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In This Issue:

Integrated pest management resources for small growers

It's the time of year when plant and seed catalogs are filling mailboxes and email inboxes. For growers, it's exciting to be choosing the plants and seeds you will be growing next year; however, do not forget this also should be the time to gather resources to manage pests for all those plants.

What IPM resources should you gather?

Resources should include books, websites and tools that will help identify and control pests on your farm. Start by considering the crops you will be growing – this includes your tried-and-true crops, as well as any new ones you are going to try. Remember, new pests can arise on any crop, so you want to be prepared even if you have grown that crop in the past. Also, consider looking at new methods to control the pests. Perhaps this year, you will try some biocontrol methods or a new chemical control.

A hand lens or magnifier can be a very helpful tool in identifying pests. There are even smartphone camera attachments you might want to try when taking photos of small pests. If you need further identification assistance, having small vials and containers on hand is helpful when gathering samples to give to a specialist.

Also consider updating your contact list with the most current phone number and email for your local agriculture service providers and experienced farmers that may be able to help. Don't forget to save the web address for the WVU Plant Diagnostic Clinic. Their website includes directions and a video on how to submit samples.

Adding this preparation to your plant and seed purchases will set you up to be on the offense against pests on your farm, rather than on the defense. This preparation should result in fewer problems and hopefully being able to nip those pesky pests early on.

Websites

- WVU Plant Diagnostic Clinic: *https://extension.wvu.edu/lawn-gardening-pests/plant-disease/plant-diagnostic-clinic*
- Mid-Atlantic Commercial Vegetables Production Recommendations: *https://extension.umd.edu/mdvegetables/mid-atlantic-commercial-vegetable-production-recommendations*
- 2021 Midwest Vegetable Production Guide: *https://www.vegedge.umn.edu/2121mwvpg*
- Tree Fruit Integrated Pest Management: *https://blogs.cornell.edu/treefruit/ipm/*
- Michigan State University Integrated Pest Management: *https://www.canr.msu.edu/ipm/agriculture/fruit/*
- Biointensive Integrated Pest Management (ATTRA): *https://attra.ncat.org/attra-pub/ summaries/summary.php?pub=146*

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Integrated pest management resources

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- Integrated Pest Management for Greenhouse Crops: *https://attra.ncat.org/attra-pub/summaries/summary.php?pub=48*
- Sustainable Pest Management in Greenhouses and High Tunnels (SARE): *https://www.sare.org/Learning-Center/Fact-Sheets/Sustainable-Pest-Management-in-Greenhouses-and-High-Tunnels*
- Greenhouse IPM with an Emphasis on Biocontrols: *https://www.sare.org/Learning-Center/SARE-Project-Products/Northeast-SARE-Project-Products/Greenhouse-IPM-with-an-Emphasis-on-Biocontrols*
- University of Vermont's Greenhouse IPM: *http://www.uvm.edu/~entlab/Greenhouse%20IPM/UVMGreenhouseIPM.html*
- Disease Management in High Tunnel Systems: *https://www.aces.edu/blog/topics/farming/disease-management-in-high-tunnel-systems/*
- How to Succeed at Scouting for Pests: *https://greenmethods.com/necessary/scouting-plan/*
- Scouting for Vegetable Pests: *https://www.cias.wisc.edu/scouting-vegetables-for-pests/*
- Scouting for Pathogens and Pests: *http://www.greenhousegrower.com/article/23610/scouting-for-pathogens-and-pests-the-basics-of-monitoring*
- An IPM Scouting Guide for Common Problems of High Tunnels and Greenhouse Vegetable Crops in Kentucky: *https://uknowledge.uky.edu/anr_reports/113/*
- BugGuide.net: *https://bugguide.net/index.php?q=search&keys=aphids&search=Search*
- Michigan State University's Enviroweather: *https://www.enviro-weather.msu.edu/*
- Climate Smart Farming Decision Tools: *http://climatesmartfarming.org/*

Resources should include books, websites and tools that will help identify and control pests on your farm.

