PennState Extension

Spotted Lanternfly Management for Homeowners

E. Smyers

Introduction

Spotted lanternfly (SLF), *Lycorma delicatula*, is an invasive planthopper, native to China, that was first detected in 2014 in southeastern Pennsylvania. It feeds voraciously on many plants, including economically important crops like fruit trees, grapevines, hops, hardwoods, and ornamentals. If you think you have SLF, do not panic! First, make sure the insect you are seeing is the spotted lanternfly. Second, learn about its life cycle and habits. Third, determine what plants it is infesting and what it is not. Fourth, employ management strategies at the proper time of the year.

Quick Facts

- SLF is a **destructive invasive pest**, threatening agricultural, timber, and ornamental industries, and the plants in your backyard.
- SLF is currently under **quarantine** in 13 counties in Pennsylvania.
- SLF **does not bite or sting**.
- **Stop the spread** of SLF by checking your car and any outdoor equipment (grills, mowers, firewood, etc.) when going in and out of the quarantine zone.
- Manage SLF on your property by **scraping eggs**, **banding trees**, removing the favored host (**tree-of-heaven**), and using **chemical control** when appropriate.

Identification and Life Cycle

There is one generation of SLF per year. The eggs are laid in late fall and hatch in the spring. Egg masses are laid on hard surfaces (trees, decks, houses, outdoor equipment, rocks, etc.) and protected with a mud-like covering. Each egg mass contains 30–50 eggs. After hatching and before reaching adulthood, SLF goes through four nymph stages. Nymphs are small (¼ to ½ inch) and hard to find. The first three stages (instars) are all black with white spots, and the last instar is red with white dots and black stripes (Figure 1). SLF adults emerge in July and are active until winter. This is the most obvious and easily detectable stage because they are large (~1 inch) and highly mobile. Adults have black bodies with brightly colored wings. Only the adults can fly. Because SLF adults jump more than fly, their wings often remain closed. SLF wings are gray with black spots, and the tips of the wings are black with gray veins.

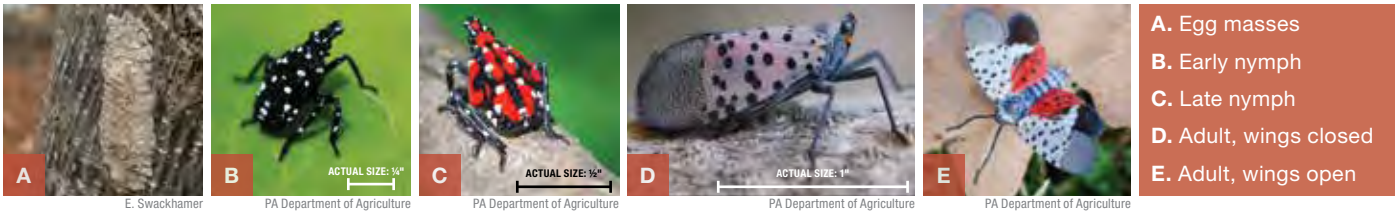

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Figure 1. The life stages of SLF, including an egg mass on a tree.

Current Distribution and Reporting

An SLF quarantine is currently in effect for 13 counties in Pennsylvania (Figure 2). If you are located outside the quarantine zone and find a spotted lanternfly, collect and report it immediately with our online reporting system at **extension.psu.edu/spotted-lanternfly** or by calling 1-888-4BAD-FLY. SLF found within the quarantine zone does not need to be reported.

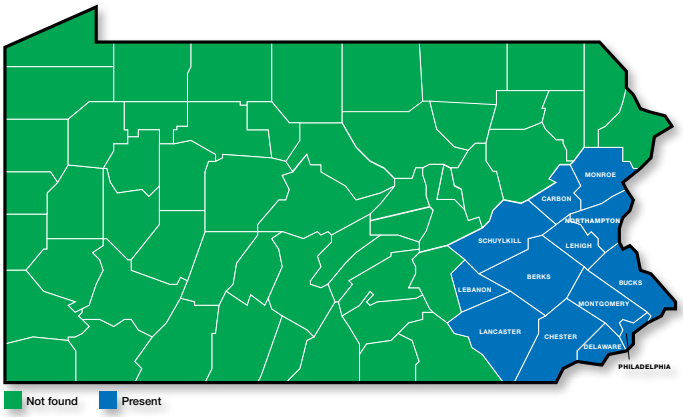

Figure 2. The distribution as of June 20, 2018, of SLF in Pennsylvania, indicated in blue. Check the Pennsylvania Department of Agriculture's website for updated distribution information.

Feeding Damage

SLF is capable of causing serious damage to its host, including oozing sap from the trees, wilting, leaf curling, and even death. SLF feeds using a piercing-sucking mouthpart tapped into the plant like a straw. When SLF feeds, it also excretes honeydew, or sugary water. This creates a sticky surface on and around plants that encourages the growth of black sooty mold. This mold is harmless to people but can cause damage to the plant. If you see black sooty mold or sticky areas on a plant or tree, it may be infested by SLF, but it could also be aphids, leafhoppers, planthoppers, or scale insects. Therefore, it is important to identify the cause of the mold, as control measures may differ for pests other than SLF. There is no way to prevent SLF from moving onto your property. Be aware that SLF is very mobile and management actions must be continuous to keep them off your property.

Management

Stop the Spread

When you travel in 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 that 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.

