VEGETABLE CROPS HOTLINE

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

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In This Issue

New Fungicide for Vegetables

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

New fungicide – I would like to announce the release of a new fungicide, Orondis® from Syngenta. It is a good product and should help commercial vegetable growers in combating downy mildew of cucurbits, Phytophthora blight of cucurbits, peppers and tomato, Buckeye rot of tomato and late blight of potato and tomato. However, I also want to discuss Orondis® because of the complicated way in which it is being released. Be advised that the listing for Orondis® in the *MW Vegetable Production Guide for 2016* (*ID-56*) is incorrect. Please see the on-line version of the *ID-56* for the most current information.

Orondis® has a new active ingredient which does not appear in any other fungicide and a novel mode of action, FRAC code U15. But you will not be able to purchase Orondis® on its own. It will be available as 3 different multi packs or co-packs. Each multi-pack will contain two jugs, each with a different active ingredient and mode of action. The products in the multi-pack are intended to be used as a tank mix. The correct use of the products will help to prevent the emergence of strains of the pathogens that are resistant to FRAC group U15. See Table 1 below for details.

This blog discusses the use of Orondis® products with cucurbits and solanaceous crops because I believe that Orondis® should have the greatest impact on these crops. However, many other crops are listed on the Orondis® label. For more details, check with Syngenta, your local chemical representative or me.

Table 1: Orondis® products will be available in 2016 as multi-packs. That is, growers will purchase a box with 2 different jugs. Each jug contains a different fungicide. Mix both products together as a tank mix in water for application. Follow the rate information on each product. Use the most restrictive REI and PHI* for each product in a multi-pack. After using one of the Orondis® products, alternate to a product with a different mode of action. Do not apply a foliar application of an Orondis® product after a soil application of an Orondis® product. That is, use soil or foliar applications of Orondis®, but not both.

Name of multi pack	Products in multi pack (REI)	Common name of a.i. (FRAC code)	Crops (PHI)	Rates
Orondis opti	Orondis Opti A (4)	Oxathiapipropilin (U15)	Cucurbits (0)	2-4.8 fl. oz/A
			Pepper (0)	
			Tomato (0)	
			Potato (5)	1.6-4.8 fl. oz/A
	Orondis Opti B (12)	Chlorothalonil (M)	Cucurbits (0)	2 pts/A cucurbits
			Pepper (3)	1.5 pts/A
			Tomato (0)	2 pts./A
			Potato (7)	¾ pts/A
Orondis Ridomil Gold SL**	Orondis Gold 200 (4)***	Oxathiapipropilin (U15)	Cucurbits (0)	2.4-19.2 fl. oz.
			Pepper (0)	
			Tomato (0)	
	Ridomil Gold SL (48)	Mefenoxam (4)	Cucurbits (5)	1-2 pts/A
			Pepper (7)	1 pt/A
			Tomato (7)	1-2 pt/A
			Potato (14)	3.2 fl oz./A
Orondis Ultra	Orondis Ultra A (4)	Oxathiapipropilin (U15)	Cucurbits (0)	2-4.8 fl. oz
			Pepper (0)	
			Tomato (0)	
			Potato (5)	1.6-4.8 fl. oz/A
	Orondis Ultra B (4)	Mandipropamid (40)	Cucurbits (0)	8 fl oz/A
			Pepper (1)	
			Tomato (1)	
			Potato (14)	

* PHI=Pre-harvest Interval in days; REI=Restricted Entry Interval in hours.

**Orondis Ridomil Gold SL may only be applied to soil.

***Orondis Gold 200 is not labeled for potato.

Updates to the 2016 MW Vegetable Production Guide for Commercial Growers

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

Updates to the *MW Vegetable Production Guide for Commercial Growers 2016* (*ID-56*)-The table below gives the changes that have been made to the on-line version of the *ID-56* as of this date. If you have purchased, or will purchase, a hard copy of this guide, please make these changes. If you use the *ID-56*, these updates will already have been incorporated.

Note, many of the changes have to do with the newly registered Orondis® products from Syngenta. Please contact me with any questions.