Books

- "Pests of the Garden and Small Farm (3rd Edition)" by Mary Louise Flint, University of California Agriculture and Natural Resources, ISBN: 9781601079749
- "Garden Insects of North America (2nd Edition)" by Whitney Cranshaw and David Shetlar, Princeton University Press, ISBN: 9780691167442
- "Good Bug Bad Bug (2nd Edition)" by Jessica Walliser, St. Lynn's Press, ISBN: 9780981961590
- "Weeds of the Northeast" by Richard H. Uva, Joseph C. Neal and Joseph M. Ditomaso, Comstock Publishing Associates, *https://www.cornellpress.cornell.edu/book/9780801483349/weeds-of-the-northeast/#bookTabs=1*
- "Good Weed Bad Weed" by Nancy Gift, St. Lynn's Press, ISBN: 9780981961569
- "Manage Insects on Your Farm" by Miguel A. Altieri, Clara I. Nicholls and Marlene A. Fritz, *https://www.sare.org/resources/manage-insects-on-your-farm/*
- "Managing Alternative Pollinators: A Handbook for Beekeepers, Growers and Conservationists" by Eric Mader, Marla Spivak and Elaine Evans, *http://www.sare.org/Learning-Center/Books/Managing-Alternative-Pollinators*
- "Greenhouse IPM with an Emphasis on Biocontrols," Pennsylvania Integrated Pest Management Program, *https://www.sare.org/resources/greenhouse-ipm-with-an-emphasis-on-biocontrols/*
- American Phytopathological Society Compendiums, *http://my.apsnet.org/APSStore/Category?Category=Compendium*

Tools

- Map of the field, high tunnel or greenhouse
- A notebook or clipboard with record-keeping sheets (plastic sheet protectors can be used)
- A hand lens or magnifier (specifically a 10× or 15× magnifier) for inspecting plant material
- White index cards for sampling small insects
- Containers for samples and a permanent marker to label containers with location information
- A digital camera for documentation
- Monitoring cards ("sticky traps") and/or a sweep net to monitor the winged stage of flying insects
- Plant markers, tags or similar markers to identify specific plants

Management of the American mink *(Neovison vison)*

The American mink is a member of the weasel family *(Mustelidae)*, which includes several other furbearer species in West Virginia, such as the river otter, long-tailed weasel, least weasel and fisher.

Description

Like all members in this family, the mink has a long thin cylindrical body with short legs. Mink, like other members of the mustelid family, also are known for their highly developed anal scent glands. Their pelage is dark brown to black with white patches that form unique patterns on the chin, throat and chest. The mink has a relatively long tail with thick fur, growing darker from the base to the tip which is nearly black. Males are larger than females (sexual dimorphism) with males weighing 1.5 to 4.5 pounds and females weighing 1.5 to 2.5 pounds. Mink range in length from 19 to 28 inches with the body making up 14 to 20 inches and the tail making up 5 to 8 inches.

Habitat

Found throughout the United States except for the arid southwest, mink occupy West Virginia wetland habitats where woody or brushy shoreline vegetation and emergent vegetation are present. These can include creeks, streams, rivers and lake borders, as well as wetland or swampy areas. Mink dig their own burrows or use those built by others, such as beaver dams, beaver lodges, and muskrat dens or houses. They also will den in log piles, rock piles, and in hollow logs and stumps.

Common across the state, mink are oftentimes harvested by trapping. Maintaining healthy mink populations depends on maintaining healthy wetland habitats. Mink are susceptible to environmental contaminants; therefore, water quality is an important component of habitat management.

Life cycle

Mink breed from late winter to early spring, and females have one litter per year with an average of two to six kits. The gestation period averages 51 days with delayed implantation. In delayed implantation, the embryo does not immediately implant in the uterus but is maintained in a state of dormancy until implantation. This reproductive mechanism allows animals to time gestation and birth to occur during favorable environmental conditions.

Mink are fierce carnivores feeding on a variety of small mammals (muskrat, mice, rabbits, etc.), fish, birds, crayfish, amphibians and reptiles.

