VEGETABLE CROPS HOTLINE

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

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In This Issue

Cucumber Beetles Just Don't Quit!

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This time of year you are likely getting bogged down in the fight against pests. The accumulation of plant pathogens, insects, and climatic conditions favoring their growth can make the last few weeks of harvest feel like the toughest point in the battle. For cucurbit growers in particular, there are a number of insect pests that are quite a nuisance. Three different beetle species are likely honing in on your ripening fruits and they may cause some significant aesthetic damage to the rind of your pumpkins, melons, and squash. This damage can also provide an entry to secondary pathogen infections that may destroy your crop. The culprits are the striped cucumber beetle (*Acalymma vitattum*; Figure 1), the spotted cucumber beetle (*Diabrotica undecimpunctata*; Figure 2), and the Western Corn Rootworm (*Diabrotica virgifera virgifera*; Figure 3). The bacterial pathogen that these beetles can transmit is no longer something to worry about, so close to harvest. But their feeding damage may be (Figure 4). At this point, pests are concentrating on the resources at hand. The striped cucumber beetles that you are seeing will find a cozy place to overwinter across the state, often in field margins, ditches or perhaps even forest edges. The spotted beetles will die off and have to make their journey north all over again next year. As for the corn rootworm, they will leave your veggies alone and move back to their preferred host next year. They are not nearly as numerous in our vegetable crops and honestly we don't know much about how they impact them. We do know how to manage them in our field crops though (but you will have to talk to a different Entomologist about that one, I can share his number!).

Figure 1. Striped cucumber beetle on watermelon leaf.

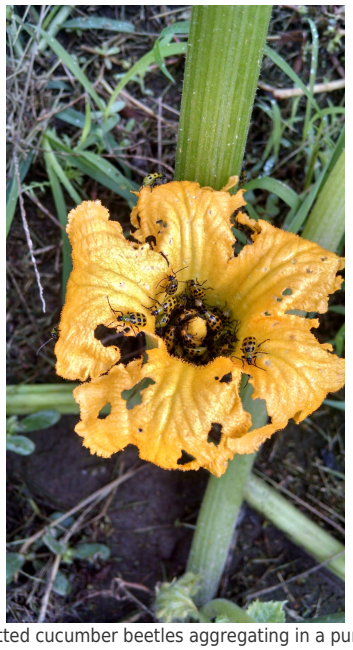

Figure 2. Spotted cucumber beetles aggregating in a pumpkin flower.

Figure 3. Western corn rootworm on a pumpkin flower.

Figure 4. Feeding damage resulting from beetles chewing on the rind (photo by Wenjing Guan)

What can you do?

I would like to answer with harvest what you can and leave a few to the beetles, but I know that is unsatisfactory and not helpful at all. If your crop is going to be in the field much longer and you are concerned about economic loss as a result of their feeding, then be sure to look closely at the pre-harvest interval (PHI) when selecting an insecticide. Exposure of pollinators is also something that needs to be considered. While you will not be harvesting from the flowers that are open in the field right now, they are still a valuable resource for pollinators. For a more complete list of your options check out the *Midwest Vegetable Production Guide* (mwveguide.org). Some products include Harvanta® (PHI: 1-d), Mustang Maxx® (PHI: 1-d). To decrease the exposure of pollinators to any of the products you may apply, do so late in the day/evening when flowers are closed and bees are not as active.

Phytophthora Blight of Cucurbits

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

Phytophthora blight was a serious disease this past season. As a result, I have had many questions about managing this disease. The following article is an update of a previous article on this subject. The questions I have been asked have ranged from what do I spray to how does this disease work? Therefore, I have written an article about the symptoms, biology and management of Phytophthora blight. I will concentrate on Phytophthora blight of cucurbits, but this disease is also a very serious problem on peppers. In the following article, I will outline some of the information I think it is important to know about this important disease.

Phytophthora blight-symptoms

Phytophthora blight symptoms may be observed on all above-ground parts of a cucurbit plant. However, cucumbers and watermelons usually have symptoms on fruit, but not on foliage. On the other hand, lesions readily form on the leaves and stems of pumpkins and squash (Figure 1). Cantaloupe, while perhaps less sensitive to Phytophthora blight than the other hosts listed here, may have symptoms on foliage or fruit.

Figure 1. Phytophthora blight symptoms can be observed on the pumpkin fruit as a white mold and on the leaf that is in contact with the fruit as a brown, necrotic area.

Lesions on leaves often start out a light green, sunken area that may be wedge shaped, becoming wider toward the margin of the leaf. With time, the lesions become necrotic. Stem lesions may cause the vine to wilt from the constricted area out toward the end of the vine (Figure 2). Lesions on fruit vary depending on the host. Lesions on watermelon are often round, water-soaked and may appear as a bruise (Figure 3). Under moist conditions, these lesions are covered with a white mold, caused the growth of *P. capsici*. Lesions on fruit may be more common on the underside of the fruit where moisture accumulates or where the fruit has sat in water (Figure 4) lesions on pumpkin may be large and occur in no particular shape. Fruit lesions that appear on the top of the fruit may be due to spread of the fungus-like organisms splashed from standing water or another lesion. Phytophthora blight may also cause damping-off of seedlings.

Figure 2. Phytophthora blight has caused a brown lesion on the squash stem.

