ELM LEAF BEETLE

Integrated Pest Management for Home Gardeners and Landscape Professionals

The elm leaf beetle, *Xanthogaleruca (=Pyrrhalta) luteola*, is a leaf-chewing pest of elm trees, especially European elm species. American and most Asian elm species are less severely fed upon. Most Chinese elm cultivars, zelkova, and many newer elm cultivars are infrequently fed upon.

IDENTIFICATION

Adults are 1/4 inch long, olive-green beetles with black, longitudinal stripes along the margin and center of the back (Figure 1). Females lay yellowish eggs in double rows of about 5 to 25 on the underside of leaves. Eggs become grayish before hatching. Larvae resemble caterpillars and are black when newly hatched and shortly after molting (shedding the old skin). After feeding, larvae become yellowish to green with rows of tiny dark tubercles (projections). Third-instar larvae grow up to 1/3 inch long and have dense rows of dark tubercles down their sides that resemble two black stripes (Figure 2). Pupae are orange to bright yellow.

LIFE CYCLE

The elm leaf beetle develops through four life stages: egg, larva, pupa, and adult (Figure 3). Adults commonly overwinter in bark crevices and woodpiles or in buildings. In spring they fly to elm foliage and chew leaves, and females lay eggs. Eggs hatch into larvae that develop through three instars (growth stages) over a period of several weeks while chewing on foliage and then crawl down the tree trunk. Mature larvae become curled and inactive (a stage referred to as prepupae), then pupate, sometimes in large numbers, around the tree base. After about 10 days as pupae, adults emerge and fly to the canopy to feed and, during spring and summer, lay eggs. The elm leaf beetle has at least one generation a year in northern California and two to three generations in central and southern California.

DAMAGE

Adults chew entirely through the leaf, often in a shothole pattern. Larvae skeletonize the leaf surface, causing damaged foliage to turn brown to whitish (Figure 4). Elm leaf beetles, when abundant, can entirely defoliate large elm trees, which eliminates summer shade and reduces the aesthetic value of trees. Repeated, extensive defoliation weakens elms, causing trees to decline. However, the elm leaf beetle has not been a significant, widespread problem in California since the 1990s.

MANAGEMENT

It is essential to correctly identify the cause of damaged elm leaves before taking management action. European flea weevil, *Orchestes alni*, also chews holes in elm leaves and causes elms to defoliate. This introduced beetle has become a serious elm pest in the eastern United States, but currently does not occur in California. Also from a distance, foliage severely chewed by beetles resembles the browning and dieback caused by Dutch elm disease fungi, *Ophiostoma (=Ceratocystis) ulmi* and *O. novo-ulmi*. Report any suspected Dutch elm disease, European flea weevil, or other new pests to the local county agricultural commissioner.

Where the elm leaf beetle is a problem, manage it with an integrated program that incorporates good cultural practices, conservation of natural enemies, regular monitoring, and the use of less-persistent insecticides, bark banding, or systemic insecticide. Recognize that elm leaf beetle populations historically have fluctuated dramatically from year to year and trees do not warrant treatment most years. When management is warranted, use a combination of methods; because

Figure 1. Adult, eggs, and first-instar larva of elm leaf beetle.

Figure 2. Third-instar elm leaf beetle larvae.

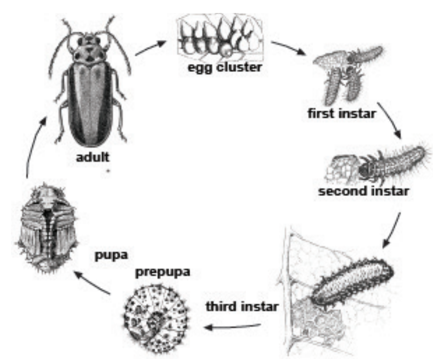

Figure 3. Elm leaf beetle stages and life cycle.

PEST NOTES
Publication 7403
University *of* California
Agriculture and Natural Resources
Statewide Integrated Pest Management Program
June 2014

no single action improves the health of elm trees or kills 100% of the pests.

Cultural Control

Good cultural care of trees is an essential component of integrated pest management. American and European elm species are adapted to summer rainfall. Maintain tree vigor, and protect trunks and roots from injury, by providing appropriate irrigation in areas with summer drought. Check for dead or dying branches and promptly remove them. Dying branches pose a limb drop (failure) hazard and provide habitat for bark beetles, *Scolytus multistriatus* and *S. schevyrewi*, which vector the Dutch elm disease fungi. Avoid unnecessary pruning; and when pruning make cuts properly, preferably during late fall and winter and when trees are young.