Habits

Even though mink are mostly nocturnal, they can be seen during the daylight hours. They are relatively small animals and are very secretive. Many mink sightings are reported by anglers, and motion-activated trail cameras often capture these mammals on the move.

Mink are fierce carnivores feeding on a variety of small mammals (muskrat, mice, rabbits, etc.), fish, birds, crayfish, amphibians and reptiles. They are considered a semi-aquatic forager, because they feed on both land and in water. These mammals are great swimmers and quite capable of catching fish and other aquatic invertebrates. Mink are sometimes called "surplus killers," killing and caching more than they can consume. Poultry producers often see this when multiple birds are killed by mink and piled up in a chicken coop.

Damage and management

Mink damage in West Virginia primarily occurs when mink get into chicken coops and kill chickens. The best defense is to exclude mink by properly sealing all openings greater than 1-inch diameter, which prevents mink access to poultry. Using poultry wire with ½-inch diameter weave will reduce the likelihood of mink gaining access to poultry, while also excluding

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Caring for your garden tools

When it comes to gardening, caring for the tools is a commonly overlooked practice. Have you ever considered that tools might lead to disease problems? Dull or dirty, unsanitized tools can lead to many problems in the garden. There are a few things you can do to get your gardening tools in shape.

General tool care

In anticipation of spring, you should attend to your gardening tools. Tool care practices that are highly recommended include:

Using sharp tools requires less effort and helps with disease prevention. (Photo credit: Mira Danilovich)

- Scrape and rinse the mud off of shovels or digging tools. You may even need to wash them in soapy water.
- If they have been neglected for a while, shears, loppers and pruners might need to be scrubbed with a wire brush or steel wool pad. They may even need to be sprayed with some oven cleaner, left to soak, then wiped off and even washed with soapy water. Air-dry or dry well with a rag before lubricating and storing away.
- Cleaning sap from pruners, loppers, shears, knives or any other blades can be done by applying a solvent, like kerosene, alcohol, mineral oil, turpentine and WD-40, using a cotton ball or pad. For dirtier jobs, use a steel wool pad soaked in the solvent. Dry the blades with a rag and lubricate with WD-40, motor oil or oil used for bicycle chain lubrication.
- After pruning trees, shrubs or any diseased plant material, clean and disinfect the tools with 10% household bleach or with at least 70% rubbing alcohol.
- The wooden handles of tools need some care as well. Wiping them with a generous amount of linseed oil will keep them in good condition. If the handles are slightly cracked or rough, sand them down with the appropriate grade of sandpaper, then apply linseed oil. If the cracks are deeper and cannot be sanded out, reinforce the handle using a tape, like hockey stick tape or duct tape.

Keeping the blades sharp

Using sharp tools requires less effort, is easier on our backs or hands, and helps with disease prevention. When sharpening a blade, always make sure you are sharpening the original beveled edge. If the edge needs to be sharpened more, use a flat file to take the nicks and chips out. Always push the file in one direction (not back and forth) and follow the original beveled angle. You can make the blade as sharp as you want. Use a sharpening stone after filing to smooth the edge.

Keeping the rust away

It is pertinent to keep tools protected from the elements, particularly from moisture. Keep tools in a dry, ventilated area. Neglected, rusty tools can be brought back to life by spraying them with rust remover (WD-40 is excellent for that). If you prefer to use an organic approach, soak the tools in vinegar and water in a 1:1 ratio overnight. After soaking, scrub the tools with steel wool, rinse, dry and lubricate. Shovels and smaller tools can be kept in a bucket filled with sand and oil. They will stay dry, lubricated and sharp until ready for use again.

Keeping tools sharp, clean, rust-free and sanitized will make gardening easier, and it is good for the garden.

Management of the American mink *(Neovison vison)*

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the weasel. Mink also are known to kill ducks and other waterfowl on lakes and ponds, an offense that is far more difficult to prevent.

