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Critical periods for weed control in an orchard

Weed competition is most critical during the early stages of tree growth, usually the first three to four years after planting (Figure 1). Weeds may reduce the bearing surface area of trees and dwarf rootstock trees that are most susceptible to weed competition. In yielding trees, weed competition is critical during the pre-bloom period, which includes the months of May and June in West Virginia. Weeds compete with trees for water, nutrients and pollinators, limiting tree yields as a result. Certain weeds may also serve as alternate hosts for insect pests and harbor disease pathogens.

When applying a residual herbicide, include an appropriate post-emergence herbicide partner in the tank mixture to completely control weeds that have germinated already. The band widths of the herbicide strip may be adjusted based on the size of trees from 3 to 5 feet. Calibrate the sprayer if band widths are adjusted to ensure that the recommended rate is applied in each treated acre.

Perennial weeds are usually the biggest source of concern for growers. Creeping perennials, such as poison ivy, Virginia creeper and brambles, spread mostly through vegetative propagules found on or beneath the soil surface. Unless the underground portion is completely killed, these spreading perennials will continue to grow into adjacent areas.

If employing mechanical methods, the goal is to deplete the food reserves present in the underground plant parts, which can be accomplished by mowing or removing top growth as frequently as every two weeks during the growing season. Using specialized equipment, such as rotary heads or blades, improves efficiency. Mechanical weed control may be labor intensive, and it has the potential of spreading weed propagules and soilborne disease pathogens around the orchard. Occasionally, mechanical removal may cause injury to trees, making them susceptible to diseases.

Figure 1. Newly planted apple trees facing severe weed competition.

To control perennial weeds within the tree row, perhaps the most effective method is application of systemic herbicides. In established orchards, systemic non-selective herbicides, such as glyphosate and glufosinate, control most perennial grass and broadleaf weeds. While using non-selective systemic herbicides like glyphosate make sure that the herbicide spray does not come into contact with tree trunks, limbs or foliage to avoid crop injury. Broadleaf herbicides, such as 2,4-D and clopyralid, are effective on certain perennials. Herbicides that selectively control grasses, such as sethoxydim, fluazifop and clethodim, can be used for control of perennial grasses, such as quackgrass and johnsongrass. To manage perennial weeds, systemic herbicides are most effective when applied in late summer or fall under good soil moisture conditions and warm temperatures to actively growing weeds. Post-emergence herbicides are less effective when applied to drought stressed weeds or to weeds under very low temperatures.

High tunnels from an entomology perspective

High tunnels are structures used to improve the growing conditions during early spring and late fall. They are effective and profitable when it comes to enhancing crop quality and yield, among other benefits. However, insect pest outbreaks are more likely to occur in high tunnels compared to open fields.

Insects in High Tunnels

Similar to greenhouse production, outbreaks of aphids, whiteflies, thrips and spider mites occur frequently and are severe in high tunnels. Reduction of rain-related mortality and decreased generation time due to increased temperatures might explain the outbreaks of those pests.

Unlike greenhouses, growers open the side walls, end walls and gable vents of high tunnels for ventilation to regulate temperature during most of the summer and on sunny days during spring and fall. Removing these physical barriers facilitates the invasion of insect pests.

A study conducted at Purdue University showed that cucumber beetles, cabbage loopers and diamondback moths were more abundant in high tunnels compared to adjacent open fields.

Insect Exclusion Screens

The use of insect exclusion screens in high tunnel openings is an effective method for keeping some insect species outside the high tunnels. Screen size should be carefully chosen because it can negatively affect yield and secondary pest abundance. Screens with small pores reduce ventilation and interfere with the cooling, which could affect vegetable quality and fruit coloration.

In studies conducted on cucumber and melon plants, screens with a pore size of 0.72 by 0.97 millimeters did not affect airflow and excluded insects as small as cucumber beetles ($1/5$ inch long by $1/10$ inch wide). However, the same screen size increased the abundance of aphids. Although increasing aphid abundance, the use of screens enhances yield compared to high tunnels without because screens exclude cucumber beetles.