Page	Comment
42	Move Oberon® from the label prohibits greenhouse use to the column label silent on greenhouse use.
43	Move Quintec® from the column label silent on greenhouse use to label prohibits greenhouse use.
74	Add row… Orondis Opti® /oxathiapiproplin (U15); chlorothalonil (M)/medium-high/U15, M
74	Add row…. Orondis Ridomil Gold SL®/oxathiapipropilin (U15); mefenoxam (4); /medium-high/U15, 4
74	Modify row… Orondis Ultra®/oxathiapipropilin (U15); mandipropamid (40)/U15, 40
74	oxathiapipropilin under common name, is one word. Same row as Orondis Ultra.
108	Under downy mildew…add Orondis Opti® Follow rates given on each container of multi-pack. 0-Day PHI. Apply as tank mix of both products in multi-pack.
108	Under downy mildew….change Orondis Ultra® entry to…. Orondis Ultra® Follow rates given on each container of multi-pack. 0-Day PHI. Apply as tank mix of both products in multi-pack.
109	Under Phytophthora …add Orondis Opti® Follow rates given on each container of multi-pack. 0-Day PHI. Apply as tank mix of both products in multi-pack.
109	Under Phytophthora…add Orondis Ridomil Gold SL® Follow rates given on each container of multi-pack. 5-Day PHI. Apply as a mix of both products in multi-pack to soil only.
109	Under Phytophthora….change Orondis Ultra® entry to…. Orondis Ultra® Follow rates given on each container of multi-pack. 0-Day PHI. Apply as tank mix of both products in multi-pack.
109	Add as recommended product under powdery mildew, “Vivando® at 15.4 fl. oz. per acre. 0-Day PHI Comment: Must be in possession of supplemental label.”
111	Add-Vivando® (12/0)/metrafenone (U8)/G under powdery mildew/Comment: must be in possession of supplemental label.
111	Add-Forum® 4.18 SC (12/0)/dimethomorph (40)/add G for downy mildew and G for Phytophthora/comment: Do not alternate with Revus®.
111	Revus®-add) in second column
111	Change G to F under powdery mildew for Inspire Super®, Luna Sensation®,Monsoon®
111	Change G to P under powdery mildew for Pristine®.
111	Add row… Orondis Ridomil Gold SL® (48/5)/oxathiapipropilin (U15), mefenoxam (4)/‘G’ under Phytophthora blight/Apply as mix of both products in multi-pack to soil.
111	Modify row… Orondis Ultra® (4/0)/oxathiapipropilin (U15), mandipropamid (40)/‘G’ under downy mildew, ‘G’ under Phytophthora blight/ Apply as tank mix of both products in multi-pack.
124	Under Phytophthora…add Orondis Opti®. Follow rates given on each container of multi-pack. 0-Day PHI. Apply as tank mix of both products in multi-pack.
124	Under Phytophthora…add Orondis Ridomil Gold SL® Follow rates given on each container of multi-pack. 7-Day PHI. Apply as a mix of both products in multi-pack to soil only.
124	Under Phytophthora….change Orondis Ultra® entry to…. Orondis Ultra® Follow rates given on each container of multi-pack. 0-Day PHI. Apply as tank mix of both products in multi-pack.
129	Under Buckeye rot/Phytophthora…add Orondis Opti® Follow rates given on each container of multi-pack. 0 Day PHI. Apply as tank mix of both products in multi-pack.
129	Under Buckeye rot/Phytophthora blight…add Orondis Ridomil Gold SL® Follow rates given on each container of multi-pack. 7-Day PHI. Apply as mix of both products in multi-pack to soil only.
129	Under downy mildew….change Orondis Ultra® entry to…. Orondis Ultra® Follow rates given on each container of multi-pack. 1-Day PHI. Apply as tank mix of both products in multi-pack.
130	Under late blight…add Orondis Opti Follow rates given on each container of multi-pack. 3-Day PHI. Apply as tank mix of both products in multi-pack.
130	Under late blight add…. Orondis Ultra Follow rates given on each container of multi-pack. 1-Day PHI. Apply as tank mix of both products in multi-pack.
132	Add row… Orondis Opti® (4/3)/oxathiapipropilin (U15), chlorothalonil (M)/‘VG’ under late blight, ‘VG’ under Phytophthora blight/Apply as tank mix of both products in multi-pack.
132	Add row… Orondis Gold 200 (48/28)/oxathiapipropilin (U15), mefenoxam (4)/‘VG’ under Phytophthora blight/Apply as mix of both products in multi-pack to soil.
132	Modify row… Orondis Ultra® (4/1)/oxathiapipropilin (U15), mandipropamid (40)/‘VG’ under late blight, ‘VG’ under Phytophthora blight/Apply as tank mix of both products in multi-pack.
132	Table footnotes: add under fungicide rating…. ‘VG=very good’
175	Add….under late blight…. Orondis Opti® Follow rates given on each container of multi-pack. 7-Day PHI. Apply as tank mix of both products of multi-pack.
175	Add….under late blight…. Orondis Ultra® Follow rates given on each container of multipack. 14-Day PHI. Apply as tank mix of both products of multi-pack.