Since there are no registered repellants or toxicants for mink and frightening devices are not effective, lethally removing mink via trapping is the best option. Mink are considered a furbearer in West Virginia and can be legally trapped during the trapping season. Landowners also can remove them outside of the trapping season by contacting their regional Division of Natural Resources office for a permit. Live capture cage traps should be used in areas with a high likelihood of catching pets. Foothold and small body gripping traps (conibear traps) can be used where catching pets is not a concern.

Biology and management of pine needle scale

Scale insects are among the most destructive pests that feed on leaves, stems and fruit of vegetative and woody plants. Armored scale is a group of scale insects characterized by their waxy covering, which protects them from predators and pesticides.

Pine needle scale *(Chionaspis pinifoliae* Fitch) is one of the most important armored scales of pine trees in the northeastern United States (Figure 1). Pine needle scale is native and has been found on approximately 45 species in the Pinaceae plant family.

Figure 1. Pine needle scale infestation. (Photo credit: Carlos Quesada)

Life cycle

Pine needle scales are sucking insects of the order hemipteran and undergo incomplete metamorphosis (egg, nymph and adult stage). Scale eggs are tiny, rosy-purple in color and are laid beneath the covering (Figure 2).

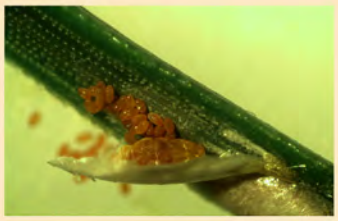

Figure 2. Eggs and adults of pine needle scale. (Photo credit: Carlos Quesada)

First instar nymphs, called crawlers, are pink in color and about ½ millimeter long. This is the only active period in the life cycle of the pine needle scale. Crawlers wander on plants until finding a suitable place where they settle for the rest of their lives (Figure 3). Once they are settled and feeding, they change to a yellowish color and produce a white wax that covers their bodies (Figure 4).

Adults resemble the nymph, only bigger and sexually mature. They are about ⅛ inch long and white to grayish-white in color. They are always found attached to evergreen needles.

Figure 3. Crawlers of pine needle scale. (Photo credit: Carlos Quesada)

In Canada and the western and most northeastern United States, pine needle scales have one generation per year. For the southern and some Midwest states, including West Virginia, the scale insect produces two generations per year. In West Virginia, they usually overwinter as mated adult females on the needles but also may winter as eggs. The first generation hatches in May and the second generation in mid- to late summer.

Plant damage

High densities of scale insects can slow the rate of carbohydrate assimilation and reduce plant vigor. This can result in leaf chlorosis, branch dieback or even death of the plant due to direct injury or outbreaks of other insects and pathogens.

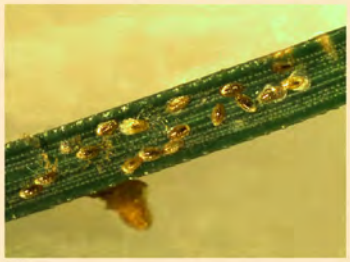

Figure 4. Settled nymphs of pine needle scale before cover development. (Photo credit: Carlos Quesada)

Outbreaks of pine needle scales are more frequent in disturbed habitats, such as in evergreen tree farms and urban landscapes, than in natural forests. The disturbed habitats can be attributed to a reduction of natural enemies due to low plant and prey diversity, pesticide residues, dust and high temperatures.

Management

When outbreaks of pine needle scales occur, insecticides are often applied to reduce plant damage and to manage scale insect populations. Timing of the

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Managing leaf mold on high tunnel tomatoes

Growing tomatoes in protected structures or high tunnels can prevent many foliar diseases; however, other diseases (like leaf mold) that thrive in high humidity without free moisture can become one of the most significant diseases of high tunnel tomatoes. Leaf mold is caused by the fungal pathogen *Fulvia fulva*, which is less common on tomatoes grown in open fields. While tomatoes are the primary plants affected by this disease, pepper and eggplant also can be infected.

