWERS
NEWS
PVGA
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for the commercial vegetable, potato and berry grower

Game Commission Increases Antlerless Allocations Following Staff Recommendations

Photo credit: Samuel Mitchell from Burst

The Game Commission announced at its April meeting that 1,095,000 antlerless deer licenses will be allocated statewide for 2023-24, which is up from the 948,000 licenses allocated for 2022-23. The Board of Commissioners, however, did not vote on the allocations, as it had in the past. Board of Commissioners President Kristen Schnepp-Giger explained with the following proclamation.

"Antlerless deer and elk license allocations must be set before the new license year begins. The April meeting of the Board of Commissioners traditionally serves as a turnstile in this process, as it's the first time that allocations developed by staff are presented publicly and finalized.

This Board intends to reconsider its role in this process, and, given that the allocations are an anticipated part of the April meeting, wishes to clarify its position moving forward.

If board member opinions enter the decision-making process, and allocations change because of them, science no longer is guiding wildlife management.

To preserve the integrity of a process that relies on science-based management to achieve population objectives, this Board will be discontinuing the practice of annually approving the number of antlerless deer and elk licenses to be allocated. This will allow the appropriate experts within the agency to prepare and finalize allocations that are in accordance with the goals set forth in the agency's deer and elk management plans.

There is no law or regulation that requires the Board to consider or approve allocations.

Because scientific management is a principle the Board believes in, it only makes sense to stand by the results of scientific work, including the development of license allocations.

This Board intends to stand by allocations developed by staff for the 2023-24 license year. We consider them final and intend – now and in the future – to allow the science-based allocations developed by staff to move forward without requiring a vote from the Board of Commissioners."

This change in how the antlerless allocations are approved is a major change as in the past the Board of Commissioners has sometimes deviated from the staff's recommendations in approving the number of antlerless license allocations for the Wildlife Management Units (WMU). In response to pressure from hunters, the Com-

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Game Commission Increases Antlerless Allocations

missioners have often decreased the number of licenses per WMU from what the staff recommended. The staff recommendations are based on the deer population data and the previous season's harvest data collected by the staff. PVGA has long advocated for the Commission to base the antlerless allocations on the staff's recommendations rather than anecdotal input from hunters.

Allocations by Wildlife Management Unit (WMU) for the 2023-24 season are as follows, with the allocation from the previous license year appearing in parentheses. Hunters should note that WMU 2H has been eliminated and its area placed within WMU 2G. The 2022-23 allocation for 2G combines 2G and 2H.

Wildlife Management Unit	2023-24 Allocation	2022-23 Allocation
WMU 1A	46,000	(43,000)
WMU 1B	37,000	(34,000)
WMU 2A	46,000	(39,000)
WMU 2B	53,000	(49,000)
WMU 2C	88,000	(67,000)
WMU 2D	86,000	(74,000)
WMU 2E	52,000	(42,000)
WMU 2F	49,000	(37,000)
WMU 2G	35,000	(31,000)
WMU 3A	21,000	(19,000)
WMU 3B	32,000	(33,000)
WMU 3C	40,000	(37,000)
WMU 3D	41,000	(41,000)
WMU 4A	61,000	(50,000)
WMU 4B	46,000	(34,000)
WMU 4C	32,000	(31,000)
WMU 4D	77,000	(55,000)
WMU 4E	54,000	(42,000)
WMU 5A	40,000	(31,000)
WMU 5B	60,000	(60,000)
WMU 5C	70,000	(70,000)
WMU 5D	29,000	(29,000)

The Commissioners again approved a statewide two-week concurrent antlered and antlerless season for regular firearms beginning the Saturday after Thanksgiving and including the Sunday after Thanksgiving. PVGA has also advocated for the current antlered and antlerless regular season to give more opportunities for hunters to take antlerless deer on farms.

The Commissioners also restructured the system for selling antlerless licenses. Previously, state law required that all antlerless licenses be issued by the county treasurers. A recent change in state law now allows all license-issuing agents to sell antlerless licenses. Now hunters will be able to directly purchase their antlerless licenses both online and at any issuing agent. The Commissioners set up a schedule of dates of when antlerless licenses are available to residents and non-residents. Only one antlerless license may be purchased in the first round of sales. Additional antlerless licenses, up to a maximum of six, can be purchased in subsequent rounds of sales.

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Our Mission:

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

Our Vision:

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

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

NEWS

This Is Why You Should Fill Out the Census of Agriculture Survey if You Are a Farmer

Elsa Sánchez

The Census of Agriculture is a collection of data used to count different types of farms and ranches and the people who run them. Data are collected through a survey that is administered every 5 years.

Hubert Hamer, the National Agricultural Statistics Service's Administrator, said many important reasons exist for participating in the Census. The federal government uses the Census to determine the amount of funding each state receives for agriculture. For example, many areas in the U.S. have been affected by severe weather. The Census is used to determine the amount of assistance funding.

The Census is also used for community and farm succession planning and to determine store/company locations, the availability of operational loans and other funding, and federal budget support for agriculture. It also helps policymakers make policies and programs to support agriculture in the area. The bottom line is the Census of Agriculture helps you and your community.

For many vegetable and berry crops, the Ag Census is the only data available on the acreages and production of individual vegetable and berry crops. Without the Ag Census data, organizations like PVGA have no information on the acreages or production amounts of these individual crops to use in describing the importance of the vegetable or berry industries to government officials or research funding grant program. PVGA needs growers cooperation in completing the Ag Census.

All farmers are legally required to complete the Census. Mr. Hamer said the completion rate is over 70%. If you have any reservations about completing the survey, please know that by federal law, data cannot be shared with or used by others. In fact, by Title 7, U.S. Code 2276, it is illegal to provide Census information by an individual to other organizations or entities. Data can only be presented in aggregate. Here is a link to the exact wording: 7 U.S. Code § 2276 - Confidentiality of information | U.S. Code | U.S. Law | LII / Legal Information Institute (cornell.edu).

For the Census of Agriculture, farms are defined as earning or potentially earning $1000 in sales in a year. This is actual earnings or the possibility of earnings. Mr. Hamer used the example of an apple orchard. A farmer may purchase trees and not have sales in the first year. However, they have the potential to have sales. In this case, the farmer should complete the Census survey. You don't need to have a farm number to complete the survey.

Enumerators from the Census of Agriculture will collect surveys at least through May 2023. You can find the survey at www.agcounts.usda.gov. This is a secure website; however, you can also respond by mail if you prefer. It takes an average of 50 minutes to complete the survey.

Dr. Sánchez is with Dept. of Plant Science at Penn State Univ. From Penn State Extension, https://extension.psu.edu/this-is-why-you-should-fill-out-the-census-of-agriculture-survey-if-you-are-a-farmer?, April 6, 2023.

Producers Who Experienced Discrimination in USDA Farm Loan Programs May Qualify for Assistance

Elsa Sánchez

The Inflation Reduction Act of 2022 includes $2.2 billion in funding for producers who experienced discrimination in the United States Department of Agriculture (USDA) Farm Loan Programs before January 1, 2021.

New information about this assistance has been added to the Farmers.gov website.

This factsheet has more information about this assistance: Inflation Reduction Act Assistance for Producers Who Experienced Discrimination in USDA Farm Loan Programs (farmers.gov).

Information on the timeline and how the funds will be distributed can be found at Inflation Reduction Act Assistance for Producers Who Experienced Discrimination in USDA Farm Loan Programs (farmers.gov). This website also contains the latest information about this assistance and will be updated as more information becomes available. Check back frequently if you believe you qualify. The USDA plans to distribute this funding by the end of 2023.

Dr. Sánchez is with Dept. of Plant Science at Penn State Univ. From Penn State Extension, https://extension.psu.edu/producers-who-experienced-discrimination-in-usda-farm-loan-programs-may-qualify-for-assistance?, April 19, 2023.

GENERAL

Trade vs. Common Names: Know Your Pesticides

Ricardo Bessin

All pesticides sold in the United States have a trade name, common name, and chemical name. While this can be confusing to many, there are important distinctions among these as they are used in different ways. To add to this complexity, some pesticides with the same common name may be sold under numerous trade names, including a large number of generic products.

Trade Name

Trade names are the names that the manufacturing company chooses to use for marketing the pesticide. If a particular active ingredient is being phased out, the manufacturer may choose to replace it in the pesticide product and change the name only slightly to take advantage of its name recognition in the marketplace. Some trade names may have several descriptors, such as 'KillzAll Granules for Lawns' or just 'KillzAll for Lawns.' But minor differences in the trade name might indicate that the two products have different active ingredients. For example, there is a line of 'Sevin' products with slightly different trade names, but when you look at the active ingredients on their labels, they have several different active ingredients or mixtures of active ingredients. Why does this matter if they are all in the same chemical class (mode of action) as they are with the Sevin products? Different active ingredients are not necessarily labelled on the same crops. Additionally, the rates may be different between the different products. Both of these can be issues when a person purchases what they thought was a replacement for what they had and do not realize there could be substantial differences in patterns of use.

Common Name

Each active ingredient has a common name. The common name is the name listed for the chemical in the active ingredients section of the label. The common name is the accepted name for the chemical and is used by all companies to describe the contents of their pesticide. Many different products sold by different companies may have the same active ingredient, hence the same common name of the pesticide. This is frequently the case when a pesticide goes off patent and generic versions become available.

Chemical Name

The chemical name usually follows the common name in the active ingredients section of the label. Chemical names can be complex and are often only used by specialists in the industry.

