2021

SPOTTED LANTERNFLY

MANAGEMENT GUIDE

PennState Extension

This is a comprehensive guide on spotted lanternfly biology, behavior, plant damage, management, and ongoing research. It is current as of April 2021.

Authors and Acknowledgments
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The authors are grateful for the illustrative assistance of Emily Damstra.

Disclaimers
These recommendations are current as of April 2021 and may change as we learn more. We encourage you to stay up to date by visiting https://extension.psu.edu/spotted-lanternfly. Check the version of this management guide and always look for the most up-to-date information. When using any pesticide, follow the pesticide label for directions, application rates, methods, and appropriate protective equipment. **Remember, the label is the law.**

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Photo Credit: Michael Houtz, Penn State

INTRODUCTION

Spotted lanternfly (SLF), *Lycorma delicatula*, is an invasive planthopper that was first detected in North America in 2014 in southeastern Pennsylvania. It has now spread to other eastern U.S. states. It is native to parts of Asia.

SLF feeds voraciously on many economically important crops like grapevines, hops, ornamental nursery plants, and several tree species. Heavy SLF feeding has contributed to the death of grapevines, the invasive tree *Ailanthus altissima* (tree-of-heaven, or TOH), and black walnut saplings. While SLF feeding can stress plants and cause localized branch damage, it is not known to directly kill other plants. SLF feeding is considered a **plant stressor** and may contribute to the long-term weakening of established plants and trees. It is currently considered to be primarily a nuisance pest in residential landscapes.

This guide will review important aspects of the biology and behavior of SLF and management options.

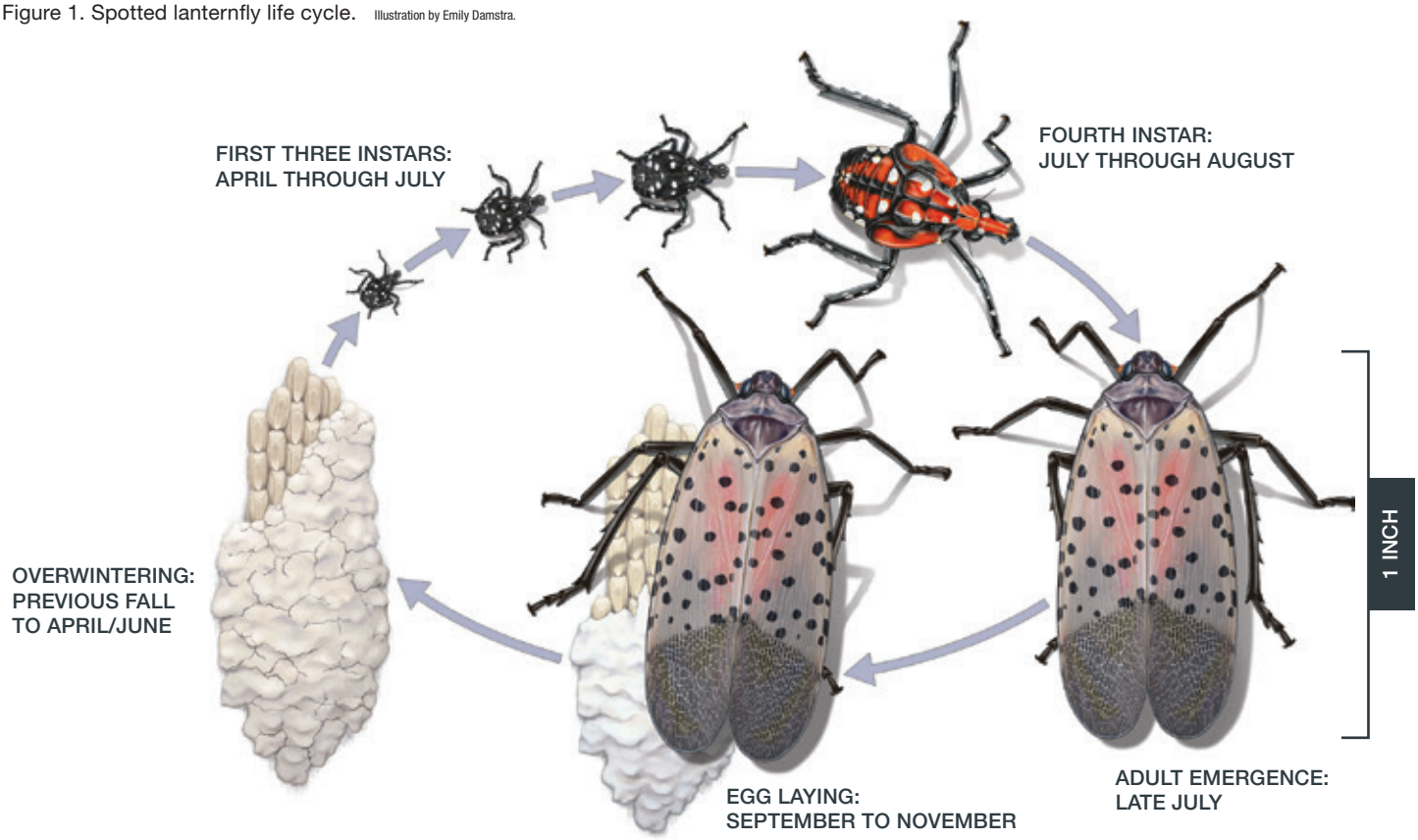
GLOWING BUGS? NOPE!

Spotted lanternfly belongs to the insect family Fulgoridae, or planthoppers. This group of insects was named after "Fulgora," the Roman goddess of lightning, because they were thought to be luminescent, like lightning bugs. In reality, they are not!

QUICK FACTS

- SLF is an **invasive pest** that feeds on a large variety of plant species, including those in the agricultural, timber, and ornamental industries, and backyard plants.
- SLF is currently under **quarantine in 34 counties** in Pennsylvania, in addition to several other states.
- SLF does not bite or sting.
- SLF is a **plant stressor** that, in combination with other stressors (e.g., other insects, diseases, weather), can cause significant damage to its host. SLF alone may not kill the tree. Some plants are at more risk than others (e.g., grapevines, maple, black walnut). Death has only been noted in tree saplings, tree-of-heaven, and grapevines.
- **Slow the spread** of SLF by checking your car and any outdoor equipment (outdoor furniture, mowers, firewood, etc.) when going in and out of the quarantine zone.
- Manage SLF on your property by **promoting plant health, scraping eggs, using traps, and using chemical control when appropriate**. Use our management decision guide to determine which actions are best to take.

Figure 1. Spotted lanternfly life cycle. Illustration by Emily Damstra.



