VEGETABLE CROPS HOTLINE

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

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In This Issue

Cucurbit Transplant Diseases

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

Gummy Stem Blight – this fungal disease causes dark brown leaf spots, however, the diagnostic feature of this disease is the water soaked lesion that is often formed under one of the seed leaves (cotyledons). Such lesions often start at the point where the seed leaf joins the stem (hypocotyl) and do not extend to the soil line (Figure 1). In time, these lesions turn a light brown in color and appear 'woody'. If one inspects the woody stem closely, it is possible to see dark specks imbedded in the stem—these are fruiting bodies of the fungus and will exude numerous spores when wet. Gummy stem blight affects both cantaloupe and watermelon.

Figure 1. Water-soaked lesion on watermelon transplant typical of gummy stem blight.

The fungus that causes gummy stem blight may be seed borne. The fungus may also survive on the residue left on contaminated transplant trays, the greenhouse floor or bench. Gummy stem blight may spread rapidly from plant to plant under warm, wet conditions.

Anthracnose – the leaf lesions caused by this disease tend to be angular and jagged (Figure 2). Stem lesions are not common but if present, are often long and may be sunken. Lesions may extend to the soil line and may be mistaken for damping-off symptoms. When moist, lesions caused by anthracnose may become an orange or salmon color. Anthracnose affects both cantaloupe and watermelon.

Figure 2. Anthracnose lesions on watermelon are often angular.

Anthracnose is easily splashed from seedling to seedling. The causal fungus may be seed borne or, like the gummy stem blight fungus, survive on contaminated surfaces.

Bacterial fruit blotch – The primary difference between the lesions caused by this disease and the fungal diseases described above is that bacterial fruit blotch (BFB) causes a water soaked leaf lesion (Figure 3). Early lesions may appear as water soaked spots. Older lesions may be brown with a water soaked margin. Lesions often start on seed leaves. The symptoms of BFB are similar to angular leaf spot (ALS). It is important to get an official diagnosis since BFB is a significant disease, while ALS is of minor importance. Bacterial fruit blotch affects both cantaloupe and watermelon.

BFB thrives under warm, wet conditions. Symptoms of BFB on leaves in the field may easily be missed until the dark, water soaked lesions on the fruit are observed. The primary method of introduction of BFB to the greenhouse or field is through seed contamination.

Figure 3. Lesion of bacterial fruit blotch on a watermelon transplant.

Fusarium wilt of watermelon – the first symptom of this disease in transplants is that affected seedlings wilt even though the soil is moist (Figure 4). While Fusarium wilt on older plants is often recognized by a one-sided wilt, seedlings seldom exhibit this symptom. Similarly, while older plants with Fusarium wilt can be recognized by a vascular discoloration inside the lower stem, it can be difficult to recognize this symptom in seedlings.

Figure 4. Fusarium wilt on a watermelon transplant.

Fusarium wilt of watermelon may be seed borne. However, the resilient spores survive well in the absence of a watermelon host for many years in the field or on unwashed transplant trays. There is preliminary evidence for a limited spread of Fusarium wilt in the transplant greenhouse.

Damping-off – the classic symptom of damping-off is the constricted, discolored lower stem (Figure 5). The seedling subsequently collapses and dies. Wilt is another common symptom that results from affected stems and roots. The base of stems may appear red-brown in color. Seedlings may also die before emergence.

There are several fungi which may cause damping-off, all of which have many hosts and survive well in soil. These diseases are not seed borne, but the fungi involved survive well on transplant trays and implements. Damping-off does not spread from plant to plant. Cool, wet conditions favor damping off.

Figure 5. Damping-off of a cantaloupe seedling.

Management – Here are some points to remember for the management of these diseases.

