



SPOTTED LANTERNFLY

Management in Vineyards

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Introduction

Spotted lanternfly (SLF), *Lycorma delicatula*, is an invasive planthopper, native to Asia, that was first detected in 2014 in southeastern Pennsylvania. As of August 2019, SLF is now found in Pennsylvania, New Jersey, Virginia, Maryland, and Delaware. Detections of SLF have been reported in New York, Connecticut, and Massachusetts; however, populations are not yet known in these states. SLF feeds on many plants, including economically important crops like fruit trees, grapevines, hops, hardwoods, and ornamentals. Significant damage has been reported from SLF feeding on grapevines, including increased susceptibility to winter injury, failure of vines to set fruit in the subsequent year, and death of vines. This guide will update you on our current knowledge and best management practices for this insect in vineyards.

Life Cycle and Identification

Spotted lanternfly is not actually a fly, but a planthopper. There is one generation of SLF per year. The eggs are laid in the fall (September–November) and hatch in the spring (late April–June). Egg masses are laid on smooth surfaces (trees, outdoor equipment, rocks, vines, posts, etc.) and protected with a mudlike covering. Egg masses usually contain around 30 eggs each but can contain as many as 80. After hatching and before reaching adulthood, SLF goes through four immature (nymph) stages. Nymphs are small ($\frac{1}{8}$ to $\frac{1}{2}$ inch) and can be hard to find. The first three stages are all black with white spots, and the last is red with white dots and black stripes (Figure 1). All nymphs are highly mobile and are

strong jumpers. SLF adults emerge in July and are active until the first hard frost. This is the most obvious and easily detectable stage because they are large (~1 inch) and mobile. Adults have black bodies with brightly colored hindwings. Only the adults can fly, and this is most commonly observed in the afternoon on warm and sunny days. SLF forewings are gray with black spots, the tips of the wings are black with gray veins, and their hindwings are red, black, and white. Because SLF adults jump more than fly, their wings often remain closed (Figure 1D).

Feeding Damage

SLF feed on plant phloem tissue (sap) using a piercing-sucking mouthpart. Current research suggests that they rely on turgor pressure of the plant to feed. SLF utilize the nutrients provided by the plant, and also rely on bacteria in their guts to help digest sap. As they feed, they ingest large quantities of sap, filtering the needed nitrogen and proteins, and excreting excess levels of sugars and water as waste products (much like aphids, scales, and other sucking insects). This excrement, called honeydew, accumulates around areas where SLF are feeding. On sunny days, you may be able to see falling honeydew from trees. Honeydew can be attractive to ants, wasps, bees, some beneficial parasitic flies and wasps, and other sugar-loving insects. As the honeydew builds up, it is often colonized by sooty mold fungi. Sooty mold doesn't directly harm plants or the surfaces it grows on, but it does act as a barrier on the leaf to block photosynthesis. Under high numbers of SLF, understory plants may die back because of sooty mold buildup. On grapevines, the trunk, cordons, and leaves may begin

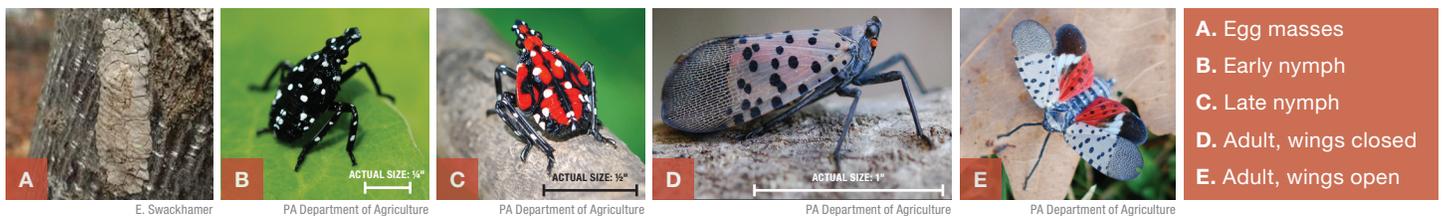


Figure 1. The life stages of SLF, including an egg mass on a tree, early nymphs, late nymphs, and the adults. Adults with both closed and open wings are shown, though adults with closed wings are more common.

to turn black with sooty mold. Sooty mold can only persist with the honeydew to feed on and will not infect the grapevine itself. While sooty mold has not yet been recorded on fruit in the United States, it is possible and could make the fruit unsaleable. In Korea, where SLF is also an invasive pest, grape growers have placed bags over individual clusters to prevent sooty mold on the fruit surface.