IDENTIFICATION AND LIFE CYCLE

There is one generation of SLF per year in Pennsylvania (Figure 1). The eggs are laid in the fall (September to November) and hatch in the spring (late April to June). Egg masses are laid on many surfaces (trees, decks, houses, outdoor equipment, rocks, etc.) and protected with a mud-like covering (Figure 2). Each egg mass contains an average of 30 to 50 individual eggs. After hatching and before reaching adulthood, SLF goes through four nymphal stages called instars. Newly hatched nymphs are small (~1/8 inch) and can be hard to find, often being mistaken for small ticks or spiders. With each molt to the next instar, the nymphs roughly double in size. The first three instars are black with white spots. The last (fourth) instar is red with white dots and black stripes and roughly 1/2 inch long. SLF nymphs and adults are strong jumpers. In Pennsylvania, SLF adults begin to emerge in July and remain active as adults until they are killed by hard freezes later in the fall. Adults are the most obvious and easily detectable stage because they are large (about 1 inch) and highly mobile. Adults have black bodies. Their forewings are gray with black spots, and the tips are black with gray veins, while their hind wings are red, black, and white. Only the adults have wings and can fly. However, because SLF adults walk more than fly, their wings often remain closed, leaving only the forewings visible. This makes them more difficult to identify in low numbers, from a distance, or when they are high in a tree. See Table 1 for a comparison of nymphs and adults.

Figure 2. Egg masses. Credit: Heather Leach and Emelie Swackhamer, Penn State

Table 1. Nymphs versus adults: how do they differ?

CHARACTERISTIC	NYMPHS	ADULTS
Appetite	Nymphs have a varied appetite, including the tender new growth of trees and shrubs; herbaceous plants such as perennial weeds; and annual and perennial flowers.	Adults feed on woodier plant species (trees, vines).
Feeding location	Nymphs often feed on any herbaceous material they encounter and the new growth of trees and shrubs (often near the tops of trees, making them difficult to see or reach).	Early adults will feed throughout trees; in the fall, they will feed more on the trunks/ branches of trees.
Movement	Nymphs are in near constant motion when they are not feeding. They climb any trees that they encounter and then launch or "fall" from the crowns and move to the next plants. They often move in groups from plant species to plant species and may only remain on the same plant for a day or two. Group aggregation increases with each life stage.	Adults tend to stay on the same plant longer (except during mating/flight activity).
		Adults often choose a favorite or "hot" tree on which to gather and feed in large numbers for several weeks later in the season. This can occur even among trees that appear similar (same cultivar, age, growing conditions, apparent health, etc.). If you have observed a hot tree that SLF adults preferred in previous years, there is a good possibility that they will return to that tree in subsequent years. These hot trees are good candidates to target with systemic insecticides.
Damage	Nymphs ingest less volume of tree sap than the adults, so a population of nymphs is thought to be less damaging than the same number of adults would be. Large numbers of feeding nymphs can damage soft-tissue perennials and annuals and cause dieback of individual tree branches.	High levels of SLF feeding may increase tree stress by reducing photosynthesis activity and nutrient levels. Damage is likely to be more apparent if the plant is already stressed by other factors.
Management	Contact insecticides may be used to control nymphs.	Contact insecticides are frequently used to control SLF adults because many of them feed on the lower parts of trees where they are more visible and easier to reach with direct sprays.
	It may be difficult to get a systemic insecticide in place in time to kill young SLF nymphs because nymphs move often. For these reasons, systemic insecticide applications are usually used to target the adult stage rather than the nymphs.	Properly applied systemic insecticides can provide weeks of control by continuing to kill SLF adults as they arrive.
Other considerations	To protect pollinators that visit flowers for nectar, never spray any insecticide on flowering plants.	Promoting plant health may help reduce the stress of SLF feeding on trees.
	Using insecticides to kill SLF nymphs will not prevent SLF from coming onto your property later in the season.	Using insecticides to kill SLF adults will not keep more SLF adults from coming onto your property.

The comparisons above are a good rule of thumb, but SLF don't always conform to them! Observe what is happening with the SLF on your property to help you make management decisions.

QUICK ID

- Egg masses are covered with a gray-brown substance, flat, and laid on many surfaces, most commonly trees.
- Long legs make SLF strong jumpers; both nymphs and adults often jump when prodded or approached.
- Early nymphs have black bodies with bright white spots.
- Late nymphs are colorful, red, and roughly the size of a nickel.
- Adults have hind wings with red patches, and gray forewings with black spots and veins. When folded, only the forewings are visible and provide camouflage against tree bark.

CURRENT DISTRIBUTION AND QUARANTINE

Currently, SLF has become established in at least nine eastern U.S. states. The spread of SLF in the current range is most likely due to a combination of (1) natural spread and population growth and (2) human-assisted movement, such as along rail lines and highways.

To protect vulnerable plants and industries, it is important to avoid spreading SLF to new areas. Many affected states have enacted quarantine orders to prevent accidental human-assisted spread of SLF. The quarantine orders require any items being moved from known infested areas be inspected and SLF destroyed before shipment. The quarantines affect all residents and businesses. All businesses conducting operations in Pennsylvania are required to get an SLF permit (see https://extension.psu.edu/spotted-lanternfly). Complying with the quarantine requires businesses to document their inspections and preventive actions. Residents should also check their belongings for all life stages of SLF before traveling within or leaving a quarantined county. Use the Checklist for Residents available from https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/Entomology/spotted_lanternfly/quarantine/Documents/SLF_Checklist_for_Residents.pdf to assist with inspection before traveling.

WHAT YOU NEED TO KNOW

- Everyone should check their belongings, vehicles, etc., for all life stages of SLF before traveling, especially if leaving a quarantined county.
- Businesses and organizations that conduct business within any quarantined county are required to get an SLF permit.
- The SLF permit is free and compliance ensures that goods and conveyances have been inspected and are considered free of SLF before moving.
- Plant nurseries and some other businesses may also need a compliance agreement. Contact the Pennsylvania Department of Agriculture (PDA) for more information.

Photo Credit: GH Photos Alamy Stock

HOST RANGE, PHENOLOGY, AND DAMAGE

Feeding Damage

SLF feed on plant sap using piercing-sucking mouthparts (Figure 3). They acquire nutrients from the plant sap and also rely on associated bacteria in their guts to support their nutritional requirements. The sap they ingest contains high amounts of sugar, which is not completely digested by the insect. They excrete the excess as a liquid waste substance called **honeydew**, which can build up below the feeding insects. On sunny days, honeydew can be seen falling from trees, resembling a light rain. Honeydew is attractive to ants, wasps, bees, and other sugar-loving insects. As the honeydew accumulates, it is often colonized by sooty mold (fungi). Sooty mold does not directly harm plants or the surfaces on which it grows, but it does physically block leaves, reducing photosynthesis. With dense groupings of SLF, understory plants may die because of the sooty mold buildup on their leaves. Sooty mold frequently stains objects such as tree trunks, decks, patios, and vehicles that are underneath affected trees. These stains can be very difficult to remove.