- Purchase seeds that have been tested for seed borne diseases such as gummy stem blight, anthracnose and bacterial fruit blotch.
- Avoid planting diseased transplants in the field. Inspect transplants growing in the greenhouse regularly. If transplants are purchased, inspect them carefully upon delivery. It may be necessary to obtain an official diagnosis if questionable symptoms are observed.
- Good sanitation is key to plant health. Clean and sanitize greenhouse surfaces between transplant generations. Implements used for planting should also be cleaned and sanitized regularly. For many growers, it may be better to purchase new transplant trays than to try to clean and sanitize old ones. Do not contaminate bags of greenhouse (soilless) mix with dirty implements or surfaces. More information on sanitation may be found here: **extension.purdue.edu/extmedia/HO/HO-250-W.pdf**
- The use of fungicides may reduce the spread of some of the diseases mentioned above from plant to plant, but are no substitute for prevention. If fungicides are used, be sure to check the label for information about rate, Restricted Entry Interval etc. Not all fungicides are labeled for greenhouse use. See page 43 in the *Midwest Vegetable Guide* for Commercial Growers (**org**) for more information on greenhouse fungicides/insecticides.

The list of diseases discussed here is not exhaustive. It is certainly possible to encounter other diseases. For more information contact Dan Egel.

Salt Accumulation for Vegetable Production in High Tunnels

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

In a recent visit to a high tunnel, we observed a severe salinity problem on tomatoes. Approximately one month after planting , most tomato plants in the affected area had not sent out any new leaves. Roots did not grow at all (Figure 1). After conducting a soil test, very high soluble salt level explains these symptoms. This article reviews the basics of soil salinity.

Figure 1. Stunted growth of tomato plants due to salt damage. Note the accumulated salt in the form of white crust on top of the soil between the rows (Photo by Dan Egel)

Salinity describes salt content in the soil. Virtually all fertilizer materials are salts, but they vary in their effects to increase salt concentration in soil solutions. In a field situation, precipitation in the form of rain and snow tend to leach salts. Since high tunnels exclude rain and snow, elevated salt levels are a common concern for high tunnel vegetable growers. Table 1 are the salt indexes of common fertilizers. If you are using a premixed fertilizer such as 12-12-12, check the fertilizer components on the bags. Note manure has very high salt index. For the same amount of materials, animal manures as well as manure-based compost in general have higher salt contents compared with synthetic fertilizers. Organic growers should be very careful in choosing compost with low salt levels, and should always avoid applying manures directly to soils in high tunnels and prevent running off of manures applied to adjacent field.

Seed germination and seedlings are most susceptible stages to salt damage. After plants are established, high salt concentrations may make it difficult for crops to obtain water from soil, therefore reducing plant growth and yield. Vegetable crops differ greatly in their sensitivity to salt damage. Table 2 has the soil salinity tolerance levels for several vegetable crops. Salinity of 2 ds/m may reduce the yield of salt sensitive crops such as bean, carrot, radish and onion while asparagus may tolerant a level greater than 5 ds/m. If you suspect you have a salinity problem, a soil test may help. But be sure to include test for soluble salts.

Excessive salt can be leached from the soil with water. The required water is determined by salt level of irrigation water and the soil, as well as other soil characteristics. As a general rule, 6 inches of water can leach soil salts by half; more water is needed to further leach the remaining salts in sandy soil. Considering the large amount of water needed, removing high tunnel plastic and exposing the soil under natural rain is the most efficient approach for reducing salinity problems.

Table 1. Salt indexes for common fertilizers (Adapted from: Fertilizer Salt Index, 2002)

Fertilizer	**Salt Index**
Manure Salts	113
Ammonium nitrate	104
Ammonium sulfate	88
Urea	74
Ammonium polyphosphate	20
Monoammonium phosphate	27
Diammonium phosphate	29
Potassium chloride	116
Potassium nitrate	69
Potassium sulfate	43
Ammonium thiosulfate	90

Table 2. Soil salinity tolerance levels for different vegetable crops (Adapted from Ayers and Westcot, 1976).

