PPP-102

PURDUE PESTICIDE PROGRAMS
Purdue University Cooperative Extension Service

PEST CONTROL IN GRAPES

Purdue University Cooperative Extension Service • West Lafayette, IN 47907

Pest Control in Grapes

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Pest Control in Grapes

Successful grape production in Indiana depends on matching the grape variety to the local environment. There are three types: American, French-American, and European. American and French-American varieties do well in Indiana. European varieties, also known as *vinifera*, are only suitable for sites with the best growing conditions.

Cold winters, frequent rains during the growing season, and hot, humid summers present a challenge to growing grapes in Indiana. Grapes require mild winters, freedom from frost, full sun exposure, and good soil drainage. Much of southern Indiana meets these requirements for growing grapes commercially. Other regions are less well suited, but commercial production of grapes is possible by selecting adapted varieties. The map below shows all the counties in Indiana with commercial vineyards.

Grapes need well drained soil on elevated ground. Elevated sites are more likely to be frost-free and have better air circulation. High moisture levels promote development of fungal diseases.

Growers typically begin with 3–4 acres of grapes. They plant 550–660 vines per acre, placed 6–8 feet apart within the row. A 3–4 foot band under the vines is kept weed-free. Rows are commonly spaced 9–10 feet apart or wider, depending on equipment size and the slope of the site. A typical commercial vineyard can remain productive for 20–25 years.

The area between rows is planted to reduce erosion and compaction. Native grass or an orchard/vineyard blend provides a mix of plants and good cover. Growers prefer vegetation that requires little mowing to minimize labor and equipment operating expenses.

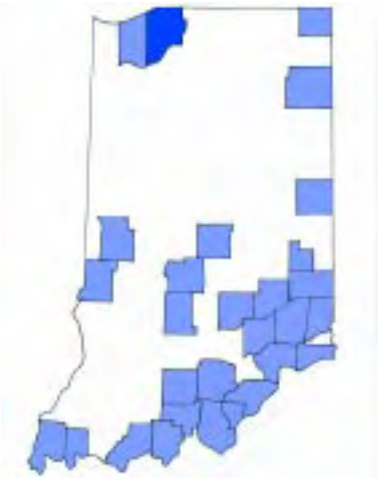
The first three years

Grapevines take three years to reach maturity. It is not until the fourth year that grapes reach full production. Growers purchase transplants from commercial nurseries. Grapevines are propagated by rooting 3-node cuttings (approximately 10 inches). These rooted grapevine cuttings are planted in early spring after the threat of hard freeze has past. Grapevines must be supported by a trellis for ease of management and optimum yield. Properly training grapevines to a trellis is essential during the first years of growth.

Weed control is critical during the first years of establishment. Pest control begins the first year to protect shoots on young vines from foliar diseases and leaf-eating insects. Preventive fungicide sprays are applied three to four times during the first two growing seasons. By the third year, vines are on the same pest control schedule as bearing vines. Third-year vines produce at half of their potential yield.

Bordelon

Approximately 40% of Indiana's grape-producing acres are planted to grapes for juice. Juice vineyards are on the average 50 or more acres.[1] The photo shows Concord grapes, a common juice grape.



Indiana counties that produce grapes for wine are in light blue. The county that produces grapes for juice is dark blue. Table grapes are not grown on a large scale in Indiana, although operators of farm markets do grow some to meet the demand of their customers.

Bordelon

Grapes grown for wine comprise 60% of Indiana's total grape acres. These vineyards are primarily along the Ohio River Valley. The average size of wine grape vineyards is 10 or fewer acres. Most growers also operate a winery.[1] The photo shows Seyval, a popular variety of wine grape grown in Indiana.

Grape Production in Indiana

Percentage of US production	less than 2%
Total acres in production, 1997	428 acres
Average yield	5 ton/acre
Yield range	2–9 ton/acre[1]
Juice produced	600–1000 gal/acre[1]
Range of prices received	$400–$700/ton[2]
Annual production cost/acre	$1700/acre[3]
Average annual pesticide cost/acre	$315/acre[3]

[1] Yield depends on variety.
[2] 1993–1996 3-year average, Economics of Midwestern Grape Production. B. Bordelon, Purdue University.
[3] 1994 Economics of Midwestern Grape Production. B. Bordelon, Purdue University.

Bearing vines

Grapevines require annual pruning to remain productive and manageable and to achieve consistent yields. Dormant vines are pruned in early spring to adjust pruning severity to account for midwinter cold injury. Growers control production by pruning to achieve consistent yields. Grapevines can potentially produce 10–12 tons per acre (average is 5 tons). Allowing vines to overproduce reduces vigor and future yields.