Figure 3. Phytophthora blight has caused the round bruised-like areas on the watermelon.

Figure 4. Phytophthora blight symptoms on this watermelon, a water-soaked rot and white mold, occur on the bottom of the fruit.

Symptoms caused by Phytophthora blight may appear similar to other diseases. For example, Pythium may also cause damping-off; often it is not easy to tell the difference between damping-off caused by Pythium and Phytophthora blight. Fusarium fruit rot of pumpkin may cause a white mold on pumpkin fruit similar to Phytophthora blight. Fusarium fruit rot lesions on pumpkin tend to appear drier compared to lesions caused by Phytophthora blight. White mold of pumpkin may be mistaken for Phytophthora blight; however, the former disease is accompanied by irregularly shaped, dark fungal bodies. Gummy stem blight or Plectosporium blight may cause stem lesions that could be confused with Phytophthora blight.

While experienced growers may learn to recognize symptoms of Phytophthora blight, if there is any doubt, it is always good to send lesions to the **Purdue Plant and Pest Diagnostic Laboratory .**

Phytophthora blight-biology

Phytophthora blight is caused by a fungus-like organism known as *Phytophthora capsici*. Even when I was in graduate school in the 1980's, my professors told us that we would discuss *Phytophthora* and related organisms in our fungus taxonomy class even though these organisms are more closely related to brown algae than to fungi. This is why we refer to the organisms that cause Phytophthora blight and downy mildew as fungus-like organisms. They are similar to fungi, but taxonomically distinct.

I promise not to bore you with a detailed taxonomy of these organisms. But the taxonomy of *Phytophthora capsici* is important.

1. We will discuss how Phytophthora blight is favored by heavy rains, standing water and poorly drained fields. This makes sense when one remembers that this fungus-like organism is closely related to brown algae, an organism that lives in water. Sometimes you will hear Phytophthora and related organisms called 'water molds'.
2. The fungicides that are most effective against Phytophthora blight and downy mildew are often not the same products that are effective against, for example, anthracnose and powdery mildew. This is because anthracnose and powdery mildew are caused by true fungi; Phytophthora blight and downy mildew are not really fungi and have different biochemistries than fungi.

Although much of Indiana was relatively dry this year, the rain that fell was often in large amounts causing occasional standing water in fields. Each time water stood in fields, the population of the Phytophthora fungus-like organism in the soil increased. The result was excellent conditions for Phytophthora blight.

Phytophthora capsici has a rather large host range. In addition to causing disease on all cucurbits, Phytophthora blight can cause disease on pepper, tomato, eggplant as well as snap beans and lima beans. Pepper plants are particularly susceptible to *Phytophthora capsici.* While tomato plants do not usually have as severe symptoms as cucurbits or pepper, Buckeye rot of tomato fruit can be caused by *Phytophthora capsici* as well as by additional species of *Phytophthora.* Artificial inoculations in a greenhouse have resulted in Phytophthora blight symptoms on spinach, radish, turnip, onion and carrot. The common purslane, jimson weed and nightshade are among the weed hosts for *Phytophthora capsici.* Since many plants are susceptible to *Phytophthora capsici,* it is difficult to use crop rotation as an effective means of managing Phytophthora blight. I have had growers complain about a vegetable crop with Phytophthora blight in a field which hadn't had, for example, pumpkins in many years. Part of the reason that Phytophthora blight can occur in such situations is the large host range described here. (Phytophthora root rot and stem rot of soybean is caused by *Phytophthora sojae,* a different organism than the one described here.)

Another reason that crop rotation is not always effective against Phytophthora blight is because of the long-lasting spores that this fungus possesses. It turns out that there are two mating types of *Phytophthora capsici.* If both mating types are present in a field, which is common, a spore type known as an oospore may form. Oospores may survive 10 years or more in the absence of any host. Crop rotations of at least 4 years without a susceptible host are recommended. However, oospores may survive longer than 4 years. The combination of a large host range and resilient spores means that crop rotation is not usually recommended as a stand-alone management technique.

The long-lived oospore isn't the only spore type for *Phytophthora capsici.* A spore type known as sporangia may form when the temperature and moisture conditions are right. Sporangia look like balloons on stalks. In the presence of water, each sporangium may break open to release 20 to 40 zoospores. Zoospores are motile and can swim to cause another infection. Zoospores may also be splashed from leaf to leaf or from plant to plant. One of the recommendations for Phytophthora blight is to manage water: avoid poorly drained fields, use raised beds, avoid overhead irrigation. The motile zoospores and

taxonomic relationship to the brown algae are some of the biological relationships that go into making those recommendations.

Temperature and relative humidity are additional factors in understanding the biology of any plant/ pathogen system. Using cucumber fruit, 77°F was the best temperature for lesion formation. However, lesions formed on cucumber from 59°F to 86°F. Lesions formed on cucumbers from 35 to 100 percent relative humidity. Phytophthora blight may cause disease, therefore, under a great range of environmental conditions.

Phytophthora blight management

Management of Phytophthora blight with fungicides is not possible unless cultural methods are also put into place. Even the best management schemes, chemical and cultural, may fail to control Phytophthora blight completely when weather conditions are conducive to the disease. Therefore, cultural management methods will be discussed first.