Integrated Pest Management

Similar to an open field, integrated pest management (IPM) should be used to control insect pests in high tunnels. IPM combines various approaches of pest control based on monitoring, pest identification, control strategies and evaluation. These approaches are categorized as cultural, mechanical, biological and chemical controls.

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Cultural Control

Sanitation is an example of a cultural control commonly used in high tunnels. Cleaning up plant matter in the fall reduces the number of overwintering sites of several insect pests, such as squash bugs, cucumber beetle and harlequin bugs. Sanitation should also be done during crop transitions in the growing period. Other cultural controls include crop rotation, proper watering and fertilization.

Mechanical Control

Mechanical control is the use of physical means to manage pests. Insect exclusion screens are an example of mechanical control in high tunnels to keep insects, such as cucumber beetles, under control.Pest trapping and hand picking are two of the most common mechanical controls for insect pests in high tunnels.

Biological Control

Biological control, also known as biocontrol, uses natural enemies, such as predators, parasitoids and pathogens (fungi, bacteria or viruses), to control the target pest. Beneficial organisms can be present naturally in high tunnels.

Also, there are several species commercially available that can be released in high tunnels. For example, several growers in West Virginia have reported that the parasitoid wasp *Encarsia* is an effective biocontrol agent of whiteflies. Lady beetles and lacewings also are commonly used to control whiteflies, aphids, thrips and spider mites.

Chemical Control

Chemical control methods use insecticides to kill pests or interrupt their development. Growers in West Virginia often prefer to use bio-insecticides (BT and Spinosad) and plant-based (oil) products over synthetic insecticides.

Pesticide certification is required when using restricted-use pesticides in agricultural commodities.

All pesticides used in the high tunnels must be labeled for greenhouse or high tunnels. In addition, the crop of application must be listed on the product label.

How to handle fall snake encounters

Since many snakes are born between July and September, snakes are often seen in late summer and early fall. Baby snakes are actively leaving the nest, disbursing and looking for their first meal, while adult snakes that breed in the fall are looking for mates. In addition, snakes are looking for a winter hibernaculum.

Regardless of your opinion of snakes, keep in mind that only two species in West Virginia pose any threat to humans. The timber rattlesnake and the northern copperhead are West Virginia's only venomous snakes. The vast majority of our snakes (18 of 20 native species) are non-venomous. Many, however, are needlessly killed due to misidentification and a common fear of snakes.

By far, the most common snake that WVU Extension Wildlife Specialist Sheldon Owen is asked to identify is the non-venomous black rat snake (Figures 2 and 3). A mouse-eater that frequents domestic structures, such as sheds and barns, the black rat snake is found statewide. Juvenile black rat snakes are lighter gray with distinct black or dark brown patches along their backs. As they age, they become darker black and lose the distinct block pattern along their backs. If you look closely, the pattern may still be present on the backs of adults. Black rat snakes are the longest snake in West Virginia with lengths reaching between 3 to 5 feet.

Figure 2. Juvenile black rat snakes are lighter gray with distinct black or dark brown patches along their backs.

Figure 3. Adult black rat snakes are darker black and lose the distinct block pattern along their backs.

Now compare that with the northern copperhead, which boasts hourglass-like banding patterns on its body and a copper-colored head. The most distinguishing features of the timber rattlesnake are the rattle on its tail and the dark chevron-shaped bands along the length of its body. An arrowhead-shaped head is one characteristic of a venomous snake. Vertical, elliptical pupils – rather than the round pupils of nonvenomous snakes – are another.

