Spotted Lanternfly Management for Landscape Professionals

PA Department of Agriculture

Introduction

Spotted lanternfly (SLF), *Lycorma delicatula*, is an invasive planthopper, native to Asia, that was first detected in 2014 in southeastern Pennsylvania. As of May 2019, SLF is now found in Pennsylvania, New Jersey, Virginia, and Delaware. Detections of SLF have been reported in New York, Connecticut, Massachusetts, and Maryland, although established populations are not yet known in these states. It feeds voraciously on many plants, including economically important crops like fruit trees, grapevines, hops, hardwood trees, and ornamentals. While SLF can cause significant damage to plants, it is mostly considered a nuisance pest in the ornamental and landscape industries.

Life Cycle and Identification

There is one generation of SLF per year. 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 mudlike covering. Egg masses average around 30 to 40 eggs each. After hatching and before reaching adulthood, SLF goes through four nymphal stages called instars. Nymphs are small (⅛ to ½ inch) and can be hard to find. The first three instars are black with white spots. The last instar is red with white dots and black stripes (Figure 1). SLF adults begin to emerge in July and are active until they are killed by the first hard frost in late 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, the tips are black with gray veins, while their hindwings are red, black, and white. Only the adults have wings and can fly. However, because SLF adults hop more than fly, their wings often remain closed, leaving only the forewings visible (Figure 1D).

E. Swackhamer | PA Department of Agriculture | PA Department of Agriculture | PA Department of Agriculture | PA Department of Agriculture

A. Egg masses *Found September—June*
B. Early nymph *Found late April—July*
C. Late nymph *Found July—September*
D. Adult, wings closed *Found July—December*
E. Adult, wings open

Figure 1. Life stages of spotted lanternfly.

Feeding Damage

SLF feeds on plant sap (phloem tissue) using their piercing-sucking mouthparts (Figure 2). 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 carbohydrate-rich (sugar) liquid, which is not completely digested by the insect. They excrete this excess as a substance called honeydew, which builds up below areas where they are feeding. On sunny days, you may be able to see honeydew falling from trees. Honeydew is also attractive to ants, wasps, bees, and other sugar-loving insects. As the honeydew accumulates, it is often colonized by sooty mold (fungi). Sooty mold doesn't directly harm plants or the surfaces on which it grows, but it does act as a photosynthetic block. In dense populations of SLF, understory plants may die because of sooty mold buildup. In landscaped areas, honeydew and sooty mold can collect on plants under trees and on patio furniture, decks, etc.

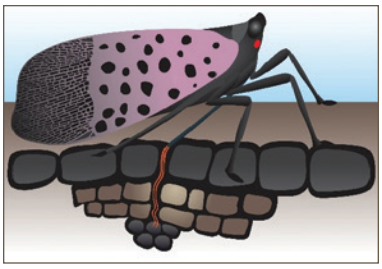

Figure 2. Spotted lanternfly with stylet (mouthpart) in phloem cells of plant. *Diagram by Nick Sloff*

Consequences of direct feeding damage to the host trees has not been quantified. Following high infestation levels, death of some tree-of-heaven and flagging on black walnut has been reported. We note that some oozing from maple and oak trees after heavy feeding by SLF was observed in 2018, and this is being watched closely. It is possible that after heavy feeding, multiple years of sustained damage, or particularly dry years, SLF may cause significant damage to ornamental and shade trees. However, currently SLF is predominantly considered a nuisance pest for homeowners, and death has not been reported in any ornamental tree.

Seasonal Host Phenology

SLF has an extremely broad host range and has been recorded feeding on over 65 different plant species. Despite this broad host range, some plants appear to be more favorable to SLF than others. Numerous variables appear to determine the attractiveness of a particular plant, including what other plants species are available in the nearby landscape, the health of the plant, the time of year, the SLF population size, and how long SLF has been present in the area. We emphasize that not every tree needs to be treated. Scout the area first, and then consider treating if high populations are found. Nymphs, in particular, seem to have an especially large host range, whereas adults seem to depend more on certain hosts. The table below represents the key plant hosts of SLF and the time at which they are most likely to be found on these hosts. The table below does not represent a comprehensive list of what SLF feeds on, but rather the patterns of SLF feeding through the season that have been observed. As plants begin to senesce at the end of the growing season, they are less likely to serve as a host for SLF. The patterns in host use may change with varying weather conditions, region, and other factors as yet undetermined.

