UC IPM
Pest Management Guidelines:
GRAPE

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An illustrated version of this guideline is available online at http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html

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UC PEER REVIEWED

This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Agricultural Pest Management.

Updates: These guidelines are updated regularly. Check with your University of California Cooperative Extension Office or the UC IPM World Wide Web site for information on updates.

Note to readers: These guidelines represent the best information currently available to the authors and are intended to help you in making the best choices for an IPM program. Not all formulations or registered materials are mentioned. Always check the label and with local authorities for the most up-to-date information regarding registration and restrictions on pesticide use. Check with your agricultural commissioner for latest restricted entry intervals.

To be used with UC ANR Publication 3343,
Grape Pest Management, 2nd edition

www.ipm.ucdavis.edu

Table Grape Year-Round IPM Program Annual Checklist

Supplement to UC IPM Pest Management Guidelines: Grape

These practices are recommended for a monitoring-based IPM program that reduces environmental quality problems related to pesticide use. Track your progress through the year using this form.

Each time a pesticide application is considered, review the Pesticide Application Checklist at the bottom of this form for information on how to minimize environmental quality problems. This program covers the major pests of table grape. Details on carrying out each practice, information on additional pests, and additional copies of this form are available from the UC IPM Pest Management Guidelines: Grape at http://www.ipm.ucdavis.edu/PMG.

This year-round program applies only to table grapes. For wine and raisin grapes, see the Wine and Raisin Grape Year-Round Program.

✓ Done	**Delayed-dormant period activities** **(San Joaquin Valley, February; Coachella Valley, December to January)** What should you be doing at this time?
	On a warm day (above 65°F), monitor trunks, cordons, and spurs for: • Mealybugs • Ants associated with mealybugs and European fruit lecanium scale • Overwintering spider mites (orange) • Cutworms Keep records (example form available online). Manage** if needed according to the PMG.
	Just before budbreak, in the San Joaquin Valley, place omnivorous leafroller pheromone traps in the vineyard. • Check traps twice weekly until a biofix date is established; thereafter, check traps weekly. • Record biofix for the first moth. • Keep records (example form available online).
	Just before budbreak, place sticky traps in and around the vineyard for glassy-winged sharpshooter. • Change traps weekly. Keep records (example form available online).
	Other pests or pest damage you may see. • Rodents • Branch and twig borer • Click beetles • Bud beetles • Eutypa dieback • Bot canker

✓ Done	**Budbreak period activities** **(San Joaquin Valley, March; Coachella Valley, January to February)** What should you be doing at this time?
	On a warm day (above 65° F), monitor trunks, cordons, and spurs for: • Mealybugs • Ants associated with mealybugs and European fruit lecanium scale • Overwintering spider mites (orange) • Cutworms Keep records (example form available online). Manage** if needed according to the PMG.
	In San Joaquin Valley continue to check pheromone traps twice weekly for omnivorous leafroller, if biofix has not been reached. • Record biofix for the first moth (example monitoring form). • Check traps weekly after biofix date is established.
	Monitor for powdery mildew using the risk assessment index followed by visual inspections. • Treat** if needed according to PMG.
	If rainfall is predicted after budbreak, consider treating** for phomopsis cane and leaf spot in sensitive varieties (Thompson seedless, redglobe).
	Note locations of vines showing poor budbreak for future assessment of abiotic disorders or diseases.
	Check sticky traps for glassy-winged sharpshooters. • Keep records (example form available online).
	Survey weeds to plan a weed management strategy if not completed earlier in the season. If herbicides** are to be used: • Record observations (example form available online). • Make your selection based on weed survey observations.
	Other pests you may see: • Grape bud beetle • Red-headed and green sharpshooter

✓ Done	**Rapid shoot growth period activities** **(San Joaquin Valley, March to May; Coachella Valley, February to May)** What should you be doing at this time?
	Look for spider mites and their natural enemies on emerging leaves weekly. • Map areas of concern for bloom monitoring.
	Monitor leafhoppers weekly, starting a month after budbreak or when first nymphs appear. When samples reach 10 leafhoppers per leaf: • Keep records (example form available online). • Treat** if needed according to PMG.
	Manage mealybugs (*Pseudoccocus*, vine): • Place vine mealybug pheromone traps in the vineyard: o Southern San Joaquin Valley, April 1 o Coachella Valley, March 1 • Check traps every 2 weeks. • Sanitize equipment before moving to uninfested areas in the vineyard. If grape or vine mealybug females are found on the vine, treat** according to PMGs.
	Monitor caterpillars if they have been a problem in the past: • Western grapeleaf skeletonizer • Grape leaffolder • Omnivorous leafroller Map areas of concern for bloom monitoring.
	Continue checking pheromone traps for omnivorous leafrollers.
	If European fruit lecanium scale has been a problem in the past, monitor female development on old wood.
	Manage ants if mealybugs and scale are a problem.
	Check sticky traps for glassy-winged sharpshooters. • Keep records (example form available online).
	Watch for shoot flagging (wilting) to determine if caused by: • Powdery mildew • Botrytis shoot blight • Branch and twig borer
	Monitor visually for powdery mildew spores and by using mildew risk index. • Treat** if needed according to PMG.
	Survey weeds to plan a weed management strategy. If herbicides** are to be used: • Make your selection based on weed survey observations. • Record your observations (example form available online).
	Look for these disease symptoms: • Bot canker • Eutypa dieback • Measles • Pierce's disease • Phomopsis cane and leafspot If infected plants are found, consult the PMG.
	Other pests you may see: • Thrips • Red-headed and green sharpshooters

✓ Done	**Bloom to veraison period activities** **(San Joaquin Valley, early May to July; Coachella Valley, April)** What should you be doing at this time?
	Monitor for western flower thrips, particularly in vineyards near drying grains. • Manage according to PMG.
	Monitor leafhopper, spider mites, and mealybugs weekly. • Keep records (example form available online). • Manage if needed according to PMGs.
	Examine leaves and shoots for Botrytis bunch rot and powdery mildew. • Manage if needed according to PMG.
	If European fruit lecanium scale has been a problem in the past, monitor for egg hatch to time treatment**.
	Continue to check omnivorous leafroller pheromone traps weekly. • Keep records (example form available online).
	Continue monitoring pheromone traps for vine mealybug. • If males are caught or honeydew, sooty mold, or ants are found, look for females on surrounding vines. • Keep records (example form available online). If grape or vine mealybug females are found on the vine, manage according to PMG.
	Remove basal leaves and lateral shoots in the fruit zone beginning around berry set to minimize summer rot, Botrytis bunch rot, and leafhopper populations, and to maximize application** coverage. • Time leaf pull before first-generation grape leafhoppers become adults. • Remove only the leaves on the shaded side of the canopy on non-divided trellis systems to prevent heat damage and sunburn of sensitive varieties (Thompson seedless, redglobe). Treat** for Botrytis before rain according to PMG.
	Monitor caterpillars if they have been a problem in the past: • Omnivorous leafroller • Grape leaffolder • Western grapeleaf skeletonizer Keep records (example form available online).
	Monitor sticky traps for glassy-winged sharpshooters: • Keep records (example form available online).
	Other pests or pest damage you may see: • Grasshopper • Black widow spiders • Whitefly • Red-headed and green sharpshooters • Grape thrips • False chinch bug

✓ Done	**Veraison period activities** **(San Joaquin Valley, June to July; Coachella Valley, May)** What should you be doing at this time?
	Monitor leafhoppers, spider mites, and mealybugs weekly. • Keep records (example form available online). Manage if needed according to PMGs.
	Continue checking pheromone traps weekly for omnivorous leafroller. • Keep records (example form available online).
	Inspect vines for grape mealybug and vine mealybug. • Educate field crew to identify and mark vine infestations for treatment**. • Manage if needed according to PMG.
	Monitor sticky traps for glassy-winged sharpshooter. • Keep records (example form available online).
	Mark locations of vines with poor growth for future confirmation and management of abiotic disorders or pests: • Bot canker • Pierce's disease • Eutypa dieback • Phylloxera • Measles • Nematodes
	Monitor for Botrytis bunch rot, powdery mildew, and summer bunch rot. • Hedge canopy to increase air movement and reduce humidity in the fruit zone. • Manage if needed according to PMG.
	Monitor caterpillars if they have been a problem in the past: • Omnivorous leafroller • Grape leaffolder • Western grapeleaf skeletonizer Keep records (example form available online).
	If necessary manage birds with netting or scare devices as fruit ripens.
	Remove weeds that have escaped treatment before they set seed.
	Consider the use of plastic vine covers for late harvest varieties, which are susceptible to Botrytis bunch rot after heavy rain.
	Other pests or pest damage you may see: • Whitefly • Red-headed and green sharpshooters • European fruit lecanium • Vinegar flies • Grasshoppers

✓ Done	**Harvest period activities** **(San Joaquin Valley, late June to early November; Coachella Valley, mid-May to early July)** What should you be doing at this time?
	Check fruit at harvest to assess the effectiveness of the current year's IPM program and to determine the needs of next year's program. • Note blocks in the vineyard that had problems.
	Check sticky traps for glassy-winged sharpshooter. • Keep records (example form available online).
	If necessary, continue managing birds with netting or scare devices.

✓ Done	**Postharvest period activities** What should you be doing at this time?
	Continue monitoring for vine mealybug on fruit and foliage. • Treat** if needed according to PMG. If vine mealybug is present, steam-sanitize equipment before moving to uninfested areas.
	In the San Joaquin Valley look for European fruit lecanium scales on leaves. • Treat** if needed just before leaf drop, according to PMG.
	Continue to mark and remove vines or cordons infested with diseases such as: • Eutypa dieback • Pierce's disease • Bot canker
	Continue to monitor for western grapeleaf skeletonizer on early harvested varieties.
	In the Coachella Valley, sample for nematodes in October if not already done in spring.
	Check sticky traps for glassy-winged sharpshooters.
	Other pests you may see: • Grape thrips • Red-headed and green sharpshooters

✓ Done	**Dormant period activities** What should you be doing at this time?
	In the San Joaquin Valley, sample for nematodes from November to February.
	Carry out dormant-season sanitation activities: • Prune late in dormancy after rains to reduce wound infections. • Destroy prunings of older infested wood to reduce pest sources. • Remove dried grape clusters on vines and disc weeds and clusters where orange tortrix or omnivorous leafroller is a problem. • In vineyards with a history of branch and twig borers, examine old pruning scars and dead parts of vines for brown frass and wood dust. • If you have vine mealybug, steam sanitize equipment before moving to uninfested area of the vineyard.
	Survey weeds to plan a weed management strategy. • Record your observations (example form available online). • Use records to make herbicide selections in vineyards where sprays** are planned.

✓ Done	**Pesticide application checklist
	When planning for possible pesticide applications in an IPM program, review and complete this checklist to consider practices that minimize environmental and efficacy problems. ✓ Choose a pesticide from the UC IPM Pest Management Guidelines for the target pest considering: ▪ Impact on natural enemies. ▪ Potential for water quality problems using the UC IPM WaterTox database. (For more information, see http://www.ipm.ucdavis.edu/TOX/simplewatertox.html.) ▪ Impact on aquatic invertebrates. (For more information, see *Pesticide Choice,* UC ANR Publication 8161, http://anrcatalog.ucdavis.edu/pdf/8161.pdf.) ▪ Chemical mode of action if pesticide resistance is an issue. ✓ Select an alternative chemical or nonchemical treatment when risk is high. ▪ Choose sprayers and application procedures that keep pesticides on target. ▪ Identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding your application site. ▪ Review and follow label for pesticide handling, storage, and disposal guidelines. ▪ Check and follow restricted entry intervals (REI) and preharvest intervals (PHI). ▪ After an application is made, record application date, product used, rate, and location of application. Follow up to confirm that treatment was effective. ✓ Consider water management practices that reduce pesticide movement off-site. (For more information, see UC ANR Publication 8214, *Reducing Runoff from Irrigated Lands: Causes and Management of Runoff from Surface Irrigation in Orchards,* http://anrcatalog.ucdavis.edu/pdf/8214.pdf.) ▪ Install an irrigation recirculation or storage and reuse system. ▪ Use drip rather than sprinkler or flood irrigation. ▪ Limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET). ▪ Consider vegetative filter strips or ditches. (For more information, see *Vegetative Filter Strips*, UC ANR Publication 8195, http://anrcatalog.ucdavis.edu/pdf/8195.pdf.) ▪ Redesign inlets into tailwater ditches to reduce erosion. ✓ Consider management practices that reduce air quality problems. ▪ When possible, choose pesticides that are not in emulsifiable concentrate (EC) form which release volatile organic compounds (VOCs). VOCs react with sunlight to form ozone, a major air pollutant.

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Wine/Raisin Grape Year-Round IPM Program Annual Checklist

Supplement to UC IPM Pest Management Guidelines: Grape

These practices are recommended for a monitoring-based IPM program that reduces water quality problems related to pesticide use. Track your progress through the year using this form.

Each time a pesticide application is considered, review the Pesticide Application Checklist at the bottom of this form for information on how to minimize water quality problems. This program covers the major pests of grape. Details on carrying out each practice, information on additional pests, and additional copies of this form are available from the UC IPM Pest Management Guidelines: Grape at http://www.ipm.ucdavis.edu/PMG.

This year-round program applies only to wine and raisin grapes. For table grapes, see the Table Grape Year-Round IPM Program.

✓ Done	**Delayed-dormant period activities** What should you be doing at this time?
	On a warm day, monitor vines and spurs for: • Mealybugs • Ants associated with mealybugs and European fruit lecanium scale • Orange overwintering spider mites • Cutworm Keep records on a monitoring form. Treat** if needed according to the PMG.
	In coastal areas, check orange tortrix pheromone traps that were put up during the dormant period. • Keep records on a monitoring form.
	Just before budbreak, put up omnivorous leafroller pheromone traps. • Check traps twice weekly until a biofix date is established; thereafter, check traps weekly. • Keep records on a monitoring form.
	If sharpshooters are a problem in your area, set out sticky traps just before budbreak for: • Glassy-winged sharpshooter In coastal regions near riparian and landscape areas: • Blue-green sharpshooter Change traps weekly. Keep records on a monitoring form.
	Keep records of other pests or pest damage you may see. • Rodents • Branch and twig borer • Click beetles • Bud beetles • *Eutypa*

✓ Done	**Budbreak period activities** What should you be doing at this time?
	On a warm day, monitor vines and spurs for: • Mealybugs • Ants associated with mealybugs and European fruit lecanium scale • Orange overwintering spider mites • Cutworm • Thrips Keep records on a monitoring form. Treat** if needed according to the PMG.
	Check pheromone traps for: • Omnivorous leafroller • Orange tortrix in coastal areas Keep records on a monitoring form.
	Monitor leaf wetness. Track powdery mildew ascospore release and mildew risk index. • Treat** if needed according to the PMG.
	Consider treating** for phomopsis cane and leaf spot if rain continues after budbreak.
	Remove vines that have spring symptoms of Pierce's disease.
	Check sticky traps for sharpshooters: • Glassy-winged sharpshooter In coastal regions near riparian and landscape areas: • Blue-green sharpshooter Change traps weekly. Keep records on a monitoring form.

✓ Done	**Rapid shoot growth period activities** What should you be doing at this time?
	Look for thrips if cold weather persists.
	Look for spider mites and their natural enemies weekly on first-emerging leaves. • Map areas of concern for bloom monitoring.
	Monitor leafhoppers weekly starting a month after budbreak or whenever first nymphs appear. • Keep records on a monitoring form.
	Continue checking pheromone traps for: • Omnivorous leafroller • Orange tortrix in coastal areas Keep records on a monitoring form.
	In southern San Joaquin Valley, put up vine mealybug pheromone traps around April 1 and check every two weeks. • If males are caught or honeydew, sooty mold, or ants are found, look for female infestations on surrounding vines. • Keep records on a monitoring form. • Treat** if needed according to PMG.
	Monitor caterpillars if they have been a problem in the past: • Western grapeleaf skeletonizer • Grape leaffolder • Orange tortrix in coastal vineyards • Omnivorous leafroller Map areas of concern for bloom monitoring.
	If European fruit lecanium scale has been a problem in the past, monitor female development on old wood.
	Manage ants if mealybugs and scale are a problem.
	Monitor sharpshooters: • Glassy-winged sharpshooter In coastal regions near riparian and landscape areas check for: • Blue-green sharpshooter Change sticky traps weekly. Keep records on a monitoring form.
	Monitor for flagging. If you see a flag, distinguish between Botrytis shoot blight and branch and twig borer.
	Monitor leaf wetness. Track powdery mildew ascospore release and mildew risk index. • Treat** if needed according to PMG.
	Survey weeds to plan a weed management strategy. • If herbicides** are used, use the late-spring weed survey form to record your observations and make pre- and postemergent herbicide selection decisions.
	Keep records of other pests or pest damage you may see: • Eutypa dieback • Phomopsis

✓ Done	**Bloom to veraison period activities** What should you be doing at this time?
	Monitor leafhopper and spider mites weekly. • Keep records on a monitoring form. • Treat** if needed according to PMGs.
	Monitor for Botrytis and powdery mildew by inspecting leaves and shoots.
	If European fruit lecanium scale has been a problem in the past, monitor for egg hatch to time treatment**.
	Check pheromone traps for: • Omnivorous leafroller • Orange tortrix (in coastal areas) Keep records on a monitoring form.
	In areas other than southern San Joaquin Valley, put up vine mealybug pheromone traps. In all areas, check traps every two weeks. • If males are caught or honeydew, sooty mold, or ants are found, look for female infestations on surrounding vines. • Keep records on a monitoring form. • Treat** if needed according to PMG.
	Monitor Pseudococcus mealybugs by looking for honeydew, sooty mold, and ant activity. • Keep records on a monitoring form. • If you see crawlers, treat** if needed according to PMG.
	To reduce possible summer rot, Botrytis, and leafhoppers, remove basal leaves or basal lateral shoots beginning around berry set. • Time leaf pull before first-generation grape leafhoppers become adults. Treat** for Botrytis prior to rain, if leaves are not removed.
	Monitor caterpillars if they have been a problem in the past: • Omnivorous leafroller • Orange tortrix • Grape leaffolder • Western grapeleaf skeletonizer Keep records on a monitoring form.
	Monitor sharpshooters: • Glassy-winged sharpshooter In coastal regions near riparian and landscape areas check for: • Blue-green sharpshooter Change sticky traps weekly. Keep records on a monitoring form.
	Keep a record of other pests or pest damage you may see; • Grasshopper • Whitefly

✓ Done	**Veraison period activities** What should you be doing at this time?
	Monitor leafhoppers and spider mites weekly. • Keep records on a monitoring form. Treat** if needed according to PMGs.
	Check pheromone traps for: • Omnivorous leafroller • Orange tortrix in coastal areas Keep records on a monitoring form.
	Check vine mealybug pheromone traps. • If males are found, or if honeydew, sooty mold, or ant activity is found, look for female infestations on surrounding vines. • Educate field crew to flag cluster infestations for treatment. Treat** if needed according to PMG.
	Monitor grape and obscure mealybugs. • Keep records on a monitoring form. • If you see crawlers, treat** if needed according to PMG.
	Monitor sharpshooters: • Glassy-winged sharpshooter Check traps weekly. Keep records on a monitoring form.
	Look for vine symptoms of Pierce's disease.
	If rain occurs shortly after veraison, monitor for *Botrytis*.
	Monitor caterpillars if they have been a problem in the past: • Omnivorous leafroller • Orange tortrix • Grape leaffolder • Western grapeleaf skeletonizer Keep records on a monitoring form.
	Look on roots of weakened vines for galls or phylloxera.
	If necessary manage birds with netting or scare devices as fruit ripens.
	Keep a record of other pests or pest damage you may see. • Whitefly • European fruit lecanium • Grasshoppers

✓ Done	**Harvest period activities** What should you be doing at this time?
	Be aware that high populations of adult leafhoppers may interfere with hand harvesting.
	Monitor for grape, obscure, and vine mealybugs. • Look for cluster infestations and mark on map. • Educate harvest crew to flag cluster infestations of vine mealybug for treatment. • Treat** vine mealybug if needed according to PMG.
	If you have vine mealybug, steam sanitize equipment before moving to an uninfested area of the vineyard.
	For Pierce's disease: • Flag vines with symptoms for removal.
	If necessary, continue managing birds with netting or scare devices.
	Treat** for *Botrytis* prior to any anticipated rain.
	Sample soil and roots for nematodes; look at roots for galls and phylloxera.
	Monitor glassy-winged sharpshooter: • Check traps weekly and keep records on a monitoring form.

✓ Done	**Postharvest period activities** What should you be doing at this time?
	If necessary, treat** for vine mealybug immediately after harvest according to the PMG.
	To reduce risk of transferring vine mealybug, do not place winery pomace in the vineyard; compost pomace or cover piles securely with clear plastic.
	Look for symptoms of Pierce's disease on vines and flag for removal.
	Look for European fruit lecanium on leaves.
	If you desire a cover crop, seed after harvest.

✓ Done	**Dormant period activities** What should you be doing at this time?
	Apply lime sulfur** for powdery mildew in areas other than Madera, Fresno, and Tulare counties.
	In coastal areas, set out orange tortrix pheromone traps by December. • Check traps twice weekly until a biofix date is established; thereafter, check traps weekly. • Keep records on a monitoring form.
	If present, treat** for Phomopsis cane and leaf spot before rainfall.
	Sample for nematodes in January or February.
	Carry out dormant-season sanitation activities: • Prune late in dormancy after rains to reduce wound infections. • Destroy prunings of older infested wood to reduce pest sources. • Remove dried grape clusters on vines and disc weeds and clusters where orange tortrix or omnivorous leafroller is a problem. • In vineyards with a history of branch and twig borers, examine old pruning scars and dead parts of vines for brown frass and wood dust. • If you have vine mealybug, steam sanitize equipment before moving to uninfested area of the vineyard.
	Survey weeds to plan a weed management strategy. • If herbicides** are used, use the late-winter survey form to record your observations and make pre- and postemergent herbicide selection decisions.

✓ Done	****Pesticide application checklist**
	Before a pesticide application is made and when planning for possible applications in an IPM program, review and complete this checklist to minimize water quality and other problems. • Follow each practice in the year-round IPM program. • Identify target pest, treatment threshold, trigger, or justification for treatment. • Consider nonchemical alternatives. • Identify important natural enemies that might be impacted by pesticide application. • Choose a pesticide from the UC IPM Pest Management Guidelines for the target pest, considering impact on natural enemies and consulting UC IPM Watertox Database for water quality concerns. Select an alternative chemical or nonchemical treatment when risk is high. • Consider chemical class if pesticide resistance is an issue. • Identify sensitive areas (for example, waterways or riparian areas) surrounding your application site. • Identify practices or mitigation measures to be used to reduce pesticide movement off-site. • Choose sprayers and application methods that minimize off-site movement. • Review and follow pesticide handling, storage, and disposal guidelines. • After an application is made, record application date, product used, rate, and location of application. Follow up to confirm that treatment was effective.

General Information

DELAYED-DORMANT AND BUDBREAK MONITORING (Wine/Raisin Grapes) (10/08)

Monitor vines and spurs once during the delayed dormant season and once at bud break to check for cutworms, mealybugs, ants, thrips, and mites. Spurs are one-year-old canes that were pruned back to 1 to 2 buds at pruning.

Use monitoring form with detailed treatment threshold information *(example form available online).*

HOW TO SAMPLE

1. On a warm day (65°F or above), monitor 20 vines by looking at 5 randomly selected vines per quadrant of the vineyard. For the best estimate of pest distribution, monitor fewer vines in more locations. Be sure to include those areas, however, where you have noticed pests in the past.
2. Monitor vines following the guidelines below. For spur monitoring choose a spur on the basal portion of a cordon closest to the crown.
3. Record your observations on a monitoring form.

PROCEDURE AND TREATMENT THRESHOLDS

Pests	Monitoring procedures	Treatment threshold
cutworms	Examine 5 buds for damage (hollowed buds). If damage is present, look for cutworms under bark, on cordons, trunk, and at soil level.	Don't treat if less than 4% of the buds per location are damaged.
pseudococcus mealybugs *(grape, obscure, longtailed)*	Look for crawlers under loose bark at the spur tip. Along *Central Coast*, also look for more mature obscure and longtailed mealybugs at base of spur, under bark.	Treat if 1 out of 5 spurs is infested.
vine mealybugs	Look for nymphs and females under bark at graft union, in old pruning wounds in the trunk, and below the base of the spur (old remnant egg sacs may be found). In sandy soils, look at soil level and at roots.	Treat during the delayed dormant period and again at bloom if vine mealybug is present. If treatment is needed, remove bark before spraying trunk and cordons.
ants	Look for ants. If found, look more closely for mealybugs or European fruit lecanium.	Identify areas of concern for spring monitoring.
mites	Look under loose bark on spur tip for orange overwintering form of Pacific or Willamette spider mite.	Identify areas of concern for bloom monitoring.
thrips	Open shoots or gently tap buds over white paper to check for thrips.	Treatment may be necessary if damage increases and temperatures remain cool.

DELAYED-DORMANT AND BUDBREAK MONITORING (Table Grapes) (10/08)

Monitor vines and spurs once during the delayed dormant season and once at budbreak to check for cutworms, mealybugs, ants, and mites. Spurs are one-year-old canes that were pruned back to 1 to 2 buds at pruning.

Use monitoring form with detailed treatment threshold information *(example form available online)*.

HOW TO SAMPLE

1. On a warm day (65°F or above), monitor 20 vines by looking at 5 randomly selected vines per quadrant of the vineyard. For the best estimate of pest distribution, monitor fewer vines in more locations. Be sure to include those areas, however, where you have noticed pests in the past.
2. Monitor vines following the guidelines below. For spur monitoring choose a spur on the basal portion of a cordon closest to the crown.
3. Record your observations on a monitoring form.

PROCEDURE AND TREATMENT THRESHOLDS

Pests	Monitoring procedures	Treatment threshold
cutworms	Examine 5 buds for damage (hollowed buds). If damage is present, look for cutworms under bark, on cordons, trunk, and at soil level.	Don't treat if less than 4% of the buds per location are damaged.
pseudococcus mealybugs *(grape, obscure, longtailed)*	Look for the presence of crawlers under the thin bark on spurs.	Treat if there is an average of 1 spur or cane with crawlers for every 10 sampled.
vine mealybugs	Look for nymphs and females under bark at graft union, in old pruning wounds in the trunk, and below the base of the spur (old remnant egg sacs may be found). In sandy soils, look at soil level and at roots.	Treat during the delayed dormant period and again at bloom if vine mealybug is present. If treatment is needed, remove bark before spraying trunk and cordons.
ants	Look for ants. If found, look more closely for mealybugs or European fruit lecanium.	Identify areas of concern for spring monitoring.
spider mites	Look under loose bark on spur tip for orange overwintering form of Pacific or Willamette spider mite.	Identify areas of concern for bloom monitoring.

PHEROMONE TRAPS (10/08)

Set out pheromone traps in vineyards to monitor the flights of omnivorous leafroller or orange tortrix (coastal areas).

GENERAL GUIDELINES FOR USING PHEROMONE TRAPS

- Place traps in each vineyard for which you need to make pest management decisions, using at least 2 traps per block.
- Distribute traps uniformly through the vineyard. Use the same trap locations each year. Place additional traps in hot spots.
- Hang traps in the shade inside the vines and at least 15 vines from the end of the rows.
- Check traps twice a week until the biofix is established; thereafter, check traps weekly.
- Remove trapped insects from the trap bottom after you count and record the trap catch on the pheromone trap and degree-days monitoring form *(example form available online*).
- Replace trap bottoms monthly or when they become covered with debris.
- Follow the manufacturer's recommendations for replacing pheromone lures. Store lures in a refrigerator or freezer.

WHEN TO PUT OUT TRAPS

Pest	Where and when to set traps	Biofix
omnivorous leafroller	Central Valley and other warm inland valley vineyards—just before budbreak	first night moths are caught consistently in traps
orange tortrix	Coastal regions—late December	when low catches are observed between late January through early February and again in early June

MONITORING INSECTS AND SPIDER MITES (10/08)

Begin monitoring weekly for mealybugs, leafhopper nymphs, and spider mites together during bloom. Divide the vineyard into quadrants. In each quadrant, randomly select 5 vines each at least a few vines in from the end of the row. Look for mealybugs, leafhoppers, and mites on each of the 20 vines.

Use monitoring form with detailed treatment threshold information *(example form available online*).

Mealybug

- Early in the season, inspect basal leaves for grape, obscure, and longtailed mealybugs and under the bark of trunks for vine mealybug.
- Later in the season, inspect all plant parts for mealybugs.
- Make a record of any vine that is infested.

Leafhoppers

- On each vine, choose one leaf at the 3rd or 4th node up from the basal node for first generation nymphs or young fully expanded leaves in the middle of the cane for 2nd or 3rd generation nymphs.
- Count and record the number of nymphs on each leaf using the monitoring form.
- Note whether they are grape leafhopper nymphs, variegated leafhopper nymphs, or both.
- Check the leaves for parasitized eggs (red, or with parasite emergence holes) and note their presence (+) or absence (-).
- Follow guidelines in the leafhopper section to determine whether treatment is required.

Spider mites

- Early in the season, choose one leaf between the 2nd and 4th nodes on each of the 20 vines. Later in the season, choose the 4th expanded leaf from the growing tip.
- Use a 10–14X hand lens and look for mites and mite predators.
- Note if mites and mite predators are present (+) or absent (-) on the monitoring form.
- Follow guidelines in the webspinning spider mite section to determine whether treatment is necessary.

MONITORING CATERPILLARS (10/08)

Grape leaffolder and western grapeleaf skeletonizer feed on foliage and heavy populations can lead to defoliation. Omnivorous leafroller and orange tortrix feed on leaves, flowers, and developing berries, but their primary damage is feeding on fruit which enables rot organisms to enter fruit.

Rapid shoot growth. Early in rapid shoot growth, start monitoring for webbing on leaves caused by omnivorous leafroller or orange tortrix to map out areas of concern for bloom monitoring. Unroll leaves with orange tortrix and look for larval parasitism. Check for leaves skeletonized by western grapeleaf skeletonizer.

Bloom. Plan to treat omnivorous leafroller, grape leaffolder, and western grapeleaf skeletonizer (also, orange tortrix in coastal regions), if they have been a problem in the past. If they haven't been a problem in the past, be sure to monitor flower clusters or leaves for the caterpillars and damage they cause in wine/raisin grapes or in table grapes, as described below, to determine the need for treatment.

After bloom. Monitor during the growing season in wine/raisin grapes or in table grapes, by examining fruit clusters for omnivorous leafroller and orange tortrix and leaves for grape leaffolder and western grape leaf skeletonizer, following the guidelines below. Treatment after veraison for omnivorous leafroller and orange tortrix is limited in effectiveness and not recommended. However, veraison monitoring for all these caterpillars will alert you to larval damage going into harvest and potential problems the following year.

Harvest. At harvest, check table grapes for damage by omnivorous leafroller and grape leafroller to assess this year's management program and to plan for next year.

HOW TO MONITOR

- Monitor 20 vines weekly by looking at 5 vines in each quadrant of the vineyard.
- On each vine, check for pests and the damage they cause by following the guidelines below.
- Record results on a monitoring form (*example form available online*) and treat using the treatment thresholds below.

PROCEDURE AND TREATMENT THRESHOLDS

Caterpillar	Procedure	Treatment threshold
Omnivorous leafroller	• Examine 10 flower/fruit clusters in the center of each of 20 vines, for a total of 200 clusters. • If you see webbing and frass, look for caterpillars. Note the number of clusters infested with omnivorous leafroller.	• At bloom, treat if any larvae are found. • After bloom, treat if 2 or more clusters are infested.
Orange tortrix *(Coastal regions only)*	• During bloom and after, examine 10 flower/fruit clusters in the center of each of 20 vines, for a total of 200 clusters. • If you see webbing and frass, look for caterpillars. Note the number of clusters infested with orange tortrix.	• If you find an average of 0.5-1 larva/vine, treatment may be warranted if parasites are not present.
Grape leaffolder	• Count the number of rolled leaves per vine. • Unroll leaves and look for both healthy and parasitized grape leaffolder larvae.	• Treatment may be warranted if population levels are increasing. Treat before larvae roll leaves.
Western grapeleaf skeletonizer	• Check for skeletonized leaves. • If present, look for caterpillars and evidence of granulosis virus. (See the western grapeleaf skeletonizer section for a description of virus infection.)	• If larvae are found and no granulosis virus is evident, treat soon after bloom.

RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN GRAPES TO NATURAL ENEMIES AND HONEY BEES (10/08)

Common name (trade name)	Mode of Action[1]	Selectivity[2] (affected groups)	Predatory Mites[3]	General Predators[4]	Parasites[4]	Honey Bees[5]	Duration of impact to natural enemies[6]
abamectin (Agri-Mek)	6	moderate (mites, western grapeleaf skeletonizer)	M	L	M/H	I[7]	moderate to predatory mites and affected insects
acetamiprid (Assail)	4A	broad (insects)	—[8]	—[9]	—	III	moderate
Bacillus thuringiensis ssp. *kurstaki*	11.B2	narrow (caterpillars)	L	L	L	IV	none
bifenazate (Acramite)	25	narrow (mites)	L	L	L	IV	short
buprofezin (Applaud)	16	narrow (sucking insects, beetles)	L	H[10]	L	IV	long
carbaryl (Sevin) dust	1A	broad (insects, mites)	M/H	H	H	I	long
carbaryl (Sevin) 80S	1A	broad (insects, mites)	M/H	H	H	I	long
chlorpyrifos (Lorsban)	1B	broad (insects, mites)	M	H	H	I[11]	moderate
cryolite (Kryocide)	9A	narrow (foliage chewing insects)	L	L	L	IV	short to none
diazinon–foliar	1B	broad (insects, mites)	L	H	H	I	moderate to long
dicofol (Kelthane)	UNC	narrow (pest mites and mites)	H	M	M	IV	long to beneficial mites
dimethoate	1B	broad (insects, mites)	H	H	H	I	long
endosulfan (Thionex)	2A	broad (insects, mites)	L	M	M	II[12]	short
fenbutatin oxide (Vendex)	12B	narrow (pest mites)	L	L	L	IV	short
fenpropathrin (Danitol)	3	broad (insects, mites)	H	H	H	I	—
fenpyroximate (Fujimite)	21	narrow (mites, some insects)	—	L	L	IV	short
hexythiazox (Savey)	10B	narrow (mites)	L	L	L	IV	short to moderate
imidacloprid (Admire)	4A	narrow (sucking insects, cutworms)	—	L	—	I[13]	—
imidacloprid (Provado)	4A	narrow (sucking insects)	—	—	H	II	short to moderate
insecticidal soap (M-Pede)	—	broad (insects, mites)	M	M	M	IV	short to none
kaolin clay (Surround)	—	narrow (sucking insects)	—	—	—	IV	—
malathion	1B	broad (insects, mites)	M	H	H	II	moderate
methomyl (Lannate)	1A	broad (insects, mites)	H	H	H	III	moderate
methoxyfenozide (Intrepid)	18A	narrow (caterpillars)	L	L	L	IV	none
neem oil (Trilogy)	—	broad (soft-bodied insects)	L	L	L	III	short
petroleum oil	—	broad (exposed insects, mites)	L	L	L	III	short to none
phosmet (Imidan)	1B	broad (insects, mites)	H	H	H	I	moderate to long
propargite (Omite)	12C	narrow (pest mites)	M[14]	L	L	IV	short
pyrethrin/piperonyl butoxide (Pyrenone)	3/27A	broad (insects)	—	—	—	III	short
pyridaben (Pyramite, Nexter)	21	broad (insect, mites)	M/H	M	—	III	short
sodium tetrathiocarbonate (Enzone)	—	broad (soil organisms)	L	L	L	IV	none
spinosad (Entrust, Success)	5	narrow (caterpillars, thrips)	L	M[15]	L/M	III	short
sulfur	—	narrow (mites)	L/H	L	H[16]	IV	short

H = high M = moderate L = low — = no information

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

Continued on next page . . .

Relative Toxicities of Insecticides and Miticides used in Grapes to Natural Enemies and Honey Bees, continued

[2] Selectivity: *broad* means it affects most groups of insects and mites; narrow means it affects only a few specific groups.

