West Virginia University
EXTENSION SERVICE

Volume 3 • Issue 3
Summer 2015

IPM Chronicle

www.anr.ext.wvu.edu/pests/publications

In This Issue:

Pollinators vital to plant reproduction

Pollinators play an important role in the reproductive success of many flowering plant species. Flowering plants need to move pollen from the male parts of a flower to the female parts of a flower, which results in fertilization and ultimately the production of seeds.

However, pollen cannot move on its own and requires assistance from animals, wind or water. Although some birds, bats and small mammals can play a role in the pollination of certain plant species, insects (e.g., bees, flies, butterflies, beetles) are the predominant animal pollinators.

Currently, there is strong evidence for a decline in insect pollinator abundance and diversity. This decline is the product of multiple factors, such as habitat loss, spread of parasites and disease, and improper use of pesticides.

Habitat loss

Replacement of native habitats with industrialized agriculture and urban sprawl has changed landscapes for the detriment of many insect pollinators. As native vegetation is replaced by crop monocultures, roads and buildings, manicured lawns, and non-native gardens, insect pollinators lose the food plants and nesting sites necessary for their survival.

The public is encouraged to plant pollinator-friendly plant species to limit this decline. Consider native floral diversity when planting and provide plants with overlapping bloom periods to ensure that floral resources, like nectar and pollen, are available throughout the year.

Figure 1. *Bee icon found on the label of pesticides that are potentially harmful to insect pollinators.*

Growing flowering cover crops is another way to provide food resources for pollinators when garden beds or crop fields are fallow. It is also important to provide areas for shelter and nesting. Hedgerows, field margins and other natural areas can provide important nesting habitat and shelter for many insect pollinators.

Parasites and disease

Parasites and disease have been damaging to the health of many insect pollinators, particularly the honeybee, *Apis mellifera*. Parasitic mites, such as the Varroa mite *(Varroa destructor)* and tracheal mite *(Acarapis woodii)*, have significantly increased the challenges of maintaining hives.

Honeybees are also affected by a range of bacterial, fungal and viral diseases. Recent studies suggest that some of these diseases are not necessarily restricted to honeybees but may be spread to wild bee species.

To limit the spread of parasites and disease, it is important that beekeepers learn to recognize the signs and symptoms of these pests early and provide appropriate control measures when needed.

Improper use of pesticides

The improper use of pesticides can negatively impact many insect pollinators. The best action the public can take to improve insect

– continued on page 8 –

Widespread *Seiridium* canker on Leyland Cypress

Leyland cypress *(xCuprossocyparis leylandii)* is a popular landscape tree widely used for screens and hedges. However, a serious disease known as *Seiridium* canker or cypress canker has shown widespread plant or twig mortality capable of disfiguring the tree, and has been occurring in many areas especially where trees have gone through severe winter, drought or fertility stresses.

Casual agent and identification of the disease

Three different species of fungal pathogen *Seiridium* can cause the disease, although most of the infections in West Virginia and surrounding areas are by *Seiridium Cardinale.* Two other species of the pathogen may be involved: *S. cupressi* and *S. unicorne.* Although several tree genera have been reported as hosts, including *Chamaecyparis, Cupressus, Cryptomeria, Juniperus, Libocedrus, Platycladus, Taxodium* and *Thuja.* In the mid-Atlantic United States, cultivated Leyland cypress *(xCuprossocyparis leylandii)* belonging to the inter-hybrid genus *xCuprossocyparis* are largely affected.

Symptoms

The most visible symptom is the flagging of yellow to reddish-brown branches that appear in the middle of normal green branches (Fig. 2). Closer examination of the base of an affected branch will reveal slightly sunken reddish cankers with resin exuding profusely (Fig. 3). However, resin flow from older trees may be relatively low and need careful observation to locate it. In addition, cankers are often not observed near the shoot tips, but are located several feet down the branch close to the trunk. These cankers may also be present on branches that do not show the flagging symptom yet.

Figure 2. *Flagging symptom due to infection of a single Leyland cypress branch by Seiridium sp. (Photo credit: M. Rahman)*

Figure 3. *Resin exudation from the canker of a Seiridium-infected Leyland cypress main trunk. (Photo credit: M. Rahman)*

Black pustule-like fruiting bodies known as pycnidia may appear breaking through the bark and may be visible under a hand lens. During rainy weather, these fruiting bodies release conidia that are spread with rain splash and new infection takes place primarily on wounded twigs of stressed trees. Drought, fertility or winter desiccation (stress) may predispose trees to infection.