Final Comments

It is a good practice, when you purchase a pesticide, to quickly check the front of the label for the common name to be certain it contains the active ingredient that you expect. Different active ingredients may have different use patterns, use restrictions, pre-harvest intervals, or environmental considerations.

Dr. Bessin is the Entomology Extension Specialist at the Univ. of Kentucky. From Kentucky Pest News, Univ. of Kentucky, May 2, 2023.

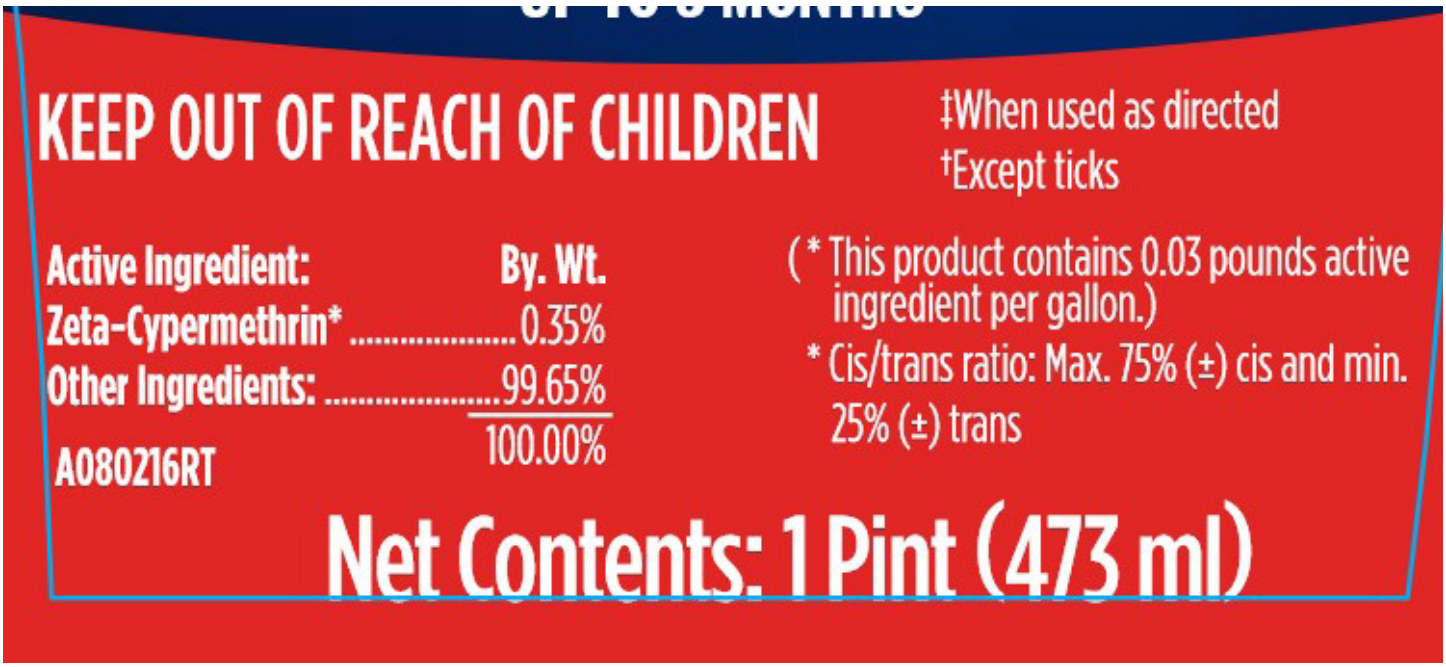

Figure 1. Common names of the pesticide must be listed in the 'Active Ingredients' portion of the label that describes the contents of the product.

VEGETABLE PRODUCTION

Blossom End Rot, Internal Whitening, and Rain Check of Tomatoes

Cultivar selection can be daunting because numerous options are on the market, and new ones become available every year.

Figure 1. This photo shows one of four sites where we are evaluating tomato cultivars based on yield. This year we studied eleven red early-season slicing cultivars. Photo: Elsa Sánchez, Penn State

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

Since 2007, the Pennsylvania Vegetable Marketing and Research Program and PVGA have provided funding for a team of scientists from Penn State University to evaluate cultivars on four sites across the state to help farmers decide which to grow. We've studied bell peppers, winter squash, pumpkins, sweet corn, and spring and fall broccoli and cabbage. This year we started, what we hope to be, an era of evaluating tomato cultivars.

The growing season brought several environment-related challenges for us at the site in central Pennsylvania. Early on, we observed many fruit with blossom end rot, later internal whitening of the fruit and the season ended with a lot of fruit with rain check. These issues appear on field-grown tomatoes frequently; however, blossom end rot and rain check were more severe this year for us, likely due to the weather and a management issue.

Data collected from a nearby weather station by the National Weather Service showed that our site's mean precipitation for June, July, and August are 4.00, 3.77, and 3.57 inches, respectively. Our site was dry, receiving 2.98, 2.52, and 2.88 inches of rain during these months. Then, in September, the site received 3.34 inches of rain, near the mean average of 3.24 inches. Mean average temperatures for June, July, and August, are 67.4°F, 71.6°F, and 69.7°F, respectively. Our site was hotter, with average temperatures of 69.3°F, 74.6°F, and 72.9°F. In fact, these average temperatures ranked as the 25th, 12th, and 13th highest since records have been kept beginning in 1893. And if you want to take it a step further, if you average the temperatures for June, July, and August, we experienced the 9th highest average mean temperature since 1893.

We also experienced some issues with our irrigation water source. Namely, several emitters in our drip irrigation system clogged despite using a disc filter. This was not a problem we had experienced before at the research farm, and it took a little investigating to determine why this happened. We used a different pond to supply water to our tomato plants than in the past. Last year, the pond was unclogged after several years of not being used. During this effort, several fish died, changing the whole ecosystem of the pond. As a result, algae grew unchecked and made their way into our irrigation pipes. The number of algae was too much for the disc filter to remove from the water. Once we figured this out, we added another disc filter to the system and washed the filters more frequently, which fixed the problem. However, our tomato plants were drought stressed for a period of about 2 to 4 weeks.

The high heat and droughty conditions due to less rainfall for the bulk of the growing season and the problem with our irrigation system likely resulted in a higher incidence of blossom end rot in our early harvests. The severe rain check we observed was likely due to the rainfall we experienced in September, after the droughty period.

Blossom End Rot

Symptoms of blossom end rot first appear at the blossom-end (bottom) of green fruit, where you'll see either white or brown, water-soaked or leathery, often sunken areas develop. The rest of the fruit ripens, but the lesions at the bottom of the fruit remain. Fruit that have blossom end rot are unmarketable.

It's been challenging to determine the root cause of blossom end rot. Through research, we know that plants undergoing environmental stressors, such as high temperatures, light levels, and salinity, are more prone to developing fruit with blossom end rot. Scientists have long believed that blossom end rot was caused by a localized calcium deficiency. More recently, some scientists have speculated that the evidence shows the opposite; that blossom end rot causes a localized calcium deficiency.

Blossom end rot is rarely accompanied by a lack of calcium in the soil. More often, it signals that the plants are going through or recently experienced a dry period, high heat or light levels, or low humidity. To some scientists, it also appears that plants that are rapidly growing when environmental stressors occur are more prone to blossom end rot.

If you see blossom end rot, check your recent soil test reports, and verify that you are applying enough calcium with fertilizers or organic nutrient sources. If calcium levels are adequate, examine your irrigation regime. You may need to supply water more often so the soil is consistently moist. Some cultivars are less prone to blossom end rot. Less prone is not the same as immune; however, scientists at the University of Illinois (see http://ipm.illinois.edu/diseases/series900/rpd906/) found 'Celebrity,' 'Fresh Pak,' 'Jet Star,' and 'Mountain Pride' to be less affected, among others. 'Early Girl' has also been mentioned as being less susceptible (https://portal.ct.gov/CAES/Fact-Sheets/Plant-Pathology/Blossom-End-Rot-of-Tomato).

Figure 2. Blossom end rot on a cluster of tomatoes. Notice the appearance of symptoms on green and ripe fruit. Photo: Tom Butzler, Penn State

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Figure 3. This photo shows several tomatoes from our cultivar evaluation with Blossom end rot. Secondary infections can occur once fruit have blossom end rot. Photo: Tom Butzler, Penn State

Internal Whitening

Symptoms of internal whitening are not present in immature fruit and may or may not appear as green, yellow, or white areas near the stem end of ripe fruit. However, when fruit are sliced open, tomatoes with internal whitening have white or green corky areas in the internal flesh.

Scientists are unsure of the exact cause of internal whitening; however, it appears to be related to potassium nutrition, heat, and plant genetics. It seems that plants growing in soils with low potassium and nitrogen have more internal whitening, and in one study fertilizing with potassium reduced the incidence of internal whitening.

It's hard to recommend management practices until internal whitening is better understood. It may help to closely monitor fertility practices, especially for potassium. If you have supplied enough potassium and the problem persists, look at calcium and magnesium levels. Potassium is a cation (K+) and can compete with other cations, like calcium (Ca+2) and magnesium (Mg+2), for cation exchange sites in soils. If calcium and magnesium levels are high in the soil, potassium may not be available for plant uptake, even if potassium levels are sufficient. You also want to have good soil drainage. Roots grown in waterlogged soils can lose the ability to uptake water and nutrients from the soil.

As with blossom end rot, it's important to maintain uniform soil moisture. Monitor your irrigation practices, particularly during periods of high heat. Practices that support robust, healthy foliage covering the fruit can reduce stress from high light levels and heat. This can lessen the incidence of internal whitening.