[3] Generally, toxicites are to western predatory mite, *Galendromus occidentalis*. Where differences have been measured in toxicity of the pesticide-resistant strain versus the native strain, these are listed as pesticide-resistant strain/native strain.

[4] Toxicities are averages of reported effects and should be used only as a general guide. Actual toxicity of a specific chemical depends on the species of predator or parasite, environmental conditions, and application rate.

[5] Ratings are as follows: I-Do not apply to blooming plants; II-Apply only during late evening; III-Apply only during late evening, night, or early morning; and IV-Apply at any time with reasonable safety to bees. For more information, see *How to Reduce Bee Poisoning From Pesticides*, Pacific Northwest Extension Publication PNW591.

[6] Duration: *short* means hours to days; moderate means days to 2 weeks; and long means many weeks or months.

[7] If rate is 0.025 lb a.i./acre, rating is II.

[8] May cause flare-ups of spider mite populations.

[9] Acute toxicity low but reproductive capacity is impacted.

[10] Kills lady beetles.

[11] If rate is 0.05 lb a.i./acre or less, rating is III.

[12] If rate is 0.5 lb a.i./acre or less, rating is III.

[13] If rate is 0.1 lb a.i./acre, rating is II.

[14] Use lowest rates for best management of western predatory mite/spider mite ratio (propargite).

[15] Toxic against some natural enemies (predatory thrips, syrphid fly and lacewing larvae, beetles) when sprayed and up to 5-7 days after, expecially for syrphid fly larvae.

[16] Highly toxic to *Anagrus* spp. parasites of grape leafhopper.

Acknowledgements: This table was compiled based on research data and experience of University of California scientists who work on a variety of crops and contribute to the Pest Management Guideline database, and from Flint, M.L. and S.H. Dreistadt. 1998. *Natural Enemies Handbook: An Illustrated Guide to Biological Pest Control*, ANR Publication 3386.

GENERAL PROPERTIES OF FUNGICIDES USED IN GRAPES (10/08)

Common name (trade name)	Chemical class	Activity	Mode of action (FRAC Group No. [1])	Resistance potential	Comments
azoxystrobin (Abound)	QoI[5]	systemic[2]	single-site (11)	high	
Bacillus pumilis (Sonata)	fermentation product	contact	various	low	
Bacillus subtilis (Serenade)	fermentation product	contact	various	low	
captan	phthalamide	contact	various	low	highly toxic to honey bee larvae
cinnamaldehyde (Cinnacure)	natural product	contact	various	low	
copper	inorganic	contact	multi-site (M1)	low	
copper hydroxide	inorganic	contact	multi-site (M1)	low	
copper sulfate	inorganic	contact	multi-site (M1)	low	
cyprodinil (Vangard)	anilinopyrimidine	mostly contact, slightly systemic	single-site (9)	high	
DCNA (Botran)	aromatic hydrocarbon	systemic (local)	single-site (14)	medium	
fenarimol (Rubigan)	DMI[3]-pyrimidine	systemic[2]	single-site (3)	high	
fenhexamid (Elevate)	hydroxyanilide	contact	single-site (17)	high	
GABA/L-glutamic acid (AuxiGro)	SAR[4] – protein	systemic	host resistance (—)	unknown	
harpin protein (Messenger)	SAR[4] – protein	systemic	host resistance (—)	unknown	
iprodione (Rovral)	dicarboximide	systemic	multi-site (2)	low	
kresoxim-methyl (Sovran)	QoI[5]	systemic[2]	single-site (11)	high	
mancozeb (Dithane)	carbamate (EBDC)[6]	contact	multi-site (M3)	low	
maneb	carbamate (EBDC)[6]	contact	multi-site (M3)	low	
mefenoxam (Ridomil Gold)	phenylamide	systemic	single-site (4)	high	
myclobutanil (Rally)	DMI[3]-triazole	systemic[2]	single-site (3)	high	
neem oil (Trilogy)	plant oil	contact	various (—)	low	
oil (JMS stylet oil)	mineral oil	contact	various (—)	low	
potassium bicarbonate (Armicarb, Kaligreen, Milstop)	inorganic salt	contact	various (—)	low	
pyraclostrobin/boscalid (Pristine)	QoI[5]/carboxamide	systemic[2]	single-site (11/7)	high	
quinoxyfen (Quintec)	quinoline	contact	single-site (13)	medium	
sulfur	inorganic	contact	multi-site (M2)	low	highly toxic to native strains of western predatory mite (*Galendromus occidentalis*) and parasites.
tebuconazole (Elite)	DMI[3]-triazole	systemic[2]	single-site (3)	high	
triadimefon (Bayleton)	DMI[3]-Triazole	systemic[2]	single-site (3)	high	
trifloxystrobin (Flint)	QoI[5]	systemic[2]	single site (11)	high	
triflumizole (Procure)	DMI[3]-imidazole	systemic[2]	single-site (3)	high	
ziram	carbamate (DMDC)[7]	contact	multi-site (M3)	low	

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode of action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode of action Group number.

[2] Generally considered to have systemic action based on performance data but has not been proven experimentally.

[3] DMI = demethylation (sterol) inhibitor

[4] SAR = systemic aquired resistance induced in host

[5] QoI = quinone outside inhibitor (strobilurin)

[6] EBDC = ethylene bisdithiocarbamate

[7] DMDC = dimethyl dithiocarbamates

— = unknown

Acknowledgment: Adaskaveg et al., 2008.Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Deciduous Tree Fruit, Nut Crops, and Grapevines.

TREATMENT TIMINGS FOR KEY DISEASES (10/08)

Note: not all indicated timings may be necessary for disease control.

Disease	Dormant	Budbreak	Full bloom	Pre-close	Veraison	Preharvest
botrytis	+++ [2]	—	+++ [1]	+++ [1]	+++ [1]	+++ [1]
downy mildew	—	+++	+++	—	—	—
eutypa	+++	—	—	—	—	—
powdery mildew	+++ [2]	+++ [3]	+++ [3]	+++ [4]	+++ [4]	+++
summer rot	—	—	—	—	+++ [1]	+++ [1]

Rating: +++ = most effective, ++ = moderately effective, — = ineffective

1 Apply only if rain is forecast.

2 Use 10 gal lime sulfur per acre in at least 100 gal water.

3 Apply budbreak and full bloom treatments every year.

4 Apply as needed (a disease risk assessment model is available to help determine need for spray).

Acknowledgment: Adaskaveg et al., 2008.Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Deciduous Tree Fruit, Nut Crops, and Grapevines.

PATHOGEN TESTING SERVICE FOR GRAPES (6/06)

The University of California's Foundation Plant Services offers pathogen testing on a fee-for-service basis for 16 different pathogens. Testing is performed using Polymerase Chain Reaction, which is one of the most sensitive methods for pathogen detection currently available. Testing is available for the following viral and bacterial pathogens of grapevines:

- Grapevine leafroll-associated virus (1–5)
- Grapevine vitivirus (A, B, & D)
- Rupestris stem pitting-associated virus
- Grapevine fan leaf virus
- Grapevine fleck virus
- Tomato ring spot virus
- Arabis mosaic virus
- Pierce's disease (*Xylella fastidiosa*)
- Phytoplasmas
- Grapevine rootstock stem lesion-associated virus (formerly know as Redglobe virus)

For more information call the Foundation Plant Services at (530) 752-3590 or view their Web site at http://fpms.ucdavis.edu.

Insects and Mites

ANTS (10/08)

Scientific Names: Argentine ant: *Linepithema humile*
Gray ant: *Formica aerata* and *Formica perpilosa*
Pavement ant: *Tetramorium caespitum*
Southern fire ant: *Solenopsis xyloni*
Thief ant: *Solenopsis molesta*

DESCRIPTION OF THE PESTS

The most prevalent of the ant species in vineyards, the Argentine ant, is about 0.13 inch (3 mm) long, uniformly deep brown to light black and does not bite or sting. The Argentine ant has one petiole node (hump) between the thorax and the gastor (swollen part of abdomen right behind the petiole). Worker ants travel in characteristic trails on vines, trellis wires, the ground, and drip irrigation laterals. They forage during all daylight hours. Ant populations peak in midsummer and early fall. Their nests are very shallow, usually within 2 inches of the soil surface.

The pavement ant is 0.13 inch (2–3 mm) long and has a dull, blackish brown body that is covered with coarse hairs. The head and thorax have many parallel furrows. Pavement ants have two nodes between the thorax and the gastor. They move in slow deliberate motion. They prefer to nest in sandy or loam soils.

The southern fire ant, also called the California or native fire ant, is light reddish brown with a black abdomen. The entire body is covered with golden hairs and has two nodes between the thorax and the gastor. Workers range in size from 0.1 to 0.018 inch (2.5–4.5 mm). They do not usually travel in conspicuous trails and will swarm over the ground when disturbed. This ant will sting when provoked. Southern fire ants build nests of loose mounds or craters near bases of vines around wetted areas and do not aggregate in colonies as large as those of the Argentine ant. They forage in the morning and early evening and are underground during hot periods.

Native gray ants, also called field ants, are larger than the other ants, measuring up to 0.3 inch (7.5 mm) and, like the Argentine ant, have one petiole node (hump). These gray ants nest in topsoil or under rocks and debris, move in an irregular jerky manner, and generally do not travel in trails or sting. *Formica aerata* is more common in the San Joaquin Valley whereas *Formica perpilosa* occurs primarily in the Coachella Valley. Native gray ants do not trail and appear solitary.

Thief ants are extremely small ants (1–1.5 mm) with yellowish, shiny bodies. They are pests of grapes primarily in the Coachella Valley.

An illustrated key that covers common ant species (except gray ants) may be of value when identifying ants in vineyards and can be found online at http://www.ipm.ucdavis.edu/TOOLS/ANTKEY/index.html.

DAMAGE

Ants can be extremely disruptive to IPM programs, especially Argentine and native gray ants. These ants feed on honeydew excreted by the European fruit lecanium scale and mealybugs. As part of this relationship, they also protect these honeydew-producing insects from predators and parasites, thus disrupting biological control.

MANAGEMENT

Ants may be more of a problem in vineyards with cover crops; the exception appears to be a vetch cover crop, because it supplies ants with adequate amounts of nectar and keeps them from moving into vines. Manage ants when they are interfering with biological control of pests. Cultural practices and sprays can be used in an integrated program.

Cultural Control

Tilling the soil for weed control will also disturb the nesting sites of ants and help to reduce their populations. Use of a French plow in the vine row will disrupt ant colonies.

Planting a cover crop of common vetch (*Vicia sativa*) can help to keep gray field ants (*Formica* sp.) off the vines. Common vetch has an abundance of nectaries that attract the ants away from the honeydew-producing insects. In studies it was planted in a 80:20 mixture with 20% Merced rye so that it could establish in late fall and winter in order to attract the ants during spring and early summer. The addition of rye to the mixture helps to provide structure and support in the cover crop for the vetch. A heavy seeding rate (120 lb/acre) helps to ensure a good stand. The effect of other nectary-bearing cover crops on attracting ants has not been evaluated. (Research using cover crops to attract Argentine ants, *Linepithema humile*, has not been conducted.)

Organically Acceptable Methods
Organically acceptable management tools are the cultural controls.

Monitoring and Treatment Decisions
Monitor the vineyard in spring when honeydew-producing insects such as scale and mealybugs appear as outlined in DELAYED-DORMANT AND BUDBREAK MONITORING (wine/raisin grapes or table grapes) and record observations on a monitoring form *(example form available online).* Check the abdomen of ants descending the trunks to see if they are swollen and translucent; this helps identify them as honeydew-collecting species. Periodically inspect for ants on arms, cordons, and canes.

Insecticides. Baits are the preferred chemical method for ant control whenever feasible. Effective bait insecticides have slow-acting toxicants that worker ants collect and feed to other ants, including nest-building immatures and queens. For the most effective and economical ant control, treat when ants are active in early spring following winter rains and again in late August.

To determine which bait to use, identify your primary ant species; fire ants are predominantly protein feeders whereas most gray and black ants are sugar feeders.

Corncob grit and oil baits. Solid baits utilize treated corncob grits mixed with soybean oil as the food attractant plus an insecticide. These are effective for the primarily protein-feeding fire ants. The toxicants tend to degrade in light, so apply baits early in the morning or late in the day when ants are active and will take the bait into the nest. Generally, corncob grit type baits are broadcast over the acreage that needs to be treated. However, spot application of baits at the location of the ant nest is preferred over widely spreading the bait because it concentrates the food where the ants are.

Sugar-water based baits. Liquid baits use a toxicant mixed in sugar water, which disguises the toxicants as well as helps attract the ants. These baits are most useful for the liquid sugar-feeding Argentine and native gray ants. Evaporation of the bait can cause the concentration of the toxicant to increase to a level in the bait that becomes repellant to ants. All liquid baits must be used in an EPA-approved bait station.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to impact on natural enemies and honey bees and environmental impact.			
LIQUID BAITS (Must be used in approved bait station such as KM Ant Pro or constructed from an approved design])			
A. S-METHOPRENE (Tango) MODE OF ACTION GROUP NUMBER[1]: 7A		4	0
B. IMIDACLOPRID› (Vitis Liquid Ant Bait) MODE OF ACTION GROUP NUMBER[1]: 4A		0	0

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

SOLID BAITS

A. ABAMECTIN*
(Clinch bait) 0.011% — 1 lb/acre — 12 — 0
Pests: narrow (fire ants); Natural enemies: other ants
Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION GROUP NUMBER[1]: 6
COMMENTS: A corncob grit and soy oil bait. For use on all citrus varieties. Effective only against fire ants because they are attracted to the soy oil mixed with corncob grits bait. Apply when fire ants are most active during the season (especially early summer and fall) and when they are most active during the day (early evening and early morning when soil temperature is above 60°F). Treatments are most effective if applied 2 days after an irrigation, when ant activity is at a maximum. Do not irrigate again until at least 24 hours after application. Do not apply if rainfall is anticipated with 4–6 hours after application. While Clinch can be broadcast using properly calibrated ground equipment to assure proper dosage and uniform distribution, spot applications at the location of the ant nest are preferred. Retreatment may be desirable after 3–4 months.

B. PYRIPROXYFEN
(Esteem Ant Bait) 0.5% — 1.5–2 lb/acre — 12 — 1
Pests: narrow (fire ants); Natural enemies: other ants
Pests: intermediate; Natural enemies: none
MODE OF ACTION GROUP NUMBER[1]: 7C
COMMENTS: A corncob grit and soy oil bait. For use on all citrus varieties. Effective only against fire ants because they are attracted to the soy oil mixed with corncob grits bait. Apply when fire ants are most active during the season (especially early summer and fall) and when they are most active during the day (early evening and early morning when soil temperature is above 60°F). Treatments are most effective if applied 2 days after an irrigation, when ant activity is at a maximum. Do not irrigate again until at least 24 hours after application. Do not apply if rainfall is anticipated with 4–6 hours after application. While this bait can be broadcast using properly calibrated ground equipment to assure proper dosage and uniform distribution, spot applications at the location of the ant nest are preferred. Retreatment may be desirable after 3–4 months.

SPRAYS

A. CHLORPYRIFOS*
(Lorsban) 4EC — 1.5–2 pt — 24 — 76
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Use allowed under a Special Local Need Registration. Chlorpyrifos may either be used for ant control or mealybug control, but not for both pests on the same grape crop. Spray to obtain thorough coverage of the base of each vine, the vine stakes, and the surrounding soil, out to about 1 ft from the base of the vine. Running a blade ahead of the sprayer to disturb the soil may increase contact of the material. Do not apply to foliage or fruit. May be used at any time during the season, keeping in mind the 76-day preharvest interval, but do not exceed 3 applications/year. Avoid drift and runoff into surface waters. In addition to water quality concerns, the EC formulation of chlorpyrifos produces volatile organic compounds (VOCs), which are a major air quality issue.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

BLACK VINE WEEVIL (6/06)

Scientific Name: *Otiorhynchus sulcatus*

DESCRIPTION OF THE PEST The black vine weevil is primarily a pest in central coast vineyards. The adult is a hard-shelled black beetle about 0.5 inch long with small patches of white scales on the forewings. A long and broad snout, typical of weevils, projects from the front of the head. In coastal areas adult emergence generally starts in early April and continues through May. About 2 to 3 weeks after they emerge, females begin laying eggs and continue for 6 to 8 weeks. Eggs hatch into white grubs (larvae) that feed on roots. Larvae feed for about 10 months before pupating in the soil during late winter.

DAMAGE

Adults are nocturnal, feeding on buds, foliage, flowers, and the cluster rachis. Significant bud damage can occur on late budding varieties. Foliar feeding is characterized by notching along leaf margins. Larvae feed underground on roots but do not appear to damage the vines.

MANAGEMENT

Weevils move from under loose trunk bark and the soil up to the vine canopy and back, so management measures target the vine trunk and the soil surface surrounding the trunk. Among cover crops, creeping red fescue supports black vine weevil larvae populations while oats, vetch, and alfalfa do not.

Adult emergence is monitored with a corrugated cardboard trap. Strip loose bark from a vine and wrap an 8- to 10-inch wide corrugated cardboard "tree wrap" around a trunk, cinching it in the middle with a plastic tie to hold it in place. Weevils will hide in the wrap's corrugations during the day. From mid- to late March, inspect the corrugations twice weekly to detect for first emergence. Thereafter, inspect weekly. This technique has shown that generally adult activity between the soil and vine peaks in mid- to late May and is complete by early July.

Black vine weevil is generally not treated; however, if chlorpyrifos (Lorsban) is used for ant control, it also will deter this insect.

BLACK WIDOW SPIDER (9/07)

Scientific Name: *Lactrodectus hesperus*

DESCRIPTION OF THE PEST

The typical adult female black widow has a shiny black body, slender black legs, and a red or orange mark in the shape of an hourglass on the underside of the large, round abdomen. The body, excluding legs is 5/16 to 5/8 inches long.

The adult male black widow is one-half to two-thirds the length of the female, has a smaller abdomen, and is seldom recognized as a black widow. The topside of its abdomen is greenish gray with a pattern of cream-colored areas and one light-colored band going lengthwise down the middle. The hourglass mark on the underside of the abdomen typically is yellow or yellow-orange and broad in the middle. The legs are banded with alternating light and dark areas.

Like males, young female black widow spiders are patterned on the top side. In the early stages they resemble males, but gradually acquire the typical female coloration with each molt. In intermediate stages they have tan or cream-colored, olive gray, and orange markings on the topside of the abdomen, a yellowish orange hourglass mark on the underside and banded legs.

The egg sacs are mostly spherical, about 1/2 inch long and 5/8 inch in diameter, creamy yellow to light tan in color, opaque, and tough and paperlike on the surface. A female may produce several egg sacs during her lifetime, which can be 2 years. Tiny, young black widows, which are nearly white in color, emerge from the egg sac and remain close together during the first days after emergence, often preying on each other. Soon afterwards, the spiderlings disperse to new locations by 'ballooning' on light silken thread and infest new areas. Webbing produced by black widow spiders is very strong compared to other spider webbing.

DAMAGE

Generally spiders play a beneficial predatory role in a vineyard and are not thought of as pests. However, in the southern San Joaquin Valley (Kern and Tulare counties) and the Coachella Valley, black widow spiders can be a problem in table grape vineyards because of quarantine issues in crops to be exported to other countries and because of the public's fear of black widows.

MANAGEMENT

In table grape vineyards, preventive treatment may be justified in crops destined for exportation. A delayed dormant treatment of chlorpyrifos (Lorsban) aimed at grape mealybug will also control black widow spider populations. Treatment at this time is very effective because the leaves are off the vine, allowing for good coverage of the trunk; however, unless the coverage is complete throughout the vineyard, the spider populations can increase before harvest.

If a mealybug treatment is not planned, an inseason treatment for caterpillars with fenpropathrin (Danitol), or methomyl (Lannate) will control black widows. Also, because there are always protected areas in the vineyard where insecticide coverage is poor (e.g., cement irrigation pipe stands, trellis poles, and cross-supports), an inseason application is often required to keep these spiders out of the grape cluster. Treatments of fenpropathrin (Danitol), or methomyl (Lannate) will suppress black widow populations, but again, full coverage is important.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

DELAYED DORMANT

A. CHLORPYRIFOS*
(Lorsban) 4EC — Label rates — 24 — 45
MODE OF ACTION GROUP NUMBER[1]: 1B
. . . *PLUS* . . . (optional)
NARROW RANGE OIL
(Superior, Supreme) — 1–2 gal — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Direct sprays at the vine from the crown down to the ground being sure to obtain thorough coverage of all above ground plant parts, especially the trunk and cordons. Application is most effective when applied during warm weather (60°F or higher). Apply in 150 to 200 gal/acre. Use allowed under a Special Local Needs registration (SLN CA-970007). Do not apply chlorpyrifos more than once a year or apply it after budbreak. Avoid drift and runoff into surface water. In addition to water quality concerns, the EC formulation of chlorpyrifos produces volatile organic compounds (VOCs), which are a major air quality issue.

GROWING SEASON

A. FENPROPATHRIN*
(Danitol) 2.4EC — 5.33–10.66 oz — 24 — 21
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Apply at least 21 days before harvest, directing spray towards fruit clusters. Coverage is very important. Use sufficient water to get the insecticide throughout the vine.

B. METHOMYL*
(Lannate) LV — 1.5-3 pt — 7 — 1-fresh,raisin 14-wine grapes
MODE OF ACTION GROUP NUMBER[1]: 1A

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

BRANCH AND TWIG BORER (10/08)

Scientific Name: *Melalgus* (=*Polycaon*) *confertus*

DESCRIPTION OF THE PEST

The branch and twig borer, also known as the grape cane borer, occurs throughout California. Adult borers are dark brown beetles, cylindrical in shape with a pronotum that is wider near the head than the posterior end. Females are about 0.7 inch long; adult males are smaller, about 0.3 to 0.4 inch long. Larvae have white bodies that are typically curved in a C-shape and enlarged at the anterior end; the head is brown. Larvae spend up to 10 months in tunnels they excavate.

DAMAGE

Both adults and larvae injure grapevines. Larvae bore into wood at dead or dying parts of vines, often in old pruning scars. Adults burrow into fruiting canes at the base of the bud or shoot, or they burrow into the crotch formed by the shoot and spur. Feeding is often deep enough to completely conceal the adult in the hole. Feeding at the base of shoots on spurs will cause shoots to wilt (flagging) and fall. This pest is most serious in cane-pruned vineyards where feeding on canes can cause them to break when shoots reach a length of 10 to 12 inches, if a strong wind occurs. Flagging can also be caused by *Botrytis*.

MANAGEMENT

Establishment of branch and twig borer in a vineyard may be attributed to one or two factors: (1) proximity to habitat suitable to the insect, such as riparian or woodland areas, old orchards, or unmaintained vineyards, and (2) failure to destroy or adequately remove dead or damaged parts of vines that may have resulted from disease (such as *Eutypa* and Pierce's disease) or cultural practices such as T-budding, lowering the vine head, or mechanical pruning.

Chemical control is normally not necessary if good cultural controls are practiced. April treatment of carbaryl for cutworms offers some measurable control of adult borers but may cause mite outbreaks later in the season.

Biological Control

The many species of general predators found under the bark of grapevines may assist in maintaining lower populations. Treatments with commercial formulations of the entomopathogenic nematode *Steinernema carpocasae,* which can move through frass tubes to infect larvae, may be of some benefit.

Cultural Control

The best way to manage branch and twig borer in vineyards is to prevent invasion and establishment of the beetles through cultural methods. Wood and brush piles of any kind of tree or shrub should be completely removed from the vineyard or burned before emergence of adult beetles in March. Remove dead or dying portions of vines and destroy them with other prunings. Do not leave grapevine prunings in the vicinity of the vineyard. All prunings must be removed from berms on the vine rows and destroyed to optimize sanitation. If mechanical cane chipping or cutting is used for pruning disposal, the residue should be incorporated into the soil or used as compost before adult emergence. Good vine health is important for reducing sites of borer establishment in vineyards.

Organically Acceptable Methods

Biological and cultural controls are organically acceptable, including the use of beneficial nematodes.

Monitoring and Treatment Decisions

Look for wilted shoots (flagging) and drying leaves when you monitor your vineyard during the period of rapid shoot growth. Examine the base of these shoots for a 0.4 inch diameter hole. If no holes are present, another possibility is a *Botrytis* infection. Cut the shoot in half and look for brown discoloration.

In the North Coast, adults continue to emerge through April. Examine old pruning scars and dead parts of vines for brown frass and fine wood dust filling the holes that were made by borer larvae. Borer holes are detected more easily during the dormant season, particularly after pruning. No control action thresholds have been established. It is unlikely that borer injury in cordon-pruned vineyards would ever justify chemical treatment if good vineyard pruning and sanitation is practiced. Cane-pruned vineyards with a history of borer injury may require treatment.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. CARBARYL*
(Sevin) 80S — 2.5 lb — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: May cause mite outbreaks; do not use where mites are a chronic problem. Extremely toxic to honey bees.

B. STEINERNEMA CARPOCAPSAE# — Label rates — NA — NA
COMMENTS: Nematodes are perishable, so store them under cool, dark conditions. Use hand sprayer to aim spray at infected cordons. Most effective when applied during January and February.

** Apply with enough water to provide complete coverage.
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.
Acceptable for use on organically grown produce.
NA Not applicable.

CUTWORMS (10/08)

Scientific Names: Variegated cutworm: *Peridroma saucia*
Spotted cutworm: *Xestia (Amathes) c-nigrum*
Brassy cutworm: *Orthodes rufula* and other species

DESCRIPTION OF THE PESTS

Cutworms are inconspicuously marked, dull-colored caterpillars ranging from 0.6 to 2.0 inch (1.5–5 cm) in length. Positive identification is important as behavioral differences affect control actions.

Mature *variegated cutworm* larvae are 1.5 to 2.0 inch (3.8–5 cm) long with smooth skin. Body color varies from pale gray to dark mottled brown intermixed with red and yellow dots along the dorsum.

Mature *spotted cutworms* are about 1.3 inch (3.5 cm) long and are a dull gray brown. A row of dark or black triangular markings are found on each side of the dorsal body surface.

Mature *brassy cutworms* are 1.0 to 1.2 inch (2.5–3 cm) long and are reddish or brassy in appearance. Of the cutworm species that attack grapes, brassy cutworm is the only one with hairs protruding from the compound eye area. A hand lens is needed to detect these hairs.

Variegated cutworm is the predominant species in the San Joaquin Valley and North Coast, while spotted cutworm is predominant in the Central Coast counties. In the North Coast, the variegated cutworm normally returns to the ground during the day but may also remain under the bark of the vine. In the San Joaquin Valley variegated cutworm larvae do not return to the soil but rather move under the bark. Spotted cutworms routinely remain under grapevine bark in all production areas.

DAMAGE

Feeding on grapevines occurs from bud swell to when shoots are several inches long. Injured buds may fail to develop. Grapevines can compensate for early season damage to buds or shoots to some extent by the growth of secondary buds. The fruitfulness of secondary buds, however, varies according to variety, and some varieties such as Thompson Seedless and Chardonnay have unfruitful or significantly less fruitful secondary buds respectively. In these varieties, destruction of primary buds can be expected to reduce the number of clusters in proportion to the number of buds destroyed.

MANAGEMENT

Historical records of cutworm infestations or damage are useful in developing monitoring strategies for individual vineyards because cutworm problems are normally spotty or localized. Many varieties of grapes can tolerate a significant amount of damage without any economic loss. No chemicals are highly effective in controlling cutworms, so frequently treatments may not be economically justified.

Biological Control

Natural enemies of cutworms include predaceous or parasitic insects, mammals, parasitic nematodes, pathogens, birds, and reptiles. The hymenopteran (wasp) parasites, including ichneumonids, chalcids, braconids, and sphecids, are the most important group of cutworm natural enemies. Predaceous beetles (often found under bark) and tachinid flies are also factors in biological control.

Cultural Control

Cultural practices have not been demonstrated to successfully control cutworms; however, some practices do affect their population abundance. Weed removal in late summer or fall may be beneficial in disrupting cutworm life cycles. Plowing or discing of weeds is not recommended before or soon after bud swell in spring where cutworms are a problem because it can cause movement of cutworms to the grapevines. Furrow and flood irrigation can be manipulated to bring cutworm larvae to the soil surface, exposing them to adverse weather and predators.

Organically Acceptable Methods

Biological and cultural controls and the Entrust formulation of spinosad are organically acceptable methods.

Monitoring and Treatment Decisions

Begin to monitor bud feeding by cutworms during bud swell in early spring. Cutworms can be monitored along with other pests following the procedures discussed in DELAYED-DORMANT AND BUDBREAK MONITORING (wine/raisin grapes or table grapes). Because cutworm infestations are clumped, many vines must be examined to detect an infestation. In spring cutworms leave the soil and climb up the vines. During the day they hid under

loose bark towards the base of the vine and come out to feed at night. Randomly select five locations in the vineyard to observe, concentrating on areas known to be chronically infested. Check 4 vines within each location for damaged buds (total 20 vines). On each vine examine 5 buds for damage (total 25 buds per location).

In cool growing regions with a long period between bud swell and shoot growth, monitoring may be needed over a 2- to 3-week period. Record results on a monitoring form *(example form available online)*.

The number of damaged buds that can be tolerated depends on variety. If secondary buds are highly fruitful, little yield loss will result even when a large proportion of buds are damaged. If less than 4% of the buds are damaged, treatment may be unnecessary. Treating an entire vineyard is seldom necessary because infestations are usually localized; consider spot treatments. Cutworm feeding after shoots are about 6 inches long does not result in significant injury.

To make sure cutworms are causing the damage, return to damaged vines at night to look for cutworm larvae. Other species of insects (grape bud beetle, click beetles, branch and twig borers, orange tortix larvae) also cause similar injury.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
A. CARBARYL*			
(Sevin) 80S	2.5 lb	12	7
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Disruptive to predators of mites and parasites of leafhoppers; do not use where mites are a chronic problem. Extremely toxic to honey bees.			
B. METHOMYL*			
(Lannate) LV	0.75–1.5 qt	7 days	Raisin/Table: 1
(Lannate) 90SP	0.5–1 lb	7 days	Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhopper. Very toxic to honey bees.			
C. SPINOSAD			
(Entrust)#	1.25–2.5 oz	4	7
(Success)	4–8 oz	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target the young larvae. A stomach poison; most effective when ingested. Heavy infestations require a second application in 4 or 5 days. To protect honeybees, apply only during late evening, night, and early morning when bees are not present in the vineyard.			
D. DIAZINON* 50W	1–2 lb	5 days	28
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Apply in May in a minimum of 100 gal water and a maximum of 200 gal water/acre. Very toxic to honey bees. Avoid drift and tailwater runoff into surface waters.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

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EUROPEAN FRUIT LECANIUM SCALE (10/08)

Scientific Name: *Parthenolecanium corni*

DESCRIPTION OF THE PEST

European fruit lecanium is a scale insect that is also known as the brown apricot scale. The adult female's domed shell is shiny brown and about 0.4 inch in diameter. Adult females are mostly found on 1- to 3-year-old wood on the underside of woody canes, cordons, and spurs where they remain for the rest of their lives. Females reproduce parthenogenetically (without mating), and eggs are laid in spring (beginning in April) beneath the female's body. Crawlers hatch from May through most of June. They move to the shoots and leaves of the current season's growth and molt to second instars from June to July.

In the North Coast a portion of the second–instar population continues development and becomes adults that produce a second generation. The crawlers of the second generation may be found on leaf petioles and shoots in August. Beginning in September, second-instar nymphs from both the first and second generation migrate back to 1- to 3-year-old wood. They overwinter under the bark in the second-instar stage. Early in spring, the second instars molt to the third-instar stage and then quickly develops into mature females that begin laying eggs in April and May. There is usually only one generation each year, but a portion of the population in the North Coast will have two generations. The second generation has not been observed in other grape-growing regions.

DAMAGE

European fruit lecanium scale produces honeydew as it feeds. Sooty mold may grow on the honeydew, causing blackened areas on leaves and fruit. When European fruit lecanium occurs in abundance, it may stunt vine growth.

MANAGEMENT

Parasites and predators often keep populations below damaging levels. Only when populations increase to great numbers should insecticide applications be considered.

Honeydew-seeking ants must be controlled to allow natural enemies of scale to aid in its control. This is best accomplished either with tillage or by treating the ants with an insecticide. See the section on ANTS for additional information on their control.

Biological Control

European fruit lecanium is attacked by several species of parasites, including *Aphytis* spp., *Coccophagus* spp., *Encarsia* spp., and *Metaphycus luteolus*. Important parasites in the North Coast region are *Metaphycus insidiosus*, *Coccophagus lycimnia*, and *Blastothrix longipennis*. Frequently, second-instar scales may be heavily parasitized early in spring before budbreak. In addition, many common predators help control this scale. These include lady beetles (*Chilocorus orbus*, *Hyperaspis* spp., *Rhyzobius lophanthae*), lacewings, the predaceous sap beetle (*Cybocephalus californicus*) and predatory seed bugs (*Phytocoris* spp.).

Organically Acceptable Methods

Organically acceptable methods of controlling European fruit lecanium include biological control and oil sprays.

Monitoring and Treatment Decisions

Monitor closely throughout the year and make a map of infested areas in the vineyard. Monitor 1- to 3-year-old wood in early March for the presence of parasitism on second-instar scale nymphs. Place the scales in gelatin capsules (available from pharmacies) to detect parasite emergence, or look for round exit holes on the scale bodies. You can also monitor female development on old wood. Monitor for crawler emergence in May by placing double-sided sticky tape around 1-year-old wood near the females, or by turning over the females and looking for crawlers.

The crawler stage is the stage most susceptible to chemical treatment, especially when using summer oil sprays. Crawlers emerge for a period of about 6 weeks, starting in mid-May. Treatment levels for scale have not been established. Determine the need for treatment of European fruit lecanium by evaluating records of honeydew from the previous season. Time treatment by monitoring for egg hatch in May; turn 10 females upside down and note if crawlers are present among the eggs. Look for mature females under cordons.

Apply the first treatment when 50% of the females show egg hatch (i.e., there are some crawlers below them). Repeat monitoring again in 2 weeks and time treatment to when 90% of the females show crawlers, or treat with imidacloprid in mid- to late May. High temperatures in the summer months may reduce populations somewhat. If populations are high in September and grapes have been harvested, apply a treatment of oil before mid-October. In late season varieties or cool regions where harvest is late, an oil treatment may not be effective if the second instars have already moved under the bark for the winter.

When monitoring late in the dormant season, watch for ants. If ants are present, look closely for mealybugs and lecanium scale as outlined in DELAYED-DORMANT AND BUDBREAK MONITORING (wine/raisin grapes or table grapes) and record your results on a monitoring form *(example form available online).*

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

SUMMER

A. NARROW RANGE OIL#
(Omni Supreme and others) — Label rates — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Apply at 50% and again at 90% egg hatch. Be sure that vines are well watered and do not apply at least 10 days before and after a sulfur application to avoid phytotoxicity. Works by contact activity only so good coverage is essential. Check with certifier to determine which products are organically acceptable.

B. NEEM OIL#
(Trilogy) — 1–2% — 4 — 0
MODE OF ACTION: Unknown. A botanical insecticide.
COMMENTS: Make two applications: one at 50% and one at 90% egg hatch.

C. IMIDACLOPRID
(Admire Pro) — 7–14 fl oz — 12 — 30
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Treat in mid- to late May. Efficacy appears to be reduced in high clay soils. Most effective in drip-irrigated vineyards with sandy soils that are not on deficit irrigation. If two applications are required because of coarse soils or where the longest period of protection is required, make the second application 21 to 45 days after the bloom application. Apply a total of 7–14 fl oz/acre; the full rate of 14 oz/acre is recommended where vigorous vine growth is expected or in warmer growing areas such as the San Joaquin or Sacramento valleys.
. . . or . . .
(Provado Solupak) 75WP — 0.75–1 oz — 12 — 0
COMMENTS: A foliar-applied product that is effective when applied at 50% egg hatch.