Figure 4. *A Leyland cypress tree showing symptom from Seiridium infections on multiple branches. (Photo credit: M. Rahman)*

Desiccation is a condition of extreme dryness within the tree. The phenomenon can be caused in winter by prolonged sub-freezing temperatures, which make it hard for trees to absorb water from frozen ground to replenish the amount lost through transpiration, especially on sunny and windy days. The fungal infection spreads primarily by releasing spores during rainy weather and allowing the rainwater to splash and carry them to other branches. Infection on multiple branches (Fig. 4) throughout the tree or main trunk can kill the entire tree.

Managing the disease

Cultural practices that include stress alleviation and eradication of infection source (previously infected limbs) play an important role in disease management. Since the fungus survives in infected bark tissue, all infected branches should be pruned about 3 to 4 inches below the cankered area and destroyed, preferably by burning.

To minimize spread of the organism during pruning, blades

– continued on page 4 –

Disease management in organic production systems

Plant diseases usually occur in the presence of harmful organisms on plants, seeds or growing media in contact with roots under the right environmental conditions. Plant species or varieties that do not possess any intrinsic capacity to tolerate or co-exist with harmful microbes are usually more damaged than those that can resist microbial aggression.

Preventive measures

Any measure that can prevent the co-occurrence of these three interacting factors (susceptible plant variety, aggressive pathogen and conducive environment) can minimize losses. There are multiple options for organic growers to break the cycle without using synthetic chemicals. However, measures must be started after careful planning so that the whole production system becomes unfavorable for disease to occur and spread.

For example, introducing a highly aggressive (virulent) pathogen can be avoided by using disease-free seed. Only save seeds from healthy plants grown under environmental conditions with low relative humidity. Since seed infection flares up under high humidity, seeds grown in an area where seed infections may occur should be treated with hot water.

Seeds or transplants should only be purchased from reputable suppliers. For a crop that has been recurrently attacked by a specific disease, replace a susceptible cultivar with a resistant cultivar or adopt a smart rotation.

Crop rotation

Organic growers know the availability of resistant/tolerant cultivars and determine which perform best under particular growing conditions. Rotation crops should always be selected from a different crop family. For example, if a field is infested with the organism that causes tomato wilt, the field should not be planted with any other solanaceous crop and rotation should be for a period of 2 to 4 years or longer depending on the survival potential of the organism.

Organic growers can also take advantage of Organic Materials Review Institute-approved products.

If a field is infested with the club root causing fungus *Plasmodiophora brassicae* and it has formed micro sclerotia, a rotation of up to 8 years may be necessary.

Weed control

Many disease organisms survive on weeds in and around the field/garden. For example, solanaceous weeds such as nightshade, horse nettle and jimson weed are major alternative hosts of *Septorai lycopersici,* the causal agent of Septoria leaf spot of tomato. Keeping the field and its perimeter weed-free helps reduce disease pressure.

Plant site and timing

Many diseases can be avoided by judicious selection of planting sites and planting time. Soilborne organisms such as *Phytophthora* and *Pythium* thrive in poorly drained soil.

Some diseases can be avoided by choosing a planting date that is not suitable for disease development. Direct seeding in moist cool soil always predisposes seeds and seedlings to damping-off pathogens such as *Pythium, Fusarium* and *Rhizoctonia.* Direct seeding or transplanting can significantly reduce damping off of a susceptible crop such as sweet pea.

Cultural practices

Numerous cultural practices prevent plant diseases. Proper spacing and row orientation may allow air movement and sunlight penetration to facilitate drying after rain, and reduce foliar disease severity in many crops, including early and late blight of tomato and potato and Septoria leaf spot on tomato.

Field sanitation including removal or destruction of diseased plant residues also reduces disease incidence in the following crop. For example, bacterial leaf spot causing organism *Xanthomonas vesicatoria* can survive on infected plant debris from year to year. Removal of debris from the field or deep plowing of the old plant residues will help in its quick decomposition and will kill the organism.