Consequences of direct feeding damage by nymphs and adults to the host trees vary greatly by host species, numbers of SLF feeding, and environmental conditions. While SLF feeding can stress plants and cause localized branch damage, **it is not known to kill plants except for TOH, black walnut saplings, and grapevines**. SLF feeding is considered a plant stressor and may contribute to the long-term weakening of established plants and trees. High levels of adult SLF feeding can reduce the photosynthetic activity of some trees. It is possible that after heavy feeding, multiple years of sustained damage, or in particularly dry years, SLF may cause significant damage to ornamental and shade trees.

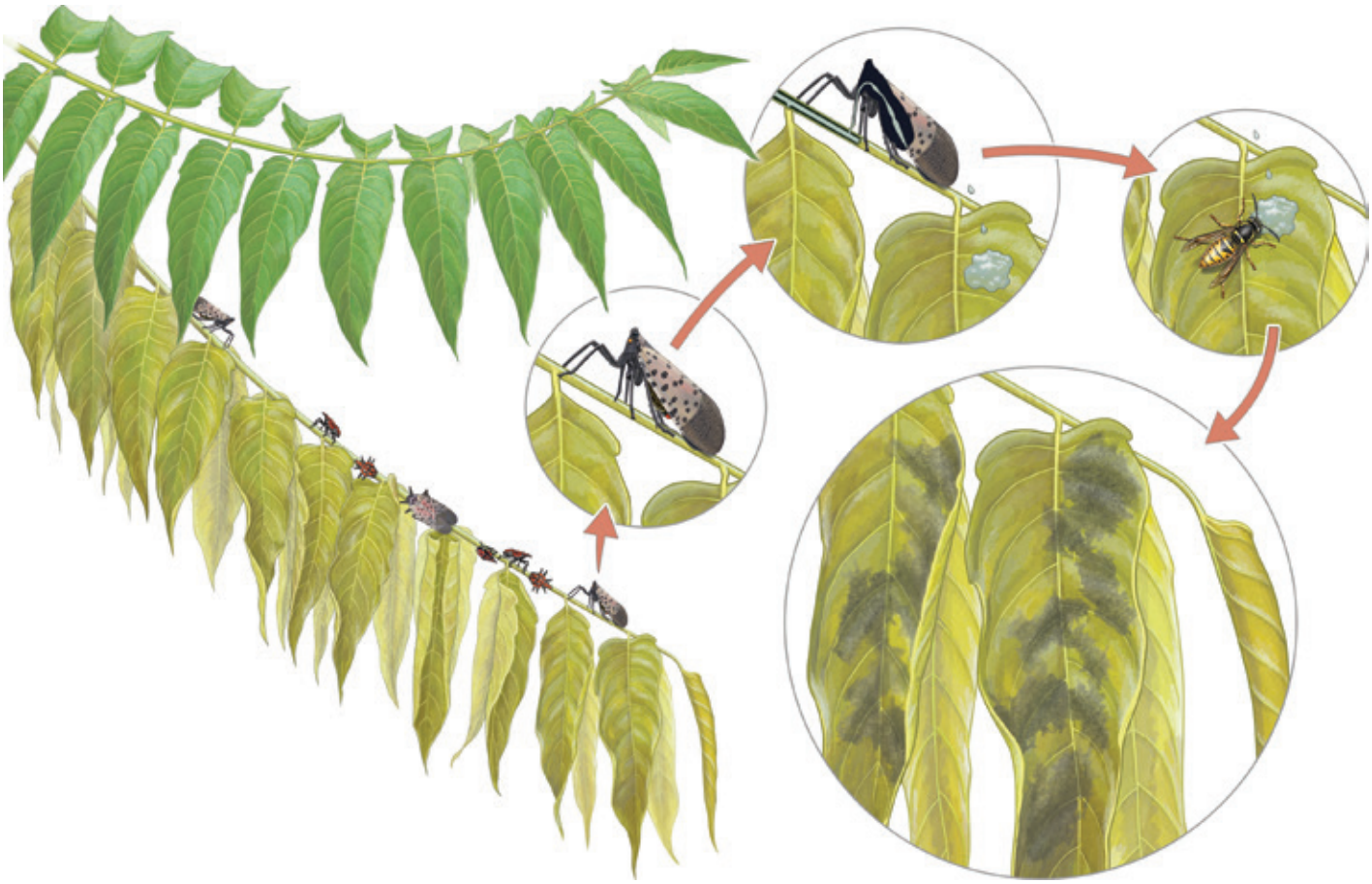


Figure 3. SLF feeding on sap and excreting honeydew, attracting sugar-loving insects, and sooty mold growing on leaves. Illustration by Emily Damstra.

Seasonal Host Preference

SLF has an extremely broad host range and has been recorded feeding on over 70 different plant species. Conifers are generally not considered to be good hosts for SLF. Despite their broad host range, some plants appear to be more favorable to SLF than others. Numerous factors may determine the attractiveness of a particular plant, including what plants species are available or absent in the nearby landscape, the health of the plant, time of year, SLF population size, and how long SLF has been present in the area. Nymphs, in particular, have an especially large host range that includes perennials and any new and tender plant growth, whereas adults seem to depend more on certain hosts, primarily woody stems of trees and vines.

Table 2 shows the key plant hosts of SLF and the time at which they are most likely to be found on these hosts; it does not represent a comprehensive list of what SLF feeds on, but rather the patterns of SLF feeding that have been observed through the season. As plants begin to lose their leaves at the end of the growing season, they are less likely to serve as hosts for SLF. The patterns in host use may change with varying weather conditions, by region, and from other factors as yet undetermined.

We strongly recommend scouting the area to determine what plants SLF prefer in your landscape throughout the season. These patterns can help you decide which management actions, if any, to take. We emphasize that **not every tree in already-infested areas needs to be treated**. Scout the area first and then consider treating if high populations are found and persist.

If you find SLF in new areas where they have not been found before, more aggressive management practices may be needed to try to prevent them from becoming established there.

WILL SLF FEED ON YOUR VEGETABLE GARDEN?

SLF, especially the nymph stage, will feed on vegetable, fruit, and herb plants. However, damage is seldom reported and only seen when plants are subject to very high SLF populations. Watch for SLF feeding on grapevine, cucumber, hops, and other herbaceous plants.

Credit: Brian Walsh, Penn State

Credit: Amy Korman, Penn State

Table 2. Common plant hosts for spotted lanternfly feeding throughout the season. As plants begin to lose their leaves at the end of the season, they are less likely to serve as hosts for SLF. Information in this table is based on observations in Eastern Pennsylvania and may vary based on local conditions.