Some cultivars are less prone to getting internal whitening. For example, Gordon Johnson and Emmalea Ernest, scientists at the University of Delaware, looked at 28 cultivars of tomatoes and found 'Jamestown,' 'FTM 6298', 'Primo Red,' and 'Red Bounty' to have the lowest incidence of Internal whitening.

Rain Check

At the tomato evaluation site at Penn State University's Russel E. Larson Agricultural Research Center, we harvested our tomato trial weekly, and at about week 11, we started noticing numerous tomatoes with rain check. Rain check is also known as cuticle cracking, weather check, crazing, and russetting. The rinds of the fruit develop numerous concentric micro-cracks, especially on the shoulders. The micro-cracks can unite and form more extensive lesions. When you touch the lesions, they feel

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Blossom End Rot, Internal Whitening, and Rain Check of Tomatoes cont. from page 7

Figure 4. (left) A tomato with internal whitening. Notice the white and green areas in the internal flesh of the fruit. (right) Another tomato shows symptoms of internal whitening. Photos: Tom Butzler, Penn State

rough and leathery. The area around the micro-cracks fails to ripen and remains green or yellow even as the rest of the fruit turns red. The symptoms we observed were severe.

Scientists haven't yet determined the exact cause of rain check. We know some cultivars are less affected than others, and large, slicer tomatoes are more susceptible than plum or cherry types. Rainfall has also been implicated. One theory is that heavy rain changes the temperature of the fruit or water uptake, which may affect the development of the rind on the shoulder. Another is that the impact on the fruit by the raindrops themselves may cause micro-cracking. Rain check tends to be more severe when periods of drought are followed by heavy rainfall. This describes the weather pattern we experienced in our field. The site received less rainfall than average in June, July, and August, and temperatures were high. Then, in September, the site received about average rainfall.

Jerry Brust, a scientist with the University of Maryland Extension, found that none of the tomatoes he evaluated growing under 30% shade cloth had rain check last year, while 10–20% of the ones growing in the open field did. Shading or protecting the fruit may be a reason using shade cloth helps. Scientists think cultivars with good leaf cover of the fruit are less likely to get rain check. As with internal whitening, practices that support robust, healthy foliage covering the fruit to reduce their exposure to sunlight can help. Another management strategy is to observe which cultivars are immune or less affected by rain check and grow those when possible.

Dr. Sánchez and Dr. Berghage are with the Dept. of Plant Science at Penn State while Mr. Butzler is with Penn State Extension. From Penn State Extension, https://extension.psu.edu/blossom-end-rot-internal-whitening-and-rain-check-of-tomatoes, October 10, 2022

Figure 5. Severe rain check on a tomato. Photo: Elsa Sánchez, Penn State

Figure 6. (left) Notice that the fruit remained yellow or green around the areas with rain check in this photo. (right) The same fruit rotated to show the back. Areas of the fruit that face up on the plant are affected by rain check. Photos: Elsa Sánchez.

VEGETABLE PRODUCTION

Crop Yield Estimates for Vegetables

Elsa Sánchez

Photo: Elsa Sanchez, Penn State

This question frequently arises: "Do you have yield estimates for vegetables?".

It is a difficult question to answer because many factors affect yields, including cultivar; nutrient, irrigation, and pest management; plant spacing; weather conditions; and more.

Since 2008, a group of Extension educators and specialists have been evaluating cultivars of various vegetables in western (Indiana County), central (Pennsylvania Furnace), and southeastern (Manheim) Pennsylvania. We have developed a table of averages and ranges of the yields we collected to estimate expected yields.

When using the table, it's essential to look at the production methods we used in our experiments. This information is key. It's impossible to relate the values to your situation without knowing the production protocols. For example, we used a plasticulture system with raised rows, a single line of drip tape, and black plastic mulch to grow our acorn squash. Suppose you are growing your acorn squash on bare, flat ground and relying only on rainfall to supply water or are growing into a cover crop mulch as part of a reduced tillage system. In that case, the values may not apply to your situation.

Yield estimates by crop

The table below lists averages and ranges for marketable and total yields per plant in pounds and numbers for muskmelon, bell pepper, pumpkin, winter squash, and sweet corn. Averages and ranges for head weight and diameter are listed for broccoli.

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Crop Yield Estimates for Vegetables

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Crop	[1]AVG MKT YLD/ plant (LBS.)	[1]AVG MKT YLD/ plant (No.)	[2]AVG TTL YLD/ plant (LBS.)	[2]AVG TTL YLD/ plant (No.)	[3]RNG MKT YLD/ plant (LBS.)	[3]RNG MKT YLD/ plant (No.)	[4]RNG TTL YLD/ plant (LBS.)	[4]RNG TTL YLD/ plant (No.)
Muskmelon (cantaloupe)	1.6	0.93	1.9	3.8	0–4.0	0–4.7	0–6.72	0–9.63
Peppers, Green bell	3.9	9.8	4.4	11	1.3–6.3	4.25–14.7	1.4–5.8	4.5–16.5
Pumpkin	38.5	2.1	–	2.2	21.8–61.0	1.1–3.3	–	1.3–3.3
Squash, Acorn	12	7.4	12.9	8.2	5.9–24.2	3.0–15.1	6.0–26.0	3.5–15.7
Squash, Buttercup/ kabocha	10.6	3.2	14.1	4.3	1.8–26.6	0.5–13.4	4.1–32.9	1.8–16.0
Squash, Butternut	15.9	5.4	18.8	7	9.9–28.7	2.5–7.9	9.9–38.0	2.8–10.3
Sweet corn, synergistic, white, and bicolor	0.7	0.93	0.72	0.98	0.24–1.1	0.58–1.0	0.24–1.1	0.37–1.1

[1]Average Marketable Yield per Plant Pounds (LBS.) or Number (No.)
[2]Average Total Yield per Plant Pounds (LBS.) or Number (No.)
[3]Range Marketable Yield per Plant Pounds (LBS.) or Number (No.)
[4]Range Total Yield per Plant Pounds (LBS.) or Number (No.)
Production Methods

Cantaloupe - https://extension.psu.edu/muskmelon-growing-methods
Peppers - https://extension.psu.edu/bell-pepper-growing-methods
Pumpkins - https://extension.psu.edu/pumpkin-growing-methods
Winter Squash - https://extension.psu.edu/winter-squash-growing-methods
Sweet Corn - https://extension.psu.edu/sweet-corn-growing-methods

	*AVG MKT Head Wt. (LBS)	*AVD MKT Head Dia. (In.)	AVG of Unmarketable Heads in 10
Broccoli, Fall	0.87	5.48	1.11
Broccoli, Spring	0.58	4.67	1.82

	**RNG of MKT Head Wt. (LBS)	**RNG of MKT Head Dia. (In.)	RNG of No. of Unmarketable Heads in 10
Broccoli, Fall	0.41–1.89	4.73–6.94	0–8
Broccoli, Spring	0.34–0.79	2.27–5.57	0–9

** Average Marketable Head Weight Pound (LBS.) or Head Diameter Inches (In.)*
***Range of Marketable Head Weight Pound (LBS.) or Head Diameter Inches (In.)*
Production Methods
Broccoli - https://extension.psu.edu/broccoli-growing-methods

Dr. Sánchez is with the Department of Plant Science at Penn State.
From Penn State Extension, https://extension.psu.edu/crop-yield-estimates-for-vegetables?, March 22, 2023.

VEGETABLE PRODUCTION

Spinach Crown Mites in Spinach

Gerald Brust

Spinach crown mites Rhizoglyphus sp. feed within the folds of new leaves in the crown of spinach plants. This feeding causes the new leaves to become deformed as they grow (Figs.1 and 2). Crown mite adults are extremely small bulbous nearly transparent mites that also may have a yellow-beige body color with reddish-brown legs (Fig. 3). A good characteristic to look for to identify these mites is the sparse long hairs mostly found on the back end of the mite (Fig. 3). Crown mite eggs are spherical and clear and laid on the creased leaf surfaces in the crown area. Some reports state that crown mites can act as vectors for plant pathogens such as Pythium and Rhizoctonia, but this is not definitive.

The spinach crown mite is most damaging in soils high in organic matter and under cool moist conditions (weather conditions we have had this past week). Because these mites can consume organic matter they can survive in soils after the crop has been removed. This is one reason they are difficult to control as they can survive for fairly long periods of time with no crop being present. The other reason they are difficult to 'control' is we do not realize they are causing the problem until it is too late.

Most control recommendations include sanitation and crop rotations as being important, as are fallow periods. Pyrethroids are a possible chemical control as is Neem; any chemical control has to get down into the crown of the plant to have any chance of working. There has been little research conducted on the most efficacious material for these mites. Mostly what is needed are warm sunny days where spinach can grow well and the environment is not so conducive to the mites.

Dr. Brust is the IPM Vegetable Specialist at Univ. of Maryland. From the ***Weekly Crop Update****, Univ. of Delaware, Vol. 31, Issue 5, April 28, 2023.*

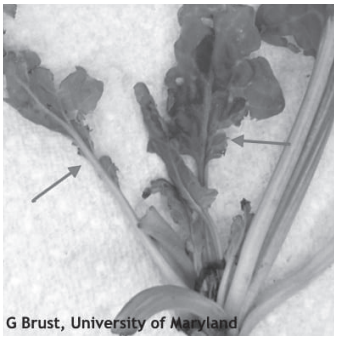


Figure 1. Crown leaves fed on by spinach crown mites are misshapen and ragged with necrotic margins as they expand

Figure 2. Crown leaves with distorted and wrinkled appearance cause by spinach crown mite feeding

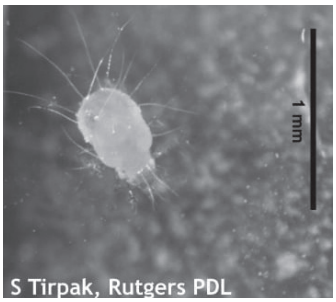


Figure 3. Spinach crown mite adult with sparse long hairs over its body

VEGETABLE PRODUCTION

Foliar Fertilization for Vegetable Crops

Gordon Johnson

Growers will apply most (>90%) of their plant nutrients for vegetable crops as soil applications (preplant, sidedressed, fertigated) based on soil tests and crop nitrogen needs.