The growing season pest management program begins with a post emergence herbicide (burndown) application in early spring. A preemergence herbicide, or preemergence tank mixed with a postemergence herbicide, is applied a month later. Scouting begins in April for grape flea beetle to prevent damage to developing buds. A protectant spray schedule for black rot, Phomopsis, downy mildew, and powdery mildew begins the first of May when shoots are 3–5 inches long and continues at 7–14 day intervals until veraison, or berry coloring. Sprays at bloom and post bloom are the most critical for control of major fruit pathogens. On the average, growers apply 9–18 pesticide spray applications per season.[1]

Pheromone traps are set for grape berry moth in late May, to determine the need for control. Scouting for phylloxera follows in early June. Insecticides are applied as needed with scheduled fungicide sprays.

Growers begin canopy management 1–3 weeks following bloom. Shoot positioning and leaf removal help to expose fruit clusters to sunlight and air movement. The increased airflow lowers humidity in the canopy, which reduces the incidence of fungal disease. It also exposes grape clusters to spray coverage and improves fruit quality.

An acceptable balance of sugar, acid, and pH determines the harvest date. The ratio varies somewhat, depending on the grape variety and weather during the growing season. The winemaker or juice processor works with the grower to determine the optimum time for harvest. In Indiana, wine grapes are hand-harvested. Juice grapes are machine-picked by the grower and shipped to the juice processor; the entire grape crop is picked at one time.

Individual wineries often write standards into their contracts regarding the percentage of damaged and diseased fruit allowed in a crop. For example, powdery mildew and bitter rot give an off-flavor to wine. Wineries also are particular about the use of sulfur, which causes an offensive odor and taste in wine.

Following harvest, a fungicide application may be made to varieties susceptible to powdery or downy mildew. These diseases cause early defoliation, which weakens the vine, reducing future production. Grapevines normally drop all their leaves at the first hard frost.

Time line for annual grape production

January

February

Pruning

March

Bud swell ***April***

Scout for grape flea beetle
Postemergence herbicide application

Bud break ***May***

Protectant sprays for fungal disease at 7–14 day intervals

Traps set for grape berry moth
Pre- and postemergence herbicide application

Bloom ***June***

Scout for phylloxera

Canopy management

Spray for Japanese beetle as needed

Postemergence herbicide application for weed breakthroughs

July

August

Veraison

September

Harvest

October

Fungicide spray to control mildew in susceptible varieties

Frost

November

December

Bordelon

Successful control of black rot relies heavily on vineyard sanitation. Mummies (shriveled, diseased grapes) left on the vine can release spores all season.

Disease pests

Diseases pose the single greatest threat to profitable grape production. Fungi, which cause most grape diseases, thrive in the hot, humid climate common to Indiana summers. In most cases, symptoms become apparent one or two weeks following fungal infection. Once infection sets in, fungal diseases are nearly impossible to control.

Black rot *(Guignardia bidwellii)*

Black rot is the biggest concern of grape growers in Indiana. The fungus overwinters in mummies (dried, shriveled grapes) left on the ground or vines. In the spring, rain releases and splashes the spores from the mummies onto the leaves, forming lesions that release spores which infect leaves and fruit all season. Growers use a spray schedule to control black rot, which also controls foliar diseases.

Acres infected: 100%[1]

Occurrence: May–August[2]

Damage: All new growth is susceptible; the rot forms reddish brown lesions, causing the grapes to eventually become hard, shriveled, black mummies.[2]

Critical timing: Early June. Control of initial infection reduces and/or eliminates fungicide applications later in the season.[1]

Crop loss: In severe epidemics during wet years, up to 100% of the crop can be lost if left untreated.[1]

Bordelon

Downy mildew infects older leaves in late summer and fall. Severely infected leaves eventually die. European varieties are more susceptible to downy mildew than American varieties.

Downy mildew *(Plasmopara viticola)*

The fungus overwinters in leaf debris on the ground. Rain splashes the spores onto the grapevine.

Acres infected: 100%[1]

Occurrence: June–August; severe outbreaks occur in wet years.[2]

Damage: Leaves develop yellowish brown lesions on the upper surface and white patches on the underside. Severely infected leaves curl and drop. Young shoots, tendrils, and stems become distorted, thickened, or curled. White, cottony patches appear on fruit during humid conditions.[2]

Critical timing: July–August[2]

Crop loss: Diseased blossoms and grape clusters can result in up to 25% yield loss. Leaf defoliation increases the susceptibility to winter injury.[1]

Powdery mildew *(Uncinula necator)*

Powdery mildew overwinters in bark crevices of the grapevine. Spores released by spring rains are the primary inoculum. Wind carries the fungus where it grows on any green surface of the vine. The infected area has a dusty or powdery appearance. Spores produced in infected areas provide secondary inoculum for infections throughout the growing season.[1]

Acres infected: 100%[1]

Occurrence: French hybrid and European varieties are more susceptible to powdery mildew than native American varieties. Powdery mildew can be a problem in dry years.[2]

Damage: Powdery mildew infects all green tissue. Infected clusters drop blossoms before the fruit sets. Infected grapes split before maturity. Infected leaves have reduced photosynthesis which reduces fruit quality[2].