Timber rattlesnakes typically prefer to hang out in forested areas with rock outcrops, rock ledges or steep slopes. Northern copperheads have been known to dwell in other places, such as forest-field edges, hedge rows, suburban woodlots, ravines along creeks, upland rocky areas, rock walls and woodpiles, as well as around barns and houses. Snakes like to find cover. If you have brush piles, debris, or any tin or metal lying out in your yard, that may attract snakes. Also remember that to deter snakes, deter their prey species. So, if you have corn cribs, old sheds and outbuildings that are home to lots of rodents, snakes will be happy to take up residence there, too.

To be snake-safe when hiking, wear boots and long pants and consider using a walking stick to hit any brush that you're walking through. When crossing a log, step on the log first and then step over it. This avoids startling a snake lying on the opposite side. If rock climbing, be aware of where you put your hands. Rocks provide great thermal environments where cold-blooded snakes like to bask. Also, campers should avoid setting up camp around brush, as snakes tend to dwell under the cover of leaves and in thickets.

If you come across a snake, it's best to leave it alone. However, if you must examine it, do so from a safe distance. Snakes can only strike about one-third to one-half of their body length, so use common sense when inspecting a snake. If the snake you encounter appears aggravated, back away and try to find a route around it. Don't try to pick it up, capture it or step on it. Most often, snakes only strike if they feel threatened or cornered. So, if you need to move a snake, use a long stick to try to move or shoo it away. If you give it an escape route, a snake will take it.

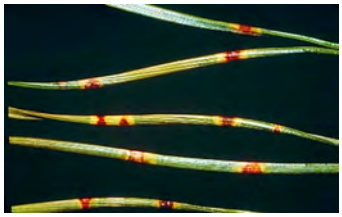
Agitated timber rattlesnakes make a rattling sound as a warning. While copperheads don't have a rattle, they still may "rattle" to threaten potential attackers by repeatedly striking the tip of their tail on leaves and other debris.

Remember, snakes play an important role in West Virginia's ecosystems. If you leave them alone, they will return the favor. For more information on snakes, please contact WVU Extension's wildlife expert, Sheldon Owen, at *sheldon.owen@mail.wvu.edu.*

If you need help removing a snake from your home, contact your local nuisance wildlife control operator or the local office of the West Virginia Division of Natural Resources.

Management of pine needle blight

The two most common needle diseases of pines include Dothistroma and brown spot needle blights. Symptoms of these diseases are so similar that identification may be supported by knowing the tree species. However, there are some other differences listed below that should help in the correct diagnosis and management.

Topic	*Dothistroma needle blight*	*Brown spot needle blight*
Hosts	Austrian, ponderosa and mugo pines are highly susceptible. Scotch and red pines are generally resistant.	Commonly found on longleaf pine. The fungus also infects seedlings of slash, loblolly, shortleaf, spruce, pitch, pond, Sonderegger (longleaf × loblolly pine), Virginia, Scots and eastern white pine.
Causal agent	Caused by the fungus Mycosphaerella pini Rostr.	Caused by the fungus *Mycosphaerella dearnessii* (syn. *Scirrhia acicula, Eruptio acicola*).
Symptom		
Spores		
Symptoms and signs	**Late summer to early fall:** Dark green bands present on recently infected needles; bands may contain yellow or tan spots. Brown or reddish-brown bands and lesions may appear on needles several weeks after infection. **Late fall to winter:** Brown, dead needle tips with the base of the needle remaining green. Dark brown or black, tiny fruiting bodies in the dead portion of the needle. **Late winter to early spring:** Previously green needle bases turn brown. Premature needle drop occurs (most severe on lower branches).	It is nearly identical to Dothistroma blight. Circular, straw-colored to light brown lesions form on needles in late summer or early fall. Spots may coalesce to kill most of the needle, resulting in premature defoliation the summer following infection.

