VEGETABLE CROPS HOTLINE

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

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In This Issue

Evidence for Spread of Fusarium Wilt of Watermelon in Transplant Trays

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

Fusarium wilt is one of the most serious diseases of watermelon in the Midwest. The disease often causes a one-sided wilt 2-3 weeks after transplanting. Whether a plant is affected, and to what degree, depends on the population of the long-lived spores in the soil that the roots contact. However, Fusarium wilt of watermelon is not known to spread from plant to plant in the field. This is in contrast with a disease such as anthracnose which can spread from plant-to-plant rapidly in one season.

Occasionally, Fusarium wilt can be observed affecting commercially produced watermelon transplants in new trays and virgin soilless mix. The most likely explanation for such outbreaks is the introduction of Fusarium wilt on seed. The distribution of Fusarium wilt from seed should appear random. However, we often observe a clustered distribution of affected seedlings as seen in Figure 1. We conducted an investigation to determine whether the distribution of Fusarium wilt in transplant trays could be shown to be statistically clustered. Our hypothesis was that the diseased transplants were in a clustered distribution, not random. Seedlings in a clustered distribution would suggest that Fusarium wilt spread from plant to plant within the transplant trays.

Figure 1. We often observe Fusarium wilt in transplant trays in a clustered distribution. We believe that Fusarium wilt may spread from plant-to-plant within a transplant tray, perhaps by soil splash or spores that have been observed on diseased seedlings.

To conduct the statistical tests, I teamed up with Judy Santini of Purdue University. We assessed disease for each watermelon transplant in 19 trays from a 2006 outbreak and 10 trays in 2016. We compared statistically the actual distribution of diseased plants to a random distribution of the same number of cells. We used a one-tailed T-test to compare the hypothesis that the mean distances for diseased plants is < the mean distance for random cells. Test repeated 10 times for each transplant tray.

2006 outbreak – In 12 out of 19 trays, the mean distance of diseased plants was statistically less than the mean of all 10 random samples.

2016 outbreak – In 3 trays out of 10, the mean distance of diseased plants was statistically less than the mean of at least 9 random samples.

Our results indicate that in at least some of the transplant trays the distribution of Fusarium wilt is clustered, not random. We believe that the most likely explanation of the clustered distribution of diseased plants in the transplant trays is the seed transmission of Fusarium wilt and subsequent plant-to-plant spread. We believe this is the first report to suggest the secondary spread of Fusarium wilt of watermelon. These conclusions apply only to Fusarium wilt in the greenhouse/transplant tray.

Recommendations to manage Fusarium wilt of Fusarium wilt include:

- Use new soil and trays or sanitize trays that are being reused.

- Purchase watermelon seed tested for Fusarium wilt.
- Scout for symptoms of Fusarium wilt of watermelon or inspect seedlings carefully upon delivery.
- Obtain an official diagnosis of possible diseased plants.
- Since this study suggests that Fusarium wilt may spread in transplant trays, don't attempt to plant healthy seedlings from trays where Fusarium wilt has been observed.

Fusarium wilt can be a serious disease of watermelon. Avoid planting seedlings that may have this disease.

MW Vegetable Guide Updates

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

The following updates have been made to the *Midwest Vegetable Production Guide for Commercial Growers 2017* (*ID-56*) since it was published in December. These updates have been made to the PDFs published on-line at mwveguide.org. If you have a hard copy of the *ID-56*, please note these changes.

Page 59-Additional plant families and example crops have been added to Table 22.

Page 82-Dual Magnum entries under asparagus weed control have been updates to include Michigan only language.

Page107-Velum Prime has been added to powdery mildew control for cucurbits; 6.5-6.84 fl. oz/A. May cause a mild yellowing of leaf margin. May be applied through drip.

Page 116- Velum Prime has been added to root knot nematode control for cucurbits; 6.5-6.84 fl. oz/A. May cause a mild yellowing of leaf margin. May be applied through drip.

Page 117-Entry for Luna Sensation should read "All cucurbits" under comments.

Page 190- Velum Prime has been added to early blight control for potato; 6.5-6.84 fl. oz/A. Apply specified dose through overhead irrigation.

Page 191- Velum Prime has been added to root knot nematode control for potato; 6.5-6.84 fl. oz/A. Apply specified dose through overhead irrigation.

Page 192- Velum Prime has been added to white mold control for potato; 6.5-6.84 fl. oz/A. Apply specified dose through overhead irrigation.