Please note that while tree-of-heaven is a strongly preferred host, we do not yet know if this is a required host. Current evidence suggests that SLF can be sustained on a variety of hosts, but we lack knowledge of what hosts are required for SLF to develop and lay viable eggs. Based on recent studies done by USDA APHIS, SLF can develop from first instar to adult on the following hosts: tree-of-heaven, chinaberry, hops, black walnut, butternut, sawtooth oak, tulip poplar, and oriental bittersweet (M. Cooperband, unpublished data).

Host	Nymphs			Adults		
	May	June	July	August	September	October
Rose (cultivated, multiflora, etc.)	■	■				
Grape (wild and cultivated)	■	■	■	■	■	■
Tree-of-heaven	■	■	■	■	■	■
Black walnut, butternut		■	■			
River birch			■	■	■	■
Willow			■	■	■	■
Sumac			■	■	■	■
Silver/red maple				■	■	■

Monitoring

As mentioned above, SLF utilizes a large range of plant hosts. Home gardeners have reported SLF feeding on their backyard plants, including cucumbers, basil, rose, peony, Russian sage, and more. In most cases, SLF will only feed on these herbaceous plants for a short period of time (less than one week). In some cases, damage on these plants has also been reported. Whether or not damage occurs appears to be largely dependent on the density of the population and other plants in proximity. We highly recommend that you monitor for SLF on a regular basis to try to predict where SLF is likely to feed and move in a given area. If there are other highly desirable hosts nearby, we recommend you focus monitoring and potential treatment on those plants. Monitoring can be done by using sticky bands (see below) or through visual inspection.

Management

It is important to understand that SLF cannot be prevented from coming onto any one property. SLF adults tend to fly to new trees to feed in the late summer. Properties adjacent to land with high populations of SLF will likely experience higher populations of SLF when the adults begin to move around. While we are currently working on developing alternative management practices for SLF, our most effective control measure to date is the use of insecticides.

Biological Control

Predacious insects and spiders, parasitoids, and fungi have all been found attacking SLF in the United States. These are generalist natural enemies and they are unlikely to greatly reduce the population levels of SLF. More research is being done to understand if we can better utilize these already existing natural enemies for SLF management. Currently, there is no commercially available biological control option available for SLF. Research is ongoing to find potential parasitoids or pathogens that can be released into the United States as a long-term control solution.

Cultural Control

Removing Preferred Host Plants

If tree-of-heaven is found on the property, we recommend its removal, if possible and practical. When removing tree-of-heaven, you should use an herbicide (see **extension.psu.edu/tree-of-heaven** for more information). If there are other tree species on the property that are not highly valued by the homeowner and have high populations of SLF, they could also be removed. Removal of preferred hosts, including wild grape and oriental bittersweet, might help reduce populations of SLF. Trees that overhang outdoor living spaces such as patios or pools can be pruned to reduce dropdown of SLF and honeydew/sooty mold accumulation. Otherwise, consider treating these trees with an insecticide to reduce the nuisance in these areas.

Banding Trees

Banding trees with sticky tape is another tool that may assist in protecting important landscape trees. Banding can also be used as a monitoring tool for the presence of SLF on a tree. Banding is more effective against the nymphal stages of SLF since adult SLF may avoid the tape. There are many commercially available sticky bands at garden stores. Please note that bycatch of nontarget insects (bees, butterflies, natural enemies, etc.) and small vertebrates (birds, squirrels, bats, etc.) is possible when using these bands. There are several ways to reduce bycatch, including caging the band in wire/mesh or using inward-facing sticky bands. More details on banding can be found at **extension.psu.edu/using-traps-for-spotted-lanternfly-management**.