Critical timing: Early season control reduces the total number of fungicide applications. Susceptible varieties often require late-season sprays. Optimum temperatures for disease development are 68–77°. Careful use of sterol inhibitors is important to reduce fungicide resistance.[2]

Crop loss: If not controlled, powdery mildew reduces vine growth, yield, and winter hardiness. Powdery mildew gives an undesired, off-flavor to wine but it is not a concern for grape juice.[2]

Phomopsis cane and leaf spot (Phomopsis viticola)

The fungus overwinters in lesions on 1- to 3-year old vines. Rain spreads the fungus to new shoots, leaves, and (later) developing grapes. Infected fruit appears similar to black rot.

Acres infected: 100%[1]

Occurrence: May–August. An increasing incidence of the disease is being seen in the state. The disease is not active in warm summer months.[1]

Damage: Heavily infected shoots are prone to wind damage. The fungus enters small green grapes but the disease is not apparent until close to harvest. As grapes ripen they become light brown and shrivel.[2]

Critical timing: Early May–mid June. The first scheduled spray application is to control Phomopsis.[1]

Crop loss: Yield is reduced because of fruit loss and weakened vines, only under severe disease outbreaks.[2]

Botrytis bunch rot (Botryotinia cinerea)

Botrytis bunch rot, or gray mold, quickly spreads from grape to grape. Varieties with tight-clustered bunches are more susceptible. The fungus overwinters in debris on the ground and on the vine.

Acres infected: 100%[2]

Occurrence: Throughout growing season, mostly at bloom and again at veraison, or berry coloring.[2]

Damage: Tissue previously injured by hail, wind, birds, or insects is susceptible to Botrytis infection. It appears on leaves as brown, necrotic lesions. Botrytis rapidly spreads throughout the grape cluster.[2]

Critical timing: Early June, at bloom; July, at bunch closing; and early August, at veraison or berry coloring.[1]

Crop loss: Botrytis bunch rot can destroy entire bunches, resulting in 25–50% yield loss in susceptible varieties.[1]

Nonchemical control

- Growers avoid planting disease-susceptible varieties. However, there are few varieties with good resistance to all major diseases. Varietal selection is often based on market demand and fruit quality.

Bordelon

The most common form of Botrytis bunch rot is the infection of ripening grapes. In purple varieties, the grapes become reddish. The grapes of white varieties turn brown and shrivel.

- Growers manage vines to promote air circulation. Most fungal diseases depend on moisture for infection and dispersal.
- Selecting sites that promote drying of leaves can reduce the spread of fungal diseases. Vineyards should not be established near woodlots, which can harbor diseases and insects.
- Fertilizer should be applied at recommended levels. Excess fertilization leads to excessive growth, which increases the moisture level in the canopy and reduces pesticide coverage.
- Good weed control is needed to promote air movement and foliage drying in the trellis. Heavy weed growth also restricts pesticide coverage.
- Removal of dead, diseased plant material (leaves, grapes, prunings) from the ground and trellis reduces the source of pathogens.

Chemical control

Most growers use a combination of protectant (on the surface as a barrier) and systemic (absorbed into the plant) fungicides. Protectants form a barrier between the plant and fungal spores. They must be applied before the pathogen infects the plant. Systemics are applied at the onset of the infection period for the specific disease and are able to stop development of the disease even after infection has occurred. All systemic fungicides also act as protectants. Protectant and systemic fungicides can be applied together as a tank mix.

Fungicides are foliar sprays and are applied by air blast sprayer, at approximately 9–18 applications per season. The most critical fungicide applications are at prebloom, bloom, and two weeks following bloom. The combination of fungicides and the spray schedule depends on several factors such as: susceptibility of the variety, environmental conditions, label instructions, and disease history.

Protectant fungicides

PHI–Pre-harvest interval REI–Restricted-entry interval

Captan (Captan)
Target diseases: black rot, downy mildew, Phomopsis cane and leaf spot[2]

Acres treated: 100%[1]

Rate and frequency: 3 lb/acre at 10–14 day intervals as needed[3]

PHI: 0[3]

REI: 4 days[3]

Comments: Often used later in season when PHI prevents use of mancozeb. Some juice processors will not accept grapes that have been treated with captan.[1]

Mancozeb (Dithane)
Target diseases: black rot, downy mildew, Phomopsis cane and leaf spot[2]

Acres treated: 100%[1]

Rate and frequency: 3 lb/acre applied at 7–10 day intervals as needed[3]

PHI: 66 days (limits use to early season applications)[3]

REI: 24 hours[3]

Comments: Mancozeb provides good control of most diseases except powdery mildew. Applied with a sterol inhibitor when also preventing powdery mildew.[3]

Carbamate (Ferbam)
Target diseases: black rot, downy mildew[2]