Page 221-a source for obtaining corn earworm traps has been added:

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Problems in Overwintered Salad Greens – White Mold and Tip Burn

(Liz Maynard, emaynard@purdue.edu, (219) 548-3674)

Some of the red and green multi-leaf lettuce plants in Figure 1 are wilted and closer inspection reveals death and soft decay at the crown and well as freeze damage (Figure 2). Getting even closer as in Figure 3 we see white fuzzy mold and find hard black sclerotia 1/8 to ¼ inch across and up to ½ inch long at the base of the plants and in the soil. These sclerotia confirm that the plants have succumbed to white mold or lettuce drop caused by the fungus *Sclerotinia sclerotiorum*. The lettuce was transplanted in September or October 2016 and the photos taken in mid to late January. We continue to see more plants succumbing to the disease.

Figure 1. Lettuce in high tunnel showing symptoms of lettuce drop caused by the fungus Sclerotinia sclerotiurum. (*Photo by Erin Bluhm*.)

Figure 2. Soft decay in center of lettuce head with lettuce crop; freeze injury and powdery mildew are also visible. (*Photo by Erin Bluhm*.)

Figure 3. A. White mycelieum of the fungus Sclerotinia sclerotiurum growing on lettuce tissue. B. Arrows mark black sclerotia of fungus Sclerotinia sclerotiurum at based of lettuce stem. (*Photo by Erin Bluhm.*)

Infection by this fungus begins when sclerotia buried in the soil produce small mushroom-like apothecia and spores from the apothecia land on susceptible plant tissue, germinate, and invade the plant. Sclerotia can also produce mycelium that can directly infect dead and dying plant material, such as dead lettuce leaves, and go on to infect heathy plant tissue. Infected areas may develop the white fuzzy mycelium of the fungus and new sclerotia form. These sclerotia can survive in the soil for several years. White mold does not spread from plant to plant except when an infected plant directly contacts an unaffected plant.

Cool temperatures (59ºF to 70ºF), wet soil and high humidity promote this disease. High soil moisture is necessary for apothecia to form. Leaf surfaces must be wet for about 48 hours in order for spores to successfully infect. These conditions are easy to find in winter high tunnels. Row covers used to raise temperature also increase humidity near the crop. In the structure where these photos were taken, poor drainage on one side of the structure could have contributed to the 10 days of high moisture conditions necessary for apothecia formation (Figure 4). Dense lettuce plantings can slow drying of surface soil after irrigation and that would also promote apothecia formation.

Figure 4. Water standing in alleyways can lead to saturated soil in growing beds, creating favorable conditions for disease. (*Photo by Erin Bluhm.*)

This disease is a concern not only for this lettuce crop, but also for other crops that may be planted in this soil. Over 360 species can be infected, but probably of most importance for many high growers are tomatoes, on which the fungus causes timber rot. The sclerotia produced on the lettuce plants can germinate later this season and infect tomatoes or other crops. The first symptom observed on tomatoes is often the wilting of scattered tomato plants. Upon closer inspection, the lower stem of an affected plant may have a light brown lesion that girdled the plant, causing it to wilt and possibly die. The lesions appear woody, which is how this disease got its alternate name: timber rot. The lesions are often accompanied by the white growth of the causal fungus as well as sclerotia. White mold may also cause a rot of tomato fruit. See https://www.extension.purdue.edu/extmedia/BP/BP-197-W.pdf for more information about the destruction this fungus can cause on tomatoes.

If conditions aren't favorable for sclerotia to germinate they can remain dormant in the soil for long periods. If this disease is known to be present, preventive management is important. Manage soil moisture to limit long periods when soil is near saturation. Reduce relative humidity to minimize the hours stems or leaves are wet.

You may notice another problem on the lettuce: powdery mildew on lower leaves. This disease arrived in the fall and has stayed with us all winter. Of three plantings, the last planting in mid-October seemed to be the least affected.

We also observed death of growing points on lettuce in January (Figure 5). This month we observed tipburn on spinach leaves (Figure 6). It is likely that both of these are a result of calcium deficiency in the young, rapidly growing tissue. And as with other calcium disorders such blossom-end rot of tomato fruit, it is likely that environmental conditions that reduce water movement into the young leaves are a contributing factor. Young leaves in the growing point of a larger lettuce or spinach plant may be surrounded by other leaves that help to create a humid environment. When combined with the high humidity under a row cover found in winter high tunnel production, the humidity may be so high that little water transpires from the leaves and so little water is drawn into the leaves from the soil. As a result, calcium, which moves with water into the plant, is also not drawn into the young leaves and the rapidly developing tissue becomes deficient, resulting in death of the growth point, or leaf margins, which causes tipburn. If soil moisture was low at a time of high demand, that would exacerbate the problem.