Organic growers can take advantage of Organic Materials Review Institute-approved products such as copper, lime, sulfur and other biological control agents available in commercial formulations. These agents should be present on the root system or on foliage before the disease causing organism can colonize the plant tissue. A combination of seed treatment with biological control agents and in-furrow application prior to seeding or transplanting should provide protection against diseases. Soil solarization in combination with biofumigation of soil using a special variety of mustard are also being explored for managing soilborne diseases.

Resources

More information on hot water seed treatment: *http://vegetablemdonline.ppath.cornell.edu/NewsArticles/HotWaterSeedTreatment.html.*

Protecting your garden from wildlife

Growing a flower or vegetable garden can be satisfying and rewarding. But when intrusive wildlife claim a garden as dinner, the only thing left to grow is frustration.

Fences

Fencing is the most efficient and cost-effective method of excluding unwanted wildlife from small gardens. The seriousness of the wildlife problem and the amount of money a gardener is willing to spend will determine the fence design and materials.

White-tailed deer are the most commonly reported cause of garden damage. In areas where deer populations or deer damage are low, a single-wire electric fence 30 inches off the ground can deter deer from a garden. To make the single-strand electric fence more effective, smear peanut butter on 3×4 inch flags of foil and attach these to the fence at regular intervals of 3 to 4 feet along the fence (Fig. 5). The peanut butter will attract deer to the fence, the deer will touch the flags with their nose or mouth, and the shock will provide adverse conditioning. Replacing the foil flags and peanut butter with strips of cloth soaked with an odor-based deer repellent is another alternative.

Rabbits can also cause significant damage to gardens. Consider using woven wire, poultry wire, or hardware cloth with a mesh opening no larger than 1 inch for rabbits. The fence should extend at least 2 feet above ground. If you add the single-wire electric fence (peanut butter or repellent) above the lower mesh fence, you will effectively exclude both deer and rabbits, saving your garden all for yourself.

Figure 5. *Peanut butter smeared on a 3×4 inch flag of foil. (Photo credit: S. Owen)*

Repellents

Wildlife repellents are a deterrent that have been used with questionable effectiveness. Several chemical repellents discourage wildlife browsing but can be expensive and must be reapplied after rain events and onto new growth. Repellents fall

– continued on page 5 –

Hot Topic: Widespread *Seiridium* canker *(continued from page 2)*

should be sterilized after each cut with 10% bleach or 70% alcohol. Plants should also be protected from desiccation or wounding induced by prolonged periods of sub-freezing temperatures.

Some stress prevention methods include watering trees in the late fall or during transient ground thawing, and covering smaller trees with burlap to provide windbreak. Adding an appropriate layer of compost or bark mulch on the ground above the root zone can also prevent ground freezing; thus, alleviate some stresses.

Currently, fungicides are not effective for controlling this disease; however, in vitro trial of fungicides, such as thiophanate methyl and boscalid, showed significant suppression of mycelial growth and spore germination (Della-Rocca et al. 2011). While Leyland cypress is the major target of *Seiridium* fungus, not all winter-desiccated trees get infected and plants affected solely by desiccation may grow back. When a tree dies from desiccation and critical infection, it's best to remove and dispose of those trees and replace them with something a bit hardier, such as 'Emerald green arborvitae' or 'Cryptomeria cypress' which are less susceptible to *Seiridium* canker.

Sources

Della-Rocca, G., Lonardo, V. and Danti, R. 2011. Newly-assessed fungicides for the control of cypress canker caused by *Seiridium cardinale.* Phytopathol. Mediterr. 50, 66-74.

Perennial weed control

Perennial weeds are most competitive and difficult to manage. They have an indeterminate lifecycle and can multiply both by seeds and vegetative organs such as stolons, rhizomes, rootstocks, tubers, bulbs, etc. As a result, they grow back or spread rapidly to the areas close by, year after year. It is not uncommon to encounter infestations of perennial weeds even in well-managed crop fields.

Control methods

Different tactics may have to be employed to control perennial weeds. Mechanical, cultural or physical methods such as repeated mowing, cultivation, hand-weeding, use of cover crops or use of mulches are effective to varying extents.