POSTHARVEST

A. NARROW RANGE OIL#
(Omni Supreme and others) — Label rates — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Be sure that vines are well watered and do not apply at least 10 days before and after a sulfur application to avoid phytotoxicity. Works by contact activity only so good coverage is essential. Check with certifier to determine which products are organically acceptable.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

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FALSE CHINCH BUG (9/07)

Scientific Name: *Nysius raphanus*

DESCRIPTION OF THE PEST

False chinch bug breeds in great numbers in grass or weedy areas, especially on London rocket, and may migrate into vineyards when these areas dry up or are plowed under and the pests search for green growth. Adults are gray and about 0.12 inch long. Nymphs are gray with reddish brown abdomens. When they migrate, they are mainly in the wingless stage, and consequently they migrate by walking. A number of winged adults are also present, but instead of flying they march along with wingless immatures.

DAMAGE

Large numbers of nymphs and adults may suck plant juices and inject a toxin that causes vines to wilt and turn brown. Because of the great number of bugs involved and their toxic injections, all the leaves on border vines can be killed in a few hours. September and October migrations are also possible.

MANAGEMENT

False chinch bugs are mainly a problem in spring if large numbers move into vineyards as vegetation in surrounding areas dries. They are only a sporadic problem but occasionally cause rapid and serious damage to young vines.

Cultural Control

If false chinch bugs have been a problem in past years, disc under stands of London rocket and other host weeds about 3 weeks before budbreak in grapevines. Do not delay discing until after budbreak, for it may result in a heavy movement of bugs from the weeds to the vines.

Organically Acceptable Methods

Cultural controls are organically acceptable.

Monitoring and Treatment Decisions

If discing weeds was not done, and high populations of false chinch bugs are found on weeds at budswell or after budbreak, a treatment may be necessary. If nymphs are found moving onto vines, spot treat both vines and adjacent weeds. Bugs migrate mainly in one direction and the wilted vines along the edge of the vineyard will show the line along which they are moving. A chemical barrier about 30 inches wide can prevent further migration.

	Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
	The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
A.	DIAZINON* 50WP MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Avoid drift and tailwater runoff into surface waters.	1 lb	5 days	28
B.	MALATHION 8 Spray MODE OF ACTION GROUP NUMBER[1]: 1B	1.5–2.5 pt	24	3
C.	FENPROPATHRIN* (Danitol) 2.4EC MODE OF ACTION GROUP NUMBER[1]: 3 COMMENTS: See label for additional requirements regarding hand labor.	10.66–21.33 fl oz	24	21

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

GRAPE BUD BEETLE (9/07)

Scientific Name: *Glyptoscelis squamulata*

DESCRIPTION OF THE PEST The grape bud beetle is a major pest in the Coachella Valley. It can be found in the Central Valley but is rarely if ever a pest problem there. The adults are a light gray color. Both sexes are about 0.25 to 0.4 inch (6–10 mm) long and 0.2 to 0.25 inch (5–6 mm) wide. There is one generation per year and larval stages are spent in the soil. Adults begin emerging from the soil in mid-January; peak emergence occurs around mid-March each year. Emergence time is not affected by aboveground temperatures.

DAMAGE

Adult beetles cause crop loss by feeding on opening buds and eating the bud center, which contains the immature leaves and flower cluster primordia. Once the new shoots are 1 to 1.5 inches long, feeding damage is negligible.

MANAGEMENT

An important part of managing grape bud beetle is keeping accurate yearly records of infested vineyards. These beetles usually occur in localized areas of a vineyard year after year. Because grape bud beetles are not equally distributed, survey all parts of a vineyard.

Monitoring and Treatment Decisions

Adults come out of daytime hiding places about 1 hour after sundown. Beetles can be monitored with a flashlight. An ultra-violet lamp is preferred because the beetles naturally fluoresce a bright silvery blue when under UV light.

Treatment decisions for adults are complex. For example, unusually warm weather can push the buds out rapidly, or cold weather may delay budbreak and provide longer exposure of buds to beetle feeding. A variable portion of buds of all varieties never open in the Coachella Valley.

During budbreak, treatment is suggested when there are one to three beetles per vine and bud damage is noticeable in Thompson Seedless vineyards. Treatment is suggested during budbreak in Beauty Seedless, Perlette, Flame Seedless, and Cardinal vineyards when there are one to two beetles per vine and bud damage is noticeable.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
A. DIMETHOATE 25WP MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Moderately disruptive to beneficials.	6–8 lb	2 days	28
B. PHOSMET (Imidan) 70WP MODE OF ACTION GROUP NUMBER[1]: 1B	1.33 lb	5 days	7

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

GRAPE LEAFFOLDER (10/08)

Scientific Name: *Desmia funeralis*

DESCRIPTION OF THE PEST

Moths of the grape leaffolder are almost black, with two white spots on the forewings and two white stripes across the abdomen. Larvae are translucent but appear greenish because ingested leaf tissue shows through the body wall. Small black spots, located above the second pair of legs, are present on later instar larvae. This helps distinguish them from omnivorous leafroller.

Grape leaffolders have three generations a year (about April-May, June 15-July 15, and August). After overwintering as pupae, moths emerge in April or May and lay flat, elliptical eggs singly on either the upper or lower surface of the leaf. Many are deposited against the leaf veins on the underside of the leaf. After hatching, larvae feed between two webbed leaves for about 2 weeks. Then each pale green, translucent larva rolls a leaf edge and feeds from the inside on the leaf edge. Larvae turn darker green as a result of this leaf feeding. If disturbed, larvae wriggle vigorously and drop to the ground without a silken thread. Mature larvae construct a separate leaf envelope on the edge of a leaf in which they pupate.

DAMAGE

Grape leafroller can reduce leaf surface by constructing leaf rolls and by leaf feeding. Twenty percent leaf reduction can be tolerated 1 month after fruit set in the San Joaquin Valley. Even more leaf damage can be tolerated later. However, third generation damage can be severe enough to cause complete defoliation, which leads to sunburned berries, soft fruit, and direct berry feeding by leaffolder larvae.

MANAGEMENT

Parasites play an important role in keeping grape leaffolder below a level that will cause damage. There seems to be no correlation between the past season's population and the current season's first generation nor with the population density that may develop later. Treatment of the first generation is rarely needed. However, inspect and judge each brood as to its potential to cause economic damage.

Biological Control

Several parasites attack grape leaffolder. Among the most common is the larval parasite *Bracon cushmani*. After stinging and paralyzing leaffolder larvae, female *B. cushmani* lay from one to several eggs on the body of leaffolder larvae. *Bracon cushmani* larvae feed externally and, after completing their development, pupate next to the consumed host. Parasitism by this parasite frequently reduces second and third generation populations to below economic levels. In addition to *B. cushmani*, several other hymenopteran parasites and at least two species of flies parasitize leaffolder. Generalist predators such as lacewings and spiders also attack grape leaffolder larvae.

Organically Acceptable Methods

Biological control and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are organically acceptable methods.

Monitoring and Treatment Decisions

Grape leaffolder can be monitored along with other pests following the procedures in MONITORING CATERPILLARS. If grape leaffolders are present in the vineyard or have been a problem in the past, plan to treat at bloom. Otherwise, monitor for the characteristic group feeding of young larvae between leaves. As larvae begin making rolls, examine the vineyard every 2 to 3 days to detect a greater than expected increase. Record results on a monitoring form *(example form available online).*

Unroll leaves to check for parasitism. Populations tend to be spotty, and defoliation of a few vines used for raisin or wine grapes can probably be tolerated; however, table grapes should probably be treated. If treatment is warranted, treat as soon as a few rolls are noticed from the generation being treated because small larvae are more easily killed than older instars. Usually treatments applied for grapeleaf skeletonizer and omnivorous leafroller will also control grape leaffolder.

At harvest check table grapes for grape leafroller damage to assess your management program and prepare for next year.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. CRYOLITE

(Kryocide) 96WP	6–8 lb	12	30
(Prokil Cryolite) 96	6–8 lb	12	30

MODE OF ACTION GROUP NUMBER[1]: 9A

COMMENTS: Wine, table, and raisin**:** 2 applications maximum. Ground application only. If used on wine grapes or grapes that may be sold to a winery for export, observe their restrictions on applications. Cryolite is a stomach poison that must be ingested by the leaffolder to be effective so good coverage is essential and best timing is before leaf rolling begins. Do not apply more than 20 lb/acre/year.

B. SPINOSAD

(Entrust)#	1.25–2.5 oz	4	7
(Success)	4–8 oz	4	7

MODE OF ACTION GROUP NUMBER[1]: 5

COMMENTS: Apply when eggs first hatch to target the young larvae. A stomach poison; most effective when ingested. Heavy infestations require a second application in 4 or 5 days. to protect honeybees, apply only during late evening, night, and early morning when bees are present in the vineyard.

C. METHOXYFENOZIDE

(Intrepid) 2F	10–16 fl oz	4	30

MODE OF ACTION GROUP NUMBER[1]: 18A

COMMENTS: An insect growth regulator that affects lepidopterous larvae only. Must be ingested; most effective when applied to young caterpillars.

D. BACILLUS THURINGIENSIS ssp. KURSTAKI#

(various products)	Label rates	4	0

MODE OF ACTION GROUP NUMBER[1]: 11.B2

COMMENTS: Only effective against young larvae. A stomach poison that must be ingested by the leaffolder to be effective; good coverage is essential. Has a short residual so is most effective when applied 3 or 4 days before leaf rolling by the main brood.

E. METHOMYL*

(Lannate) LV	0.75–1.5 qt	7 days	Raisin/Table: 1
(Lannate) 90SP	0.5–1 lb	7 days	Wine: 14

MODE OF ACTION GROUP NUMBER[1]: 1A

COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites, parasites of leafhopper and may contribute to mealybug outbreaks as well.

F. CARBARYL*

(Sevin) 80S	1.25–2.5 lb	12	7
(Sevin) 10% Dust	20–25 lb	12	7

MODE OF ACTION GROUP NUMBER[1]: 1A

COMMENTS: May encourage mite outbreaks; do not use where mites are a chronic problem.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

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GRAPE PHYLLOXERA (10/08)

Scientific Name: *Daktulosphaira vitifoliae*

DESCRIPTION OF THE PEST

Grape phylloxera is a tiny aphidlike insect that feeds on *Vitis vinifera* grape roots, stunting growth of vines or killing them. This pest prefers heavy clay soils that are found in the cooler grape-growing regions of the state such as Napa, Sonoma, Lake, Mendocino, and Monterey counties, as well as the Sacramento Delta and the foothills. Although grape phylloxera is present in the heavier soils of the San Joaquin Valley, damage may not be as severe. It is not a pest on sandy soils.

The majority of grape phylloxera adults are wingless females. They are generally oval shaped, but those that lay eggs are pear shaped. They are small (0.04 inch long and 0.02 inch wide) and vary in color from yellow, yellowish green, olive green, to light brown, brown, or orange. Newly deposited eggs are yellow, oval, and about twice as long as wide. Nymphs resemble adults except they are smaller.

Grape phylloxera overwinter as small nymphs on roots. In spring when soil temperatures exceed 60°F, they start feeding and growing. First instar nymphs are active crawlers and may move from plant to plant in the ground, on the soil surface, or by blowing in the wind. They may also be moved between vineyards on cuttings, boots, or equipment. Established phylloxera feed externally in groups on roots. In fall when soil temperatures fall below 60°F, all life stages die except the small nymphs. There are three to five generations each year.

Occasionally, winged phylloxera are seen in *V. vinifera* vineyards, but they are believed to be sterile under California conditions.

DAMAGE

Grape phylloxera damage the root systems of grapevines by feeding on the root, either on growing rootlets, which then swell and turn yellowish, or on mature hardened roots where the swellings are often hard to see. Necrotic spots (areas of dead tissue) develop at the feeding sites on the roots. The necrotic spots are a result of secondary fungal infections that can girdle roots, killing large sections of the root system. Such root injury causes vines to become stunted and produce less fruit.

Severity of infestation will differ with the vigor of the grapevine as well as with soil texture and drainage. Leaf-galling forms of phylloxera that are common in eastern states are extremely rare in California vineyards.

MANAGEMENT

Resistant rootstocks are the only completely effective means for phylloxera control in the most severely affected areas. A pesticide treatment will not eradicate phylloxera populations; the chemical cannot easily penetrate the heavy soils that this pest prefers. Also, effectiveness of a treatment is difficult to evaluate because although many phylloxera may be killed, populations may rebound rapidly and resume feeding on the vines. Because it may take years of insecticide treatments to reverse severe damage, treatments to prevent damage may be a better strategy than curative treatments.

Biological Control

Little information on biological control of grape phylloxera is available; environmental and root conditions are more important than natural enemies.

Cultural Control

Avoid rootstocks that have *V. vinifera* parentage because virulent biotypes of phylloxera can be selected and may eventually damage these rootstocks (the biotype B damage of the rootstock AXR#1 in many counties in California is an example of this type of problem). It is necessary to use rootstocks that have strong resistance and no *V. vinifera* parentage for durable protection against phylloxera. Contact your farm advisor for the most recent information on local rootstock trials and suggestions on the best rootstock for specific agronomic conditions. When planting a new vineyard use only clean propagating material and do not hold clean material in infested areas before planting. Young resistant rootstock vines will support low phylloxera populations and may be stunted if replanting occurs in heavily infested soils. Contact your farm advisor for suggestions on replanting procedures.

In the hot Central Valley, phylloxera damage may be reduced by good water management, fertilization, and other cultural practices that help limit plant stress.

Organically Acceptable Methods
Resistant rootstocks are an organically acceptable management tool for this pest.

Monitoring and Treatment Decisions
Initial infestations of grape phylloxera appear as a few weakened vines. These insects are difficult to detect in an apparently healthy vineyard. Therefore, monitor vines at harvest in an area of the vineyard that has consistently displayed weaker growth, especially vines at the edges of the weak areas. Grape phylloxera are more readily identified on vines growing in poor soils because their impact is greater on these vines than on vigorously growing vines.

In North Coast vineyards infected vines may initially exhibit potassium deficiency symptoms. The infested area expands concentrically at a rate of two- to fourfold a year. Satellite infestations frequently establish downwind from larger infested areas. When searching for phylloxera, be aware that populations die out on declining vines. Therefore, concentrate monitoring efforts on the periphery of declining areas where damage symptoms are still minimal. Dig near the trunk of vines under the drip emitter and look for whitish yellow, hooked feeder roots that are galled. Examine the galls with a hand lens for the presence of phylloxera.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. SODIUM TETRATHIOCARBONATE
(Enzone) — Label rates — 4 days — 14
MODE OF ACTION: Unknown. A thiocarbonate insecticide.
COMMENTS: Crop must be at least 1 year old or injury may occur. Can be applied anytime during the growing season by metering it into irrigation water in drip, flood, or furrow irrigation systems. When vineyards have a moderate to high level of infestation, this material may not be effective.

B. IMIDACLOPRID
(Admire Pro) — 7–14 fl oz — 12 — 30
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Has been shown to reduce populations when applied in 1 or 2 drip irrigations; also allows an increase in root growth. Best results occur when 2 applications of 16 oz each are made per year. Soil moisture is important for effective soil application; follow label instructions carefully. Do not exceed 0.5 lb imidacloprid/acre/year.

** Apply with enough water to provide complete coverage.
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

HOPLIA BEETLES (9/07)

Scientific Name: *Hoplia* spp.

DESCRIPTION OF THE PESTS

Hoplia beetles are robust beetles that measure 0.25 to 0.3 inches long. The dorsum of the adult beetles is reddish brown and their heads are darker. The underside of the body is silvery and shiny. The whitish larvae are found in the ground and are C-shaped with a bulbous posterior. Adults emerge from the soil in spring and fly to vineyards to feed and mate.

DAMAGE

Feeding damage is usually sporadic within the vineyard but may recur annually in the same area. Plant injury usually occurs when shoots are 12 to 14 inches long and consists of feeding on developing fruit clusters and leaves.

MANAGEMENT

Damage by hoplia beetles occurs so seldom that in most cases spot treatments applied where damage is observed are sufficient. Spring treatments applied for other pests probably suppress most hoplia infestations that do occur. Few products are registered specifically for this use.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
A. PHOSMET (Imidan) 70W MODE OF ACTION GROUP NUMBER[1]: 1B	1–2.12 lb	5 days	7-14
B. CARBARYL* (Sevin) 80S MODE OF ACTION GROUP NUMBER[1]: 1A COMMENTS: Extremely toxic to honey bees and may cause mite outbreaks. Do not use where mites are a chronic problem.	2.5 lb	12	7

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

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LEADCABLE BORER (6/06)

Scientific Name: *Scobicia declivis*

DESCRIPTION OF THE PEST

Leadcable borer is a cylindrical black beetle, 0.25 to 0.35 inch long, that emerges from round holes in trunks or cordons of damaged vines and from dead wood during spring and early summer. The head of the leadcable borer is mostly concealed from above by a hoodlike pronotum. Larvae are 0.35 inch long and cream colored with a small, dark head. The larvae are C-shaped and may be found feeding in tunnels on the vine. This beetle is not a common pest of grape, but has been observed in San Joaquin County and North Coast vineyards. It has also been reported to infest oak wine barrels and corks.

DAMAGE

Adults bore into wood to prepare egg tunnels. Leadcable borer larvae feed in trunk or cordon wood for up to 9 months during development, creating frass-filled tunnels that can weaken vine structure. They can reinfest the wood from which they emerge. Distribution of infested vines is typically localized within vineyards.

MANAGEMENT

The best method of control is good sanitation. Remove prunings and dead wood from the vineyard and destroy by burning or by thoroughly discing or flailing before adults emerge in spring. Remove dead or damaged wood from vines. Leadcable borer can become a chronic problem in infested vineyards and may take several years to control by cultural means. No material is registered specifically for this pest; however, sprayable materials used for cutworms, grape leaffolder, and other species applied when adult beetles are present may also help control leadcable borer. Once this borer is in the wood, however, chemical control is not effective.

LEAFHOPPERS (10/08)

Scientific Names: Western grape leafhopper: *Erythroneura elegantula*
Variegated leafhopper: *Erythroneura variabilis*

DESCRIPTION OF THE PESTS

The grape leafhopper is a pest of grapes north of the Tehachapi Mountains, especially in the San Joaquin, Sacramento, and North Coast valleys. It is also a problem in warmer, interior Central Coastal valleys. The variegated leafhopper is the major pest of grapes in southern California and in the Central Valley as far north as San Joaquin County.

Leafhoppers overwinter as adults and are found in spring on basal grape leaves and weeds. The adult grape leafhopper is about 0.12 inch (3 mm) long and light to pale yellow with distinct dark brown and reddish markings. Eggs of the first brood are laid in epidermal tissue on the underside of the leaves in April and May and appear as a bean-shaped, blisterlike protuberance that is slightly less than 0.04 inch (1 mm) long. Although similar in size to the grape leafhopper, the variegated leafhopper is darker in color and distinctly mottled brown, green, and white with a reddish tinge. The nymphs are almost transparent when first emerged, becoming orange-brown to yellow-brown, in contrast to the white nymphs of the grape leafhopper. Eggs are similar in appearance to the grape leafhopper but laid deeper within the leaf tissue. This latter characteristic reduces the effectiveness of the egg parasite against variegated leafhopper.

DAMAGE

Nymphs and adults of both species remove the contents of leaf cells, leaving behind empty cells that appear as pale yellow spots or stippling. If populations are high, the entire leaf may be pale yellow or white. Loss of leaf efficiency and leaf drop can occur when leafhopper densities are extremely high. This can result in fruit sunburn and may delay fruit ripening, especially in young vines. If there is a significant reduction in the overall photosynthetic capacity of the vine, young or stressed vines may have less shoot growth the following season.

The accumulation of small droplets of excrement on berries and the associated growth of sooty mold results in berry spotting that is a concern in table grapes. Adult leafhoppers are also a nuisance to workers when populations are high at harvest time. Their excrement appears as minute, sticky clumps that darken with age.

MANAGEMENT

Although leafhoppers infest most vineyards in California, they may not require chemical treatment because vines can tolerate fairly high populations without harm, and predators and parasites may be able to maintain leafhopper populations below tolerance levels. In coastal regions and the Central Valley, however, grape leafhopper populations may occasionally reach damaging levels and require treatment. If chemical control of leafhopper is necessary, wait until the second (summer) generation, whenever possible, before treating.

Biological Control

Many natural enemies help to provide control of leafhopper Egg parasites, including *Anagrus epos* and other *Anagrus* spp., are commonly found in vineyards during part of the season. These parasites may be more abundant in vineyards that are adjacent to prune, plum and almond orchards, and riparian areas where other leafhoppers that overwinter in the egg stage reside. *Anagrus* spp. can parasitize these eggs and survive the winter. After a leafhopper egg is parasitized it becomes visibly red. Unfortunately, this parasite is not as effective on variegated leafhopper eggs as it is on those of the grape leafhopper. Sulfur sprays applied for fungal control are very toxic to *Anagrus* spp.

General predators of grape leafhoppers include spiders, green lacewings (*Chrysopa* spp.), minute pirate bugs (*Orius* spp.), lady beetles (*Hippodamia* spp.), and predaceous mites. The predaceous mite, *Anystis agilis*, is an important predator of first instar nymphs especially in the North Coast. Although many growers have experimented with releases of lacewings for leafhoppers, control of economic populations has not been achieved in university field trials.

Cultural Control
Removing basal leaves or lateral shoots during berry set and the 2-week period following (before adult leafhoppers emerge), as recommended for Botrytis bunch rot management, will normally reduce peak leafhopper populations during the season by 30-50%. This coupled with *Anagrus* activity may preclude the need for insecticide treatment even when leafhoppers exceed the thresholds below. Time leaf removal to coincide with first generation nymphal development up to and including the 5th instar but just before adults are present. Also, leaf removal will improve coverage and efficacy of pesticides. In warmer growing areas, be careful not to remove excessive numbers of leaves, which can lead to sunburned fruit. Preventing overly vigorous vine growth will also help suppress leafhoppers.

If the vineyard is accessible before budbreak and erosion is not a risk, remove weeds in vineyards and surrounding areas before vines start to grow in spring to reduce adult leafhopper populations that might disperse to new grape foliage.

Organically Acceptable Methods
Biological and cultural control methods, including basal leaf removal, assist in control. Narrow range oils, insecticidal soaps, or kaolin clay may give partial control when nymphs are small. Soaps may spot table grapes and should only be used before bloom on this crop.

Monitoring and Treatment Decisions
About 4 weeks after budbreak, or whenever nymphs first appear, begin sampling for leafhoppers. Randomly select 20 vines in each block of the vineyard, each at least a few vines in from the end of the row.

How to monitor:
- *First generation nymphs*—On each vine, choose one leaf at the 3rd or 4th node up from the basal node.
  Second and third generation nymphs—Choose young but fully expanded leaves in middle of canes.
- Count nymphs on underside of each leaf. Note whether they are grape leafhopper nymphs, variegated leafhopper nymphs, or both.
- Check the leaves for red, parasitized eggs or eggs with emergence holes.
- Record observations on a monitoring form *(example form available online).*

Continue monitoring weekly until harvest. Starting at bloom, combine leafhopper monitoring with monitoring for spider mites and mealybugs see MONITORING INSECTS AND SPIDER MITES.

Treatment thresholds. Treatment thresholds vary according to leafhopper generation; whether grapes are being grown for table, wine, or raisin use; canopy size; region; and degree of parasitization. A level of 10-30% parasitism on eggs of the first generation may result in economic control of the grape leafhopper during the second and third generations. However, if the leafhopper population is made up primarily of the variegated leafhopper, economic control by this parasite is less likely, although a combination of parasite and predator activity can be effective. Use the general guidelines below to help determine treatment needs. If treatment is necessary, removing basal leaves will allow better spray coverage and thus improve pesticide efficacy.

Wine and raisin Thompson Seedless grapes. For the first generation, treatment is not necessary if 20 or fewer nymphs per leaf are found. If *Anagrus* is active on eggs of the first generation, it is best not to treat unless leafhopper numbers are well above 20 per leaf. Also helpful is the removal of basal leaves before adults of the first generation appear, as described under CULTURAL CONTROL, to allow better spray coverage and thus improve efficacy of the pesticide. If you have to treat, wait until more than half the nymphs are in the third instar; this allows sufficient time for most eggs to have hatched.

For the second or third generation on wine and raisin Thompson Seedless grapes, the treatment threshold is 15 to 20 nymphs per leaf. Generally lower populations do not need treatment. However, coastal wine grapes with a low incidence of parasitism and small canopies may have a threshold of 10 to 20 nymphs per leaf. Vigorously growing vines can support higher populations.

Table grapes. Treatment level is lower for table grapes because they need better fruit protection. For the first generation, treat if more than 15 leafhopper nymphs per leaf are found. In the second and third generations, early varieties (Flame Seedless) should not exceed 10 nymphs per leaf; midseason varieties (Thompson) 5 to 10 nymphs per leaf; and late varieties (Emperor) 5 to 8 nymphs per leaf. Large populations of adult leafhoppers in the fall are very annoying to workers who are hand harvesting grapes. A treatment just before harvest may be warranted if adult populations are high.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. IMIDACLOPRID
(Provado Solupak) 75WP — 0.75–1 oz — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Foliar application: allow at least 14 days between applications. Do not exceed 0.5 lb a.i. of imidacloprid/acre/year.
. . . *or* . . .
(Admire Pro) — 7–14 fl oz — 12 — 30
COMMENTS: Apply a total of 7-14 fl oz/acre in one or two drip irrigation applications. Two applications 21–45 days apart are recommended on coarse soils or where the longest periods of protection are required. Make first application between budbreak and pea-berry stage. A total of 14 fl oz/acre is recommended where vigorous vine growth is expected or in warmer growing areas such as the Coachella, San Joaquin, or Sacramento valleys. Soil moisture is important for effective soil application; follow label instructions carefully.

B. BUPROFEZIN
(Applaud) 70WP — 9–12 oz — 12 — 30
MODE OF ACTION GROUP NUMBER[1]: 16
COMMENTS: An insect growth regulator; kills predatory beetles. Good coverage is essential. Apply no more than 2 applications/season. Allow at least 14 days between applications. Use allowed under FIFRA section 2(ee) recommendation.

C. ACETAMIPRID
(Assail) 70WP — 1.1 oz — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 4A

D. PYRETHRIN/ PIPERONYL BUTOXIDE
(Pyrenone Crop Spray) — Label rate — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 3 and 27A
COMMENTS: Spray containers with 1 pt/150 gal water and as needed. Apply alone or in combination with a narrow range oil. Use in combination with a narrow range oil when treating the first generation leafhoppers, except on table grapes. Do not use oil on later generations.

E. ENDOSULFAN*
(Thionex) 50W — 2–3 lb — 2 days — 0
MODE OF ACTION GROUP NUMBER[1]: 2A

F. INSECTICIDAL SOAPS/NARROW RANGE OIL# — Label rates — 12 — 0
MODE OF ACTION: Contact insecticides with smothering and barrier effects.
COMMENTS: Partially effective on low leafhopper populations if applied when nymphs are small. Research indicates soap works better in combination with low rate of oil. Care must be taken as both products can spot the waxy bloom on the berry. Do not apply sulfur within 10 days of a sulfur spray.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
G. DIMETHOATE 25WP	6–8 lb	2 days	28
MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: To avoid visible deposits on grapes, do not apply after berries reach 0.25 inch diameter. May not be effective in all areas due to resistance. Disruptive to natural enemies.			
H. KAOLIN CLAY# (Surround) WP	12.5–37.5	4	14
MODE OF ACTION: Unknown. An inorganic insecticide. COMMENTS: An organically acceptable alternative for wine grapes.			

** Apply with enough water to provide complete coverage.

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

Acceptable for use on organically grown produce.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

MEALYBUGS (PSEUDOCOCCUS) (10/08)

Scientific Names: Grape mealybug: *Pseudococcus maritimus*
Obscure mealybug: *Pseudococcus viburni*
Longtailed mealybug: *Pseudococcus longispinus*

DESCRIPTION OF THE PESTS

Three species of mealybugs in the genus *Pseudococcus* may infest vineyards: the grape, obscure, and longtailed mealybugs. The primary species of concern in North Coast and San Joaquin Valley vineyards are the grape and obscure mealybugs. In Central Coast vineyards, obscure and longtailed mealybugs can cause damage. In the Coachella Valley, longtailed mealybug may occur. Vine mealybug, *Planococcus ficus,* is covered in a separate section of this publication.

Life cycles. Grape and obscure mealybugs lay yellow to orange eggs within an egg sac; longtailed mealybugs give birth to live crawlers. Crawlers of all three species are yellow to orange-brown in color. The grape mealybug has two generations each year and overwinters as an egg or crawler in or near a white, cottony egg sac under loose bark and in the cordons or upper portions of the trunk. In spring most grape mealybug crawlers move toward the base of spurs and then onto expanding green shoots, reaching maturity in mid-May to early June. Most females return to old wood to lay eggs that hatch from mid-June to July. First generation crawlers then move out to the green portions of the vine to feed on fruit and foliage in late June or early July; mostly immatures are seen through July. Adult females will appear in late summer and early fall. Some females will oviposit in the fruit clusters but the majority of the females return to the old wood to lay the overwintering eggs.

Obscure and longtailed mealybugs do not diapause over the winter and have multiple overlapping generations with all life stages present on the vines year round. Obscure mealybug overwinters under the bark of the trunk, cordons, and spurs (the same as grape mealybug). In late spring some obscure mealybugs begin to feed on leaves, but the majority of the population remains hidden under the bark or in the tight clusters.

Appearance. Adults of all three *Pseudococcus* species are about 0.2 inch long, flat, oval shaped, and have a white waxy covering with wax filaments sticking out from circumference of the body. Longer filaments from the posterior end make these mealybugs appear to have "tails." These filaments are longer than those on the vine mealybug, a newly introduced species that is covered in a separate section.

The grape mealybug and the obscure mealybug closely resemble each other. One method of distinguishing them in the field is to poke a female with a sharp point (without puncturing the body) to elicit the release of a defensive excretion. If the color of the fluid excreted is reddish orange, then it is most likely grape mealybug; if it is clear, it is most likely obscure mealybug. Another distinguishing characteristic is based on the different life cycles of the two species: grape mealybug diapauses in winter and has two generations a year that do not overlap. Consequently, if only one or two life stages of a mealybug are present at a given time, it is most likely a grape mealybug because obscure mealybug does not diapause and thus all life stages are present throughout the year.

Longtailed mealybug is similar in appearance to the other two species but has much longer waxy filaments on the posterior end (they are as long or longer than the body of the adult female). Longtailed mealybugs are only a problem in Central Coast vineyards.

DAMAGE

In recent years there have been increases in the number of grape mealybug infestations in the San Joaquin Valley and North Coast and an increase in the incidence of obscure and longtailed mealybugs in Central Coast vineyards. Susceptibility to mealybug damage varies by variety. It is worse on varieties that produce clusters close to the base of the shoot because the fruit often touches old wood. Mealybugs damage grapes by contaminating clusters with cottony egg sacs, larvae, adults, and honeydew. Often the honeydew is covered with a black sooty mold. All three species can transmit grape viruses.

MANAGEMENT

Detecting and marking mealybug infestations during harvest is a key to monitoring populations the following season. Once established, parasites and predators can help keep populations down, but an

infestation may slowly spread unless controlled with insecticides. Leaving untreated areas in the vineyard is effective in increasing predator and parasite populations, however, under heavy population pressure, this may not be feasible. When treating mealybugs, leave at least one out of every 10 acres untreated to provide a refuge for natural enemies, or treat with an insecticide that is not toxic to parasites, see RELATIVE TOXICITIES TABLE.

Honeydew-seeking ants must be controlled in order to allow natural enemies of mealybugs to aid in mealybug control. Controlling ants may sufficiently allow parasites and predators to control mealybugs. Ant control is best accomplished either with tillage, cover crops of common vetch, or with sprays of chlorpyrifos (Lorsban) directed at the soil surface. Chlorpyrifos may only be used for either mealybug control in grapes in a given year or for ant control but not both. See the section on ANTS for additional information on control.

Biological Control
Many natural enemies play a part in the biological control of mealybugs. At least five species of parasitic wasps attack grape mealybugs in California. Little research on these parasites has been conducted, but it is assumed they play a prominent role in regulating populations. The impact of the different species varies from time to time and place to place. Grape mealybugs that are parasitized by two tiny wasps, *Acerophagus notativentris* and *Pseudophycus angelicus*, have multiple emergence holes that are easily seen with a hand lens. Ants must be controlled to keep them from interfering with these natural enemies. Two parasitic wasps, *Pseudophycus flavidulus* and *Leptomastix epona*, have been imported for release against obscure mealybugs but are not commercially available. To ensure survival of parasites, do not use methomyl or other disruptive insecticides during the growing season.

The most effective mealybug predator is a lady beetle called the mealybug destroyer, *Cryptolaemus montrouzieri*, which can be found in coastal regions. Cecidomyiid flies prey on mealybug eggs and small larvae. These predators plus lacewings, minute pirate bugs, and spiders are important in keeping mealybug populations in check.

Cultural Control
If gray field ants (*Formica* spp.) are tending grape mealybug and protecting them from parasites, studies show that planting a cover crop of common vetch (*Vicia sativa*) can help reduce the number of ants present on the vines. Common vetch has an abundance of extra floral nectaries that attract the ants away from grape mealybug, thus exposing the mealybugs to parasites. In research studies, common vetch was fall seeded in a 80:20 mixture with 20% Merced rye. The cover crop established itself in late fall and winter so that by early spring it was ready to attract the ants. A heavy seeding rate (120 lb/acre) helps to ensure a good stand. The effect of other nectary-bearing cover crops on attracting ants has not been evaluated. (Research using cover crops to attract Argentine ants, *Linepithema humile*, has not been conducted.)

Grape mealybug infestations can also be reduced by training vines so that clusters hang freely and do not touch the wood.

Monitoring and Treatment Decisions
Monitor mealybugs closely throughout the year. Detecting and mapping populations at harvest is important for monitoring populations the following season. Infestations may be spotted in both summer and winter by looking for the presence of honeydew and sooty mold. Also, look for ants on the vines because their presence is a good indication of a mealybug infestation. If ant activity is high, however, the amount of honeydew on the plant may be minimal because the ants harvest it.

Be sure to monitor parasitism by collecting mealybugs and holding them in gelatin capsules (available from pharmacies) to detect parasite emergence. If parasitism is found, leaving untreated areas of the vineyard can provide refuges in which the parasites can survive.

If monitoring indicates that population levels are low, a single treatment in the delayed dormant period should be adequate. For high infestation levels, treat both in the delayed dormant season (January to March) and in summer. Crawlers and young nymphs are the stages most susceptible to insecticides. *Grape mealybugs* have two generations a year, and crawlers are present from delayed dormancy to early spring and again in summer (June or July). The most effective treatment timing is when crawlers are

present. *Obscure and longtailed mealybugs* do not diapause in winter and, therefore, all life stages can be present in the vines. Studies indicate that the most effective treatment timing for these two species is in the delayed dormant period (chlorpyrifos) or in late spring (imidacloprid).

Delayed dormant treatments. If the vineyard had an infestation at harvest, monitor for mealybugs in late February to early March. (This monitoring can be done along with monitoring for other pests as described in DELAYED-DORMANT AND BUDBREAK MONITORING (wine/raisin grapes or table grapes). Peel back the thin bark on spurs in the current season's prunings and look for the presence of crawlers. For wine and raisin grapes, if an average of one spur or cane of every five sampled (i.e. 20% or more) has crawlers, a delayed dormant treatment is warranted. For table grapes, the threshold is an average of one spur or cane of every 10 sampled (10% or more). Record results *(example formavailable online).* Applications are best made as dilute sprays applied by a ground rig.

Spring treatments. If a delayed dormant treatment was not applied, be sure to monitor in late March or April for immatures under the bark in cordons and spurs. Monitor for mealybugs along with other pests as outlined in MONITORING INSECTS AND SPIDER MITES.

Summer treatments. In late May/early June, examine the base of spurs for mature grape mealybug females and/or ant movement on the vine.

- Choose 20 vines from different areas of the vineyard.
- Inspect 1 spur per vine to determine how many of the 20 vines are infested. Note that ant movement and honeydew are signs of mealybug presence.
- Record each vine that has a spur with grape mealybug on a monitoring form *(example form available online).*
- Treatment may be warranted if 20% or more of the spurs on wine and raisin vines are infested with female grape mealybug; the threshold for table grapes is 4%.
- Be sure to monitor parasitism by collecting mealybugs and holding them in gelatin capsules to detect parasite emergence. If parasitism is found, leaving untreated areas of the vineyard can provide refuges for parasites.