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Topic	*Dothistroma needle blight*	*Brown spot needle blight*
Fruiting bodies	The fruiting bodies are black, pinhead-sized specks in the needle lesions.	Two types of fruiting bodies are produced. Conidia are produced in acervuli, which appear on lesions as small black dots visible to the naked eye. Ascospores are produced in pseudothecia embedded in dead leaf tissue.
Infection biology	Dothistroma spp. produce conidia that are dispersed by rain splash. Long-distance dispersal of conidia is thought to occur through conidia being carried in clouds, fog or mist, or by human transportation of infected seedlings. The spores spread by wind and rain and can infect needles throughout the growing season. New needles are susceptible once they emerge from the needle sheaths. The black fruit bodies appear in the fall; however, the spores are released the following spring and summer.	Ascospores discharged during periods of rain, dew and fog are the principal means by which the brown spot fungus invades nursery beds. Ascospores are disseminated by the wind and initiate light, scattered infections, sometimes great distances from the source. Conidia are produced in acervuli on the lesions resulting from ascospore infection. Conidia are disseminated short distances by rain splash and cause local buildup of the disease. Ascospores are produced on seedlings two to three months after the seedlings are infected. Both spore forms overwinter in dead and infected needle tissue.
Control measures	Cultural controls to promote more rapid drying of foliage may help. Prune surrounding plants, control weeds in the area and space plants properly. The copper fungicides, including fixed or neutral copper compounds and bordeaux mixtures, are registered for use on pine to control Dothistroma needle blight. Two sprays are required – one when needles are just emerging in mid-May and another when new needles are fully expanded. Control measures are most successful when cultural controls begin as soon as the disease is identified, with chemical controls started the following spring. **Maintain good air circulation around trees** Do not overcrowd plants. Use the mature size of the tree as a spacing guide when planting. Remove the bottom most branches from the trunk to help increase circulation around the tree canopy. **Mulch under trees** Remove all weeds under the trees. Maintain a 3- to 4-inch-deep, even layer of wood chip mulch around your tree to prevent weed growth. Leave at least a 2-inch square between the mulch and the trunk to allow for air movement. Do not mound the mulch around the trunk of the tree. Inspect the depth of the mulch layer each year. Add additional mulch to maintain a 3- to 4-inch depth.	Control measures are most successful when cultural controls begin as soon as the disease is identified, with chemical controls started the following spring. **Prevention** Use superior seed that is resistant to the disease. Remove and destroy all infected seedlings and infected pines growing in and around the nursery. **Cultural** In the spring, plant seed in rows at low densities of about 15 seedlings per square foot. Plant in well-drained beds. Use mulch to reduce mortality from sand splash, but do not use pine needles as mulch. Promote growth of existing ectomycorrhizal fungi by controlling soil pH (less than 6.0 is optimal) and avoiding excess levels of phosphorus. If necessary, inoculate beds with the mycorrhizal fungus Pisolithus tinctorius. Clip needles periodically during the growing season to prevent toppling and to expedite spraying and lifting. Remove clipped needles from nursery bed areas. Avoid pruning when it is raining or at any time when the seedlings are wet. Root prune seedlings to a depth of 7 inches from 6 to 12 weeks before lifting.

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Topic	*Dothistroma needle blight*	*Brown spot needle blight*
Control measures ***(continued)***	**Fungicides** If trees have a history of Dothistroma needle blight, copper fungicides can be used to protect new needles from infection. Fungicides need to be applied twice – once just before buds open in the spring (typically in mid-May) to protect previous year's needles; and once after new needles have grown to their full length (in early to mid-summer).	**Chemical** Spray with Bordeaux mixture, maneb or chlorothalonil, which are effective and registered for use on brown spot. Seedlings should be sprayed with a foliar fungicide at 10- to 30-day intervals – depending upon the amount of rainfall – from the beginning of April through October. Begin spraying in the spring when the new secondary needles are 1 to 2 inches long. Four to six applications are usually enough. Spray with a fungicide the day before pruning and again immediately after pruning. Swab cutting blades with denatured alcohol or a 10% solution of sodium hypochlorite. A seedling root-dip treatment in a 5% active ingredient benomyl-kaolin mixture prior to packing at the nursery or at the reforestation site is very effective in reducing brown spot in the field. This treatment is very economical and significantly improves both growth and survival of planted seedlings.