Opportunities in Hydroponics

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

Travelling through Indiana last summer, I realized that many growers plant their crops in soil inside their high tunnels or greenhouses. Soilless production offers different benefits and challenges. This is the first article in a series focusing on soilless crop production in high tunnels and greenhouses. Today we are discussing Hydroponics.

What is Hydroponics? The word hydroponics technically means ‘working water’, derived from the Latin words “hydro” meaning

water and “ponos” meaning labor. Hydroponics is a method to grow plants using a mineral nutrient solution, in water and without soil. Two types of hydroponics are commonly found: a) solution culture, and b) medium culture. Solution culture types include continuous flow solution culture (Nutrient Film Technique) and Aeroponics. Medium culture types include ebb and flow sub-irrigation, run to waste, deep water culture and passive sub-irrigation systems.

History. The first research published on the production of spearmint in water was conducted by John Woodward in 1699. Discoveries made in the late 19th century by German scientists Sachs and Knop resulted in the development of the technique of soilless cultivation. This work inspired Dr. W.F. Gericke (University of California) in the 1920’s to develop a solution culture technique. Following his work, Hoagland and Arnon (University of California) developed a complete hydroponic nutrient solution in 1938, the ‘Hoagland Solution’. The solution was modified several times by different researchers. However, the soilless cultivation technique was first used on a large scale during World War II to produce food for the American troops stationed on the in fertile Pacific islands.

Solution Culture:

1. Nutrient Film Technique (NFT). This is the most common system used in solution culture. The water containing all the dissolved nutrients is recirculated on a continuous basis past the roots. A shallow stream (film) of water flows in a watertight, dark channel. The plant roots develop at the bottom of the channel, allowing for an abundant supply of oxygen and nutrients to the roots. The channel is installed at a recommended slope of 1:100, but 1:30 and 1: 40 is also used at times. As a general guide, the flow rate is 1 liter (0.26 gal.) per minute with an upper limit of 2 liter (0.53 gal.) per minute. Channel length should not exceed 10-15 meters (33-49 ft.). It is very important that the operator pay close attention to irrigation (24 hr. continuous), nutrient balances, water temperature and pathogens. This is a very productive system, but unforgiving when mistakes are made (Figure 1).

Figure 1. Lettuce is grown in channels using the Nutrient Film Technique

2. Aeroponics. In this system roots are continuously or discontinuously kept in a dark environment saturated with a mist or an aerosol of nutrient solution. This is a very popular system for the production of mini potato tubers (potato seed production). This system use less water than the NFT system, but is more capital intensive and requires a high level of technical knowledge. Production is very dependent on the functioning of the system, meaning the grower cannot afford an interruption in electricity or water supply or any mechanical failure.

Medium Culture: With medium culture a solid medium is used for root growth and anchorage, the plants are either sub- or top irrigated, and the plants are planted in a container. Today we are only concentrating on the Ebb and Flow and Run to Waste production systems.

1. Ebb and Flow. In most cases growers make use of ebb and flow benches to subirrigate potted plants. However, large scale farms sometimes make use of big cement basins to subirrigate a large numbers of plants at one time. This technique is often used for seedling production and the production of potted plants in the floriculture industry. This technique does require large volumes of water. A root pathogen free environment is key to the success of this system.

Figure 2. Ebb and Flow benches used for seedling propagation

2. Run to Waste. This system consists of plants planted in a soilless substrate in individual containers and they are individually irrigated. Generally the excess irrigation water that runs out of the container is not collected for recycling purposes. However, this system is ideally suited for the collection of irrigation water if the high tunnel or greenhouse floor is covered with a plastic flooring film or when the container is situated in a trough that allows for the collection of water. It is important to note that disinfection of recycled water is absolutely imperative to avoid any root disease issues. More information in regards with irrigation water recycling will be provided in a follow up article.