Vegetable crops	**Yield potential**			
	100%	**90%**	**75%**	**50%**
Asparagus	5.0	8.0	11.0	13.0
Bean	1.0	1.5	2.3	3.6
Beet	4.0	5.1	6.8	9.6
Broccoli	2.8	3.9	5.5	8.2
Cabbage	1.8	2.8	4.4	7.0
Cantaloupe	2.2	3.6	5.7	9.1
Carrot	1.0	1.7	2.8	4.6
Cucumber	2.5	3.3	4.4	6.3
Lettuce	1.3	2.1	3.2	5.2
Onion	1.2	1.8	2.8	4.3
Pepper	1.5	2.2	3.3	5.1
Potato	1.7	2.5	3.8	5.9
Radish	1.2	2.0	3.1	5.0
Spinach	2.0	3.3	5.3	8.6
Sweet corn	1.7	2.5	3.8	5.9
Sweet potato	1.5	2.4	3.8	6.0
Tomato	2.5	3.5	5.0	7.6

Root and Seed Maggots

(Rick Foster, fosterre@purdue.edu, (765) 494-9572)

The cool, wet weather we are experiencing is perfect for the root and seed maggots, namely cabbage maggot, onion maggot, and seedcorn maggot. One way of avoiding damage from these pests is to wait until the soils warm up to 70°F before planting, but that is not always possible. The use of row covers early in the season can physically prevent the flies from being able to lay their eggs on the soil near the base of the plants. There are some insecticides available, which vary by crop. Lorsban®, for the crops on which it is labeled, is probably the most consistent of the available insecticides. Capture LFR® has shown decent efficacy on melons and other crops. Melon growers who are putting Admire Pro® or Platinum® on as a soil drench at planting should not expect any control of seedcorn maggots from those applications.

Soil Temperatures in the Past Two Weeks

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

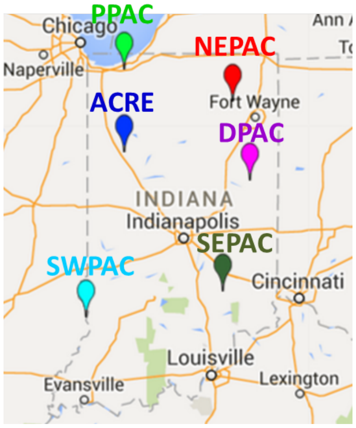

Figure 1 Purdue agricultural centers

Soil temperatures are critical for seed germination and are closely related to occurrences of some early season soilborne disease and pest problems on vegetable crops. Plant vegetable crops after the soil is warm enough ensure good seed germination and fast crop establishment. The figures below show daily average soil and air temperatures at recorded at six locations (Figure 1) in Indiana from April 25 to May 8 that maybe helpful in assessing soil conditions for planting across the state. More information regarding recommended soil temperatures for vegetable planting can be found in the articles https://www.hort.purdue.edu/ext/ho-186.pdf and https://vegcropshotline.org/article/seedcorn-maggots-and-wireworms/