Water management is perhaps the most important control measure for Phytophthora blight. If possible, choose fields with well drained soils. At best, such fields will have soils sufficiently light so that rains seep into the field shortly after each rain. If the soils are relatively heavy, hopefully there are no areas where water ponds after a rain. Even a few such areas are likely to be hot spots where Phytophthora blight can start. Once the disease has a foothold, Phytophthora blight can quickly work its way across a field, splashing from plant to plant.

Plants on raised beds are less likely to have the crown area under water after heavy rains. The use of drip irrigation instead of overhead irrigation, if possible, will help to reduce spread of the disease. Overhead irrigation, if used, should be applied so that the leaf surfaces dries before dew formation. Under no circumstances should irrigation water be allowed to stand in the field.

The use of a no-till situation such as for pumpkin or squash planted into a wheat cover crop may reduce splash dispersal of the *P. capsici* spores and generally seems to keep the surface of pumpkins clean. However, if wheat or rye tend to keep the soil wet, then Phytophthora may be a problem. Soil type and density of the cover crop are important factors.

It is not clear whether plastic mulch favors Phytophthora blight or not. On the one hand, plastic mulch can act as a barrier to soil which may harbor *P. capsici.* On the other hand, water may readily pool on the plastic; such pools may contain *P. capsici* which may then splash up into the canopy with the next rain. Perhaps plastic mulch that is well fitted to slightly domed beds will act as a management tool for Phytophthora blight. Beds that are domed will help prevent water from standing on plastic mulch.

Since *P. capsici* spores may survive in surface water, a pond used for irrigation may spread *P. capsici* if a vegetable field with Phytophthora blight drained into that pond. A field with Phytophthora blight that drains into a river or stream may lead to spread of the disease in a field downstream.

There are no cultivars with host resistance to Phytophthora blight in cucurbits. Through experience, however, growers may learn what varieties are very susceptible and should be avoided.

Another feature of the Phytophthora blight organism is its potential to survive a long time in the soil. Most specialists recommend at least a 4-year crop rotation before planting a cucurbit crop. In the meantime, avoid susceptible crops such as tomatoes, peppers and green beans (see biology section).

Fungicides are an important part of most management schemes for cucurbit Phytophthora blight. However, under conducive weather conditions and in the absence of the cultural controls mentioned above, fungicides will be ineffective. In addition, some strains of *P. capsici* have been shown to be resistant to select fungicides.

While cucumber and watermelon fruit are very susceptible to Phytophthora blight, the foliage is not usually affected. In contrast, pumpkin and squash fruit and foliage are susceptible to Phytophthora blight. Therefore, cucumber and watermelon fruit need to be protected by fungicides, while pumpkin and squash foliage and fruit need to be protected. Cantaloupe foliage and fruit may be symptomatic, but this crop doesn't seem as susceptible as the other crops mentioned here.

Fungicides should be applied to pickling cucumber when fruit are 1, 2 and 3 inches long in addition to applications before and after significant rain events. Watermelon should have a preventative fungicide application at softball stage and approximately weekly thereafter.

Effective fungicides include:

- Zampro®
- Revus 2.08 SC®
- Elumin®
- Presido 4FL®
- Ranman®
- Ridomil Gold® – Since strains of the Phytophthora blight fungus that are resistant to Ridomil might be present, be sure to alternate this product with others with different modes of action.
- Orondis® products (Orondis Ultra® and Orondis Ridomil Gold®). Do not follow a soil application of Orondis Ridomil Gold® with foliar applications of either Orondis Ultra® or Orondis Opti®. Orondis Ultra® and Orondis Ridomil Gold® are combinations of two different systemic active ingredients.
- The use of Actigard®, Forum® and products with phosphite as an active ingredient (e.g., Agri-Phos®, Confine Extra®, Phostrol®, Rampart®) in spray programs early in the rotation can be helpful. For example, it might make sense to apply one of these products when watermelons are softball size.
- The products Gavel® and Zing!® are premixes of the systemic active ingredient zoxamide and the contacts mancozeb and chlorothalonil, respectively. These products may be useful because the combination of systemic and contact active ingredients can help manage fungicide resistance.

It is essential that one use products in such a way as to alternate FRAC codes. Use several different modes of action in a year if possible. In addition, some of these products have restrictions on how many times they can be used in a season. Re-entry periods and pre-harvest intervals should be noted on the label. For the most part, these products will not be useful controlling foliar diseases such as gummy stem blight, powdery mildew or anthracnose. Some of the products listed as effective against Phytophthora blight may also be effective against downy mildew. However, downy mildew is not present every year in Indiana.

In 2017, a research study looked at several different alternations of products for the management of Phytophthora blight of watermelon. Alternations which proved useful included:

- Zampro® alternated with either Orondis Gold® or Orondis Opti® (note that Orondis Ultra® and Zampro® cannot be alternated because both have a group 40.
- Revus® alternated with Presidio®.
- Actigard® followed by Ranman® tank mixed with Ridomil Gold®,

followed by Presidio®, followed by Elumin®, followed by an Orondis® product. Although this scheme is complicated, in general, alternations with lots of FRAC groups are a good idea.

None of the alternation schemes had more than 5 applications.