Mechanical

While employing mechanical methods, the goal is to deplete the food reserves present in the underground organs, which can be accomplished by mowing or removal of top-growth at frequent intervals during the growing season (Fig. 6). Mechanical weed control may be labor intensive and have the potential to spread weed propagules and soilborne disease pathogens around the field.

Cultivating or tilling an area with perennial weeds that have stolons or underground creeping roots or rhizomes may aggravate the problem by breaking them into fragments and spreading them around. Commonly used mulches are usually not very effective in controlling perennial weeds.

Figure 6. *Underground storage organ of a perennial weed, such as a broadleaf dock (Rumex obtusifolius) shown above, has to be depleted to obtain control. (Photo credit: C. Venable)*

Chemical

Chemical control is the most common and effective method to manage perennial weeds. Systemic non-selective herbicides such as glyphosate and glufosinate are effective. Broadleaf herbicides such as 2,4-D or triclopyr are also effective to control certain perennials.

Herbicides such as sethoxydim, fluazifop, and clethodim are effective to control certain perennial grasses if applied at the proper stage. In general, systemic herbicides are more effective when applied from late summer to mid-fall when there is adequate moisture present in the soil. Application of such herbicides when the weeds are under drought stress may provide only partial control.

Integrated

Planning ahead or preventive methods prior to planting a field could go a long way to manage perennial weeds. Leaving the field with perennial weeds fallow for a year followed by an application of a systemic herbicide such as glyphosate in late summer or early fall will help control them. This may be followed by planting a suitable cover crop in late fall and applying a burn-down herbicide prior to planting the crop during the following year.

Protecting your garden from wildlife *(continued from page 4)*

into two categories: scent and taste. Scent repellents use an offensive smell to discourage wildlife from entering an area. The most common scent repellents are rotten egg- and blood meal-based products. Taste repellents employ an offensive taste to discourage wildlife from browsing on plants. Wildlife must feed on the treated plants to experience the bad taste. The most common taste repellents are capsaicin-based (a chemical found in hot peppers).

A possible scent-based repellent for summer use is Milorganite. Milorganite is a fertilizer (5-2-0) manufactured from treated sewage sludge (biosolids) from the Milwaukee Metropolitan Sewage District. In addition to providing nutrients, this fertilizer has been found to repel deer from gardens and crops during the summer months. Milorganite is an organic fertilizer, which means it is manufactured from living material, but it is not certified for use in organic farm production.

Tissue sampling for determining fertilizer needs

We have heard so many times that fertilizer needs are determined by the soil test and leaf analysis. While the soil test provides information about pH (the soil's ability to supply nutritional elements), the best way to obtain a snapshot of the nutritional levels within the plant is by having a plant tissue analysis done. Standard recommendation is for the tissue analysis to be done every two to three years. Frequent monitoring enables us to be proactive in taking corrective measures at the first signs of nutrient level drop before the deficiency symptoms appear.

Collecting the sample

The sampling method used will depend upon the type of fruit crop being analyzed.

Fruit trees

It is best to collect tissue sampling for leaf analysis from July through mid-September. Keep in mind that leaves located at the bottom of the shoot are too old and have very little mineral absorption happening at this stage of development. Also, the leaves at the top of the shoot are too young and will not reveal the true status of the nutrients within the tree. Research has shown that the best representation of the nutrient levels is obtained from the leaves collected from the middle of the current season's growth, which would be the fifth or sixth leaf when counting from the top (Fig. 7).

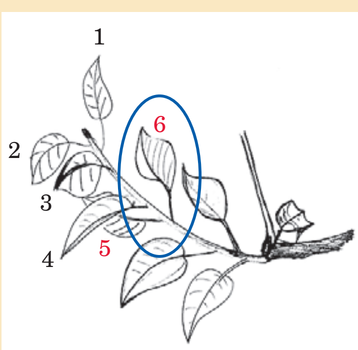

Figure 7. *Collect leaves from the middle of the current season's growth, which would be the fifth or sixth leaf when counting from the top.*

It is necessary to collect 100 healthy leaves from all sides of the canopy (Fig. 8). Avoid leaves damaged by insects and/or diseases. In an orchard situation where there are multiple trees, the recommendation is to take ten leaves from ten different trees. Before sending to the lab for analysis, the leaves must be triple-rinsed to avoid cross contamination from sprays, foliar fertilizers and dust. After washing them, place the leaves on paper towels one-file deep and leave them to air-dry. Then, place the leaves in a perforated paper bag and send to the lab for analysis.