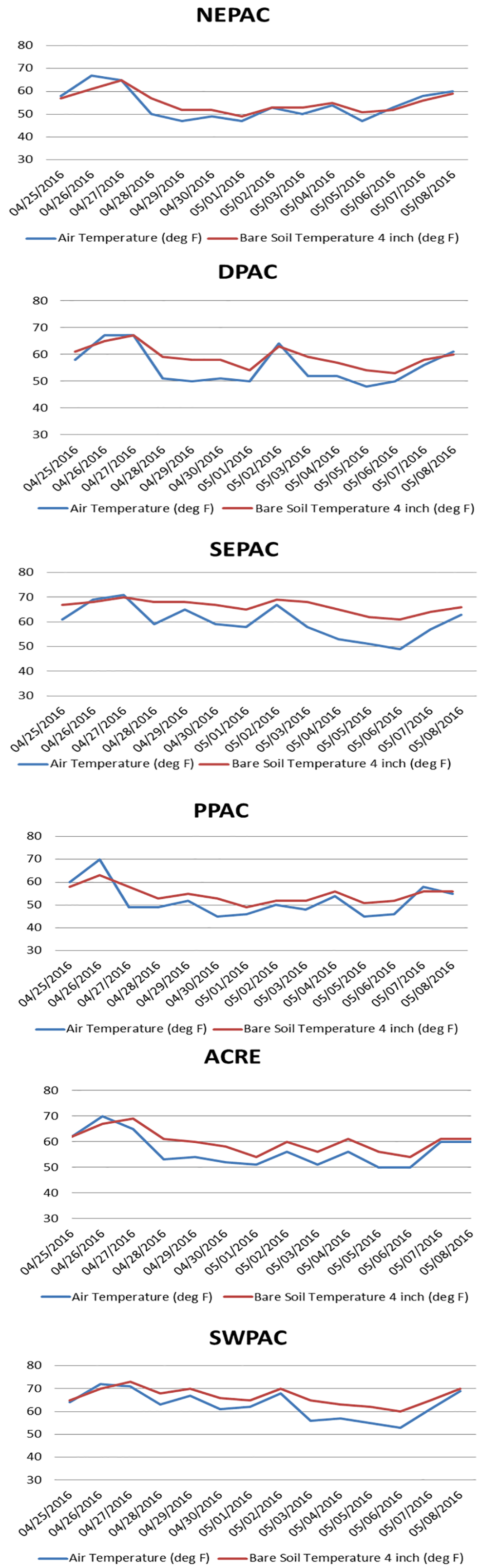

Figure 2. Daily air and soil temperatures from April 25 to May 8.

Corn Earworm

(Rick Foster, fosterre@purdue.edu, (765) 494-9572)

I caught my first earworm (Figure 1) moth in a pheromone trap last week. Earworms are very polyphagous, meaning they will eat lots of different plants. I suspect that any females that are flying are laying their eggs on wild plants of some sort and not on the seedling stage sweet corn or dent corn that is present in fields around the state. If you are one of the aggressive growers who grows sweet corn in the greenhouse and transplants it to the field to get that early market, your plants (unless they are covered by row cover) may be subject to earworm egg laying and feeding. This generation of larvae will be long gone before ears begin to form, so your only concern will be the foliar feeding damage and not ear infestation.

Corn earworm. (Photo by Dan Egel)

Freeze/Frost Probability Maps

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

The freeze/frost probability maps developed by Indiana State Climate Office are a great source for deciding field planting date. Figure 1 shows the average last day of 36°F or lower in Indiana; Figure 2 shows the dates, after which the last 36°F occurred in 1 in 10 years (10% chance).

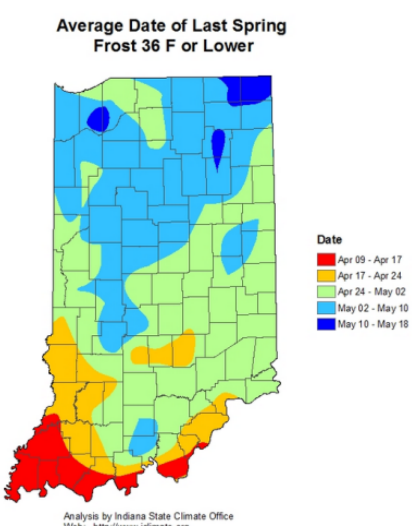

Figure 1. Average date of last spring frost 36 F or lower

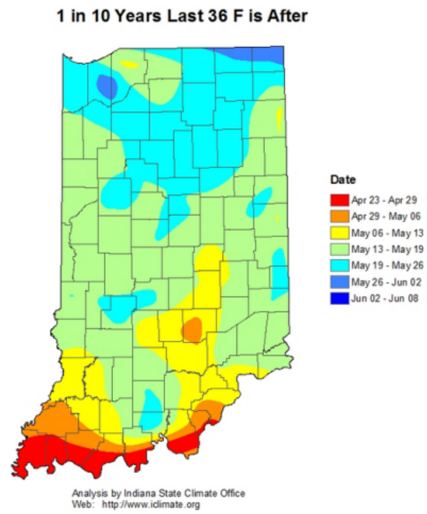

Figure 2. The last 36 F occurred in one in 10 years after the dates

Fungicide Spray Schedule for Cantaloupe and Watermelon

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

Foliar diseases of cantaloupe and watermelon can be a major negative impact on yield and fruit quality. This article will discuss management tools including cultural measures and fungicide schedules.