Figure 5. Death of leaves at lettuce growing point. (*Photo by Erin Bluhm.*)

Figure 6. A. Death of spinach leaf tip or 'tipburn' can begin when young leaf is still expanding (arrows in B, C).

A first step in addressing these problems is to assure that soil calcium levels are adequate and uptake by the plants is not hindered by excess of other cations such as magnesium or potassium. A soil test will help to determine if that is the case and appropriate amendments added as needed. But even if soil levels are reasonable the problems can occur under conditions of high humidity or inadequate water supply described above. With these factors in mind, other potential solutions would be to reduce humidity around the plants by adjusting management of row covers and ventilation, reducing plant density, or altering planting arrangement to create better air flow.

Dan Egel contributed to this article.

Learn How to Graft Tomato Plants

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

A new video explaining how to graft tomato plants is now available on-line https://youtu.be/3cq0SZOsJAo

Soil Tests

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

Figure 1. Sample soil to 6 inches with a soil probe

We can never emphasize too much the importance of conducting soil tests. Ideally, soil test should be conducted on a yearly basis. The reason soil testing is so important is because it provides information about the nutrient composition of the soil so that growers will know how much fertilizer to apply for the following season. In addition, soil tests enables farmers to find out if there are concerns, such as pH, salinity etc. If these factors are off track, we might be able to address the problems before planting. In most cases, addressing the problems before planting is more efficient and cost effective than during the season.

Purdue Agronomy Extension provides a list of laboratories that offer soil test services https://ag.purdue.edu/agry/extension/pages/soil_testing.aspx I will use the A&L Great Lakes Lab as an example, explaining how to use this service. A&L Great Lakes laboratories provide seven (S1 to S7) soil test packages. S1 is the basic test covering organic matter, pH, cation exchange capacity and macronutrients including phosphorus, potassium, magnesium, calcium. I would recommend you invest a little more money for their recommendations. In that way, you will receive the information regarding the amount of lime, and P, K, Mg, Ca fertilizers you should apply according to the next crop and the soil status. If you want to have a better understanding of each of the characters, *Interpretive Guide for soil Test Reports* (https://cdn.shopify.com/s/files/1/0979/5626/files/FS21_-_Interpretive_Guide_for_Soil_Test_Reports.pdf?14031145444614994333) is a good source for the information.

You may notice that the basic package does not include nitrogen. This is because nitrogen is readily leachable in soil, it changes dramatically during the season, and what shows in the soil test does not reflect what is in soil at the time when plants need it. Because of these reasons, nitrogen is normally not included in the soil test. Then how do we determine the amount of nitrogen fertilizers we should apply? A great source to find the information is through *Midwest Vegetable Production Guide for Commercial Growers 2017* (https://ag.purdue.edu/btny/midwest-vegetable-guide/Pages/default.aspx). The handbook provides the information of nitrogen requirements for most vegetables. When you are searching for the information in the handbook, you may notice the recommendations vary according to soil organic matter. This is

because soil organic matter serves as a slow released fertilizer source in the soil. A portion of the nitrogen can be supplied through organic matter decomposition. Therefore, fewer nitrogen fertilizers are needed with high organic matter soils. With that said, we should understand now that although basic soil test does not include nitrogen, the soil organic matter information would provide us a clue of determining how many nitrogen fertilizers should apply.

Soils provide enough micronutrients in most cases. But because vegetable crops can be particularly sensitive to certain micronutrients. It is recommended to include micronutrients in the soil test. A&L Great Lakes laboratories provide service S3 covering the most important micronutrients (zinc, manganese, iron, copper and boron) and sulfur. The lab also provides recommendations for the amount of micronutrients needed if they are in the low range.

Another service I would recommend vegetable growers particularly those growing vegetables in high tunnels to consider is S2 (basic test plus soluble salts and sodium). Because high tunnel excludes natural rainfall and snow, the extra fertilizers we applied over the years can accumulate in the soil to a high salt level. High tunnel growers should always watch for the soluble salts level in their soil and be cautious about applying fertilizers. Soil test is a great way to find out if salinity is a concern.

Last but not least, if you are uncertain how to take soil samples, this publication is a great source for the information https://cdn.shopify.com/s/files/1/0979/5626/files/Soil_Sampling_Analysis.pdf?9125530855932982961 Remember that the lab will send you the results no matter what soil you send to them, but only if you did right in sampling soil, the results won't be meaningful or even could be misleading for the decisions you need to make.

Garden Sprayer vs Backpack Sprayer

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

The use of tractor drawn pesticide sprayers is not practical for many smaller growers. Two alternatives are garden-sprayers or backpack sprayers. I will argue here that garden-sprayers are not suited for most commercial pesticide use.

