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Biology and Management of Grape Phylloxera

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Grape phylloxera, *Daktulosphaira vitifoliae* (Fitch), is becoming a more important pest of grapes as growers in Arkansas and in other north central states in the United States plant more French-American hybrid cultivars.

Biology. Grape phylloxera, *Daktulosphaira vitifolia*e (Fitch), is a key pest of grape throughout the world. This pest has two forms that either attack the root (radicicola) or the foliage (gallicola). In humid climates like the Ozarks, grape phylloxera overwinter either as immature grape phylloxera feeding on roots or as eggs laid on the trunk in the fall.

During spring and summer, the root form produces several generations that feed on the roots (Fig. 1) causing root tips to swell into nodosities (Fig. 2 and 3).

In August, winged forms emerge from the soil and produce eggs. These eggs hatch and mature in September and early October into males or females that mate, and the female lays one egg that overwinters on the trunk.

In early April, eggs on the trunk hatch into first-generation yellow crawlers. These crawlers move to grape shoots to feed on the first to third expanding terminal leaves of the season. The leaf forms a gall around each crawler (Fig. 4, inside). The first generation crawlers usually form less than five galls per leaf (Fig. 4). During April and early May, each crawler matures into a fundatrix or stem mother (center of Fig. 5, inside). Each stem mother produces a second generation of 100 to 300 oblong,

Figure 1. Root form of grape phylloxera on a grape root

Figure 2. Root form of grape phylloxera cause swollen grape root tips called nodosities (circled)

Figure 3. Root form of grape phylloxera (circled) feeding on grape root nodosities

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Figure 4. Mature grape phylloxera stem mother galls (circled) on first to third expanded leaves at the base of shoot in May

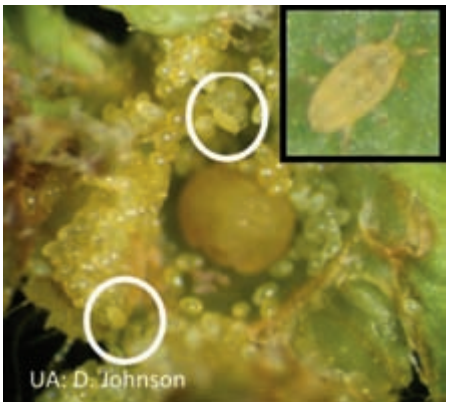

Figure 5. Mature foliar grape phylloxera gall with many eggs and two crawlers (circles and inset) in May

Figure 6. Mature stem mother gall (circle) on first to third mature leaf and immature, "rash-like" galls on the underside of expanding terminal leaf caused by crawler (inset) feeding on top side of leaf on June 15 (Hillsboro, MO)

yellow eggs (Fig. 5) that hatch into yellow, six-legged crawlers (circles and inset on Fig. 5).

New crawlers walk further up shoots to expanding terminal leaves (usually the fifth to eighth leaves on shoot). These infested leaves often have 50 or more galls per leaf (Fig. 6). The lower leaf surface of newly infested expanding leaves have immature galls that appear like a rash (Fig. 6). The upper surface has shallow open pits. Using a magnifying lens, you can see a crawler inside each open pit (Fig. 6, inset). These exposed crawlers are susceptible to insecticide sprays until the gall closes over them (see **Chemical Control**).

Throughout the summer, a certain portion of the foliar grape phylloxera crawlers walk or drop to the soil surface, walk down cracks in the soil (occurs more in clay soils that dry and crack) and eventually feed on roots (Fig. 1) and cause root tip swellings (nodosities) (Fig. 2 and 3). Four or more generations of crawlers are produced during the summer.

Damage. Most leaves of susceptible cultivars that expand after late May have more than 50 galls per leaf (Fig. 7) (see **Susceptible Cultivars**). Severe leaf galling prevents leaf expansion; causes leaf distortion and shortened shoots that reduce photosynthesis, poor canopy architecture, leaf necrosis, premature defoliation, delayed ripening, reduced crop quality; and predisposes vines to winter injury.