To monitor vegetable nutrient status during the growing season, tissue testing is recommended just prior to critical growth stages. Growers can then add fertilizers to maintain adequate nutrient levels during the growing season or correct nutrient levels that are deficient or dropping.

Foliar fertilization is one tool to maintain or enhance plant nutritional status during the growing season. Often quick effects are seen and deficiencies can be corrected before yield or quality losses occur. Foliar fertilization also allows for multiple application timings post planting. In addition, there is reduced concern for nutrient loss, tie up, or fixation when compared to soil applications.

However, foliar fertilization has limitations. There is the potential to injure plants with fertilizer salts, application amounts are limited (only small amounts can be taken up through leaves at one time), multiple applications are often necessary (increasing application costs) and foliar applications are not always effective, depending on the nutrient targeted and plant growth stage.

Where foliar fertilization does have a good fit is for deficiency prevention or correction, particularly when root system function is impaired. This commonly occurs when there is extended rainy weather and soils are waterlogged. Foliar fertilization is also necessary when soil conditions, such as low pH, causes the tie up of nutrients so that soil uptake is limited. Foliar fertilization can also be used to target growth stages for improved vegetable nutrition thus improving color, appearance, quality, and yield.

Foliar fertilizers are applied as liquid solutions of water and the dissolved fertilizers in ion or small molecule form. Foliar nutrient entrance is mostly through the waxy cuticle, the protective layer that covers the epidermal cells of leaves. Research has shown that there is limited entrance through the stomata. While the waxy cuticle serves to control water loss from leaf surfaces, it does contain very small pores that allows some water and small solute molecules to enter into the underlying leaf cells. These pores are lined with negative charges. Fertilizer nutrients in cation form or with neutral charges enter most readily through these channels: this includes ammonium, potassium, magnesium, and urea (NH_4^+, K^+, Mg^{++}, CH_4N_2O respectively). In contrast, negatively charged nutrients (phosphate-P, sulfate-S, molybdate-Mo) are much slower to move through the cuticle (they must be paired with a cation). Movement through the cuticle is also dependent on molecular size, nutrient concentration, time the nutrient is in solution on the leaf, whether the nutrient is in ionic or chelated form (complexed with an organic molecule), and the thickness of the leaf cuticle.

Another factor in foliar fertilizer effectiveness is what happens once the nutrient enters into the leaf area. Some smaller molecules or those with less of a charge are readily transported in the vascular system to other areas of the plant (NH_4^+, K^+, Mg^{++}, Urea). Other larger molecules and more strongly positive charged nutrients stay near where they enter because they bind to the walls of cells in intercellular areas that contain negative charges. Tightly held nutrients include Calcium, Manganese, Iron, Zinc, and Copper (Ca^{++}, Mn^{++}, Fe^{++}, Zn^{++}, Cu^{++}). Therefore, when applied as foliar fertilizer, calcium does not move much once it enters plant tissue, the negatively charged nutrients such as phosphorus and sulfur are very slow to enter the plant, and iron, manganese, copper, and zinc are slow entering and do not mobilize once in the plant.

The following is a list of the major plant nutrients that are effective as foliar applications, fertilizer forms best used for foliar applications, and recommended rates;

Foliar applications of nitrogen (N) can benefit most vegetables if the plant is low in N. Urea forms of N are the most effective; methylene ureas and triazones are effective with less injury potential; and ammonium sulfate is also effective. Recommended rates are 1-10 lbs per acre.

Foliar potassium (K) is used on fruiting vegetables such as tomatoes and melons. Best sources are potassium sulfate or potassium nitrate. Recommended rate is 4 lbs/a of K.

Foliar magnesium (Mg) is used on tomatoes, melons, and beans commonly. The best source is magnesium sulfate and recommended rates are 0.5-2 lbs/a of Mg.

Foliar calcium is often recommended, but because it moves very little, it must be applied at proper growth stages to be effective. For example, for reducing blossom end rot in tomato or pepper fruits, foliar calcium must be applied when fruits are very small. Best sources for foliar calcium are calcium nitrate (10-15 lbs/a), calcium chloride (5-8 lbs/a) and some chelated Ca products (manufacturers recommendations).

Iron (Fe), manganese (Mn), or zinc (Zn) are best applied foliarly as sulfate or chelated forms. Rates are: Fe, Mn, 1-2 lbs/a, and Zn ¼ lb/a. While these metal micronutrients are not mobile, foliar applications are very effective at correcting local deficiencies in leaves.

The other micronutrient that can be effective as a foliar application is boron. Boron in the Solubor form is often recommended at 0.1 to 0.25 lbs/a for mustard family crops such as cabbage as a foliar application. Boron is very toxic to plants if applied in excess so applying at correct rates is critical.

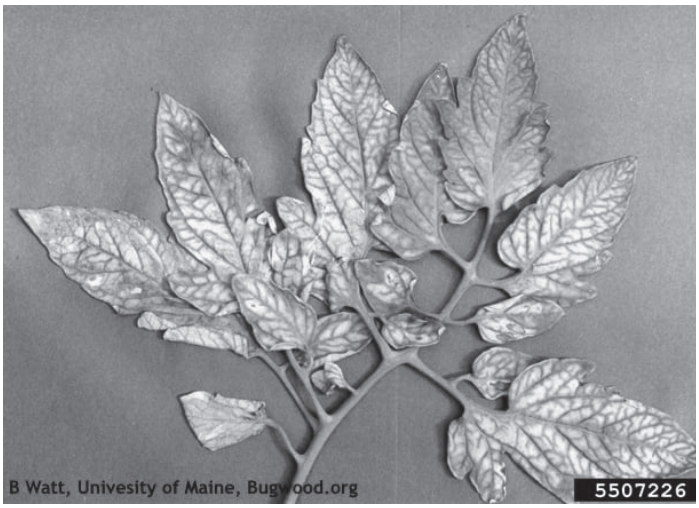
VEGETABLE PRODUCTION

For foliar fertilizers to be most effective they should remain on leaves or other targeted plant tissue in liquid form as long as possible. Urea and ammonium nitrogen forms, potassium, and magnesium are normally absorbed within 12 hours. All other nutrients may take several days of wetting and rewetting to be absorbed. Therefore, it is recommended that foliar fertilizers be applied at dusk or early evening when dew is on the leaves, in high volume water, and using smaller droplets to cover more of the leaf. Applications should also be made when temperatures are moderate and wind is low. While foliar fertilizers are sometimes applied with pesticides, for best effectiveness and reduced phytotoxicity potential it is recommended that they be applied alone. Use only soluble grade fertilizers for foliar applications (many are already provided in liquid form) and adjust water pH so it is slightly acidic.

Foliar fertilizers are most effective when applied to younger leaves and fruits. Research has shown that as leaves or fruits age, cuticles thicken, and these thicker cuticles absorb significantly lower amounts of nutrients such as potassium. However, younger plant tissue is also the most susceptible to potential fertilizer burn.

Because foliar fertilizers are in salt forms they can damage plant tissue if applied at rates that are too high. Generally a 0.5-2% fertilizer solution is recommended. Certain vegetables are more sensitive to fertilizer salt injury than others. Vegetables with large leaves with thinner cuticles (such as muskmelons) have greater risk of salt injury when compared to crops, such as cabbage, that have thick cuticles. Apply foliar fertilizers at recommended rates and dilutions for each specific vegetable crop.

In addition, some fertilizer sources are much more likely to cause injury than others. In the past this was given as the salt index for a fertilizer, the lower the salt index the less osmotic stress the fertilizer would place on the plant tissue. A better index would be the osmolality values for the fertilizer material. For foliar nitrogen materials, osmolality values (mmol/kg) for common N sources are as follows: Urea = 1018, UAN-28 = 1439, Ammonium sulfate = 2314, Potassium nitrate = 3434. This shows that potassium nitrate has over 3x the osmotic stress potential compared to urea when applied as a foliar fertilizer. This means that potassium nitrate has much more potential to cause salt injury to plants than urea and must be used at lower rates.



Magnesium deficiencies are common in tomatoes. Foliar applications of magnesium are effective in correcting this problem.

*Dr. Johnson is Extension Vegetable & Fruit Specialist at the Univ. of Delaware. From the **Weekly Crop Update**, Univ. of Delaware, Vol. 31, Issue 5, April 28, 2023.*

VEGETABLE PRODUCTION

Linear Bed Foot Method for Determining Fertilizer Needs for Vegetable Crops on Plastic Mulch

Gordon Johnson

In the Mid-Atlantic Commercial Vegetable Production Recommendations, fertilizer recommendations are given on a per acre basis. For crops grown on plastic mulch, the most common bed spacing between rows is used and recommendations are based on linear bed foot (LBF) values.