Steps of Spotted Lanternfly Management

1	**Stop the spread**
2	**Scrape eggs**
3	**Band trees to catch nymphs**
4	**Remove tree-of-heaven**
5	**Apply insecticides**

Egg Scraping

Walk around your property to check for egg masses on trees, cement blocks, rocks, and any other hard surface. If you find egg masses on your property from September to June, you can scrape them off using a plastic card or putty knife (Figure 3). Scrape them into a bag or container filled with isopropyl alcohol or hand sanitizer. This is the most effective way to kill the eggs, but they can also be smashed or burned. Remember that some eggs will be laid at the tops of trees and may not be possible to reach.


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Figure 3. Scraping SLF egg masses from a tree.

Tree Banding

When the nymphs first hatch, they will walk up the trees to feed on the softer new growth of the plant. Take advantage of this behavior by wrapping tree trunks in sticky tape and trapping the nymphs. Any tree can be banded, but we recommend specifically banding tree-of-heaven, the preferred host, or trees where you see a lot of egg masses or nymphs (Figure 4). Special tape for this purpose can be purchased, though duct tape wrapped backward and tight to the tree also works well. Push pins can be used to secure the band. Adult SLF will avoid tape, so it is essential to band trees in the spring when there are nymphs. Be advised that birds and small mammals stuck to the tape, while rare, have been reported. Check and change traps every other week.


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Figure 4. A banded tree with SLF nymphs stuck at the bottom.

Host Removal

Tree-of-heaven (*Ailanthus altissima*) is an invasive plant, but it is common in landscape plantings, agricultural areas, and along the sides of roads. This is the preferred host for SLF and current management efforts are focused on removing this tree. This involves applying an herbicide to the tree and cutting it down from July to September. Failure to apply herbicide will result in new growth from the stump; even when treated, multiple applications may be necessary over time to completely kill the tree. These trees can get very tall, so seek the help of a tree care service if necessary. Tree-of-heaven is named because of its rapid growth, which can reach up to 100 feet tall and 6 feet in diameter. The bark of tree-of-heaven is similar to the outside of a cantaloupe. When crushed, the leaves put off a foul odor that many describe as rotten peanut butter. There are both male and female trees, and only female trees produce seed. They spread by seed and will also produce "clones" by their roots. This tree can be mistaken for other native species, including black walnut, hickory, and staghorn sumac. For help identifying and treating this plant, visit **extension.psu.edu/spotted-lanternfly**. While tree-of-heaven is a preferred host, SLF feeds on a large variety of plants, including many of the trees in your backyard. Removing these may not be preferred; refer to the next section for further guidance.

Chemical Control

Insecticides can be contact, systemic, or both, and may vary greatly in the length of control after application (i.e., residual activity). Contact insecticides kill SLF when the chemical contacts the insect as a direct spray to the adult or nymph, or when the pest walks over a surface with pesticide residue on it. Systemic insecticides are absorbed by the tree through sprayed leaves, roots, and or woody tissue and are moved by its vascular system to other parts of the tree. SLF is killed as it feeds on any part of the tree, even if it was not sprayed directly (e.g., spraying the lower part of the tree will protect the tree tops). Systemic insecticides work best when applied in the spring and early summer, before the more mobile adults emerge. However, they can protect the tree and kill adults depending on the application timing and type. Systemic products will often give contact activity when sprayed directly to live SLF, but contact activity from surface residues is often relatively short as the product is absorbed into the tree.

There are four main methods to apply insecticides: **tree injection** and **bark sprays** (applied by professional applicators), and **soil drench** and **foliar sprays** (can be applied by homeowners). The Pennsylvania Department of Agriculture and the United States Department of Agriculture are currently using the systemic insecticide dinotefuran as injections or

Active Ingredient	Mode of Exposure	Example Products
acetamiprid (neonicotinoid)	systemic/contact	Ortho Flower Fruit & Vegetable Insect Killer
azadirachtin* (botanical)	contact	Neemix 4.5 Insect Growth Regulator
bifenthrin (pyrethroid)	contact	Ortho Bug-B-Gon Insect Killer for Lawns & Gardens, The Anderson's Turf Products Duocide Insect Control, Bug Blaster II Turf Ornamental Insect Control
carbaryl (carbamate)	contact	The Anderson's Turf Products Duocide Insect Control, Sevin Bug Killer, Bayer Complete Insect Killer for Gardens, Ortho Bug-Geta Plus Snail Slug & Insect Killer
dinotefuran (neonicotinoid)	systemic/contact	Ortho Tree & Shrub Insect Control, Zylam Insecticide, Safari Insecticide, Transtect Insecticide
imidacloprid (neonicotinoid)	systemic/contact	Ortho MAX Tree & Shrub Insect Control, Ferti-Lome Tree & Shrub Systemic Insect Drench, Bayer Tree and Shrub Insect Control, Bonide Annual Tree & Shrub Insect Control with SYSTEMAXX
thiamethoxam (neonicotinoid)	systemic/contact	Ambrands AMDRO Quick Kill Lawn & Landscape Insect Killer
soaps*	contact	Concern Insect Killing Soap C, Ortho Elementals Insecticidal Soap, Safer Insect-Killing-Soap

*Organic product

Note: This product list provides an example of products with these active ingredients. It is not an endorsement or specific recommendation.

bark sprays on tree-of-heaven to kill SLF. Both methods work well and have residual activity that lasts from several weeks to several months. These application types, however, can only be applied by certified pesticide applicators, including tree care professionals, and can be costly.