SLF are voracious feeders and can be extremely abundant as adults in vineyards. Adults start to appear in vineyards in August, but high populations are not typically observed until mid- to late September (Figure 2). Based on 2018 monitoring data, more SLF adults were found on the vineyard edge compared to the interior, suggesting that they are present in the surrounding landscape and reinvading the vineyard after insecticide applications. Most SLF are observed feeding on the shoots, though later into the season more can be found on older wood (e.g., trunk and cordon). Vines that had significant feeding by SLF either produce mainly tertiary, nonfruitful shoots or have died in following year. Preliminary data suggest that SLF feeding may reduce the hardiness of the vine, causing winter damage of bud or vascular tissue (i.e., phloem and xylem). If you had high levels of SLF feeding in the summer or fall, you should evaluate bud injury before pruning the vines; moderate to high levels of bud injury require differing pruning strategies, such as increasing the number of buds retained to compensate for bud mortality or renewing trunks.

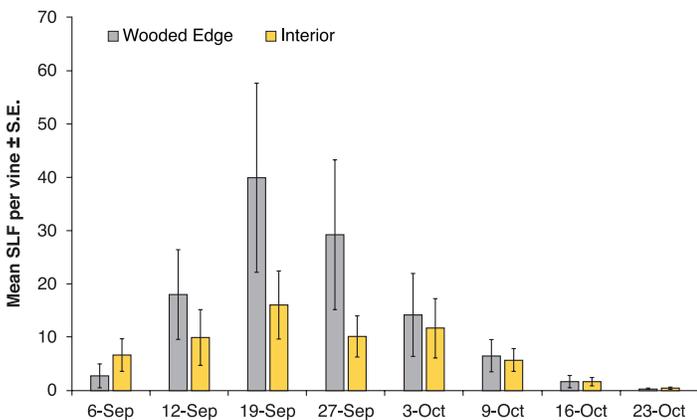


Figure 2. The average number of SLF adults per vine across 8 different vineyards in the vineyard interior and adjacent to the wooded edge.

Seasonal Host Phenology

SLF has a broad host range and has been recorded feeding on over 65 different plant species. Despite this wide host range, some plants appear to be more favorable than others. Whether a plant is heavily fed upon appears to be highly dependent on what is available in the nearby landscape, the health of the plant, the time of year, and how long SLF has been present in the area. 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 plants below do not represent a comprehensive list of all potential hosts of SLF, but rather the most likely transition of SLF through the season.** As plants begin to go dormant for winter, they are less likely to serve as a host for SLF. Additionally, this data is largely built on observations from 2017 and 2018, both of which were wet years in Pennsylvania. The patterns in host use may change with varying weather conditions, by region, and other factors.

Please note that while tree-of-heaven is a strongly preferred host, we do not yet know if this is a host required for SLF development,

or only a preferred source of food. Current evidence suggests that SLF can be sustained on a variety of hosts, but we lack knowledge on what hosts are required for SLF to develop and lay viable eggs. Based on recent studies done by USDA APHIS, SLF can complete their development from egg hatch to adult on the following hosts: tree-of-heaven, chinaberry, hops, black walnut, butternut, sawtooth oak, tulip tree, and oriental bittersweet (M. Cooperband, unpublished data).

Key Plant Hosts of SLF and the Times They Can Be Found on These Hosts

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 utilize a large range of plant hosts. We recommend that you monitor your vineyard and the wood edge for SLF on a regular basis (at least weekly), especially when adults are found in late July–November. In particular, look for the invasive plant tree-of-heaven and other plants listed in table above. In the early summer, SLF nymphs are small and can be difficult to see. Nymphs tend to feed on softer tissue (at the tops of trees/herbaceous plants) and are often found on the undersides of leaves. Adults will be present on the trunks of trees and can be seen flying and gliding around where they are feeding. If you have not yet detected SLF in your vineyard, scouting for and monitoring tree-of-heaven is the best place to start. A comprehensive guide on identification and removal of tree-of-heaven can be found at extension.psu.edu/tree-of-heaven. If there are other highly desirable hosts nearby, we recommend you focus monitoring and potential treatment on those plants. Monitoring plants can be done using either visual checks or sticky bands wrapped around the trees (see below for more information on sticky bands).