Phytophthora blight can be serious and difficult to control because it is a foliar disease caused by an organism that survives years in the soil in the absence of a host. Many foliar diseases do not survive for long periods without a host; an example would be anthracnose of watermelon which may spread rapidly across a field, but survives in crop residue-not as a resilient spore. Fusarium wilt of watermelon, in contrast, is a soil borne disease that can survive for years in the soil, but does not spread across the field in one season. Because Phytophthora blight is a foliar disease caused by an organism that survives well in the soil, management can be a challenge in years when the weather is conducive to this important disease.

A recent extension bulletin on Phytophthora blight can be found here.

Tips for Managing Tomato Spotted Wilt Virus (TSWV)

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Tomato spotted wilt virus (TSWV) is a plant disease caused by a virus that infects more than 1,000 species of plants, including ornamentals and vegetables. Visual symptoms of TSWV vary depending on the plant that is infected, but general characteristics include yellow or brown ringspots on fruit and small, dark-colored ringspots on foliage that may make the entire leaf appear bronzed in severe cases (Figure 1). The virus is moved (vectored) from plant to plant by the piercing-sucking feeding of tiny insects called thrips. So, managing this disease requires strong and continued efforts to: (1) manage the source of the virus (other plants that are already infected), and (2) manage thrips, which move the virus from infected plants to healthy plants.

Figure 1. TSWV symptoms on a tomato plant and fruit.

The insect that moves TSWV from plant to plant: Thrips

1. Thrips feed on plants by puncturing the outer layer of leaf cells and sucking up the contents, which results in silvering, stippling, and discolored flecking of the surface (Figure 2 and 3). Thrips feeding may also cause leaves and flowers to be deformed in appearance.

Figure 2. Silvering and flecking caused by thrips feeding on tomato leaves.

Figure 3. Feeding damage from thrips on tomato fruit.

2. Larval (immature) thrips are the only life stage that can acquire ("pick up") TSWV when they feed on infected plants, but adult thrips are the only life stage that can transmit (spread) the virus to new plants. This means adults can only infect healthy plants if they fed on an infected plant as a larva. TSWV is not transmitted vertically from adult thrips to offspring.

Figure 4. The two nymphal stages of thrips: smaller, first instar (on right) and larger, second instar (on left). Photo credit: John Obermeyer.

3. Thrips lay their eggs inside leaves or flower petals where they are difficult to reach with insecticides. Once eggs hatch, the larvae often remain in protected areas, like inside flower buds or within leaves at the top of the plant. After two larval stages (Figure 4), thrips move down to the soil or leaf litter and enter a pupal stage where they are inactive (no feeding and almost no movement) (Figure 5). During this phase, the insects are not managed by insecticides that are directed at the leaves.

Adult thrips live for 30-45 days and can lay 150-300 eggs. The development from egg to adult ranges from 7.5 – 13 days depending on temperature; warmer temperatures = faster development.

4. Several species of thrips transmit TSWV, but the most important ones are the western flower thrips, tobacco thrips, and onion thrips. Because thrips are so tiny, they can be carried by the wind from surrounding areas or on your clothing as you move from outdoor to indoor environments.

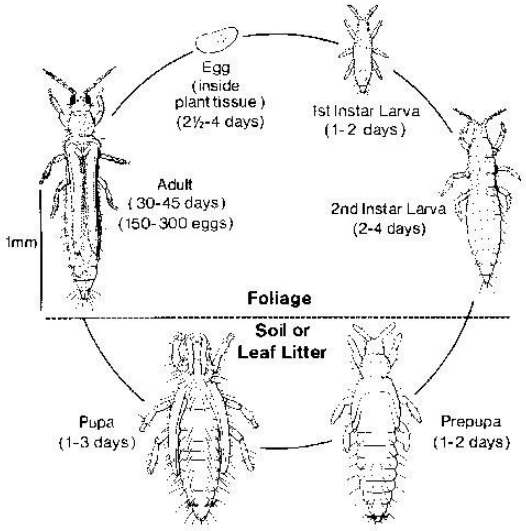

Figure 17

Figure 5. Diagram of the thrips life cycle. Image adapted from http://vegetablemdonline.ppath.cornell.edu/factsheets/Virus_SpottedWilt.htm

Keeping TSWV out of your greenhouse

1. Start with healthy, virus-free plants and **inspect all incoming plant material for TSWV symptoms and thrips infestation.** Vegetatively-propagated ornamentals can be an important source of TSWV! For example, you could accidently introduce TSWV into your greenhouse from propagated plants or transplant seedlings that are already infected, then once thrips arrive, they will spread the virus to other plants in the greenhouse. *Do not buy vegetable starts that are produced in the same greenhouse as ornamentals.* Seed transmission is not considered important for spread of this disease.

2. **Manage weeds, both inside and around your greenhouse because they are an important source of the virus each year (Table 1).** Many perennial ornamentals and weeds can be infected by TSWV and these plants can become a source of the virus at any given time during the current or following year.