Choose species or cultivars that resist both Dutch elm disease and elm leaf beetle when planting (Table 1). Pest-resistant elms include Accolade, Emerald Sunshine, Frontier, Prospector, and most Chinese elms, except Dynasty.

Control Action Guidelines. Healthy elm trees can tolerate substantial damage to leaves; total defoliation may have little long-term effect on healthy elms, especially if leaf damage occurs late in the season. Suggested guidelines are to take action when needed to prevent greater than 40% defoliation (portion of leaf area chewed or leaves dropped prematurely); or if damage is less tolerable or occurring earlier in the growing season, a treatment threshold of 20% defoliation may be used. For additional information on how to predict the amount of defoliation from each beetle generation refer to the 1998 publication by Dahlsten and others listed in References.

Timing of action varies according to the control methods and situation. To avoid unacceptable defoliation, when using methods that kill a smaller proportion of the pests or take longer to provide control allowing beetles to continue to feed and damage leaves, take action sooner than you would when using faster-acting methods.

Monitoring

Determine the need and effective timing for any pesticide application by visually inspecting leaves at about weekly intervals beginning in spring when the first generation of eggs and larvae are expected. Watch for the appearance of clusters of yellowish to gray eggs and caterpillar-like larvae. The calendar date of peak abundance and damage varies greatly from year to year depending on spring temperatures. If beetles are too abundant, use the heat accumulation method discussed in Degree-Day Monitoring to determine the optimal time to inspect foliage and to accurately time insecticide application.

If you plan to spray foliage or apply systemic insecticide to trunks, make the application when first- and second-instar (small) larvae are abundant. With bark banding discussed below, band as soon as third-instar (larger) larvae are observed on leaves.

If you drench or inject soil with a root-absorbed, systemic insecticide, the most effective application time is spring when elm trees flush new leaves or shortly after leaf flush. The time for action is before you know definitely whether beetles will become abundant enough to warrant this preventive application.

Generally, insecticide application is unlikely to be warranted if:

- beetles and damage were low during late summer the previous year;
- systemic insecticide was properly applied the previous growing season; or
- the winter was relatively warm or wet or both, because this weather apparently causes more "hibernating" beetles to die before elm leaves appear in spring.

If any of the above circumstances are true, avoid insecticide application unless monitoring of plants reveals that elm leaf beetles are present and excessively abundant.

Degree-Day Monitoring. Monitor temperatures to determine the optimal time to inspect elm leaves and (if beetles are too abundant) apply insecticide. Generally the higher the temperature, the sooner beetles and damage appear in the spring. When spring temperatures are cooler, elm leaf beetles appear later because they do not feed, grow, or reproduce below a "threshold temperature" of about 52°F.

Figure 4. Damage due to elm leaf beetle feeding.

To predict the peak abundance of each elm leaf beetle life stage, temperatures are monitored in units called degree-days. One degree-day is 1 degree above the insect's lower threshold temperature maintained for a full day. For the elm leaf beetle, degree-days above 52°F are accumulated for each season beginning March 1. The first- and second-instar larvae of first-generation elm leaf beetles are most abundant at about 700 degree-days above 52°F accumulated from March 1. If populations are high and damage is anticipated, foliar insecticide spray or trunk spray or injection of systemic insecticide at about 700 degree-days will catch susceptible larvae at their greatest abundance.

Elm leaf beetle development can easily be predicted using the point-and-click, degree-day calculator online at http://www.ipm.ucanr.edu/calludt.cgi/DDMODEL?MODEL=ELB&CROP=landscape. If you manage large numbers of elms, you can further improve your treatment by using degree-days in combination with egg presence-absence sampling, as explained in the 1993 publication by Dahlsten and others listed in References.

Biological Control

Elm leaf beetle populations are usually low at least partly because of biological control by native predators and introduced parasites. Predators of the elm leaf beetle include certain bugs, earwigs, lacewing larvae, and predaceous ground beetles. The easiest to recognize parasite is a small black tachinid fly, *Erynniopsis antennata*. After *Erynniopsis* larvae feed inside and kill beetle larvae, the parasite's 1/5 inch long, black to reddish pupae can be seen at the tree base among the yellowish, unparasitized beetle pupae (Figure 5). For more photographs of this beneficial fly, see the Natural Enemies Gallery at www.ipm.ucanr.edu/PMG/NE/elm_leaf_beetle_parasite.html.