HOST	NYMPHS			ADULTS		
	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
Rose (cultivated, multiflora, etc.)						
Perennials						
Grape (wild and cultivated)						
Tree-of-heaven						
Black walnut, butternut						
River birch						
Willow						
Sumac						
Red/silver maple						

Monitoring

We strongly recommend monitoring high-value plants on a regular basis to observe where SLF is feeding throughout the season. Home gardeners have reported SLF nymphs feeding on cucumber, basil, rose, peony, Russian sage, and many more plants. In some cases, damage to these plants has been reported when SLF populations are high. SLF nymphs generally feed on herbaceous plants for only a short period of time (less than one week) and then move to other plants. If there are favorite host plants and/or high populations of SLF nearby, we recommend you focus monitoring and potential management on those high-value plants. You can monitor with traps (see below) or through periodic visual inspection. **Don't assume that all plant damage you see is caused by SLF.** Remember, other factors can cause plant health decline, including other insects, diseases, and weather conditions.

Seasonal Population Fluctuations

SLF nymphs and adults frequently move from one plant to another throughout the season, which can make assessing the population size difficult. If you have a lot of their favorite plants in your area, you might experience high populations of SLF because they have access to a plentiful food source. We recommend monitoring regularly.

Annual Population Fluctuations

In newly infested areas, SLF populations tend to increase steadily over several seasons, and preferred individual host plants tend to remain consistently favored from year to year. However, observations of populations near the original introduction indicate that numbers can drastically drop or rebound from season to season. It is believed that population density, host fitness, natural enemies, and weather conditions play a role in these fluctuations, but further research is needed. **Unfortunately, after a year with low population numbers, it is not uncommon to see an increase in the population the following year.**

MANAGEMENT

It is important to understand that **SLF cannot be prevented from coming onto any one property**. SLF is a complex pest problem, and unfortunately, there is no "one size fits all" solution. Each situation is different and deciding on a plan of action requires everyone to assess their situation and decide what makes sense for them. Properties can experience sudden increases in populations of nymphs, but this occurs more commonly with adults. SLF adults tend to fly to new trees to feed in the late summer. Additionally, the presence of **low numbers of SLF may not necessitate treatment**.

Deciding If and When to Treat for Spotted Lanternfly

SLF nymphs and adults are both fairly easy to kill with insecticides; even the less-toxic insecticides like soaps and oils can work well. That said, there are many things to consider before deciding to use an insecticide to kill SLF on landscape trees or shrubs. Some things you should take into account are (1) the number of SLF present, (2) whether they are on a preferred host plant where they are likely to remain or on a plant they will move away from after a shorter visit, (3) the size and health of the plant, (4) the presence or absence of preferred host plants in the landscape, (5) and the life stage of SLF present. If you decide to use an insecticide, use the least-toxic but effective option. Use only insecticides that are registered by the Environmental Protection Agency (EPA) and approved for the site, and **read and follow the label directions**.

Use the steps below to think about your situation, goals, and the available management options. Continue to remain vigilant and adapt your action plan if your unique situation changes.

First, assess your risk by considering SLF population size and the vulnerability of your plants (Figure 4).

1. Population severity: Monitor your surroundings and watch for patterns in movement and feeding, and the presence of honeydew and sooty mold.
2. Likelihood of impacting plants: This is the likelihood that SLF will feed on existing plants, and the presence (or absence) of other stressors affecting the plant, such as damaged trees, excessive rain or drought periods, disease, age, and poor planting sites.

After thinking realistically about the risk that SLF poses to your property and trees, the next step is deciding on a course of action that works for you. Figure 5 summarizes many management options that may help. Use options in the lower steps of Figure 5 before resorting to the careful use of chemical insecticides only when necessary. Keep in mind that as you increase in steps, environmental impact and cost of the management tactic may increase. The time, effort, and

LIKELIHOOD OF IMPACT: what plants are present?	**SEVERITY:** how many SLF are present?			
	Low (occasional egg masses, nymphs, or adults)	**Tolerable** (few egg masses, nymphs, or adults)	**Undesirable** (many egg masses, nymphs, adults, and sooty mold present)	**Intolerable** (heavy levels of adult and nymph feeding, extensive amounts of sooty mold)
Few SLF favorite plants (maples, willow, birch, tree-of-heaven)	**LOW RISK**			
Many SLF favorite plants (maples, willow, birch, tree-of-heaven)				
Plants under **stress** (weather, diseases)				
Proximity to vulnerable plants (young plants, vineyards, etc.)				**HIGH RISK**

Figure 4. Assess your risk using SLF population size and plant vulnerability. If you are in an area where SLF has not been previously, all SLF should be captured and destroyed if possible and reported.

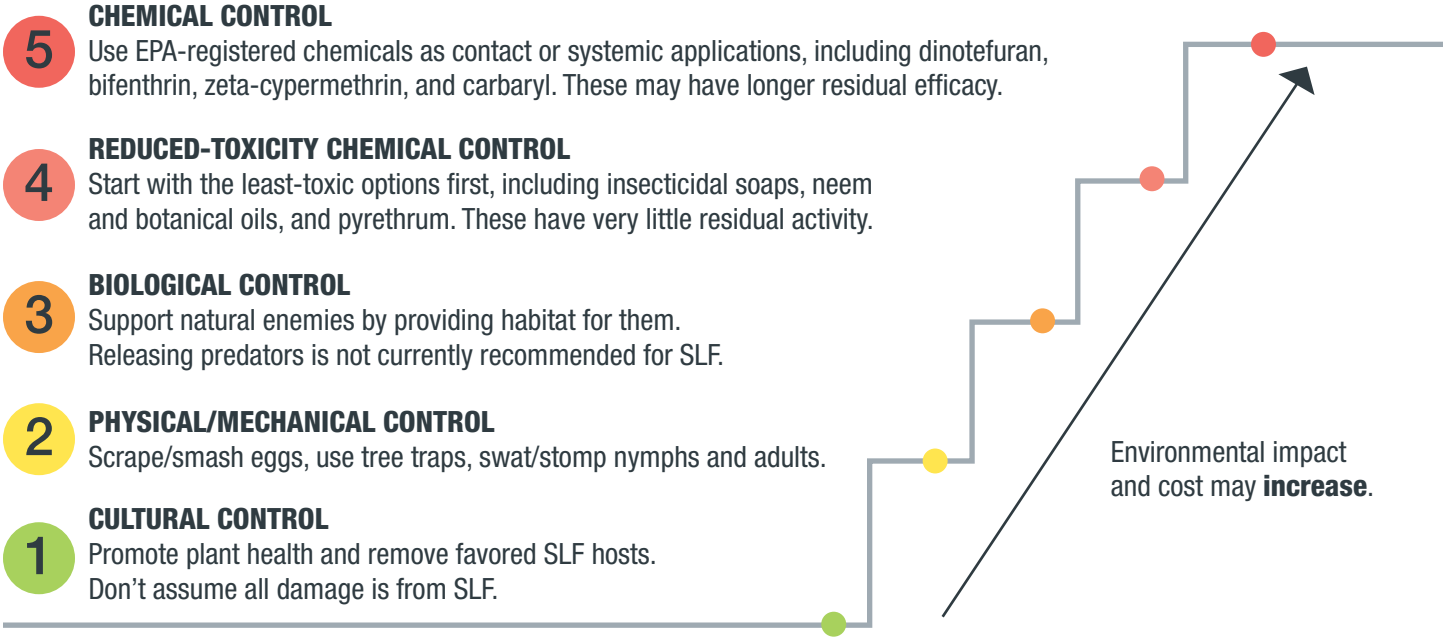


Figure 5. Use options in the lower steps before resorting to the careful use of chemical insecticides only when necessary.

cost of the action plan you choose will vary depending on many factors. You may have the ability, tools, and desire to implement some management options yourself, or you may choose to hire a pest management professional (see https://extension.psu.edu/choosing-a-qualified-pest-management-or-lawn-care-company). Table 3 provides a quick reference of roughly when control options should be employed.