Figure 7. Second and third generation grape phylloxera galled leaves on the same shoot and severely galled leaf (inset)

In eastern North America, foliar-infested grapes also have the root form causing nodosities on small roots but no tuberosities on larger roots (Jubb, 1978; Williams, 1979; Stevenson, 1970ab; Williams and Shambaugh, 1988; McLeod and Williams, 1991, 1994). Bates et al. (2001) found that root grape phylloxera alone, lack of irrigation alone and combination of root grape phylloxera and water stress caused 21, 34 and 54 percent decreased 'Concord' vine dry mass, respectively.

In drier growing regions like California and Europe, the root form of grape phylloxera not only induces nodosities on small roots but causes tuberosities on larger, older portions of the root.

Tuberosities allow entry of secondary, soil-borne pathogens into the grape roots that leads to root necrosis and eventually to vine death of pure French *V. vinifera* cultivar vines.

Susceptible Cultivars. Growers should be aware that the following cultivars hybridized from French *V. vinifera* and American *Vitis* species get economically damaging leaf galling by grape phylloxera: Aurora, Cascade, Catawba, Cayuga White, Chambourcin, Chancellor, Chelois, DeChaunac, Delaware, Himrod, Lakemont, Norton/Cynthiana, Rayon D'Or, Reliance, Rougeon, Seibel, Seyval, Vidal, Vidal Blanc, Vignoles (Ames, 1999; Johnson and Lewis, 1993; Jubb, 1976; McLeod and Williams, 1991, 1994; Skirvin et al., 1997; Stevenson, 1970ab; Townsend, 1990; Sleezer, 2009).

Degree-Day Model. On a grape phylloxera-susceptible cultivar, record the date when vines begin to expand the first grape leaves in late March to early April (**biofix**). After this biofix date, begin accumulating daily degree-days (DD) (base 43° F; reported by Belcari and Antonelli, 1989) by using the following equation for DD:

DD = average daily temperature – 43

Table 1. Grape rootstocks resistant to the root form of grape phylloxera

Rootstock Parentage	Rootstocks
V. riparia x *V. rupestris*	'3309', '101-14', 'Schwarzmann' (***used in Ozarks***)
V. rupestris	'Saint George'
V. riparia	'Gloire de Montpelier'
V. berlandieri x *V. riparia*	'161-49', 'SO4', 'Teleki 8 B', '5BB', '5 C Teleki', 'Kober 125 AA', '420 A'
V. berlandieri x *V. rupestris*	'99 R', '110 R', '1103P', '140R'
V. riparia x *V. solonis*	'1616 C'
V. riparia x *V. cordifolia* x *V. rupestris*	'44-53 M'
V. riparia x *V. berlandieri* x *V. rupestris*	'Gravesac'

Source: Candolfi-Vasconcelos <http://berrygrape.org/phylloxera-resistant-rootstocks-for-grapevines/>

The second-generation crawler emergence period occurs from 554 to 800 DD accumulated after the biofix date (insecticide spray period) or from early to late May. Third-generation crawlers begin emerging from second-generation galls after 1,200 DD, which was June 12, 2009, in Altus, AR.

Scouting. Twice weekly from 450 to 700 DD after biofix, inspect for grape phylloxera crawlers on susceptible vines with a history of foliar galling. On several susceptible vines, look for mature stem mother galls on the three oldest leaves. Use a 10X magnification hand lens to check for crawlers on the upper leaf surface by the mature gall or inside a mature gall that has been cut open (Fig. 5, inset). You can delay insecticide sprays until you begin to see expanding terminal leaves with pin-sized galls that appear pitted. Inspect these leaves with a hand lens to see a yellow crawler inside each immature, opened gall on the upper leaf surface (Fig. 6, inset).

Timing Sprays. Apply insecticide (Table 2) to foliage in May when you first see yellow crawlers in stem mother galls (Fig. 5) and see immature galls (rash-like) on the expanding terminal leaves (Fig. 6). An alternative to insecticide is to apply Surround kaolin clay (Table 3) to the foliage, which may take a couple passes of sprayer to whitewash foliage with Surround. As long as crawlers are present (two to three weeks), maintain whitewashed appearance of foliage by reapplying Surround after rains or as new terminal leaves develop or keep foliage protected with insecticide (see **Chemical Control**).