Know the foliar diseases that are likely to become a problem for Indiana production. The three most common foliar diseases of cantaloupe and watermelon are: Alternaria leaf blight, anthracnose and gummy stem blight. Other diseases of importance include Phytophthora blight and downy mildew.

A healthy field of cantaloupe or watermelon starts with healthy seed and transplants. Inspect seedlings as they are growing or at delivery for possible diseases. As suspicious symptoms arise, get an official diagnosis by calling me or sending the sample to the Purdue Plant and Pest Diagnostic Laboratory.

Remember, do not wait until symptoms of disease develop. Keep a regular schedule. To help watermelon growers apply fungicides according to the weather, Dr. Rick Latin at Purdue University developed MELCAST, a weather-based disease-forecasting system.

Contact fungicides should be the backbone of most cantaloupe and watermelon spray schedules. Two contact fungicides for this purpose have the active ingredient chlorothalonil or mancozeb. They may be used all season-long. Since both of these active ingredients have the FRAC code M, there is no need to alternate to a different mode of action.

Alternatively, contact fungicides may be used for most of the season with a few applications of relatively more expensive systemic fungicides included in the schedule. A contact fungicide is alternated with the systemic fungicides or systemic fungicides with different FRAC codes are used back-to-back. It is important not to use fungicides with the same FRAC codes back to back.

If the decision to integrate a few systemic fungicides into an application schedule is made, when should the systemic products be used? It is my belief that systemic products should be used at about lay-by. That is, at the point where the vines are piled on top of the plastic mulch-just after the last vine turning. However, a trial to determine the best time to apply systemic fungicides has been funded by the Illiana Watermelon Association this year at the Southwest Purdue Ag Center.

The comments above are applicable to the common foliar diseases mentioned above (Alternaria leaf blight, anthracnose and gummy stem blight). Let me briefly discuss two other diseases-Phytophthora blight and downy mildew.

Phytophthora blight is caused by a soilborne fungus-like organism. It is favored by heavy rains and poorly drained soils. More information about Phytophthora blight can be found in issue 600 of the *Vegetable Crops Hotline*. The most effective fungicides are specialized systemic fungicides. Since Phytophthora blight does not affect watermelon vines, start fungicide applications when fruit are about softball size. Cantaloupe are less susceptible to Phytophthora blight compared to watermelon, however cantaloupe vines may become diseased. Therefore, specialized products should be started whenever conditions become conducive.

The fungus-like organism that causes downy mildew of cucurbits doesn't overwinter in Indiana. Since the disease must 'blow in', downy mildew doesn't usually appear in Indiana until August or September. It doesn't make sense to apply specialized downy mildew products until the disease is nearby. Watch for developments at this website http://cdm.ipmpipe.org/ or read the *Vegetable Crops Hotline*.

Some general comments. Contact fungicides, such as chlorothalonil and mancozeb, are designed so that if applied to foliage in a manner to get good coverage the foliage is protected. That is, the fungicides covers the foliage and inhibits spores that may be deposited on leaves. Contact fungicides do not move into the plant.

Systemic fungicides move into the plant. But how far the system fungicides moves within the plant depends on the product. Most do not move more than inch. Almost all systemic fungicides move toward the tip of the plant, not toward the base or roots. Systemic fungicides may have some efficacy against existing disease. Nevertheless, both contact and systemic fungicides are much more effective when applied before disease has become established.

I have mentioned a few fungicides in particular here, but just as examples. There may be other fungicides more effective for your purpose. See the *Midwest Vegetable Production Guide for Commercial Growers* for more information.

Another version of this article was published in the veggiediseaseblog.org.

Cost Considerations Prior to the Purchase of a High Tunnel or Greenhouse

(Petrus Langenhoven, plangenh@purdue.edu, (765) 496-7955)

The cost of high tunnel and greenhouse infrastructure is high. The purchase price of high tunnels can vary between $2.00 and $7.00 per square foot, while climate controlled greenhouse costs can vary between $7.00 and $30.00 per square foot. Several factors have an impact on the costs of setting up new high tunnel or greenhouse infrastructure.