Stop the Spread

If you are in the known range of SLF, do your part to prevent moving them farther. If you are outside the known range, you should take a picture of them or collect some samples for evidence, destroy them if you can and report your findings on the SLF website (https://extension.psu.edu/spotted-lanternfly). When you travel within and out of the quarantine zone, check your car and outdoor equipment (grills, outdoor furniture, landscaping supplies, mowers, etc.). Check for SLF egg masses from late fall to early spring. Remember, egg masses may be underneath your car or in your wheel well. During all other times of the year, check for nymphs and adults, and keep your windows rolled up when you park. Don't store things or park under infested trees, and don't move firewood.

Biological Control

Currently, there are no known natural enemies of SLF that are expected to reduce populations in the United States. Some generalist predators (spiders, praying mantises, parasitoids, birds, etc.) will attack and eat SLF. Additionally, two species of fungal pathogens were identified in Pennsyl-

Table 3. Management options for spotted lanternfly throughout the year.

MANAGEMENT OPTIONS	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Don't move any life stage of SLF	■	■	■	■	■	■	■	■	■	■	■	■
Scrape and destroy eggs	■	■	■	■	■				■	■	■	■
Spray eggs with dormant rate of horticultural spray oil		■	■	■								
Use circle traps					■	■	■	■	■	■		
Contact insecticide applications (after hatch and avoid bloom)					■	■	■	■	■	■		
Systemic application of imidacloprid (after bloom)					■	■	■					
Systemic application of dinotefuran (after bloom)							■	■	■			

vania that can attack and kill SLF. One species, *Beauveria bassiana*, was the focus of recent research in SLF-infested woodlots. This pathogen is commercially available as a biopesticide. We do not currently recommend *B. bassiana* for management of SLF; however, continued research may lead to optimizing the use of *B. bassiana* for inclusion in future recommendations. Researchers are also exploring the native range of SLF to search for natural enemies for potential release in the United States. These efforts are currently under evaluation in USDA quarantine facilities.

Cultural Control

Removing Preferred Host Plants

Removal of preferred host plants has not been specifically evaluated for success in managing SLF populations, but removing certain infested trees can prevent honeydew and sooty mold accumulation on property beneath them. If possible and practical, we recommend removal of tree-of-heaven (TOH). It is invasive in the United States and has other negative environmental effects. When removing TOH, use an herbicide to kill the root system (see the "Tree-of-Heaven" fact sheet at https://extension.psu.edu/tree-of-heaven for more information). However, removal of TOH or other host plants is unlikely to consistently reduce SLF numbers. In addition to removal, some TOH can be left remaining and treated with a systemic insecticide to attract and kill SLF as they feed. TOH is a dioecious plant, meaning there are separate male and female trees. If allowing some TOH to remain, keep the male trees where possible, in order to prevent females from reseeding the area.

Finding and Destroying SLF Eggs

Female SLF will lay their eggs in a variety of places and on a wide range of surfaces. One common place to find eggs is on or near trees where females were feeding during the egg-laying period in the fall. Tree hosts preferred by SLF during the fall include red maple, silver maple, and willows—these trees are an excellent place to start looking for egg masses! However, SLF will also lay eggs on other trees on which they do not typically feed, including black cherry, pine, and others. They will lay eggs in protected areas under rocks and on lawn furniture, decks, fences, rusty metal, and many other surfaces.

SLF eggs can be destroyed by scraping them from the surface where they were laid into an alcohol solution (e.g., rubbing alcohol or hand sanitizer) where they should be left permanently (Figure 6). Eggs can also be destroyed by thoroughly smashing them.

It is important to keep in mind that you will not be able to reach all the egg masses deposited on a tree. Researchers have documented that less than 2 percent of the egg masses laid on trees were at a reachable height (up to 10 feet from the ground), leaving 98 percent of the egg masses above reach (Figure 7). We do not recommend using ladders or climbing trees to get to the unreachable eggs.

Each destroyed egg mass can remove up to 30 to 50 SLF from the next year's generation, but you are unlikely to destroy all SLF in an area. Continued management strategies may be necessary the following year.

Using Traps

If you have SLF on your property, you can use traps to kill them and possibly reduce infestation on your trees. SLF nymphs and adults crawl up from the tree trunk to feed higher on the tree, and traps are used to intercept them. The recommended trap for SLF is a funnel-style trap called a "circle trap." Sticky bands, which capture SLF in sticky material as they move up the tree, have also been used to capture SLF. However, these are not recommended because this sticky material is not selective and can capture other animals, including pollinators, butterflies, birds, squirrels, and more. Sticky bands should never be used without a wildlife barrier installed around them (see below). Relatively easy to install, traps are a nonchemical method of killing SLF that can be a good option for residential landscapes.

Installation

Trapping is not possible on bushes or most vines because they don't have trunks that are large enough in diameter for the trap. Traps work best on trees with smooth bark; bark with deep grooves may allow SLF to crawl underneath the trap. Place the trap about 4 feet from the ground and secure

Figure 6. Destroy SLF eggs by scraping them from the surface where they were laid into an alcohol solution. Credit: Pennsylvania Department of Agriculture

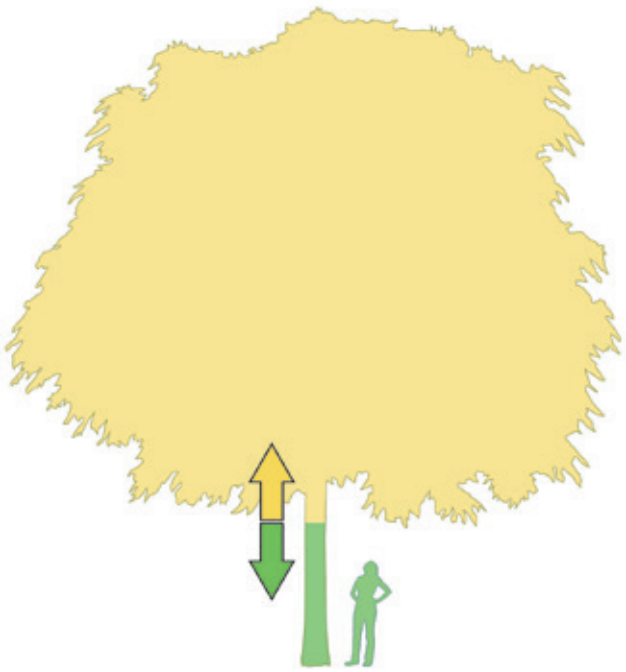


Figure 7. Less than 2 percent of egg masses laid on trees are at a reachable height. Illustration by Emily Damstra.

