VEGETABLE CROPS HOTLINE

A newsletter for commercial vegetable growers prepared by the Purdue University Cooperative Extension Service

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In This Issue

Tomato Leaf Mold Diseases

(Dan Egel, egel@purdue.edu, (812) 886-0198)

In 2015 and 2018, I observed Cercospora leaf mold of tomato in high tunnel operations. In Hotline articles in those years, I noted that Cercospora leaf mold is normally a subtropical disease. This disease has again been observed in 2021 on tomatoes in high tunnels. I'm still not certain of the importance of this disease or where it is coming from, but this article will compare Cercospora leaf mold and standard leaf mold of tomato.

Leaf mold of tomato is common in Indiana tomato production, especially in high tunnels and greenhouses. Leaf mold is caused by *Passalora fulva*. In contrast, Cercospora leaf mold is caused by *Pseudocercospora fuligena* and is more common in the warm, humid climate of the tropics or subtropics than in the Midwest. Both diseases cause chlorotic (yellow) lesions which are visible on the upper side of the leaf (Figure 1 and 2). The chlorotic area caused by Cercospora leaf mold is usually more of a mustard yellow than that caused by *P. fulva* leaf mold in which the lesions are a brighter yellow. Some literature suggests that *P. fulva* causes an olive-green growth only on the underside of tomato leaves. However, I have observed a green mold on both sides of leaves affected by leaf mold, in severe cases. Cercospora leaf mold can normally be differentiated from *P. fulva* leaf mold because the former is caused by a black fungus that grows primarily on the underside of the leaf (see Figures 3 and 4). Literature suggests that Cercospora leaf mold can occur on stems, however, I have never observed this. Leaf mold caused by *P. fulva* occurs only on leaves. Neither disease causes lesions on fruit. However, loss of foliage from either of these diseases can cause loss of yield or loss of fruit quality.

Figure 1. Leaf mold causes yellow areas on the top of tomato leaves.

Figure 2. On the underside of tomato leaves, leaf mold may cause a gray-green sporulation.

Figure 3. Cercospora leaf mold causes yellow lesions on the top of tomato leaves.

Figure 4. Cercospora leaf mold often causes a dark looking mold on the bottom of tomato leaves.

Both pathogens are reported to overwinter on crop residue in soil. The reason why leaf mold caused by *P. fulva* is more common in Indiana than Cercospora leaf mold caused by *P. fuligena* may be that the optimum temperature for leaf mold is 71° to 75° F, while the optimum for Cercospora leaf mold is 82° F. Both diseases may be managed by sanitation. Clean out high tunnel tomatoes between crops. A floor covering that prevents infected leaves from entering the soil will help lessen disease severity. Floor coverings should be cleaned and sanitized between seasons. In the field, practice crop rotation and till under the crop as soon as the last fruit is picked.

Varieties with partial or complete resistance exist for both diseases. Ask your seed representative.

Fungicides which control *P. fulva* leaf mold should help to lessen disease severity in *P. fuligena* Cercospora leaf mold. Products that have been effective for leaf mold include: products with the active ingredient mancozeb (e.g., Dithane®, Manzate®, Penncozeb®), Inspire Super®, Tanos® and Quadris Top®. See *The Midwest Vegetable Production Guide for Commercial Growers 2021* for more information. Be certain to watch the pre-harvest intervals. My experience with leaf mold has been that 2 to 3 applications of a fungicide once symptoms are observed should be enough to manage the disease. Fungicide applications can be stopped, in most cases, once harvest has started. If symptoms don't show up until harvest has started, the disease will probably not become severe enough to reduce yields or fruit quality of determinate tomato plants. Always be sure to choose a fungicide labeled for greenhouse use if necessary. And always read the label.

I am interested to know if Cercospora leaf mold is becoming more common in Indiana. Contact me if you think the description here matches what you have observed on your tomatoes. Or contact me if you have questions.

Late-season Insect Management in Veggies, Especially Tomatoes

(Elizabeth Long, eylong@purdue.edu, (765) 796-1918) & (Laura Ingwell, lingwell@purdue.edu, (765) 494-6167)

If you're like us, as the season winds down it may seem like your insect pest management efforts are beginning to look a bit more reactive and less preventative. We're hearing from growers that aphids, mites, caterpillars and stinkbugs are especially challenging in various veggie crops now, particularly tomatoes! In an attempt to ease some stress, here's a few tips about identifying the signs and symptoms of damage by these late-season pests, focusing on tomatoes.