1. **Location** – It is essential that the terrain selected for the construction of high tunnel and greenhouse infrastructure be well drained and level. High tunnels and greenhouses displace rainfall and provision has to be made for drainage infrastructure to redirect the water. Additionally, provision has to be made for new irrigation lines and if necessary, electricity and gas. As a general rule the distance of high tunnels and greenhouses from obstacles like trees or a building should be twice the height of that obstacle. This also applies to the distance between high tunnels or greenhouses when they are orientated east-west. When the orientation is north-south the distance can be as little as 4 feet between the tunnels. Windbreaks can be an important protection strategy if your farm is located in a high wind area. The effectiveness of windbreaks, i.e. trees or structural, is determined by its height, density and orientation, and should be on the northwest and southeast side of the infrastructure. Furthermore, the distance of your farm from contractors and vendors can increase the cost of infrastructure development.
2. **Crop Type and Growing Environment** – The type of crop grown (warm weather or cool season), the climatic conditions at the production location, and the main production season targeted will determine the specifications of the infrastructure and equipment necessary to produce the crop; i.e. warm weather crops produced in colder climates during the winter will require a higher level of investment. Considerations will include, but are not limited to, the snow load of the structure, the type of glazing material used and the amount of additional heat and light that needs to be provided. Similarly cool season crops that are grown during the hottest time of the year will require systems that can cool the production environment. If a crop is grown that requires trellising, then there is a need for a crop support system which either can be fixed to the high tunnel or greenhouse or can be a stand-alone system within the infrastructure. The type of crop, the growth substrate and container used, and climatic conditions will determine the type of irrigation system used.
3. **Size and Technology** – High tunnels can vary in size, anywhere from 20 ft. wide and 48 ft. long to 34 ft. wide and 96 ft. long, along with variability in height. Questions

to ask when choosing the structure design and options include:

- Do I need gable shutters or a continuous ridge vent, and roll-up windows on the side?
- Are the shutters, ridge vent and roll-up windows going to be manually adjusted or will it be automated?
- How high do I need the roll-up windows to open; 4 ft., 5 ft. or higher?
- What is the end wall going to look like and what material will it be made of?
- Which additional climate (i.e. screen, extraction and circulation fans, misting, wet-wall, boiler, propane heater) and irrigation equipment and control systems will be required?
- Which floor covering material will be used?
- Which glazing material am I going to use?
- If it is plastic, will it be a single or double layer?

Similar to high tunnels, climate controlled greenhouses can vary in size, but one greenhouse can also cover several acres. The level of sophistication in gutter-connect greenhouses can also vary significantly.

It is clear that infrastructure costs are influenced by many factors. But what is certain is that the cost per square foot is driven by size, design and equipment needs. Usually smaller high tunnels and greenhouses cost more per square foot. Similarly, a more extensive and complicated design with the additional need for more equipment will result in a higher cost per square foot.

More importantly, the crop type, production window targeted, consumer demand and price will determine when a crop is produced and the level of infrastructure investment needed. A higher investment in a fully climate controlled greenhouse will result in better yield forecasting and ultimately higher yields of high quality compared to a high tunnel. It is imperative for the grower to do a comprehensive economic feasibility study and life cycle analysis to compare implementation costs between high tunnels and greenhouses to gains from increased production capacity and quality. Existing or new farming enterprises need a business plan that can help with the decision making process. Dr. Maria Marshall, a professor at Purdue University's Agricultural Economics Department, developed an online business planner that can help you write a business plan using a question and answer format. The **INventure Business Planner** tool can be found at http://www.purdue.edu/newventure/.

Be Sure to Use Proper Techniques When Collecting Water Samples

(James Scott Monroe, jsmonroe@purdue.edu, (812) 886-0198)

With the 2016 growing season upon us, many produce growers will soon be collecting water samples from irrigation and postharvest water sources for microbiological analysis. Using proper techniques to collect water samples will help to prevent inaccurate testing results.