Acres treated: 20%[1]

Rate and frequency: 3 lb/acre at 10–14 day intervals as needed[3]

PHI: 7 days[3]

REI: 24 hours[3]

Comments: Maximum of three applications.[3] Applied instead of captan or mancozeb. Seldom used.[1]

Ziram (Ziram)
Target diseases: black rot, downy mildew, Phomopsis cane and leaf spot[2]

Acres treated: 20%[1]

Rate and frequency: 3–4 lb/acre applied at 7–14 day intervals as needed. Not commonly used.[3]

PHI: 21 days[3]

REI: 48 hours[3]

Comments: 24(c) registration for use in Indiana.[3] Maximum 28 lb/acre/season.[3] Often used if juice processor restricts use of mancozeb or captan.[1]

Copper (copper sulfate, Bordeaux mixture, Cocide)
Target disease: downy mildew

Acres treated: less than 20% of total acres[1]

Rate and frequency: See label.[3]

REI: 24 hours[3]

Comments: Copper is an alternative control if juice processor does not accept grapes treated with mancozeb or captan. Copper can damage the leaves and fruit of sensitive varieties.

Sulfur
Target disease: powdery mildew

Acres treated: less than 20% of total acres[1]

Rate and frequency: See label.[3]

REI: 24 hours[3]

Comments: Sulfur only controls powdery mildew. Some grape varieties are extremely sensitive to sulfur. Sulfur can give wine an offensive odor and taste.

Systemic fungicides

PHI–Pre-harvest interval REI–Restricted-entry interval

Sterol inhibitors
Myclobutanil (Nova)

Target diseases: black rot, powdery mildew[2]

Acres treated: 75%[1]

Rate and frequency: 3–5 oz/acre at 7–14 day intervals[3]

PHI: 14 days[3]

REI: 24 hours[3]

Comments: Potential for development of resistant strains of powdery mildew fungus limit use to maximum of 24 oz/acre/season.[3]

Triadimefon (Bayleton)
Target diseases: black rot, powdery mildew[2]

Acres treated: 75%[1]

Rate and frequency: 2–6 oz/acre at 7–14 day intervals[3]

PHI: 14 days[3]

REI: 12 hours[3]

Comments: Potential for development of resistant strains of powdery mildew limit use to maximum of 18 oz/acre/season.[3]

Fenarimol (Rubigan)
Target diseases: black rot, powdery mildew[2]

Acres treated: 20%[1]

Rate and frequency: 3 fl oz/acre applied at 7–14 day intervals[3]

PHI: 30 days[3]

REI: 12 hours[3]

Comments: Resistant strains of powdery mildew fungus limits use to maximum of 19 oz/acre/season.[3]

Triflumizole (Procure)
Target diseases: black rot, downy mildew, powdery mildew

Acres treated: less than 20% of total acres[1]

Rate and frequency: 4–8 oz/acre applied at 7–14 day intervals[3]

PHI: 7 days[3]

REI: 24 hours[3]

Comments: Maximum of 32 oz/acre /season[3]

Other systemic fungicides

Metalaxyl (Ridomil)
Target diseases: downy mildew[2]

Acres treated: 20%[1]

Rate and frequency:[3]

Ridomil Gold Copper	2–2.5 lb/acre	4 applications, maximum
Ridomil MZ 72	2.5 lb/acre	4 applications, maximum
Ridomil Gold MZ	11–15 oz/acre	4 applications, maximum

PHI: 66 days[3]

REI: 24 hours[3]

Comments: To prevent potential resistance it is sold as a mix with a protectant fungicide.

Azoxystrobin (Abound)
Target diseases: black rot, downy mildew, powdery mildew, Phomopsis cane and leaf spot[1]

Acres treated: 20%[1]

Rate and frequency: 11–15 fl oz/acre at 10–14 day intervals applied in an alternating block spray program[3]

PHI: 14 days[3]

REI: 12 hours[3]

Comments: Only fungicide that controls all four major diseases. Maximum of 6 applications/season. To prevent disease resistance, cannot be applied as two consecutive applications.

Cyprodinil (Vanguard)
Target disease: Botrytis bunch rot

Acres treated: less than 20% of total acres[1]

Rate and frequency: 10 oz/acre when used alone or 5–10 oz/acre in tank mix applied in 2 or 3 applications[3]

PHI: 7 days[3]

REI: 12 hours[3]

Comments: Maximum of 20 oz/acre/season[3]

Iprodione (Rovral)

Target disease: Botrytis bunch rot

Acres treated: less than 20% of total acres[1]

Rate and frequency: 1.5–2 lb/acre applied 4 times[3]

PHI: 7 days[3]

REI: 12 hours[3]

Resistance management for powdery mildew

The maximum number of applications of sterol inhibitors must be followed to prevent resistant strains of the powdery mildew fungus. Good spray coverage at the full use rate helps to prevent resistance. Studies have shown that using less than the full use rate hastens the development of resistance.

