

INTRODUCTION

Nymphs and adults of the leafhopper genus *Erythroneura*² are occasionally serious pests that feed and reproduce on backyard and commercial grapes throughout New Mexico. By mid-summer, affected foliage is increasingly dotted with tiny white feeding marks made by nymphs and adult leafhoppers. Serious, persistent infestations may reduce photosynthesis, cause defoliation and losses in fruit quality and quantity, and even affect vine productivity the following year.³ Additionally, they can make fruit susceptible to other damaging insects. High populations of grape leafhoppers can be major annoyances for field workers, especially during grape harvest.



Figure 1. Two species of grape leafhoppers. Variegated leafhopper (left) and the common western grape leafhopper (right) on a grape leaf. Photo courtesy of J.M. French.

Grape Leafhoppers in New Mexico— Descriptions and Life Cycles

While several species of *Erythroneura* leafhoppers probably occur on grapes in New Mexico, the most commonly encountered are the western grape leafhopper, *E. elegantula*, and the eastern grape leafhopper, *E. comes*. The variegated leafhopper, *E. variabilis*, may occur in some parts of the state.

Adults of all three species are about 3 mm long and, at rest, are shaped like narrow, elongated wedges, broadest across the junction of head and thorax and tapering

sharply at rear (Figure 1). Large compound eyes are visible on either side of the triangular head. When the adult is at rest, the flat, nearly translucent forewings are held roof-like over the folded membranous hind wings and abdomen. Characteristic of all leafhoppers, the elongated lower hind legs have numerous short spines along their lengths. The needle-like piercing-sucking mouthparts are located on the rear margin of the head and project back between the bases of the forelegs. The

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²Insect order Hemiptera, family Cicadellidae, genus *Erythroneura*.

³Tiny, leaf-feeding *Erythroneura* leafhoppers are not considered vectors of *Xylella fastidiosa*, the causative agent of Pierce's disease of grapes. To date, that distinction belongs to the half-inch-long glassy-winged sharpshooter (*Homalodisca vitripennis*, formerly *coagulata*), which feeds for extended periods in the deeper xylem tissues of the stem where *Xylella* is most likely present. While *H. vitripennis* has not been found in New Mexico yet, *X. fastidiosa* has been confirmed in New Mexico grapes, chitalpa (an ornamental flowering tree), and peach, suggesting alternative vectors (but not *Erythroneura*) or planting of infected grape stock.



Figure 2. Example of leafhopper damage on grape leaves: “light” (top left), “moderate” (top right), and “heavy” (bottom, center). Photo courtesy of J.M. French.

Hatchling nymphs are nearly colorless miniatures of the adults they will become, except hatchlings are wingless. Nymphs will spend the next two to four weeks actively moving around their grape leaf habitat, feeding intermittently and growing and molting through five stages. When disturbed, even the smallest of them run sideways rapidly, usually jumping to safety. Like the adults, nymphs have piercing-sucking mouthparts and are restricted to a totally liquid diet of plant sap drawn from individual leaf cells; the cells are killed in the process, resulting in a white dot at each feeding site. Damage is cumulative, resulting in a leaf that looks like the green color has been increasingly sand-blasted (Figure 2).

Serious foliar damage and loss can affect fruit cluster quality and quantity, which are especially important to commercial produc-

ers. Exposed grape clusters can sunburn, take longer to develop color, develop abnormal coloration, or even wither. Grapes or grape clusters may not reach full size. Sugar accumulation and acid degradation are both retarded due to lack of effective leaf area.

Leafhopper excrement, or honeydew, is also a liquid and contains undigested sugars and excess water. Nymphs and adults spray their honeydew, resulting in small shiny or sticky dots on the foliage. Light deposits of honeydew may be washed off fruit before eating or processing, but heavier amounts can be increasingly attractive to bees, wasps, flies (both filth and fruit-feeding species), and fruit-feeding beetles. When humidity is high, honeydew can sustain growth of sooty mold, which blackens fruit and foliage. Affected foliage will fall from the vine.

Leafhopper nymphs molt as they mature, leaving their cast skins stuck on the undersides of the foliage. Neither the nymphs nor these delicate skins should be confused with whiteflies, which are entirely different insects. Short wing pads will be visible on the thorax of the largest nymphs; these are non-functional until the insects molt to adults. Colors and color patterns on the nymphs may be helpful in distinguishing some species of *Erythroneura*. Western and eastern grape leafhoppers transition from nearly colorless to white with yellow

small size of the leafhopper and its mouthparts suit it for feeding in individual leaf cells.

Adults of these three common species are basically creamy white with weakly defined yellow markings on the head, thorax, and forewings. The eastern grape leafhopper is the palest of the three, while the variegated grape leafhopper is usually the darkest, with brown and green tones. Western grape leafhoppers are pale like *E. comes*, but have a few red dashes and dots on their forewings.