Table 1. Partial Host Range of Tomato Spotted Wilt Virus[1]

Ornamentals			
African violet	Columbine	Geranium	Poppy
Amaryllis	Cosmos	Gladiolus	Primrose
Anemone	Cyclamen	Gloxinia	Ranunculus
Aster	Dahlia	Impatiens	Salvia
Begonia	Delphinium	Larkspur	Snapdragon
Calendula	Dusty miller	Marigold	Statice
Calla	Exacum	Nasturtium	Stock
Chrysanthemum	Fuchsia	Peony	Verbena
Cineraria	Gaillardia	Petunia	Zinnia
Vegetables			
Bean	Celery	Kale	Pepper
Broccoli	Cowpea	Lettuce	Potato
Cabbage	Cucumber	Pea	Spinach
Cauliflower	Eggplant	Peanut	Tomato
Weeds			
Burdock	Curly dock	Lambsquarter	Pigweed
Buttercup	Field bindweed	Morning glory	Shepherdspurse
Chickweed	Jimsonweed	Nightshade	Wild tobacco
Clover			

[1]Table modified from Putnam and Dutky, *Tomato Spotted Wilt Virus,* Maryland Department of Agriculture.

3. **Once TSWV is confirmed in your greenhouse, remove and destroy all infected plants** because they cannot be cured and will serve as a source of new infections.

What to do RIGHT NOW

Although the growing season is winding down, you still need to keep your guard up, especially in controlled environments.

1. Sanitation! Remove and destroy all plant material from this year's crop ***promptly***, as soon as you are done harvesting. This is especially important if you have confirmed TSWV and thrips in your crop. Physically remove all old crops from controlled environments and destroy them away from the controlled environment by plowing, disking, etc. Whether a field or controlled environment, allow ground to lay fallow for 2-3 weeks if possible to break the life cycle of any remaining thrips.

2. Manage (i.e. remove) all weeds within and around the space (Figure 6). Almost all of the weed species that are commonly encountered in Indiana can host these pests, and many of these weeds have been reported to host the virus as well, including nightshade, morning glory, lambsquarter, clover, chickweed, and the list goes on (Table 1). Any weeds that overwinter in your high tunnel or greenhouse have the potential to host both the insects and the pathogens they transmit. Remove the weeds and leave the structure open throughout the winter if possible.

Figure 6. Weeds within and between high tunnels that can harbor both the insect and the virus.

To Prepare for Next Year

1. Variety selection can be key for managing TSWV. If possible, select a tomato variety that is resistant to this virus.

2. Look at your insecticide regime and be sure that you are rotating products. Thrips and mites both develop resistance quickly to insecticides. It may be necessary to invest in some different products to break the thrips life cycle. Be sure that you refer to the IRAC code (Insecticide Resistance Action Committee). These codes have been established, in part, for growers to easily select chemistries that have different modes of action (in other words, the way it works to kill the pest). To reduce the development of resistance, do not make more than two applications of the same product (IRAC code) in a row. Table 2 is a list derived from the Midwest Vegetable Production Guide (mwveguide.org) with insecticides that *are allowed* for high tunnel/greenhouse use in Indiana.

Table 2. Pesticides allowed in high tunnel production for control of thrips on tomato.

Trade Name	Active Ingredient	REI[1] (hr)	PHI[2] (days)	IRAC[3] code
Admire Pro	Imidacloprid	12	21	4A
Azera	Azadiracthin & pyrethrins	12	0	UN/3A
Baythroid	Beta-cyfluthrin	12	0	3A
Brigade	Bifenthrin	12	1-tomato, 7-pepper	3A
Entrust	Spinosad	4	1	5
Exirel	cyantraniliprole	12	1	28
Minecto Pro	Abamectin & cyantraniliprole	12	1	6,28
Mustang Maxx	Zeta-cypermethrin	12	1	3A
Rimon	novaluron	12	1	15
Torac	Tolfenpyrad	12	1	21A
Venom	Dinotefuran	12	21 soil, 1 foliar	4A
Warrior II*	Lambda-cyhalothrin	24	5	3A

* Not for use against Western Flower thrips
[1]REI = Re-entry interval
[2]PHI = Pre-harvest interval
[3]IRAC = Insecticide Resistance Action Committee

3. Consider incorporating a beneficial organism to prey on the soil-dwelling stages of thrips. This should be considered in the off-season as it will take time to find a supplier and determine their ordering and shipping deadlines. You should plan to incorporate these organisms early in the season (prior to, or at the first sight of thrips). Two commonly available options include predatory soil-dwelling mites (*Stratiolaelaps scimitus*) and entomopathogenic nematodes (nematodes that eat insects, *Steinernema* spp.). Chemistries such as novaluron, spinosad, tolfenpyrad and acetamiprid applied in the soil as a drench or drip are compatible with the predatory mite species (i.e. the chemical won't destroy the population of beneficial mites). Bifenthrin, imidacloprid and lambda-cyhalothrin have been reported as non-toxic and safe to use with entomopathogenic nematodes. Various suppliers of beneficial insects have an interactive tool on their website to look at the impacts of a chemical product on the beneficial organism.

Figure 7. Orius insidiosus, a native insect in Indiana that feeds on thrips.

4. Using reflective mulches under plants can reduce TSWV infection by repelling thrips.

During the Growing Season

1. Monitor for the presence of thrips by placing yellow sticky cards just above the crop canopy (Figure 8 and 9). It is recommended to place 1 sticky card per 1000 square feet, as well as near doors and air vents to monitor the movement of thrips from outside. Check sticky cards every week and record the number of thrips captured to monitor population levels and inform management decisions.