Biological Control

Currently, there are no known natural enemies of SLF that are thought to reduce populations in the United States. Some generalist predators (spiders, praying mantises, etc.) will attack and eat SLF. Additionally, a parasitic wasp is known to attack SLF in low numbers, and two species of fungal pathogens have been identified attacking SLF in PA. These are currently being investigated for their potential use against SLF. Researchers have also been exploring the native region of SLF to search for natural enemies to release in the United States, and these are currently undergoing evaluations in USDA quarantine facilities.

Cultural Control

Removal of Attractive Host Plants

If tree-of-heaven is found on the property, we recommend that you either remove it or treat it with a systemic insecticide. Currently, we have no data on whether insecticide treatment or removal is better for SLF management. If there are other attractive trees on the property that are not be desired by the landowner, they can be removed. Removal of these other hosts, including wild grape and other wild vines, might help reduce populations of SLF. If removing tree-of-heaven, you must use herbicide (see extension.psu.edu/tree-of-heaven for more information). Failure to use effective herbicide

on this tree will result in more tree-of-heaven being quickly produced from the roots and stumps. SLF have also been observed to take refuge and feed on the weeds found in the vineyard; keeping your grass mowed regularly may help reduce this habitat for SLF.

Banding Nearby Trees

Banding trees with sticky tape might help reduce SLF numbers locally, though it may not reduce SLF populations over larger areas. Banding can also be used as a monitoring tool. Banding is more effective on the nymphal stages of SLF since the adult SLF often avoid the tape. There are many commercially available bands at garden stores. Please note that bycatch of nontarget insects (bees, butterflies, natural enemies, etc.), birds, and mammals (squirrels, bats, etc.) is possible when using these bands. There are a number of ways to reduce this bycatch, including caging the band in wire or using inward-facing sticky bands. More details on banding can be found at extension.psu.edu/using-traps-for-spotted-lanternfly-management.

Mechanical Destruction of Eggs

Scraping SLF egg masses and placing them permanently in an alcohol solution (e.g., rubbing alcohol, hand sanitizer) or physical destruction of eggs (smashing) are other approaches to kill SLF. Destruction of eggs might help reduce nymph populations in the spring, though it may not reduce or prevent SLF from infesting a vineyard, especially during the adult stage. It is important to consider that SLF egg masses are laid on many surfaces, including rocks, trees, fence posts, and outdoor furniture. In vineyards, they are found most commonly underneath cordons, on the vines, and on the metal and wooden posts (Figure 3). Additionally, egg masses can be found at all heights on a tree, so areas above a reachable height will be missed. If you are mechanically destroying the egg mass, we recommend that you use a hard, flat tool (e.g., putty knife, plastic card) and scrape the egg mass downward into a container. Once finished, submerge all egg masses in alcohol. They can also be smashed, but you need to be sure you are applying pressure to the entire egg mass, or you may miss some eggs. Eggs burst open when they are smashed.

Heather Leach



Chemical Control

Egg Masses

Based on studies done in 2018 and 2019, some insecticides have ovicidal action. All studies were done on intact egg masses (with

covering) in February–April. Of the nine insecticides evaluated, only Lorsban Advanced (chlorpyrifos) using the dormant rate offered 100 percent mortality to the egg mass. JMS Stylet-Oil (paraffinic oil) at the dormant rate offered control ranging from 51 to 71 percent mortality (Note: The control mortality in these studies was 35 percent.). Lorsban has specific label restrictions and is not currently labeled for spotted lanternfly control. Lorsban Advanced can be applied as a prebloom for brown marmorated stink bug, cutworm, mealybug, and scale. Only one application of chlorpyrifos is allowable per season. Chlorpyrifos can be phytotoxic, so avoid applications after budbreak.

Nymphs

Limited information is available on the threat that the immature stages of SLF (nymphs) pose to grapevines. However, we expect that standard insecticide applications for grape pests such as Japanese beetle should also be effective at killing the early nymphs present in the vineyard. It is still important to monitor for populations of nymphs in your vineyard and apply treatment as needed. In some cases, spot treatments may only be needed for dense populations of nymphs (e.g. >10-20 per vine). We have noted that nymphs will use the trellis wire to travel to new vines and feed; however, because they can't fly, they don't appear to reinfest vineyards or cause feeding damage to the same degree as the adults. As such, we recommend using products with high knockdown activity, but residual activity is not necessarily needed (e.g., zeta-cypermethrin or carbaryl). Multiple insecticides are available to control nymphs (Table 2).