Some insecticides available at your local garden or hardware store can be used as either soil drenches or foliar sprays. Be sure the product is meant for this type of application by reading the product label. Foliar sprays with contact insecticides are applied to surfaces where SLF feeds and walks, which includes the base of a tree, such as tree-of-heaven, where spotted lanternflies are abundant. They can also be applied directly to SLF nymphs and adults. Foliar sprays with systemic insecticides are best applied to leaves and green tissue of trees. This does not need to be the entire tree and can be leaves within your reach. While systemic insecticides can be applied to the bark of trees (bark sprays), they require special penetrants (only available to certified pesticide applicators) to effectively move them into the tree and kill SLF. Systemic insecticides on the leaves of trees will readily move throughout the rest of the tree. Systemic insecticides applied to foliage will be taken up by the tree quicker than systemic insecticides applied with soil drenches.

Soil drenches with systemic insecticides and water 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 are best applied in the spring to trees such as tree-of-heaven or other favored hosts that have had high SLF populations in the past and are likely to have them again. Soil drenches may take several days or weeks to move into the tree. They should not be used to kill high numbers of SLF as you see them. Depending on the product and rates used, soil drenches have the advantage of longer residual activity (several weeks to several months) over foliar applications.

Currently suggested active ingredients for homeowners, their mode of exposure, and example products are provided in the table. Please note that most products currently available are not registered for use on SLF. These products and their companies are not liable for results when used on SLF. Research is ongoing to find the insecticides that are most effective on SLF, but that are safe to humans, pets, beneficial insects, and the environment. More detailed field trials are being conducted with a wider range of insecticides on SLF in summer 2018 to better understand direct efficacy and the residual activity of various products available to homeowners. We have not yet evaluated nontarget effects of listed products on beneficial insects, including pollinators. We do not recommend treating your entire property because these products are not specific to SLF and beneficial insects may be affected as well. Only treat areas where SLF is abundant.

These recommendations are current as of June 20, 2018, and may change as we learn more. We encourage you to stay up to date by visiting our website. Check the version of this fact sheet (listed below following the publication code number) 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.

Summary

Spotted lanternfly is a destructive invasive pest, threatening agricultural, timber, and ornamental industries, and the plants in your backyard. Together, we can take action to limit the spread and damage from this pest.

- If you find SLF outside the quarantine zone, report it! **extension.psu.edu/spotted-lanternfly** or 1-888-4BAD-FLY
- Don't let SLF spread. Check your car, outdoor equipment, etc., for SLF eggs, nymphs, and adults when moving in and out of the quarantine zone. Don't move firewood.
- Help us reduce SLF populations by scraping egg masses from trees, houses, and anywhere else you find them.
- Band trees to trap and kill nymphs in the early spring.
- Remove tree-of-heaven, the preferred host for SLF.
- If needed, protect your trees by applying insecticides using foliar or soil drench methods or consult a local tree care service. Always follow label instructions when applying any pesticide.
- Keep in touch and stay up to date! Sign up for our newsletter and find new information on SLF at **extension.psu.edu/spotted-lanternfly**.

Prepared by Heather Leach, spotted lanternfly extension associate; David Biddinger, tree fruit research entomologist and research associate professor; and Greg Krawczyk, extension tree fruit entomologist and research associate professor.

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Applying pesticides for Spotted lanternfly control – a guide for homeowners

Read the Label First

Spotted lanternflies are an invasive pest affecting homeowners in several eastern Pennsylvania counties. The United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS), the Pennsylvania Department of Agriculture (PDA) and Penn State University are working together to stop the spread of this pest that has the potential to cause economic injury to many of our crops, ornamentals and hardwood trees.

Homeowners become increasingly aware of this insect as it grows and progresses through its life stages and want to know what pesticides are effective against them. There are strict rules for the use of pesticides. Application of pesticides on private property by the property owner is permitted in Pennsylvania. Anyone performing a commercial application or applying a pesticide to a property other than their own must have a current license issued by and monitored by PDA and be covered by business insurance.

All pesticides are certified through the Environmental Protection Agency (EPA). Each has a unique registration number that must be printed on the label. The EPA Reg. No. of a product consists of two set of numbers separated by a hyphen, for example EPA Reg. No. 12345-12. All pesticides are regulated through the Federal Insecticide Rodenticide and Fungicide Act (FIFRA).

Extensive research, experimentation and testing are required to receive an EPA number. If a product does not have a registration number, it means that it has not been verified by the EPA. It is important to **always Read the Label first**. The *label is the law* and you are liable for any damage that may occur from misuse. There is a great deal of information on a label. If you have trouble seeing the small print use a magnifier or have someone read it to you. You can look up the product online for a more readable version of the label. It is easy to search for any pesticide product at www.epa.gov. If you do not have access to the online site, call your local Penn State Extension office to receive printed information. *Not being able to read the label is no excuse for misuse*.

The label provides explicit directions for the use of the product. It specifies where and when it can be used, what weather conditions may preclude its use and what protective clothing you should wear such as gloves, eye protection, long sleeves or a respirator. There are instructions on how to mix and apply and how to clean-up and dispose of leftover product. It stipulates how long after application it is safe to re-enter the area. There may also be information pertaining to water setbacks and effects on non-target species such as fish, honeybees and other pollinating insects. Wash your hands well after using any chemical. You may want to shower and change your clothing.