The LBF system can be used to express fertilizer rates for any fertilizer delivery method with mulched beds, including production systems using bed placed fertilizers. In the production systems that rely on the drip irrigation system to deliver water and fertilizers, the LBF fits closely because growers already know the total length of drip tubing in an acre. LBF can also take into account areas for drive rows used for sprayers such as in watermelons or cantaloupes.

The following are LBF values that fertilizer recommendations are based on in the Mid-Atlantic on plastic mulch:

Cucumbers: 7,260 linear bed ft./acre (6-foot bed spacing, 2 rows per bed)

Eggplant: 7,260 linear bed ft./acre (6-foot bed spacing, one row per bed)

Muskmelons and Mixed Melons: 7,260 linear bed ft./acre (6-foot bed spacing, 1 row per bed)

Peppers: 7,260 linear bed ft./acre (6-foot bed spacing, 2 rows per bed)

Summer Squash: 7,260 linear bed ft./acre (6-foot bed spacing, 2 rows per bed)

Tomatoes: 7,260 linear bed ft./acre (6-foot bed spacing, one row per bed)

Watermelons: 6,222 linear bed ft./acre (7-foot bed spacing, one row per bed)

If bed widths are different then adjustments should be made to fertilization rates and if unplanted drive rows are used then rates per acre will also be reduced.

To make these adjustments you need to know the following:

Real-estate acre: Farm land (land area) that occupies 43,560 square feet. This term also may be called “gross acre” and refers to the land area used for crop production, including the cropped land plus the land used for drive rows, field rows roads and drainage ditches.

Cropped area: The portion of the real-estate acre used solely for crop production. Alternatively, the cropped area is the land remaining after uncropped land, such as drive or access roads, have been subtracted from the real-estate area. If the entire area is used for crop production, then the cropped area is equal to the real-estate area. Otherwise, the cropped area is less than the real-estate area.

Some watermelon examples:

1) Crop is grown on 8-foot bed centers, not 7-foot: Total bed feet would be 43,560 / 8 or 5,445 LBF.

Fertilizer would be reduced by 6,222 - 5,445 = 777 / 6,222 = 12.5% so if the recommendation is 125 lbs of N per acre you would reduce that by 16 lbs (109 lbs N per acre).

2) A drive row is placed after every 8 beds on 7-foot centers. The cropped area is 8 / 9 or 89%. So the LBF would be 11% less. If the recommendation is 125 lbs/acre N, then the actual amount applied would be 0.89 * 125 or 111 lbs of N per acre.

For more information on Linear Bed Foot for fertilizer recommendations go to this University of Florida fact sheet: https://edis.ifas.ufl.edu/pdffiles/ss/ss51600.pdf. Much of the information used in this article was taken from this publication.

Dr. Johnson is Extension Vegetable & Fruit Specialist at the Univ. of Delaware. From the Weekly Crop Update, Univ. of Delaware, Vol. 31, Issue 4, April 21, 2023.

Cut Seedlings and the Potential Culprits

Laura Ingwell

Each year we get several reports of seedlings being cut at or near the base of the plant/soil surface. The critter who gets the blame most often is cutworms. And that makes sense because the damage is in the name. However, with closer inspection, it seems that the blame can often be misplaced. There are other organisms, many of which have a backbone, that may be the culprit. Here we will review cutworm identification and discuss other possible causes for cut seedlings.

Cutworm diversity and biology

The black cutworm (Figure 1) is our most commonly found species in field crops In Indiana, but we also have dingy, claybacked, and variegated cutworms.

So, how do you tell the difference, and does it really matter? Timing and the type of damage caused can give clues to the species. Black cutworms do not overwinter in the Midwest. We monitor their arrival every spring with pheromone traps. Once they arrive in large numbers (intensive captures), we begin predicting their development and subsequent damage with heat unit accumulations. To stay up to date on black cutworm trapping information, subscribe to the Purdue Extension Entomology Pest & Crop Newsletter. While trap catches are high as of late, there have not been enough heat units accumulated this spring for black cutworms to get 1/2 to 3/4 inches long, that being the size where they cut plants.

Figure 1. Various sizes (ages) of black cutworm larvae (Photo by John Obermeyer).

The other three species of cutworms that can be found in Indiana include the dingy (Figure 2), claybacked (Figure 3), and variegated (Figure 4). The dingy cutworm, probably the second most common species, is primarily a leaf feeder and will rarely cut

Figure 2. Dingy cutworm larva (Photo by John Obermeyer).

plants, and if it does, the cutting is above the ground. The dingy and claybacked cutworms overwinter as partially grown larvae. Therefore finding cutworms 3/4 of an inch or more at this time would likely point to these species. Given that many of the reports we receive on potential cutworm damage occur in high tunnels, there is always the possibility that some of the other species may be overwintering in that habitat or that their development could be accelerated because of increased heat units. High tunnels always make things a bit messy when it comes to pest biology!

Cutworms are generalist feeders that readily eat a wide range of vegetable and fruit crops (Figures 5-6). Species like the black cutworm exhibit the characteristic snipping of young plants (seedlings and new transplants) right at the base of the stem where it emerges from the soil, leaving behind seedlings that appear to have been 'cut down', thus the name 'cutworm.' Most often, if the cut seedling is damaged by cutworms, you will find the top of the plant with herbivore damage near the root/stem. Occasionally cutworms will drag the top down into their burrow and continue to feed, but you should be able to find this under the ground cover if you are scouting often. In addition to early-season stem cutting and defoliation, cutworms can also cause damage later in the season. For example, we have seen cutworms feeding on ripening tomato fruit in high tunnels – an unpleasant discovery!

Figure 3. Claybacked cutworm larva curled in the identifiable 'C'" shape on a leaf (Photo by John Obermeyer).

Figure 3. Claybacked cutworm larva curled in the identifiable 'C'" shape on a leaf (Photo by John Obermeyer).

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Cut Seedlings and the Potential Culprits

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Figure 5. Cutworm larva emerging from the soil to feed on a young pumpkin seedling (Photo by Liz Maynard).

Other potential causes

There are other insects that occur in the soil and feed on dead/decaying plant material. These include beetle grubs (juvenile stage of beetles), crane fly larvae, millipedes, centipedes, worms, and other even smaller invertebrates. If you go digging in the soil, you will likely encounter some of these, which are typically not to blame for troubles with seedling establishment.

Rabbits are on the list of top contenders in my book. They have been detrimental in our high tunnel strawberry production but are too cute to get mad about (Figure 7). They are voracious little critters and will leave a clean-cut stem in their tracks. The plants are usually cut at a 45-degree angle up to about 2.5' from the ground. Furthermore, when we suspect rabbit damage, there is very consistent plant removal, as if they just eat their way straight down the nicely planted rows.

Some of a rabbit's favorite crops include peas, beans, lettuce, and beet leaves. In general, they avoid asparagus, cucurbits, solanaceous crops, corn, onions, and herbs. However, if there is not much available, they can't be picky. Management can include exclusion, frightening devices like motion-activated sprinklers, repellents, and trapping depending on local laws.

Moles, voles, and mice are the remaining contenders. Mice leave nibble marks here and there, with signs of their feeding left behind in the form of mouse pellets, a contaminant for our produce growers. They don't usually cause widespread destruction unless they are harvesting nest material. I witnessed this mess when they ate my master's thesis trees off at the base and piled them into a neat little nest in the middle of the greenhouse. I have not seen reports of this happening with fruit and vegetable plants. Traps and baits are usually effective at controlling this group of pests.

*Dr. Ingwell is with the Dept. of Entomology at Purdue Univ. From the **Vegetable Crops Hotline**, Purdue Univ., No. 718, May 2, 2023.*

Figure 7. Rabbits munching on the strawberry patch in the high tunnels at Meigs Horticulture Farm (Photo by Laura Ingwell).

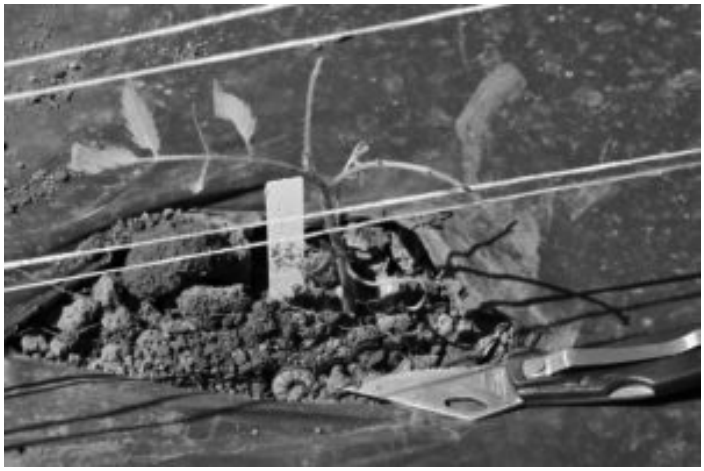

Figure 6. Variegated cutworm larva and damage on tomato seedling (Photo by John Obermeyer).

Blueberry Pollination

Gordon Johnson

Northern highbush blueberry bushes can produce berries even when there is no or limited pollen movement by bees. Some of the flowers can turn into berries, even if there are poor pollination conditions or low bee activity during bloom. However, often these berries will be small, slow to ripen, and may drop off early. For maximum potential yield, it is important that the flowers are visited by bees during bloom to transfer sufficient pollen while the flower is still viable so that fertilization can occur, leading to seed set, berry expansion, and larger berries.

In addition, some varieties benefit from cross pollination. Fields should be planted with a combination of varieties that bloom around the same time and that are compatible. For cultivars dependent on having cross-pollination for full yields, this can provide a 10-20% increase in yield from the improved fruit set and berry size.