Figure 3. Tomato plants grown in individual bags filled with substrate, using the Drain to Waste system

Different types of containers can be used in a run to waste system. It could be a plastic bag or a pot of different dimensions, a slab of substrate covered with plastic or it could be a continuous trough filled with substrate. It all depends on which system is best for the crop and the management style of the grower. Some very popular inorganic substrates include rockwool, perlite and vermiculite. Other popular organic substrates include pine sawdust, peat, coir (coconut fiber) and rice hulls. All of these substrates have different physical and chemical properties and will be discussed in more detail in the series of articles.

Figure 4. Cucumbers grown in a continuous trough filled with substrate, using the Drain to Waste system

However, a good growing media (substrate) should have physical and chemical properties that allow for nutrient retention, gas exchange/aeration, and water retention and drainage. The type of plant produced, and the cost and availability of the substrate will determine which substrate is best suited for maximum growth and yield. Each substrate have different characteristics and requires different cultivation techniques and management practices.

Soilless crop production allows the grower total control the production environment, especially the root zone. The root zone pH and electrical conductivity (EC) can be adjusted at any time. More frequent irrigations allow for better control over the pH, EC and nutrient availability, which in the end optimizes production. Recycling of the excess irrigation water can also bring great savings to the grower in terms of the amount of water and fertilizer used.

In the next *Vegetable Crops Hotline* issue I will focus on 'Soil vs. Soilless High Tunnel and Greenhouse Production' and we will also take a look at 'Growth Substrates'.

Seed and Root Maggots

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

Three species of seed and root maggots attack vegetables in Indiana. The seedcorn maggot (Figure 1) feeds on seeds and seedlings of sweetcorn, cucurbits, lima and snap beans, peas, and other crops. Cabbage maggots can cause serious damage to transplants of cabbage, broccoli, cauliflower, and Brussels sprouts and make the fleshy roots of radishes, turnips, and rutabagas unmarketable. Onion maggots are pests of seedling onions, developing bulbs and onions intended for storage.

Figure 1. Seedcorn maggot on corn kernel (*Photo by John Obermeyer*)

Seedcorn maggot flies emerge in April and May and lay eggs preferentially in areas with decaying organic matter. Fields that are heavily manured or planted to a cover crop are more likely to have seedcorn maggot injury. Maggots burrow into the seed and feed within, often destroying the germ. The seeds fail to germinate and plants do not emerge from the soil, leaving gaps in the stand. When infested seeds germinate, the seedlings are weak and may die. Maggots also will feed within the stems of transplants.

Any condition that delays germination may increase damage from this pest. Damage can be reduced by planting into a well-prepared seedbed, sufficiently late to get rapid germination. The slower the rate of growth, the greater the likelihood of seedcorn maggot injury. For any type of early season transplant, soil temperatures should reach at least 70° F or more for 4-5 days in a row to avoid maggot injury. Anything that raises soil temperature (black or clear plastic mulch) will increase soil warming and decrease the possibility of seedcorn maggot injury. Once damage is observed, the only management strategy available is the

decision to replant or not. If you decide to replant, be sure to use treated seed. When resetting transplants be sure to wait 5 days from the first evidence of wilted plants before you reset. Unfortunately, we don't have any insecticides that can be applied at planting time that will provide good control of seedcorn maggots. Admire Pro® and Platinum®, which both provide several weeks of excellent systemic control of striped cucumber beetles when applied at planting, are not labeled for seedcorn maggots and the control is marginal at best. Capture LFR® is labeled for control of wireworms, grubs, and other soil insects on cucurbits but not for seedcorn maggots. I have one year of data with Capture® that showed fairly promising results, but more data are needed.

Cabbage maggot (Figure 2) injury is also favored by cool, wet conditions. The flies, slightly smaller than a housefly, emerge in late April or early May and lay white eggs at the base of newly set plants. Larvae from this first generation tunnel in the roots of small plants, causing the plants to appear sickly, off color or stunted, and may cause them to die. Early cabbage and turnips are particularly vulnerable to damage. Control of first generation maggots can be achieved using soil insecticides such as Capture LFR, Lorsban or diazinon at planting or transplanting. For short season crops such as radishes and turnips, long-residual insecticides cannot be used. Cabbage maggots usually do not affect later planted crucifers.