The life cycles of all grape leafhoppers involve simple metamorphosis, proceeding from eggs through a series of five active nymph stages to adults. Depending on temperatures and elevations, grape leafhoppers may have two to three generations annually.

As soon as foliage appears in the spring, adult females are ready to feed and lay eggs. The female extends her saber-like egg-laying appendage (an “ovipositor”) to puncture the leaf epidermis and inject her eggs individually between the upper and lower surfaces of the leaf. Freshly laid eggs are sausage-shaped, about 0.8 mm long, and colorless. Eggs hatch in one to two weeks. With high pest pressure, eggs may be laid side by side in single layers between the larger veins on the leaf blades; extensive damage can cause defoliation even before the leaves expand to full size.

patches on the body by the fifth nymphal stage. Variegated grape leafhoppers become progressively darker with each molt, changing from semi-transparent to light yellowish-orange to mottled brown with developing patterns of green, white, and red by the fifth nymphal stage. Noting these subtle differences may be important for commercial growers in determining whether or when to control grape leafhoppers (see following sections on pest management).

In spring and summer, grape leafhoppers mate soon after becoming adults, the life cycle begins again, and populations increase. Adults produced in spring and summer probably survive two to three months. However, as day lengths and temperatures decrease in late summer and early fall, the last generation of grape leafhoppers enters diapause, a physiological state that reduces metabolic rates, suppresses reproduction, and permits the insects to survive several months on stored body fat during the winter when no fresh grape foliage is available. Diapausing adult grape leafhoppers usually overwinter in tangles of weeds, grasses, fallen leaves, mulches, and other ground debris in and around vineyards or backyard growing areas.

As temperatures increase in the spring and foliage appears on host plants, surviving adult grape leafhoppers emerge from diapause and their overwintering sites. They are relatively strong fliers and may fly for some distance to find suitable host plants, including newly transplanted grapes. Adults feed and mate and females deposit their eggs, starting a new round of generations.

Natural Enemies of Grape Leafhoppers

Various natural enemies can suppress grape leafhopper populations to some extent, although it may not be enough to prevent economic damage, especially in commercial vineyards.

Predators of grape leafhoppers include a variety of spiders, green lacewings, some lady beetles, big-eyed bugs, assassin bugs, predatory stink bugs, predaceous mites, and others. Different life stages of some of these will prefer leafhopper eggs, while others are more effective on certain stages of the nymphs or adults.

A tiny wasp, *Anagrus* sp. (Hymenoptera, Mymaridae), may parasitize the eggs of western grape leafhoppers in New Mexico, particularly later in the growing season. Approximately the same size as an *Erythroneura* egg, the female wasp taps leaf surfaces with its antennae to locate host material. She injects her egg through the leaf epidermis into the leafhopper egg. The developing wasp grub kills the leafhopper by feeding inside its egg. The wasp grub pupates inside the remains of the egg and

emerges as a new adult wasp within a few weeks. Actively parasitized leafhopper eggs turn brick red briefly. These wasps are totally harmless to humans and are not likely to be seen by the casual observer.

Integrated Pest Management of Grape Leafhoppers

While it can be defined in various ways for different crops and situations, integrated pest management (IPM) is an effective and environmentally sensitive approach to managing pests that relies on combinations of common-sense, basic practices. For grape growers, awareness of the life cycles and damage potentials of pests like grape leafhoppers and their interactions with the crop environment are important components for building an IPM program. Certain cultural, physical/mechanical, biological, and chemical means of manipulating crops like grapes and various pests like leafhoppers should be considered by homeowners and commercial producers alike. Practices that are feasible, economical, effective, fairly compatible, and least hazardous to people, property, and the environment are most desirable. Some of the following recommendations will be practical for all producers to incorporate, but others are more applicable to commercial growers.

For Homeowners

Select grape varieties that potentially will grow and produce well in your area. Plant and support vines in the sunniest area of the yard. Water vines adequately throughout the year. Avoid over-fertilization of grape vines since that can favor population development of more pests than just leafhoppers. Learn to prune vines properly. Remove fallen leaves, weeds, and other ground debris from the vicinity of grape vines, reducing harborage for pest insects. Reasonably healthy, properly maintained vines can tolerate some pest damage without major fruit quality or vine health problems.

Learn to identify different life stages of grape pests and beneficial arthropods that occur throughout the year. Take samples of unfamiliar insects promptly to your county Extension agent for identification.

Grape leafhoppers are easily able to outstrip the feeding and reproductive capacities of any of their natural enemies. Check the health and status of vines and fruit at least weekly during the growing season. If damage reaches unacceptable levels, insecticides may be needed to protect the vines and grape crop.