When collecting water samples, one should start with the appropriate collection container. Many laboratories will only test water samples that are received in their containers. Consequently, it is important to select a lab, determine their individual requirements, and obtain the appropriate containers prior to collecting samples. Generally, containers used for water sampling will be large enough to hold at least 100 ml of water. The interior should be sterile and the container should be sealed to prevent contamination. Sampling containers may also contain crystals or tablets when received from the lab. These tablets or crystals are made of sodium thiosulfate and are place in the container to neutralize any chlorine that may be in the water sample. They should not be removed.

If irrigation water from a well is being sampled, it is a good idea to collect the sample as close to the water source as possible. This means collecting the sample from the outlet that is closest to the well. Prior to collecting, the rim of the outlet (valve, spigot, etc.) should be sanitized. This can be done using a flame or chlorine. The system should then be allowed to run and water should be allowed to flow out of the outlet long enough to flush the system. A good rule of thumb is to run the system at least 3-5 minutes longer than is necessary to empty the volume of stagnate water remaining from the last use. To collect the sample, the seal on the sample container should be removed or broken and the sample container should be opened only as far as needed to collect the sample. Containers should be filled at least to the fill line and should be closed as quickly as possible. Once the sample is collected, the container should be marked with the date and time of collection and immediately cooled. Samples should be kept as cool as possible by icing or refrigerating until they are delivered to the lab. Many labs have a maximum time interval between collection and sample receipt, usually 24 hours. Samples received too long after collection will not be processed. Those growers who are covered under the Food Safety Modernization Act Produce Rule should pay special attention to time requirements, as the rule specifies EPA Method #1603, which only allows a maximum of 8 hours from sample collection to processing.

If sampling from surface water, such as ponds and lakes, one should try to sample at a depth of 6-12 inches. The container should be submerged prior to opening the lid. The container should then be filled and the lid put back in place prior to removing it from the water. If a dock or other structure is not available for access to deeper water, one can attach a sample container to a pole. Care should be taken not to sample too close to the bottom, as sediments may be collected with the sample. If one finds it necessary walk into the water, sampling should be done ahead of the muddy front that is stirred up by motion. Remember that excess rainfall can also stir up bottom sediments and alter test results. Samples should not be taken immediately after rainfall. Best practice is to collect the sample during a time when the water would normally be used for irrigating. If irrigating from flowing surface water, such as a creek or stream, and it is necessary to wade into the water, be sure to sample from the upstream side, again to avoid collecting stirred up sediments.

Collecting samples of water used for postharvest is similar to collection from an irrigation well. One should select an outlet close to where water lines come into the packing facility. All attachments such as aerators or garden hoses should be removed. The outside rim of the outlet should then be sanitized and water should run through the outlet for 3-5 minutes. The sample container may then be filled, taking care to make sure that the container is open for as little time as possible.

In many cases, unexpected results from a water test can be traced back to poor or inappropriate collection techniques. Details such as not flushing the system, failing to remove attachments, and sampling too near the bottom of surface water can drastically alter water test results. Taking some time to practice proper collection techniques prior to the upcoming season will help to ensure that your water test results are as accurate as possible.

Upcoming Events

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

Beginning Farmer Tours

May 26: South Circle Farm, Indianapolis. Urban agriculture, organic farming and key tools for managing small-scale farming operations.

June 25: Silverthorn Farm, Rossville. Organic fruits and vegetables, pastured pork and working with restaurants.

July 14: Melon Acres, Oaktown. Community-supported agriculture and agritourism.

Sept. 29: River Ridge Farm, Roann. Four-season vegetable farming, operating an on-farm store, and farm-to-school programs.

The tours are free, but registration is required. Registration at https://mdc.itap.purdue.edu/wk_group.asp?wk_group=BeginFarmer

For more information about the Beginning Farmer and Rancher program, or the farm tour schedule, contact Kevin Gibson at (765) 496-2161 or kgibson@purdue.edu.

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