Figure 2. Onion maggots on garlic (*Photo by John Obermeyer*)

Onion maggot flies emerge throughout May and lay eggs at the base of onion plants. The maggots attack the underground portions of the onion plants and cause plants to wilt and die. Seeded onions are more susceptible than transplanted onions. Do not overseed to compensate for losses to onion maggots. The flies do not space their eggs evenly, so you may end up with smaller bulbs because the plant spacing is too close. The second-generation flies emerge during July and the third generation emerges during late August and early September. Each generation will damage onions.

Removing cull onions after harvest and planting as far as possible from fields planted to onion the previous year can reduce damage. Soil drenches of Lorsban® (dry bulb only) or diazinon at planting will effectively control first generation maggots and provide some control of the second generation. As the onions begin to mature, they become physically resistant to attack from onion maggots, unless they have been injured in some way. Be careful during field operations not to damage the growing plants in any way. A nick in an onion bulb allows the maggots to enter and begin feeding. Also, the flies are attracted to damaged onions to lay eggs. Reducing the amount of physical damage to the onions at harvest as much as possible will also reduce the amount of injury from the third generation. Do not apply foliar sprays to kill flies before they lay eggs.

Pheromones and Pheromone Traps

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

One way insects communicate with individuals of the same species is with pheromones. Pheromones are volatile chemicals released by an insect that usually can be detected only by individuals of the same species. There are a number of different types of pheromones, but the most common type is the sex pheromone. Usually the females will emit a tiny amount of a chemical that attracts the male to her and increases the likelihood of mating. Because the chemical is volatile, air currents carry it. The male detects the pheromone in the air with receptors on his antennae. He then flies upwind to find the source of the pheromone, a prospective mate. The chemical compositions of pheromones for a number of pest species have been identified and synthetic copies can be produced in the laboratory. Synthetic pheromones can be used in conjunction with traps to catch male insects.

Listed below are some, but certainly not all, of the suppliers of pheromones and traps.

Alpha Scents, Inc. 1089 Williamette Fals Drive, West Linn, OR 97068. 503-342-8611; www.alphascents.com

Gempler's; P. O. Box 270; 100 Countryside Dr.; Belleville, WI 53508; 800-382-8473; www.gemplers.com

Great Lakes IPM; 10220 Church Rd., NE; Vestaburg, MI 48891; 517-268-5693; www.greatlakesipm.com

Insects Limited Inc.; 16950 Westfield Park Rd.; Westfield IN 46074-9374; 317-896-9300; www.insectslimited.com

Pacific Biocontrol Corporation; 620 E. Bird Lane, Litchfield Park, AZ 85340; 623-935-0512 or 800-999-8805; www.pacificbiocontrol.com

Scentry Biologicals Inc.; 610 Central Ave.: Billings MT 59102; 800-735-5323; www.scentry.com

Trece Incorporated; P. O. Box 129. Adair, OK 74330; 866-785-1313; www.trece.com

You can buy most pheromone traps from these suppliers, but for corn earworm/tomato fruitworm, I recommend that you use the wire mesh trap which is available from: Bob Poppe's Service; 25738 N. 3200 Road; Lexington, IL 61753; 309-723-3201. The wire traps catch more moths and last longer than the nylon traps.

To get the most from your pheromone traps, they must be used properly:

- Place the traps and the pheromones out before you would

normally expect the insect pest to be active. That way you can monitor the adult activity, which will warn you that damage from the larvae may be coming soon. Corn earworm pheromone traps should go out about June 1.
- Be careful how you store pheromones. Ideally, they should be frozen until ready for use. At the very least, they should be refrigerated. If you keep them on the dashboard of your truck, they won't work well when you place them in the trap.
- When handling pheromone lures, do not touch them with your hands. Use a pair of forceps or wear latex gloves. This is especially important when you are using pheromones for more than one pest. Contamination of a lure with another pheromone will likely reduce the effectiveness.
- Lures usually should be changed every 3-4 weeks, although this will vary for individual lures.
- Check traps regularly, at least weekly. Daily would be better.