Post-harvest fungicide applications to vines

Varieties susceptible to downy mildew and powdery mildew may need continued protection from these diseases after the grapes are harvested. These mildews damage leaves or cause grapevines to lose their leaves prior to normal leaf drop at the first frost. Premature leaf drop weakens the vine, which increases the risk of winter injury and reduces yield the following year. Foliar sprays of fungicides are continued at pre-harvest rates within the maximum limits.

Research

Foliar fertilizers and potassium products are being tested for the control of powdery mildew. Studies have shown that they eliminate existing fungus. Potassium products currently being tested include potassium monophosphate (eKsponge) and potassium bicarbonate (Kaligreen, Armicarb).[1]

Oils are also useful for controlling powdery mildew and managing fungicide resistance.[1]

Insect pests

Insect pests cause fruit loss, foliar damage, and vector diseases.

Grape berry moth (Endopiza viteana)

The grape berry moth is the primary insect pest of Indiana grapes. Infestations vary from vineyard to vineyard, within a vineyard, and from year to year.

Acres infested: 100%[1]

Occurrence: The grape berry moth overwinters in cocoons on the vineyard floor and in adjacent woodlots. The first generation emerges in June. The second generation appears in August. A third generation occurs in the South and occasionally in the North.

Bordelon

Japanese beetles and damaged leaves. The Japanese beetle prefers to feed on the smooth, thin leaves of French hybrid varieties.

Damage: The second generation causes the most damage by tunneling into and feeding on green fruit. A single larva can destroy two to six grapes in a cluster, and several larvae often feed on a cluster.

Threshold: Sprays should begin within three weeks of the appearance of adult male moths in pheromone traps, to target the egg hatch, or when scouting finds more than 5% larval damage to grape clusters.[2]

Crop loss: Insect damage usually causes less than 10% loss. But without control, damage will increase each year.[1]

Nonchemical control

- Destroying dead leaves in the fall or early spring kills overwintering pupae.
- Pheromone traps can be used in vineyards with a history of the pest. Egg laying occurs two to three weeks following the trapping of adult male moths. A protective spray at this time reduces or eliminates the need to spray later in the season.
- Pheromone rope ties can be used to disrupt male grape berry moths; to be effective, vineyards must be over five acres, and the majority in Indiana are not.

Japanese beetle *(Popillia japonica)*

Adult beetles feed on more than 250 plant species and grapes are a preferred host.

Acres infested: 100%[1]

Occurrence: Adults emerge from the ground and begin feeding in June and July. One generation hatches each season.

Damage: Adults feed on leaves only. Damaged leaves have a lacy appearance.

Threshold: No economic threshold exists. An accepted threshold for beginning spray applications is 15% of the leaves damaged.[2]

Crop loss: Without control, Japanese beetles can completely defoliate an entire vine. Premature leaf loss increases the vine's susceptibility to winter injury and reduces the vine's long-term productivity.

Phylloxera *(Daktulosphaira vitifoliae)*

Two forms of the aphid-like phylloxera exist. The root gall form feeds on the outside of roots, causing galls or swellings. The foliar form occurs on the leaves and creates galls at the feeding sites. The foliar form causes the greatest problem. Most American and French hybrid varieties are resistant to the root gall form. Susceptible varieties are grafted onto phylloxera-resistant rootstock.

Acres infested: 100%[1]

Occurrence: June

Damage: The vine will die if the roots are heavily infested. Leaves heavily infested with galls can result in defoliation and retarded shoot growth.

Threshold: None established. Preventive spray applications are made at bloom or when galls appear. Early season control is critical; late season treatments are not effective.

Crop loss: Leaves must be 70% infested with galls before yield loss

occurs. French-American and European varieties are very susceptible to phylloxera damage. Phylloxera cannot be completely eradicated after it infests a vineyard.

Grape flea beetle (Altica chalybea)

Although considered a minor pest, the grape flea beetle can pose a serious threat to developing buds on grapevines.

Acres infested: Variable, present statewide but not every year.[1]

Occurrence: Overwintered beetles emerge and feed on buds in April.

Damage: Adults chew holes in developing buds, killing the primary shoot, which reduces yield. Larvae and adults also feed on leaves but do not cause significant damage.

Threshold: 4% bud damage[2]

Crop loss: If uncontrolled, the grape flea beetle can cause major yield loss.[1]

Bordelon

The grape flea beetle is easily spotted on vines and buds on warm, sunny days. Scouting should be done around the edges of the vineyard first, where the grape flea beetle enters from nearby woodlots.

Nonchemical control

- Cultivating between rows destroys pupae. However, cultivation alone will not control beetles.
- Cleaning brush and woodlots near vineyards limits the overwintering sites for the grape flea beetle.