Aphids

Remember that most aphids prefer to feed on the underside of leaves and on developing leaf tissue. Look for the aphids themselves, their shed exoskeletons (exuvia), or a shiny leaf surface where excess honeydew (aphid excrement) has been deposited. Aphids can be winged, or wingless. The main concern with aphid infestations is the transmission of plant pathogens and the cumulative loss of nutrients as they literally suck the fuel right out of the crop. However, you need not worry about pathogen transmission if infestations occur near harvest. If growing under cover (greenhouse, high tunnel, etc.), aphid populations can grow quickly and result in reduced fruit quality. The common aphid culprits on tomato are the green peach aphid and tomato/potato aphid. The former has a broad host range and can move from weed to crop to weed. The latter only feed on solanum crops and weeds (nightshades, tomato, pepper, potato and eggplant). If you have not been spraying a lot of insecticides throughout the season, you will likely find a variety of aphid natural enemies. Before making any applications to control aphids, take an inventory of the natural enemies that are present and evaluate their impact on the population. This can include flagging an infested plant, coming back 2-3 days later to see if that

population has grown and spread, or if it has remained the same. Natural enemies include the minute pirate bug (Figure 1), syrphid fly larvae (Figure 2), parasitoid wasps, lacewing larvae (Figure 3), and lady beetle adults and larvae (Figure 4). If a pesticide application is needed, using a product such as Beleaf® can target piercing-sucking pests, such as aphids, with minimal negative effects on beneficial natural enemies.

Figure 1. Minute pirate bug, Orius insidiosus. (Photo by John Obermeyer.)

Figure 2. Syrphid fly larva pictured with corn anthers. (Photo by John Obermeyer.)

Figure 3. Green lacewing larva. (Photo by John Obermeyer.)

Figure 4. Convergent ladybeetle larva. (Photo by John Obermeyer.)

Mites

This time of year two spotted spider mites can be one of the most threatening pests. They will feed on leaves and move onto the fruits themselves. They are very small and difficult to detect until the populations are at high levels, producing the visible webbing they use as a highway to move among the plants. For early identification, look for stippling on the upper surface of leaves (Figure 5). This symptom is the result of their feeding on and damage to individual cells of the leaf. In hot and dry conditions, especially if the plants are drought stressed, two spotted spider mite populations can grow rapidly. Again, flag any parts of the plant where you see the mites and watch for an increase in their damage on individual leaves or more symptoms on surrounding leaves. There are a number of mite natural enemies (including other predatory mites) that may be present and suppressing the spider mite population. If you see that damage is worsening and have many weeks of production left, or young susceptible plants next to the infested crop, make an application of a miticide. Spider mites have a wide host range and can feed on multiple crop and weed plants. If there are only 1-2 weeks left in your production, then a treatment is likely not necessary.

Figure 5. Stippling symptom resulting from spider mite feeding on the underside of the leaf.

Caterpillars

There are several kinds of caterpillars that may feed on tomato

leaves and fruits, including tomato hornworm, armyworms, and earworms/fruitworms. These caterpillars can be devastating, especially in high tunnels – they may eat lots of foliage from plants, reducing plant vigor, bore directly into ripe or unripe fruit, and several species produce large amounts of frass (insect poo) that accumulates in fruit wounds and is just plain unsightly (Figures 6a,b). If you have caterpillars in your tomato crop, you are likely to identify their symptoms easily: look for large, open holes in leaves and open wounds (sometimes with the culprit present!) in fruits. Signs of caterpillars may be a bit trickier as some caterpillars are experts at camouflage and may hide in plain sign. However, because they usually eat a lot, they produce a lot of waste (a key sign!), so you can follow their trail of frass to where they are on the plant. Be sure to get a confirmation on the ID of caterpillars in your crop and follow the appropriate scouting and action thresholds before applying an insecticide. As with other pest insects, caterpillars have a suite of natural enemies that attack them, particularly parasitoid wasps and predatory stink bugs, and by limiting excessive sprays against caterpillars, you can reduce flare-ups of secondary pests, like mites and aphids. If applications are warranted, there are many *Bacillus thuringiensis* (Bt) products (such as DiPel® or Agree®) that are effective against most of these species and target only lepidopterans (butterflies and moths).