Farewell to IPM Associate Whitney Dudding

Whitney Dudding, our IPM associate since 2018, will be leaving us to take on a job as the assistant manager of the Evansdale Greenhouse, which is part of the WVU Davis College of Agriculture, Natural Resources and Design.

As the IPM associate, Whitney assisted with the day-to-day functioning of the WVU Plant Diagnostic Laboratory under the supervision of Mahfuz Rahman. She also assisted with research and Extension activities of Rakesh Chandran and Carlos Quesada as well as Daniel Frank, formerly with WVU Extension.

Whitney carried out an ambitious scouting program at commercial tree fruit orchards during her time with us. She enjoyed her interactions with producers and county agents and participated actively in events, such as the State Fair of West Virginia and the West Virginia Small Farm Conference. Whitney worked diligently to enhance the plant diagnostic and IPM programs at WVU Extension and will be missed. We wish Whitney a successful and fulfilling career down the road!

Bitter pit in apples – brown sunken lesions not caused by disease

As you're going through your orchard or backyard and looking at your apple trees, you might see some brown, sunken lesions (Figure 4) that may not have been there just a year ago. These lesions are accentuated by very hot and humid weather.

Most often, people would associate these symptoms with a disease or an insect pest injury, and it even resembles injury induced by the Brown Marmorated Stink Bug. But, as it turns out, it does not have anything to do with either. It is a case of bitter pit, a very serious physiological disorder related to calcium deficiency in the fruit (Figures 4 and 5).

Figure 4. Bitter pit due to calcium deficiency, displayed as sunken, brown lesions. (Photo credit: M. Danilovich)

Figure 5. Collapsed, corky cells just below the fruit skin. (Photo credit: M. Danilovich)

What causes bitter pit?

One of the important roles that calcium (Ca) plays in fruit is to be part of the building blocks of cell membranes and cell walls. When there are insufficient levels of Ca, the tissue starts to die and collapse, leaving these brown, corky indentations within the apple flesh just below the skin (Figure 5).

Sometimes, a soil test might indicate plenty of Ca in the soil, but the fruit shows symptoms of Ca deficiency. That is a topic for another discussion, but let's just say that there are other elements in the soil that might be chemically blocking calcium availability through their antagonistic effect on calcium. A good example would be a very high levels of potassium (K) and magnesium (Mg), which would cause low levels of calcium and boron (B).

Some apple cultivars are more prone to the bitter pit disorder than others. It is commonly found on Honeycrisp, Cortland, Norther Spy, Golden Delicious, Kingston Black, Ashmed's Kernel and Spitzenburg.

Bitter pit is influenced by climate, the soil pH that controls the solubility and availability of the mineral elements in the soil, fertilization practices, crop load, and tree vigor. Generally, with a small crop load, fruits are larger and more prone to calcium deficiency and bitter pit.

How to manage bitter pit?

There are several things we can do to minimize bitter pit effect. Maintain optimum soil pH, which should be slightly acid around 6.5. Keep boron at optimum levels since its deficiency can contribute to bitter pit. Potassium and magnesium levels should be kept at the optimum values or slightly below, due to their antagonistic effect on calcium. While out of the grower's control, it helps when the humidity and temperatures are not too high (80 F or above).

Take steps to help make sure the crop load is balanced and adequate for the tree size; small crop load translates into large fruit that is more prone to bitter pit. Heavy pruning will result in very vigorous growth with reduced crop load, making fruit more prone to bitter pit. Do not apply a heavy dose of nitrogen (N) fertilizer to prevent a vigorous growth response from inducing bitter pit.

Lastly, commercial growers are spraying Ca in the form of calcium chloride (CaCl2), starting with the first spray a week after the petal fall.

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