Chemical control

An air blast sprayer applies insecticides as cover sprays. Most are tank mixed and applied with fungicides on an as-needed basis.

PHI–Pre-harvest interval REI–Restricted-entry interval

Carbaryl (Sevin)
Target pests: grape flea beetle, grape berry moth, Japanese beetle[2]

Acres treated: 100%[1]

Frequency and rate[3]: 2–3 applications

Sevin 50WP	4 lb/acre
Sevin 80S	2.5 lb/acre
Sevin XLR Plus	2 qt/acre

PHI: 7 days[3]

REI: 12 hours[3]

Azinphosmethyl (Guthion)
Target pest: grape berry moth[2]

Acres treated: 80%[1]

Frequency and rate[1]: 2 applications

Guthion 35W	2.1–2.8 lb/acre
Guthion 50 WP	1.5–2.5 lb/acre

PHI: 21 days

REI: 48 hours

Comments: Restricted use chemical. Do not use azinphosmethyl more than three times a season.[3] Azinphosmethyl can be tank mixed with carbaryl or methoxychlor for better control.[1]

Phosmet (Imidan)
Target pests: grape berry moth, Japanese beetle[2]

Acres treated: 50%[1]

Frequency and rate: 1.3 –2.12 lb/acre as needed (higher rate used to control Japanese beetle)[3]

PHI: 14 days[3]

REI: 24 hours[3]

Endosulfan (Thiodan)
Target pest: phylloxera (foliar form)[2]

Acres treated: 50% as needed[1]

Frequency and rate[2]: 2 applications, at bloom and 2 weeks later

Thiodan 50WP	2 lb/acre
Thiodan 3EC	1.33 qt/acre

PHI: 7 days[3]

REI: 24 hours[3]

Comments: Endosulfan is the only insecticide labeled for control of the foliar form of phylloxera. Endosulfan can cause phytotoxicity in sensitive varieties.

Weed pests

Weeds must be controlled not only in producing vineyards but also prior to planting a vineyard. One to two years prior to planting grapes, perennial weeds such as dock, quackgrass, multiflora rose, poison ivy, Canada thistle, Johnson grass, and brambles must be reduced. Cultivation, herbicides, or a combination of the two can be used to decrease weed populations before planting the grapevines.

Weeds must be controlled during the first two years following transplanting of grapevines. Young grapevines do not compete well with grasses and other weeds. Weeds deprive young grapevines of water, nutrients, and sunlight.

Although weeds remain a problem, once grapevines are established a wide range of herbicides and nonchemical practices give flexibility in controlling weeds. Indiana growers have benefited from new equipment with shielded sprayers that allow application of contact herbicides. Preemergence herbicides rarely provide season-long weed control, especially in cool, wet springs.

Bordelon

A 3- to 4-foot area under the trellis is kept weed-free. Permanent sod is grown between rows.

Weed types

Annual grasses: many species
Broadleaf weeds: dandelions, ironweed
Perennial weeds: bindweed, morningglory, nutsedges (especially in wet areas)

Acres affected: 100%[3]

Occurrence: May–August[3]

Damage: In established vineyards weed control is an essential part of disease control. Heavy weed infestations keep foliage wet, encouraging development of fungal diseases. Vine-type weeds climb the trellis with grapevines, making weed control difficult. Weed vines increase the humidity within the canopy and shade leaves and fruit.

Crop loss: In new plantings, weeds can reduce vine growth 70–80%. Weeds must be controlled in new plantings, but most pre-

emergence herbicides are labeled for older vines. Heavy weed growth also increases incidence of disease.[3]

Nonchemical control

- Commonly used mulches to control weeds are plastic, wood chips, sawdust, and composted grape pomace.
- Cultivation is limited to lighter, sandy soils. Many soil types in Indiana are too heavy and wet for cultivation when it is needed.
- Hand-hoeing can be done in smaller vineyards to control weeds.

Chemical control

Acres treated: All vineyards use herbicides, but only a 3–4 ft band under the row is treated.[3]

PHI–Pre-harvest interval REI–Restricted-entry interval

Nonbearing vines

Nonbearing vines are typically less than 3 years old and not yet producing at their full potential.

Post emergence control

Glyphosate (Roundup)
Target weeds: most grasses and broadleaves[3]

Application: 1–5 qt/acre in 10–40 gal water/acre
Applied as pre-emergence broadcast application, directed spray, or wiper application to growing weeds.[2]

PHI: 14 days[2]

REI: 12 hours[2]

Comments: Avoid contact with vines or severe damage will occur.[2]

Paraquat (Gramoxone Extra)
Target weeds: most grasses and broadleaves[3]

Application: 2–3 pt/acre in 30–100 gal water/acre
Requires wetting agent. Sprayed directly on emerged weeds.[2]

REI: 12 hours[3]

Comments: Restricted-use pesticide. Avoid contact with young shoots, foliage, and fruit.[3]