Adults

Adults will most likely appear in your vineyard beginning in late August but could arrive as early as late July. Many of the same insecticides that are effective at killing the nymphs are also good at controlling the adults: dinotefuran (Scorpion, Venom), bifenthrin (Brigade, Bifenture), thiamethoxam (Actara), carbaryl (Carbaryl, Sevin), and zeta-cypermethrin (Mustang Maxx) (Table 2). Many of these products now have 2(ee) label amendments, making it legal to apply specifically for spotted lanternfly on grape and some other crops (peach, apple). If you know you're going to have high SLF populations in your vineyard (e.g. hundreds), the early use of long-residual products (particularly thiamethoxam and bifenthrin) with longer preharvest intervals (PHIs) could be used in August. Closer to harvest, compounds with short PHIs will need to be used. These products often have reduced residual activity and will therefore require repeated applications for adequate control (Table 2).

Before applying any insecticide, **you must read and follow the label** to be sure you are making a legal application with timings and rates, and have appropriate personal protection equipment (PPE), reentry intervals (REIs), preharvest intervals (PHIs), and warnings for pollinator protection. To check the most up-to-date label information, visit www.CDMS.net. While SLF has only one generation per year, to reduce the likelihood of insecticide resistance, you should rotate the use of different insecticide classes/modes of action for SLF throughout the season. The use of pyrethroids and some other insecticide classes may flare up secondary pests such as mites, aphids, or scales.

As a relatively recent introduction that has caused injury in only a limited number of PA vineyards thus far, we have not yet been able to establish definitive economic thresholds and critical application timing to prevent injury. You should monitor the population levels in vineyards closely and frequently as we have seen mass movement of adult SLF into vineyards within just a few days.

Table 2

Trade Name	Active Ingredient	Class (IRAC Group)	Toxicity to Bees	Rate per Acre	Control Method	PHI (days)	REI (hours)	Labeled for SLF on Grape in PA?	Life Stage Tested	Longevity	SLF Activity
Brigade 10WSB	bifenthrin	Pyrethroid (IRAC 3)	H	16 oz	C, I	30	12	Yes, 2(ee)	Nymphs, adults	****	++++
Actara 25WDG	thiamethoxam	Neonicotinoid (IRAC 4A)	H	3.5 oz	S, C, I	5	12	Yes, 2(ee)	Nymphs, adults	****	++++
Scorpion 35SL	dinotefuran	Neonicitinoid (IRAC 4A)	H	5 fl oz	S, C, I	1	12	Yes, 2(ee)	Nymphs, adults	***	++++
Carbaryl 4L	carbaryl	Carbamate (IRAC 1A)	H	2 qt	C, I	7	12	No Note: Sevin XLR has 2(ee)	Nymphs, adults	***	++++
Danitol 2.4EC	fenpropathrin	Pyrethroid (IRAC 3)	H	21.33 fl oz	C, I	21	24	No	Nymphs	**	++++
Malathion 8F	malathion	Organophosphate (IRAC 1B)	H	1.88 pts	C, I	3	12	Yes, 2(ee)	Nymphs, adults	**	++++
Mustang Maxx 0.8EC	zeta-cypermethrin	Pyrethroid (IRAC 3A)	H	4 fl. oz	C, I	1	12	Yes, 2(ee)	Nymphs, adults	**	+++
Avant 30DG	indoxacarb	Oxadiazine (IRAC 22)	H	6 oz	C, I	7	12	Yes, 2(ee)	Nymphs, adults	*	++
Imidan 70WP	phosmet	Organophosphate (IRAC 1B)	H	1.33 lb (nymphs); 2.125 lb (adults)	C, I	14	336	Yes, 2(ee)	Nymphs, adults	*	++ for nymphs; 0 for adults
Assail 30SG	acetamiprid	Neonicitinoid (IRAC 4A)	M	5.2 oz	S, C, I	3	48	Yes, 2(ee) on nymphs only	Nymphs, adults	*	+
JMS Stylet Oil	Paraffinic oil	Mineral Oil (Unknown)	L	3%	C	14	4	No	Egg masses	Unknown	++
Lorsban Advanced	chlorpyrifos	Organophosphate (IRAC 1B)	H	1 qt	C	35	24	No	Egg masses	Unknown	++++

Control method: S = systemic; C = contact; I = ingestion; **Longevity rating:** * = < 1 day; ** = 3-7 days; *** = 10-14 days; **** = 14-21 days; **Activity:** + = slight; ++ = moderate; +++ = good; ++++ = excellent; **Toxicity to bees:** L = low; M = medium; H = high. Registrations and labels may change, and human error is always possible. You must read and follow the most current label before applying any pesticide. The trade names listed here are examples of products that have been tested on SLF; this list is not an endorsement of any product. Other products with the same active ingredient and rates will likely offer similar control as what is shown above.