The typical garden sprayer that may be found at a garden shop or hardware store usually has a 1 or 2-gallon capacity and a nozzle whose output may be manually adjusted from stream to spray (Figure 1). Such sprayers use air pressure generated by a hand pump. Some models have a valve to quick-release air pressure. While such sprayers may be useful for cleaning tasks, they are not appropriate for commercial pesticide applications for the reasons stated below.

Figure 1. A typical garden sprayer with an adjustable nozzle and hand pump is not suitable for applying most commercial pesticides.

Let's start off discussing the adjustable nozzles on garden sprayers. These nozzles may be inadvertently moved to provide a different stream or spray. That is, the output may be changed from a full spray to a more stream-like output. We quantified the output of a garden sprayer in a stream vs spray mode. The output in stream mode was more than twice the output in spray mode. This means that if one accidentally turns a spray nozzle, the volume output will change.

It is important for the output on a sprayer to remain constant because most commercial pesticide labels are based on amount per area—for example, fl. oz. per acre. If the output changes, the amount of pesticide applied changes. If the amount of pesticide is less than the labeled amount, the application will likely be ineffective. Too much pesticide wastes money and may cause damage to the plant. Therefore, the adjustable nozzles that are so useful for household jobs make garden sprayers unsuited for commercial pesticide applications.

A second disadvantage for the use of garden sprayers for commercial pesticide application is the difficulty in maintaining a constant pressure. The method of creating pressure in a garden sprayer is by a hand pump. This pressure, however, will begin to decrease with use. As pressure decreases, output also decreases. Therefore, to maintain constant pressure and output the hand-pump needs to be in constant use. For most users, constant use of the hand-pump of garden sprayer is impractical.

To demonstrate how output of the garden sprayer changes with pressure, we collected volume of a sprayer with 5 hand pumps vs 15 pumps. The output with 15 pumps was almost twice the output with 5 pumps. As discussed above, most commercial pesticide labels are on an area basis. Therefore, a sprayer with an output that varies with pressure/time is unacceptable.

Most backpack sprayers, in contrast, are well suited for commercial pesticide use (Figure 2). Effective backpack sprayers will have:

- Fixed hollow cone or flat fan nozzles located on a boom. Sprayers with 3-4 nozzles located on a boom are easier to use and calibrate than wand type sprayers such as in Figure 1.
- An easy to read pressure gauge so that the same output can be maintained throughout the field (Figure 3). The sprayer may be powered by a motor, CO_2 or by a hand-pump.
- For most applications, a 4-5-gallon capacity should be adequate.

Figure 2. This backpack sprayer has three nozzles on a boom and a hand-pump that can be worked constantly.

Figure 3. A gauge on the handle of the backpack sprayer allows one to constantly monitor pressure.

Fixed or hollow-cone nozzles are designed for pesticide application (Figure 4). Such nozzles are fixed and provide a constant output. The sprayer shown here was modified from a single wand to a boom with three nozzles. The total for back pack sprayer and boom was about $100. The use of nozzles on a boom allow for easy calibration and use. The backpack sprayer in figure 2 allows the user to hold the boom in one hand and constantly pump with the other so that proper pressure is maintained. Note that a gauge on the handle allows one to monitor the pressure periodically.

A separate article will discuss the use and calibration of a backpack sprayer.

Figure 4. This flat fan nozzle provides constant output.

Backpack Sprayer Use

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

Small vegetable growers may find pesticide applications with a tractor driven sprayers impractical. Such growers may turn to hand sprayers. In a separate article, I argued that garden sprayers are not appropriate for most commercial pesticide applications. In this article, I will discuss the use and calibration of a backpack sprayer, an excellent alternative to a garden sprayer for small growers. The remainder of this article will discuss one method of calibrating a backpack sprayer.

Most pesticides are labeled for use on an area basis, typically an acre. Therefore, the first task in calibration is to measure the area to be treated. Let's say that tomatoes are grown in a greenhouse where the production covers 30 X 100 feet = 3,000 square feet. For our staked tomato example, we will use a volume-based method of pesticide measurement. For this method:

1. Determine the volume of water required to cover the fully-grown crop on an acre-basis. See discussion later.
2. Mix the acre rate (or portion of an acre) of the particular pesticide to be applied in the volume of water determined in step 1.
3. Apply the mixed pesticide to the plants.

For example, if Dithane F45 is labeled at 2.4 quarts per acre, and it takes 100 gallons of water per acre to adequately cover mature staked tomatoes, mix 2.4 quarts in 100 gallons for an acre of staked tomatoes. Now, let's calculate the pesticide rate for our greenhouse example.