Glufosinate (Rely)
Target weeds: barnyard grass, foxtail, jimsonweed, sheperdspurse, smartweed[3]

Application: 1 lb formula at 3–6 qt in a minimum of 20 gal of water/acre sprayed directly on emerged weeds[3]

REI: 12 hours[3]

Comments: Maximum application of 18 qt/acre/year.[3]

Sulfosate (Touchdown)
Target weeds: grasses and broadleaves–jimsonweed, mustard, annual morningglory, ragweed, smartweed, velvetleaf[3]

Application: 5.33 pt (maximum) in 10–30 gal water/acre/year
Requires a surfactant or wetting agent. Applied as spot treatment or as a wiper application.[3]

REI: 12 hours[3]

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Shield on this sprayer prevents herbicide from contacting young grapevines.

Comments: Do not use within 12 months of first harvest.[2]

Fluazifop (Fusilade)
Target weeds: grasses[3]

Application: 1–1.5 qt/acre plus crop oil concentrate at 1 qt or spreader at 1 pt in 25 gal water/acre
Applied to actively growing grass.[3]

REI: 12 hours[3]

Comments: Do not apply within 12 months of first harvest. Crop oils can severely burn young vines.[3]

Clethodim (Prism)
Target weeds: grasses[3]

Application: 13–34 fl oz/acre plus crop oil
May be used as spot treatment.[3]

REI: 12 hours[3]

Comments: Do not use within 12 months of first harvest.[2] Do not apply more than 68 fl oz /acre/year. Crop oils can severely burn young vines.[3]

Sethoxydim (Poast)
Target weeds: grasses[3]

Application: 1.5–2.5 pt plus 2 pt crop oil in 10–20 gal water/acre
Applied as directed spray when grass is actively growing.[3]

REI: 12 hours[3]

Comments: Maximum application of 2.5 pt/application or 5 pt/season.

Preemergence control

Isoxaben (Gallery)
Target weeds: broadleaves–dandelion, lambsquarter, mustard, nightshade, ragweed, smartweed, velvetleaf[3]

Application: 0.6–1.33 lb/acre in 10 gal of water applied late summer/early fall or spring prior to weed germination[3]

REI: 12 hours[3]

Comments: Do not apply within 12 months of first harvest.[3]

Isoxaben and trifluralin (Snapshot 2.5 TG)
Isoxaben and oryzalin (Snapshot 80 DF) *most used formula*[1]
Target weeds: broadspectrum of grass and broadleaf control[3]

Application: 2.5–5 lb/acre[3]

REI: 12 hours[3]

Comments: Do not use within 12 months of first harvest.[2] Cost of $150 per acre limits use.[1]

Oryzalin (Surflan)
Target weeds: grasses and broadleaves–lambsquarter, mustards, pigweed, purslane[3]

Application: 2–6 qt/acre in 20–40 gal water/acre band-sprayed[3]

REI: 12 hours[3]

Napropamide (Devrinol)
Target weeds: grasses and broadleaves–mustards, purslane, pigweed[3]

Application: 8 lb in 20 gal water/acre[3]

REI: 12 hours[3]

Comments: Do not allow spray to contact fruit or leaves.[3]

Trifluralin (Treflan)
Target weeds: grasses and broadleaves–lambsquarter, pigweed, purslane[3]

Application: 0.5–2.0 active ingredient/acre incorporated
Check label for rate, depending on soil texture, annual rainfall, and whether plantings are new or established.[3]

REI: 12 hours[3]

Pendimethalin (Prowl)
Target weeds: grasses and broadleaves–lambsquarter, pigweed, purslane[3]

Application: 2–4 qt in 20 gal water[3]

REI: 12 hours[3]

Comments: Apply only to dormant, nonbearing vines.[3]

Dichlobenil (Casoron or Norosac)
Target weeds: grasses and broadleaves–jimsonweed, chickweed, lambsquarter, pigweed, ragweed, smartweed, velvetleaf[3]

Application: 100–150 lb/acre soil surface applied Nov.–Feb. or incorporated in late fall to early spring[3]

REI: 12 hours[3]

Comments: Can be applied 4 weeks after transplanting.[3]

Bearing vines

A typical herbicide schedule for bearing vines is burndown in the early spring; preemergence herbicide, or pre and post emergence tank mix one month later before weed germination; then a post emergence herbicide matched to weed breakthroughs.[1]

Preemergence control

Growers commonly use an oryzalin and simazine mix one year, alternated with either norflurazon or diuron the following year to control changes in perennial weed populations.[1]

The following preemergence herbicides are restricted to use on older vines.