Scraping Eggs

Scraping SLF egg masses and placing them permanently in an alcohol solution (e.g., rubbing alcohol, hand sanitizer) is another approach to reduce SLF damage. It is important to consider that SLF egg masses are laid on many surfaces, including rocks, trees, fence posts, and outdoor furniture. Additionally, because egg masses can be found at all heights on a tree, safely reaching all of them is not practical.

Chemical Control

Ovicides

Based on studies done in 2018 and 2019, preliminary data suggest some insecticides have ovicidal action. All studies were done on intact egg masses (with covering) in February to April. The most effective ovicide that was tested for use on ornamentals was JMS Stylet Oil, a refined mineral-oil-based product, which offered up to 71 percent mortality of the egg masses when used at the 3 percent rate (note: The control mortality in these studies was 35 percent).

Contact Insecticides

Many commonly available insecticides that kill insects on contact are effective against SLF. Efficacy, residual activity, and toxicity vary between products. We recommend trying the least toxic options first. Toxicity to mammals can be determined from the LD_{50} values found on the Safety Data Sheet (SDS) for each product, and toxicity to birds, fish, and bees can be found in the table below. If systemic insecti-

Control Tactic	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Scrape eggs	■	■	■	■							■	■
Use dormant rate of horticultural spray oil on egg masses*		■	■	■								
Use tree traps (sticky bands)					■	■	■	■	■	■		
Make contact insecticide applications					■	■	■	■	■	■		
Make soil drench systemic applications (post-bloom only)				■	■	■	■	■	■			
Make trunk spray or tree injection systemic applications							■	■	■			

*Some trees are sensitive to horticultural spray oil.

Note: This is a guide for when to use management tactics to manage SLF. Read each label carefully and apply according to the label directions. These are our current best recommendations for management tactic timing, but not all combinations of active ingredient, timing, application methods, and tree species have been tested.

cides are not used, frequent use of contact insecticides may be needed to control SLF for the entire season. Always apply insecticides after bloom is finished to help protect natural enemies and pollinators.

Systemic Insecticides

We recommend the use of systemic insecticides for adult SLF control only in high-population areas and high-value trees. Research trials are ongoing to evaluate the best application method, active ingredients, how much insecticide is needed to kill SLF, and how long the insecticide application will last. Based on current data, most systemic applications will last at least two months. Obtaining additional months of control is possible but highly variable depending on many factors (application method, active ingredient, weather, tree species and size, etc.). Proper timing of the application also seems to be very important for effectiveness.

Always read the label and apply the pesticide according to directions. 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 stipulated by the label. This is true regardless of lack of adequate target pest control (SLF) due to the variable conditions as noted above. Always apply insecticides only after bloom is finished to help protect natural enemies and pollinators.

Three application methods are used to get systemic insecticides to be taken up by the plant: injection, trunk sprays, and soil drenches.

Injection

Based on current information, injection with dinotefuran has been successful at killing SLF in a variety of tree species, including tree-of-heaven, silver maple, and red maple. Death of SLF has been observed in less than 24 hours after injecting a tree. Injections with imidacloprid have also been evaluated with good success. Other products with different active ingredients will be tested in 2019.

Trunk Spray

Trunk sprays with dinotefuran have also been successful. This treatment program is currently being used by USDA APHIS and the Pennsylvania, New Jersey, and Virginia Departments of Agriculture. Observed death of SLF may take longer than with injected applications but is still likely to occur within a few days of treatment. If the label requires a bark penetrant, be sure this is included in your application. Trunk spray applications of imidacloprid have had variable results and more research is needed.