Figure 8. *Collect 100 leaves from all four sides of a tree. In commercial orchards, collect ten leaves per tree from ten randomly selected trees. (Photo credit: M. Danilovich)*

Strawberries

Collect at least ten newly expanded leaves after renovation in late July to early August. Leaves should be washed, air-dried, placed in a perforated paper bag and mailed to the lab for analysis.

Blueberries

A minimum of 100 fully expanded leaves from the middle of the current shoot growth should be collected in midsummer (from mid-July until mid-August). Avoid leaves from the various canes that come from the base of the bush, as well as leaves near the fruit clusters. Wash and dry leaves as previously described before sending them to the lab for analysis.

Brambles

Leaf samples should be collected during the first week of August. Collect the youngest fully expanded leaves from randomly selected primocanes (current season's growth). After washing and drying them, send them to the lab for analysis.

Grapes

Most laboratories are performing analysis on grape leaf stems (petioles); however, there are some that will use leaf blades as well. Collect 100 fully developed leaves with petioles from the middle of the current season's shoots. Remove the leaf blade and keep the petioles. Even though washing the petioles might not be necessary, it is best to wash them to eliminate any possibility of cross contamination. It is best to dry them for a few days. Then, place the air-dried petioles in a paper bag and send them to the lab for analysis.

Where to send the sample

Several universities, such as Penn State, Michigan State, Maryland and Cornell, are offering the analysis service. Check their websites for more information.

Decision making based on scouting data *(Part 3)*

Collecting data on pests is only part of a monitoring system. Before making any decisions you need to analyze the data you have collected, then determine if you need to spray or release biocontrol agents.

2011 Scouting Form – New Greenhouse

							Average						
Week	**WF**	**FG**	**A**	**THp**	**X**	**GDT**	**WF**	**FG**	**A**	**THp**	**X**	**#**	**ART**
1	0	362	0	0	0	362	0.0	30.2	0.0	0.0	0.0	12	30.2
2	0	121	0	0	0	121	0.0	17.3	0.0	0.0	0.0	7	17.3
3	0	295	0	0	1	296	0.0	24.6	0.0	0.0	0.1	12	24.7
4	32	903	0	0	1	936	2.7	75.3	0.0	0.0	0.1	12	78.0
5	0	933	0	0	0	933	0.0	77.8	0.0	0.0	0.0	12	77.8
6	33	1895	0	0	1	1929	2.8	157.9	0.0	0.0	0.1	12	160.8
7	17	949	0	0	3	969	1.4	79.1	0.0	0.0	0.3	12	80.8
8	25	462	0	0	7	494	2.1	38.5	0.0	0.0	0.6	12	41.2
9	19	292	0	0	14	325	1.6	24.3	0.0	0.0	1.2	12	27.1
10	7	208	0	0	2	217	0.5	16.0	0.0	0.0	0.2	13	16.7
11	20	201	0	0	0	221	1.7	16.8	0.0	0.0	0.0	12	18.4

Figure 9. *Partial spreadsheet with scouting data for whiteflies (WF), fungus gnats (FG), aphids (A), Thrips (THp) and other insects (X). The grand total (GDT) was calculated as well as an average for each insect type and total per card using the total number of card counted (#). (Image: B.E. Liedl)*

Analyzing data

Pick a method of graphing your data to help you visualize the extent of any pest problems. Organize the numeric data from your weekly scouting form into a spreadsheet that includes the total number of whiteflies, fungus gnats, aphids, thrips and other pests. Include the total number of cards that were counted so you can calculate an average (see Fig. 9). Having the data organized in a spreadsheet makes it easier to graph and identify trends. Keep the original scouting sheets in a binder to refer to any comments or track trends in the location of insect pests.

Graphing data

Next, graph the data over the season to identify trends that could be used to predict what you might encounter in the future. Start by looking at the average number of insects per sticky card per week for general trends (Fig. 10). While you can look at the numbers directly in the spreadsheet, graphing allows easier visualization of the data over several seasons.

In our greenhouse, the spring season of 2007 and 2008 had very few insects, but in 2010 and 2011 the insects were out of control. This became even more obvious when the total number of insects counted was graphed (Fig. 11A).