Since we calculated the size of our greenhouse production as 3,000 square feet, we can figure the proportion of acre of our production. 3,000 square feet/43560 square feet per acre = 0.07 acres.

Next, we must consult the label to determine how much product to apply per acre. Let's say we want to apply Dithane F45, which is labeled for tomatoes in the greenhouse at 2.4 quarts per acre. How much should we measure for our tomato greenhouse

example?

0.07 acres of greenhouse tomatoes x 2.4 quarts/acre labeled rate = 0.17 quarts for greenhouse example (Since there are 32 fl. oz in a quart, we have 0.17 x 32 = 5.5 fl. oz).

Next we must determine how much water to use with 5.5 fl. oz. of product in our backpack sprayer. Therefore, we must calibrate our sprayer. Let's break this down into a few steps.

1. Measure off a portion of the area to be treated. For our greenhouse example, we will measure 60 feet for calibration purposes. Since we have 6 rows of tomatoes at 100 feet each we have 600 linear feet of tomatoes. (We are using for calibration a tenth of the total area to be treated).
2. Fill your sprayer with a known amount of water. We will put one gallon (128 fl. oz.) of water in our sprayer.
3. Spray the water onto the calibration area.
    1. The person who will be doing the spraying should be the one doing the calibration.
    2. If the person or equipment changes, then the calibration needs to be re-done.
    3. The walking pace needs to be constant.
4. After the 60 feet of tomatoes has been sprayed completely (did you spray both sides of your staked tomatoes?), completely empty the left-over water into a measuring device. In our example, we had 96 ounces of water left (128-96=32 fl. oz.). Therefore, 32 ounces of water was applied on 60 linear feet. How much water would we need for the entire greenhouse (600 linear feet of tomato)?

Multiply 32 fl. oz. of water that was applied on our calibration area x 10 to equal the total area to be treated. Therefore, we need to add our 5.5 fl. oz. of Dithane F45 in 320 fl. oz. of water or 2.5 gallons of water. That is, it will take 2.5 gallons to cover our tomatoes in the greenhouse example.

Here are a few other items to consider.

- It is best to repeat the calibration a few times to make sure that amount of water applied is accurate.
- The pace that is used in walking on the product must remain constant throughout the entire area and from application to application. It might help to keep in mind a particular piece of music or use a mechanical metronome to keep a constant pace.
- As the crop grows, it may be best to use a different number of nozzles on the boom. For example, at the start of the season one might use 2 nozzles while blocking off the remaining nozzles. When extra nozzles are used, the system must be re-calibrated.
- In the example above, we used 2.5 gallons of water on 0.07 acres. Since 3000 sq. ft. is about 1/14th of an acre that works out to be about 35 gallons per acre of water (2.5 gallons X 14). In general it is best to keep the water per acre amounts to 20 gallons or more. The idea is to thoroughly wet the plant tissue. In most cases, one does not want run off.

The example above is for a liquid fungicide. If instead the fungicide is a dry formulation, then the calculation might go like this: Penncozeb at 2 lb/acre x 0.07 acres = 0.14 lb. (2.25 oz).

How to measure out a dry oz? Don't measure out the Penncozeb in a measuring cup designed for liquids. Weigh the 2.25 oz on a kitchen scale or on some other appropriate device. Pesticides that are given in fluid ounces should be measured in measuring cup-like devices; pesticides that are given in dry ounces must be measured on a scale. For example, a kitchen scale that may purchased at a well-known box store for about $10 can be used for weighing out dry pesticides. When we used a liquid measuring device for Penncozeb, the amount of Penncozeb was underestimated by 20%!

There are other methods of sprayer calibration. The important point is to spend time calibrating your sprayer equipment, whatever method you use. Proper calibration takes time, but must be done if pesticides are to be applied properly.

High Tunnel Screening for Insect Pest Management

(Lan Kaplan, ikaplan@purdue.edu) & *(Laura Ingwell, lingwell@purdue.edu)*

Screening can be an effective measure to exclude unwanted pests from colonizing your crops. In high tunnels, one of the biggest challenges to successfully implementing exclusion screening is managing the unintended side effect: reduced airflow. In spring we are clamoring to get inside the warmth that high tunnels provide, but by mid-summer they can become one of the most dreaded environments to work in. The temperatures inside high tunnels beyond mid-June can quickly exceed those suitable to plant growth. The key to maintaining crop production during this time is proper ventilation. Therefore, selecting an insect screen that will effectively exclude pests while minimizing reductions in airflow is crucial. We have been investigating the ability of such screens to keep biological control agents in and cucumber beetles out while maintaining a suitable growing environment for cucumbers, tomatoes and melons.