Neonicotinoid Seed Treatment on Cucurbits

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

In recent years, many seed companies have begun using the neonicotinoid insecticide thiamethoxam (FarMore) as a seed treatment on cucurbit and other vegetable seeds. Thiamethoxam is a systemic insecticide that moves from the seed coat into the seedling and then moves throughout the plant. Research has shown that these seed treatments provide about 3 weeks of excellent control of cucumber beetles, aphids and other pests. Unfortunately, the systemic nature of the insecticide also results in residues being present in the pollen that could potentially be harmful to honey bees and other pollinators. Although these seed treatments are a good pest management tool, growers should be cautious in how they use them to avoid possible harm to pollinators. Our research has shown that cucurbits that are grown in the greenhouse for 4-5 weeks before being transplanted into the field, do not have enough of the insecticide left in the stem and leaves to provide any protection from striped cucumber beetles, although there is sufficient residue in the pollen to harm pollinators. Therefore, I don't recommend the use of insecticide treated seed for crops grown as transplants. For direct seeded crops, the seed treatment will provide about 3 weeks of control so growers should weight the benefit of the seed treatment vs. the potential harm to pollinators. If you choose to direct seed untreated seeds, you still have the option of using foliar insecticides for control of cucumber beetles, with less risk to pollinators.

Edema on Tomato Rootstocks

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

Tomatoes grown in controlled environment are exposed to conditions that are different from their original habitats. As a result, varieties that are not specifically bred for greenhouse production may respond to the controlled environment with abnormal symptoms. One group of the symptoms is called edema. Bumps, galls or blisters develop on tomato leaves, petioles or stems (Figure 1). In severe conditions, it causes leaf curling, distortion and abscission (Figure 2). A couple of factors including high humidity, excessive water in the soil, air pollution, and low light condition could cause the symptom. Tomato varieties respond differently in susceptibility to the physiological disorder, and the primary contributing factors can also be different among tomato varieties.

Figure 1. Edema symptom on tomato leaves (*Photo by Dan Egel*)

Figure 2. Edema causes tomato leaf curing on 'Maxifort' seedlings

The most severe case of edema that we have observed so far is on tomato rootstocks including 'Maxifort'. This is not surprising as most of the commercial tomato rootstocks are hybrid of wild tomatoes *Lycopersicon esculentum* and *L. hirsutum*. Both of the species are highly susceptible to the physiological disorder. We

noticed a dramatic difference of 'Maxifort' grown in two greenhouses. One of them is made of polycarbonate that has 18% of UV light transmittance, the other one is made of polyethylene with 80% of UV light transmittance. Edema developed on 'Maxifort' that are grown in the polycarbonate greenhouse at the time when plants had 3-5 true leaves. However, the symptom was not observed on 'Maxifort' grown in the polyethylene greenhouse. A study conducted at University of Wisconsin confirmed that the primary contributing factor for edema on 'Maxifort' is due to lack of ultraviolent light, while soil moisture affect severity of the symptom to a smaller extent.

If the rootstocks show edema symptom, can they still be grafted? As a general rule, we do not want to graft plants that are diseased or stressed. However, edema is not contagious, and it can be managed by exposing plants to full sunlight if the symptom is detected in an early stage. If the symptom is reduced, those rootstock plants can still be used in grafting. However, if the symptom is at an advanced stage that leads to abscission of most of the leaves, those plants can not be grafted.

Lettuce Drop

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

Cool season crops such as lettuce are becoming a more popular crop among Indiana greenhouse/high tunnel growers. One of the most important diseases of lettuce is known as lettuce drop.

The symptoms of lettuce drop are often noticed after the thinning stage, early in the crop development. The early symptoms may include browning of leaves. Later on in the crop development, the outer most leaves of the lettuce plant may wilt. As the disease become more severe, inner leaves may become infected. Eventually, the entire plant may collapse. The plant often has white mold on the leaves and dark irregular fruiting bodies may be observed (Figure 1). The dark fruiting bodies are known as sclerotia.

Figure 1: The symptoms of lettuce drop include a white mold that covers much of the plant and the dark, irregular sclerotia that are observed here. (*Photo by Wenjing Guan*).

Two different organisms may be responsible for lettuce drop. *Sclerotina sclerotiorum* and *S. minor*.

Lettuce drop caused by *S. sclerotiorum* requires a chilling period (52 to 59° F) for the sclerotia to turn into mushrooms smaller than a dime. These mushrooms then produce spores that may cause disease of lettuce if there is adequate leaf wetness. *S. minor*, in contrast, is seldom caused by spores from a mushroom. Instead, lettuce drop caused by *S. minor* is often caused by direct germination of the sclerotia in the soil.

In summary, *S. sclerotiorum* usually causes disease through mushrooms that sprout after a sufficient chilling period. Thus, mushrooms some distance away from the lettuce could cause *S. sclerotiorum* infection. *S. minor* mostly causes disease through direct germination of sclerotia in the soil. *S. minor* infections, therefore, are most likely the result of close contact with soil infested with sclerotia.