Be mindful of children and pets in the area. Some people are hyper-sensitive to chemicals. There are special restrictions for commercial applicators related to notifications when a treatment is to be made. Some people are against the use of any chemical. Consider this if you live in a close neighborhood and your pesticide application will affect adjacent properties.
More is not always better. Insecticides are formulated and tested to be applied in exact amounts at established rates. You should never apply at a higher rate than specified on the label. Lesser rates may not give adequate control. Sometimes two applications will be necessary

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Right now, there are no products available to homeowners that are specifically labeled for control of spotted lanternfly (SLF). Several insecticides are known to be effective. Choose something that is labeled for ornamental plants and/or trees. Insecticides are sold by a commercial name. You must read the contents to determine which active ingredient they contain and in what concentration. There are contact insecticides that kill the insect directly. Systemic insecticides are applied to the insect's food source which move throughout the plants and kill the insects after they feed on the plant. The success rate of any product depends upon your adherence to the directions.

It is important to do your research **BEFORE** you use an insecticide. Read the Label first. Check PDA and the Penn State Extension websites for comprehensive information on SLF biology and control, active ingredients, commercial names and product recommendations.

https://extension.psu.edu/spotted-lanternfly-management-for-homeowners

http://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/Entomology/spotted_lanternfly/Documents/Spotted%20Lanternfly%20%20Property%20Management.pdf

Spotted lanternfly Management Chart

Checklist for Residents
Living in Spotted Lanternfly Quarantine Areas

IMPORTANT: Before you move outdoor items from the quarantine area, check for spotted lanternfly egg masses, adults, and nymphs. Make sure all items are pest free before you move them. Help keep this pest from spreading.

Check before you move

Recreational or Camping Items

- ☐ Backpacks
- ☐ Basketball backboards
- ☐ Bicycles
- ☐ Boats/Boat trailers
- ☐ Campers
- ☐ Ice chests
- ☐ Motorcycles
- ☐ Motor homes
- ☐ Recreational vehicles
- ☐ Snowmobiles
- ☐ Tarps
- ☐ Tents
- ☐ Other

Outdoor Household Items

- ☐ Barrels
- ☐ Cardboard or wooden boxes
- ☐ Outdoor poles
- ☐ Plant containers
- ☐ Firewood
- ☐ Propane or oil tanks
- ☐ Trash cans
- ☐ Refrigerators/Freezers
- ☐ Storage sheds
- ☐ Shutters
- ☐ Storm/Screen doors and windows
- ☐ Window awnings
- ☐ Outdoor furniture
- ☐ Other

Building Materials

- ☐ Bricks/Cinder blocks
- ☐ Cement mixing tubs
- ☐ Lumber
- ☐ Roofing materials
- ☐ Tools and toolboxes
- ☐ Workbenches
- ☐ Skidsters/Forklifts
- ☐ Pipes
- ☐ Other

Yard and Garden Items

- ☐ Dog houses, rabbit sheds, chicken coops, etc
- ☐ Barbecue grills
- ☐ Carts
- ☐ Cold frames
- ☐ Fencing
- ☐ Garden tillers
- ☐ Yard decorations
- ☐ Garden tools
- ☐ Backhoes
- ☐ Lawnmowers
- ☐ Signs and posts
- ☐ Storage sheds
- ☐ Tractors and trailers
- ☐ Trees, shrubs and plants
- ☐ Other

Children's Playthings

- ☐ Play houses
- ☐ Kiddie pools
- ☐ Bicycles, scooters
- ☐ Sandboxes
- ☐ Other

Checklist for Residents
Living in Spotted Lanternfly Quarantine Areas

IMPORTANT: Before you move outdoor items from the quarantine area, check for spotted lanternfly egg masses, adults, and nymphs. Make sure all items are pest free before you move them. Help keep this pest from spreading.

If you find any of these life stages of the Spotted Lanternfly, remove, devitalize, place in a sealed bag, and dispose of bag in the garbage.

Adult Spotted Lanternfly, present in autumn months.

Spotted Lanternfly nymphs, present in spring and summer months. (Images from Park et al. 2009)

Fresh Spotted Lanternfly egg mass (outlined in red). Egg masses are present in autumn and winter months, blending in with their surroundings.

By signing this checklist, I am confirming that I have inspected my vehicle and those items I am moving from the Spotted Lanternfly quarantine area, and do not see any egg masses or insects in or on anything I am moving.

Signature _____ Address _____ Date _____

Please sign, date, and keep this checklist in your vehicle with you – use it each time you need it.

For more information, visit the Pennsylvania Department of Agriculture website:
www.pda.state.pa.us/spottedlanternfly

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Spotted Lanternfly Management Options: Placing Sticky Bands on Trees

There is a new invasive insect in Pennsylvania, *Lycorma delicatula*, commonly known as the spotted lanternfly (SLF). This insect can damage apples, grapes, hops, and ornamental and hardwood trees. The United States Department of Agriculture (USDA) and the Pennsylvania Department of Agriculture (PDA) are trying to contain the infestation, reduce populations of this pest and possibly eradicate it. These efforts rely on cooperation from everyone including residents, property owners, municipalities, and businesses. Several different ways of controlling SLF are being used, and more are being developed from on-going scientific experiments.

This fact sheet summarizes one method of capturing and killing SLF: placing sticky bands on trees.