Figure 8. Several thrips (designated with arrows) captured on a yellow stick card. Image from Cornell University, J. P. Sanderson

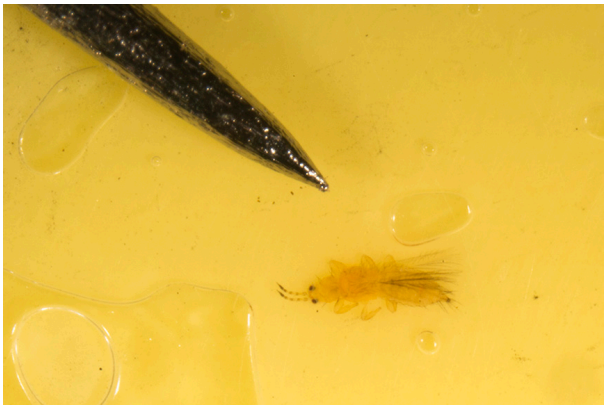
Figure 9. Close up of adult thrips captured on a yellow sticky card. Photo by John Obermeyer.

2. Spray insecticides in the morning, when thrips are most active. Five-day insecticide application intervals are more effective than 7-day intervals in reducing thrips infestation. Follow a rotation plan when applying insecticides to prevent the development of resistance.

3. Follow the label closely. Many products kill the insect by coming into contact directly so adequate coverage and rates of application are crucial to get the most out of a product. If possible, apply insecticides

with equipment that produces very small spray particles that will penetrate foliage and flowers to provide the best coverage. *Note: Some insecticides may damage certain plants so please read and follow all label instructions*

4. Protect plants early, when they are young and most vulnerable which is also when thrips populations tend to be lower and you have a better chance of getting them under control.

5. Continue to manage weeds. They can be a continuous source of pests (the insects and the virus) during the growing season, either between planting dates or even between applications of a chemical.

6. For TSWV in particular, if infection rates are low (only a few plants) and it is early in the season it is advantageous to remove infected plants to reduce the spread of the virus.

7. If feasible, install exclusion netting. The number of thrips entering a greenhouse may be greatly reduced by covering the doors and air intakes with a fine mesh (400 mesh) cloth.

Dry Conditions Expected for the Rest of September

(Beth Hall, hall556@purdue.edu)

The rain events northern Indiana saw last week may be the last significant precipitation seen in Indiana for the next several weeks. The US Drought Monitor has already place most of the state in abnormally dry to moderate drought conditions and there doesn't seem to be much relief in sight. South-central Indiana's precipitation amounts so far for September rank as low as the 2nd percentile when compared to the 1981-2010 climatology period (Figure 1). Fortunately, temperatures have not been too unseasonably warm to enhance the evaporative demand from the atmosphere, but there are still many crops hoping to soak up as much end-of-season moisture as they can before harvest. The climate outlooks from the national Climate Prediction Center are indicating significant confidence for below-normal precipitation through the first week of October and the monthly precipitation outlook for October is indicating slight confidence for below-normal precipitation throughout the month (Figure 2).

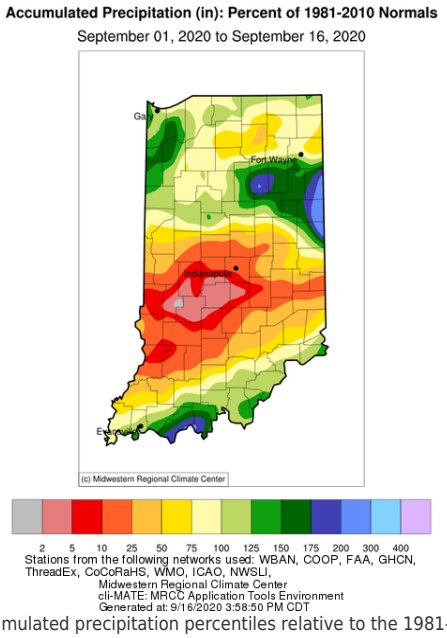

Figure 1. Accumulated precipitation percentiles relative to the 1981-2010 climate normal period for September 1 – 16, 2020.

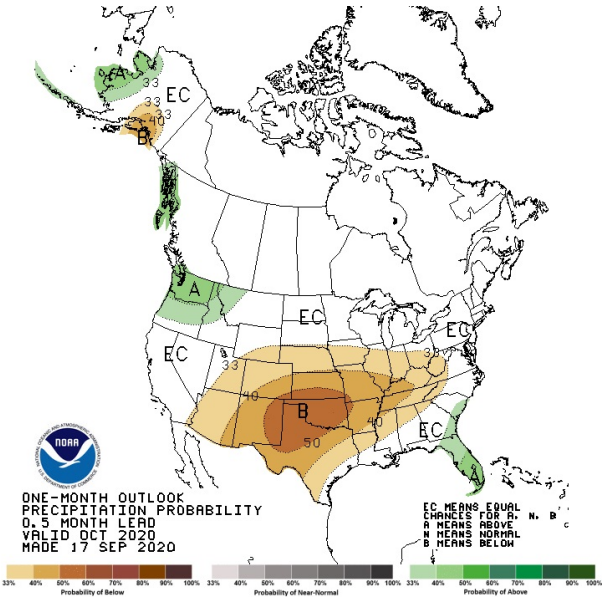

Figure 2. Precipitation probability outlook for October 2020 where shading indicates confidence for above- (green) or below- (browns) normal conditions.