We have looked at three different insect screen sizes over the past few years: small (0.40 x 0.45 mm), medium (0.26 x 0.82 mm), and large (1.00 x 4.00 mm) pore sizes. It was immediately obvious that one of them was not suitable. The small screen size increased temperatures inside the high tunnels 6˚F on average, even more on the hottest days, and led to temperatures exceeding plant growth and development limits the majority of the season (Figure 1). It also made it unbearable to work in these tunnels. We saw no changes in temperature or relative humidity in tunnels covered with the medium or large screen sizes (Figure 2).

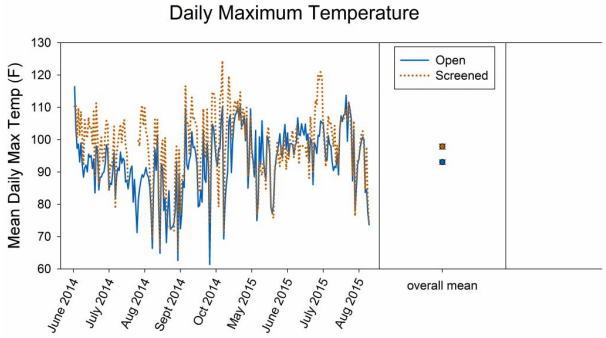

Figure 1. Temperature profiles across 2 years (2014-2015) as a result of the small insect screening installed to cover all ventilation openings compared to open tunnels.

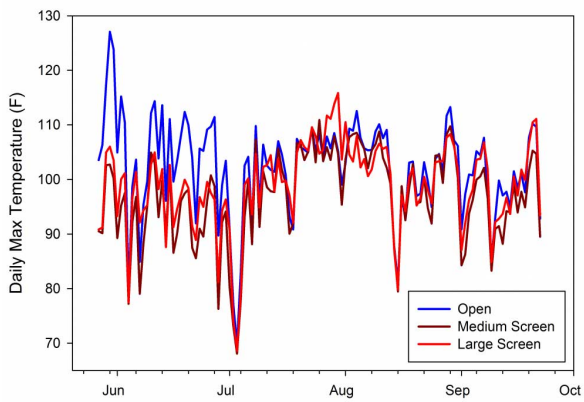

Figure 2. Temperature profiles from 2016 comparing open tunnels, medium screens and large screens covering all ventilation openings.

When growing melons in the screened tunnels, we used commercially available bumble hives to achieve pollination. Harvest was highest in tunnels with the medium sized insect screen (Figure 3), which may be attributed to the exclusion of cucumber beetles and bacterial wilt. Therefore, we would recommend the medium sized screen (0.26 x 0.82 mm) to exclude cucumber beetles or similar-sized insect pests. We did not identify a screen size that would eliminate aphids and the diseases they transmit.

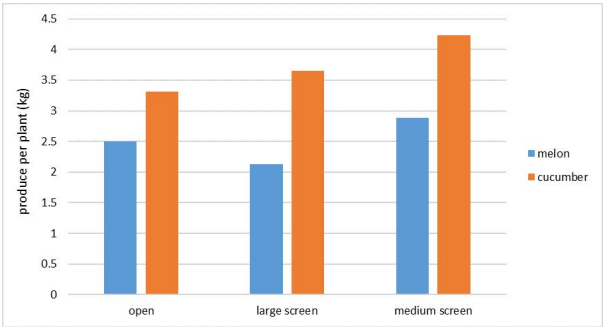

Figure 3. Yield comparison among open tunnels, medium and large screens in 2016.

When considering installing insect exclusion screening on your high tunnels, first identify the pests that you are hoping to exclude. Consider the cost of the materials in addition to the potential for incorporating pollinators depending on the crop, savings in alternative pest management and the longevity of the material. We used the screens for two years during our testing and left it on the tunnels throughout the winter. There was minimal deterioration observed and we predict that they could be used for at least 3 years, if not more.