Cluster monitoring. Clusters that touch old wood can also be monitored during the period from June 15 to July 15. If no crawlers are detected in the clusters, little or no infestation is present. If a single treatment is applied in summer, make a foliar application in June, 1 to 2 weeks after egg hatch. Be sure to make summer treatments when mealybugs are small and vulnerable; once they are more than half-grown, foliar treatments may not be effective.

On raisin and wine grapes, make a dilute application, whereas only make concentrate applications on table grapes at this time of year to avoid berry spotting. It is important to note that once mealybugs have moved into the clusters and after bunches in wine grape varieties have closed, foliar treatments are not effective. *Educate field workers or harvest crew to recognize mealybug cluster infestations and flag vines for treatment.*

Postharvest treatments are not effective against *Pseudococcus* mealybugs because the majority of the population is in the egg stage under the bark and not vulnerable to foliar treatments at this time.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

SPRING

A. IMIDACLOPRID
(Admire Pro) 7–14 fl oz 12 30
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Imidacloprid binds readily to soil; when the soil is rewetted and plant roots are actively absorbing water, the insecticide is also absorbed by roots. Best when applied in a drip irrigation system; otherwise, French plow the soil, apply as a ground spray, and immediately irrigate. Apply from 7-14 fl oz/acre in one or two drip irrigation applications. On coarse soils or where the longest period of protection is required, make two applications. Make the first application from bloom through the pea-sized berry stage and the second 21 to 45 days later, keeping in mind the preharvest interval. The full rate of 14 oz/acre is recommended where vigorous vine growth is expected or in warmer growing areas such as the San Joaquin or Sacramento valleys or where mealybug populations are heavy. Do not exceed 0.5 lb a.i. of imidacloprid/acre/year. Adequate soil moisture is important at the time of application; follow label instructions carefully.

SUMMER

Note: *Make applications before mealybugs move into clusters and before bunches in winegrape varieties have closed.*

A. BUPROFEZIN
(Applaud) 70WP 12 oz 12 30
MODE OF ACTION GROUP NUMBER[1]: 16
COMMENTS: An insect growth regulator. This material targets the early stage nymphs on the vine that are exposed and still moving around before they settle under the bark to feed. Good coverage is essential. Tank mixes are not recommended. Do not apply more than twice per season and allow at least 14 days between application. In regions outside of the North Coast, most effective when applied once in the delayed dormant period and once in early summer (May-June). In the North Coast, the first application of buprofezin is not recommended until late spring or early summer. Buprofezin may be detrimental to the mealybug destroyer *(Cryptolaemus montrouzieri)* when applied during the summer. Use allowed under a FIFRA 2(ee) Recommendation.

B. METHOMYL*
(Lannate LV) 0.75–1.5 qt 7 days Raisin/Table: 1
(Lannate) 90SP 0.5–1 lb 7 days Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhoppers.

C. DIMETHOATE 400 2 qt 2 days 28
DIMETHOATE 25WP 6–8 lb 2 days 28
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Moderately disruptive to beneficials. The wettable powder formulation is recommended for table grapes, which are spotted by the emulsifiable concentrate formulation. The emulsifiable formulation, however, is preferred for wine grapes. Use of Dimethoate 400 allowed under a FIFRA 2(ee) Recommendation.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

OMNIVOROUS LEAFROLLER (10/08)

Scientific Name: *Platynota stultana*

DESCRIPTION OF THE PEST

The adult omnivorous leafroller is bell-shaped with blackish gray snoutlike mouthparts that protrude forward from the head. Forewings are dark rusty brown with the tip being tan in color. Size varies from 0.38 to 0.5 inch long. Omnivorous leafroller overwinters in the larval stage in grape mummies, vineyard weeds, and other trash in the vineyard. In spring, larvae complete their development and moths emerge and lay shinglelike egg masses on grape leaves. After about 5 days these eggs hatch, and larvae web two young leaves together to form a nest in which they feed. It does not roll leaves as does the grape leaffolder; instead, it ties leaves together and feeds inside. Later, nests can be found in flower clusters (May) and bunches (June-Sept.), as well as on leaves and in shoot tips.

Omnivorous leafroller larvae are often confused with grape leaffolders. Omnivorous leafrollers can have either a black or brown head capsule, depending on the instar. Mature larvae range in color from cream to brownish green with whitish slightly convex tubercles on the top of the abdomen. The grape leaffolderdoes not have whitish tubercles. In addition omnivorous leafroller larvae usually drop to the ground on a thread when disturbed, rather than dropping directly, as is the case with the grape leaffolder.

Generally, there are four flight periods each year with a partial fifth in warmer years. Adult flights generally occur in spring (Feb-April), late May, mid-July, and late August or early September. The first of five larval instars appears a short time after a flight starts.

DAMAGE

The omnivorous leafroller can cause serious damage in California's Central Valley and inner coastal vineyards. Although it does feed on leaves, flowers, and developing berries, the most significant damage occurs after veraision when feeding allows rot organisms to enter fruit at the damage sites.

MANAGEMENT

Populations are usually small in spring and early summer but may increase greatly later in summer and cause severe berry rot problems. The increase may be a result of migration triggered by the drying out of weed plant hosts. Consequently, cultural control is an important component in managing this pest. Spring treatments are recommended if the vineyard has a history of problems with this pest. Otherwise chemical treatments are necessary only when monitoring indicates a need.

Biological Control

More than 10 species of parasites have been recorded from omnivorous leafroller. However, seldom does mortality from these parasites exceed 10%. Predators such as lacewings, minute pirate bugs and spiders have also been found to feed on omnivorous leafroller larvae.

Cultural Control

During the dormant season remove mummy clusters and control vineyard weeds. French plow and disc clusters and weeds to bury overwintering larvae living on weeds in ground duff and dried berries. During dormancy, prune out old fruit mummies and destroy by flailing or shredding. Early harvest can also prevent infestation by fourth generation larvae. Removing basal leaves will also improve coverage and efficacy of cryolite, *Bacillus thuringiensis*, and other pesticides. In warmer growing areas, be careful not to remove excessive numbers of leaves, which can lead to sunburned fruit.

Organically Acceptable Methods

Cultural and biological controls and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are acceptable on organically certified grapes.

Monitoring and Treatment Decisions

Treat for omnivorous leafroller at bloom if the vineyard has a history of this pest or if a serious infestation occurred in the previous season. Otherwise, monitor to determine the need for treatment. Monitor along with other caterpillars as outlined in MONITORING CATERPILLARS; record results on a monitoring form *(example form available online)*.

Acceptable damage levels at harvest are about 1-2% for raisin grapes and less for wine and table grape varieties. Trying to reduce damage any further than this threshold would probably not be cost effective.

Thorough coverage with spray applications is extremely important to protect the berries. Such coverage is difficult in tight bunches so make a major effort to control this pest before bunch closing. Improved coverage and efficacy of pesticides can be obtained by removing basal leaves, see CULTURAL CONTROL. In Central Valley and other warm inland valley vineyards, use pheromone traps, degree-days, and monitoring to assess omnivorous leafroller populations.

Pheromone traps. Place pheromone traps in the vineyard just before budbreak, and check traps twice a week. Information obtained from trap catches is used to establish a biofix, which is an identifiable point in the life cycle of this pest. For omnivorous leafroller, the biofix is the first night moths are consistently caught in traps. Continue to monitor with pheromone traps through fruit set, until berries are pea-sized, to track adult flights of subsequent generations. For information on placing and monitoring traps in a vineyard, see PHEROMONE TRAPS.

Degree-days. Once biofix is reached, begin accumulating degree-days from the biofix using a lower threshold of 48°F and an upper threshold of 87°F. (For assistance in calculating degree-days, see Degree-days" on the UC IPM Web site). When 500 degree-days have accumulated, egg hatch starts, and it is time to sample clusters.

Monitoring. At bloom, monitor 200 flower clusters (10 clusters in the middle of 20 vines) to determine if omnivorous leafroller is present. If you find any omnivorous leafrollers or damage, treat.

Following bloom, if there is a cover-crop or abundant weeds, use a sweep-net to sample for larvae or thoroughly inspect the weeds. If larvae are found in the weeds but not in the grape clusters, start sampling clusters intensively for second generation larvae at 300 degree-days after the 2nd flight biofix (minimum of once a week and 200 clusters). Treatments are warranted if more than 1% of the clusters have omnivorous leafroller larvae or nests. Because of the additional foliage at this time (late June-early July), apply second generation treatments at a slow speed (max. 3 mph) to achieve adequate coverage of the clusters.

If surrounding crops are producing omnivorous leafroller moths, a 3rd generation treatment might be necessary. Monitor table grapes at harvest for omnivorous leafroller damage to assess this year's management program and to plan for next year.

Common name (trade name)	Amount / Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
FIRST GENERATION			
A. CRYOLITE			
(Kryocide) 96WP	6–8 lb	12	30
(Prokil Cryolite) 96	6–8 lb	12	30
MODE OF ACTION GROUP NUMBER[1]: 9A			
COMMENTS: Wine, table, and raisin**:** 2 applications maximum. Ground application only. If used on wine grapes or grapes that may be sold to a winery for export, observe their restrictions on postbloom applications. Early season treatment effectively reduces populations and doesn't cause outbreaks of other pests (mites, leafhoppers). Can provide season-long control of light-to-moderate populations. Good coverage of clusters is critical. Cryolite is a stomach poison that must be ingested to be effective.			
B. METHOXYFENOZIDE			
(Intrepid) 2F	10–16 fl oz	4	30
MODE OF ACTION GROUP NUMBER[1]: 18A			
COMMENTS: Do not apply more than 48 fl oz / acre / season. Early season treatment effectively reduces populations and doesn't cause outbreaks of other pests (mites, leafhoppers).			

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
C. SPINOSAD			
(Entrust)#	1.25-2.5 oz	4	7
(Success)	4-8 oz	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target young larvae. A stomach poison; most effective when ingested. Heavy infestations may require a second application in 4 or 5 days. Early season treatment effectively reduces populations and doesn't cause outbreaks of other pests (mites, leafhoppers). To protect honeybees, apply only during late evening, night, and early morning when bees are present in the vineyard.			
SECOND/THIRD GENERATION			
A. METHOXYFENOZIDE			
(Intrepid) 2F	10–16 fl oz	4	30
MODE OF ACTION GROUP NUMBER[1]: 18A			
COMMENTS: Do not apply more than 48 fl oz/acre/season.			
B. SPINOSAD			
(Entrust)#	1.25-2.5 oz	4	7
(Success)	4-8 oz	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target young larvae. A stomach poison; most effective when ingested. Heavy infestations may require a second application in 4 or 5 days. To protect honeybees, apply only during late evening, night, and early morning when bees are present in the vineyard.			
C. BACILLUS THURINGIENSIS ssp. KURSTAKI#			
(various products)	Label rates	4	0
MODE OF ACTION GROUP NUMBER[1]: 11.B2			
COMMENTS: Two applications 10–14 days apart on light-to-moderate summer broods is effective if first brood was treated. Only effective against young larvae. Is not harmful to predatory mite populations.			
D. METHOMYL*			
(Lannate LV)	0.75–1.5 qt	7 days	Raisin/Table: 1
(Lannate) 90SP	0.5–1 lb	7 days	Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A			
E. CARBARYL*			
(Sevin) 80S	2.5 lb	12	7
F. PHOSMET			
(Imidan) 70WP	1.33 lb	5 days	7
MODE OF ACTION GROUP NUMBER[1]: 1B			
G. DIAZINON* 50W	1–2 lb	5 days	28
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Apply in a minimum of 100 gal water and a maximum of 200 gal water/acre. Avoid drift and tailwater runoff into surface waters.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

ORANGE TORTRIX (10/08)

Scientific Name: *Argyrotaenia franciscana (= A. citrana)*

DESCRIPTION OF THE PEST

Although orange tortrix is found in other areas it is generally considered a pest of grapes in the coastal areas and valleys where there is a marine influence for part of the day. At rest the orange tortrix adult is bell shaped and about 0.5 inch (12 mm) long. The female is orange-brown and generally has a faint V-shaped marking located midwing. The male is similar to the female except that it has darker markings. Eggs are laid in overlapping masses. The straw-colored caterpillars have a brown head and prothoracic shield. They are about 0.5 inch (12 mm) long when mature and very active. If disturbed, they wriggle sideways or backwards and either drop to the ground or hang by a silken thread. There are three overlapping generations per year and all developmental stages of this pest can be present throughout the growing season.

The garden tortrix, *Ptycholoma peritana*, frequently appears in orange tortrix traps and can be distinguished from orange tortrix by the dark brown diagonal stripe on the forewings that create a chevron pattern when the moth is at rest. The chevron pattern on the garden tortrix is darker than that of the orange tortrix. Garden tortrix also has a light-colored margin on the edge of the chevron, which orange tortrix lacks.

DAMAGE

Orange tortrix causes the same kind of damage as the omnivorous leafroller in inland areas. Overwintering larvae feed on any soft, exposed vine tissue, weeds, and in grape mummies on the vine. Spring feeding is on buds, and leaves. Larvae then enter the bunches as early as bloom time and make nests of webbing among the berries. Besides injury to leaves and berry stems, their feeding on berries allows entry of bunch rot disease organisms.

MANAGEMENT

If orange tortrix is a problem, encourage biological control by the judicious use of insecticides, clean up the vineyard during the dormant period as described under cultural control and, if treatments are necessary, spot treat when possible, using thorough coverage of vines.

Biological Control

In coastal vineyards the dominant parasite of orange tortrix is *Exochus nigripalpus subobscurus*. The adult *Exochus* wasp is about 0.25 inch (6 mm) long, with a black head and body and yellow legs. This internal larval parasite emerges after the larva pupates and can be detected by the presence of round emergence holes. Moderate to heavy parasitism in late spring has resulted in season-long biological control in coastal vineyards. There are indications that coyote brush grown near vineyards in the Salinas Valley will increase parasitism by this parasite by allowing the parasite to overwinter on orange tortrix and other hosts found in the coyote brush. At least three other wasp species and one fly parasite are known to attack orange tortrix.

Spiders are often found in orange tortrix nests and undoubtedly feed on larvae.

Cultural Control

Clean up the vineyard during the dormant period. During winter, larvae are often found in weeds such as mallow (cheeseweed), curly dock, mustards, filaree, lupine, and California poppy. Vineyard cover crops of oats and barley are also attractive to this pest. Remove dried grape clusters on vines, and disc weeds and clusters on the ground. Do this work at least a month before shoots begin to develop in spring. Damage can often be prevented by harvesting as early as possible.

Organically Acceptable Methods

Cultural and biological controls and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are organically acceptable management tools.

Monitoring and Treatment Decisions

Check vineyard areas that have a history of infestation or where infestation is suspected. See MONITORING CATERPILLARS section for monitoring procedures. Check varieties with compact clusters, developing shoots,

flowers, or fruit clusters. Examine 10 flower clusters in the center of each of 20 vines for a total of 200 clusters. Look for rolled leaves that are glued to shoots. Also look for evidence of parasitism. Record results on a monitoring form *(example form available online).* Later in the season, look for orange tortrix larvae and webbing in the bunches. If you find an average of 0.5-1 larva/vine, treatment may be warranted if parasites are not present. If the infestation is not widespread, spot treatments can be used. Inside coverage of bunches is essential; treat both sides of the row.

Pheromone traps. Pheromone traps for this pest are available and are useful in timing flights and subsequent treatments in coastal vineyards. Place pheromone traps in the vineyard in late December. Low-trap catches at the end of January to early February represent the beginning of adult emergence, which will give rise to the first generation. Be sure to distinguish orange tortrix from garden tortrix, which may also be caught in traps but isn't a pest. Garden tortrix has a diagonal dark stripe that forms a chevron pattern when the wings are at rest and spot on each side of the forewing; both are lacking on orange tortrix moths). Use the low trap catches in late January through early February as the biofix (identifiable point in the life cycle) to start accumulating degree-days; low trap catches represent the beginning of adult emergence. Monitoring with pheromone traps after biofix will provide more information about subsequent generations of orange tortrix in the vineyard. For information on placing and monitoring pheromone traps, see PHEROMONE TRAPS.

Degree-days. Use degree-day accumulation, with a lower threshold of 43°F and an upper threshold of 78°F, from the date of lowest moth catch to predict the subsequent stages of the insect's life cycle. (For assistance in calculating degree-days, see "Degree-days" on the UC IPM Web site at http://www.ipm.ucdavis.edu.) Allowing 1,000±50 degree-days to accumulate after the date of lowest trap catch in late January/early February and in early June will indicate the timing of applications for control of the first and second generations.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
BLOOM			
A. METHOXYFENOZIDE			
(Intrepid) 2F	10–16 fl oz	4	30
MODE OF ACTION GROUP NUMBER[1]: 18A			
COMMENTS: Do not apply more than 48 fl oz/acre/season.			
B. SPINOSAD			
(Entrust)#	1.5–2.5 oz	4	7
(Success)	4–8 oz	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target the young larvae. A stomach poison; most effective when ingested. Heavy infestations require a second application in 4 or 5 days. to protect honeybees, apply only during late evening, night, and early morning when bees are present in the vineyard.			
C. CRYOLITE			
(Kryocide) 96WP	6–8 lb	12	30
(Prokil Cryolite) 96	6–8 lb	12	30
MODE OF ACTION GROUP NUMBER[1]: 9A			
COMMENTS: Wine, table, and raisins: 2 applications maximum. Ground application only. If used on wine grapes or grapes that may be sold to a winery for export, observe their restrictions on postbloom applications. Early season treatment effectively reduces populations and doesn't cause outbreaks of other pests (mites, leafhoppers). Can provide season-long control of light-to-moderate populations. Good coverage of clusters is critical. Cryolite is a stomach poison that must be ingested to be effective.			
D. BACILLUS THURINGIENSIS ssp. KURSTAKI#			
(various products)	Label rates	4	0
MODE OF ACTION GROUP NUMBER[1]: 11.B2			
COMMENTS: Works best when 2 applications are applied 10 days apart in dry, warm weather during spring when shoots are less than 18 inches long and orange tortrix is found rolling leaves at tip of shoot. Good coverage is critical. Not as effective later in season when larvae are in the fruit bunches. Not harmful to predatory mites.			

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
GROWING SEASON			
A. METHOXYFENOZIDE			
(Intrepid) 2F	10–16 fl oz	4	30
MODE OF ACTION GROUP NUMBER[1]: 18A			
COMMENTS: Do not apply more than 48 fl oz/acre/season.			
B. SPINOSAD			
(Entrust)#	1.5–2.5 oz	4	7
(Success)	4–8 oz	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target the young larvae. A stomach poison; most effective when ingested. Heavy infestations require a second application in 4 or 5 days. to protect honeybees, apply only during late evening, night, and early morning when bees are present in the vineyard.			
C. METHOMYL*			
(Lannate LV)	0.75–1.5 qt	7 days	Raisin/Table: 1
(Lannate) 90SP	0.5–1 lb	7 days	Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhopper.			
D. CARBARYL*			
(Sevin) 80S	2.5 lb	12	7
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: May encourage mite outbreaks; do not use where mites are a chronic problem. Extremely toxic to honey bees.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

PACIFIC COAST WIREWORM (CLICK BEETLE) (6/06)

Scientific Name: *Limonius canus*

DESCRIPTION OF THE PEST

Adults of the Pacific Coast wireworm are about 0.5 inch (13 mm) long, reddish brown to black, with a prothorax that has pointed posterior tips. They are commonly known as click beetles because, if held, it will bend its body backwards and then quickly straighten it to create an audible snap.

The larval stage of this insect lives in the soil and is commonly referred to as a wireworm. Wireworms have hard bodies that are slender, cylindrical yellowish to brown in color, and about 0.75 inch long when full grown. It takes about 3 to 4 years for the wireworm or click beetle to complete its live cycle. Most of the time is spent in the larval stage, but all stages may be present at once. In grapes, the larval stage is not considered a pest whereas the adult click beetle can be damaging.

DAMAGE

The click beetle can feed on buds in spring. The injury to the bud looks essentially the same as that of the grape bud beetle. Unlike the grape bud beetle and the cutworm, the click beetle is a day feeder. Overwintering in the ground litter, it emerges in spring on warm days. Click beetles are often seen in large numbers resting on cover crops during the day. Even with these high populations in the vineyards, they seldom cause economic damage to grapes.

MANAGEMENT

No material is registered for use on this pest; however, click beetles usually occur in conjunction with cutworm infestations and it has been observed that the spray materials used for cutworms also control click beetles.

SHARPSHOOTERS (10/08)

Scientific Names: Blue-green sharpshooter: *Graphocephala atropunctata*
Glassy-winged sharpshooter: *Homalodisca vitripennis* (=*H. coagulata*)
Green sharpshooter: *Draeculacephala minerva*
Red-headed sharpshooter: *Xyphon* (=*Carneocephala*) *fulgida*

DESCRIPTION OF THE PESTS

Sharpshooters are in the same insect family as leafhoppers (Cicadellidae).

Blue-green sharpshooter. The blue-green sharpshooter has green to bright blue wings, head, and thorax, and yellow legs and abdomen, which are visible on the underside. It is about 0.4 inches long. In California they are found in coastal regions near riparian and landscape areas.

The blue-green sharpshooter feeds, reproduces, and is often abundant on cultivated grape. It also feeds and reproduces on many other plants but prefers woody or perennial plants such as wild grape, blackberry, elderberry, and stinging nettle. Mugwort, which is a perennial, is a major breeding host. The blue-green sharpshooter is most common along stream banks or in ravines or canyons that have dense growth of trees, vines, and shrubs. It can also be abundant in ornamental landscaping. Because it feeds on succulent new growth in areas of abundant soil moisture and shade, it is seldom found in unshaded, dry locations but also finds plants in constant deep shade unattractive.

The blue-green sharpshooter has one generation a year in most of California and a second generation in some parts of the state. They overwinter in riparian vegetation. In late winter and early spring, adults become active, and a small percentage begin moving into nearby vineyards for feeding and egg laying starting just after budbreak. Their movement into vineyards increases as natural vegetation dries up. Eggs hatch from May through July. Some of the nymphs become adults by mid-June, and the number of young adults continues to increase through July and August. In August when grape foliage is less succulent, blue-green sharpshooters begin to move back to nearby natural habitats. Populations of blue-green sharpshooter are always larger in natural vegetation than in vineyards.

Glassy-winged sharpshooter. The glassy-winged sharpshooter, is a large insect compared to the other leafhoppers. Adults are about 0.5 inch long and are generally dark brown to black when viewed from the top or side. The abdomen is whitish or yellow. The head is brown to black and covered with numerous ivory to yellowish spots. These spots help distinguish glassy-winged sharpshooter from a close relative, smoke-tree sharpshooter (*H. lacerata*), which is native to the desert region of southern California and slightly smaller in size. The head of the smoke-tree sharpshooter is covered with wavy, light-colored lines, rather than spots. Immature stages (nymphs) of the glassy-winged sharpshooter are smaller than the adult, wingless, uniform olive-gray in color, and have prominent bulging eyes.

Females lay their eggs in masses of up to 28 in the lower leaf surface of young leaves that have recently expanded. When it is first laid, the egg mass appears as a greenish blister on the leaf. The female covers the leaf blister with a secretion that resembles white chalk, making them easy to see. Shortly after egg hatch, the leaf tissue that contained the egg mass begins to turn brown. The dead leaf tissue remains as a permanent brown scar.

Nymphs emerge in 10 to 14 days and proceed to feed on leaf petioles, small stems, and leaves while they progress through five molts before becoming winged adults. There are two generations a year.

Glassy-winged sharpshooter has become established in most of southern California. It remains localized in central and northern California where eradication programs are being conducted to confine its spread. It occurs in unusually high numbers in citrus and avocado groves and on numerous kinds of plants in irrigated ornamental landscapes, riparian areas, and native woodlands.

Green sharpshooter and red-headed sharpshooter. The green sharpshooter prefers lush dairy pastures, permanent grasses, and areas that are continually irrigated. They favor watergrass, bermudagrass, Italian rye, perennial rye, and fescue for food. Red-headed sharpshooters feed and breed only in areas where bermudagrass grows. Grapes are accidental hosts of these grass-feeding sharpshooters. In central California, insect movement is usually to the east (downwind at dusk) of pastures, weedy hay fields, or other grassy areas. The presence of neighboring hay fields or permanent pastures should be considered when planting a vineyard.

The green and red-headed sharpshooters have three generations per year. They overwinter as adults and lay eggs from late February to early March. The overwintering adults do not live long, thus it is probably the second generation that moves into the vineyard.

DAMAGE

Sharpshooter feeding does not cause damage in grape; however, these insects vector the bacterium *Xylella fastidiosa*, which causes Pierce's disease in grapes. (This bacterium also causes alfalfa dwarf disease and almond leaf scorch in California.) The blue-green sharpshooter is the most important vector of *Xylella fastidiosa* in coastal grape-growing areas. The glassy-winged sharpshooter is the primary vector in the Coachella Valley, Temecula, and Kern County. The green sharpshooter and the red-headed sharpshooter are present in coastal areas, but they serve as the primary vectors in most areas of the Central Valley.

When sharpshooters feed on vines, they inject the bacterium, which multiplies in the water-conducting system and causes water stress of the plant. Symptoms from early spring infections may become visible by fall of the year infected, but that is variety dependent. In vines infected the previous year, budbreak will be delayed or absent in spring, and leaf scorch appears by early summer and increases through fall, causing clusters to dry. Early-season infections (March-May) are more likely to survive the next winter than late summer infections and become chronic. *Xylella fastidiosa* can kill vines 1 to 3 years after infection.

The glassy-winged sharpshooter feeds much lower on the shoot in summer than do the other sharpshooter vectors in California. It also feeds at the base of second-year canes, which may increase the number of late-season infections that survive the winter and become chronic infections. Feeding by this sharpshooter also occurs during winter on one- to two-year old vines and can transmit the bacterium even during dormancy. If the inoculum enters the wood below where winter pruning cuts are made, the feeding can lead to chronic infections. Rather than the generally linear increase in Pierce's disease incidence over several years that has been experienced where other sharpshooters are the vectors, glassy-winged sharpshooter may increase the rate of vine-to-vine spread of Pierce's disease during a single season. Growers should try to reduce numbers of glassy-winged sharpshooter whenever they are present in vineyards.

MANAGEMENT

Pierce's disease control is based entirely on preventing infection. Do not allow vectors to enter vineyards from areas adjacent to vineyards, especially during spring months. Immediately remove vines with Pierce's disease symptoms as soon as they are seen in all vineyards subject to influxes of glassy-winged sharpshooter. Vineyards within 0.5 to 1 mile of citrus or avocado groves are at greatest risk.

Insecticide treatments aimed at controlling the vector in areas adjacent to the vineyard have reduced the incidence of Pierce's disease by reducing the numbers of sharpshooters immigrating into the vineyards in early spring. The degree of control, however, is not effective for very susceptible varieties such as Chardonnay and Pinot Noir or for vines less than 3 years old. If a vineyard is near an area with a history of Pierce's disease, use varieties that are less susceptible to this disease.

Monitoring and Treatment Decisions for Blue-green and Glassy-winged Sharpshooters

The best time to start assessing the need for managing the blue-green or glassy-winged sharpshooters is at budbreak. Monitoring at this time will enable you to observe movement of sharpshooters into your vineyard from surrounding vegetation.

- Monitor for glassy-winged sharpshooter in all vineyards through late summer.
- Monitor blue-green sharpshooter in coastal vineyards and in vineyards with a history of problems until late May or 1 month after treatment.
- From May to July, make visual searches and sample with a sweep net riparian areas or ornamental landscapes adjacent to the vineyard.

To monitor for sharpshooters:

- In late February just before budbreak, place several double-sided yellow sticky traps (at least 4x7 inches for bluegreen sharpshooters and 9x11 for glassy-winged sharpshooter) in areas adjacent to vineyards that serve as habitat for sharpshooters, such as riparian areas and ornamental landscapes.
- In the vineyard place a minimum of 6 traps per block, 100-200 feet apart for blue-green sharpshooters. Be sure that some of the traps are placed 50 feet within the vineyard

perimeter. For glassy-winged sharpshooter, place one trap per 10 acres within 30 feet of the vineyard perimeter, especially on edges adjacent to alternate hosts such as citrus.
- Check traps once per week beginning at budbreak and more frequently after 2-3 days of warm weather. Continue to monitor traps for blue-green sharpshooters until late May or for a month after treatment. Monitor traps for glassy-winged sharpshooters throughout the season until daytime temperature remains below 65°F.
- Remove insects from the trap after counting and recording on a monitoring form (*example form available online)*.
- Replace traps every 2 weeks or when they become excessively dirty or discolored and especially on edges adjoining other alternate glassy-winged sharpshooter hosts such as citrus.

Treatment is warranted for blue-green sharpshooters if:
- After successive warm days above 70°F, there is a sharp increase in the number of sharpshooters trapped.
- More than an average of 7 are caught per trap/week in riparian or ornamental habitats.
- Visual inspections reveal more than 1 sharpshooter/vine.

Treatment is warranted for glassy-winged sharpshooters if:
- They are present in the vineyard.

Blue-green sharpshooters. Treat vegetation along the edges of the vineyard where sharpshooters are observed. If sharpshooters have migrated into the vineyard and new shoot growth on grapevines is longer than a few inches, also treat the first 200 to 300 feet in from the edge of the vineyard. Replace traps after spraying and continue monitoring traps and vegetation. Respray if trap catches indicate another population increase. The goal is to eliminate more than 95% of the vector population.

Riparian vegetation management has proven to be effective in reducing the damaging spring populations of blue-green sharpshooters. Because these areas are ecologically sensitive and regulated by federal, state, and local legislation, the unauthorized removal of vegetation is prohibited or restricted. Vegetation management of these areas must be acceptable or beneficial for wildlife and water quality and maintain the integrity of the riparian habitat. For additional information, contact the California Department of Fish and Game for current regulations and guidelines. For more information, see the complete *Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards* online at http://www.cnr.berkeley.edu/xylella/control/PDNorthCoast/info.htm.

Glassy-winged sharpshooter. In addition to trap monitoring, do visual searching to monitor for eggs, nymphs, and adults. Combine the visual search with the leafhopper and mite sampling. Management of glassy-winged sharpshooter in vineyards adjacent to other host crops is best if done on an areawide basis. This approach relies on monitoring agricultural crops, vineyards, and other plant species, and treatment of overwintering hosts. Apply insecticide treatment to vineyards if any glassy-winged sharpshooter life stage is discovered in a vineyard or if there is a potential for movement of this pest into the vineyard. Systemic insecticides (imidacloprid) are currently the most effective materials for control of glassy-winged sharpshooter in vineyards.

Monitoring and Treatment Decisions for Green and Red-headed Sharpshooters
In the Central Valley, insecticide treatments for these sharpshooters are of little value overall because overlapping generations result in the continuous presence of eggs inside protective leaf tissues of host plants from February through fall. Sprays are not effective against eggs. In alfalfa fields, orchards, or field-crop areas, the grass weeds growing in or at the margins of the crop support green sharpshooter populations, and red-headed sharpshooter populations are supported in areas with bermudagrass. Eliminate weedy grasses whenever possible. Monitor with a sweep net areas of grass weeds that are adjacent to the vineyard and cannot be eliminated. (Green and red-headed sharpshooters are not attracted to yellow sticky traps and must therefore be monitored with a sweep net.) An average catch of two or more sharpshooters per 50 sweeps in a total of 400 sweeps is cause for concern. About all that can be done is to try to purchase or lease adjacent properties and manage them so that sharpshooter populations do not build up.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. IMIDACLOPRID
(Provado Solupak) 75WP — 0.75 oz — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: A foliar-applied product that gives a fast kill of sharpshooters but lasts only about 2 weeks. Do not apply more than 2 oz of product/year. Allow at least 14 days between applications.
. . . *or*. . .
(Admire Pro) — 7-14 fl oz — 12 — 30
COMMENTS: Soil-applied product that provides a slower kill of sharpshooters than foliar-applied Provado but remains effective longer.

B. ACETAMIPRID
(Assail) 70WP — 1.1 oz — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 4A

C. DIMETHOATE* 400 — 2 qt — 2 days — see comments
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: This treatment is suggested for blue-green sharpshooter in coastal areas (see text above). Check with your county agricultural commissioner about the use of this material under a Special Local Needs registration for Napa, Sonoma, Mendocino, Lake, San Luis Obispo, Santa Barbara and Riverside counties. Apply with a ground rig-handgun sprayer to a band of natural vegetation about 50–100 ft wide along the vineyard edge. If sharpshooters have migrated into the vineyard and there is more than a couple inches of new shoot growth on the vines, treat the first 200–300 ft of vineyard in from the edge of the natural vegetation. It is best to treat during warm weather and as soon as possible in the morning before winds increase. Avoid drift into water. Maximum of 2 applications/year in riparian areas. Disruptive to beneficial insects.

D. FENPROPATHRIN*
(Danitol) — 5.33–10.66 fl oz — 24 — 21
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Not recommended for the San Joaquin Valley because of problems with mite outbreaks. See label for additional requirements regarding hand labor.

E. KAOLIN CLAY#
(Surround) WP — 12.5–37.5 lb — 4 — 14
MODE OF ACTION: Unknown. An inorganic insecticide.
COMMENTS: Repels but does not kill sharpshooters. Apply at 7- to 21-day intervals as infestations occur; apply before infestation, if possible. Supplemental pest control methods may be needed for full control.

** Apply with enough water to provide complete coverage.
\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
\# Acceptable for use on organically grown produce.
[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

THRIPS (10/08)

Scientific Names: Grape thrips: *Drepanothrips reuteri*
Western flower thrips: *Frankliniella occidentalis* and others

DESCRIPTION OF THE PESTS

Thrips are small insects, 0.04 inch long, with distinctive feathery wings. Color varies from yellow to brown in color. Grape thrips and western flower thrips are the most important species causing damage on grapes. Both species may be found in most grape-growing areas. Grape thrips populations usually reach their greatest numbers in July; this coincides with peak vine growth, and as vine growth slows, the numbers of thrips decreases. Western flower thrips populations peak in May, coinciding with grape bloom and the drying up of winter plant hosts.

DAMAGE

Table grapes are susceptible to fruit damage caused by the western flower thrips. They create halo-spotting on the fruit when they oviposit in berries during bloom and up to fruit set or shortly thereafter. Both western flower thrips and grape thrips can scar berries with their feeding, which renders certain white varieties used for table grapes unmarketable. Thrips scarring is primarily a problem on Red Globe, Calmeria, Italia, and occasionally on Thompson Seedless. Fruit feeding discontinues in summer when both species feed on new vegetative growth.

In the North Coast, western flower thrips can feed in emerging shoots in early spring and stunt shoots and cause leaves to cup, especially during cool, rainy springs. Grape thrips may attack shoot tips in late spring or early summer although damage does not become apparent until the population has already decreased. While summer damage of leaves by thrips is common, it is not considered a problem for most varieties. However, a heavy grape thrips population can be a problem in Salvadors.

MANAGEMENT

In general, thrips, are a minor problem on wine and raisin grapes in California with the exception of large populations on emerging shoots in cool-growing regions; however, table grapes are susceptible to thrips damage and may require treatment. For table grapes, make thrips management decisions based on pest population and damage in previous years and varietal susceptibility.

Biological Control

Little is known about natural control of thrips in vineyards but predators such as minute pirate bugs undoubtedly play a role in keeping populations in check.

Cultural Control

Avoid mowing cover crops infested with thrips at budbreak or before bloom because thrips may move to vines and cause shoot stunting.

Organically Acceptable Methods

Biological and cultural controls and sprays of the Entrust formulation of spinosad are acceptable in organically managed vineyards.

Monitoring and Treatment Decisions

On cool days after budbreak monitor for thrips. Open shoots or gently tap buds over white paper to check for thrips.

Table grapes. During the period of rapid shoot growth, inspect flowers or fruit clusters for adults or larvae, as well as the predatory minute pirate bug, by striking clusters three times over a white piece of cardboard. Normal population levels of western flower thrips range from 5 to 25 adults and 10-50 larvae per cluster. High levels exceed 150 adults and 300 larvae per cluster, but damaging population levels for grape thrips in clusters has not been determined. Bloom sprays may be necessary to prevent berry scarring in table grape vineyards.

At harvest look for damage caused by thrips to assess this year's management program and to plan for next year.