Soil Drench

Little data on soil drench applications of insecticides to control SLF is available to date. The insecticide needs time to be taken up by the tree roots, and this is often the method with the greatest time delay until it begins to kill SLF. Postbloom spring applications of imidacloprid soil drenches are recommended, whereas dinotefuran should be applied mid-summer until September to target adult SLF. Soil drench application is a commonly used method, especially for formulations widely

Active Ingredient	Toxicity*			Application Method	Recommended Timing	Life Stage Targeted	Activity Against SLF	Residual Activity
	Bird	Fish	Bee					
Systemic Products								
Dinotefuran	—	—	H	Soil drench	July to September	Adults	Excellent	Excellent
Dinotefuran	—	—	H	Trunk spray	July to September	Adults	Excellent	Excellent
Dinotefuran	—	—	H	Trunk injection	July to September	Adults	Excellent	Excellent
Imidacloprid	M	M	H	Soil drench	After flower to July	Adults	Variable	Variable
Imidacloprid	M	M	H	Trunk injection	July to September	Adults	Excellent	Excellent
Contact Products								
Bifenthrin	M	H	H	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Excellent	Excellent (up to two weeks of activity)
Carbaryl	S	N	H	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Excellent	Good (up to one week of activity)
Zeta-cypermethrin	S	H	H	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Excellent	Poor
Malathion	M	H	H	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Excellent	Poor
Neem oil	—	H	H	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Good	Poor
Natural pyrethrins	N	H	M	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Excellent	Poor
Insecticidal soaps	N	N	N	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Good	Poor
Tau fluvalinate, tebuconazole	H	H	N	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Excellent	Poor
Parafinic oil or horticultural spray oil	—	—	—	Trunk, branch, and foliage sprays	Spring and late fall for spot treatments, as needed	Nymphs and adults	Good	Poor
Parafinic oil or horticultural spray oil	—	—	—	Dormant oil for egg masses	February to April, before egg hatch	Egg masses	Fair	N/A

This table is based on the experiments we have done to date and should not be considered final or complete.

*N = nontoxic; S = slightly toxic; M = moderately toxic; H = highly toxic; — = data not available.

available to home gardeners. Read the label carefully and follow the directions to achieve best results.

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 can persist in groundwater for extended periods. When exposed to sun, both of these compounds break down readily. To protect surface water, systemic insecticides should not be applied near open water sources (ponds, lakes, streams).

Pollinators, Other Insects

Many of the trees on which SLF have been observed feeding in high densities are also pollinated by bees (e.g., maples and oaks). It is possible that trees treated with systemic insecticides could have insecticide residue in the flowers and nectar the following spring. Neonicotinoid insecticides, in particular, have been associated with bee health decline. Additionally, there are many native insects that utilize these trees at the same time as SLF (e.g., caterpillars, beetles, lady beetles, lacewings, parasitoid wasps) and could be affected by the treatment. Pyrethroids can also be damaging to natural enemy populations and could cause populations of secondary pests, such as mites and scale, to flare up. Generally, systemic insecticides are considered to have a reduced impact on natural enemies compared to broad-spectrum foliar-applied insecticides. We are currently conducting research to determine the effect of SLF treatments on pollinators and other nontargets.

Ongoing Research

Research is ongoing to find better SLF management strategies and understand the biology and behavior of SLF. This research includes the search for biological control options (native and introduced predators, parasitoids, and fungal pathogens), evaluating pesticides and their nontarget effects, and determining economic injury levels on various hosts. Research on the impact on tree health 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.

Summary

1. Spotted lanternfly is currently considered a nuisance pest in the ornamental and landscape industries. It has not been observed to kill ornamental or shade trees to date.
2. Always scout for spotted lanternfly first before deciding to make a treatment. Not every tree on any given property needs to be treated.
3. The active ingredients, methods, timing, and other insecticide data presented here are guidelines. We are still conducting research and continually refining these guidelines. Always follow the label for any pesticide application made.
4. Check for updated versions of this fact sheet and other news related to spotted lanternfly by visiting **extension.psu.edu/spotted-lanternfly**.

Prepared by Heather Leach, Amy Korman, and Emelie Swackhamer.

This fact sheet was produced by Penn State Extension in collaboration with the Pennsylvania Department of Agriculture and the United States Department of Agriculture.

extension.psu.edu

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Where trade names appear, no discrimination is intended, and no endorsement by Penn State Extension is implied.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability, or protected veteran status.

Produced by Ag Communications and Marketing

© The Pennsylvania State University 2019

Code EE0264 2.5M05/19mpc