Flowers of blueberries are generally less attractive to honeybees than other flowers due to the relatively low nectar. Because of this, move bees into blueberry fields after 5% bloom but before 25% percent of full bloom to avoid movement to more preferred flowering plants. Placement near to the blueberry field can also help to keep them focused on the crop.

Research has shown variation across northern highbush cultivars in their needs for bee pollination due to the relative attractiveness of different cultivars and their degree of self-compatibility. Experience shows that a minimum of 2 hives per acre are needed. In some cases, 5 hives per acre are recommended (such as for Jersey and Earliblue). Some growers are using up to 8 colonies per acre to ensure good pollination if spring weather is cool and there are only a few good days for honeybee activity. A rule of thumb is that you'll need 4 to 8 honeybees per bush in the warmest part of the day during bloom to get blueberries pollinated.

Figure: Honeybee pollinating a blueberry flower.

Bumblebees are very efficient at pollinating blueberry, with activity at lower temperatures than honeybees, faster visits to flowers, and higher rates of pollen transfer per flower visit. A single visit of a bumble bee to a blueberry flower can deposit sufficient pollen to get full pollination, whereas three visits are needed by honeybees.

Blueberry information was adapted from https://bee-health.extension.org/pollinating-highbush-blueberries/

*Dr. Johnson is Extension Vegetable & Fruit Specialist at the Univ. of Delaware. From the **Weekly Crop Update**, Univ. of Delaware, Vol. 31, Issue 5, April 28, 2023.*

BERRY PRODUCTION

Strawberry Disease Identification: Neopestalotiopsis (aka Pestalotia) or a More Traditional Disease?

Kathleen Demchak

Neopestalotiopsis (Pestalotia) is a new strawberry disease that has been causing problems on the East Coast for a few years now.

Figure 1: Leaf symptoms typical of Neopestalotiopsis (Pestlotia). Photo: Kathy Demchak, Penn State

Neopestalotiopsis (or Pestalotia) was present in plug plant material distributed in Pennsylvania and the Mid-Atlantic in the fall of 2021. Here are some photos and tips on how to tell it apart from other foliar and fruit diseases. We don't know whether this disease will continue to show up in the spring, but be on the lookout. Matted-row growers should know that this disease has not been found on the plant material used in matted-row plantings so far, so if you see similar symptoms, you are most likely seeing one of our more traditional diseases, but let your local extension educator know so we can follow up.

Pestalotia foliar symptoms progress very quickly during warm wet spells. Large portions of infected leaves are invaded within a few days under these conditions, and though the speed of invasion varies somewhat with cultivar, disease progression is noticeable over just a few days. Other foliar diseases, if widespread enough, can also invade large portions of the leaf and coalesce, but tissue invasion is much more gradual.

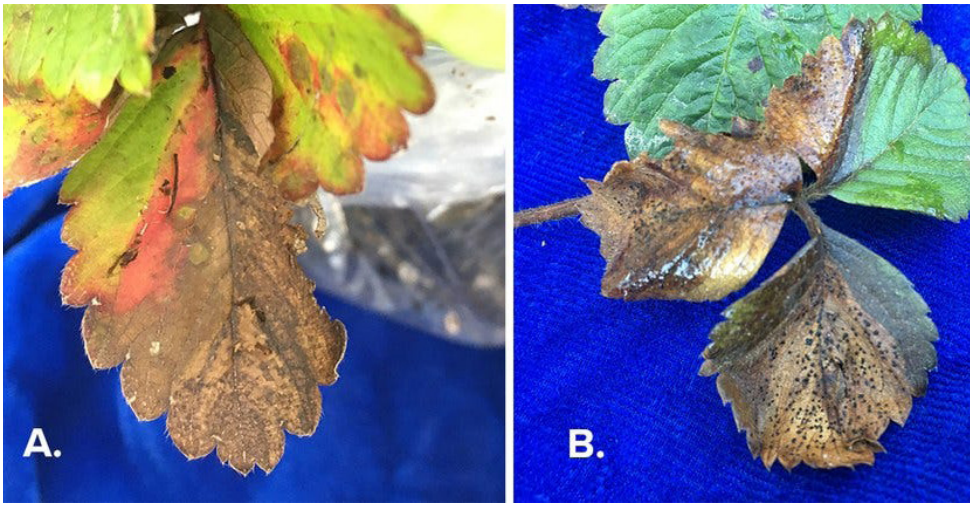

Figure 2: (A) Death of leaf tissue caused by angular leaf spot, not Neopestalotiopsis. Though a large portion of the tissue is dead, angular blotches can still be seen. (B) Black pycnidia form in lesions of leaves infected by Neopestalotiopsis. Note that healthy leaf tissue is continuing to be invaded. Photos: Kathy Demchak, Penn State

A second differentiating feature is that if you put leaves infected with Neopestalotiopsis in a plastic bag with a wet paper towel to keep humidity high, you will see many black pynidia that look like tiny black pimples emerge on the leaves within a few days. These black pynidia occur with other diseases, too, but there will only be a few of them, and it takes longer for them to appear. With Neopestalotiopsis, any green tissue will continue to be invaded during this time.

Figure 3: Black tendrils of spores emerging from pycnidia on a strawberry leaf infected by Neopestalotiopsis. Photo: Kathy Demchak, Penn State

The third differentiating feature is that in a few more days (or possibly as long as a week), tendrils of black spores will emerge from the pynidia that curl as they grow. You will need a magnifying glass to see these, and you will only see them if the leaves are not rubbed against other leaves, as these tendrils are delicate and easily broken off. Eventually, these tendrils will fall off and, if gathered on a white piece of paper, look like flecks of black pepper. It is easy for them to be picked up and moved around on wet hands or clothing, which could be one way this disease gets moved so easily.page

Disease progression stops during the winter, so whether this disease will continue to be seen in the spring remains to be seen. However, if symptoms are observed, by looking closely at the above photos, you should be able to determine whether the symptoms are caused by Neopestalotiopsis or another disease. Thiram and Switch are still the two best products available for control.

Ms. Demchak is with the Dept. of Plant Science at Penn State Univ. From Penn State Extension, https://extension.psu.edu/strawberry-disease-identification-neopestalotiopsis-aka-pestalotia-or-a-more-traditional-disease?, February 16, 2022.

Rhizoctonia solani: Prevention and Management on Vegetable Transplants

Thomas Ford

Rhizoctonia solani is an aggressive soil-borne pathogen that can be found in field soils, high tunnel soils, and greenhouse floors.

Rhizoctonia solani can cause infected seedlings to collapse in the greenhouse. Please note the constricted stem at the soil line on watermelon. This vegetable grower lost his entire bench of watermelon transplants. Photo by Thomas Ford, Penn State

Rhizoctonia can infect a wide array of vegetable crops, causing root and/or crown rots, stem cankers, and leaf infections. *Rhizoctonia solani* colonizes organic matter and will form black hardened sclerotia in the soil that helps this pathogen to persist in the field for many years.

Rhizoctonia solani, unlike other fungal pathogens, does not produce spores, but its mycelium can fragment or break off, which allows it to be spread by wind and splashing water to susceptible plant species. *Rhizoctonia solani* can also be introduced into the greenhouse via contaminated soil, tools, and equipment. Sanitation is the key to preventing this pathogen from entering your greenhouse. Vegetable transplants that develop cankers due to infection from *Rhizoctonia solani* will often perform poorly as transplants and may decline and die when transplanted into the field.

Rhizoctonia infections tend to be the most severe in greenhouses due to environmental factors and crowding during propagation and transplant production. In greenhouse environments, this pathogen can cause damping-off in an entire plug or seedling tray within a few days after infection. Greenhouse temperature management is critical because *Rhizoctonia solani* becomes very pathogenic when air temperatures rise above 90°F. So as spring temperatures climb in the greenhouse, remember to promptly vent the greenhouse when your air temperatures reach 80°F.

Rhizoctonia solani infection in young plants is typically called damping-off. When seedlings or young transplants are infected, the plants will collapse and lay on the soil. In some cases, some root decay may be observed, but more often, crown infections cause the stem to develop a brown constricted area on the lower stem at or just above the soil line. Damping-off usually moves in a circular pattern in the flat or plug tray. It usually starts at a single infection point and then radiates out in a circular pattern from the center. Growers may also notice the growth of brown spider-like

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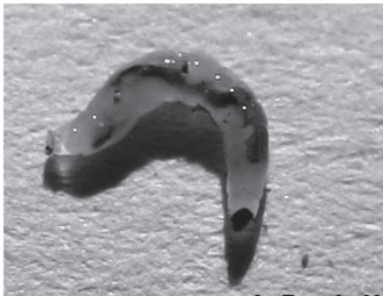
GREENHOUSE PRODUCTION

Managing Fungus Gnats and Shoreflies

Tina Smith

Identification. Fungus gnat adults are mosquito-like in body shape, about 1/8 inch long, with long legs, a clear pair of wings, and long antennae. Fungus gnats are weak fliers and are frequently observed resting on the media in the pot or run¬ning over the foliage or other surfaces. We see them often in spring when gray cool conditions lead to a lot of wet soil as plants are just starting to get going. Their larvae (*Bradysia* spp.) are white and legless, about 1/4 inch long when mature, and have a shiny black head (Figure 1). Larvae feed on plant roots, sometimes causing damage to seedlings directly when populations are very high, or by allowing for pathogens to attack weakened roots.