Wine grapes. From dormancy through budbreak, monitor for thrips along with other pests in wine/raisin grapes as outlined in DORMANT/DELAYED DORMANT AND BUDBREAK MONITORING. Inspect new shoots in spring, especially in cool regions, for shoot scarring and distorted leaves. In these areas treatment may be necessary if damage increases and cool temperatures persist. Record observations on a monitoring form *(example form available online).*

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
A. SPINOSAD			
(Entrust)#	1.25–2.5 oz	4	7
(Success)	4–8	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target the young larvae. Heavy infestations require a second application in 4 or 5 days.			
B. IMIDACLOPRID			
(Provado Solupak) 75WP	0.75–1 oz	12	0
MODE OF ACTION GROUP NUMBER[1]: 4A			
COMMENTS: Foliar application: allow at least 14 days between applications. Do not exceed 0.5 lb a.i. of imidacloprid/acre/year.			
C. DIMETHOATE 25WP	6–8 lb	2 days	28
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Lower than label rates can be used in early season when vine canopy is not dense. To avoid visible deposit on berries, do not apply after berries reach 0.25 inch diameter. Moderately disruptive to beneficials. Resistance may be a problem in some populations.			
D. METHOMYL*			
(Lannate) LV	0.75–1.5 qt	7 days	Raisin/Table: 1
(Lannate) 90SP	0.5–1 lb	7 days	Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhoppers. Short lived, may not provide long enough control.			
E. NARROW RANGE OIL#			
(JMS Organic Stylet Oil)	1–2 gal	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: Apply early in the season (from 1-inch shoot length until set) for thrips control. Will help prevent shoot damage in early spring but not effective for berry scarring. Commonly used when shoot growth is slowed by cool, spring temperatures. (Also controls mites and serves as a contact treatment for powdery mildew in spring.) Using ground equipment, spray for optimum coverage of leaf surfaces. Repeat sprays every 1–14 days. Late season applications may leave a residue on post-veraison berries. Do not apply with copper when fruit is present; do not apply within 10 days of sulfur. Read label carefully for other use restrictions.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

VINEGAR FLIES (10/08)

Scientific Names: *Drosophila melanogaster, D. simulans*, and other species

DESCRIPTION OF THE PESTS

Various species of *Drosophila* are known as vinegar or pomace flies. Adults are small, yellowish flies and are commonly attracted to fermenting fruit of all kinds. Populations build up as the fruit harvest season progresses. The 0.25-inch-long maggot-shaped larva can be found in cull and damaged fruit in the vineyards. Oblong pupae occur wherever larvae are found and have a forked breathing tube at one end. The life cycle in summer is only 7 to 8 days, with the adult laying 700 to 800 eggs in a 20- to 30-day life span.

DAMAGE

Vinegar fly is a problem of damaged or cracked fruit. Eggs are laid in damaged or exposed fleshy tissue and larvae feed on the berries. The primary damage by this pest, however, is the sour rot organisms that it vectors from bunch to bunch in the vineyard.

MANAGEMENT

The key to controlling vinegar fly is to reduce the incidence of summer bunch rot. Good fertilizer and irrigation management and use of gibberellins (Thompson Seedless only) may reduce the number of tight bunches, thus decreasing the incidence of bunch rot. Good sanitation practices in storage or processing plants are helpful in reducing populations of this pest. Preharvest treatments are not effective; pyrethrin materials are used postharvest to kill adult flies. In table grapes, note the presence of vinegar flies at harvest as an indicator of bunch rot diseases.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to impact on natural enemies and honey bees and environmental impact.

POSTHARVEST

A. PYRETHRIN/PIPERONYL BUTOXIDE
(Pyrenone Crop Spray) Label rates 12 NA
MODE OF ACTION GROUP NUMBER[1]: 3 and 27A
COMMENTS: Spray containers with 1 pt/150 gal water and as needed. Apply to fruit in field, storage, or processing plants.

** Apply with enough water to provide complete coverage.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

NA Not applicable.

VINE MEALYBUG (10/08)

Scientific Name: *Planococcus ficus*

DESCRIPTION OF THE PEST

Vine mealybugs are small (adult females are about 1/8 inch in length), soft, oval, flat, distinctly segmented, and covered with a white, mealy wax that extends into spines (filaments along the body margin and the posterior end). The vine mealybug has a pinkish body that is visible through the powdery wax, and it is slightly smaller than the *Pseudococcus* mealybugs. The waxy filaments that protrude from the body of the vine mealybug are shorter than those on the *Pseudococcus* mealybugs, and the vine mealybug does not possess long tail filaments. The adult male is smaller than the female, has wings, and flies short distances to mate. There are three to seven generations a year.

All or most life stages of the vine mealybug can be present year-round on a vine depending on the grape-growing region. In the North Coast during winter months, the only life stages found are nymphs located under the bark predominately at the graft union, on trunk pruning wounds, and below the base of spurs. In other regions during the winter months, vine mealybug eggs, crawlers, nymphs, and adults are under the bark, within developing buds, and on roots.

As temperatures warm in spring, vine mealybug populations increase and become more visible as they move from the roots and trunk to the cordons and canopy. By late spring and summer, vine mealybugs are found on all parts of the vine: hidden under bark and exposed on trunks, cordons, first- and second-year canes, leaves, clusters, and roots. Ants may transport vine mealybug from the roots to above ground plant parts where they continue to tend vine mealybugs throughout the remainder of the growing season.

In the North Coast, vine mealybug has not been found on vine roots; however, in other regions, it has occasionally been found on the root system, especially in areas with light soils. Other mealybugs found infesting grapes are only found on the aboveground portions of the vine. In addition, the vine mealybug is much more likely to be found on leaves during the growing season than the other mealybugs. During summer when vine mealybugs are in the canopy, they can be located well above the fruit zone and will lay eggs on the leaves, while *Pseudococcus* mealybugs do not. Vine mealybug does not diapause during the winter, and it appears to be more sensitive to cold temperatures than grape mealybug.

DAMAGE

Damage by the vine mealybug is similar to that of other grape-infesting mealybugs in that it produces honeydew that drops onto the bunches and other vine parts and serves as a substrate for black sooty mold. If ants are not present, a vine with a large population of this pest can have so much honeydew that it resembles candle wax. Also, the mealybug itself will be found infesting bunches making them unfit for consumption. Like the grape, obscure, and longtailed mealybugs, vine mealybug can transmit grape viruses.

MANAGEMENT

In California, the vine mealybug occurs in the Coachella and Central valleys, the Central and North coasts, and the Sierra foothills. The host range of the vine mealybug includes grape, fig, date palm, apple, avocado, citrus, and a few ornamentals. To date, vine mealybug has only been found feeding on grapevines in California. This pest is spreading to new areas of the state and IPM programs are under development.

Because several different species of mealybugs may infest grapevines, it is important to know which species of mealybug is present because management programs for the various mealybugs differ. If you find mealybugs in your vineyard, collect the largest mealybugs you can find and place them in a jar of alcohol or sealed plastic bag. Take the sample to either your UCCE Farm Advisor or county agricultural commissioner. The phone number and location of these offices can be found in the government pages of the phone book under "County Government." For more information on identification, visit UC Kearney Agricultural Center's mealybug web pagefound at http://vinemealybug.uckac.edu/VMB.htm.

Biological Control

The parasites that attack *Pseudococcus* mealybugs do not attack the vine mealybug, therefore two potential candidates for natural control have been imported and released in Riverside, Kern and Fresno counties. The most successful of these has been *Anagyrus pseudococci.* This species has provided up to 20% parasitism in some vineyards in the Coachella Valley and up to 90% parasitism in the San Joaquin Valley. It is extremely important to promote parasites because they are active late in the growing season and can reduce vine

mealybug populations before the pest begins to move to the lower part of the trunk in October. To a limited extent, they can parasitize vine mealybug when it is located under the bark where chemicals cannot penetrate. Ants must be controlled to keep them from interfering with these natural enemies (see the section on ANTS for information on their control).

In the coastal regions a lady beetle called the mealybug destroyer, *Cryptolaemus montrouzieri,* attacks vine mealybug eggs and crawlers.

Cultural Control
The female mealybug is unable to fly so it must be carried by humans, equipment, birds, or be present on vines at the time of planting. Do not allow contaminated equipment, vines, grapes, or winery waste near uninfested vineyards. Movement of equipment that pushes brush or any over-the-row equipment can be a major source of infestations in new locations; steam sanitize equipment before moving to uninfested portions of the vineyard. Do not spread infested cluster stems or pomace in the vineyard. To reduce contamination, cover all pomace piles with clear plastic for several weeks, and avoid creating piles that consist predominately of stems.

Organically Acceptable Methods
Biological and cultural controls are organically acceptable management tools. No research studies have yet been done in California on the efficacy of oils or calcium polysulfide in controlling vine mealybug, but they have not proven effective in controlling the grape mealybug.

Monitoring and Treatment Decisions
Follow the monitoring guidelines in DELAYED-DORMANT AND BUDBREAK MONITORING (wine/raisin grapes or table grapes) to monitor these and other pests in the early season and record results on a monitoring form *(example form available online).* Starting at bloom, monitor for vine mealybug along with other pests as outlined in MONITORING INSECTS AND SPIDER MITES.

Pheromone traps for this pest are available and useful for determining if a vine mealybug infestation is near or in your vineyard. The lure that is placed inside each trap contains the sex pheromone that female vine mealybugs use to attract winged adult males. Tent-shaped, red traps are recommended because the shape and color tend to reduce the number of non-target insects that are caught.

Place traps in and around the vineyard by April 1 in the southern San Joaquin Valley to May in areas further north and June in the North and Central Coasts:

- Choose two trap sites for each 20-40 planted acres.
- Put one trap in the center of the block and the other on the edge near a staging area. These traps can attract vine mealybug males from as far away as 1/4 mile.
- Attach traps to the trellis wires so that they are in the cluster area.
- Label the trap with the block name and row number of its location and the dates it remains in the vineyard.
- Check traps for the presence of male vine mealybug every 2 weeks through November.
- Follow the manufacturer's recommendations for storing and replacing pheromone lures.
- Record observations on a monitoring form *(example form available online*).

It is essential to use a dissecting microscope to identify the male mealybug. (Male vine mealybugs are smaller than adult thrips and are very difficult to see even with a hand lens.) The sex pheromone is specific to the vine mealybug, but the traps may also contain other male mealybugs depending on the site. If there are questions as to the identification of the mealybug species, take samples to a farm advisor or county agricultural commissioner or refer to the Male Vine Mealybug Identification Sheet located online at http://ucce.ucdavis.edu/files/filelibrary/2161/27012.pdf.

The number of males found in a trap depends upon its proximity to the infestation and to the time of year. In the North Coast, new infestations have been located near traps that caught very low numbers in June (5 to 10 males per trap per week) and high numbers in fall (more than 50 males per trap per week). In the San Joaquin Valley, an infested vineyard will have between 20 to 300 or more males per trap per week. In either region, low numbers of male vine mealybugs found in a trap may mean that the infestation is located in an adjacent block or in a more distant vineyard. If males are found, increase the number of traps in the vineyard, and locate the infestation by examining lower leaves for honeydew.

After bloom, pull basal leaves to look for vine mealybug crawlers and honeydew in the canopy and look under the bark on the trunk and cordons. During bloom and veraison, treatment may be warranted for a high population of nymphs on leaves, but if possible it is better to wait until postharvest to treat in order to preserve natural enemies.

Check table grapes at harvest for vine mealybug damage to assess this year's management program and to plan for next year. When needed, make treatments for table grapes in November to reduce emission of volatile organic compounds (VOCs).

Vine mealybug produces more honeydew than other mealybugs, and this is particularly noticeable if there are no ants present. Thus, when searching for vine mealybugs during summer, look for honeydew exudates on the clusters, trunk, and cordons. These exudates will resemble melted candle wax, if the infestation is severe, and basal leaves will appear shiny and sticky. Sooty mold will grow on the honeydew, and permanent parts of the vine will appear black in fall and winter. Also look for fallen leaves beneath the canopy in July and August. To locate less severe infestations, it is necessary to look for all stages of the insect under the bark predominately at the graft union, on trunk pruning wounds, and below the base of the spur. Also, the presence of ants moving up and down the vine may indicate the presence of *Pseudococcus* mealybugs, vine mealybug, or European fruit lecanium scale.

If vine mealybug is found in the vineyard, treatment is recommended. There are two approaches to managing mealybugs: eradication and yearly management. Eradication using chemical applications is most likely to be successful in young vineyards or in vineyards where only a few isolated vines are infested. In mature vineyards with heavy, loose bark, strip the bark off the trunk and cordons before a chemical application to increase chances of success. Eradication is most probable in areas where there are no nearby vine mealybug-infested vineyards. If 2 years of effort do not eliminate vine mealybug from the vineyard, then switch to a yearly management program.

Management in newly infested vineyards (eradication). If vine mealybug is discovered in the vineyard in late summer or fall, and if preharvest interval restrictions permit, apply methomyl or dimethoate to infested vines. Take precautions during harvest operations to prevent movement of insects to noninfested vines. Apply a foliar insecticide immediately after harvest if possible (before the nymphs begin to move to the lower parts of the trunk), to kill mealybugs on the leaves and wood so that the infestation is not spread to other parts of the vineyard when leaves drop or when the vines are pruned.

The following year, apply a delayed dormant treatment of chlorpyrifos or buprofezin and then, in areas with light soils, treat with imidacloprid at bloom. Make either a single application of imidacloprid or a split one, depending on soil type. During summer, treat with buprofezin. Other materials (methomyl and dimethoate) are available for treating vine mealybug during summer, but they are not as effective and are more disruptive of beneficials. (In the North Coast, the first application of buprofezin is not recommended until late spring or early summer; imidacloprid is not as effective in controlling pests in heavy clay soils.) The University of California recommends following this program for a maximum of 2 years. If vine mealybug is still present in the vineyard after 2 years, switch to a yearly management program.

Yearly management program.
Areas with light-textured soils—In vineyards known to be infested with vine mealybug, make a bloom time application of imidacloprid either as a single application or a split application through the drip-line. The following year, either treat with chlorpyrifos in the delayed dormant period, or with buprofezin in the delayed dormant period and again in the summer. Alternating insecticides each year helps to prevent the development of insect resistance.

Areas with heavy clay soils—In vineyards known to be infested with vine mealybug, make an application of buprofezin or methomyl as soon as crawlers are present on the leaves (in late spring to early summer); a second application can be made no sooner than 14 days later. (For table grapes, an application can be made earlier than late spring.) Apply a foliar insecticide immediately after harvest to kill mealybugs before the nymphs begin to move to the lower parts of the trunk in late October.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

DELAYED DORMANT

A. CHLORPYRIFOS*
(Lorsban) 4EC — Label rates — 24 — 45
MODE OF ACTION GROUP NUMBER[1]: 1B
. . . *PLUS* . . . (optional)
NARROW RANGE OIL
(Superior, Supreme) — 1–2 gal — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: In spring, ants move the female mealybugs from the roots to plant parts above ground. Spray to obtain thorough coverage of all aboveground plant parts, especially the trunk and cordons where mealybugs are located. Spray residues at the base of the vine will help control vine mealybugs in spring when they are being transported up the vine. Application is most effective when applied during warm weather (60°F or higher) because mealybugs are most active at this time. Apply during January for grapes harvested in June in the Coachella Valley. Use allowed under a 24(c) registration (SLN CA-970007). Do not apply chlorpyrifos more than twice a year for the control of both vine mealybug and the Pseudococcus mealybugs or apply it between budbreak and harvest. Avoid drift and runoff into surface water. Chlorpyrifos has been found in surface waters at levels that violate federal and state water quality standards. In addition to water quality concerns, the EC formulation of chlorpyrifos produces volatile organic compounds (VOCs), which are a major air quality issue.

B. BUPROFEZIN
(Applaud) 70WP — 12 oz — 12 — 30
MODE OF ACTION GROUP NUMBER[1]: 16
COMMENTS: An insect growth regulator. Good coverage is essential. This treatment targets the young nymphs on the vine that are exposed and still moving around before they settle down under the bark to feed. In regions outside of the North Coast, it is most effective when applied once in the delayed dormant period and once in early summer (May-June). In the North Coast, the first application is not recommended until late spring or early summer. Tank mixes are not recommended. Do not apply more than twice per season and allow at least 14 days between applications. Use allowed under a FIFRA 2(ee) Recommendation.

BLOOM

A. IMIDACLOPRID
(Admire Pro) — 7-14 fl oz — 12 — 30
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Imidacloprid binds readily to soil; when the soil is rewetted and plant roots are actively absorbing water, the insecticide is absorbed by roots. Uptake and thus efficacy may be reduced in heavy clay soils that are not irrigated. Best when applied in a drip irrigation system; otherwise, French plow the soil, apply as a ground spray, and immediately irrigate. Apply from 7-14 fl oz/acre in one or two drip irrigation applications. On coarse soils or where the longest period of protection is required, make two applications. Make the first application from bloom through the pea-sized berry stage and the second 21–45 days later, keeping in mind the preharvest interval. The full rate of 14 oz/acre is recommended where vigorous vine growth is expected or in warmer growing areas such as the Coachella, San Joaquin, or Sacramento valleys or where mealybug populations are heavy. Do not exceed 0.5 lb a.i. of imidacloprid/acre/year. Adequate soil moisture is important at the time of application; follow label instructions carefully.

SUMMER *(to obtain clean fruit and to avoid spreading the pest at harvest or by premature leaf drop)*

A. IMIDACLOPRID
(Admire Pro) — 7-14 fl oz — 12 — 30
MODE OF ACTION GROUP NUMBER[1]: 4A
COMMENTS: Best applied between bloom and pea-sized berry stage. If two applications are required because of coarse soils or where the longest period of protection is required, make the second application 21-45 days after the bloom application. Apply a total of 7-14 fl oz/acre; the full rate of 14 oz/acre is recommended where vigorous vine growth is expected or in warmer-growing areas such as the Coachella, San Joaquin, or Sacramento valleys or where mealybug populations are heavy. Do not exceed 0.5 lb a.i. of imidacloprid/acre/year. Adequate soil moisture is important at the time of application; follow label instructions carefully. Use allowed under a 24(c) registration.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
B. BUPROFEZIN			
(Applaud) 70WP	12 oz	12	30
MODE OF ACTION GROUP NUMBER[1]: 16			
COMMENTS: Restricted entry interval: 12 hours. An insect growth regulator. This material targets the early stage nymphs on the vine that are exposed and still moving around before they settle under the bark to feed. Good coverage is essential. Tank mixes are not recommended. Do not apply more than twice per season and allow at least 14 days between application. In regions outside of the North Coast, most effective when applied once in the delayed dormant period and once in early summer (May-June). In the North Coast, the first application of buprofezin is not recommended until late spring or early summer. Buprofezin may be detrimental to the mealybug destroyer *(Cryptolaemus montrouzieri)* when applied during the summer. Use allowed under a FIFRA 2(ee) Recommendation.			
C. ACETAMIPRID			
(Assail) 30SG	2.5 oz	12	14
(Assail) 70WP	1.1 oz	12	14
MODE OF ACTION GROUP NUMBER[1]: 4A			
D. METHOMYL*			
(Lannate) LV	0.75–1.5 qt	see comments	see comments
(Lannate) 90SP	0.5–1 lb	see comments	Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhoppers. Although the preharvest interval is 1 day for raisin and table grapes, the restricted entry interval is longer and affects the actual time after which hand harvest can occur for table grapes. Restricted entry interval is 7 days before August 15 and 21 days thereafter, unless residue studies are conducted, in which case, the 21 can be dropped to 10.			
E. DIMETHOATE 400	2 qt	2 days	28
DIMETHOATE 25WP	6–8 lb	2 days	28
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Moderately disruptive to beneficials. The wettable powder formulation is recommended for table grapes, which are spotted by the emulsifiable concentrate formulation. The emulsifiable formulation, however, is preferred for wine grapes. Use of Dimethoate 400 allowed under a Special Local Needs registration.			
POSTHARVEST			
A. CHLORPYRIFOS*			
(Lorsban) 4E	Label rates	24	NA
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Apply in a minimum of 150 gal water/acre. Treat infested vineyards immediately after harvest to minimize the movement of live mealybugs. Use allowed under a SLN registration (SLN CA-970007). Growers may apply this material under this SLN or under SLN CA-940018 but not both. Avoid drift and runoff into surface waters. In addition to water quality concerns, the EC formulation of chlorpyrifos produces volatile organic compounds (VOCs), which are a major air quality issue.			
B. METHOMYL*			
(Lannate) LV	0.75–1.5 qt	see comments	NA
(Lannate) 90SP	0.5–1 lb	see comments	NA
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhoppers. Restricted entry interval is 7 days before August 15 and 21 days thereafter, unless residue studies are conducted, in which case, the 21 can be dropped to 10.			
C. DIMETHOATE 25WP	6–8 lb	2 days	NA
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Moderately disruptive to beneficials.			

** Apply with enough water to provide complete coverage.

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

NA Not applicable.

WEBSPINNING SPIDER MITES (10/08)

Scientific Names: Pacific spider mite: *Tetranychus pacificus*
Willamette spider mite: *Eotetranychus willamettei*
Twospotted spider mite: *Tetranychus urticae*

DESCRIPTION OF THE PESTS

The Pacific spider mite is the primary pest mite species in the San Joaquin Valley and may also be the primary pest mite in certain North Coast grape-growing areas. Adult Pacific spider mite females vary from slightly amber to greenish in color. Later in the season as they go into diapause or under high population densities adult females can turn orange to reddish. Upon emergence adult Pacific spider mites are almost void of food spots. As feeding begins usually two large diffuse spots appear forward and two smaller spots appear on the rear portion of the abdomen. Pacific spider mite prefers the warmer upper canopy of the vine. Although it can cause damage early in the season, Pacific spider mite generally prefers the hotter, dryer part of the season. Because they are so similar in appearance, it is difficult to discern between the Pacific and Willamette spider mites unless they are side-by-side. The Pacific mite is larger in size than the Willamette mite. Pacific spider mite forelegs are reddish in color and those of Willamette spider mite are translucent to pale yellow.

The Willamette spider mite is pale yellow. It is often considered an early-season mite. It prefers the cooler parts of the plant and is found mostly in the shady parts of the vine. In certain areas (e.g., North Coast) and during certain years, populations can persist throughout the growing season. Willamette spider mite is primarily a problem in the Salinas Valley and Sierra foothill production areas where it can cause economic damage to varieties such as Zinfandel. In the North Coast it can cause damage in early spring when shoot growth is delayed or later in the season in vines with small canopies. Willamette spider mite is seldom a pest in the San Joaquin Valley, especially on Thompson Seedless.

The twospotted spider mite, *Tetranychus urticae,* is almost identical in appearance to the Pacific spider mite except it rarely has spots on the rear of the body. It is only occasionally found on grapes in California and rarely causes damage.

DAMAGE

Damage caused by each species can help in identifying each species. Pacific spider mite damage begins as yellow spots. As damage progresses, dead (necrotic) areas appear on the leaves. High populations can render the leaves unfunctional with leaf burning and bronzing and copious amounts of webbing. Damage is worse along the shoulder and tops of the vine canopies. Willamette spider mite feeding in mid- or late season causes foliage to turn yellowish bronze, but usually no burn occurs unless vines are weak. In red varieties, infested leaves may turn reddish.

MANAGEMENT

Manage webspinning spider mites in a vineyard by integrating biological, cultural and chemical controls.

Biological Control

Many natural enemies help to control pest mite populations. The western predatory mite, *Galendromus* (=*Metaseiulus) occidentalis*, is commonly present in vineyards and can be quite effective in reducing all stages of spider mite populations. This mite is translucent to light amber, pear shaped, and quite active. The effectiveness of this predator depends upon its ability to increase its population size as the season progresses. Disruptive sprays applied early will reduce the survival of this beneficial mite. Naturally occurring predator mites will survive sulfur sprays and dusts, but released ones may not survive dusting sulfur unless they have sulfur resistance. Predator mites, including insecticide-resistant ones, are available commercially to augment populations in the field. Other predators, including sixspotted thrips (*Scolothrips sexmaculatus*), can also be important. To preserve these natural enemies, avoid using disruptive materials, especially carbaryl, dimethoate, dicofol, and methomyl.

Cultural Control

Apply water or other materials formulated to reduce dust on roads in the vineyard. If possible, maintain resident vegetation or other cover in the vineyard middles to further reduce dust. Irrigate in a manner that will avoid stressing vines. Although overhead watering has been shown to reduce mite problems, it can also increase some disease problems.

Organically Acceptable Methods
Organically acceptable methods include biological and cultural control methods as well as oil or soap sprays.

Monitoring and Treatment Decisions
Monitor for webspinning spider mites as part of dormant and budbreak spur monitoring as described in the DELAYED-DORMANT AND BUDBREAK SAMPLING (wine/raisin grapes or table grapes) and record observations on a monitoring form *(example form available online*). During rapid shoot growth, look for spider mites and predatory mites weekly on the first emerging leaves. During bloom, follow the guidelines for MONITORING INSECTS AND SPIDER MITES. When monitoring mites, note the presence of mite predators. The table below can be used in determining the treatment guidelines for various combinations of Pacific mite injury levels and predator-prey distributions in Thompson Seedless raisin vineyards. After bloom, record your observations on the insect and mite monitoring form *(example form available online).*

	Predator-prey distribution ratios for pacific spider mites in Thompson Seedless raisin vineyards[1]			
Pacific mite injury levels (% leaves infested)[1]:	**Rare (less than 1:30)**	**Occasional (1:30 to 1:10)**	**Frequent (1:10 to 1:2)**	**Numerous (greater than 1:2)**
light (less than 50%)	delay treatment to increase predators	delay treatment	treatment not likely necessary	treatment not necessary
moderate (50-65%)	treat if population is increasing rapidly	may delay treatment to increase predation	treatment may not be needed if the predator-prey distribution ratio is increasing rapidly	treatment not needed
heavy (65-75%)	treat immediately	may delay treatment a few days to take advantage of increasing predation	treatment may not be needed if predators are becoming numerous	treatment not needed, damage not increasing
very heavy (greater than 75%)	treat immediately	treat immediately	teat immediately unless predator-prey distribution ratio increasing very rapidly; carefully evaluate damage	treatment may not be necessary if population is dropping because of very high (greater than 1:1) predator-prey distribution ratios; carefully evaluate damage

[1] Thompson Seedless vines are very vigorous and will tolerate more mite feeding than less vigorous varieties. Consequently, injury levels would be lower for other varieties, but predator-prey ratios and comments are applicable to all varieties.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. PROPARGITE
(Omite) 30WP — 5–9 lb — see comments — 21
MODE OF ACTION GROUP NUMBER[1]: 12C
COMMENTS: Apply no more than twice/season. Lower rates allow greater survival of beneficials. Restricted entry interval is 14 days for wine and raisin grapes and 21 days for table grapes.

B. FENBUTATIN-OXIDE*
(Vendex) 50WP — 1–2.5 lb — 48 — 28
MODE OF ACTION GROUP NUMBER[1]: 12B
COMMENTS: Do not apply more than twice /season. Lower rates allow greater survival of beneficials.

C. FENPYROXIMATE
(Fujimite) 5EC — 2pt — 12 — 14
MODE OF ACTION GROUP NUMBER[1]: 21
COMMENTS: Apply in 50-200 gal water with higher volumes in vineyards with dense canopies.

D. PYRIDABEN
(Nexter) 75WP — Label rates — 12 — 7
(Pyramite) 60WP — Label rates — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 21
COMMENTS: Alternate with miticides of a different chemistry to minimize the development of resistance.

E. ABAMECTIN*
(Agri-Mek) 0.15%EC — 8–16 fl oz — 12 — 28
MODE OF ACTION GROUP NUMBER[1]: 6
COMMENTS: Do not make more than 2 applications/growing season. Dust on leaves will inhibit absorption of this material. Effectiveness is also reduced by sulfur burn on leaves.

F. NARROW RANGE OIL#
(Saf-T-Side, etc.) — Label rates — 4 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: For Pacific spider mite, apply before bloom to get the best coverage and to delay the development of the population by 3–4 weeks. If an additional treatment is needed, apply 2 weeks after berry set (on raisin and wine grapes only; do not use on table grapes after bloom). For Willamette spider mite, apply oil after budbreak in a 1% spray. Do not apply within 10 days of a sulfur application. Check with certifier to determine which products are organically acceptable.

G. INSECTICIDAL SOAPS#
(M-Pede) — Label rates — 12 — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Can cause berry spotting.

H. NEEM OIL#
(Trilogy) — Label rates — 4 — 0
MODE OF ACTION: Unknown. A botanical insecticide
COMMENTS: For organically grown crops, check with your certifier for any restrictions that apply.

I. HEXYTHIAZOX
(Savey) 50DF — 3–6 oz — 12
MODE OF ACTION GROUP NUMBER[1]: 10B
COMMENTS: For use on nonbearing vines only. Do not make more than 1 application per year. More effective early in season on egg stage. If there is an abundance of adults, this material is not effective. Because this material is applied early in the season, it is best used in vineyards with chronic mite problems.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
J. DICOFOL (Kelthane) 50WSP	2.5 lb	48	7

MODE OF ACTION: UNC

COMMENTS: May not be effective in all areas due to resistance. Disruptive to predaceous mites and lady beetles. Do not make more than two applications per season.

K. GALENDROMUS OCCIDENTALIS#

COMMENTS: Releases are most successful when host plants (green beans) are placed directly on vines. Use a minimum of 1,000 predators per acre.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

WESTERN GRAPELEAF SKELETONIZER (10/08)

Scientific Name: *Harrisina brillians*

DESCRIPTION OF THE PEST

The metallic bluish or greenish black western grapeleaf skeletonizer moths fly during the day. Body length is about 0.6 inch and the wing span is 1 to 1.3 inches. There are three generations per year in the Central Valley and two generations in the cooler coastal regions. Adults of the first generation in the Central Valley emerge from hibernating pupa in early spring to June. The pale yellow or whitish capsule-shaped eggs are laid in clusters on the underside of grape leaves. After hatching, the larvae line up and feed side-by-side on the leaf underside until the early fourth instar stages. There are five larval stages. The first two stages are cream colored, the third stage is brownish, and the fourth and fifth stages are yellow with two purple and several blackish bands. Larvae have conspicuous tufts of long black poisonous spines that cause skin welts on field workers. The fifth or last larval stage is about 0.6 inch long. When mature, larvae crawl under the loose bark or into ground litter and spin a dirty, whitish cocoon to pupate.

DAMAGE

First through the early fourth instar larvae feed on the lower leaf surface, leaving only the veins and upper cuticle. This gives leaves a whitish paperlike appearance; eventually the entire leaf turns brown. The late fourth and all fifth stage larvae skeletonize the leaves, leaving only the larger veins. When abundant, larvae can defoliate vines by July. When vines are severely defoliated, larvae will then feed on grape clusters, which can result in bunch rot. Defoliation can also result in sunburn of the fruit and loss of quality. Defoliation after harvest may weaken vines by affecting stored reserves. Larvae also can cause problems for workers at harvest because hairs on their bodies can irritate the skin if they are brushed against.

MANAGEMENT

Western grape leaf skeletonizer does not occur in all grape-production areas because the moths are not long-distance fliers and this pest has been slow to spread in California since its first appearance in the 1940s. In areas where it does occur, granulosis virus usually keeps populations below economically damaging levels. When the virus is insufficient, western grapeleaf skeletonizer is easily controlled with insecticides that are also effective on other caterpillars, leafhoppers, or thrips.

Biological Control

Two insect parasites, *Apanteles harrisinae* and *Amedoria misella* (*Sturmia harrisinae*), attack western grapeleaf skeletonizer larvae. Thousands of these parasites have been released in the San Joaquin Valley, and *Amedoria misella* is common in many vineyards in the San Joaquin Valley.

A granulosis virus, endemic in southern California, has been introduced in selected areas with excellent success. It is extremely infectious when it is introduced into an outbreak population of western grapeleaf skeletonizer. Symptoms of populations infected with the virus include: (1) eggs within clusters are scattered instead of compactly laid, and the number of eggs is reduced; (2) most eggs fail to hatch; (3) larvae consume tiny patches of tissue rather than consuming entire areas of the leaf; (4) diseased larvae are sluggish and feed solitarily instead of in tight groups and usually tend to wander irregularly, leaving a visible trail of liquid excrement; and (5) larval growth and coloration change, and larvae shrink and eventually die. This virus is transmitted from one generation to the next by disease-carrying adults that survive a low degree of infection in the larval stage.

Organically Acceptable Methods

Biological control and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are acceptable for organically certified grapes.

Monitoring and Treatment Decisions

If the granulosis virus is not present, the amount of leaf damage will increase with each generation. Monitor end and border vines during the first generation. This can be done at bloom when monitoring for other caterpillars; see MONITORING CATERPILLARS. Record results on a monitoring form *(example form available online)*. If larvae are found and the virus is not present, treat soon after bloom. If needed later in season, treat when young larvae are found.

Check table grapes for sunburned fruit, a possible sign of defoliation caused by western grape leaf skeletonizer.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.			
A. METHOXYFENOZIDE			
(Intrepid) 2F	10–16 fl oz	4	30
MODE OF ACTION GROUP NUMBER[1]: 18A			
COMMENTS: Do not apply more than 48 fl oz/acre/season.			
B. SPINOSAD			
(Entrust)#	1.5–2.5 oz	4	7
(Success)	4–8 oz	4	7
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply when eggs first hatch to target the young larvae. A stomach poison; most effective when ingested. Heavy infestations require a second application in 4 or 5 days. To protect honeybees, apply only during late evening, night, and early morning when bees are not present in the vineyard.			
C. CRYOLITE			
(Kryocide) 96WP	6–8 lb	12	30
(Prokil Cryolite) 96	6–8 lb	12	30
MODE OF ACTION GROUP NUMBER[1]: 9A			
COMMENTS: Wine and Raisin: Limit of 2 applications/season. Table: One application only and not after fruit formation. If used on wine grapes or grapes that may be sold to a winery for export, observe their restrictions on applications. A stomach poison that must be consumed by larvae so thorough coverage is important. Less harmful to natural enemies than methomyl and carbaryl and provides long residual action.			
D. BACILLUS THURINGIENSIS ssp. KURSTAKI#			
(various products)	Label rates	4	0
MODE OF ACTION GROUP NUMBER[1]: 11.B2			
COMMENTS: Only effective against young larvae. Provides fairly good control, has a short residual life, and is not harmful to natural enemies. If coverage is not satisfactory or if all the eggs have not hatched, requires a second treatment.			
E. ACETAMIPRID			
(Assail) 70WP	1.1 oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 4A			
F. ABAMECTIN*			
(Agri-Mek) 0.15%EC	8–16 fl oz	12	28
MODE OF ACTION GROUP NUMBER[1]: 6			
COMMENTS: Do not make more than 2 applications/growing season. Dust on leaves will inhibit absorption of this material. Effectiveness is also reduced by sulfur burn on leaves.			
G. IMIDACLOPRID			
(Provado Solupak) 75WP	1 oz	12	0
MODE OF ACTION GROUP NUMBER[1]: 4A			
COMMENTS: Foliar application: allow at least 14 days between applications. Do not exceed 0.5 lb a.i. of imidacloprid/acre/year.			
H. METHOMYL*			
(Lannate) LV	0.75–1.5 qt	7 days	Raisin/Table: 1
(Lannate) 90SP	0.5–1 lb	7 days	Wine: 14
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not feed treated grapes to livestock. Disruptive to predators of mites and parasites of leafhoppers. Has a short residual life. When used for late-season leafhopper control, this material also controls skeletonizer larvae.			

** Apply with enough water to provide complete coverage.
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.
[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

Diseases

ARMILLARIA ROOT ROT (Oak Root Fungus) (10/08)

Pathogen: *Armillaria mellea*

SYMPTOMS

Vines infected with Armillaria root rot become nonproductive and often die within 2 to 4 years. Adjacent vines may develop weak, shorter shoots as they are infected by the pathogen. White mycelial mats can be found under the bark at the soil line. Dark, rootlike structures (rhizomorphs) may be seen growing in the soil near infested grapevine roots.

COMMENTS ON THE DISEASE

The fungus survives on diseased wood and roots below ground for many years. Healthy plant roots can become infected when they come in contact with inoculum, including rhizomorphs, from a preceding orchard crop or nearby oak trees. Flood waters sometimes spread infected roots in a vineyard. The fungus is favored by soil that is continually damp. Although the pathogen produces mushrooms, they are not considered significant in disease spread.