Adults of a tiny wasp, *Oomyzus gallerucae* (Eulophidae), feed on elm leaf beetle eggs; and the parasite's larvae feed inside eggs. The *Oomyzus* adult leaves a round hole when it emerges from beetle eggs, which remain golden. When unparasitized and a beetle larva has emerged, the egg shell is whitish with a ragged hole (Figure 6). Another tiny eulophid wasp that kills beetle pupae, *Baryscapus brevistigma*, leaves one or more small round holes in the pupae and emerges from around the tree base.

Conserve these parasites and predators by avoiding foliar applications of residual (long-lasting), broad-spectrum insecticides. To obtain maximum benefits from biological control, minimize pesticide application, use less-persistent products, or apply insecticide as a bark band in an integrated program.

Chemical Control

Where elm leaf beetle damage is anticipated to be intolerable, chemical controls include:

- foliar spraying a nonresidual (nonpersistent) contact insecticide or a short-residual, translaminar insecticide
- bark banding, spraying bark with a residual, contact insecticide
- systemic insecticide, which can be applied various ways

A professional applicator must be hired to use certain methods.

Monitor beetle abundance and damage, as discussed above, to determine treatment need, choice of method, and timing. Apply insecticide only when beetles are present or expected to become too abundant. Insecticides can have unintended effects, such as contaminating water, poisoning natural enemies and pollinators, and causing secondary pest outbreaks. Completely read and follow the product label instructions for the safe and effective use of the insecticide.

Nonresidual, Contact Insecticides. Where elm foliage can be thoroughly sprayed, nonresidual, contact insecticides can provide control. These can be useful on small trees, to supplement bark banding (discussed below), during the first year of treatment and when early-season beetle populations are high. Products include azadirachtin (AzaMax, Safer Brand BioNeem), neem oil (Green Light Neem, Schultz Garden Safe Brand Neem), narrow-range oil (Bonide Horticultural Oil, Monterey Horticultural Oil), and pyrethrins, which many products combine with piperonyl butoxide (Ace Flower & Vegetable Insect Spray, Garden Tech Worry Free Brand Concentrate).

These insecticides have low toxicity to people and pets and relatively little adverse impact on pollinators and natural enemies. To obtain adequate control, spray must thoroughly cover the underside of infested leaves; and typically, foliage must be sprayed more than once per season.

Short-Residual Insecticides. Spinosad is foliar sprayed, absorbed short distances into plant tissue (it has translaminar activity), and persists about 1 week. It can be easier to obtain control using spinosad in comparison with the products above. Spinosad (Captain Jack's Deadbug Brew, Conserve, Monterey Garden Insect Spray) can be toxic to certain natural enemies (e.g., predatory mites, syrphid fly larvae) and bees when sprayed and for about 1 day afterward. Do not apply spinosad to plants that are flowering.

Figure 5. Elm leaf beetle prepupae (left) pupae, and pupae of the *Erynniopsis antennata* parasite.

Figure 6. Eggs from which elm leaf beetle larvae emerged are whitish. Eggs from which *Oomyzus gallerucae* parasites emerged (center) are golden.

Bark Banding. Spraying a small area around the tree trunk with a residual, contact insecticide kills larvae when they cross the treated bark and migrate down after feeding in the canopy. Bark banding reduces damage by later beetle generations by reducing the number of elm leaf beetles that pupate and emerge as adults, especially when done to all nearby elms.

Bark banding alone will not provide satisfactory control in many situations, especially if only one or a few trees are treated. Expect good control during the first season of bark banding on Siberian elms (*Ulmus pumila*). When banding more susceptible species such as English and Scotch elms, expect little or no control the first year if beetles are abundant during the first generation; banding all nearby elms for several consecutive years can provide control after the first year of treatment.

To bark band spray a several feet wide area encircling the trunk around the first main branch crotch. Carbaryl (Sevin) can be applied at the rate labeled for bark beetles (about 2% active ingredient). Pyrethroids (e.g., fluvalinate) labeled for application to bark also provide control. Bark banding may need to be done by a licensed pesticide applicator, because effective products generally are not available for home users. Do not use products labeled only for foliar application. The product will not be effective for trunk banding unless the label includes directions for application to bark.