Backyard growers will find a variety of insecticide products formulated for their specific needs at nurseries,

garden centers, and discount and home improvement stores. Spend time critically reading labels. Those with both “grape” and “leafhoppers” on the label are good candidates. Those products not labeled for either the crop or the pest are likely not good candidates; they may not be effective against the pest or they could cause harm to the plant or its fruit. Note that some products are labeled “ready to use” and are appropriate for small jobs; these products are often sold with their own applicators. Other products are concentrates suitable for dilution and larger jobs; these require purchase of an appropriate, reusable applicator. Products appropriately labeled for the backyard grower may include one or more of the following active ingredients: pyrethrins, various pyrethroids, imidacloprid, carbaryl, and malathion.

Regardless of the active ingredient or formulation, follow all directions for safe, effective application and storage. Pay special attention to when a treated area may be re-occupied by pets or children. The label will state how often the product may be reapplied and the amount of time required to lapse, if any, between the last application and grape harvest.

For Organic Growers

Certified organic grape producers can plan or modify their own IPM programs using other appropriate practices outlined in this publication. However, according to requirements in the National Organic Program Final Rule, certified organic producers must demonstrate to their certifiers that they have exhausted all alternative means of controlling a pest before requesting approval to apply an appropriately labeled “OMRI Approved” insecticide.

Two pyrethrin formulations are currently registered in New Mexico and meet OMRI⁴ standards.

For Commercial Growers

Many factors determine if grape leafhopper populations are economically significant in any given year. These could include grape variety selections, canopy features, natural enemy activity, weather conditions, time of season, vineyard layout and locality, types of crops or non-crop areas surrounding the vineyard, and general vineyard maintenance. Regular and frequent scouting for pests in vineyards is essential.

Cultural Control

1. **Variety selection.** Early maturing varieties of grapes may sustain less fruit damage than late maturing varieties.

2. **Weed control.** In late winter and early spring, tilling weeds and other debris in the production area also reduces harborage for overwintering leafhoppers. Tilling done early in the morning when temperatures are cooler may destroy more overwintering leafhoppers than later in the day when the insects can be more active.
3. **Canopy management.** Some growers remove the basal leaves on their vines during the first generation of grape leafhoppers to reduce pest numbers later in the season. Remember that removing too many leaves may result in sunburned fruit.
4. **Fertilizer management.** Like other insects, grape leafhoppers may prefer and flourish on vines that are over-fertilized.
5. **Sanitation.** Eliminating fallen foliage and other debris in and around the production area reduces harborage for overwintering leafhoppers.

Scouting Routine

Guidelines have been developed for commercial growers to estimate grape leafhopper populations and set potential treatment thresholds. Basically, ONLY the nymphs are counted on selected leaves in sites scattered around the vineyard; do not count cast skins or adults. Remember that the nymphs are wary and will likely run sideways across the leaf as soon as the leaf is turned over. With a little practice, sampling the vines and recording data will become quicker and easier to do. Growers are also able to check on the progress of the crop and make notes on other problems and their locations in the vineyard. Consider the following protocol to get reasonably reliable results.

1. The best time to begin sampling the vines for leafhopper nymphs should be three to four weeks after bud break or when nymphs begin to appear on basal leaves.
2. For relatively small vineyards, sample the entire vineyard as one block. For larger properties where different varieties are planted in large blocks or where blocks are in different locations, consider sampling each block separately.
3. While sampling and counting are important, so is RECORDING all of your counts. Create a permanent data table for each block and transcribe results

⁴OMRI = Organic Materials Review Institute

from each scouting date either on paper or on a computer software program. A pictorial graph of results by block over time may be helpful in determining trends in pest populations as well as the impacts various control measures might have.

4. Counts should be done weekly and analyzed promptly as described in step 3.
5. When sampling in the vineyard or block, first select a “starting row” and then sample every fifth row from there. Avoid end rows and four or five vines from the ends of rows during the sampling process. Walk down the sample row, choose a vine, turn over a leaf, and quickly count JUST the nymphs. Record the location and count, do it again on a second leaf on the same vine, and then repeat the sampling process (two sample leaves/chosen vine) for every 10 to 20 vines down the row.

NOTE: In the spring, adults emerging from overwintering sites will lay eggs on the more mature six to eight basal leaves on the vines. This is most likely where the first generation nymphs will be found in the beginning of the season and also where leaf samples should be taken. From mid to late season, the 2nd and 3rd generation nymphs will be found mostly in the middle of the canes; this is the area for sampling leaves.