MANAGEMENT

Because there are no known Armillaria-tolerant grape rootstocks, preplant chemical fumigation of the soil is the only control for oak root fungus. Treatment is best undertaken in September to November when the soil is still dry. Several preparatory steps are involved:

- Before planting or replanting in affected soil, remove, pile, and burn all diseased vines, tree stumps, and roots greater than 1.5 inch in diameter.
- In treating portions of an existing vineyard, healthy appearing vines adjacent to those showing symptoms are often also infected and should be removed. If removed, include the area in the fumigation treatment.
- Before fumigation with methyl bromide or sodium tetrathiocarbonate, dry out the soil as much as possible. The drier the soil, the deeper the chemical will penetrate and the more effective the treatment will be. Do this by withholding water during summer and by using cover crops (such as sudangrass or safflower) to further deplete soil moisture. Finally, deep-till the dried area, being careful not to spread any diseased roots.

Common name (trade name)	Amount / Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider the general properties of the fungicide as well as information relating to environmental impact.			
A. METHYL BROMIDE*	Label rates	48	
COMMENTS: Preplant treatment. May only be used under a Critical Use Exemption. Fumigants such as methyl bromide are a source of volatile organic compounds (VOCs) but are not reactive with other air contaminants that form ozone: methyl bromide depletes ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.			
B. SODIUM TETRATHIOCARBONATE (Enzone)	Label rates	4 days	
COMMENTS: Make application 1–4 weeks before planting.			
C. METAM SODIUM* (Vapam, etc.)	Label rates	48	
COMMENTS: Apply in winter when soil moisture is high. Fumigants such as metam sodium are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.			

** Apply with enough water to provide complete coverage.
* Permit required from county agricultural commissioner for purchase or use.
Not applicable.

BOT CANKER (10/08)

Pathogens: *Botryoshaeria* spp.

SYMPTOMS

Bot canker causes death of arms, cordons, and vines. The wedge-shaped, darkened cankers that develop in the woody vascular tissue are indistinguishable from Eutypa dieback. Unlike Eutypa dieback, there are no foliar symptoms.

COMMENTS ON THE DISEASE

Bot canker is a pruning wound disease commonly seen in vines 10 or more years old. Pycnidia, spore-producing structures produced on surface of canker, provides inoculum for infection. Bot canker is the major cause of arm and cordon death statewide and is most prevalent south of Madera County.

MANAGEMENT

If your table grape vineyard has a history of Bot canker, look for symptoms of poor budbreak in spring and for damage symptoms in late summer or fall.

Pruning wounds provide an infection site. Once infected, complete removal of canker is necessary. On older vines, doubling of spurs to replace lost spur positions and extensive cordon retraining is necessary to maintain production. Cultural practices, such as proper water and fertilizer management and good pruning techniques, designed to maintain vine vigor are necessary and may enable the vines to outgrow infections by this organism.

BOTRYTIS BUNCH ROT (10/08)

Pathogen: *Botrytis cinerea*

SYMPTOMS

Early-season shoot blight may occur following frequent spring rains. Flowers can become infected during bloom; generally the fungus then becomes dormant until late in the season when sugar concentration increases in the infected berry. The fungus then resumes growth and spreads throughout the berry. Infected berries split and leak, thus allowing the pathogen to grow and sporulate on berry surfaces and spread to adjoining berries by mid-season. Spores from infected fruit can directly infect intact, ripe berries as harvest approaches.

COMMENTS ON THE DISEASE

The fungus overwinters as sclerotia in berry mummies on the ground or left hanging on the vine and in canes. Germination and spore production occur in spring. Infections require free water for a definite period of time depending on temperature. Infections may occur during bloom should rains occur; preclose rachis infections often occur on Chardonnay. Late-season infections are most severe when relative humidity exceeds 92%, free moisture is present on the fruit surface, and temperatures are in the 58° to 82°F range. Berries that have been damaged by insects, birds, machinery, etc. may become infected at any time after the fruit begins to ripen because the juice in the berry can provide the necessary water and nutrients for fungal growth.

MANAGEMENT

Successful management of Botrytis bunch rot can be achieved through the use of several strategies. The efficacy of a fungicide depends on getting good coverage, and coverage is affected by the canopy and stage of growth. By employing cultural control methods, properly applying fungicides, and using resistant varieties, the disease can be managed.

Cultural Control

Excellent control has been achieved using canopy management and leaf removal in particular. Removal of basal leaves or basal lateral shoots at or immediately after berry set has resulted in significantly reduced incidence and severity of disease. In warmer growing areas, be careful not to remove excessive numbers of leaves, which can lead to sunburned fruit. This condition is made worse when leaves are removed later in the season. If leaves are removed at cluster set, the berries acclimate readily to the sunlight and develop a thick cuticle that helps prevent sunburn as well as Botrytis infection.

On cordon-trained vines, only remove leaves from the side of the vine that receives morning sun. Do not remove lateral shoots. If leaves are not removed and weather is dry in spring, one fungicide application should be made sometime between bloom and pea-size berries. Otherwise, apply sprays before rainfall especially at bloom or after veraison.

Northern and coastal production areas. Remove leaves or lateral shoots around clusters beginning at late bloom and continue to berry set.

Central Valley. Remove leaves (from bloom to berry set) or hedge (mid-season) to open canopy.

Organically Acceptable Methods

Canopy management and other cultural control methods along with sprays of Organic JMS Stylet Oil and Serenade are organically acceptable methods.

Monitoring and Treatment Decisions

Look for flagging shoot tips or entire shoots during rapid shoot growth. If you see flagging, attempt to break or cut the shoot in the region between the flaccid area and the adjacent area with normal turgor. Brown discoloration on the cut surface is evidence of *Botrytis*.

If the entire shoot is involved, look for a hole at the base, which could indicate feeding by branch and twig borer.

If basal leaves are not removed, apply fungicides before rain in northern and coastal production areas to prevent flower infections. Research data shows a trend toward better control if fungicides are applied at bloom, preclose, and veraison. If leaf removal is practiced, then sprays can be limited to one application if wet weather occurs during bloom (or none if no rain occurs). Thorough coverage is essential for all fungicide treatments.

A fungicide application may also be warranted if a major rain is expected late in the season when grapes are nearly mature. Otherwise, management of Botrytis bunch rot following bloom generally relies on proper cultural practices as outlined in SUMMER BUNCH ROT.

At harvest, check table grape for Botrytis symptoms to assess this year's management program and to plan for next year.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM Program, taking into account efficacy. Also consider the general properties of the fungicide as well as information relating to environmental impact.

Note: *Treatments can be made in conjunction with plant growth regulators and other applications.*

A. CYPRODINIL
(Vangard) WG — 10 oz — 12 — 7
MODE OF ACTION GROUP NAME (NUMBER[1]): Anilinopyrimidine (9)
COMMENTS: Do not apply more than 20 oz/acre/season. Rate is 5–10 oz if tank-mixed with another fungicide.

B. FENHEXAMID
(Elevate) 50WDG — 1 lb — 12 — 0
MODE OF ACTION GROUP NAME (NUMBER[1]): Hydroxyanilide (17)
COMMENTS: Do not apply more than 3 lb a.i. product/acre/season.

C. IPRODIONE
(Rovral) 4F — 1.5–2 lb — 48 — 7
MODE OF ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)
COMMENTS: Do not apply more than 4 times/season. Addition of a narrow range oil (superior, supreme) at 1% increases the effectiveness of this material.

D. PYRACLOSTROBIN/BOSCALID
(Pristine) — 8–10.5 oz — 24 — 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and Carboxamide (7)
COMMENTS: Do not apply on Concord, Worden, Fredonia, Niagara, and related varieties. Do not make more than 2 sequential applications before rotating to a fungicide with a different mode of action.

E. NARROW RANGE OIL#
(Organic JMS Stylet) — 1% — 4 — 0
MODE OF ACTION GROUP NAME (NUMBER[1]): A contact fungicide with smothering and barrier effects.
COMMENTS: Foliage burn may occur if oil is applied within 2 weeks of sulfur or captan sprays. Oil will temporarily remove the 'bloom' on the berries; to avoid this, do not spray within 2 weeks of harvest.

F. BACILLUS SUBTILIS#
(Serenade Max) — 1–3 lb — 4 — 0
MODE OF ACTION: A biological fungicide.

G. CAPTAN 50WP — 2 lb — 4 days
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)
COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.

H. DICHLORAN
(Botran) 75WSB/75W — Label rates — 12 — 0
MODE OF ACTION GROUP NAME (NUMBER[1]): Aromatic hydrocarbon (14)
COMMENTS: May be applied at onset of bloom. Do not apply in combination with sulfur products in sensitive varieties. Up to 5.33 lb may be applied per season.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
I. MANCOZEB			
(Dithane M-45, Penncozeb 75DF)	1.5–2.5 lb	24	see comments
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Do not apply after bloom. Do not apply more than 6 lb a.i./acre/season.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

CROWN GALL (6/06)

Pathogen: *Agrobacterium vitis*

SYMPTOMS

Gall formation is the typical symptom of this disease. Galls may be produced on canes, trunks, roots, and cordons and may grow to several inches in diameter. Internally galls are soft and have the appearance of disorganized tissue.

COMMENTS ON THE DISEASE

Agrobacterium tumefaciens is systemic in grapevine wood. The pathogen can be in plant debris from the vines that is buried in the soil where it can survive for several years. If new vines are planted they can be infected. Galls commonly develop where plants have been suckered or injured during cultivation or pruning. Galls frequently will appear where the vine tissue has been damaged by freezing temperatures. Natural growth cracks in woody root tissue also appear to be good sites for infection. The galls may girdle the vine and disrupt the flow of nutrients, thus restricting vine growth. If infested vines are field grafted or T-budded, gall formation may push the bud shield or graft union off the vine.

MANAGEMENT

Crown gall can be controlled by good sanitation, the avoidance of injury, and the avoidance of using wood systemically infected by the pathogen. Heat treatment of planting stock can eliminate the bacteria, but reinfection can occur once the vine is planted in the field. In areas where winter injury to the vines occurs, disease incidence will be high if the vines are infested. Grow tubes left on young vines over the winter may increase the incidence of crown gall in infected vines. Chemical treatments are generally not effective. Currently available products only treat the symptoms and do not eliminate the bacterial infection.

DOWNY MILDEW (9/07)

Pathogen: *Plasmopara viticola*

SYMPTOMS

The fungus attacks all green parts of the vines, particularly the leaves. Depending on the incubation period and leaf age, lesions are yellowish and oily or angular, yellow to reddish and brown and limited by the veins. Sporulation of the fungus appears as a delicate, dense, white, cottony growth in the lesions. Infected shoot tips thicken, curl ("Shepherd's Crook") and become white with sporulation. They eventually turn brown and die. Similar symptoms are seen on petioles, tendrils and young inflorescences, which, if attacked early enough, ultimately turn brown, dry up and drop. The young berries are highly susceptible. They appear grayish when infected (gray rot) and become covered with a downy felt of fungus sporulation. Berries become less susceptible as they mature, but rachis infections can spread into older berries (brown rot, no sporulation). Infected berries of white cultivars may turn dull gray-green, while those of black cultivars turn pinkish red. Infected berries remain firm, compared to ripening healthy berries, and drop easily. Portions of the rachis or the entire cluster also may drop.

COMMENTS ON THE DISEASE

Grape downy mildew occurs mainly in regions where it is warm and wet during the vegetative growth of the vine. Limited rainfall in spring and summer generally limits the spread of the disease in California. Surviving inoculum may be present in California at low levels and initially may have been introduced on plant material from outside of California. In most regions the fungus survives the winter mainly as oospores in fallen leaves. However, in California's generally mild winters, survival of the fungus in buds, shoot tips, and persistent leaves may be more important than in other grape-growing regions.

The pathogen is dispersed by splashing rain and wind. The infection process can take less than 90 minutes. Infection generally occurs in the morning and the incubation period is about 4 days. Downy mildew is favored by all factors that increase the moisture content of soil, air and host plant. Rain and irrigation practices are principal factors in promoting epidemics. The optimum temperature for development of the disease is 68° to 77°F (20° to 25°C) with extremes ranging from 50° to 86°F (10° to 29°C). In California the greatest potential for disease development exists when a wet winter is followed by late spring rains. The potential is high as well in the event of early fall rains.

MANAGEMENT

Preventive management consists of effective soil drainage and reduction of sources of overwintering inoculum. In a vineyard that depends on sprinkler irrigation, extend the interval between irrigations as long as possible.

Fungicides for use against downy mildew can be categorized as either preventive or curative. The preventive fungicides (mancozeb, maneb, and copper compounds) must be applied before an infection period begins. New growth following application will not be protected. Include a spreader/sticker agent to prevent the material from washing off with rain. In vineyards with a history of downy mildew, apply early season copper sprays as part of a preventive program, especially during wet springs.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM Program, taking into account efficacy. Also consider the general properties of the fungicide as well as information relating to environmental impact.

A. AZOXYSTROBIN

(Abound)	11–15.4 fl oz	4	14

MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Begin applications at budbreak. Alternate with chemicals that have a different mode of action. Do not apply more than 2 sequential applications of this material or more than 6 applications/year.

B. PYRACLOSTROBIN/BOSCALID

(Pristine)	8–10.5 oz	24	14

MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and Carboxamide (7)
COMMENTS: Do not apply on Concord, Worden, Fredonia, Niagara, and related varieties. Do not make more than 2 sequential applications before rotating to a fungicide with a different mode of action.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
C. KRESOXIM-METHYL (Sovran)	3.2–4.8 oz	12	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Begin application at budbreak.			
D. MEFENOXAM/COPPER HYDROXIDE (Ridomil Gold/Copper)	1–2 lb	48	66
MODE OF ACTION GROUP NAME (NUMBER[1]): Phenylamide (4) and Multi-site contact (M1)			
COMMENTS: Apply up to 4 times beginning before bloom. Do not apply more than a total of 0.8 lb. active ingredient mefenoxam/crop/season. Do not apply after bloom. Do not use on copper-sensitive varieties.			
E. TRIFLOXYSTROBIN (Flint)	4 oz	12	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Do not apply to Concord grapes or crop injury may result. Begin applications when conditions are favorable for disease and continue on a 7- to 10-day interval as needed. Use shorter interval when disease pressure is severe. Do not apply more than twice consecutively.			
F. BASIC COPPER SULFATE 99%#	Label rates	24	see label
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1)			
COMMENTS: Begin application when shoots are 0.5 inch long, then repeat at 10- to 14-day intervals as needed. Some vinifera may be sensitive to copper sprays. Not all copper compounds are approved for use in organic production; be sure to check individual products.			
G. COPPER HYDROXIDE	Label rates	24	see label
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1)			
COMMENTS: Use 1–3 lb hydrated lime/acre in combination with cupric hydroxide. May be applied either as a dilute or concentrate spray. Use for the last 1 or 2 late-season applications following early-season application of another fungicide. Slight to severe foliar injury may occur on copper sensitive varieties.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

EUTYPA DIEBACK (10/08)

Pathogens: *Eutypa lata, E. leptoplaca,* and other fungi in the Diatrypaceae family.

SYMPTOMS

Eutypa dieback delays shoot emergence in spring, and causes shunted shoots and leaves that are chlorotic, tattered, and cupped. Symptoms in the wood are characterized by darkened cankers that develop in the vascular tissue. The cankers are often wedge shaped (like a pie chart) in cross-cuts of affected cordons or trunks. Cankers develop faster in the direction of the roots than toward the end of cordons. Extensive infections lead to vine death.

COMMENTS ON THE DISEASE

Eutypa dieback is not generally visible in vines younger than 5 to 6 years old although vines may still be infected. The disease is most easily seen in vines established for 10 or more years. The fungus survives in diseased wood and produces perithecia in old, infected host tissue under conditions of high moisture. In California several plants in addition to grape serve as reservoirs for the pathogen including almond, apricot, blueberry, cherry, crab apple, *Ceanothus* spp., kiwi, pear, oleander, and native plants including California buckeye, big leaf maple, and willow. Ascopores are discharged from perithecia soon after rainfall. Infection occurs through pruning wounds, which remain susceptible much longer early in the dormant season than later in the dormant season. Overall susceptibility is about 6 weeks.

MANAGEMENT

Prune late in the dormant season to promote rapid healing of wounds. Remove and burn infected wood inside the vineyard and dead wood in adjacent vineyards and orchards to reduce the spread of the pathogen. Cut out and remove dead arms and cordons from the vineyard during dormancy. Completely remove all cankers, pruning below the canker on the vine or trunks until no darkened canker tissue remains. Make large cuts directly after a rain because the risk for infection is lowest at this time, as the atmospheric spore load has been washed out temporarily (or is at its ebb). Double pruning cordon-trained vines can help final pruning cuts to be made quickly and late in dormancy, thus reducing the chance for infection. For additional protection, consider treating pruning wounds.

In table grapes, note locations in the vineyard with poor budbreak in spring. Examine these areas in fall for disease damage. Mark locations of vines with poor growth for future confirmation and management.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider efficacy and the general properties of the fungicide as well as information relating to environmental impact.

A. THIOPHANATE-METHYL
(Topsin-M) WSB — 1% — 7 days
MODE OF ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)
COMMENTS: Mix as a 1% paste and apply to cut or pruned surfaces immediately after cutting. Use allowed under a Special Local Needs label.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

NA Not applicable.

MEASLES (Esca) (10/08)

Pathogen: Nine species of fungi in the genus *Phaeoacremonium*. The perfect stage has been found for three: *Togninia minima*, *T. californica*, and *T. fraxinopennsylvanica*

SYMPTOMS

Affected leaves display small, chlorotic interveinal areas that enlarge and dry out. Foliage symptoms are frequently called "esca." In red varieties dark red margins surround the dead interveinal areas. Severely affected leaves may drop and canes may dieback from the tips. Symptoms may occur at any time during the growing season but are most prevalent during July and August. On berries, small, round, dark spots, each bordered by a brown-purple ring, may occur. These spots may appear at any time between fruit set and ripening. In severely affected vines the berries often crack and dry on the vine or are subject to spoilage.

COMMENTS ON THE DISEASE

Measles are caused by several species of *Togninia*, a fungus that produces perithecia on grapevines in old, rotted vascular tissue. Ascospores are released from fall and winter into spring with rainfall; temperatures do not seem to be limiting for spore release. Ascospores reinfect the vine through pruning wounds. Wounds remain susceptible up to 16 weeks after pruning with susceptibility declining over time. The pathogen enters the current season's vascular tissue and it is believed that symptoms are expressed in the same year that new infections occur. Symptoms are caused by a toxin produced in the vascular tissue and include both leaf striping and fruit spotting. Other symptoms that appear in May are shoot tip dieback and tendril dieback.

Another species of fungus, *Phaeomoniella chlamydospora*, that causes the disease is closely related to the species of *Togninia* listed above and is also an endophyte in grapevine. This fungus overwinters as pycnidia in 3-5 year-old pruning wounds and releases pycnidiospores with rainfall from fall through spring. The pathogen also infects the vine through current year pruning wounds and produces symptoms.

With both pathogens, there can occur a 50% reduction in shoot growth.

MANAGEMENT

Measles is more prevalent in areas with consistently high summer temperatures, such as the Central Valley, and in areas with heavy spring rainfall. Generally, plantings that are 10 years of age or older are affected, although measles has been seen on fruit and foliage on younger vines. In table grapes, mark areas of poor budbreak in spring. Examine these areas at harvest for disease symptoms.

Control can be achieved with use of liquid lime sulfur. However, it is important that the product get into the cracks and crevices of the vine because that is where the fungal fruiting bodies reside. Other treatments include use of wax or tree tar to fill the holes on the vine. Though still experimental, there would be no way for the fungus to reinfect the vine if these holes are plugged up.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider the general properties of the fungicide as well as information relating to environmental impact.

A. THIOPHANATE-METHYL
(Topsin-M) WSB — 1% — 7 days
MODE OF ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)
COMMENTS: Mix as a 1% paste and apply to cut or pruned surfaces immediately after cutting. Use allowed under a Special Local Needs label.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

NA Not applicable.

PHOMOPSIS CANE AND LEAFSPOT (10/08)

Pathogen: *Phomopsis viticola*

SYMPTOMS

Phomopsis cane and leafspot appears as tiny dark spots with yellowish margins on leaf blades and veins. Spots first show 3 to 4 weeks following rain. Leaf death may occur if large numbers of spots build up. Basal leaves with heavy infection become distorted and usually never develop to full size. On shoots, small spots with black centers similar to those found on leaves occur usually on a basal portion of the shoot. After spots lengthen a few millimeters, the epidermal layers of the shoots usually crack at the point of infection. Heavy infection usually results in a scabby appearance of the basal portions of the shoot. On clusters, spots similar to those that occur on shoots occur on the flower cluster stems.

Lesions on leaves, shoots, and clusters become inactive during the summer heat but rain just before harvest can cause light brown spots on clean berries and spots quickly enlarge and become dark brown. Berries may shrivel and become mummified. Infected canes appear bleached during the dormant season. Severely affected canes or spurs exhibit an irregular dark brown to black discoloration intermixed with whitish bleached areas. The black specks visible in the bleached areas are pycnidia that develop during the dormant season.

COMMENTS ON THE DISEASE

This disease is most severe in northern grape-growing regions (North Coast and northern San Joaquin Valley) where spring rains are common after budbreak; moisture is required for infection. Infections generally occur when shoots begin to grow. Spores are released in large quantities from the overwintering pycnidia on diseased canes and spurs. These are splashed by rain onto early developing shoots and infection occurs when free moisture remains on the unprotected green tissue for many hours.

MANAGEMENT

Spur and cane lesions provide most of the inoculum for new infections. Reducing the source of the disease is important. In table grapes, mark areas in the vineyard exhibiting poor budbreak in spring. Later examine these areas for disease symptoms. A treatment of liquid lime sulfur before rainfall in fall will reduce the viability of pycnidia as well as reduce overwintering *Botrytis* sclerotia and powdery mildew spores.

In all areas, spring foliar treatments are advisable if rainfall is predicted after budbreak. Apply materials before the first rain after budbreak and before 0.5 inch shoot length (and again when shoots are 5 to 6 inches in length). Contact materials such as copper, sulfur, ziram, mancozeb, and maneb must be reapplied after significant rainfall in order to protect shoots up to 18 inches in length. If several rains are predicted, use systemic fungicides (azoxystrobin and kresoxim-methyl).

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider the general properties of the fungicide as well as information relating to environmental impact.			
DORMANT SEASON			
A. LIQUID LIME SULFUR#	Label rates	see label	see label
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
COMMENTS: Reduces overwintering structures of *Phomopsis* as well as *Botrytis* and powdery mildew spores.			
SPRING FOLIAR TREATMENT			
A. KRESOXIM-METHYL (Sovran)	3.2–4.8 oz	12	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Begin application at budbreak.			

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
B. AZOXYSTROBIN (Abound) F	11–15.4 fl oz	4	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Do not apply more than 3 sequential sprays before alternating with a fungicide that has a different mode of action. Apply before disease development begins. Follow label directions, especially as they pertain to number of applications allowed per year.			
C. CAPTAN 50WP	2 lb	4 days	
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
COMMENTS: Captan-treated grapes prohibited in Canada. Do not apply more than 24 lb/acre/year. Do not apply in combination with, immediately before, or closely following oil sprays.			
D. MANEB 80WP	1.5–2.5 lb	24	see comments
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Do not apply after bloom.			
E. MANCOZEB (Dithane M-45)	Label rates	24	see comments
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Do not apply after fruit set or more than 7.5 lb/acre/season. Do not apply after bloom.			
F. PYRACLOSTROBIN/BOSCALID (Pristine)	8–10.5 oz	24	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and Carboxamide (7)			
COMMENTS: Do not apply on Concord, Worden, Fredonia, Niagara, and related varieties. Do not make more than 2 sequential applications before rotating to a fungicide with a different mode of action.			
G. ZIRAM (Ziram) 76DF	3–4 lb	48	see comments
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Apply before buds swell and repeat after blossoming but before fruit forms. Do not apply after bloom.			
H. LIME SULFUR	15–20 gal	48	see label
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
COMMENTS: Apply as a directed spray in 80–100 gal water/acre. Apply in the delayed dormant period to kill spores.			
I. SULFUR# (Micronized Dry Flowable)	6 lb	see comments	see label
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
COMMENTS: In some counties there is a 3-day restricted entry period when using sulfur; consult your county agricultural commissioner. Apply just before or immediately after post budbreak rains. Do not apply within 3 weeks of an oil application.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

PIERCE'S DISEASE (10/08)

Pathogen: *Xylella fastidiosa*

SYMPTOMS

In vines that are infected in spring, symptoms of Pierce's disease first appear as water stress in midsummer, caused by blockage of the water-conducting system by the bacteria. The occurrence of the following four symptoms in mid- to late summer indicates the presence of Pierce's disease: (1) leaves become slightly yellow or red along margins in white and red varieties, respectively, and eventually leaf margins dry or die in concentric zones; (2) fruit clusters shrivel or raisin; (3) dried leaves fall leaving the petiole (leaf stem) attached to the cane; and (4) wood on new canes matures irregularly, producing patches of green, surrounded by mature brown bark. Delayed and stunted shoot growth occurs in spring following infection even in vines that did not have obvious symptoms the preceding year.

Leaf symptoms vary among grape varieties. Pinot Noir and Cabernet Sauvignon have highly regular zones of progressive marginal discoloration and drying on blades. In Thompson Seedless, Sylvaner, and Chenin Blanc, the discoloration and scorching may occur in sectors of the leaf rather than along the margins.

Usually only one or two canes will show Pierce's disease symptoms late in the first season of infection, and these may be difficult to notice. Symptoms gradually spread along the cane from the point of infection out towards the end and more slowly towards the base. By mid-season some or all fruit clusters on the infected cane of susceptible varieties may wilt and dry. Tips of canes may die back; roots may also die back. Vines of susceptible varieties deteriorate rapidly after appearance of symptoms. Shoot growth of infected plants becomes progressively weaker as symptoms become more pronounced.

Climatic differences between regions can affect the timing and severity of symptoms, but not the type of symptoms. Hot climates accelerate symptoms because moisture stress is more severe even with adequate soil moisture.

A year after the vines are infected some canes or spurs may fail to bud out, and shoot growth is stunted. New leaves become chlorotic (yellow) between leaf veins, and scorching appears on older leaves. From late April through summer infected vines may grow at a normal rate, but the total new growth is less than that of healthy vines. In late summer leaf burning symptoms reappear.

COMMENTS ON THE DISEASE

The bacterium that causes Pierce's disease lives in the water-conducting system of plants (the xylem) and is spread from plant to plant by sap-feeding insects that feed on the xylem. Symptoms appear when a significant amount of xylem becomes blocked by the growth of the bacteria. (This bacterium is also responsible for alfalfa dwarf disease and almond leaf scorch in California.) Insect vectors for Pierce's disease belong to the sharpshooter (Cicadellidae) and spittlebug (Cercopidae) families. The blue-green sharpshooter (*Graphocephala atropunctata*) is the most important vector in coastal areas. The green sharpshooter (*Draeculacephala minerva*) and the red-headed sharpshooter (*Carneocephala fulgida*) are also present in coastal areas but are more important as vectors of this disease in the Central Valley. Other sucking insects, such as grape leafhoppers, are not vectors.

A new Pierce's disease vector, the glassy-winged sharpshooter, has recently become established in California. This vector is a serious threat to California vineyards because it moves faster and flies greater distances into vineyards than the other species of sharpshooters. The glassy-winged sharpshooter occurs in unusually high numbers in citrus and avocado groves and on some woody ornamentals. Until now, these plants have not been sources of Pierce's disease vectors.

Since the early 1990s, the glassy-winged sharpshooter has been seen in high numbers in citrus along the coast of southern California. It subsequently has become locally abundant further inland in Riverside and San Diego counties. In 1998 and 1999, high populations on citrus and adjacent vineyards were seen in southern Kern County and in 2001, hundreds of vines had Pierce's disease. The glassy-winged sharpshooter is expected to spread north and eventually become a permanent resident of various habitats throughout northern California.

Glassy-winged sharpshooter feeds and reproduces on a wide variety of trees, woody ornamentals, and annuals in its region of origin, the southeastern United States. Crepe myrtle and sumac are especially preferred. It reproduces on Eucalyptus, coast live oaks, and a wide range of trees in southern California. But because glassy-winged sharpshooter is a relatively new arrival to the state, it is not clear yet which regions and habitats it will become permanently established in.

The principal breeding habitat for the blue-green sharpshooter is riparian (riverbank) vegetation, although ornamental landscape plants may also harbor breeding populations. As the season progresses, these insects shift their feeding preference, always preferring to feed on plants with succulent growth. In the Central Valley, irrigated pastures, hay fields, or grasses on ditch backs are the principal breeding and feeding habitats for the green and red-headed sharpshooters. These two grass-feeding sharpshooters also occur along ditches, streams, or roadsides where grasses and sedges provide suitable breeding habitat.

Some vines recover from Pierce's disease the first winter following infection. The probability of recovery depends on the date of infection. Infections that occur until June have the greatest probability of surviving until the following year. Recovery rates also depend on grape variety; recovery is higher in Chenin Blanc, Sylvaner, Ruby Cabernet, and White Riesling, compared to Barbera, Chardonnay, Mission, Fiesta, and Pinot Noir. Thompson Seedless, Cabernet Sauvignon, Gray Riesling, Merlot, Napa Gamay, Petite Sirah, and Sauvignon Blanc are intermediate in their susceptibility to this disease and in their probability of recovery. In tolerant cultivars the bacteria spread more slowly within the plant than in more susceptible cultivars. Once the vine has been infected for over a year (i.e., bacteria survive the first winter) recovery is much less likely.

Young vines are more susceptible than mature vines. Rootstock species and hybrids vary greatly in susceptibility. Many rootstock species are resistant to Pierce's disease, but the rootstock does not confer resistance to susceptible *Vinifera* varieties grafted on to it. Finally, the date of infection strongly influences the likelihood of recovery: late infections (after June) by blue-green sharpshooters, green sharpshooters, and red-headed sharpshooters are least likely to persist the following growing season. This may not be the case with glassy-winged sharpshooter, however, because it feeds on leaves near the base of the cane, as well as on 2-year old dormant wood.

MANAGEMENT

Insecticide treatments aimed at controlling the vector in areas adjacent to the vineyard have reduced the incidence of Pierce's disease by reducing the numbers of sharpshooters immigrating into the vineyards in early spring. The degree of control, however, is not effective for very susceptible varieties such as Chardonnay and Pinot Noir or for vines less than 3 years old. If a vineyard is near an area with a history of Pierce's disease, plant varieties that are less susceptible to this disease. Monitor and treat for insect vectors as described in the section on SHARPSHOOTERS.

During the dormant season, remove vines that have had Pierce's symptoms for more than one year; they may be chronically infected and are unlikely to recover or continue to produce a significant crop. Also, remove vines with extensive foliar symptoms on most canes and with tip dieback of canes even if it is the first year that symptoms have been evident. From summer through harvest, mark slightly symptomatic vines; reexamine for symptoms the following spring through late summer or fall and remove vines that have symptoms for a second year. Pruning a few inches above the graft union of vines with moderate foliar symptoms (some canes on entire cordons without symptoms or no symptoms at the bases of most canes) may eliminate Pierce's disease and allow vigorous regrowth the following year, but symptoms will reappear in many (30–40%) or most of these severely pruned vines the second year.

For table grapes, examine vines for poor budbreak in spring. Later in the season, look for pests and damage.

Because the glassy-winged sharpshooter feeds much lower on the cane than other sharpshooters in California, late-season (after May-June) infections and infections occurring during dormancy made by the glassy-winged sharpshooter can survive the winter to cause chronic Pierce's disease. This enables vine-to-vine spread of Pierce's disease, which has not been the case in California. Vine-to-vine spread can be expected to increase the incidence of Pierce's disease exponentially rather than linearly over time, as has been normal for California vineyards affected by Pierce's disease. Insecticide treatments of adjacent breeding habitats, such as citrus groves, has been the most effective approach.

Removing diseased vines as soon as possible when Pierce's disease first appears in a vineyard is also critical to help reduce the infection rate. Early and vigilant disease detection and vine removal is recommended for any vineyards that experience influxes of the glassy-winged sharpshooter.

Long-term studies are being conducted on the effect of riparian vegetation management in reducing disease incidence and severity in North Coast vineyards. Riparian vegetation management has proven to be effective in reducing the damaging spring populations of blue-green sharpshooters. Because these areas are ecologically sensitive and regulated by federal, state, and local legislation, the unauthorized removal of vegetation is prohibited or restricted. Vegetation management of these areas must be acceptable or beneficial for wildlife and water quality and maintain the integrity of the riparian habitat. For additional information, contact the California Department of Fish and Game for current regulations and guidelines. For more information, see the complete *Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards* can be viewed online at http://www.cnr.berkeley.edu/xylella/control/PDNorthCoast/info.htm.

POWDERY MILDEW (10/08)

Pathogen: *Erysiphe necator*

SYMPTOMS

Symptoms of powdery mildew include red blotchy areas on dormant canes. On leaves, initial symptoms appear as chlorotic spots on the upper leaf surface. Signs of the pathogen appear a short time later as white, webby mycelium. As spores are produced, the infected areas take on a white, powdery or dusty appearance. On fruit and rachises the pathogen appears as white, powdery masses that may colonize the entire berry surface.

COMMENTS ON THE DISEASE

The fungus survives the winter as dormant mycelium in buds or as chasmothecia (spore structures). Chasmothecia are the most important sources of overwintering inoculum. They mature in late summer and fall on infected green tissue and are washed onto the cordons and spurs with fall and winter rainfall. On warm winter and spring days when moisture is abundant, chasmothecia burst and release ascospores. Conidial spore production occurs 7 to 10 days after primary infection by ascospores and will continue throughout the season as long as moderate temperatures (70° to 85°F) exist.

MANAGEMENT

Season-long control is dependent upon reducing early-season inoculum and subsequent infection. Thus treatment must begin promptly and be repeated at appropriate intervals. Timing of the first treatment depends on fungicide used and growth stage. Frequency of treatment thereafter depends on fungicide choice and weather conditions. Monitor and use the powdery mildew index (PMI) model to determine necessary spray intervals. Treatment may be discontinued for wine and raisin grapes when fruit reaches 12 Brix but should be continued up to harvest for table grapes.

All powdery mildew fungicides, with the exception of oil, are best used as protectants. Discontinue the use of soft chemistry products (sulfurs, biologicals, systemic acquired resistance products, and contact materials) when disease pressure is high because by themselves they will not provide adequate control. If eradication is necessary, a light summer oil may be used anytime in the season if there is no sulfur residue present (i.e. at least 2 weeks after a sulfur treatment). Basal leaf removal can improve coverage and efficacy of powdery mildew fungicides on clusters.

Organically Acceptable Methods

Sulfur, Serenade, Sonata, and Organic JMS Stylet Oil are acceptable on most organically certified grapes; check with your certifier for details.

Monitoring and Treatment Decisions

In spring, the overwintering chasmothecia produce ascospores, which are the primary source of infection. Ascospores are released when 0.1 inch of rain or irrigation is followed by 13 hours of leaf wetness when temperatures are between 50° and 80°F. Seven to 10 days after this initial infection, monitor vineyards for the presence of powdery mildew by collecting 10 to 15 basal leaves from 20 or so vines at random and examining the undersurface for powdery mildew spores. If spores are found, then monitor disease development by using the powdery mildew risk assessment index.

Powdery Mildew Index (PMI). Once initial infection occurs, ideal temperatures for growth of the fungus are between 70° and 85°F. Temperatures above 95°F for 12 continuous hours or longer cause the fungus to stop growing. The powdery mildew index assesses the risk of disease development by relating it to air temperature and tells you how often you need to spray to protect the vines. When using the powdery mildew index, always monitor the vineyard for signs of the disease. If evidence of the disease is not recent, don't treat. You may monitor temperatures in your own vineyard and calculate the PMI using the rules below, or you may use weather equipment that has the UC Davis PMI built into its software.

Initiating the index. After you find powdery mildew, an epidemic will begin when there are 3 consecutive days with 6 or more continuous hours of temperatures between 70° and 85°F as measured in the vine canopy.