Symptoms

Leaf mold is most prevalent and visible on the tomato leaf; however, under high disease pressure, it may spread to the petioles, stems, blossoms and fruit. Older leaves are affected first, and gradually the disease spreads to younger leaves. Pale greenish-yellow spots with irregular margins appear on the upper side of the leaf, while the lower side shows growth of olive-green to brown velvety mold. The centers of the spots have a darker olive-green color due to higher fungal growth and sporulation. As the spots become larger, they can merge together killing the whole leaf. As a result, leaves dry up and may drop from the plant, but in most cases, they remain attached to the plant for a long time.

Leaf mold symptoms on upper and lower tomato leaf surface. (Photo credit: University of Kentucky Vegetable IPM Team)

Symptoms of leaf mold sometimes can be confused with other diseases, like powdery mildew, which also is more common in high tunnels than field-grown tomatoes. More specifically, yellowish spots caused by powdery mildew fungus can show overlapping symptoms. However, powdery mildew spots will not have olive-green to brown velvety mold growth on the lower side of the lesions. Also, a white talcum powder-like growth will be prevalent on the upper side of the leaf.

Epidemiology and environmental factors

High humidity (>85%) favors leaf mold development, which can be the determining factor for the occurrence of the disease in high tunnels. Although high tunnels are protected from heavy rainfall events which prevents free moisture deposition on foliage, the environment is prone to high humidity due to restricted air movement and the buildup and condensation of transpired water molecules inside.

F. fulva can cause leaf mold at a wide range of temperatures ranging from 40 to 94 F; however, the optimum temperature range for the disease's growth and development is 72 to 75 F. This pathogen can survive saprophytically on crop residue for at least one year and in the soil as an overwintering mass of hyphal threads known as sclerotia.

Disease management

When managing leaf mold on tomatoes in the high tunnel environment, consider the following suggestions:

- **Resistant varieties**: Tomato varieties with resistance to leaf mold are available, and growers using high tunnels with a history of leaf mold are encouraged to use those. These varieties should be used as part of an integrated disease management program in combination with cultural control practices. Because there are several races of the pathogen, the resistant variety should have resistance against a prevalent race in a growing environment.
- **Cultural control**: Keeping humidity below 85% inside the high tunnel plays a vital role in disease management. A combination of cultural practices, such as raising the sides of high tunnels to improve air movement or using exhaust fans to take the humid air out a few times per day, can help reduce the relative humidity.
- **Sanitation and stubble removal**: Infected crop residue should be removed from the high tunnel ground at the end of each season to reduce inoculum for the following crop if rotation is not an option. High tunnel structures and tools should be washed and sanitized between crops – this includes trays, benches, stakes, twine, wire, etc.
- **Proper spacing and pruning**: Air movement can be obstructed if plant canopies are too dense; thus, spacing should be optimum to allow air movement. Lower leaves and shoots also can be pruned to allow air movement.

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Choosing the correct herbicide to control aquatic weeds

Weeds in ponds and lakes can be aesthetically unpleasant and interfere with human activities. There are several options for controlling pond weeds. These include taking preventive measures like proper site selection and pond management; mechanically removing them with weed commercial rakes, harvesters or dredgers; implementing cultural practices, such as reducing water levels; using a biological control agent, like triploid grass carp; or using herbicides.

The situation will determine the appropriate control strategy. For instance, mechanical or cultural practices may be used to clear smaller areas or new weed infestations. Grass carp may be used for long-term weed management with limited selectivity of vegetation controlled. However, using a combination of suitable techniques is often the most effective and environmentally safe way to control aquatic weeds.

Aquatic weeds in ponds and lakes can be aesthetically unpleasant and interfere with human activities.

Choosing an herbicide

Several herbicides can be used to manage aquatic weeds. The herbicide and the formulation used must be labeled and registered for aquatic use. Choosing a specific herbicide for this purpose would depend on such factors as weeds to be controlled, the size and location of treatment area, time of the year, water use and movement, and regulatory restrictions. The water's oxygen depletion, especially during the summer months, also should be taken into consideration. Using the appropriate herbicide at the correct time to prevent fish kill is another important consideration.