it tightly against the tree by wrapping the material tightly, stapling it into the tree, or using pushpins. To preserve the health of the tree that you are trying to protect, avoid using nails or wounding the green living tissue underneath the bark. Only set up traps on trees on your property or where you have permission to do so. Remember to remove all parts of the trap at the end of the season. We suggest using traps as soon as SLF hatch (late April through June). Traps can capture large numbers of nymphs. While adult SLF can also be captured by tree traps, they may avoid them, resulting in less effectiveness later in the season.

Circle Traps

A circle trap is a modified funnel that you can purchase commercially or build yourself (Figure 8). The container used to collect SLF can be a plastic bag or a jar. For a detailed guide on how to build your own trap, see "How to Build a New Style Spotted Lanternfly Circle Trap" at https://extension.psu.edu/how-to-build-a-new-style-spotted-lanternfly-circle-trap. Some people have built similar traps devising a range of methods that work. Building these traps is a good project for anyone who wants to destroy SLF while saving money by using materials they may already have on hand.

Sticky Bands

Sticky bands and tree-banding glue are available for purchase online and from your local garden center or hardware store. To date, we have not found any commercially available band to be better than another. However, this method is not recommended due to the risk of capturing nontarget organisms. When banding for SLF using sticky material, you may trap nontarget animals (bycatch), including beneficial insects, small mammals (bats, squirrels, etc.), small birds, and lizards. **Always accompany your sticky band with a wildlife barrier to prevent bycatch.** To do this, you can build a guard over the band using vinyl mesh netting (e.g., window screening) to prevent animals from contacting the sticky surface (Figure 9). Chicken wire is not effective because it allows small birds and pollinators to pass through. Secure the screening to the tree by pleating it with pushpins. It should extend several inches above and below the sticky band and be close to the tree at all points to prevent creatures from flying or climbing underneath. There is also a commercially available band that uses a white fiber material to hold the inward-facing sticky side of the band away from the trunk of the tree. This creates a protected sticky surface, which reduces the potential of catching birds and other animals. Homemade bands using

Figure 8. A homemade circle trap secured to a tree.
Credit: Emelie Swackhamer, Penn State

Figure 9. A sticky band covered with vinyl mesh to prevent bycatch. The screen still allows SLF to crawl up from the base of the tree to come in contact with the sticky material but prevents mammals, birds, and pollinators from coming into contact with the band.
Credit: Elizabeth Finlay, Penn State

products like duct tape or petroleum jelly on water-resistant paper are less effective than commercially available sticky bands because they lose their stickiness easily and can allow SLF to escape.

If you decide to use sticky bands, check them every day. If you capture an animal, do not attempt to free it by yourself. You may put the animal and yourself in danger. If you wish to try to save the animal, cover any exposed sticky material with plastic wrap or tissue paper to reduce additional entanglement, remove the band from the tree as carefully as possible, and take the animal to a wildlife rehabilitation center. To find a center, see the Pennsylvania Association of Wildlife Rehabilitators website, https://pawr.com/.

Using Insecticides for SLF

Insecticides can kill insect pests on **contact** and/or by being present **systemically** in a plant that the insect pests eat (Tables 4, 5, and 6). The duration of control that remains after application (i.e., residual activity) varies depending on which type of insecticide is used. Property owners should consider hiring a certified pesticide applicator to make insecticide applications. Professional applicators have specialized training and equipment to treat trees. Hiring a professional may reduce your risk of pesticide exposure and save time, but it may cost more than doing the application yourself.

Table 4. Characteristics of contact versus systemic insecticides.

CHARACTERISTIC	CONTACT INSECTICIDES	SYSTEMIC INSECTICIDES
How they kill	SLF are killed when the chemical contacts the body of the insect.	Systemic insecticides are absorbed by roots, bark, or leaves and moved through the vascular system to other parts of the plant, killing the insect when it feeds on the treated plant.
Application method	Spray with appropriate equipment.	There are four methods: foliar, injection (usually applied by professionals), trunk spray, and soil drench.
Longevity	Residual activity is dependent on product, but can be from 0 to 14 days; less-toxic contact insecticides require thorough coverage of the insect's body and tend to work for a short period.	This depends on application method and product, but can be up to two months or more; keep in mind that systemics take time to move into the tree. Systemic insecticides should only be applied to actively growing trees, so they should not be applied in late fall or winter.
When is it recommended for SLF?	Target populations of nymphs or adults; to protect pollinators, do not apply insecticides to blooming plants.	Most systemic insecticide applications are recommended for adult SLF. Apply systemic insecticides only after bloom is finished to protect pollinators and other beneficial insects. Do not apply systemic insecticides to plants that SLF will not feed on—they need to feed in order to ingest the poison.

Table 5. Systemic products for spotted lanternfly adults.

ACTIVE INGREDIENT	TOXIC TO BIRDS	TOXIC TO FISH	TOXIC TO BEES	APPLICATION METHOD	RECOMMENDED TIMING	ACTIVITY AGAINST SLF	RESIDUAL ACTIVITY
Dinotefuran	S	S	H	Soil drench, trunk spray, or trunk injection	July to September	Excellent	Excellent
Imidacloprid	M	M	H	Soil drench	After flowering to July	Variable	Variable
Imidacloprid	M	M	H	Trunk injection	July to September	Variable	Excellent

N = nontoxic; S = slightly toxic; M = moderately toxic; H = highly toxic; — = data not available.
This table is based on the experiments we have done to date and should not be considered final or complete.

Table 6. Contact products for nymphs and adults.

ACTIVE INGREDIENT	TOXIC TO BIRDS	TOXIC TO FISH	TOXIC TO BEES	ACTIVITY AGAINST SLF	RESIDUAL ACTIVITY
Beta-cyfluthrin	M	H	H	Excellent	Excellent (up to two weeks of activity)
Bifenthrin	M	H	H	Excellent	Excellent (up to two weeks of activity)
Carbaryl	S	N	H	Excellent	Poor
Zeta-cypermethrin	S	H	H	Excellent	Poor
Malathion	M	H	H	Excellent	Poor
Neem oil*	—	H	H	Good	Poor
Natural pyrethrins*	N	H	M	Excellent	Poor
Insecticidal soaps*	N	N	N	Good	Poor
Paraffinic oil or horticultural spray oil*	—	—	—	Good	Poor

N = nontoxic; S = slightly toxic; M = moderately toxic; H = highly toxic; — = data not available.
*Some products may have organic labeling.
This table is based on the experiments we have done to date and should not be considered final or complete. The contact insecticides can include spraying on trunk, branch, and foliage.