1. Starting with the index at 0 on the first day, add 20 points for each day with 6 or more continuous hours of temperatures between 70° and 85°F.
2. Until the index reaches 60, if a day has fewer than 6 continuous hours of temperatures between 70° and 85°F, reset the index to 0 and continue.
3. If the index reaches 60, an epidemic is under way. Begin using the spray-timing phase of the index.

Spray timing. Each day, starting on the day after the index reached 60 points during the start phase, evaluate the temperatures and adjust the previous day's index according to the rules below. Keep a running tabulation throughout the season. In assigning points, note the following:

- If the index is already at 100, you can't add points.
- If the index is already at 0, you can't subtract points.
- You can't add more than 20 points a day.
- You can't subtract more than 10 points a day.

1. If fewer than 6 continuous hours of temperatures between 70° and 85°F occurred, subtract 10 points.
2. If 6 or more continuous hours of temperatures between 70° and 85°F occurred, add 20 points.
3. If temperatures reached 95°F for more than 15 minutes, subtract 10 points.
4. If there are 6 or more continuous hours with temperatures between 70° and 85°F AND the temperature rises to or above 95°F for at least 15 minutes, add 10 points. (This is the equivalent of combining points 2 and 3 above.)

Use the index to determine disease pressure and how often you need to spray to protect the vines. Spray intervals can be shortened or lengthened depending on disease pressure, as indicated in the table below.

SPRAY INTERVALS BASED ON DISEASE PRESSURE USING THE POWDERY MILDEW INDEX

			Suggested spray schedule			
Index	Disease pressure	Pathogen status	Biologicals[1] and SARs[2]	Sulfur	Sterol-inhibitors[3]	Strobilurins[4]
0-30	low	present	7- to 14-day interval	14- to 21-day interval	21-day interval or label interval	21-day interval or label interval
30-50	intermediate	reproduces every 15 days	7-day interval	10- to 17-day interval	21-day interval	21-day interval
60 or above	high	reproduces every 5 days	use not recommended	7-day interval	10- to 14-day interval	14-day interval

1 *Bacillus pumilis* (Sonata) and *Bacillus subtilis* (Serenade)
2 SAR = Systemic acquired resistance products (AuxiGro, Messenger)
3 tebuconazole (Elite), triflumizole (Procure), myclobutanil (Rally), fenarimol (Rubigan), and triadimefon (Bayleton)
4 methyl (Sovran), and pyraclostrobin/boscalid (Pristine)

RESISTANCE MANAGEMENT

Alternating fungicides with different modes of action is essential to prevent pathogen populations from developing resistance to fungicides. This resistance management strategy should not include alternating or tank mixing with products to which resistance has already developed. Do not apply more than two sequential sprays of a fungicide before alternating with a fungicide that has a different mode of action.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM Program, taking into account efficacy. Also consider the general properties of the fungicide as well as information relating to environmental impact.

Note: *Treatments can be made in conjunction with plant growth regulators and other applications.*

STEROL INHIBITORS

A. TEBUCONAZOLE
(Elite) 45DF — 4 oz — 12 — 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)
COMMENTS: Begin treatment when shoots are 8 to 10 inches long. Can be applied earlier but research shows that a wettable sulfur application (5 lb/100 gal water/acre) at budbreak should be used first. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14 to 21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 8 to 10 inches and treatments with sterol inhibitors or strobilurins begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry.

B. TRIFLUMIZOLE
(Procure) 50WS — Label rates — 12 — 7
MODE OF ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)
COMMENTS: Begin treatment when shoots are 8 to 10 inches long. Can be applied earlier but research shows that a wettable sulfur application (5 lb/100 gal water/acre) at budbreak should be used first. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14 to 21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 8 to 10 inches and treatments with sterol inhibitors or strobilurins begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry. Do not apply more than 32 oz of product/acre/season.

C. MYCLOBUTANIL
(Rally) 40WP — 4 oz in 50 or more gal water/acre — 24 — 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)
COMMENTS: Begin treatment when shoots are 8 to 10 inches long. Can be applied earlier but research shows that a wettable sulfur application (5 lb/100 gal water/acre) at budbreak should be used first. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14 to 21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 8 to 10 inches and treatments with sterol inhibitors or strobilurins begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry. Apply no more than 1.5 lb maximum/season. Do not apply by air.

D. FENARIMOL
(Rubigan) EC — 3–6 oz — 12 — 30
MODE OF ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)
COMMENTS: Begin treatment when shoots are 18 inches long. Precede with a wettable sulfur application (5 lb/100 gal water/acre) that is applied at budbreak. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14–21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 18 inches and treatments with this fungicide begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry. Do not apply more than 19 oz/acre/season.

STROBILURINS

A. AZOXYSTROBIN
(Abound) — 11–15.4 fl oz — 4 — 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Begin treatment when shoots are 8 to 10 inches long. Can be applied earlier but research shows that a wettable sulfur application (5 lb/100 gal water/acre) at budbreak should be used first. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14 to 21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 8 to 10 inches and treatments with sterol inhibitors or strobilurins begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

B. TRIFLOXYSTROBIN
(Flint) 1.5–2 oz 12 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Do not apply to Concord grapes or crop injury may result. Begin treatment when shoots are 8 to 10 inches long. Can be applied earlier but research shows that a wettable sulfur application (5 lb/100 gal water/acre) at budbreak should be used first. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14 to 21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 8 to 10 inches and treatments with sterol inhibitors or strobilurins begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry. Do not apply more than 8 oz/acre/season.

C. KRESOXIM-METHYL
(Sovran) 3.2–6.4 oz 12 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Begin treatment when shoots are 8 to 10 inches long. Can be applied earlier but research shows that a wettable sulfur application (5 lb/100 gal water/acre) at budbreak should be used first. During cool springs when growth is slow, an additional wettable sulfur treatment is advisable 14 to 21 days later. Apply subsequent sulfur treatments at 14- to 21-day intervals until shoots reach 8 to 10 inches and treatments with sterol inhibitors or strobilurins begin. Because shoot growth rate is weather dependent, shoot length should not be used as a spray date indicator after the first treatment. Alternate use with fungicide of different chemistry. Do not apply more than a total of 1.6 lb/acre/year.

D. PYRACLOSTROBIN/BOSCALID
(Pristine) 8–10.5 oz 24 14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and Carboxamide (7)
COMMENTS: Do not use on Concord, Worden, Fredonia, Niagara, or related grape varieties. Do not make more than 2 sequential applications before rotating to a fungicide with a different mode of action.

SULFUR COMPOUNDS

A. SULFUR#
(dust, wettable, flowable, or micronized) Label rates see comments see label
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)
COMMENTS: In some counties there is a 3-day restricted entry period when using sulfur; consult your county agricultural commissioner. To help prevent off-site drift, use wettable sulfur instead of dusting sulfur when canopies are minimal (less than 12 inches). Begin treatment at budbreak to 2-inch shoot growth. Reapply at 7-day intervals if treating every other middle or at 10-day intervals if treating every middle. Reapply if sulfur is washed off by rain or irrigation. Sulfur can cause injury to foliage and fruit when applied just before or on days when the temperature exceeds 100°F. The amount/acre may be reduced during periods of high temperature to prevent burning. Do not apply within 3 weeks of an oil application.

BIOLOGICALS

A. BACILLUS PUMILIS#
(Sonata) 2–4 qt 4 0
MODE OF ACTION: A biological fungicide.
COMMENTS: Begin making applications before disease onset or when disease pressure is low. Repeat at 7- to 10-day intervals until disease pressure is intermediate, then switch to a strobilurin, sterol inhibitor, oil, or sulfur. Apply in sufficient water to obtain thorough coverage.

B. BACILLUS SUBTILIS#
(Serenade Max) 1–3 lb 4 0
MODE OF ACTION: A biological fungicide.
COMMENTS: Begin making applications before disease onset or when disease pressure is low. Repeat at 7- to 10-day intervals until disease pressure is intermediate, then switch to a strobilurin, sterol inhibitor, oil, or sulfur. Apply in sufficient water to obtain thorough coverage.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
SYSTEMIC ACQUIRED RESISTANCE PRODUCTS			
A. HARPIN PROTEIN			
(Messenger)	4.5–9 oz	4	0
MODE OF ACTION: Unknown.			
COMMENTS: Begin applications when new shoot growth is present. Apply as a foliar spray on 7- to 14-day intervals before the onset of the disease when disease pressure is light. Discontinue use under moderate to heavy disease pressure.			
B. GABA/L-GLUTAMIC ACID			
(AuxiGro)	4 oz or 2-4 oz as a tank mix	4	0
MODE OF ACTION: Unknown.			
COMMENTS: Must be applied before the onset of powdery mildew infections. May be applied alone, in alternating applications with other powdery mildew products, or in tank mix combinations with other powdery mildew products. Discontinue use when disease pressure is moderate to heavy. Do not exceed 24 oz/acre/crop.			
CELL SIGNALING INHIBITOR			
A. QUINOXYFEN			
(Quintec)	3–4 fl oz	12	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinoline (13)			
COMMENTS: Spray on a 14-day interval, otherwise use 5-6.6 fl oz to spray on a 21-day interval.			
CONTACT MATERIALS			
A. NARROW RANGE OIL #			
(Organic JMS Stylet Oil, Saf-T-Side, etc.)	2%	4	0
MODE OF ACTION GROUP NAME (NUMBER[1]): A contact fungicide with smothering and barrier effects.			
COMMENTS: Never mix oil and sulfur or apply one within 2 weeks of the other. Can be used as a protectant or eradicant. As a protectant, alternate it prebloom with the sterol inhibitors. At the 2% rate, this oil is an excellent eradicant and can be used as a stand-alone program at anytime during the season (except within 2 weeks of a sulfur treatment); good coverage is essential. Apply at 14- to 18-day interval. Do not use on table grapes after berry set.			
B. POTASSIUM BICARBONATE #			
(Kaligreen)	2.5–5 lb	4	1
(MilStop)	2.5–5 lb	1	0
MODE OF ACTION: An inorganic salt.			
COMMENTS: Conditionally acceptable for use on organically grown produce; check with your certifier. Apply by ground only in sufficient water (25 gal/acre minimum) to ensure complete and thorough coverage of foliage and crop. Most effective when alternated with a sterol inhibitor and used as a protectant. Field reports suggest this material has eradicant activity; but this has not been demonstrated in University research. If used as an eradicant, contact of the disease organism is essential. Use of non-acidifying spreader/sticker or nonphytotoxic crop oil is recommended.			
C. INSECTICIDAL SOAP #			
(M-Pede)	1.5–2%	12	0
MODE OF ACTION GROUP NAME (NUMBER[1]): A contact fungicide with smothering and barrier effects.			
COMMENTS: Alternate use with one of the sterol inhibitors. Apply in 100–150 gal water/acre. Complete coverage of upper and lower leaf surfaces, as well as grape clusters, is essential for control. Apply every 7–10 days. Do not combine with sulfur or apply within 3 days of a sulfur application. Do not apply to Calmeria or Italia varieties of grapes.			

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

SUMMER BUNCH ROT (Sour Rot) (10/08)

Pathogens: *Aspergillus niger*, *Alternaria tenuis*, *Botrytis cinerea*, *Cladosporium herbarum*, *Rhizopus arrhizus*, *Penicillium* sp., and others

SYMPTOMS

As berries ripen and sugar content exceeds 8%, injured fruit become increasingly susceptible to invasion by a wide variety of naturally occurring fungi. Invasion occurs at the point of injury caused by insect or bird feeding, mechanical or growth cracks, or lesions resulting from powdery mildew or black measles (esca). The resulting rot can be severe as it progresses beyond the original injury. Masses of black, brown, or green spores develop on the surface of infected berries. Bunch rot often culminates in sour rot, especially in the central and southern San Joaquin Valley. Sour rot is caused by a variety of microorganisms, including acetic acid bacteria, which are spread by vinegar flies attracted to the rotting clusters.

Slip skin of Red Globe grapes is also associated with summer bunch rot organisms. Symptoms include hairline cracks in the berry skin, watery discoloration of berries, and general berry breakdown. Decay continues to develop slowly under cold storage conditions.

MANAGEMENT

Rotting fruit clusters present during veraison are indicative of summer bunch rot. Management of this disease complex is based on reducing injury or damage to the fruit, thus preventing invasion by bunch rot organisms. Basal leaf removal at or after berry set has given excellent control of summer bunch rot in the San Joaquin Valley. In warmer growing areas, be careful not to remove excessive numbers of leaves, which can lead to sunburned fruit. Remove leaves only from the side of the vine that receives afternoon shade. Also, leafhopper populations and damage caused by omnivorous leafroller have been reduced by this cultural practice. Treat at preclose and veraison if summer bunch rot has been a problem in the past.

To reduce growth-related damage to the berries, follow proper irrigation, fertilizer, fruit thinning, and canopy management practices. Prune to achieve vine balance between vegetative growth and cluster number. Also control powdery mildew and damaging populations of omnivorous leafroller and other berry feeders.

In table grapes, look for symptoms of summer rot on fruit during harvest to assess this year's management program and to prepare for next year. Also, note that the presence of VINEGAR FLIES may indicate bunch rot infections.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider efficacy and the general properties of the fungicide as well as information relating to environmental impact.

Note: *Treatments can be made in conjunction with plant growth regulators and other applications.*

A. IPRODIONE
(Rovral) 4F — 1.5–2 lb — 48 — 7
MODE OF ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)
COMMENTS: Combinations of iprodione mixed with copper can be effective against summer bunch rot. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.

** Apply with enough water to provide complete coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions. Fungicides with a different Group number are suitable to alternate in a resistance management program. For more information, see http://www.frac.info/.

Nematodes (10/08)

Scientific Names: Root knot nematodes: *Meloidogyne incognita, M. javanica, M. arenaria,* and *M. hapla*
Dagger nematodes: *Xiphinema americanum* and *X. index*
Citrus nematode: *Tylenchulus semipenetrans*
Lesion nematode: *Pratylenchus vulnus*
Ring nematode: *Mesocriconema (=Criconemella) xenoplax*

DESCRIPTION OF THE PESTS

Plant parasitic nematodes are microscopic, unsegmented roundworms that feed on plant roots by puncturing and sucking the cell contents with a needlelike mouthpart called a stylet. They live in soil and within or on plant tissues. Of the many genera of plant parasitic nematodes detected in soils from California vineyards, root knot, dagger, citrus, lesion, and ring nematodes are the most important ones. Other nematodes associated with grape in California include stubby root nematode, *Paratrichodorus minor*; spiral nematode, *Helicotylencus pseudorobustus*; and needle nematode, *Longidorus africanus*. Of these, only needle nematode has been found to be damaging to grapes in California. Pin nematode, *Paratylenchus hamatus*, is frequently found in vineyards but is not thought to cause damage to this crop.

Dagger, ring, and lesion nematodes are most prevalent in north and Central Coast vineyards, and in the San Joaquin Valley. Root knot and citrus nematodes occur most commonly in the San Joaquin Valley and southern California. The needle nematode is found mainly in southern California.

Species introduction, native habitat, soil texture, grape cultivar, cropping history, weed spectrum, and growing region are the determining factors as to which nematode is present in which vineyard.

DAMAGE

Plant parasitic nematodes feed on roots, reducing vigor and yield of the vine usually in irregular patterns across the vineyard. Damage patterns are frequently associated with soil textural differences. Root knot nematodes penetrate into roots and induce giant cell formation, usually resulting in root galls. Giant cells and galls disrupt uptake of nutrients and water, and interfere with plant growth. *Xiphinema americanum*, the most common species of dagger nematode, weakens vines by feeding near the root tip and is a specific vector of yellow vein virus (also known as tomato ringspot virus). The dagger nematode, *Xiphinema index*, can cause yield reduction in some varieties, but is more important for its transmission of grapevine fanleaf virus. Both ring and dagger nematodes feed from outside the roots, but can reach the vascular tissues with their long stylet. Root lesion nematode restricts the growth of roots as it feeds and migrates in and out of roots; it can be especially damaging to newly planted vines. Citrus nematodes establish feeding sites with their heads embedded in cortical tissue and their posterior ends outside the roots. Their feeding disrupts the uptake of nutrients and water, and interferes with plant growth.

SYMPTOMS

The symptoms described below are indicative of a nematode problem, but are not diagnostic as they could result from other causes as well. Generally, nematode infestations result in areas of the vineyard with vines that lack vigor and have restricted growth and reduced yields. Root knot nematodes produce small galls on the roots (about 0.125 inch in diameter), but they can be larger when multiple infections cause galls to coalesce. The dagger nematode, *X. index*, feeds on root tips causing them to swell in a manner similar to the nodosities caused by phylloxera. Virus transmission by dagger nematode produces symptoms on leaves such as yellowing of veins, mosaic, and malformation with symptom expression less apparent among white varieties and in warmer regions. Infestation by root lesion nematode restricts top growth of young vines. If young vines are planted in soil infested with lesion nematode, root systems may be severely restricted and sometimes exhibit brown lesions. Soil adheres to roots infested with citrus nematode giving them a dirty appearance. Ring nematodes cause general aboveground lack of vigor and reduced vine growth and yields.

FIELD EVALUATION

To make management decisions, it is important to know the nematode species present and to estimate their population. If a previous orchard or vineyard had problems caused by nematodes that are also listed as pests of grape, population levels may be high enough to cause damage to the young vines.

If nematode species have not previously been identified, take soil samples and send them to a diagnostic laboratory for identification. The best time to sample differs according to region, type of nematode, and variety of grapes. Bloom and harvest times, which influence nematode populations, also differ according to region. Research has shown that populations of citrus nematode are highest in the Coachella Valley from February through March and again in October. In the San Joaquin Valley, *X. index* populations are most likely to be detected in November through February. Root knot nematodes are more likely to be found at any time of the year.

To get the greatest numbers and the most reliable indication of nematode populations, irrigate three days before sampling (or wait for three consecutive days of rain). Collect soil samples from 0 to 18 inch depth between the dripper spot and the vine trunk (as long as the emitter is halfway between the two vines). Roots encountered during sampling should be included. Divide the vineyard into sampling blocks that are representative of cropping history, crop injury, or soil texture. Take samples of soil and symptomatic roots from around five randomly chosen vines per block, mix them thoroughly, and make a composite sample of about 1 quart (1 liter) for each block. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, the previous crop/variety, and the current variety grown or that you intend to grow. See UC/ANR Publication 3343, *Grape Pest Management*, 2nd edition, for more details). Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor for more details about sampling, to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

Look for nematode symptoms in the vineyard late in the growing season to prepare for future management.

MANAGEMENT

Cultural practices. To naturally rid an old vineyard site of the effects of *X. index* and grapevine fanleaf virus, it is necessary to forgo planting grapes for more than 10 years. This period of time is required to allow old roots to decompose and nematode numbers to decrease. This will increase the length of time before a new vineyard exhibits virus symptoms, but will not prevent reinfestation. Do not rotate sites with crops or plant cover crops that are hosts to nematodes. No single rootstock is resistant to all root knot nematodes and there are numerous other nematodes of concern. Broadest resistance is present in Ramsey, Freedom, and several rootstocks in the Teleki series (5C is the only one that has been specifically tested). Selection of a rootstock is a risky endeavor because of their excessive or inadequate growth in certain situations and their limited breadth of resistance. Consult your farm advisor for the appropriate site selection and cultural practices associated with each rootstock.

Manures and other soil amendments can improve vine vigor and frequently reduce the effect of nematode infestation. To reduce stress on vines, take measures to prevent soil compaction and stratification, to improve soil tilth and drainage, and to control other pests. Proper irrigation and fertilizer application also reduce stress on vines and help lessen the effect of nematodes such as root knot.

Chemical. Vineyards planted in fumigated ground are known to have generally improved growth and yields compared to those planted on nonfumigated ground. Contact your local farm advisor to discuss the most effective application method and timing when making a postplant application.

Always read and carefully follow all label information when applying soil fumigants.

Common name (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to environmental impact.

PREPLANT

A. METHYL BROMIDE* — 400–600 lb — 48

COMMENTS: Use allowed only with a Critical Use Exemption permit. Use the higher rate for fine-textured soils. Apply methyl bromide in a broadcast fumigation using tarps, or fumigate the soil with 300 lb/acre, invert the top 12 inches of soil, and refumigate in 14 days with 150 lb/acre. Fumigants such as methyl bromide are a source of volatile organic compounds (VOCs) but are not reactive with other air contaminants that form ozone: methyl bromide depletes ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

B. METAM SODIUM* — 75 gal — 48

COMMENTS: Metam sodium is seldom as effective as methyl bromide because it is seldom applied properly. It also does not penetrate plant roots very well and it is very difficult to get 4–5 ft down from the surface. Before applying this material, thoroughly cultivate the area to be treated to break up clods and deeply loosen the soil. After cultivation and about 1 week before treatment, flood irrigate the field with 6–8 acre-inches of water. After treatment, do not plant for 30 days, or 60 days if soil is high in organic matter or below 50°F. Fumigants such as metam sodium are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

C. SODIUM TETRATHIOCARBONATE
(Enzone) — Label rates — 4 days

COMMENTS: Make application 1–4 weeks before planting, following label directions.

D. 1,3-DICHLOROPROPENE*
(Telone II) — Label rates — 5 days

COMMENTS: Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

POSTPLANT

A. FENAMIPHOS*
(Nemacur 3) — Band application: 2 gal — 48 — 2

COMMENTS: Follow spray band or granular applications applied to berms with sufficient irrigation to wet the root zone. Do not exceed 2 gal/acre/season in a 50% band.

. . . or . . . — Drip irrigation: 1 qt–1 gal — 48 — 2

COMMENTS: Best results are achieved when soil is irrigated and allowed to stand for 24 hours before application. Research in the San Joaquin Valley indicates most effective control is achieved when 1 gal is applied over a 2-hour period, followed by a second gal a few hours later. In the Coachella Valley, research has shown that best results occur with 3 applications of 0.33 gal/acre applied over a 0.5–1 hour period at 3-day intervals in spring and again in fall for a total of 2 gal/acre/year.

B. SODIUM TETRATHIOCARBONATE
(Enzone) — Label rates — 4 days — see comments

COMMENTS: Crop must be at least 1 year old or injury may occur. Apply early season applications after budbreak and late season applications after harvest.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
NA Not applicable.

Weeds

INTEGRATED WEED MANAGEMENT (10/08)

Weed control in vineyards enhances the establishment of newly planted vines and improves the growth and yield of established vines. Growers have many weed management tools available to achieve these objectives; however, the methods of using these tools vary from year to year and from vineyard to vineyard.

Weed management is part of an overall vineyard management system; plants on the vineyard floor can influence other pests such as insects, mites, nematodes, and diseases. A weed management program should start before new vines are planted. The more difficult-to-control weeds (particularly perennials) are easier to manage before vines are planted. Weeds reduce vine growth and yields by competing for water, nutrients, and sunlight. Competition is most severe during the first 4 years of the vine's life or where root growth is limited. Weeds around the grapevine trunk not only compete directly with vine growth, but provide a good habitat for field mice or voles, which can girdle and kill young vines. Gophers are most prevalent in nontilled vineyards and are common where broadleaf weeds, such as field bindweed and perennial clovers, predominate. These animals feed on the roots and weaken or kill young vines. Dry weed growth is a fire hazard. For optimum yields and vine health, control weed growth, especially in the area next to the base of young vines.

After about the third year, the effect of competition from weeds is somewhat lessened as vines become established, and shading from the vineyard canopy reduces weed growth. In older vineyards, however, weed growth can interfere with cultural practices and harvest. For example, tall weeds can disrupt the application pattern of water from low-volume spray emitters. Frequent cultivation near vines can injure vine roots or the base of the vine trunk. Vine trunk injuries can encourage crown gall or collar rot infections.

Integrated weed management practices vary considerably from vineyard to vineyard. Location in the state, climatic conditions, soils, irrigation practices, topography, and grower preferences significantly influence vineyard floor management decisions and the tools used. Weeds are commonly controlled either chemically or mechanically in a 2- to 5-foot-wide strip in the vine row. The area between vine rows may be chemically treated, mechanically mowed, or tilled. Alternatively, mulches, subsurface irrigation, and flamers can also be used to control weeds in vineyards. Often several weed management techniques are used in a vineyard depending upon weed species, age of vines, soil conditions, and grower preference.

Soil characteristics are important to weed management. Soil texture and organic matter influence which weed species are present, the number and timing of cultivations required, and the activity and residual effects of herbicides. Annual species, such as puncturevine, crabgrass, horseweed, and *Panicum* spp., or perennials like johnsongrass, nutsedge, and bermudagrass are more prevalent on light-textured soil whereas perennials such as curly dock, field bindweed, and dallisgrass are more common on heavier-textured soils. Less preemergent herbicide is required for weed control on sandy, light soils, but residual control may be shorter than on clay or clay loam soils. Use low rates of herbicide on sandy soils or those low in organic matter. Clay soils are slower to dry for effective cultivation than sandy loam soils; thus, more frequent cultivation is practiced on lighter soils than heavy soils.

The irrigation method, amount of water applied, and pattern of rainfall affects weed growth as well as the frequency and timing of cultivation and the selection of chemicals and their residual activities. Frequent wetting of the soil promotes more rapid herbicide degradation in the soil. Herbicide degradation is generally faster in moist, warm soils than in dry, cold soils. Degradation is also more rapid under drip emitters or micro-sprinklers than under furrow irrigation. The first irrigation following an herbicide application is the most critical in terms of how far the herbicide is moved into the soil; subsequent irrigation is less important to the movement of the herbicide.

When properly used, herbicides registered for use in vineyards can control most weed species. In most situations, combinations or sequential applications of herbicides will be required to provide

effective, economical control. Before using any herbicide, identify the weed species to be controlled, then read and follow product label directions carefully.

Herbicides are traditionally discussed as two groups: those that are active against germinating weed seeds (preemergent herbicides) and those that are active on growing plants (postemergent herbicides). Some herbicides have both pre- and postemergent activity. Herbicides vary in their ability to control different weed species. Check the SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL tables and consult product labels for specific weed control activity. Herbicides can be combined for controlling a broader spectrum of weeds.

Preemergent herbicides. Preemergent herbicides are active in the soil against germinating weed seedlings. These herbicides are applied to bare soil and are leached into the soil with rain or irrigation where they affect germinating weed seeds. If herbicides remain on the soil surface without incorporation, some will degrade rapidly from sunlight. Weeds that emerge while the herbicide is on the surface, before it is activated by rain or irrigation, will not be controlled. Also, large weed seeds, such as wild oat, may germinate in the soil below the herbicide zone and still be able to emerge.

Postemergent herbicides. Postemergent herbicides are applied to control weeds already growing in the vineyard. They can be combined with preemergent herbicides or applied as spot treatments during the growing season. In newly planted vineyards, selective postemergent herbicides are available for the control of most annual and perennial grasses, but not broadleaf weeds. Young vines need to be protected from contact by some postemergent sprays. Be sure to check and follow individual label instructions.

In most vineyards, herbicides are used only on a narrow strip of soil centered on the vineyard row; thus, the area treated with herbicides in these vineyards is 15 to 30% of the total vineyard area.

Application equipment must be accurately calibrated to apply the proper amount of herbicide to the soil and young growing weeds. For safe application and to minimize drift, spray equipment should be equipped with a short boom that has low pressure (LP), flat fan nozzles. Off center (OC) nozzles are often used on the end of the boom to apply chemicals in the vineyard row. Some herbicides require special use precautions as indicated in the table below. Always read and follow the entire product label before using any pesticide.

For treatment of small areas, especially for perennial weeds, a backpack sprayer or low-volume controlled droplet applicator can be used. Extreme care needs to be exercised to avoid drift of herbicides (such as glyphosate-Roundup and Touchdown, oxyfluorfen-Goal, or paraquat-Gramoxone) to vine leaves or green stems.

MONITORING

Many different species of summer and winter annual and perennial weeds are found infesting California vineyards. Weeds vary from area to area and year to year; even within a vineyard. To determine the best control practices, conduct weed surveys at least twice each year: once in late winter and again in late spring or summer to determine the spectrum of weeds present. These surveys are the basis for weed management decisions about herbicide choice or cultivation equipment and practices.

Spring weed survey. A survey in late spring or summer can help in determining the spectrum of weeds present and decision-making on herbicide choice or cultivation practices.

Keep records of your weed surveys *(example form available online)* so that you can track weed population information from year to year to better understand ongoing weed control problems such as resistance.

Winter weed survey. By surveying weeds in late winter and keeping track of your observations *(example form available online)*, you can identify any species that escaped control from earlier

management and know what perennials are present. If herbicides were used, surveying identifies whether you need to change to a different herbicide.

Keep survey records so that you can track weed population information from year to year to better understand ongoing weed control problems such as resistance.

How to survey your fields for spring and winter weeds:

- Survey your vineyard in late fall/winter to identify winter annuals and perennials and again in late spring or early summer after summer annuals have germinated.
- If you use cultivation for weed control, monitor at least 2 weeks before you plan to cultivate.
- Pay particular attention to perennials. Check for re-growth of perennials a few weeks after cultivation.
- Pay attention to 'wet spots' as these may be problem areas in terms of weed growth.
- Survey areas around the vineyards as these areas could be a potential source for wind disseminated weed seeds such as marestail, fleabane etc.
- Sketch a diagram of the vineyard and mark areas where perennials are found.
- Keep records of your survey results. By knowing what species are present, you will be able to make appropriate decisions on cultural and chemical controls.

Information collected over a period of years tells you how weed populations may be changing and how effective your management operations have been. This way you can return and see how well your weed management actions are working.

WEED MANAGEMENT BEFORE PLANTING

Control annual and perennial weeds before planting a vineyard to reduce the competition from weeds during vineyard establishment. It is especially important to control established stands of perennial weeds before grapevines are planted in order to reduce their competition in the new vineyard and to avoid potential injury to young vines from herbicides. Perennial weeds that can be especially troublesome are field bindweed, johnsongrass, dallisgrass, bermudagrass, and nutsedge.

Nonchemical controls. An especially effective method of weed control before planting vines is to cultivate, then irrigate to germinate new weeds, and cultivate again to destroy seedling weeds. Frequent cultivation lowers weed seed populations in the soil, thus reducing weed growth. At least two cycles of cultivation, irrigation, followed by a shallow cultivation are needed for a marked reduction in weed seedlings. Unfortunately, this method is not effective on established perennial weeds.

A method of control for perennial grasses such as bermudagrass and johnsongrass is to cultivate the soil when it is very dry. Cultivation cuts the rhizomes into small pieces so they can dry. The soil is reworked frequently using spring tooth harrows to pull new rhizomes to the surface and dry them out as well. If the soil is irrigated or rain occurs before total control of the perennial plant is achieved, the rhizome pieces will begin to grow and the effectiveness of this practice is reduced. By the same token, working the soil when wet can increase the population of perennial weeds, because each piece of cut rhizome can root and develop into a new plant.

Field bindweed growth can be reduced for 1 to 2 years by deep plowing or with a reclamation blade (a large V-shaped blade) to cut the roots 16 to 18 inches deep in dry soil. Populations of nutsedge can be reduced by deep plowing with large moldboard plows to bury the nutlets to a depth of at least 12 inches.

Seedlings of perennials can be controlled with repeated cultivation.

Soil solarization is a nonpesticidal method of controlling soil-borne pests by placing clear plastic sheets on moist soil during periods of high ambient temperature. The plastic sheets allow the sun's radiant energy to be trapped in the soil, heating the upper levels. Solarization during the

hot summer months can increase soil temperature (108-131°F at a depth of 2 inches) to levels that kill many disease-causing organisms (pathogens), nematodes, and weed seedlings. It leaves no toxic residues and can be easily used on a small or large scale. Soil solarization also improves soil structure and increases the availability of nitrogen (N) and other essential plant nutrients. (For additional information see *Soil Solarization*, U.C. Publications, 21377.)

Chemical control. Weed seedlings and established annual weeds can be controlled either with preemergent or postemergent herbicides before planting. Before planting a vineyard, use a preemergent herbicide in conjunction with a rotation crop, and make sure the residual period of the herbicide is not long enough to preclude planting the vines. Postemergent herbicides generally have a short soil residual and are safer to use before planting vines. Many growers prefer to use preemergent herbicides only after the vines have been planted to avoid possible exposure to herbicides that may be in the backfill soil.

WEED MANAGEMENT IN NEW VINEYARDS

Grapevines are most sensitive to weed or cover crop competition during the first few years of growth and where soil depth is limited. Weedy vineyards may require several more years to become economically productive than weed-free vineyards. Regardless of the method used to control weeds, be careful not to injure vines with chemicals, or to mechanically damage the vine trunk or roots. As grapevines become established, competition from weeds is lessened as shade from the vine canopy reduces weed growth.

Cultivation. Some growers prefer to manage weeds without herbicides for the first year or two after planting. This usually requires hoeing, cultivating, or using weed knives (less than 2 inches deep) around vines several times during spring and summer as well as cultivating or mowing between vine rows. This is best accomplished when weeds are still in the seedling stage; it becomes more difficult when weeds are allowed to get large. Hand tools are generally used close to the vine to minimize injury, particularly when the vines are young. Mechanical cultivators available for use in the vine row include: weed knives, spyder cultivators, and rotary tillers. Rotary tillers such as a Weed Badger, Kimco, or Clements Hoe are most effective if used on loose soil that is not rocky. Hand-held mechanical flails (Weed Eaters) may be used, but can injure vine trunks. Disks or mowers can be used between the rows. Mechanical control of weeds must be done repeatedly when weeds are immature. The equipment should be set to cut shallowly, to minimize damage to vine roots. As weeds mature, they are difficult to control, may clog equipment, and produce seed. When using any mechanical equipment around vines, be careful not to injure the grapevine feeder roots or trunk.

Cover crops. Planted cover crops can also be used to reduce weed populations between vine rows. With cover crops, the species selected and management will differ from one area of the state to another. Be sure to select a cover crop that will not become competitive with the young vines. Cultivation in preparation for planting a winter annual cover crop will also reduce weed growth. To preserve surface cover, mow the cover crop to the correct height recommended for that crop.

Mulches. Weeds in the vine row can also be controlled using mulches. Organic mulches (cereal straw, green waste, composted wood chips) or synthetic mulches of polyethylene, polypropylene, or polyester can be used around young vines. Always apply mulches when the soil surface is free of weeds. Mulches prevent the growth of weed seedlings by blocking light and preventing it from reaching the soil surface. They create more uniform moisture conditions, which in turn promotes young vine growth. However, mulches may also provide a good habitat for gophers, voles, field mice, and snakes or be a source of new weed seed that came with the mulch. Mulches do not control perennial weed growth unless all light can be excluded. Some woven fabric mulches offer excellent weed control for several years, but the initial cost of purchase and installation is high.

Herbicides. To control weeds with herbicides after grapevines are planted and before bearing, apply a preemergent herbicide (e.g., oryzalin, napropamide, or oxyfluorfen) to either a square or circle around each vine (at least 3–6 feet across) or as a band down the vine row. Herbicides can also be applied to control weeds after they emerge. Selective herbicides are available for annual

grass control and suppression of perennial grasses (e.g., sethoxydim, fluazifop, and clethodim), but to be effective they require the addition of an adjuvant (either a nonionic surfactant or a nonphytotoxic oil). These materials do not control nutsedge or broadleaf weeds and clethodim is the only one that will control annual bluegrass. Paraquat can be used to control weeds near young vines protected with shields or wraps. The nonselective herbicide glyphosate can control broadleaf weeds after emergence, but it should be used only around mature vines with brown bark and should not be allowed to contact leaves or green shoots.

In conjunction with the use of herbicides in the vine row, mow or cultivate the weeds between the rows. Mowing may be required four to eight times during spring and summer, whenever weeds are 6 to 8 inches high. Cultivation is required when weed seeds germinate following each irrigation.

WEED MANAGEMENT IN ESTABLISHED VINEYARDS

It takes at least 3 years for a vineyard to become established under normal growing conditions. Established vines are more tolerant of many herbicides than newly planted vines, thus increasing the options available for weed control. Generally weeds are controlled between vine rows by discing or mowing, with a basal treatment of herbicide around each vine or with a strip application of herbicide down the vineyard row.

Cultivation. Cultivation can be used in established vineyards to control annual and biennial weeds and seedlings of perennial weeds. Control seedlings of field bindweed, bermudagrass, and johnsongrass before they are 3 weeks old or they may form perennial structures such as rhizomes. Cultivating established perennials in an irrigated vineyard often increases the weed problem. Cultivation also cuts and damages the roots of vines, reducing the ability of the vine to take up nutrients and allowing access to the vine of soil pathogens.