Inspect foliage regularly and spray bark when mature larvae are first observed on leaves. For more accurate timing, accumulate degree-days and spray the trunk when about 700 degree-days (above 52°F) have accumulated from March 1. A single application of carbaryl to the bark each spring can kill most larvae that crawl over it all season long. To determine if the bark band is still effective, regularly inspect around the base of trees throughout the season. If many beetles have changed from greenish prepupae (the stage killed by banding) to yellowish pupae (unaffected beetles), a second application may be warranted.

Systemic Insecticides. Systemic insecticides are absorbed by one plant part (e.g., trunks or roots) and moved (translocated) to leaves or other plant parts. In comparison with systemics that are sprayed onto foliage, products labeled for soil drench or injection or for trunk injection or spraying minimize environmental contamination and may be more effective. Trunk application of systemic insecticide can provide relatively rapid control. There is a longer time delay between soil application and insecticide action. Most uses require hiring a professional pesticide applicator. Some home-use products can easily be drenched into soil around the tree trunk using the mix-and-pour method.

Systemic neonicotinoids include dinotefuran (Safari) and imidacloprid (Bayer Advanced Tree & Shrub Insect Control, Merit). Properly applied, one application can provide season-long control. The insect growth regulator abamectin (Agri-Mek) and the organophosphate acephate (Lilly Miller Ready-to-Use Systemic, Orthene) are other available systemic insecticides.

Some systemic insecticides can cause spider mite outbreaks. Foliar sprays of them can be toxic to beneficial insects that contact spray or treated leaves.

Systemics can translocate into flowers and have adverse effects on natural enemies and pollinators that feed on nectar and pollen. However, elms are wind pollinated and most elm species flower before leaves flush and before the recommended times of insecticide application.

Table 1. Elm (*Ulmus*) Tree Susceptibility to Dutch Elm Disease (DED) and Elm Leaf Beetle (ELB).

Tree		Susceptibility	
Elm Common Name	**Scientific Name**	**ELB**	**DED**
Emerald Sunshine	*Ulmus propinqua*[3]	R	R
Patriot	*(U. glabra X U. carpinifolia X U. pumila) X U. wilsoniana*	R	R
Prospector	*U. wilsoniana selection*	R	R
Frontier	*U. carpinifolia X U. parvifolia*	R	MR
Morton Accolade	*U. japonica X U. wilsoniana*[3]	R	MR
American New Horizon	*U. americana selection*	R	S
Homestead	*U. glabra X U. carpinifolia X U. pumila*	R	S
Morton Glossy Triumph	*U. pumila X U. japonica X U.?*[3]	R	S
New Horizon	*U. pumila X U. japonica*[3]	R	S
Morton Plainsman Vanguard[1]	*U. pumila X U. japonica*[3]	R	HS
Morton Red Tip Danada Charm	*U. japonica X U. wilsoniana*[3]	R	HS
Morton Stalwart Commendation	*U. carpinifolia X U. pumila X U.?*[3]	R	HS
Pioneer[1]	*U. glabra X U. carpinifolia*	R	HS
American Valley Forge[1]	*U. americana selection*	MR	R
Chinese[2]	*U. parvifolia*	MR	R
zelkova	*Zelkova serrata*	MR	R
Siberian	*U. pumila*	MR	S
Dynasty Chinese[2]	*U. parvifolia selection*	MR	HS
American	*U. americana*	HS	S
English	*U. procera*	HS	HS
Scotch	*U. glabra*	HS	HS

KEY
HS = Highly susceptible
MR = Moderately resistant
R = Resistant
S = Susceptible
? = hybrid cultivar includes some uncertain or unknown elm parentage

1. Have exhibited poor growth structure and high pruning requirement when young and grown in California.
2. Dynasty is highly susceptible to ELB, most Chinese elms (e.g., Allee, Athena, Drake, Evergreen, and True Green) are resistant to elm leaf beetle. However, in coastal areas where elm anthracnose is a serious problem, Brea and Drake cultivars can be good choices because they are resistant to elm anthracnose.
3. Budded onto *U. pumila* rootstock, Scientific Name is for the scion (upper trunk and canopy).
Source: McPherson et al. 2009.