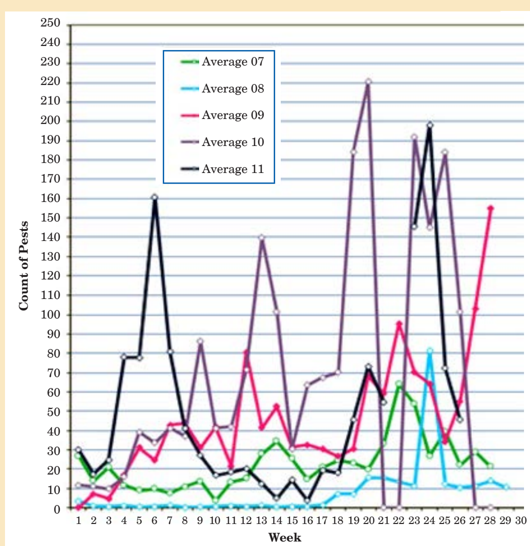

Figure 10. *Average number of insects per sticky card per week in the springs of 2007-2011. (Image: B.E. Liedl)*

When only the total whitefly counts for each week was graphed (Fig. 11B), it was evident that the problems seen in 2010 were due to a large whitefly population but not in 2011. Figure 9 shows that the high counts were not due to whiteflies in 2011 but fungus gnats.

Analyzing graphs

Figure 11B illustrates a trend where whiteflies increase as the season progresses every year. Because we have seen this trend for several years, we work to keep the numbers of whiteflies down early in the season. A threshold of between five to ten whiteflies per card in any location triggers the use of a control method. This is easier to do when the problem is detected early because we can achieve better pesticide coverage with the smaller plant

– continued on page 8 –

Decision making based on scouting data *(Part 3)* *(continued from page 7)*

canopy by targeting specific problem areas.

However, we can expect that by the end of April or beginning of May the numbers will increase and require weekly sprays, which will be difficult to apply with the large foliage canopy.

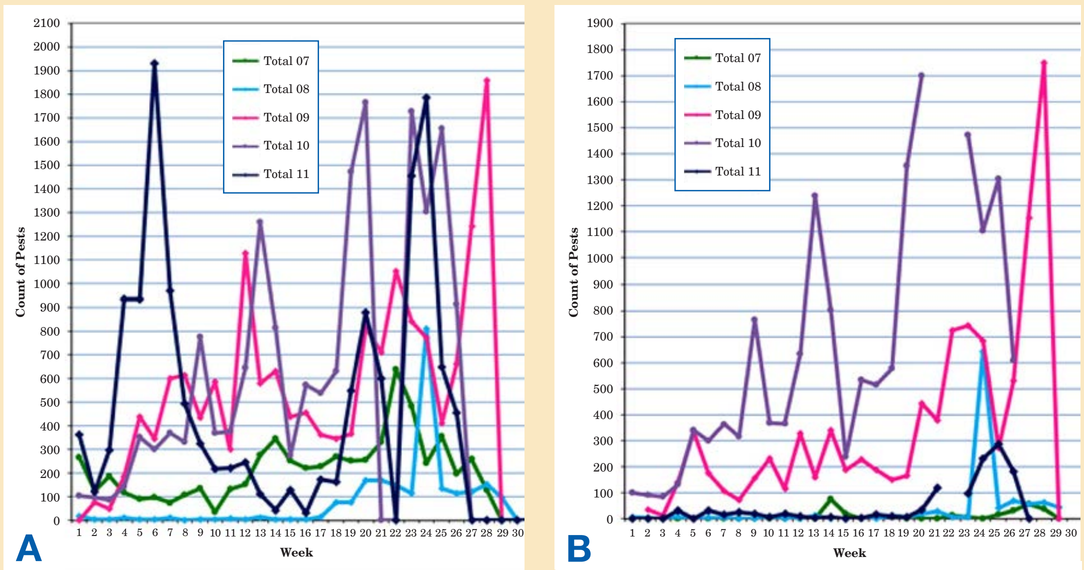

Figure 11. *Total number of insects (A) and whiteflies (B) counted per week in the springs of 2007-2011. Red arrows indicate when pesticides were sprayed in 2010. (Image: B.E. Liedl)*

Analyzing graphs will also identify better compounds to spray (Fig. 11B). Over time, you can determine what your threshold is for a given pest and what treatments work best in your operation.