Types of herbicides

To simplify the decision-making process, it is useful to understand the basic types of herbicides. Classification of aquatic herbicides may be based on herbicide activity and selectivity. Herbicides may be active at the site at which they come into contact with the plant (contact herbicide), or they may have to be absorbed by the plant and transported to different parts where they become active (systemic herbicide).

Contact herbicides

A contact herbicide will kill only exposed tissues or plant parts that come into physical contact with the herbicide. These herbicides usually act faster than systemic herbicides. Examples of common aquatic herbicides that have contact activity are diquat (Reward), carfentrazone and flumioxazin (Propeller). Contact herbicides are effective in controlling annual weeds (weeds that take a year to complete the life cycle) and to treat shorelines, ramps and small bodies of water where quick kill is desired and plant regrowth is not a concern.

Systemic herbicides

Systemic herbicides, which move inside the plant to become active, usually will kill the entire plant eventually. They act more slowly than contact herbicides. Common systemic herbicides for aquatic weed control include 2,4-D, glyphosate and fluridone. These herbicides offer a longer duration of weed control and are especially effective to control perennial weeds.

Different herbicides are used to manage algae. Most algae respond to copper-containing herbicides – usually formulated as copper sulfate, copper carbonate or chelated copper. Herbicides that contain diquat and flumioxazin also are considered to be effective to manage certain types of algae.

Aquatic weed management

To be optimally effective, the herbicide should adequately cover the plant surface. Floating and emergent weeds can be controlled with a contact or systemic herbicide applied directly as a spray to the weed. However, submerged weeds are best controlled

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Effective management of pine needle scale

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application is important for effective management, because the scales become less susceptible to insecticides as they age.

Several insecticides with different active ingredients kill pine needle scales when targeted at the crawler stage. Horticultural oils and reduced-risk insecticides, such as buprofezin, pyriproxyfen and spirotetramat, are recommended to manage pine needle scale because of their efficacy and compatibility with beneficial insects. Other active ingredients, such as bifenthrin, imidacloprid, dinotefuran and acephate, also kill pine needle scale; however, they are harmful to beneficial organisms and can cause spider mite outbreaks. Many products are commercially available with the mentioned active ingredients but federal laws indicate that the site of application must be listed on the pesticide label.

Managing leaf mold

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- **Chemical control**: High tunnels are considered closed structures that are equivalent to greenhouses; therefore, only chemical products labeled for greenhouse use can be applied. A few products allowed in high tunnels and greenhouses include Mural, Inspire Super, Revus Top, Quadris Top, Tanos, copper, mancozeb and Gavel. It is important to note that without lowering relative humidity, these products may not provide the expected disease control. Application of products should be initiated and timed with the early symptom observation documented from the previous growing season. Fungicide applications should be made if other methods can't keep the disease under control and repeated according to label instructions. Remember to alternate between chemical families with particular active ingredients to avoid the development of resistance in the pathogen population.

Choosing the correct herbicide

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by an herbicide that will form a dilute solution and remain active after being applied to the pond. Limited or no water movement will be necessary for such treatments to be effective.

Aquatic herbicides are usually formulated as granules or liquids. Liquids are diluted with water and then applied with a sprayer or other equipment. Granular formulations can be applied by using a gloved hand, a scoop or a fertilizer spreading bucket.

Liquid formulations are more economical for large-scale treatments since they are more concentrated. Granules are more effective for deep (4 feet or more) ponds and smaller treated areas. Directions for dilution and application are clearly stated on the labels.

The stage of application is another important factor. Contact herbicides usually work better when applied to young, actively growing weeds, but systemic herbicides, like glyphosate, are more effective when applied later in the growing season to facilitate better movement to the underground organs.

Selective weed control can be the most challenging predicament when trying to manage aquatic weeds. The herbicide of choice should control the weeds without causing much injury to the desirable vegetation. This will depend primarily on the flora and fauna of the pond. The label of a given herbicide carries a list of weeds it controls fully or partially.

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