Cultural Control: Greenhouse tests and small field-plot experiments demonstrated that compost in soils reduced root necrosis due to fungal pathogens (Granett et al., 2001, 2003). Also, organically managed vineyards had less fungal pathogen damage than conventionally managed vineyards (Granett et al., 2001). However, more research is needed to demonstrate any deleterious affect on root grape phylloxera.

In the Ozarks, the number of grape phylloxera feeding on roots (Fig. 1) and the number of root nodosities per vine (Fig. 2 and 3) vary by grape cultivar and environment. For growers planting pure *V. vinifera* cultivars, it is recommended that scions be grafted to rootstock resistant to the root form of grape phylloxera (Table 1). Two rootstocks successfully used in the Ozarks are '3309' and '101-14'. The parentage of grape phylloxera-resistant rootstocks derived from crosses of American *Vitis* species are listed in Table 1. Some of these rootstocks also resist nematodes and are adapted to a particular vineyard soil type or climatic condition.

Chemical Control: Spray as soon as possible if there are walking yellow crawlers inside the galls or if you see immature galls forming on expanding terminal leaves. At this point, crawlers are still exposed in immature, opened galls and can be killed by an insecticide application (see **Timing Sprays**). Several insecticide formulations are registered and reported as effective against foliar grape phylloxera in Ohio (McLeod and Williams, 1994; Williams and Fickle, 2005) and in Missouri (Johnson et al., 2008, 2009).

Table 2. Registered insecticides and a crop protectant registered against foliar grape phylloxera on grape

Common Name	Trade Name and Formulation	Rate Per Acre	Group Number; Chemical Name; Mode of Action (site of action)
Imidacloprid	Admire Pro Systemic Protectant	7 to 14 fl oz	4A; Neonicitinoid; Nicotinic acetylcholine receptor agonists
Acetamiprid	Assail 30 SG	2.5 oz	4A; Neonicitinoid; Nicotinic acetylcholine receptor agonists
Fenpropathrin	Danitol 2.4 EC	10 2/3 lb	3A; Pyrethroids; Sodium channel modulators
Spirotetramat	Movento	6 to 8 fl oz	23; Tetramic acid derivatives; Inhibitors of acetyl CoA carboxylase-lipid synthesis, growth regulation
Kaolin clay	Surround WP Crop Protectant	25 lb	Repellent particle barrier film

Table 3. Suppliers of Surround Crop Protectant particle film (kaolin clay) used to whitewash foliage

Suppliers	Address/Online URL	Phone and Fax
Engelhard Corporation	101 Wood Avenue, Iselin, NJ 08830 Online: http://www.cdms.net/LDat/ld7K7005.pdf http://www.orfeteknik.com.tr/MyNewDir2/pdf/US.walnut.brochure.pdf	Ph. 877-240-0421
Gardens Alive	5100 Schenley Place, Lawrenceburg, IN 47025 Online: http://www.gardensalive.com/category.asp?c=13	Ph. 812-537-5108
Peaceful Valley Farm Supply, Inc.	P.O. Box 2209, 125 Clydesdale Court, Grass Valley, CA 95945; Online: http://www.groworganic.com/browse_425_Weed__Pest_Control.html	Ph. 888-784-1722
Seven Springs Farm	426 Jerry Lane NE - Check, VA 24072 Online: http://www.7springsfarm.com/	Ph. 540-651-3228

Registered formulations include Admire Pro, Assail, Danitol, Movento and Surround (Table 2). Danitol and Movento required one application against second-generation crawlers, whereas Assail worked as well as Danitol when applied twice at a 15-day interval (Johnson et al., 2008). Admire Pro suppresses foliar grape phylloxera when applied into the root by early April by chemigation, side-dress or hill drench. In the past, Endosulfan, an organochlorine compound, was the standard formulation used against grape phylloxera, but it was phytotoxic to many cultivars sensitive to sulfur. **Endosulfan is no longer registered for use on grape against grape phylloxera**.

For registered insecticide formulations and rates per acre, see Table 2 or the current printed or online versions of MP144, *Insecticide Recommendations for Arkansas,* and MP467, *Arkansas Small Fruit Management Schedule,* at <www.uaex.uada.edu> or the *Midwest Commercial Small Fruit and Grape Spray Guide* at <http://www.ag.purdue.edu/hla/Hort/Pages/sfg_sprayguide.aspx>.

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