Sticky bands placed on trees can destroy many spotted lanternflies

Young SLF nymphs captured on a sticky band

SLF are often found moving up and down on tree trunks. These moving SLF can be captured on the sticky surfaces of bands placed around trees. This method can effectively destroy many SLF without using insecticides.

Sticky bands are usually placed about 4 feet from the bottom of a tree and secured to the tree with a push pin. The stickiness of the type of band you are using will determine how effectively you can catch different life stages of SLF. Less sticky types of bands can capture the younger nymphs, but might not capture the oldest nymphs or adults very well. Older stages of SLF are sometimes strong enough to walk across the less sticky bands without getting stuck, and they may actually avoid the bands entirely.

Be careful when discarding used sticky bands--some of the SLF that have been captured may still be alive. To eliminate the possibility of spreading any living SLF, either double-bag the bands before discarding them, or burn the bands if allowed by your municipality.

One drawback of using sticky bands is that they can capture other creatures. Other insects are often caught, and some of them may be beneficial insects. Occasionally a bird (such as a woodpecker), small mammal (such as a squirrel), or other animals have been captured. Think about this possibility and have a plan for how you would react to this situation before using sticky bands.

continued

How to obtain sticky bands:

There are several types and sources of sticky bands: bands supplied to residents who volunteer in a program offered by the PDA, commercially available bands, and home-made bands.

PDA volunteer program bands: The PDA has been using sticky bands made with brown paper. In 2018, the PDA will supply sticky bands (as limited supplies allow), to residents who participate in the PDA's official volunteer program. Volunteers must live in the quarantined area. In spring 2018, the following 13 counties are included in the quarantined area: Berks, Schuylkill, Carbon, Monroe, Northampton, Lehigh, Montgomery, Bucks, Philadelphia, Delaware, Chester, Lancaster and Lebanon.
To see a map of the current quarantined area go to:
PlantIndustry/Entomology/spotted_lanternfly/quarantine/Documents/Lycorma%20Quarantine%20Map%20

SLF captured on a sticky band

PDA volunteers will band only *Ailanthus altissima* (Tree of Heaven). Volunteers must change the bands every two weeks and report the number of SLF captured into the PDA database. If you are interested in completing the training required to participate in the PDA volunteer program in 2018, send your contact information to: kmb52@psu.edu (please include your name, phone numbers, email address, mailing address and the municipality of the property where you will place the bands) or call 610-391-9840 to sign up. Potential volunteers will be contacted with information about the training and where they can pick up banding supplies.

Commercially available bands: If you do not want to be an official volunteer in the PDA program or if you are interested in using sticky bands to kill SLF on trees other than tree of heaven, you can purchase a variety of types of sticky bands from several commercial sources. Some companies sell tree banding kits that consist of a roll of tree wrap and a sticky substance to spread onto the wrap. There is 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 somewhat protected sticky surface which may lower the potential of catching birds and other animals.

Tree bands you can make: You can wrap several widths of duct tape around a tree trunk, sticky side facing in, and coat it with a sticky substance such as petroleum jelly. Petroleum jelly can discolor bark or even injure the bark of young trees, so avoid getting it on the bark. For more information see the article at:
https://fyi.uwex.edu/gypsymothinwisconsin/making-a-sticky-barrier-band/

Some residents have used other materials including duct tape with the sticky side facing outward or fly paper, to band their trees.

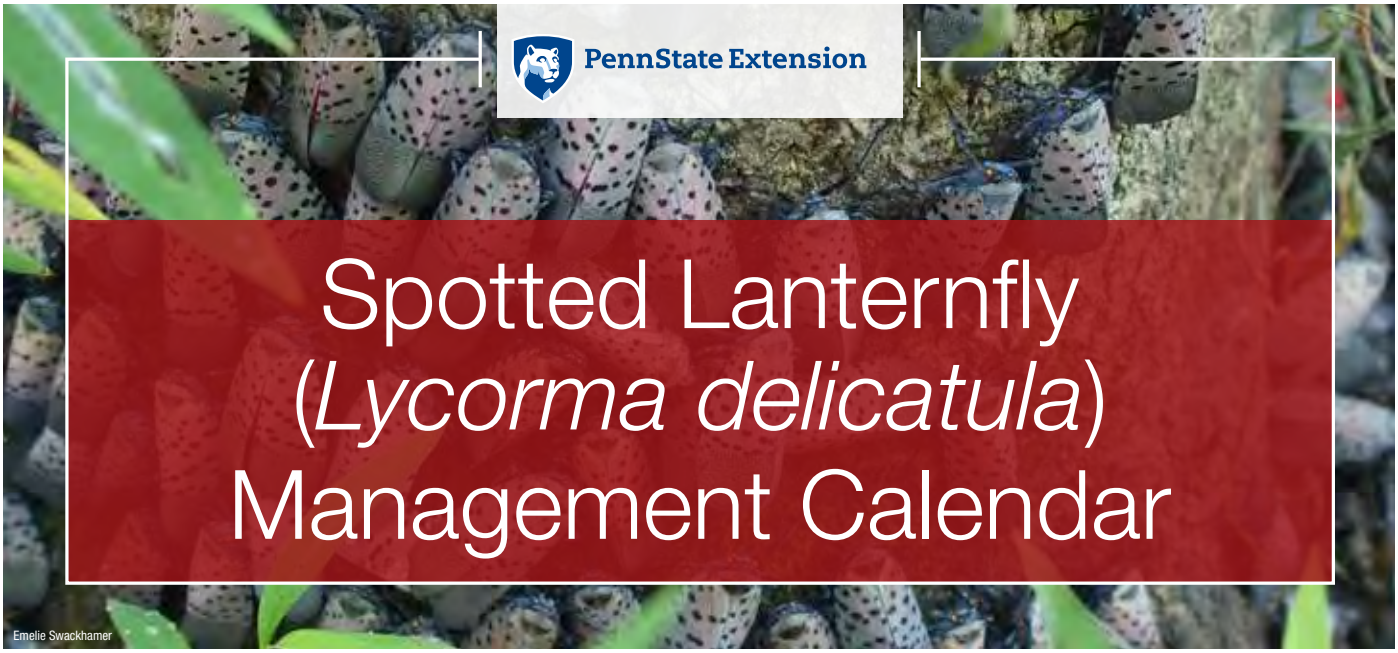
By using sticky bands, people who care for trees are able to capture and kill many SLF, especially in their early nymphal stages. This is one method that can reduce SLF populations in the infested area. Sticky bands are also useful to monitor for SLF in areas where it has not been found.