Figure 6a. Yellow striped armyworm feeding in a tomato. (Photo by E.Y. Long)

Figure 6b. Yellow striped armyworm feeding damage and frass on tomatoes. (Photo by E.Y. Long)

Stinkbugs

Stinkbugs are piercing-sucking feeders that cause cosmetic damage and reductions in tomato fruit quality, particularly in tomato varieties destined for solid-pack or fresh market. Fruits that have been damaged by stinkbugs are still safe to eat, but they may not look as appealing (Figure 7). You are more likely to see stinkbug damage than the stinkbugs themselves on your tomatoes – although if you search you may certainly find them! The stinkbugs that are most likely to be feeding on your tomato crop are the one-spotted stink bug and the brown marmorated stink bug. Both nymphs and adults of these stinkbugs may feed on green or red fruits, and feeding damage may not be obvious until harvest. Look for needle-pin like spots on the surface of green fruits, but note that a faint, white ring will appear around feeding spots on red (ripe) tomatoes. Stinkbugs also have their natural enemies, including parasitoid wasps, other predatory bugs and stinkbugs, and spiders. Insecticide applications are more likely to be needed in solid-pack or fresh market plantings, and if they are needed growers can use organic products such as kaolin clay or insecticidal soap, or a range of synthetic active ingredients. It is important to get good coverage of and penetration into the plant canopy- if possible apply products with ground equipment because they provide better coverage into the plant canopy and soil beneath plants.

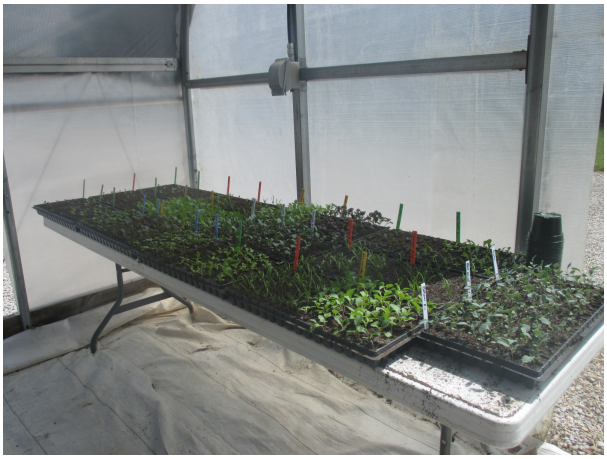
Figure 7. One-spotted stink bug on tomato. (Photo by E.Y. Long)

Please consult the *Midwest Vegetable Production Guide* (mwveguide.org) for spray recommendations and note that we have updated filters in the search so if you are growing under cover you can select only products allowed in a greenhouse, or only organic (OMRI) approved, etc. And as always, the label is the law.

Heat Effects on Cool-season Vegetables

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198) & *(Liz Maynard, emaynard@purdue.edu, (219) 548-3674)*

As warm-season crops are harvested, many vegetable farmers start the process of transitioning to cool-season crops. Leafy greens and root vegetables are ready to be planted. High temperature is present across the state recently. The heat stress may affect germination and growth of some of the vegetables.



Cool-season vegetable transplants are growing in the corner of a high tunnel.

Spinach is probably one of the most heat-sensitive crops in seed germination. Although studies show spinach seeds can germinate at temperatures from 40 to 86° F, optimum germination occurs at approximately 70° F. Germination rate drops abruptly above 75° F. Lettuce seed germination is also heat sensitive. Some cultivars have better heat tolerance than others, but in general, germination rate is reduced with temperatures above 75° F. Seed germination of many leafy greens in the Brassica family such as mustard, pac choi and kale have better heat tolerance in general, and there are cultivars that can grow well under heat. Swiss chard is in the same family as spinach, but it can stand better under high temperatures. If spinach and lettuce have to be planted under the recent heat, it is critical to apply irrigation frequently as a cooling approach, and germinate the seeds under shade if it is possible.

Vegetative growth of Brussel sprouts, cabbage and broccoli can occur under a wide range of temperatures and in general, can grow well under the heat. However, head or sprout formation of these crops is sensitive to heat stress. Seedlings of beet can grow at warmer temperatures, but the roots develop rapidly under heat and become lignified and fibrous. Foliage growth of carrot can tolerate high temperatures, but roots tend to be short and stubby and develop strong flavors.