The TOMI Project Aims to Help Tomato Growers Better Manage Foliar Diseases

(Lori Hoagland, lhoaglan@purdue.edu)

Effectively managing foliar diseases including late blight (LB), early blight (EB), and Septoria leaf spot (SLS), is one of the biggest challenges facing organic tomato growers. New, resistant hybrid varieties are available, but organic growers often plant heirloom varieties instead because they are perceived to have superior flavor and growers can save seed. Copper fungicides can provide fair control of these diseases, but these products are contact, not systemic, and must be applied often, which can negatively impact soil and water quality. The tomato organic management and improvement project (TOMI), led by Lori Hoagland in the Horticulture Department at Purdue, brings together a multidisciplinary team of researchers from across the U.S. to develop short, medium and long-term solutions to this challenge. In the short-term, the team aims to identify biofungicide and biostimulant combinations that can effectively control LB, EB and SLS. Greenhouse and field trials are underway testing various combinations of these products in Indiana and North Carolina. Preliminary results from 2016 indicate the some biologically based products are as effective as copper fungicides in controlling these diseases. In the medium-term, the team aims to develop new open-pollinated tomato varieties that are resistant to LB, EB and SLS, and have exceptional fruit flavor demanded by consumers shopping in local markets. Breeding populations are being screened alongside commercial controls in organic field trials at university research stations in Indiana, North Carolina, Oregon and Wisconsin, and recombined during winter in the greenhouse to strengthen desirable traits. Further screening and selection of lines for potential release will be conducted in collaboration with organic growers in on-farm trials during 2017 and 2018. Finally, the team aims to develop an improved understanding of factors that regulate expression of induced systemic resistance (ISR), which refers to an enhanced defensive state in plants mediated by beneficial microbes. In the long-term, this research will help this biologically based form of disease control to be integrated into future breeding programs, and management practices that enhance ISR expression in the field identified. Greenhouse and field trials are underway to determine how variety, soil and microbial factors regulate ISR expression.

Results of the research conducted by the TOMI project will help both organic and conventional tomato growers better manage foliar diseases, while meeting the demands of local customers for superior tomato flavor. This project was funded in 2014 by an Organic Research and Extension Initiative grant, part of the USDA's National Institute of Food and Agriculture. Award #2014-51300-22267. Additional information and updates about this project can be accessed at http://eorganic.info/tomi.

Webinars to Focus on Organic Tomato Breeding, Flavor, and Disease Management

The TOMI project and eOrganic are partnering to host two online webinars this month that highlight the project and feature results to date. The first in this two-part live-broadcast series was held on March 7th at 2:00 p.m. Eastern, and the second will be held on March 30th at 2:00 p.m. Eastern. Both webinars are free and open to the public. Pre-registration is required to participate in the live webinars. Both webinars will be archived on the eOrganic website and available for viewing at: http://articles.extension.org/pages/25242/webinars-by-eorganic.

Webinar 1: Tomato Varietal Improvement

When: March 7, 2017 at 2:00 p.m. Eastern (1:00 p.m. Central, 12:00 p.m. Mountain, 11:00 a.m. Pacific)

Cost: Free

Register: Click here or visit http://articles.extension.org/pages/74055/tomato-varietal-improvement

Organic vegetable growers need varieties that are adapted to their farming systems. In this webinar, presenters will describe how farmers and formal breeders can develop improved vegetable varieties on their farm or in their breeding program using examples from the TOMI project. Specific topics will include: identifying key traits and choosing appropriate parents, making crosses and selecting from populations for desirable traits, using genetic markers to aid in selection, and more.

Webinar 2: Using Biofungicides, Biostimulants and Biofertilizers to Boost Crop Productivity and Help Manage Vegetable Diseases

When: March 30, 2017 at 2:00 p.m. Eastern (1:00 p.m. Central, 12:00 p.m. Mountain, 11:00 a.m. Pacific)

Cost: Free

Register: Click here or visit http://articles.extension.org/pages/74056/using-biofungicides-biostimulants-and-biofertilizers-to-boost-crop-productivity-and-help-manage-vege

Effectively managing diseases is one of the biggest challenges facing organic vegetable growers. There is currently a wide range of biologically based products available on the market that claim to boost crop growth and help plants withstand many plant diseases. However, there are few independent, science-based studies to validate the efficacy of some of these products as well as instructions detailing how and when to apply them to achieve the best results. In this webinar, presenters will describe the different types of products available in the marketplace today, provide an overview of recent studies evaluating their efficacy, and discuss strategies for identifying the most effective products and application practices.

Introducing PIFF: The Purdue Initiative for Family Firms

(Maria Marshall, mimarsha@purdue.edu) & *(Renee Wiatt, reneewiatt@purdue.edu)*

The Purdue Initiative for Family Firms (PIFF) is a new initiative in Purdue's College of Agriculture, housed in the Department of Agricultural Economics. PIFF is an integrated research, outreach, and teaching program. It offers educational programs that address the major competencies needed for effective family business ownership and management. The goal of the initiative is to prepare family business stakeholders—strategically, financially, and emotionally—for the significant and sometimes unpredictable transitions and decisions that must be made, which determine the success and continuity of the family business.