For more information about the SLF go to:

www.agriculture.pa.gov/spottedlanternfly
https://extension.psu.edu/spotted-lanternfly

This is not an endorsement of any product or producer. This is not a complete list of possible products or brands.

Prepared by: Emelie Swackhamer, Horticulture Extension Educator, Montgomery County, March 2018.



Best Time to Use Management Practices

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Destroy egg masses	■	■	■	■	■				■	■	■	■
Use sticky bands to capture spotted lanternfly					■	■	■	■	■	■	■	
Registered insecticides can be effective[1]					■	■	■	■	■	■	■	
Avoid moving gravid (fertilized) females[2]							■	■	■	■	■	■
Avoid moving viable egg masses[2]	■	■	■	■	■				■	■	■	■
Treat most tree-of-heaven (*Ailanthus altissima*) trees with herbicide[1,3]							■	■	■			
Treat tree-of-heaven "trap" trees with systemic insecticides[1,4]						■	■	■				

1 **ALWAYS READ PESTICIDE LABELS AND FOLLOW THE DIRECTIONS.**

2 Before you move outdoor items from the quarantine area, check for spotted lanternfly egg masses, nymphs, and adults and destroy them. To be in compliance with the quarantine order, use the checklist at **www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/Entomology/spotted_lanternfly/Documents/SLF%20Checklist%2011-12-2014.pdf** when you have to move items from inside the quarantine to outside.

3 Tree-of-heaven is an exotic invasive tree introduced from China. It is dioecious, meaning a tree is either male or female. It grows in colonies that consist of groups of stems all growing from one root system. All of the trees growing from one root system are the same sex. It is best to use male trees as "trap" trees because they do not produce seed. Tree-of-heaven trees will resprout vigorously from their roots after cutting, even if stumps are treated with an herbicide. To control tree-of-heaven trees, treat using foliar, basal bark, or hack-and-squirt herbicide applications from July through September. If tree-of-heaven stems need to be removed, wait 30 days after treatment to cut the trees down. Repeat herbicide applications may be necessary to completely control tree-of-heaven roots. Killing all tree-of-heaven trees may result in spotted lanternflies moving to surrounding plants, increasing pest damage on them.

4 About 15 percent of tree-of-heaven trees should be left alive to serve as trap trees to attract spotted lanternflies. Leave only male, non-seed-bearing trees if possible to limit seed production.

Life Stage Present (one generation per year in Pennsylvania)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Eggs	■	■	■	■	■				■	■	■	■
Nymphs					■	■	■	■	■	■		
Adults								■	■	■	■	■

There are several ways to reduce populations of the spotted lanternfly (SLF). Professional pest managers use an integrated approach called integrated pest management (IPM) to eliminate as many SLF as possible while minimizing potential risks to the environment. One IPM method for destroying SLF is using "trap" trees. Thousands of SLF can be killed by one trap tree. The Pennsylvania Department of Agriculture (PDA) is establishing many trap trees in the infested area to kill as many SLF as possible while minimizing pesticide use. Property owners can also establish trap trees on their land or hire a professional service to help them.

How do trap trees work?

Tree-of-heaven (*Ailanthus altissima*) is a preferred host for SLF. In the fall, many SLF adults relocate to feed on tree-of-heaven. To set up trap trees, most tree-of-heaven trees are killed. The remaining tree-of-heaven trees are treated with an insecticide that is moved throughout the entire tree. When the SLF adults feed on the treated trap trees, they ingest the systemic insecticide and die. As additional SLF relocate to feed on the trap trees, they also die.

Steps to establish a trap tree to kill SLF:

1. Identify all tree-of-heaven trees on the site. Spotted lanternflies seem to prefer certain tree-of-heaven trees over others. Locate specific trees that are most attractive to the spotted lanternfly based on the number of insects feeding on them. For information on how to identify tree-of-heaven, see these fact sheets at **extension.psu.edu/tree-of-heaven** or **extension.psu.edu/spotted-lanternfly-identifying-tree-of-heaven-and-some-native-look-a-like**.

2. Treat approximately 85 percent of the tree-of-heaven trees with a properly labeled herbicide. Kill all female tree-of-heaven trees if possible; they produce seed and contribute to the spread of this invasive tree. Leave only a few male tree-of-heaven trees that appear to be more attractive to the insect to serve as trap trees.