Postharvest Management

After mating and laying eggs in the fall, SLF have been observed to become less active and eventually die. In 2018, the last SLF observed in a vineyard was on October 31. After harvest, it is likely that you will continue to have SLF populations in your vineyard, and we recommend postharvest insecticide applications. In this case, you can use products with a longer residual for longer control and reduce the number of applications you need. After egg masses have been laid (late November), scout your vineyard and surrounding wood edge for egg masses and consider their removal or treatment.

Quarantine Regulations

If you conduct business within the SLF quarantine in PA and move products, vehicles or other conveyances within or out of the quarantine, the Pennsylvania Department of Agriculture requires that you obtain a SLF permit. The permit training is free and can be taken online at extension.psu.edu/spotted-lanternfly. The permit ensures that you and all employees have been properly trained on the identification and biology of SLF, and your vehicles and shipments are inspected and found to be SLF-free before moving. For SLF adults, which can be found crawling all over many surfaces, including harvest bins, tractors, trucks, etc., you must be sure that all of these materials are free of SLF. If receiving shipments of fruit or juice within the quarantine zone, those businesses must also hold a SLF permit. If a business that needs an SLF permit is caught without one, fines may be issued. Specific questions about the permit can be directed to SLFPermit@PA.gov. Other states have quarantines and permit requirements for this pest, and there is reciprocity of these permits between states.

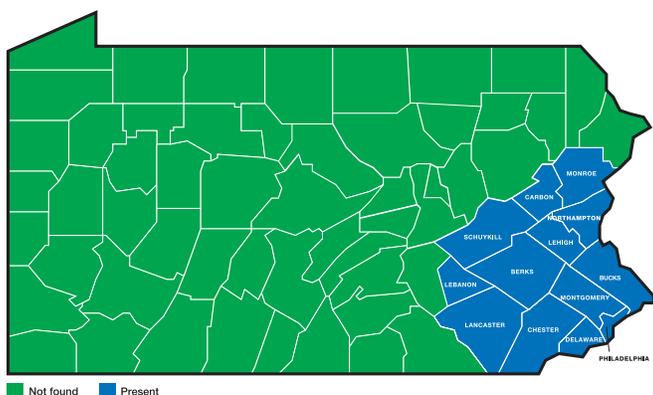


Figure 4. The blue counties indicate the current SLF quarantine zone within PA. Last updated: August 2019.

Summary

1. SLF may cause significant damage to grapevines, including increased susceptibility to winter injury, failure of vines to set fruit in the following year, and death of vines.
2. Scout for tree-of-heaven and other highly desirable hosts surrounding your vineyard (e.g., wild grapevines, black walnut).
3. Monitor your vineyard and surrounding wooded edge for SLF at least weekly, especially during August–October.
4. Apply insecticides if SLF is present in considerable numbers in your vineyard. Finding only a few SLF throughout the vineyard may not warrant a spray.
5. After application of insecticides, continue to monitor and spray as needed. SLF are susceptible to many insecticides, but they quickly reinvade your vineyard from the surrounding landscape, making them difficult to control.
6. After SLF have laid eggs, check your vines (trunk and cordon), posts, and surrounding wood edge for SLF egg masses. If there are many egg masses, we recommend they be removed or sprayed.
7. If you had significant feeding from SLF in the summer or fall, check bud mortality and consider leaving more buds on the vine when pruning to avoid winter injury.
8. If you're conducting business in the PA quarantine zone, you must get an SLF permit from the Pennsylvania Department of Agriculture, which can be found at extension.psu.edu/spotted-lanternfly.

We encourage you to stay up to date by checking our website at extension.psu.edu/spotted-lanternfly, attending regular extension meetings, or contacting your local extension educator. Research on this important pest is ongoing, and information may change as we learn more about this insect. Be sure to check online for updated versions of this fact sheet. *Last updated August 2019.*

Prepared by Heather Leach, David Biddinger, Greg Krawczyk, and Michela Centinari.

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