Unless the product label directs otherwise, do not apply systemic insecticides to plants during flowering or shortly before flowering, wait until after plants have completed their seasonal flowering. With soil application, when possible, wait until nearby plants also have completed flowering as their roots may take up some of the soil-applied insecticide.

If applying systemic insecticide, use soil application or a trunk spray whenever possible. It is difficult to repeatedly place insecticide at the proper depth with systemic injection and implants, and these methods injure trees and can spread plant pathogens on contaminated tools. When injecting or implanting multiple trees, before moving to work on each new tree, scrub any plant sap from tools or equipment that penetrate trees and disinfect tools with a registered disinfectant (e.g., bleach). At least 1 to 2 minutes of disinfectant contact time between contaminated uses is generally required. Consider rotating work among several tools and use a freshly disinfected tool while the most recently used tools are being soaked in disinfectant. Avoid methods that cause large wounds, such as implants placed in holes drilled in trunks. Do not implant or inject roots or trunks more than once a year.

Residual, Foliar Sprays. Foliar sprays of broad-spectrum insecticides with residues that can persist for weeks are not recommended for elm leaf beetle control. Products to avoid include carbamates (carbaryl or Sevin), nonsystemic organophosphates (malathion), and pyrethroids (fluvalinate, permethrin). These are highly toxic to natural enemies and pollinators and can cause spider mite outbreaks. Because their use in landscapes and gardens can run or wash off into storm drains and contaminate municipal wastewater, these insecticides are being found in surface water and are adversely affecting nontarget, aquatic organisms.

REFERENCES

Dahlsten, D. L., D. L. Rowney, and A. B. Lawson. 1998. IPM helps control elm leaf beetle. *Calif. Agric.* 52(2):18–24. Univ. Calif. Agric. Nat. Res. Also available online at http://californiaagriculture.ucanr.edu.

Dahlsten, D. L., S. M. Tait, D. L. Rowney, and B. J. Gingg. 1993. A monitoring system and developing ecologically sound treatments for elm leaf beetle. *J. Arboriculture* 19(4):181–186. Also available online at http://joa.isa-arbor.com.

Dreistadt, S. H., J. K. Clark, and M. L. Flint. 2004. *Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide.* 2nd ed. Oakland: Univ. Calif. Agric. Nat. Res. Publ. 3359.

Dreistadt, S. H., D. L. Dahlsten, D. L. Rowney, S. M. Tait, G. Y. Yokota, and W. A. Copper. 1991. Treatment of destructive elm leaf beetle should be timed by temperature monitoring. *Calif. Agric.* 45(2):23–25. Univ. Calif. Agric. Nat. Res. Also available online at http://californiaagriculture.ucanr.edu.

McPherson, G., L. Costello, J. Harding, S. Dreistadt, M. L. Flint, and S. Mezger. 2009. National elm trial: Initial report from Northern California. *Western Arborist*. Fall 2009:32–36. Also available online at http://www.fs.fed.us/psw/programs/uesd/uep/products/CUFR_780_Elm_trials_2009.pdf.

AUTHORS: S. H. Dreistadt, UC IPM Program, UC Davis; and **A. B. Lawson**, Entomology, California State University, Fresno.

TECHNICAL EDITOR: M. L. Flint
EDITOR: K. Beverlin

ILLUSTRATIONS: Figs. 1–2 and **4–6**, J. K. Clark; **Fig. 3**, adult, first instar, second instar: L. O. Howard. 1895. The Shade-tree Insect Problem in the Eastern United States. Yearbook of the USDA. Washington, D.C.; egg cluster, prepupa: F. Silvestri. 1910. Bollettino del Laboratario di Zoologia Generale e Agraria. Portici 4:246-289; Third instar: John Muir Institute. 1979. The Elm Leaf Beetle. Berkeley, CA; Pupa: G. W. Herrick. 1913. Cornell Univ. Agric. Exp. Sta. Bull. 333.

This and other Pest Notes are available at www.ipm.ucanr.edu.

For more information, contact the University of California Cooperative Extension office in your county. See your telephone directory for addresses and phone numbers, or visit http://ucanr.org/ce.cfm.

University of California scientists and other qualified professionals have anonymously peer reviewed this publication for technical accuracy. The ANR Associate Editor for Pest Management managed this process.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

Produced by **UC Statewide Integrated Pest Management Program**
University of California, Davis, CA 95618-7774

UC IPM

UC PEER REVIEWED

University *of* California
Agriculture and Natural Resources