   Herbicides recommended to kill tree-of-heaven trees contain the active ingredient triclopyr, which comes in two formulations: water based (amine) and oil based (ester). Both formulations are effective for controlling tree-of-heaven. Other herbicides are effective; but to prevent herbicide injury to trap trees through common root systems, limit herbicide selection to triclopyr. Herbicide application methods effective for controlling tree-of-heaven include foliar sprays, basal bark, and spaced-cut hack-and-squirt applications. Treating cut stumps is ineffective at controlling the tree-of-heaven; it will *not* control the roots. For more information about herbicide application methods, go to **extension.psu.edu/publications/uh174**.

   Herbicide applications made to control tree-of-heaven are most effective when applied from July 1 to September 30, when the plant is exporting sugars to the roots. Applications made outside this window are not effective at controlling the roots and may only injure aboveground growth.

   Cutting tree-of-heaven is often necessary to remove potentially hazardous trees, but it is not useful as a stand-alone control measure. They will resprout vigorously from stumps and roots. In situations where tree-of-heaven stems need to be removed, it is best to treat them with herbicide first and then cut. Allow 30 days for the herbicide to take effect before cutting. For information on how to control tree-of-heaven, see **plantscience.psu.edu/research/labs/weed-ecology/research/wildland-weed-management/publications/invasive-species-quicksheets/ailanthus**.

3. Treat the remaining tree-of-heaven trap trees with an insecticide that will move throughout the tree. For best results, apply the insecticide according to the label in June through August. When spotted lanternflies feed on treated trees, they will die. Systemic insecticides known to be effective and labeled to treat ornamental trees, including tree-of-heaven, contain the active ingredients dinotefuran or imidacloprid. PDA is using dinotefuran to establish trap trees. Treating only trap trees reduces the total amount of insecticide used in comparison to large-scale contact insecticide applications.

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PennState Extension

Spotted Lanternfly on Grapes and Tree Fruit

Biology, management and slowing the spread of the spotted lanternfly on grapes and tree fruit in the Mid-Atlantic Region.

ARTICLES

Spotted lanternfly on apple in Berks County, PA in October 2017. Photo: Erica Smyers, Penn State

The Spotted Lanternfly (*Lycorma delicatula*) (SLF) is an invasive insect pest dangerous to the U.S. fruit and forest industries. It was first detected in September 2014 in Berks County, PA by the Pennsylvania Department of Agriculture and the Pennsylvania Game Commission. In three years the SLF quarantine zone has expanded to 6,900 square miles, and it was recently detected in Delaware and New York, becoming a regional and potentially national pest.

Management strategies are needed to slow its spread to other regional fruit growing centers and to provide fruit growers with timely management tactics. This phloem-feeding Asian-native insect feeds upon over 65 species of plants and as such, is projected to become a serious pest of timber, ornamental trees, tree fruit orchards, grapes, stone fruit, and other small fruits such as blueberries. It can kill hops and feeds on several types of vegetables. SLF honeydew (sugary SLF excrement) and sooty mold (growing on honeydew) damage were found in vineyards in 2016, only two years after first detection.

In 2017, extensive sooty mold growth was observed on and around forest trees, such as tree of heaven, willow, and maples, and blackening of adjacent plants in the forest understory. Black walnut feeding caused yellowing and shocked trees into a general decline. SLF spread to more vineyards in 2017, reducing yield in one, and having as yet unknown long term effects on health of grapevines. In late August, for the first time, large numbers of SLF were observed flying into and feeding on the trunks and branches of apple trees as well as nectarines and peaches. Immediate damage to tree fruit was not observed by the immigrating adults, but SLF egg cases found on the trees put the trees at risk for heavier and more sustained feeding by SLF nymphs and adults in Spring 2018. As an invasive pest in South Korea, SLF spread rapidly and caused

significant wilting, dieback and mortality of grape vines and spread throughout the country in only 3 years.

Sooty mold on rocks and base of *Ailanthus* tree with SLF infestation. Photo: Emelie Swackhamer, Penn State

There are large gaps in our current understanding of SLF biology in the U.S. These must be filled in order to manage this pest effectively. Alternate hosts, reproductive requirements, pesticide susceptibility, nutritional requirements, pheromone communications, flight distances, voltinism, diapause requirements and other biological aspects are unknown for the U.S. population. Egg cases are laid on hard surfaces like tree bark, but also vehicles, rail cars, and shipping palettes portending rapid and distant spreading by man rather than due to the limited flight abilities of SLF adults or to the hopping abilities of the nymphs. Cold temperatures that proved lethal to SLF eggs in Korea apparently are not lethal to U.S. SLF, making most of the U.S. suitable habitat for SLF.

The SLF invasion is similar to another recently invasive pest, the brown marmorated stink bug, which caused $37 million in damage to the mid-Atlantic fruit industry in 2010. Like SLF, BSMB has many alternate hosts, quickly spread to surrounding states and eventually to the West Coast and

Europe. While SLF does not feed on fruit like BMSB, it has the potential to mechanically vector diseases such as fire blight in apple and cause a general decline of tree and small fruits through loss of vigor or systemic feeding shock similar to that seen from high populations of pear psylla on pear trees in what is referred to as 'psylla shock'. SLF also has only a single generation each season and at least currently spends most of its life cycle outside the orchards in natural areas, moving into orchards and vineyards as adults in huge numbers in the late fall like BMSB. We say 'at least currently' because what little is known about its biology in Asia has not helped much in predicting its behavior in Pennsylvania and because in at least one vineyard in Berks County, SLF has been found in all stages from spring to fall within the vineyard.