Contact Insecticide Applications

Contact insecticides kill the insect when they contact the insect's body. You can use a contact insecticide to kill SLF within a few hours or days. Less-toxic contact insecticides require thorough coverage of the insect's body and tend to work for a short period. Other contact insecticides persist longer in the environment and can kill SLF that move into the area even after the spray has dried. These persistent contact insecticides tend to be more toxic.

Contact insecticides are applied to plants as sprays. Sprays of insecticides have the greatest potential to impact nontarget organisms on the site being treated, cannot be made to blooming plants, have a higher potential to drift off target, and also have an increased risk of killing beneficial organisms, which can lead to unintended pest flareups.

Systemic Insecticide Applications

Trunk Injection

Trunk injection requires specialized equipment and is usually applied by professionals. Trunk injection can provide the most accurate dosing of a tree, often with the least amount of material used, as very little material is lost to the environment outside the tree. Products labeled for trunk injection may not have restrictions on volume of active ingredient permitted per acre per year and can allow for more trees per acre to be treated without violating the label restrictions. Be sure to follow the insecticide label and equipment manufacturer's instructions. SLF death has been observed less than 24 hours after injecting a tree with dinotefuran. Injections of imidacloprid have also been successful but take longer to become effective. As with other application methods, the environmental conditions and health of the tree can greatly affect the speed at which the insecticide becomes effective.

Trunk Spray

Trunk sprays (also referred to as "bark banding" or "bole sprays") with dinotefuran have also been successful. Observed death of SLF may take longer by trunk spray than with injected applications but is still likely to occur within a few days of treatment. If the label requires a bark penetrant as a spray adjuvant, be sure to include it in your application. It is important to properly dose the trees based on size measurement, not simply "spray until runoff." It is often necessary to pause the application to wait for the material to be absorbed so the full dose as dictated by tree diameter at breast height (DBH) may be applied. Large trees with exfoliating bark, such as mature silver maples, may be difficult to properly treat with this method because the bark can reduce the penetration of the insecticide into the living tissue. Additionally, trees that have a compromised vascular system (i.e., are wounded) may not be able to translocate the insecticide as well as other trees.

Soil Drench and Soil Injection

Soil drenches of systemic insecticides are applied into the soil around the trunk of the tree. The insecticide is taken up by the roots and moved into the rest of the tree. Ideally, soil drenches work best when applied in the early summer to trees that had high SLF populations in the past and are likely to have them again. To protect pollinators, soil drenches of systemic insecticides should be applied after a tree's flowers have faded. Soil injection by plant health professionals with specialized equipment can provide more precise application than soil drenching, but it also relies on applying a water-soluble insecticide to the root zone of an individual plant. Little efficacy data from soil drench or soil injection applications of imidacloprid to control SLF is available. The insecticide needs time to be taken up by the tree roots, giving this method the greatest time delay until it begins to kill SLF. Dinotefuran soil drenches tend to be taken up and provide efficacy much faster and more consistently than imidacloprid, but they are less precise than trunk sprays or injection. The amount of water needed to carry the insecticide into the tree is also very important. It is recommended that a soil drench of imidacloprid be applied in the spring (post bloom) and dinotefuran be applied in midsummer through September to target adult SLF. Read the label carefully and follow the directions to achieve best results.

Foliar Applications

Foliar applications with appropriately labeled systemic products can provide rapid contact efficacy for the control of SLF. Generally, this application method provides the lowest dose of systemic active ingredient to individual trees compared to the other methods discussed previously and thus also provides the shortest duration of residual efficacy. In general, foliar applications of systemic insecticides are not recommended for SLF except in specific cases, particularly for nymphs.

Ovicides to Kill Egg Masses

Experiments have shown that some insecticide sprays can kill SLF eggs. So far, all experiments were done between February and April using egg masses that had intact protective coverings. The most effective insecticides tested that are registered for use on ornamentals were horticultural and dormant oils. When oils were applied directly to the egg masses at a concentration of at least 3 percent, they were effective in killing up to 75 percent of treated eggs. Labels must be followed to prevent plant damage, and not all plants should be sprayed due to phytotoxic damage potential.

These experiments suggest that registered insecticidal oils may provide some control of eggs if they are applied between February and April in high enough volumes to get excellent coverage. Oils offer a lower-toxicity option and may provide some control of egg masses that are not accessible for scraping or smashing. However, for egg masses that are within a reachable area, scraping or smashing will provide greater efficacy than currently available ovicides. We are actively researching other ovicides that could provide increased control, and we encourage you to stay up to date on our progress.

Pesticide Safety

Avoid overreacting to the situation and teach others not to overreact.

Many people are fearful of SLF and worry that it may affect the health of their trees. From observations in previous years, we believe that a few SLF feeding on a large, healthy tree are unlikely to cause permanent damage. On the other hand, thousands of SLF might weaken a tree, but to date, no one has quantified how many will harm a tree or how badly the tree will be affected. Consider destroying SLF on individual trees by trapping or swatting them instead of using insecticides. If you decide to use an insecticide to kill SLF, there are some important safety measures and pesticide rules to follow. Before using any pesticide product, always read the label and be informed to be safe.

Only use registered insecticides to kill SLF.

Recipes for homemade sprays made from cleaning, automotive, cooking, or other household products might be more harmful to the environment or your plants than people realize. Insecticides that are registered with the EPA have been tested for safety and efficacy. The label provides important information, including directions for safe mixing and use and precautions to protect pollinators and the environment. Additionally, in Pennsylvania, the site where you plan to use an insecticide (e.g., "ornamental trees" or "vegetable plants") must be listed on the product label. You must use the rate and application method that corresponds with the site use.

Read the label and follow all directions.

Plan to spend time reading the label. You can find labels for insecticides online—read them before you buy anything. Read the label, figure out how much of the product you will need to do the job, and then you will know how much you need to buy. Some labels are formatted as booklets taped onto the side of the product container (Figure 10). Peel back the tape and read all the information before using the insecticide. Use a highlighter to mark the specific directions for the way that you will use the product. This also makes it easier to go back and find the right section the next time you use it.

Protect yourself from insecticide exposure.

When you use an insecticide, the risk depends on (1) the toxicity and (2) how much you are exposed to it. If you use a highly toxic pesticide, you can reduce your risk by limiting your exposure. If you use a less-toxic pesticide but experience a high amount of exposure, your risk increases. Follow the label directions and use safe practices. Use appropriate, properly functioning application equipment. Wear the recommended protective clothing and gear. Wash your protective clothing separately from your other laundry.

Use the right amount.