Purude Initiative for Family Firms

PIFF provides multi-generational family businesses with research-based business management resources aimed at improving personal leadership performance and driving operational growth. PIFF's ambition is to prepare family business owners, managers, and stakeholders (including non-owner spouses and future owners) to be effective stewards of their family enterprises.

PIFF publishes a quarterly newsletter that will house an article from each part of the pie, found on the PIFF website – purdue.ag/piff. The four quarters of the pie include topics of: estate andpersonal financial planning, strategic business planning, maintaining family bonds, and leadership and succession planning. Each section houses articles, guides, and assessments of related topics, which can be viewed online or downloaded. Also found on the website is a *Question of the Month*, PIFF Research, an option to subscribe to our quarterly newsletter, and more information on upcoming events.

PIFF is doing and will continue to do research targeted at providing valuable information that family businesses can directly implement. The information that PIFF provides is targeted towards all family businesses – from farms and agribusinesses to printing businesses. An example of such research would be the *FB-BRAG*, a new assessment aimed at examining family business functionality. The FB-BRAG allows users to measure family business functioning from a variety of viewpoints, in a way that holistically incorporates family and business functionality into one assessment. The *FB-BRAG* can be downloaded here!

Voles Problems in Vegetables?

(Liz Maynard, emaynard@purdue.edu, (219) 548-3674) & *(Michael J O'Donnell, modonnel@purdue.edu, (765) 747-7732)*

Voles can cause serious damage to crops grown in high tunnels. They can also damage vegetables grown in the field. Help us understand the problem and identity solutions by taking a short survey. Find it here: http://tinyurl.com/vole-survey. Thank you!

Upcoming Events

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

Hydroponic Lettuce Production Workshop

The department of Horticulture and Landscape Architecture is hosting a Hydroponic Lettuce Production Workshop on Wednesday, March 29, 2017, 8:30 am to 11:30 am (EST) in room 222, Horticulture Building at Purdue University. Topics include: Most common mistakes made during hydroponic lettuce production (Petrus Langenhoven); Nutrition, temperature and supplemental lighting for hydroponic lettuce production (Krishna Nemali); Market access (Jodee Ellett), and Tour of hydroponic lettuce research at HLA (Krishna Nemali and Petrus Langenhoven). The workshop is free, please RSVP no later than March 20, 2017 by contacting Lori Jolly-Brown (ljollybr@purdue.edu). For More information, please contact Petrus Langenhoven (plangenh@purdue.edu) or Krishna Nemali (knemali@purdue.edu).

Michiana Vegetable & Fruit Growers Meeting

Purdue Extension and Michigan State University Extension services are hosting a daylong event that runs from 8:00 am to 4:00 pm on March 21, 2017, at the Elkhart County 4-H Fairgrounds, 17746 County Road 34, Goshen, Indiana. Topics include: Marketing; Understanding soil test; Nutrient management; Insect management in fruits and vegetables; Greenhouse and high tunnel management; Tomato and cucurbit disease management. The registration fee is $30. PARP credits are available for an additional $10. Registration dealine is March 14. To access the complete agenda and registration, go to https://extension.purdue.edu/Kosciusko/Pages/article.aspx?intItemID=23932 For more information, contact John Woodmansee at jwoodman@purdue.edu

Horticultural Business Webinar

The Horticultural Business Webinar will be held on March 29, 2017, 11:00 am-12:00 pm EST. Participants will learn main objections prospects have to saying yes; how to sell a relationship and make a fortune; what pitfalls to avoid that can kill the deal; top attributes of sales success. The webinar is free, click here to register:
https://purdue.qualtrics.com/jfe/form/SV_bIXhXsqnMOlIH6R

eOrganic Webinars

eOrganic provides a series of great webinars in organic farming practices and research. The upcoming webinars that might interest vegetable farmers include Using Biofungicides, Biostimulants and Boifertilizers to Boost Crop Productivity and Help Manage Vegetable Diseases (March 30); Use of High Glucosinolate Mustard as an Organic Biofumigant in Vegetable Crops (April 11). Registration and more information about the webinar series are available at http://articles.extension.org/pages/25242/webinars-by-eorganic

2017 Small Farms Winter Webinar Series of University of Illinois

University of Illinois Extension presents a weekly educational series for the small farm community. All the webinars are free and are recorded. Upcoming topics might interest vegetable growers include Benefits of Mulching Vegetables (March 23); Soil Management for High Tunnels (March 30). Information about registration and the list of topics can be found at https://web.extension.illinois.edu/registration/?RegistrationID=15522 All the webinars are or will be available at http://www.youtube.com/c/IllinoisLocalFoods

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