Simazine (Princep)
Target weeds: grasses and broadleaves–jimsonweed, annual morninggglory, mustards, ragweed, smartweed, velvetleaf[3]

Application: Sandy, light soils: 2.5 lb/acre; dark, heavy soils: 6 lb/acre in a minimum of 20 gal of water
Band-sprayed under trellis before weed germination. Often tank mixed with oryzalin.[3]

REI: 12 hours[3]

Comments: Vines must be established 3 years.[3]

Norflurazon (Solicam)
Target weeds: grasses and many broadleaves–dandelion, fall panicum, jimsonweed, mustards, ragweed, velvetleaf[3]

Application: Sandy, light soils: 2.5 lb/acre; dark, heavy soils: 5 lb/acre in at least 20 gal of water
Band-sprayed below trellis before weed germination.[3]

REI: 12 hours[3]

Comments: Do not apply after bud break on sandy soils. Vines must be established 24 months.[3]

Diuron (Karmex)
Target weeds: broad spectrum grass and broadleaf control[3]

Application: Sandy, light soils: 2 lb/acre; dark, heavy soils: 4 lb/acre in 25–40 gal water
Rotated with norflurazon as weed populations change. Band-sprayed under trellis before weed germination.[3]

REI: 12 hours[3]

Comments: Vines must be established 3 years.[3]

Postemergence control

Glyphosate (Roundup)
Target weeds: most grasses and broadleaves[3]

Application: 1–5 qt/acre in 10–40 gal water/acre applied as a pre-emergence broadcast application, directed spray or wiper application to growing weeds[3]

PHI: 14 days[3]

REI: 12 hours[3]

Comments: Avoid contact with any part of the grapevine except mature bark.[3]

Paraquat (Gramoxone Extra)
Target weeds: most grasses and broadleaves[3]

Application: 2–3 pt/acre in 30–100 gal water/acre; wetting agent required
Sprayed directly on emerged weeds. Applications repeated as needed.[3]

REI: 12 hours[3]

Comments: Restricted-use pesticide. Avoid contact with young shoots, foliage, fruit.[3]

Glufosinate (Rely)
Target weeds: barnyard grass, foxtail, jimson weed, sheperdspurse, smartweed[3]

Application: 3–6 qt/acre in a minimum of 20 gal water/acre sprayed directly on emerged weeds. Applications repeated as needed.[3]

REI: 12 hours[3]

Comments: Maximum application of 18 qt/acre in 12 months.[3]

Herbicide Drift

Damage: Drift damage from 2,4-D and other phenoxy herbicides are frequently confused with disease or insect injury. Symptoms are stunted, misshapen leaves with thick veins. Some varieties are more susceptible.

Critical timing: Early May at bud break to pre bloom. Grapes are most susceptible when shoots and leaves are rapidly growing in mid May.[1]

Crop loss: Depending on timing, drift can cause up to 90% yield loss. Exposure at bloom, or just prior to bloom, can cause abortion of the cluster. Repeated exposure (even small amounts) will decrease long-term yield potential.[1]

RESOURCES

Newsletters and websites

Facts for Fancy Fruit newsletter. Department of Horticulture and Landscape Architecture. Purdue University.
http://www.hort.purdue.edu/fff/

State of Indiana Pesticide Impact Assessment Program website.
http://www.btny.purdue.edu/PPP/SIPIAP/

Commercial Vegetable and Specialty Crops Home Page. Purdue University.
http://www.hort.purdue.edu/hort/ext/veg/

Down the Garden Path newsletter. Plant and Pest Diagnostic Lab. Purdue University.
http://www.ppdl.purdue.edu/ppdl/Newsletters.html

Vintage Indiana newsletter. Indiana Wine Grape Council.
http://info.aes.purdue.edu/AgResearch/IN_winewww.html

Research papers

Bordelon, B.P. and S.C. Weller. 1997. Preplant cover crops affect weed and vine growth in first-year vineyards. HortScience. 32:1040-1043.

Bordelon, B.P., D.C. Ferree, and T.J. Zabadal. 1997. Grape bud survival in the Midwest following the winter of 1993–1994. Fruit Varieties Journal 51:53-59.

Salzman, R., R.A. Bressan, P.M. Hasegawa, E.N. Ashworth, and B.P. Bordelon. 1996. Programmed accumulation of LEA-like proteins during desiccation and cold acclimation of overwintering grape buds. Plant, Cell & Environment 19:713-720.

Extension publications

Bordelon, B.P., 1995. Grape Varieties for Indiana. Purdue University Cooperative Extension Service. HO-221.

Bordelon, B.P., 1995. Growing Grapes in Indiana. Purdue University Cooperative Extension Service. HO-45.

References

1. Bruce Bordelon, 1999, personal communication.
2. Funt, R.C., M.A. Ellis, C. Welty. 1997. Midwest Small Fruit Pest Management Handbook. The Ohio State University. Bulletin 861.
3. Bordelon, B.P., S.C. Weller, R.E. Foster, and P.C. Pecknold. 1999. Indiana Commercial Small Fruit and Grape Spray Guide.Purdue University Cooperative Extension Service. ID-169

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