It is still too soon to know if the first hard freeze (temperature at or below 28°F) will occur earlier than normal this year. However, if you are interested in learning more about the range of dates when the first hard freeze occurred in your area, check out the Midwestern Regional Climate Center's Vegetation Impact Program's suite of tools – particularly their freeze maps (https://mrcc.illinois.edu/VIP/frz_maps/freeze_maps.html). Users can see maps of the dates of the earliest, median, and latest hard first freezes in the fall, for example. They can also explore these products through the mapping interface where one can zoom in closer to a location and click on the nearest station for further information (https://mrcc.illinois.edu/gismaps/freeze_guidance.htm).

As the growing season approaches its end, Figures 3 and 4 show the accumulation of modified growing degree days (MGDDs) across Indiana since April 1st and how this year's accumulation compares to past years since 2016. For northern locations, 2020 MGDDs ranked in the top 3 of the past 5 years, whereas most southern locations saw 2020 MGDDs ranked in the bottom third, if not lowest of recent years.

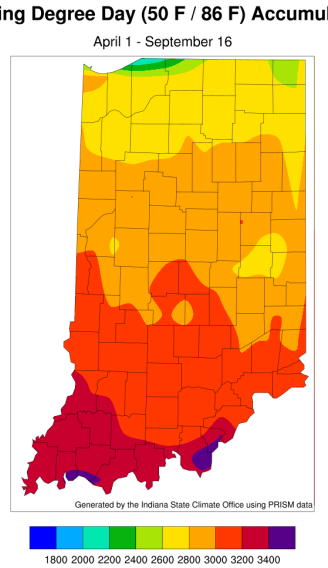

Figure 3. Modified accumulated growing degree-day units for April 1 – September 16, 2020.

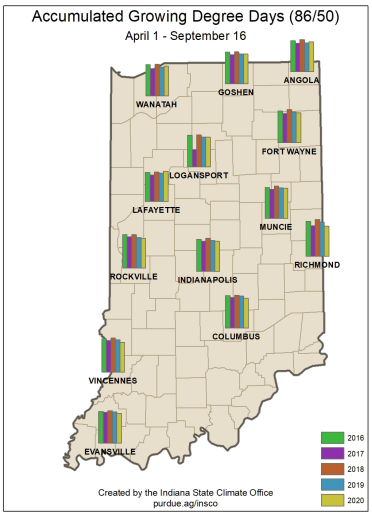

Figure 4. Comparison of accumulated modified growing degree days for April 1 through September 16 for 2016 through 2020.

Survey of Watermelon Nutritional Status in Southern Indiana — Magnesium and Potassium

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

Thanks to growers' collaboration and help from Superior Ag, we collected plant tissue samples from 12 watermelon fields at different crop growing stages in Southern Indiana in the 2020 season. In this article, I want to discuss two of the issues that standout from these tests.

One is the generally low or deficient Magnesium (Mg) levels across majority of the samples. In highly leached sandy soils, magnesium levels are usually low. Magnesium uptake is strongly influenced by soil pH. It is most available to plants at pH between 6.5 to 8.5 in sandy soils. With that said, if soil pH was lower than 6, it is almost certain we would see Mg deficiency in plant tissues. Magnesium is a mobile nutrient in plants, symptoms of deficiencies appear first on old leaves, as yellowing between the veins. Magnesium can be supplied through dolomitic limestone. But dependency on Mg release from dolomitic lime may not be adequate, especially if the limes were applied in spring, in which Mg availability may be limited to the second or third crop. Results from this survey illustrate the need for supplement Mg fertilizer application in watermelon production, especially when soil test indicating Mg was in the low range.

The second observation is the generally low Potassium (K) levels in plant tissue samples. Potassium is involved in maintaining plant water movement. When K is deficient, cell wall and stems are weakened; sugar and starch tend to accumulate in leaves rather than in fruit and roots. Potassium plays many important roles, deficiency of potassium directly affects yield and qualify of the crop. The adequate range of K for watermelons on the dry weight basis is 4.0-5.0% at flower stage, 2.5-3.5% at small fruit stage, and 3.5-4.5% at older fruit to harvest stage (Bryson et al., *Plant Analyaiss Handbook III*). The survey showed K levels in most watermelon samples were lower than the recommended ranges, this is particularly true toward the later part of the season. In healthy and recent developed leaves, nitrogen (N) to K ratio is about 1:1. However, in most of the samples, N is at sufficient or excessive levels; and the percentages of N are much higher than that of K at all cropping stages. Levels of K and N are known to be closely related. Without sufficient K, N tends to be high in plant tissues. Abundant N may increase plant sensitivity to diseases while K combats this effects; abundant N stimulates rapid and soft growth while K encourages growth of firmer tissue; negative effect of high nitrogen on fruit quality are also countered by K. Results from this survey indicate nitrogen may not be a limiting factor for watermelon crops at least for 2020 season, but K could be.

Improved Tool can Help Midwest Farmers with Cover Crop Decisions

Cover crops have been shown to improve water and soil quality, reduce erosion and capture nutrients. Choosing the right cover crop, however, can be difficult.