Review scouting records

At the end of each season, examine scouting records for any additional trends. Look at specific places in the scouting map where pests first emerge or where the counts rise faster than others. This will allow you to consider changes in your crops and/or management strategies for the next season. Developing and implementing a scouting and monitoring program will enable you to be proactive in your approach to pests in your farm operation.

Resources

Dufour, Rex. Biointensive Integrated Pest Management. 2001. ATTRA: The National Sustainable Agriculture Information Service. *https://attra.ncat.org/attra-pub/summaries/summary.php?pub=146.*

Cornell University Integrated Pest Management Program. "Developing, Implementing and Evaluating a Management Plan" in Integrated Pest Management for Bedding Plants: A Scouting and Pest Management Guide. *http://www.nysipm.cornell.edu/publications/bpguide99/.*

Pollinators vital to plant reproduction *(continued from page 1)*

pollinator health and survival is to follow an integrated pest management approach to control pests and avoid unnecessary pesticide applications. Choose pesticides carefully and select products with the lowest toxicity rating to insect pollinators whenever possible. Also, avoid applying pesticides during midday hours when pollinators are most likely to be out foraging on flowers. Pesticides that are potentially harmful to insect pollinators will have new label warnings that include a bee icon (Fig. 1), or have language under the label's "environmental impacts" statement about their potential risks. It is important to follow all pesticide label instructions carefully.

Managing cucumber beetles

Cucumber beetles are one of the most serious insect pests of cucurbit vegetables (e.g., cucumbers, melons, pumpkins and squash). Beetles feed on the foliage, flowers and fruit of host plants. Adult cucumber beetles may also transmit bacterial wilt, which causes plants to wilt and die.

Two species of cucumber beetles are common in West Virginia: the striped cucumber beetle, *Acalymma vittatum,* and the spotted cucumber beetle, *Diabrotica undecimpunctata howardi.*

The striped cucumber beetle has a black head and yellow body with three black stripes on its back that extend to the tip of the abdomen (Fig. 12). The spotted cucumber beetle is similar in appearance, but has 12 black spots on its back (Fig. 10). Both species are approximately 6 millimeters in size.

Damage and lifecycle

Damage from cucumber beetles begins in spring by adults feeding on the stems, cotyledons and emerging leaves of young cucurbit plants. During this time female beetles begin laying groups of oval, orange-yellow eggs in the soil near the base of plants.

Once eggs hatch, the larvae immediately begin feeding on plant roots. The larvae pupate in the soil and emerge later in the summer as adults. The new generation of adults feed primarily on the foliage and flowers of plants. However, if populations are high the beetles will also feed on stems and fruit.

Adults of both species can transmit the pathogen that causes bacterial wilt in cucurbits. Bacterial wilt is a serious disease of cucumber and muskmelon, and to a lesser extent, pumpkin, squash and watermelon. Because there is no cure for bacterial wilt, infected plants should be removed immediately before other beetles can feed on the plant and spread the bacterium.

Figure 12. *Adult spotted (left) and striped (right) cucumber beetle (Photo credit: Daniel Frank).*

Control methods

Various methods may be used to manage cucumber beetles in vegetable gardens. Planting cucurbit crops later in the season (mid-June) when germinating conditions are more favorable and after peak feeding activity can help reduce damage.

Row covers can also be used early in the season to protect plants as they become established. However, row covers must be removed once blossoms appear to allow for pollination by bees.

Trap crops consisting of early-planted cucurbits can be used to attract initial populations of cucumber beetles. These crops are then sprayed with an insecticide before the primary crop becomes susceptible to attack.

Chemical options for control of cucumber beetles include numerous compounds in the pyrethroid (e.g., cyfluthrin, lambda-cyhalothrin, permethrin), neonicotinoid (e.g., acetamiprid, imidacloprid) and carbamate (e.g., carbaryl) class of insecticides.

Insecticides available for use in organic crop production include pyrethrins and kaolin clay (*Note:* kaolin clay only discourages egg-laying and feeding). At the end of the season, it is also important to remove garden debris and leaf litter to reduce overwintering sites used by cucumber beetle adults.

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