Root-knot Nematode on Vegetable Crops

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

Root-knot nematodes (RKN) are a devasting soilborne pest on a wide range of vegetables and fruits. They are most active in well-aerated soils and they like warm weather. Increasingly, we saw this pest in our regions. Root-knot nematode infections result in root swellings called galls, and heavily infected crops by RKN display aboveground symptoms such as stunted growth, wilting, and leaf yellowing. Read this article to learn more about RKN damage.

As part of a federally funded research project, our extension team and nematology lab at Purdue are trying to understand the extent of damage caused by root-knot nematode on vegetable crops in Indiana, as well as identify the RKN species that exist in our region. This effort will help us develop effective management approaches. If you suspect you have RKN problem on your vegetable crops, please contact Wenjing Guan (guan40@purdue.edu) or Dan Egel (egel@purdue.edu). Our phone number is (812) 886-0198. Thank you.

Root-knot nematode damage on watermelon includes the galls on the roots seen here. The vines may be stunted and the yields may be reduced. Photo: Dan Egel

Drought Intensifying Across Central Indiana

(Beth Hall, hall556@purdue.edu)

A lack of abundant precipitation over the past month has caused abnormally dry conditions to expand across Indiana this week with several counties in central Indiana intensifying to the *Moderate Drought* stage of the US Drought Monitor (Figure 1). Some intense weather systems passed through the state this week (Figure 2), however, this was not enough to fully alleviate the deficit that has been building up over the past 30 days. Figure 3 shows the percent of the climatological normal amount of precipitation that was received over the recent 30-day period. Note areas in red that indicate the precipitation received this year for that period was similar to the 10th to 25th percentile of the driest amounts recorded from 1991 through 2020 for that same period of time. In other words, that is very dry. According to the National Oceanic and Atmospheric Administration, east-central Indiana would need three to six inches of rain to bring the Palmer Drought Index back to within normal ranges; most of the rest of Indiana would need up to three inches (https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/addpcp.gif).

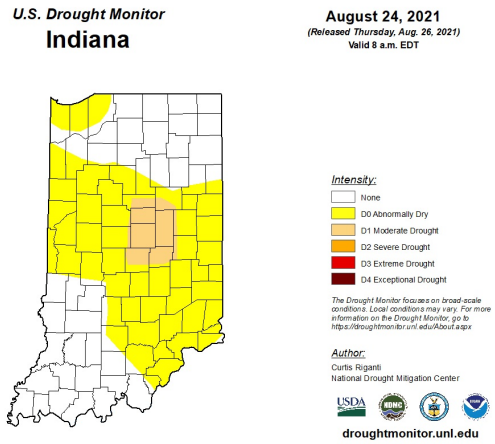


Figure 1. US Drought Monitor conditions for Indiana as of 24 August 2021.

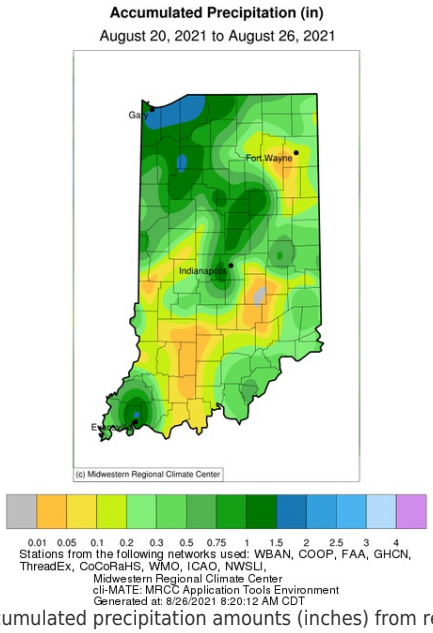


Figure 2. Accumulated precipitation amounts (inches) from reported from August 20-26, 2021.

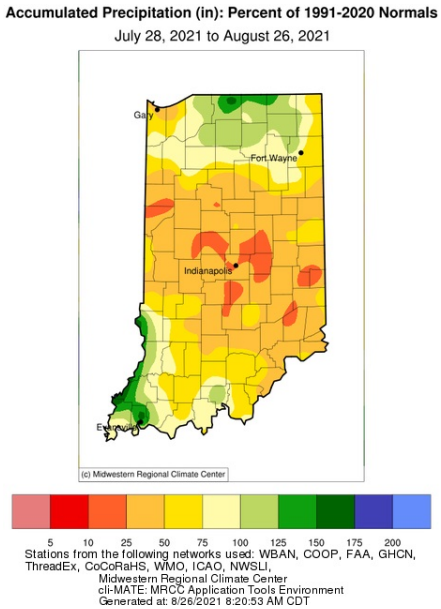


Figure 3. Precipitation from July 28, 2021 through August 26, 2021 presented as the percentage of the 1991-2020 climatological normal period.