6. Select leaves at random to get a better representation of population numbers. During the summer, nymphs prefer to feed on the interior leaves of the canopy. If only outer leaves are sampled, nymph populations may be missed or underestimated.
7. **NOTE:** If western and variegated grape leafhoppers occur in a vineyard, it may be worthwhile to keep separate counts of each species, if possible. The tiny egg-parasitic wasp, *Anagrus* sp., may destroy more eggs of western grape leafhoppers than those of variegated leafhoppers; the small wasp and its short ovipositor can successfully reach the superficially laid eggs of the western grape leafhopper but not the deeper ones of the variegated species. By keeping the counts separate and comparing them over time, the presence of the wasp might be indicated indirectly. Treatment decisions could still be made accurately based on actual numbers of pests.
8. To determine the need for insecticidal control of grape leafhoppers, calculate the average number of

nymphs per leaf for each block on each sampling date. That is, for each data set for a block, add the total number of nymphs counted and divide by the number of leaves sampled. According to recommendations in California publications, an average of more than 20 leafhopper nymphs per leaf with no indication of natural enemies present may justify treatment. Depending on local New Mexico conditions, commodity prices, and grower experience, a treatment threshold may be higher or lower than 20 nymphs per leaf.

Chemical Control

If grape leafhopper populations are creating unacceptable damage despite cultural practices and biological control, then chemical control may be necessary. Table 1 lists a variety of active ingredients and modes of action for various insecticides. Some are contact insecticides, some are systemic, and others are insect growth regulators. While some insecticides work well on both nymphs and adults, insect growth regulators, in particular, are effective only on immature stages. While most labels state a product will control a given pest when used as directed, others show “suppression only.” Generally, if economically damaging leafhopper populations are present, the best time to apply an insecticide should be during the second generation nymph stage, approximately mid-July. Continue to monitor pest populations after treatment to determine efficacy and also to determine if or when to make additional treatments; again, follow label directions.

To prolong the efficacy of pesticides used for controlling grape leafhoppers or other grape pests, rotate insecticides with different modes of action (MOA number) over the growing season. This reduces the selection pressure on a pest population to become genetically resistant to a particular group of insecticides. To minimize confusion and reduce technical jargon for growers and applicators, the Insecticide Resistance Action Committee (IRAC) has simplified the expression of MOA to a set of numbers from 1 to 28. The MOA number can be found near the trade name of the insecticide on recently printed product labels.

Before making any pesticide treatment for grape leafhoppers, carefully read the product label. Determine the “re-entry interval” (REI) as well as any personal protective equipment (PPE) needed for application or follow-up field work. Adjust sampling dates and field work as needed. Note the application details and date on your data tables and determine changes in leafhopper populations post-treatment.

Table 1. List of Registered Insecticides for Use on Grape and Grape Leafhoppers in New Mexico

Active Ingredient	Mode of Action	G/R**	Notes
Carbaryl	1a	G	Carbamate, contact
Malathion	1b	G	Organophosphate, contact
Bifenthrin*	3a	R	Pyrethroid, contact
Beta-cyfluthrin	3a	R	Pyrethroid, contact
Cyfluthrin*	3a	R	Pyrethroid, contact
Fenpropathrin	3a	R	Pyrethroid, contact
Zeta-cypermethrin*	3a	R	Pyrethroid, contact
Pyrethrins	3a	G	Plant extract, 2 products lack the synergist piperonyl butoxide and are OMRI-approved for commercial organic production; other commercial products with pyrethrins contain piperonyl butoxide and are NOT OMRI-approved for organic grape production.
Acetamiprid	4a	G	Neonicotinoid, contact, systemic
Dinotefuran	4a	G	Neonicotinoid, contact, systemic
Imidacloprid*	4a	G	Neonicotinoid, contact, systemic
Thiamethoxam	4a	G	Neonicotinoid, contact, systemic
Abamectin*	6	R	Contact
Fenpyroximate	21a	G	Contact, more effective on nymphs
Pyridaben	21a	G	Contact, more effective on nymphs
Indoxacarb	22a	G	Population suppression

*Some products contain only this active ingredient. Other products contain this and 1 or 2 other active ingredients.

**G = General use products (no applicator license required for purchase or use)

R = restricted use products (current pesticide applicator license required for purchase and use)

Table 1 summarizes information on approximately 75 products currently registered in New Mexico for use on grape and grape leafhoppers. The active ingredients are categorized as “general use” or “restricted use” (valid NM Private Applicator license required for purchase and use) along with appropriate MOAs. Growers are advised that many products have only one active ingredient, but they can also find products with two or occasionally three active ingredients. Those with multiple active ingredients may be helpful in managing resistance in grape leafhoppers when used in an insecticide rotation plan.



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NOTES

Disclaimer: *The pesticide recommendations in this publication are provided only as a guide. The authors and New Mexico State University assume no liability resulting from their use. Please be aware that pesticide labels and registration can change at any time; by law, it is the applicator's responsibility to use pesticides ONLY according to the directions on the current label. Use pesticides selectively and carefully and follow recommended procedures for the safe storage and disposal of surplus pesticides and containers.*

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