It is my opinion that lettuce drop in Indiana greenhouses is more likely caused by *S. sclerotiorum.* Part of the reason for this belief is that *S. sclerotiorum* is the same organism responsible for white mold of tomato. Tomato is a common crop in Indiana greenhouses and is commonly rotated with lettuce. Also, sclerotia produced by *S. sclerotiorum* tend to be larger and more irregularly shaped than those produced by S. minor. The sclerotia in figure 1 are from Indiana and are most likely *S. sclerotiorum.*

Fungicides may help to reduce the incidence of lettuce drop. Products labeled and either approved or silent on greenhouse use include: Botran 75W®, Cannonball®, Fontelis®, Rovral® and Switch®. The product Contans®, which is organically approved in many systems, is a hyperparasite of both *S. sclerotiorum* and *S. minor*. Contans® must be worked into the soil.

Other cultural methods of disease reduction include:

- Deep plow soil to get sclerotia well under the soil surface.
- Long crop rotations with a non-host may help to reduce disease.
- Anything which can be done to increase ventilation/decrease leaf wetness will help to reduce disease severity of lettuce drop caused by *S. sclerotiorum.*

Please see the *Midwest Vegetable Production Guide for Commercial Growers 2016* (*ID-56*) for more information <mwveguide.org>.

Produce Rule Water Testing Requirements

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

In January 2016, *Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption*, otherwise known as the Produce Rule, became law. This rule, as part of the Food Safety and Modernization Act, sets a standard for produce food safety. Not all growers are covered by the rule. An excellent flowchart to help determine coverage may be found at

http://www.fda.gov/downloads/Food/GuidanceRegulation/FSMA/UCM472499.pdf. Those growers who are covered by the rule will have from 2-4 years, depending on farm size (defined by gross sales), to be in compliance. All growers will then receive an additional 2 years to comply with the water testing component of the rule.

The water testing component of the produce rule requires growers to regularly test irrigation water. Growers irrigating with surface water (ponds, lakes, streams, ditches) are required to collect and test 20 samples over a two-year period in order to establish a baseline. Once the baseline is established, 5 samples must be collected and tested every year thereafter. Growers using underground water sources (i.e. wells) will be required to initially collect and test 5 samples over a one-year period in order to establish a baseline. Once the baseline is established, below ground water sources will need to be tested once annually.

When writing the produce rule, the Food and Drug Administration (FDA) chose to use generic *E. coli* as an indicator of water quality. Indicators, while not human pathogens, are used to indicate the potential for contamination with a human pathogen. The reasoning is that if the indicator organisms are present, there is a reasonable likelihood that human pathogens may also be present. As a result, water samples collected by growers who are covered by the produce rule will need to be tested for generic *E. coli*, in addition to any other tests the grower may require.

For all irrigation water, the geometric mean of sample results cannot exceed 126 colony forming units (CFU) of generic *E. coli* per 100 ml of water. Additionally, the statistical threshold value cannot exceed 410 CFU generic *E. coli* per 100 ml. In the case of surface water, the initial 20 samples will be used to confirm that the irrigation water meets quality standards. After baseline establishment, growers will use the most current year's test results (5 samples) and the 15 most recent test results from previous years to create a rolling dataset of 20 test results from which new threshold calculations are performed annually. In the case of irrigation water from below-ground sources, an initial 4 samples will be used to confirm that the irrigation water meets quality standards. After baseline establishment, growers will use the previous year's test results (1 sample) and the 3 most recent test results to create a rolling dataset of 4 test results from which new threshold calculations are performed annually.

This standard applies to all water applied to the crop prior to harvest. In writing the produce rule, FDA chose not to differentiate between methods of irrigation. Consequently, the water testing requirement and thresholds apply whether growers utilize drip or overhead irrigation. In cases where growers' test results exceed the thresholds, the issue must be addressed and corrected. Growers have the following options:

1. Allowing time for microbial die-off in the field between irrigation and harvest. Growers may assume a 0.5 log reduction per day in microbe levels.
2. Treating the water or water source with an approved sanitizer
3. Finding an alternative water source that meets requirements.