The Midwest Cover Crops Council (MCCC) —made up of representatives from 12 Midwest states and universities, including Purdue, the province of Ontario and other agricultural stakeholders — is rolling out an improved cover crop selection tool that will help farmers make those decisions. Users select their state/province and county and then select the goals they have for cover crops — erosion control, nitrogen scavenger, fighting weeds and providing forage, etc. They also can provide information about the cash crops they are planting and drainage data for their fields. The tool offers the best cover crop options for the specified conditions. Clicking on the cover crops brings up data sheets that offer more information about each crop, seeding rates and more.

"This gives good information about the species that will fit each user's unique situation — their rotations, timeframes and goals," said Anna Morrow, program manager for the MCCC and a staff member in Purdue's Department of Agronomy. "We've been able to give users a visual way to take in and process that information."

The Midwest Cover Crops Council's new cover crop selection tool offers cover crop recommendations and seeding dates customized for individual goals and historical weather data by county. (Photo/Midwest Cover Crops Council)

The updated tool includes more accurate seeding dates for each county based on 30-year National Oceanic and Atmospheric Administration frost date data; changes to seeding dates and rates to align with new research; and is now mobile-friendly and complies with the Americans with Disabilities Act.

"We met with farmers, researchers, government agencies, agribusiness leaders and stakeholders in all the states and provinces we represent to get the most up-to-date information available and update the tool in ways that would be most beneficial for our users," Morrow said. "This

tool is good for farmers who want to get started with or are currently using cover crops and need to get reliable, current information to help them make the best decisions for their operations."

The tool has updated data for Iowa, Illinois, Minnesota, Wisconsin, Ohio, Michigan and Ontario. North Dakota and South Dakota, which were not part of the original tool, have been added. The remaining four states, Indiana, Missouri, Kansas and Nebraska, have been recently updated or added to the tool and will be updated again over the next two years.

The MCCC will hold a live, one-hour webinar at noon Eastern (11 a.m. Central) Sept. 23 to demonstrate the new tool and answer questions. To register for the webinar, view a recorded version later and access the tool, go to mccc.msu.edu/selector-tool/.

The updates were made possible by funding from North Central Region Sustainable Agriculture Research and Education Program and Grain Farmers of Ontario.

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Agriculture News Page

NCR-SARE to Host Farmer Rancher Grant Writing Webinar, Tuesday, September 22nd

North Central Region Sustainable Agriculture Research and Education (NCR-SARE) will host a Farmer Rancher Grant Program grant webinar on Tuesday, September 22 from 4-5:30pm CDT.

This webinar will help guide participants through the process of submitting a grant proposal to NCR-SARE's Farmer Rancher grant program. Join Joan Benjamin, NCR-SARE Farmer Rancher Grant Program Coordinator, to learn how to write a strong proposal and project budget and where to get help. NCR-SARE will record the webinar and make it available online.

To Join the Webinar

Join the NCR-SARE Farmer Rancher Grant Program Zoom webinar online (registration is not required) by 4pm CDT on Tuesday, September 22 at: https://umn.zoom.us/j/91714725738

If you are not able to connect using Zoom, you may dial in at (651) 372-8299, but you will not be able to see the slides being shared.

Test Your System Before the Webinar

Prior to the webinar, please join a test Zoom meeting to familiarize yourself with Zoom and test your connection. Simply visit http://zoom.us/test. You can also contact Marie Flanagan before the meeting at mart1817@umn.edu or (612) 625-7027.

Technical Problems?

Contact Marie Flanagan at mart1817@umn.edu or (612) 625-7027 prior to the meeting. Alternately, Zoom has a "Getting Started" guide to help you become familiar with Zoom: https://support.zoom.us/hc/en-us/articles/360034967471.

About the NCR-SARE Farmer Rancher Grant Program

NCR-SARE Farmer Rancher Grant Program proposals are due on December 3, 2020 at 4pm CST.

NCR-SARE's Farmer Rancher Grant Program is a competitive grants program for farmers and ranchers who want to explore sustainable solutions to problems through on-farm research, demonstration, and education projects. Proposals should show how farmers and ranchers plan to use their own innovative ideas to explore sustainable agriculture options and how they will share project results. Sustainable agriculture is good for the environment, profitable, and socially responsible.

There are three types of competitive grants: individual grants ($9,000 maximum), team of two grants for two farmers/ranchers from separate operations who are working together ($18,000 maximum), and group grants for three or more farmers/ranchers from separate operations who are working together ($27,000 maximum). NCR-SARE expects to fund about 50 projects in the twelve-state North Central region with this call. A total of approximately $720,000 is available for this program for 2021.

NCR-SARE is accepting online submissions for the Farmer Rancher Grant Program. More information about the online submission system can be found in the call for proposals; find the call for proposals online. Tutorials for using the online application system are available as well. Visit https://northcentral.sare.org/Grants/Apply-for-a-Grant/Farmer-Rancher-Grant/ for everything you need to know about NCR-SARE's Farmer Rancher Grant Program.

You can find more information about sustainable agriculture online as well.

Each state in SARE's North Central Region has one or more State Sustainable Agriculture Coordinators who can provide information and assistance to potential grant applicants. Interested applicants can find their State Sustainable Agriculture Coordinator online.

With support from an NCR-SARE Farmer Rancher grant project, an Oneida White Corn Growers Group in Wisconsin set out to build their knowledge about growing white corn, and to learn how to use fish emulsion to fertilize it.