We are proposing a collaboration among regional planthopper specialists, applied grape and tree fruit entomologists, and extension educators as well as Dr. Tracy Leskey, USDA-ARS Appalachian Fruit Research Station, Kearneysville, WV, who has led over ten years of research on BMSB management through a previous USDA grant which several of the researchers were a part of. We will develop IPM tactics to address short-term control needs as well as more basic biological research for longer term solutions. Spinoffs from these efforts in fruit should also help in nuisance control from homeowners plagued with huge numbers SLF in the quarantine zone and for the timber and ornamental industries.

Potential Economic Impacts

Slowing the spread of SLF will protect multiple industries. The Pennsylvania grape industry is a thriving and multi-dimensional commodity with over 12,000 acres under production. In the U.S., PA is the 5th largest producer of wine grapes and third largest producer of juice grapes as well as the 4th and 5th largest producers of apple and peaches respectively with tree fruit and small fruit production valued at over $100 million. The U.S. is the world´s second largest producer of apples with an estimated farm gate value of $3.5 billion and downstream economic impact of $14 billion. Roughly 25% ($954 million) of fresh apples are exported. A SLF quarantine could threaten this export market. Forests comprise 17 million acres in Pennsylvania, which is the largest producer of hardwoods ($5.5 billion annually) in the U.S. and is also at risk of SLF damage and export restrictions. Damage to the trees and understory plants (from sooty mold growth) may affect wildlife populations and decrease resistance to plant disease. Although too early to assign economic value, the potential economic impact of SLF in the U.S. could be staggering.

Spotted lanternfly adults on grape in Berks County, PA in October 2017. Photo: Erica Smyers, Penn State

Current Situation

On October 18, 2017, a joint hearing of the Pennsylvania Senate and House Agriculture and Rural Affairs Committee addressed the Spotted Lantern Fly outbreak. Testimony was given by the Pennsylvania Department of Agriculture (PDA), Penn State research and extension, and county administrators and fruit and wine growers from the SLF quarantine zone. Fruit growers and homeowners in the quarantine zone already plagued by huge numbers of SLF and those who fear they will be invaded are adamant about developing cultural or chemical control methods. Testimony from the owners of an affected winery and grape/tree fruit orchard describe an almost 90% loss in grape tonnage and a corresponding loss in fruit quality which was valued at one farm at $400,000, despite several pesticide spray applications. They testified that they needed all possible help in the form of pesticide control recommendations and research for biological control options in order for them to remain in business in coming years due to SLF. Special concern was expressed about the effect that heavy feeding in 2017 would have on the winter hardiness, disease susceptibility and vectoring, and long term viability of vines and trees affected by heavy feeding.

Grape and fruit growers that have already seen greatly increased spray bills due to the invasive BMSB 10 years ago, have expressed concern about increased spray costs, issues with marketing a

product in a quarantine zone, the impact of increased pesticide use on current IPM programs that would cause flare-ups of secondary pests such as mites and aphids that would require additional non-SLF sprays, or the use of pesticides that could cause harm to managed and native pollinators.

Translating information and delivering actionable products to end-users:

Development of actionable recommendations for growers and homeowners affected by SLF is the core goal of our regional project. We will develop an integrated monitoring and management program for specialty crops that will integrate SLF management with management of other insect, mite, and disease pests. At its core will be a web-based decision support tool linked to an interactive map. As SLF populations change, geo-referenced farms will be notified and recommendations will be made. This tool can be used by growers and their advisors to predict consequences of different pest management scenarios on costs and benefits to crop yield or quality, and provide a confidence level in those predictions (i.e., uncertainty is represented). We will use comparisons between observations and model predictions to update the model, using a “big data”, adaptive management approach to continually improve its predictions. As a result, each time the online decision-support tool is used, predictions will reflect new knowledge gained from coordinated data collection. In short, our goal is to gather and curate data in order to improve the accuracy of decisions continually over time. What we learn from SLF biology, economic injury, and management with both pesticides and biological control will be presented to farmers/land managers in a practical way they can use to manage and slow the spread of this pest.

Spotted lanternfly on apple in Berks County, PA in October 2017. Photo: Erica Smyers, Penn State

Penn State graduate student Erica Smyers studying under Julie Urban and Mike Saunders on SLF adults has developed preliminary pesticide control data using grape insecticides. She has shown in caged studies in the quarantine zone that SLF appears to be much easier to control than BMSB with the best control coming from neonicotinoid products such as Venom, Actara, and Assail as expected, but also excellent control with contact poisons such as Sevin, Malathion, and Imidan. Unlike with BMSB, however, the pyrethroids were somewhat weaker at controlling SLF adults with some variability between products. Of the organic products tested, Insecticidal Soap gave the best control, with Neem and Natria (sulfur and natural pyrethrin) being somewhat weaker. Growers within the quarantine zone have also observed that SLF is not that hard to control, but that residual activity of insecticides was important due a constant influx of new adults into treated areas. We will make this data available in a future Fruit Times article along with a preliminary rating of homeowner pesticides that were also tested on SLF adults.

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