The warm temperatures, along with very high amounts of water vapor (humidity), have made this week uncomfortably muggy.

There was hope that this mugginess would be behind us, but weather patterns and high tropical storm activity has kept above-average humidity lingering. Accumulated growing degree days now range from about 2300 units in northern Indiana to a little over 2900 units in southern Indiana (Figure 4). Figures 5 and 6 show how these degree-day accumulations compare to climatology and recent years, respectively.

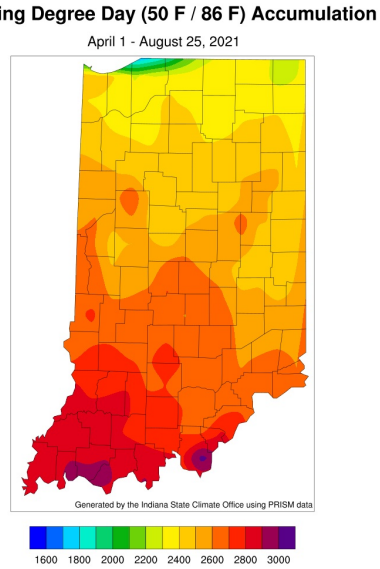


Figure 4. Accumulated modified growing degree days for April 1 through August 25, 2021.

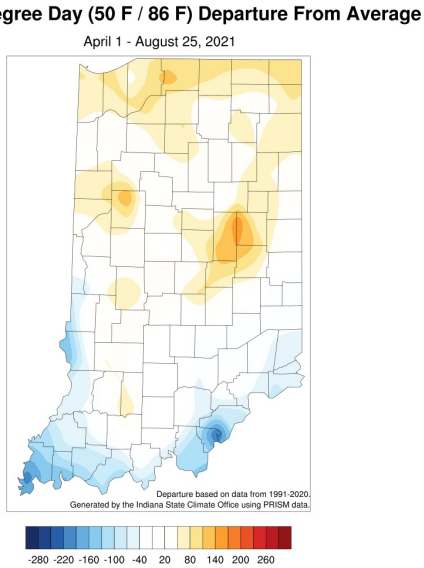


Figure 5. Accumulated modified growing degree day departure from the 1991-2020 climatological average for April 1 through August 25, 2021.

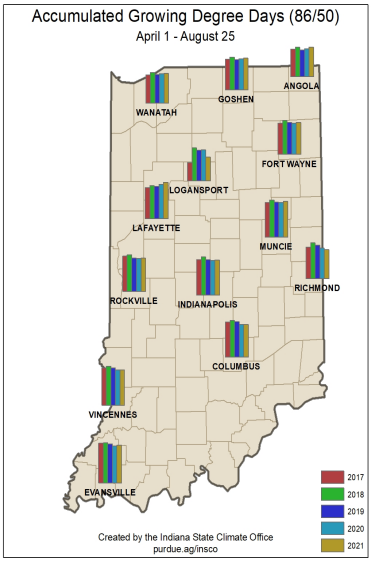


Figure 6. Comparison of 2021 modified growing degree day accumulations from April 1 – August 25 to the past four years.

Resources for Biopesticides for Vegetable Disease Management

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

Dr. Margaret McGrath's lab from Cornell University has developed a great resource for growers interested in using biopesticides to manage vegetable diseases.
https://www.vegetables.cornell.edu/ipm/diseases/biopesticides/

This article provides a general introduction of biopesticides, major types of biopesticides, and the pros and cons of using them. The website also lists representative biopesticide products that are available for managing diseases of major vegetable groups. Information include active ingredient, Organic Materials Review Institute (OMRI) status, and targeted diseases of each product.

USDA Accepting Applications to Help Cover Costs for Organic Certification

Organic producers and handlers can now apply for U.S. Department of Agriculture (USDA) funds to assist with the cost of receiving or maintaining organic certification. Applications for the Organic Certification Cost Share Program (OCCSP) are due Nov. 1, 2021.

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