The adult fungus gnat is sometimes confused with another small dark-bodied fly called the shore fly, *Scatella stagnalis*. Shore flies have more robust bodies than fungus gnats and their antennae are very short. Their most distinguishing characteristic is the presence of five light-colored spots on each of their dark wings. Shore flies are also stronger, faster fliers than fungus gnats. In the larval stage shore flies can be distinguished by the opaque, tannish-brown color of the body and the absence of a head capsule.



Fungus gnat larva. Photo: L, Pundt

Damage. Fungus gnats and shore flies are attracted to damp locations where fungi are apt to flourish. Fungi are a major part of their diet. Studies have shown that fungus gnats develop more rapidly and have greater survival on fungal diets. In the absence of a fungal food source however, fungus gnats are capable of feeding on healthy plant tissue. Fungus gnats are general feeders and can injure a number of flower

Rhizoctonia solani: Prevention and Management

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mycelium on the soil or media surface or on infected plants under humid conditions.

Young transplants in the field may develop stem cankers or root rot from inoculum in the field or from latent infections that first arose in the greenhouse. Leaves that come in contact with the soil can also become colonized by *Rhizoctonia solani* resulting in the development of leaf lesions. As plants mature in the field, they become less susceptible or resistant to *Rhizoctonia solani* infection. Pythium is another common pathogen observed in vegetable crops. It may cause similar symptoms as *Rhizoctonia solani*, but Pythium is more apt to cause root rots than stem cankers in field-grown vegetables.

Most growers may find it difficult to tell the difference between *Rhizoctonia* and *Pythium* infection in field-grown vegetables. Penn State Extension and other Land Grant Institutions operate plant disease clinics or diagnostic laboratories. Clients can submit infected specimens directly to these laboratories or through their local Extension offices. An information sheet must be submitted with each plant sample to assist the lab in the diagnostic process. Penn State Extension does not charge for vegetable specimens submitted to our Plant Disease Clinic. You may access the Penn State Plant Disease Clinic at https://plantpath.psu.edu/about/facilities/plant-disease-clinic to download submission forms and the submission procedures. You may also stop by your local Extension office, and their friendly staff assistants will send the sample to the plant disease lab for you.

Prevention is the first step in limiting *Rhizoctonia solani* infection in the greenhouse. Growers should practice good sanitation by using sterile media and sanitized flats to germinate and grow vegetable transplants. Weeds and organic debris on the greenhouse floor should also be removed prior to introducing seedlings, plug trays, or transplants into the greenhouse. Humidity and temperature management in the greenhouses are also critical in preventing *Rhizoctonia solani* infection.

Growers that have observed *Rhizoctonia solani* infection in their vegetable transplants may consider using appropriately labeled protectant fungicides and biofungicides to protect their seedlings, plugs, or transplants in the greenhouse. Plant protectants labeled for use on vegetable transplants for *Rhizoctonia solani* in the greenhouse include:

- Actinovate (Streptomyces lydicus) OMRI listed
- Bio-Tam (Trichoderma asperellum + Trichoderma gamsii) OMRI listed
- Howler (Pseudomonas chlororaphis strain AFS009) OMRI listed
- RootShield + (Trichoderma harzianum strain T-22, Trichoderma virens strain G-41) OMRI listed
- SoilGard 12 G (Trichoderma virens GL-21) OMRI listed
- azoxystrobin (Heritage, Quadris, and others)

*__Before purchasing__ or using any labeled pesticide in the greenhouse or field, please review the pesticide label carefully to ensure that it can be used legally on your vegetable crops to manage pests or plant diseases.

For additional information on preventing and managing vegetable disease in the transplant greenhouse, high tunnel, or field, please contact one of Penn State Extension's Vegetable Team's Field-based educators. For your convenience, our team members can be found in the table below:

Penn State Extension Vegetable Team

Field-based Educators	Location	Email	Office Telephone
Raymond Balaguer Barbosa	Philadelphia area	rmb6391@psu.edu	215-471-2200
Tanner Delvalle	Schuylkill County	tcd125@psu.edu	570-391-0982
Megan Chawner	Lehigh County	mzc335@psu.edu	610-391-9840
Maria Gorgo	Chester County	mag38@psu.edu	484-335-2091
Dr. Tim Elkner	Lancaster County	tee2@psu.edu	717-925-8786
Dr. Karly Regan	Franklin County	kjr5470@psu.ed	717-263-9226
Leah Fronk	Juniata County	lxf339@psu.edu	717-436-7744
Sara Hricko	Columbia County	seg5335@psu.edu	570-784-6660
Thomas Butzler	Clinton County	tmb124@psu.edu	570-858-0183
Thomas Ford	Cambria County	tgf2@psu.edu	814-472-7986
Bob Pollock	Indiana County	rcp3@psu.edu	724-465-3880
Glen Bupp	Butler County	gbb5154@psu.edu	412-482-3451

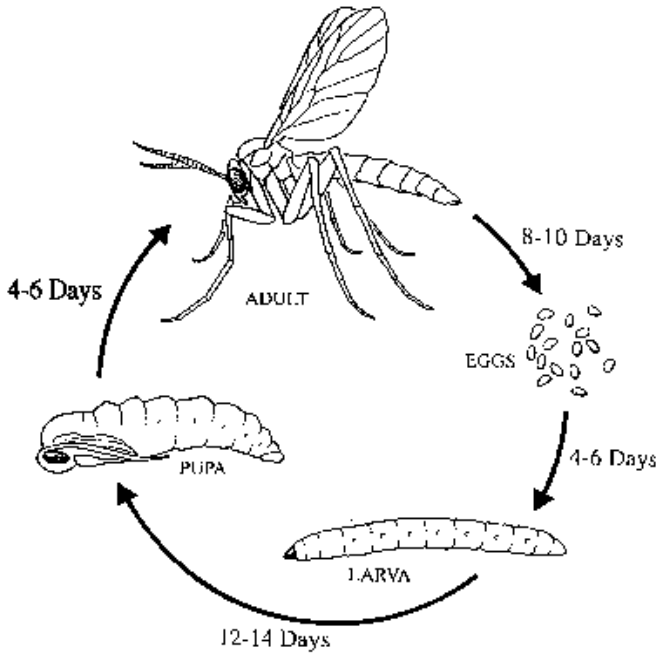
Mr. Ford is with Penn State Extension in Cambria Co. From Penn State Extension, https://extension.psu.edu/rhizoctonia-solani-prevention-and-management-on-vegetable-transplants?, April 4, 2023.

crops grown in the greenhouse. Adults are primarily a nuisance however, larvae feed on plant roots, fungi and decaying organic matter and tunnel into the crown and stems of plants. The feeding damage creates wounds that allow soilborne pathogens to enter and can kill plants. Fungus gnat larvae may also carry some soil-borne pathogens such as *Pythium*, *Thielaviopsis* and *Fusarium*. Fungus gnats are a common problem on greenhouse crops growing in media that contains a high percentage of peat moss or compost. Larvae present in infested plants or soil can lead to prolonged emergence of adults.

Shore flies are not known to feed on healthy plant tissue. Adult and larval stages of shore flies feed primarily on algae or decaying organic matter and breed in moist environments.

Life Cycle of Fungus Gnats. The life cycle of fungus gnats is shown in Figure 2. A female fungus gnat may lay up to 300 whitish eggs in clusters of 20 to 30 or more on the surface or in the crevices of moist soil or potting media rich in organic matter. Eggs hatch in about six days. Larvae feed for 12-14 days before changing into a pupa, which is formed inside a silken pupal chamber in the soil. The pupal stage may last 5-6 days and adults live up to 10 days. The life cycle from egg to adult requires approximately 4 weeks depending on temperature; development time decreases as temperatures increase, as is true of most insects.

Life Cycle of Shore Flies. Eggs are laid singly on the surface of algae. Larvae have eight pairs of short legs and a breathing tube with two dark colored openings called spiracles at the posterior end. Pupation occurs at the edge of the algae mats. Breeding takes place in stagnant and strongly saline water found in greenhouses as a result of excessive irrigation and soil leaching. To reduce shore fly numbers, eliminate algae, avoid over watering, and limit fertilizer run-off.



Life cycle of the fungus gnat

Management Strategies

- Fungus gnat and shore fly populations may be partially suppressed by sanitation practices that reduce breeding areas.
- Wet areas under benches should be eliminated if possible by

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Managing Fungus Gnats and Shoreflies

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controlling the use of water or changing the construction of the floor. Accumulations of soil, media, or decayed plants under benches should be avoided.

- Potting media should be pasteurized before use if possible.
- Moist potting soil high in organic matter that has been left outdoors for long periods may contain fungus gnat larvae. Fungus gnats and shore flies may also be introduced into the greenhouse in the media of infested plants purchased from other greenhouses.
- Keep areas below benches free of spilled potting mix, weeds and other debris in which fungus gnats and shore flies might breed.
- Eliminate standing pools of water on solid benches, on walks, and under benches. This may be accomplished by proper grading and drainage in the greenhouse and by improving watering practices to prevent runoff.
- Eliminate algae as best you can. Several algicides are currently registered for algae control in the greenhouse. Dis-infectants can be used as part of pre-crop cleanup program and during the cropping cycle for routine algae man¬agement. 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.
- Thoroughly inspect all incoming plant material and make early treatments.

It should be noted that fungus gnat problems are most serious in potting mixes amended with composts lacking in matu¬rity (not completely composted). Microbial activity is excessively high in such mixes, and fungus gnats thrive.

It has also been reported that a pulse in adult emergence follows watering of pots that were previously allowed to dry down. This expected peak in adult fungus gnat populations can be used to time sprays targeting adults or subsequent drenches aimed at larvae.