Water used for postharvest must be potable, which means no detectable generic *E. coli*. It is the responsibility of each farm to be able to demonstrate that their postharvest water meets this quality standard. In the case of farms using well water for packing lines or for other postharvest uses, they will need to document that the water is of sufficient quality by having the well tested in accordance with the procedures for underground water. This means collecting an initial four samples over a one-year period, establishing a baseline, and then testing one sample annually. Growers who are using well water for postharvest are advised to begin this process as early as possible in the growing season in order to establish their baseline prior to this season's harvest. In establishing the baseline, tests from last season may be used, as long as all the tests are taken within a one-year period.

Please feel free to contact me at 812-886-0198 or jsmonroe@purdue.edu should you have any questions about water testing or any other components of the produce rule.

Community Meeting to Discuss Indiana Fresh Produce Food Safety Audit Service

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

Fruit and vegetable farmers, wholesale produce buyers, agency personnel, and others are invited to attend a Community Meeting to discuss the potential development of an Indiana Fresh Produce Food Safety Audit Service. This community event is a critical component of a study being conducted by New Venture Advisors and Liz Maynard to assess whether or not an Indiana Food Safety Audit Service should be developed and, if so, how it should be structured.

This community meeting will be an opportunity for us to hear from fruit and vegetable farmers who would want to utilize an Indiana Audit Service and are interested in helping to shape the concept. We are also seeking ideas and feedback from wholesale produce buyers, members of state agencies and other stakeholders in Indiana.

When: Wednesday, March 23, 2016, 1PM – 5PM Eastern Time

Location: Third Floor, Discovery Hall, Indiana State Fairgrounds, Indianapolis

RSVP by Friday March 18th: Liz Maynard, emaynard@purdue.edu or 219-548-3674.

If you are unable to attend but want to hear about other opportunities to participate in this study, please contact Liz and we will be in touch.

Announcement of 2016 Young Beekeeper of the Year Award

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

If you are an Indiana beekeeper and if you are under 22, please note the 2016 Young Beekeeper of the Year Award

This is a statewide contest with great prizes. Application procedure and additional information can be found at YBA Information-Application Form. Application deadline is September 1, 2016.

Upcoming Events

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

Food Safety Program

A series of workshops will help produce marketers better understand food safety practices to lower the risk of contamination by a foodborne illness. Workshop "On-Farm Food Safety for Produce Direct Marketers" will be held on the following dates and locations (all times local):

* March 23: Allen County Extension Office, 4001 Crescent Ave., Fort Wayne; 9 a.m.; James Wolff at 260-481-6826.

* March 24: Kosciusko County Extension Office, 202 W. Main St., Warsaw; 6:30 p.m.; Kelly Heckaman, 574-372-2340.

* April 5: Harrison County Extension Office, 247 Atwood St., Corydon; 6 p.m.; Miranda Ulery, 812-738-4236.

* April 26: Morgan County Administration Building, 180 S. Main St., Martinsville; 7 p.m.; Amanda Dickson, 765-342-1010.

* April 28: Posey County Fairgrounds, 111 Harmony Township Road, New Harmony; time to be announced. Jon Neufelder, 812-838-1331.

There is no cost, registration is available at http://bit.ly/1nhXZyt. For any additional questions, contact Scott Monroe at jsmonroe@purdue.edu or 812-886-0198.

Workshop: Solar Energy Applications for Agriculture

Location: Shipshewana Event Center, 760 S Van Buren St, Shipshewana, IN 46565

Date: March 23, 9:00 am to 3:00 pm EST

This workshop will demonstrate the benefits of the use of solar energy on small farms. Topics include solar thermal hot water applications for agriculture; Indiana solar installations; USDA Rural development REAP grant and loan guarantee program etc. To register, contact Steve Engleking at 260-499-6334 or sengleking@purdue.edu by March 16. More information is available at https://extension.purdue.edu/pages/event.aspx?intEventID=3170&ED=7754

Good Food Festival & Conference

Location: UIC Forum, 725 W. Roosevelt Road, Chicago IL 60608
Date: March 24-26

More information is available at http://www.goodfoodfestivals.com/

Smart Vegetable Gardening 101 Webinar Series

Location: Webinar

Date: March 15-April 19, 6-7 pm on Tuesdays

Smart Vegetable Gardening 101 Webinar series is an online class for introductory and beginning vegetable gardeners held by Michigan State University Extension. It comprises six one-hour online classes. More information is available at http://msue.anr.msu.edu/events/smart_vegetable_gardening_101_webinar_series_march_thru_april_2016

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