Using more than the labeled amount of an insecticide is not a good idea, and it is illegal. The goal is to effectively kill SLF and not release any more insecticide into the environment than necessary. Using more than what is listed on the label also wastes money. Certain products and/or applications may have restrictions on the cumulative amount of pesticide applied per designated timeframe or acreage. It is illegal to exceed limits of product use that are specifically written on the label. This is true even if adequate control has not been achieved due to the variables noted above.

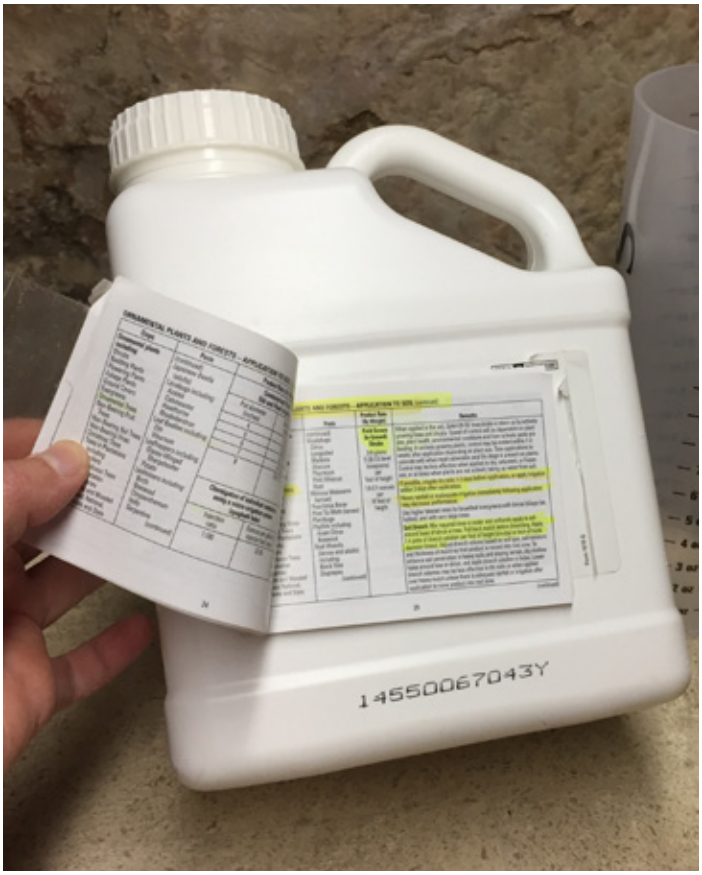


Figure 10. Some product labels are formatted as booklets that are taped onto the side of the product container. Peel back the tape and read all the information before using the insecticide.

Photo courtesy of Emelie Swackhamer, Penn State

Avoid using the same insecticide all the time.

Some insects have developed resistance to specific insecticides that have been used repeatedly to kill them. When this happens, that insecticide has little effect on the insect. We have not seen resistance occur in SLF yet, but it is best to rotate between different groups of insecticides to reduce that risk (see https://edis.ifas.ufl.edu/pi121 for more information).

Choose the least-toxic insecticide that is effective.

Use the least-toxic option that is effective for SLF. Look for two things on the label to check the toxicity of the product:

1. Designation as an organic insecticide, which can be lower in toxicity and less harmful to the environment. They will include a logo from the Organic Materials Review Institute (OMRI) on their label.
2. The signal word, which is required to be prominently displayed on the front of most insecticide product labels. Most insecticides have one of four signal words on the label: (1) "CAUTION" appears on insecticides with lower mammalian toxicity, (2) "WARNING" appears on insecticides that have medium toxicity, (3) "DANGER" appears on insecticides with the highest toxicity or greatest risk to eyes or skin, and (4) "DANGER POISON" and a skull and crossbones symbol appear on insecticides that are extremely toxic when consumed, inhaled, or absorbed through the skin or eyes (they may also be fatal at very low doses). Some insecticides with extremely low toxicity, including several made from botanical oils, are not required to have a signal word on the label because they are classified as "reduced risk" by the EPA.

Potential Nontarget Effects of Insecticides

Water Contamination

Every precaution should be taken to protect surface water and groundwater from pesticide contamination. Trunk injections pose the smallest risk to contaminating water because the insecticide goes directly into the tree. Soil drench applications should only occur directly adjacent to the trunk of the tree, as directed on the label. Soil drenches should not be applied to sandy soils or where the water table is shallow. Both dinotefuran and imidacloprid and their breakdown degradants can persist in groundwater for extended periods. When exposed to sun, both of these compounds break down readily, but their degradants may persist for much longer. To protect surface water, systemic insecticides should not be applied near open water sources (ponds, lakes, streams).

Pollinators and Other Insects

Many of the trees on which SLF has been observed feeding in high densities are also pollinated by bees (e.g., maples). It is possible that trees treated with systemic insecticides could have insecticide residue in their flowers and nectar the following spring. Neonicotinoid insecticides, in particular, have been associated with bee health decline. Additionally, many native insects (caterpillars, beetles, lacewings, etc.) utilize these trees at the same time as SLF and could be affected by the treatment. Pyrethroids can also be damaging to beneficial insect populations and could cause populations of secondary pests, such as mites and scales, to flare up. Generally, systemic insecticides applied by trunk injection, trunk spray, and soil drench are considered to have a reduced impact on natural enemies compared to broad-spectrum foliar-applied insecticides.

Photo Credit: GH Photos Alamy Stock

ONGOING RESEARCH

Research is ongoing to understand the biology and behavior of SLF and to find better management strategies. Research on tree health impact is focused on the physiological response of the tree to SLF feeding, which will involve the study of sap flow and the nutritional status of the plant over time. We are also evaluating whether SLF has a required plant host, and developing a ranked list of the preferred hosts.

Better management strategies may be developed by determining economic injury levels on various hosts, searching for useful biological control options (native and introduced predators, parasitoids, and fungal pathogens), and evaluating pesticide efficacy and nontarget effects. Stay up to date with this research by visiting https://extension.psu.edu/spotted-lanternfly.

SUMMARY

1. Spotted lanternfly is currently considered primarily a nuisance pest in residential landscapes.
2. Death of ornamental and shade trees has not been directly linked to SLF to date. SLF is considered a plant stressor. High infestation levels may reduce photosynthetic activity and energy storage. Don't attribute all plant health decline to SLF.
3. **Always scout for spotted lanternfly first before deciding to make a treatment.** Not every tree on any given property needs to be treated. Be aware that SLF populations may fluctuate from year to year; don't assume what happened last year will happen in the coming year.
4. The active ingredients, methods, timing, and other treatment suggestions presented here are guidelines. We are conducting research to refine these guidelines.
5. Always follow the label for any pesticide application you make.
6. Check for updated versions of this fact sheet and other news related to spotted lanternfly by visiting https://extension.psu.edu/spotted-lanternfly.

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