Prevention and early detection are the keys to controlling this insect, thus reducing the introduction and spread of disease in the greenhouse.

Adult fungus gnat and shore fly on sticky card. Photo: Tina Smith

Detection and Monitoring. As with any pest, fungus gnat and shore fly control programs are built on prevention and monitoring. To prevent infestations, establish a weekly scouting/monitoring routine for the duration of the crop.

To monitor for larvae, place raw potato chunks with peel removed on the soil surface. Larvae are attracted to the po-tato chunks, under which they move and congregate. Check the potato chunks daily for larvae. Potato disks cut one inch in diameter and 1/2 to1 inch thick work well. Ten potato disks may be sufficient to monitor a 10,000 sq. ft green¬house. Check disks after 48 hours, and count the number of larvae on each disk and any that are present on the growing medium surface. In addition, choose plants on each bench and inspect the soil surface and around the base of the plant including the stem just below the soil line. Record the loca¬tion and the level of infestation. Badly infested containers of plants should be removed as they serve as a source of infestation.

Adult flies can be monitored with yellow sticky cards placed at the base of the plant at soil line. Weekly inspections of yel¬low sticky cards can detect the onset of an infestation, and continued recording of the number of adults per card per week can aid in evaluating the efficacy of control efforts.

Space 3" x 5" yellow sticky cards 1-4 per 1,000 sq. ft. throughout the greenhouse. Place yellow cards in a horizontal position just above the soil surface, or lay them on the top of the pots. For early detection, position cards near doorways and vents or among new plants being placed in the house. If time permits, check the cards twice weekly particularly when temperatures warm up in the spring. Research conducted at Cornell University showed that red sticky traps captured more fungus gnat adults than yellow sticky traps. However, yellow sticky traps are commercially available and can be used for a variety of pests in the greenhouse.

Once fungus gnats and/or shore flies begin appearing on sticky cards (Figure 3) or larvae are seen under potato chunks, then it is time to make treatment decisions.

Management. Insect growth regulators, microbials and other pest control materials applied to the growing medium may be effective in controlling fungus gnat larvae. Most pest control materials do not affect eggs or pupae so repeat applications may be needed.

The soil-borne bacterium *Bacillus thuringiensis israelensis* (Gnatrol) may be used before fungus gnat larval populations are high since the bacterium must be ingested in order to be effective. Applications are more effective on the young larvae (1st instar) than mature (3rd and 4th instars). *Bacillus thuringiensis israelensis* should be applied until fungus gnat populations start to decline. It is not effective against shorefly larvae. Apply a drench or in irrigation system according to label directions. It is reported to be toxic to larvae for only 48 hours, so treatments must be repeated.

Biological Control. Several biological control organisms are available for control of fungus gnats including a pre-daceous mite (*Hypoaspis miles*), the parasitic nematode *Steinernema feltiae*, and the rove beetle *Atheta coriaria*.

Beneficial nematodes and predaceous mites used for fungus gnat control do not appear to work as well against shore flies because of the semi-aquatic environment in which they live. Beneficial nematodes (S. carpocapsae) will infect shore fly larvae but may not offer sufficient levels of control in commercial greenhouses. In unsprayed greenhouses, a tiny para¬sitoid of shore flies, *Hexacola neoscatellae*, occurs naturally in greenhouse and may slow the growth rate of shore fly populations.

Atheta coriaria (Rove beetle) (see info below) may be an option for biological control but will not work on Shore fly larvae that are in standing water. Atheta is a generalist predator that feeds on fungus gnat and shore fly larvae. All stages of Atheta actively search for prey. Because they can fly, adults can travel through a greenhouse, for distribution and faster population development. The adult beetles and the larvae will mainly search for eggs, young larvae and pupae.

Hypoaspis miles (Predatory mite): This predatory mite prefers to feed on first instar fungus gnat larvae and will also feed on thrips pupae. It may also feed on debris and algae. It is important to make releases early in the growing season before fungus gnat larval populations are abundant. Applications can also be directed to the soil beneath greenhouse benches. Avoid applications into the growing media prior to planting because this decreases survival. Applications need to be initiated after planting and the growing medium should be moist

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but not saturated. Hypoaspis miles is active when growing medium temperatures are greater than 50°F.

Steinernema feltiae: This beneficial nematode attacks fungus gnat larvae. Nematodes are applied as a drench to containers or flats and they can also be applied through drip irrigation systems, however filters must be removed. Apply nematodes two to three days after inserting cuttings, planting plugs, or starting seeds. To assess the viability of shipments prior to application, place a small quantity of the product in a shallow container with a few drops of tepid water. After a few minutes, look for active nematodes which have a slight 'J' curve at the ends of their bodies.

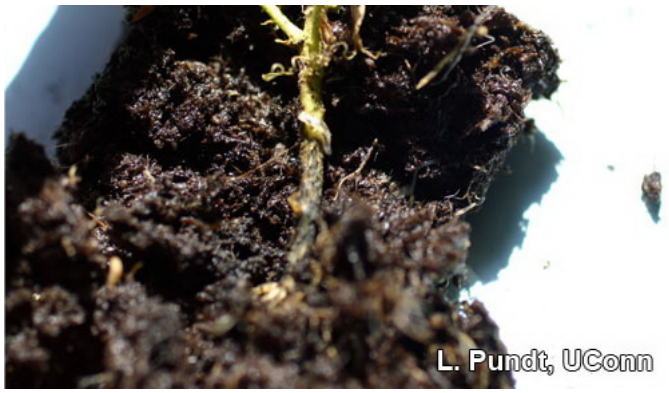
Repeat applications are usually needed. Growing medium temperatures must be 50-80°F with optimum tempera¬tures of 60-70°F. Irrigate the growing medium before and after applying nematodes. The nematodes require mois¬ture in order to move within the pores of the growing medium. Apply nematodes in the evening or on cloudy days because the nematodes are extremely sensitive to ultraviolet light desiccation. In general, beneficial nematodes are compatible with most pest control materials except for carbamate and organophosphate pesticides.

***Atheta coriaria* (Rove beetle):** The rove beetle is a generalist predator that feeds on fungus gnat and shore fly larvae and reportedly thrips pupae, in the growing medium. Adults are slender, dark brown to black and covered with hairs. The adults are 1/8 inch long with very short wing covers. They fly throughout the greenhouse from original release sites. Larvae are cream to brown in color, depending on age. Both stages inhabit cracks and crevices in the grow¬ing medium. Once established in a greenhouse, rove beetles may be present year-round although populations may fluctuate depending on fungus gnat populations. Because they are generalist feeders, they consume other natural enemies including H. miles. In addition, young rove beetle larvae may be fed upon by soil-dwelling predatory mites. Rove beetles are commercially available as adults from most biological control suppliers. Optimum temperatures are 65-80°F and relative humidity of 50-85%. Both adults and larvae are difficult to detect by scouting since they tend to hide in the cracks and crevices of growing medium. Rove beetles are compatible with beneficial nematodes.

Hunter Flies: Yellow sticky cards my trap hunter flies (Coenosia attenuata) adults, which either fly into unsprayed greenhouses during the growing season or are introduced on new plant material. Hunter fly adults resemble the common house fly adults. In addition to fungus gnat adults, hunter fly adults attack and feed on shore fly, whitefly and leafminer adults. Adult hunter flies only attack prey that are flying. The soil-dwelling larvae are also predaceous and feed on fungus gnat larvae and other insects in the growing medium.

Synacra paupera: This parasitoid may also be captured on sticky cards especially in unsprayed greenhouses. Females insert eggs into fungus gnat larvae which hatch and feed on the fungus gnat larvae. Parasitized fungus gnat larvae live until pupation, after which an adult *Synacra paupera* emerges. Their maximum rate of increase is higher than fungus gnat larvae at 73°F.

Pesticide Treatments. If insecticides are used for treatment, soil treatments (pot drenches and sprenches) directed toward the larval stage at the first sign of insect activity are best used to manage fungus gnats. Make sure material is applied to a depth of 1" or more. Materials are most effective when they are retained in the media. Keep this in mind when fertilizers, fungicides and water all need to be applied to plants. For example, if a fungicide and an insecticide is necessary, apply the fungicide first, then water it in with the insecticide. The fungicide will be moved into the root zone where it is needed and the insecticide will stay in the top where it is needed. Some insecticides are labeled for use on greenhouse floors and under benches in addition to treatments to pots. Carefully read and follow all label directions.



Fungus gnat larvae in soil. Photo: L. Pundt

Fungus gnats are common pests on plants such as geraniums, poinsettia, begonias and bulbs, especially if soilless mixes high in peat moss or immature compost are used. Insecticides may not affect eggs or pupae, and repeated applications may be necessary.

For a list of pesticides and more information on using biological control to manage fungus gnats see the current issue of the New England Greenhouse Floriculture Recommendation Guide (https://ag.umass.edu/greenhouse-floriculture/publications-resources/new-england-greenhouse-floriculture-guide).

Further Reading

- The University of California's factsheet on Fungus Gnats, Shore Flies, etc. (http://ipm.ucanr.edu/PMG/PESTNOTES/pn7448.html)
- Using Beneficial Nematodes to Manage Pests in Greenhouses (video at https://www.youtube.com/watch?v=Y67yhIIQdLU).

Ms. Smith is with the Univ. of Massachusetts Extension Greenhouse Crops and Floriculture Program Emeritus. From the ***Vegetable Notes for Vegetable Farmers in Massachusetts****, Univ. of Massachusetts Extension, Vol. 35, No. 3, March 16, 2023.*

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