Flaming. Flaming is a method that can be used to control young weeds in mature vineyards. Use either a single flame that is directed to the base of the vine or several burners on a boom to flame the weeds between the vineyard rows. Flame is only effective on young weeds. Do not use flaming around young vines because it may damage the thin, green bark. Adjust equipment speed for desired weed injury without igniting or damaging the vine trunks. In mature vineyards annual broadleaf weeds can be controlled with flaming but grasses are somewhat tolerant. Never use flaming where there is dry, dead vegetation or where leaves or duff have collected around the base of the vine. Dry vegetation may ignite and cause a fire that can girdle the vines. Flaming may also damage or ignite mulches in the vineyard.

Mulches. Mulches can also be used for weed control as discussed in the section WEED MANAGEMENT IN NEW VINEYARDS. Because organic mulches degrade, they must be replenished annually. As mulches degrade they become a perfect growth medium for weed species such as common groundsel, prickly lettuce, common sowthistle, and panicle-leaf willowherb.

Herbicides. If using herbicides to control weeds, apply a preemergent herbicide or combinations of herbicides in fall after harvest, or split into two applications (fall and spring), or in winter with a postemergent (foliar) herbicide if weeds are present. It is possible to use postemergent herbicides as new weeds germinate. For greatest safety, direct herbicide sprays only at the soil or at weed foliage, not at the vine leaves, shoots, or 1- to 2-year-old wood. In vineyards where tree rows are mulched or sprayed, often there are fewer weeds to treat, thus a visual weed-seeking sprayer can be used to reduce herbicide use and effects on the environment.

Frequently, two or more herbicides need to be applied to obtain adequate weed control. It is critical to identify the weed species present in the vineyard as described above in the section on Monitoring to determine which herbicide or combinations will provide the most effective control. Combinations may include one or more preemergent herbicide or a mixture of preemergent and postemergent herbicides. Read and follow label directions carefully before combining herbicides.

Cover crops. Cover crops are planted in some vineyards to replace the resident weed vegetation on the vineyard floor. These winter annual cover crops are fall-seeded cereal crops such as wheat,

oat, cereal rye, or barley, or for nontilled vineyards 'Blando' bromegrass, 'Zorro' fescue, or subterranean clovers. These are seeded into a prepared seedbed between vine rows in late September through mid-November. Most plants will reseed themselves if mowed in January or early February and then allowed to regrow into April and May. Mowing after the seeds mature ensures seeds for the next season. Keep cover crops away from young vines. Changing cover crop species reduces the potential for buildup of disease pathogens, weeds, rodents, and insect pests. For more information on cover crops, consult UC/ANR Publication 21471, *Covercrops for Califomia Agriculture*, or UC/ANR Publication 3338, *Cover Cropping in Vineyards: A Growers Handbook*.

WEED MANAGEMENT IN ORGANIC VINEYARDS (6/06)

If you choose not to use synthetic and systemic pesticides then you should go the extra distance to try to keep the vineyard as clean as possible. Weeds serve as an excellent host for fungal disease and should be routinely controlled by all grape growers. Vineyards differ from orchards because the foliage and fruit are typically much closer to the ground. Mildew spores are easily splashed back onto vines from weed hosts. Perennial weeds are definitely the worse problem, but annuals, such as marestail (*Conyza canadensis*), can grow among the vines and grapes to a height of 6 feet in one season and serve the same host function as the other weeds. Weed control in organically managed vineyards requires special attention to preventing weed problems before they start. Cover crops planted in middles and mechanical control of weeds in the vine row are key components of an organic weed management program.

WEED MANAGEMENT BEFORE PLANTING

It is critical to have minimum or no weed competition at the time of planting new vines so weed control before planting is important. Take measures to deplete the soil weed seed bank. A summer fallow treatment of irrigation followed by tillage and then drying can reduce weed seed numbers in the soil. Repeat this cycle several times to further deplete weed seeds in the soil. Weed seeds located in the surface 4 inches of soil can be buried to depths where they cannot emerge with a soil-inverting plow such as a Kverneland plow; a moldboard plow will not sufficiently invert the soil to be effective.

Soil solarization. Soil solarization of the planned vine row can also significantly reduce weed populations. The soil must be moist and the width of the solarized area should be at least 6 feet. Bury all sides of the plastic to create a seal on the soil; this also helps prevent the plastic from being blown away by wind. Machines that lay down the plastic are available to automate the process.

Solarization must be done during summer and should be started at least by the beginning of August to have sufficient time (4 to 6 weeks) to complete the process. Clear plastic or a plastic with a coating that suppresses weed seed germination can be used. Black plastic suppresses weed seed germination but will not heat the soil sufficiently for solarization. Plastic mulches may not be successful in suppressing species like nutsedge.

WEED MANAGEMENT AFTER PLANTING

Cultivation. Mechanical cultivation uproots or buries weeds. Weed burial works best on small weeds, while larger weeds are better controlled by destroying the root-shoot connection or by slicing, cutting, or turning the soil to separate the root system from the soil. Keep cultivation shallow to minimize damage to crop roots and to avoid bringing more weed seeds near the surface to germinate.

Perennial weeds with established root systems are difficult to kill with a single tillage operation. With tillage, the top is removed and a new top is generated using the underground reserves. For perennials, tilling 3- or 4-inches deep reduces the reserves, forcing the weeds to use a greater portion of the reserves available to regenerate. Several companies make cultivation equipment. Trip mechanisms on vineyard cultivators prevent damage to the vines. Even the best cultivators will not eliminate all weeds, thus hand hoeing is often needed. Hand cultivation alone may be effective on a small scale.

Mulches. Mulches can also help with weed control in the vineyard. The mulch blocks light, preventing weed germination or growth. Many materials can be used as mulches including municipal yard waste, wood chips, straw, hay, sawdust, and newspaper. To be effective, mulches need to block all light to the weeds; therefore different mulch materials vary in the depth necessary to accomplish this. Organic mulches must be maintained in a layer 4 or more inches thick. Organic mulches breakdown with time and the original thickness typically is reduced by 60% after one year. Cover crops can be grown in the middles; in the spring "mow-and-throw" the mulch in around the base of the vines. Weeds that emerge through the mulch can be controlled using an organic contact herbicide or with hand hoeing. Do not plant cover crops under the vine row because excess competition may occur, possibly reducing grape yields.

Herbicides. Several organic, contact-type herbicide products are registered for use. These soap-based (Scythe), clove oil based (Matran 2), or acetic acid based (All-Down) products all damage any green vegetation contacted, including the leaves and young stems of grape vines. Apply these products as

directed sprays against woody stems and trunks. Because these herbicides only kill contacted tissue, good coverage is essential. Thus, adding an organically acceptable surfactant is recommended. Because these materials lack residual activity, repeat applications will be needed to control new flushes of weeds.

Flaming. Flamers can be used for weed control in the vine row, with propane-fueled models being most common. Fire causes the cell sap of plants to expand, rupturing the cell walls; this process occurs in most plant tissues at about 130ºF. Weeds must have less than two true leaves for greatest efficiency of the burner. Grasses are harder to kill by flaming because the growing point is below the ground. After flaming, weeds that have been killed change from a glossy to a matte finish. This occurs very rapidly in most cases. Foliage that retains a thumb print when pressure is applied between your thumb and finger has been adequately flamed. Typically, flaming can be done at 3 to 5 mph through fields, although this depends on the heat output of the unit being used. Repeated flaming can likewise be used to suppress perennial weeds such as field bindweed. Care must be taken to avoid igniting dry vegetation, which could injure the vines, or start a wildfire.

Weeder geese. Geese can often be used to manage grass weeds in vineyards. Geese prefer grass species and will eat other weeds and crops only after the grasses are gone and they become hungry. If confined, they will even dig up and eat johnsongrass and bermudagrass rhizomes, which they have a particular preference for. Both of these weeds can be especially troublesome in vineyards. Generally, about 4 geese per acre are needed. They require water for drinking, and some form of protection from predators (dogs, coyotes, etc.). Young geese are preferred, as they eat larger quantities of food, although having at least one older goose, helps to protect the younger birds. Consult the following Web site for further information on geese: http://www.metzerfarms.com/weeder.htm. Other animals sometimes used in organic vineyards include sheep and goats. Sheep will effectively remove all weeds down to ground level. Goats are browsers and must be carefully managed to avoid damage to the vines. Both sheep and goats are generally used during the time when grapes are dormant and the chance of grazing damage is minimal.

Vine-Row Management
Manage weeds in the vine row with in-row cultivation, mulches, hand hoeing, or flaming. The choice of method depends in part on the type of irrigation system.

Furrow-irrigated vineyards. Furrow-irrigated vineyards are amenable to in-row cultivation. Cultivation is probably the most widely used method of weed control in organic systems. Other options include the use of cultivation, organically approved herbicides, flaming, and the use of weeder geese.

Microsprinkler-irrigated vineyards. Few options are available in organic vineyards with microsprinklers. In-row cultivators may damage irrigation lines and emitters. Surface lines can be suspended in the vines or on stakes to allow for in-row mowing, cultivation, or flaming underneath. The microsprinklers are suspended upside down. Hand hoeing, possibly flaming, organically approved herbicides, and weeder geese also could be used for weed control. Protect trunks of young vines from flamers or herbicides to avoid injury; also keep flamers away from the plastic irrigation tubing. Mulches can suppress weed growth. Weeds that emerge through the mulches must be removed by hand hoeing or with the use of organic herbicides.

Drip-irrigated vineyards. Weed control options for surface drip-irrigated vineyards are similar to those available for micro-sprinklers. However, if drip lines are suspended or subsurface drip irrigation is used, cultivation, flaming, or mulches can all be used.

Middles Management
Similar to many conventionally managed vineyards, weeds in the middles of organic vineyards are commonly managed with cover crops and/or mowing.

Consider planting a cover crop in the area between vine rows. Resident vegetation does not usually grow uniformly enough to compete well with newly invading weeds. In addition, resident vegetation includes weed species that continually colonize the vine row. An annual cover crop that reseeds itself will compete against weeds and reduce the potential for problems in the future.

If there is a potential for frost and the cover crop is tall, mow once before bloom to minimize frost damage; the cover crop will regrow and flower later in the season. However, the cover crop will be most competitive if mowing can be avoided. After most species in the cover crop have produced seed, mow or roll it using a ringroller. The ringroller will allow more seed production and also create a surface mulch that will prevent emergence of weed seeds.

SPECIAL WEED PROBLEMS (6/06)

Most of these special weed problems can be minimized through an active preplant weed management program.

BERMUDAGRASS. Bermudagrass is a vigorous spring- and summer-growing perennial. It grows from seed but its extensive system of rhizomes and stolons can also be spread during cultivation. In vineyards, it is very competitive for moisture and nutrients. Seedlings are controlled with preemergent herbicides. If bermudagrass develops in a vineyard or in localized areas, immediately spot treat it with a postemergent herbicide such as glyphosate (Roundup).

DALLISGRASS. Dallisgrass is a common perennial weed found in vineyards. It can be highly competitive in newly planted vineyards; in established vineyards it competes for soil moisture and nutrients. Dallisgrass seedlings germinate in spring and summer, and form new plants on short rhizomes that developed from the original root system. Dallisgrass seedlings can be controlled with cultivation or with preemergent herbicides. It has a clumpy growth habit that gives it a bunchgrass appearance. Treatment with glyphosate has been successful in controlling dallisgrass infestations.

FIELD BINDWEED. Field bindweed is a vigorous perennial weed that either grows from seed, which can survive for up to 30 years in the soil, or from stolons, rhizomes, or extensive roots. Because of the seed's longevity in the soil, it is critical to destroy plants before they can produce seed. The plants may spread from stem or root sections that are cut during cultivations, however cultivation controls seedlings. If field bindweed appears in or around the vineyard, spot treat with high label rates of glyphosate.

HAIRY FLEABANE. Hairy fleabane, also called flax-leaf fleabane, is a summer annual that reproduces by seed. If emergence occurs in late summer, it can act as a biennial. Each plant can produce over 40,000 seeds, which are disseminated by wind. Hairy fleabane is often found growing in the same location as horseweed, a related species. Frequent tillage or soil disturbance can significantly reduce the population. Soil-residual herbicides, such as simazine (Princep) and isoxaben (Gallery), can provide good control before the plants emerge. Once plants have emerged, applications of glufosinate (Rely), 2,4-D, or combinations of these two herbicides can provide good control of seedlings. Glyphosate-resistant populations of hairy fleabane in the U.S. and worldwide are less prevalent than those of horseweed. Do not use repeated applications of low rates of glyphosate (Roundup, Touchdown), especially to plants taller than 6 inches, or resistance to this herbicide may develop.

HORSEWEED. Horseweed, also referred to as marestail, is typically a summer annual weed. However, when seed germinates in late summer, it can act like a biennial. More than 200,000 seed are produced by a single plant and disseminated by wind 1/4 mile or more. Horseweed hosts the glassy-winged sharpshooter (a carrier of Pierce's Disease). Frequent mechanical tillage offers good control as long as the plants are less than the rosette stage of growth. Flaming or mowing does not provide adequate control. Soil-residual herbicides, including simazine (Princep), isoxaben (Gallery), and flumioxazin (Chateau), provide good control at high label rates. Glufosinate (Rely) and 2, 4-D provide the best control on emerged plants from the seedling to rosette stage. Control in California with glyphosate (Roundup, Touchdown) is variable. Horseweed is known to develop resistance to glyphosate where repeated applications are used.

JOHNSONGRASS. Johnsongrass is a perennial weed that spreads from seed or from an extensive system of underground rhizomes. It grows vigorously in spring and summer when it overtops newly planted vines and competes for light, moisture, and nutrients. Severe setback of a young vineyard can occur under these conditions. Postemergent application of fluazifop or clethodim can be used around newly planted vines. If johnsongrass develops in or around vines in an established vineyard, spot treat it with glyphosate to prevent the spread of its rhizomes.

NUTSEDGE. Yellow nutsedge is a perennial weed that reproduces from underground tubers that survive for 2 to 5 years in the soil. The tubers are easily spread by cultivation equipment. Each tuber contains several buds that are capable of producing plants. One or two buds germinate to form new plants; however, if destroyed by cultivation or an herbicide, then a new bud is activated. In established vineyards, if nutsedge develops, spot treat it with glyphosate.

BLACKBERRY. Blackberries (Himalayan and California) are vigorous perennial vines that are often found around vineyard margins and sometimes around grapevines. They interfere with all cultural operations, especially pruning and harvest. For best control, spot treat with glyphosate at the flower stage or after fruiting when there is good soil moisture and the plants aren't stressed. A re-treatment may be required on large clumps if regrowth occurs. If blackberry is growing into a vine, separate the berry vine from the grapevine before treating so the herbicide will not get into the grapevine.

LITTLE MALLOW (CHEESEWEED). Little mallow is an annual or biennial plant that is sometimes not controlled with preemergent herbicides. Plants larger than 4 to 6 inches won't be controlled well with glyphosate. Mature plants are tall and woody with a large taproot that can be removed with a shovel or with cultivation. Oxyfluorfen effectively controls seedlings and young plants.

COMMON AND SCIENTIFIC NAMES OF WEEDS COMMONLY FOUND IN CALIFORNIA VINEYARDS (10/08)

Common Name	Scientific Name
asparagus	*Asparagus officinalis*
barley, hare	*Hordeum murinum*
barnyardgrass	*Echinochloa crus-galli*
bermudagrass	*Cynodon dactylon*
bindweed, field	*Convolvulus arvensis*
blackberries	*Rubus* spp.
bluegrass, annual	*Poa annua*
bromegrasses	*Bromus* spp.
burclover, California	*Medicago polymorpha*
canarygrass	*Phalaris canariensis*
catsear, common	*Hypochaeris radicata*
chickweed, common	*Stellaria media*
clover, white	*Trifolium repens*
cockleburs	*Xanthium* spp.
crabgrasses	*Digitaria* spp.
cudweeds	*Gnaphalium* spp.
dallisgrass	*Paspalum dilatatum*
dandelion	*Taraxacum officinale*
dock, curly	*Rumex crispus*
fescue, red	*Festuca rubra*
fescues	*Festuca* spp.
fiddlenecks	*Amsinckia* spp.
filarees	*Erodium* spp.
fleabane, hairy	*Conyza bonariensis*
fluvellins	*Kickxia* spp.
foxtails	*Setaria* spp.
goosefoot, nettleleaf	*Chenopodium murale*
groundcherries	*Physalis* spp.
groundsel, common	*Senecio vulgaris*
henbit	*Lamium amplexicaule*
horseweed, common	*Conyza canadensis*
johnsongrass	*Sorghum halepense*
knotweed, common	*Polygonum* spp.
ladysthumb	*Polygonum persicaria*
lambsquarters, common	*Chenopodium album*
lettuce, prickly	*Lactuca serriola*
ovegrasses	*Eragrostis* spp.
mallow, little (cheeseweed)	*Malva parviflora*
miner's lettuce	*Claytonia perfoliata*
mullein	*Verbascum* spp.
mustards	*Brassica* spp.
nettles	*Urtica* spp.
nightshades	*Solanum* spp.
nutsedge, purple	*Cyperus rotundus*
nutsedge, yellow	*Cyperus esculentus*
oat, wild	*Avena fatua*
pigweeds	*Amaranthus* spp.
pineappleweed	*Chamomilla suaveolens*
poison-oak, Pacific	*Toxicodendron diversilobum*
polypogon, rabbitfoot	*Polypogon monospeliensis*
puncturevine	*Tribulus terrestris*
purslane, common	*Portulaca oleracea*
radish, wild	*Raphanus raphanistrum*
redmaids (desert rock purslane)	*Calandrinia ciliata*

Continued on next page . . .

Common and Scientific Names of Weeds Commonly Found in California Vineyard, continued

Common Name	Scientific Name
rocket, London	*Sisymbrium irio*
ryegrass, Italian	*Lolium multiflorum*
sandburs	*Cenchrus* spp.
shepherd's-purse	*Capsella bursa-pastoris*
smartweed, pale	*Polygonum lapathofolium*
sorrel, red	*Rumex acetosella*
sowthistles	*Sonchus* spp.
speedwells	*Veronica* spp.
sprangletop	*Leptochloa* spp.
starthistle, yellow	*Centaurea solstitialis*
thistle, Russian	*Salsola tragus*
velvetleaf	*Abutilon theophrasti*
willowherb, tall annual	*Epilobium brachycarpum*
witchgrass	*Panicum capillare*

SUSCEPTIBILITY OF SPRING/SUMMER WEEDS TO HERBICIDE CONTROL (10/08)

	PREEMERGENCE											POSTEMERGENCE							
	DIC	DIU	FLM	ISO	NAP	NOR	ORY	OXY	PEN	SIM	TRI	CLE	FLU	GLU	GLY	OXY	PAR*	SET	24D
ANNUAL GRASSES																			
barnyardgrass	C	C	C	N	C	C	C	P	C	P	C	C	C	C	C	N	P	C	N
crabgrasses	P	C	C	N	C	C	C	P	C	N	C	C	C	C	C	P	C	C	N
fescues	C	C	P	—	C	C	C	P	C	C	C	P	N	P	C	N	C	N	N
foxtails	C	C	C	N	C	C	C	N	C	C	C	C	C	C	C	N	C	C	N
lovegrasses	P	C	C	N	C	C	C	P	C	P	C	C	C	C	C	N	C	C	N
sandburs	C	C	P	N	C	C	C	N	C	P	C	C	C	C	C	N	P	C	N
sprangletops	C	N	C	N	C	C	C	P	C	N	C	C	C	C	C	N	C	C	N
witchgrass	—	P	P	—	C	C	C	P	C	C	C	C	C	P	C	N	C	C	N
ANNUAL BROADLEAVES																			
cockleburs	P	C	—	—	C	C	N	C	N	C	N	N	N	P	C	C	C	N	C
cudweeds	C	C	—	C	C	C	N	N	N	C	N	N	N	P	C	P	N	N	P
fleabane, hairy	C	C	P	C	N	P	N	P	N	C	N	N	N	C	C	P	C	N	C
fluvellins	C	P	—	—	N	—	N	P	—	P	N	N	N	—	P	P	P	N	—
goosefoot, nettleleaf	C	C	C	C	C	C	C	C	C	C	C	N	N	P	C	C	C	N	C
groundcherries	C	C	C	C	N	C	C	C	C	C	N	N	N	C	C	C	C	N	C
horseweed	P	P	C	C	N	P	N	P	N	C	N	N	N	C	C	P	P	N	C
knotweed, common	C	C	—	C	C	C	C	C	C	C	C	N	N	P	C	P	P	N	P
ladysthumb	—	C	—	—	—	—	—	—	—	C	—	N	N	—	C	—	P	N	—
lambsquarters, common	C	C	C	C	C	P	C	C	C	C	C	N	N	P	C	C	P	N	C
lettuce, prickly	C	C	P	C	C	C	N	C	N	C	N	N	N	C	C	C	C	N	C
mallow (cheeseweed)	C	C	C	C	P	C	P	C	P	N	P	N	N	C	P	C	N	N	P
nightshades	C	C	C	C	N	C	N	C	P	C	N	N	N	C	C	C	C	N	C
pigweeds	P	C	C	C	C	P	C	C	C	C	C	N	N	C	C	C	C	N	P
puncturevine	P	C	C	C	P	C	P	C	P	P	P	N	N	P	C	C	C	N	C
purslane, common	C	C	C	C	C	P	C	C	C	C	C	N	N	C	C	C	C	N	C
smartweed, pale	C	C	—	—	—	—	—	—	—	C	—	N	N	—	C	—	P	N	P
speedwells	—	P	—	—	C	P	P	C	P	C	C	N	N	—	C	P	C	N	—
starthistle, yellow	C	C	—	—	P	P	N	C	C	C	N	N	N	P	C	C	P	N	C
thistle, Russian	C	P	C	C	P	C	P	P	P	P	P	N	N	C	C	P	C	N	C
velvetleaf	C	C	P	C	N	—	P	C	N	C	N	N	N	C	C	N	P	N	C
willowherb, tall annual	—	C	C	P	N	P	C	C	—	C	N	N	N	C	C	N	P	N	C
PERENNIALS (SEEDLINGS)																			
bermudagrass	C	C	N	N	C	C	C	N	C	P	C	C	C	C	C	P	C	C	N
bindweed, field	C	P	N	C	N	P	P	C	P	P	P	N	N	C	C	P	C	N	C
dallisgrass	C	C	N	N	P	C	C	N	C	C	C	C	C	C	C	N	C	C	N
dandelion	C	C	—	C	C	N	N	C	N	C	N	N	N	C	C	C	N	N	C
dock, curly	C	C	—	C	P	N	P	C	C	C	C	N	N	C	C	C	C	N	C
johnsongrass	C	C	N	N	P	C	P	N	P	P	C	C	C	C	C	N	C	C	N
ESTABLISHED PERENNIALS																			
asparagus	N	N	N	—	N	N	N	N	N	N	N	N	N	N	P	N	N	N	—
bermudagrass	N	N	N	N	N	P	N	N	N	N	N	C	P	P	C	N	P	P	N
bindweed, field	P	N	N	C	N	N	P	N	N	N	P	N	N	P	P	N	P	N	P
blackberries	N	N	N	—	N	N	N	N	N	N	N	N	N	N	C	N	N	N	—
catsear, common	P	N	N	—	N	C	N	N	N	N	N	N	N	P	P	N	N	N	—
clover, white	N	N	N	C	N	N	N	N	N	N	N	N	N	P	P	N	N	N	P
dallisgrass	N	N	N	N	N	N	N	N	N	N	N	C	P	P	C	N	N	P	N
dandelion	P	N	N	C	N	N	N	N	N	N	N	N	N	P	C	N	N	N	P
dock, curly	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N	N	P
johnsongrass	N	N	N	N	N	N	N	N	N	N	N	C	P	P	C	N	N	P	N
nutsedge, purple	P	N	N	N	P	N	N	N	N	N	N	N	N	P	P	N	N	N	N
nutsedge, yellow	P	N	N	N	N	P	N	N	N	N	N	N	N	P	P	N	N	N	N
poison-oak, Pacific	N	N	N	—	N	N	N	N	N	N	N	N	N	N	C	N	N	N	—
sorrel, red	P	N	N	—	N	N	N	N	N	N	N	N	N	N	P	N	N	N	—

Continued on next page . . .

Susceptibility of Spring/Summer Weeds to Herbicide Control, continued

	COMBINATIONS				
	GLY/ORY	GLY/OXY	GLY/SIM/ORY	OXY/ORY	PAR*/ORY
ANNUAL GRASSES					
barnyardgrass	C	C	C	N	P
crabgrasses	C	C	C	P	C
fescues	C	C	C	N	C
foxtails	C	C	C	P	C
lovegrasses	C	C	C	P	C
sandburs	C	C	C	P	P
sprangletops	C	C	C	N	C
witchgrass	C	C	C	N	C
ANNUAL BROADLEAVES					
cockleburs	C	C	C	C	C
cudweeds	C	C	C	P	P
fleabane, hairy	P	C	C	P	C
fluvellins	P	C	P	P	C
goosefoot, nettleleaf	C	C	C	C	C
groundcherries	C	C	C	C	C
horseweed	C	C	C	—	—
knotweed, common	P	C	C	P	P
ladysthumb	—	—	—	—	—
lambsquarters, common	C	C	C	C	C
lettuce, prickly	C	C	C	C	C
mallow (cheeseweed)	P	C	C	C	C
nightshades	C	C	C	C	C
pigweeds	C	C	C	C	C
puncturevine	C	C	C	P	C
purslane, common	C	C	C	P	C
smartweed, pale	—	—	—	—	—
speedwells	C	C	C	P	C
starthistle, yellow	C	C	C	P	C
thistle, Russian	C	C	C	P	C
velvetleaf	C	C	C	N	C
willowherb, tall annual	C	C	C	C	C
PERENNIALS (SEEDLINGS)					
bermudagrass	C	C	C	C	C
bindweed, field	C	C	C	C	C
dallisgrass	C	C	C	P	C
dandelion	C	C	C	C	C
dock, curly	C	C	C	C	C
johnsongrass	C	C	C	P	C
ESTABLISHED PERENNIALS					
asparagus	P	P	P	N	N
bermudagrass	N	N	N	N	N
bindweed, field	P	N	P	P	N
blackberries	N	N	N	N	N
catsear, common	N	N	N	N	N
clover, white	N	N	N	N	P
dallisgrass	N	N	N	N	N
dandelion	N	N	N	N	N
dock, curly	N	N	N	N	N
johnsongrass	N	N	N	N	N
nutsedge, purple	N	N	N	N	N
nutsedge, yellow	N	N	N	N	N
poison-oak, Pacific	N	N	N	N	N
smartweed, water	N	N	N	N	N
sorrel, red	N	N	N	N	N

C = control P = partial control N = no control — = no information

CLE = clethodim (Select Max)
DIC = dichlobenil (Casoron)
DIU = diuron (Karmex, etc.)
FLM = flumioxazin (Chateau)
FLU = fluazifop-p-butyl (Fusilade 2000)
GLU = glufosinate (Rely)
GLY = glyphosate (Roundup, Touchdown)
ISO = isoxaben (Gallery)
NAP = napropamide (Devrinol)
NOR = norflurazon (Solicam)
ORY = oryzalin (Surflan)
OXY = oxyfluorfen (Goal)
PAR = paraquat* (Gramoxone Inteon)
PEN = pendimethalin (Prowl)
SET = sethoxydim (Poast)
SIM = simazine (Princep)
TRI = trifluralin (Treflan)
24D = 2, 4-D

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SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL

(10/08)

	PREEMERGENCE											POSTEMERGENCE							
	DIC	DIU	FLM	ISO	NAP	NOR	ORY	OXY	PEN	SIM	TRI	CLE	FLU	GLU	GLY	OXY	PAR	SET	24D
ANNUAL GRASSES																			
barley, hare	C	C	C	N	C	C	C	P	C	C	C	C	C	C	C	P	C	C	N
bluegrass, annual	C	C	C	N	C	C	C	P	C	C	C	C	N	C	C	P	C	N	N
bromegrasses	C	C	P	N	C	C	C	P	C	C	P	C	C	C	C	N	C	C	N
canarygrasses	C	C	P	N	C	C	C	P	C	C	C	C	C	C	C	N	C	C	N
oat, wild	P	P	P	N	C	P	P	P	P	C	P	C	C	C	C	N	C	C	N
polypogon, rabbitfoot	—	C	P	—	C	C	C	P	C	C	C	C	C	P	C	—	C	C	N
ryegrasses	—	C	P	N	C	C	C	P	C	C	C	C	C	C	C	N	C	C	N
ANNUAL BROADLEAVES																			
chickweeds	C	C	C	C	C	C	C	P	C	C	C	N	N	C	C	P	C	N	P
burclover, California	—	P	P	—	P	N	N	P	N	P	N	N	N	C	C	P	P	N	—
fiddlenecks	C	C	—	C	C	C	C	C	C	C	C	N	N	P	C	C	C	N	P
filarees	C	C	C	C	C	C	N	C	C	C	P	N	N	C	P	C	C	N	C
groundsel, common	C	N	C	C	P	P	P	C	N	C	N	N	N	P	C	C	C	N	C
henbit	C	C	C	C	P	P	P	C	C	C	P	N	N	C	C	C	C	N	P
miner's lettuce	C	C	—	—	C	C	C	C	C	C	C	N	N	C	C	C	C	N	—
mustards	C	C	C	C	P	P	N	C	N	C	N	N	N	C	C	P	C	N	C
nettles	C	C	C	C	P	C	P	C	C	C	C	N	N	C	P	C	P	N	P
pineappleweed	C	P	—	—	C	C	N	C	C	C	N	N	N	C	C	P	P	N	P
redmaids (desert rockpurslane)	C	C	—	—	N	C	C	C	C	C	C	N	N	C	C	C	C	N	—
rocket, London	C	C	C	C	C	C	P	C	P	C	N	N	N	C	C	C	C	N	C
shepherd's-purse	C	C	C	C	P	C	N	C	N	C	N	N	N	C	C	P	C	N	C
sowthistles	C	C	P	C	C	P	P	C	N	C	N	N	N	C	C	C	C	N	C

	COMBINATIONS				
	GLY/ ORY	GLY/ OXY	GLY/ SIM/ ORY	OXY/ ORY	PAR*/ OXY
ANNUAL GRASSES					
barley, hare	C	C	C	P	C
bluegrass, annual	C	C	C	C	C
bromegrasses	C	C	C	P	C
canarygrasses	C	C	C	N	C
oat, wild	C	C	C	P	C
polypogon, rabbitfoot	C	C	C	N	C
ryegrasses	C	C	C	N	C
ANNUAL BROADLEAVES					
chickweeds	C	C	C	P	C
burclover, California	P	P	P	P	C
fiddlenecks	C	C	C	C	C
filarees	P	C	C	P	C
groundsel, common	C	C	C	C	C
henbit	C	C	C	C	C
miner's lettuce	C	C	C	C	C
mustard	C	C	C	P	C
nettles	C	C	C	P	C
pineappleweed	C	C	C	P	C
redmaids (desert rockpurslane)	C	C	C	C	C
rocket, London	C	C	C	P	C
shepherd's-purse	C	C	C	P	C
sowthistles	C	C	C	P	C

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DIU = diuron (Karmex, etc.)
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FLU = fluazifop-p-butyl (Fusilade 2000)
GLU = glufosinate (Rely)
GLY = glyphosate (Roundup, Touchdown)
ISO = isoxaben (Gallery)
NAP = napropamide (Devrinol)
NOR = norflurazon (Solicam)
ORY = oryzalin (Surflan)
OXY = oxyfluorfen (Goal)
PAR = paraquat* (Gramoxone Inteon)
PEN = pendimethalin (Prowl)
SET = sethoxydim (Poast)
SIM = simazine (Princep)
TRI = trifluralin (Treflan)
24D = 2, 4-D

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HERBICIDE TREATMENT TABLE (10/08)

Common name (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to environmental impact.

SITE PREPARATION
Established weeds

A. GLYPHOSATE

(Roundup)	0.5–4 lb a.i.	4	14
(Touchdown)	0.75–3.75 lb a.i.	12	14

WSSA MODE OF ACTION GROUP NUMBER[1]: 9
COMMENTS: Apply with a controlled applicator or with low-pressure, flat fan nozzles. For annual weed control use 10–40 gal water/acre with 1 lb/acre. Apply to young annuals or vigorously growing perennials in flowering stage. Some perennials require the high rate for control. May be used on young weeds in strips that will be the vine row, followed by planting into the dead weeds. Weeds should not be cultivated for 7–14 days after treatment to obtain maximum control. New weeds usually do not establish for a month or more, due to the no-till effect. Do not use more than 10.6 lb/acre/year.

B. 2,4-D — Label rates — 48 — 40
WSSA MODE OF ACTION GROUP NUMBER[1]: 4
COMMENTS: Controls horseweed and hairy fleabane. Can use in combination with glyphosate for broader weed control. Apply before weeds bolt for most effective control.

C. PARAQUAT* — 0.6395–1 lb a.i. — 24 — 0
(Gramoxone Inteon)
WSSA MODE OF ACTION GROUP NUMBER[1]: 22
COMMENTS: Apply in 20–60 gal water/acre to young weeds. Use 0.5% nonionic surfactant. Repeat treatment as new growth occurs.

AFTER PLANTING
Before weeds emerge

A. ORYZALIN — 2–6 lb a.i — 24 — 0
(Surflan AS)
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Nonbearing and bearing vineyards. Apply to the surface in 20–60 gal water/acre. Best if irrigated after application or applied before rainfall. If rain does not occur within 21 days, sprinkle irrigate with 0.5–2 inches of water. May be combined with a postemergent herbicide if weeds are present. The higher rates give the longest soil residual. Usually used at 4 lb/acre. Residual period: 6–12 months.

B. NAPROPAMIDE — 4 lb a.i. — 12 — 35
(Devrinol 50 DF)
WSSA MODE OF ACTION GROUP NUMBER[1]: 15
COMMENTS: Nonbearing and bearing grapevines. Apply to the surface in 20–60 gal water/acre. Must be incorporated within 7 days of application or sprinkler irrigated. A second application of 4 lb can be made during any one growing season. May be combined with a postemergent herbicide if weeds have emerged. Residual period: 4–10 months.

C. OXYFLUORFEN — 1–2 lb a.i — 24 — 14
(Goal) 2XL
WSSA MODE OF ACTION GROUP NUMBER[1]: 14
COMMENTS: Nonbearing and bearing grapevines. Apply in 20–60 gal water/acre on firm soil. Must not be mechanically disturbed or poor weed control will result. Often combined with oryzalin. Check label for use period, cut-off dates, and restrictions. Residual period 4–10 months.

Common name (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)

D. DIURON — 2.4–3.2 lb a.i. — 12 — 0
(Karmex, Direx)
WSSA MODE OF ACTION GROUP NUMBER[1]: 7
COMMENTS: Direct spray to the soil under grapevines at least 3 years of age. Do not apply more than 3.2 lb a.i./acre/season. Diuron is sometimes combined with other preemergent herbicides to broaden spectrum of weeds controlled. These combination treatments frequently use lower rates of diuron. Do not apply around vines with trunks less than 1.5 inches in diameter. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. **Note:** Pay special attention to soil texture/rate adjustments; do not use on soils with less than 1% organic matter. Residual period: 8–12 months. For best results, apply during the winter months when weeds are less than 2 inches. See label for rainfall concerns.

E. FLUMIOXAZIN — 0.188–0.38 lb a.i. — 12 — 60
(Chateau) 51WDG
WSSA MODE OF ACTION GROUP NUMBER[1]: 14
COMMENTS: Nonbearing and bearing grapevines. Applied as a directed spray; avoid contact with foliage or green wood. Rainfall 1/4 to 1/2 inch needed within 21 days for activation. Can be tank-mixed with other herbicides for broader weed control. Provides about 1 month residual activity for every 2 oz applied.

F. ISOXABEN — Label rates — 12 — 365
(Gallery) 75DF
WSSA MODE OF ACTION GROUP NUMBER[1]: 21
COMMENTS: For use in nonbearing vineyards only. Provides control of hairy fleabane, horseweed, and many other broadleaf weeds. Apply before seeds germinate and incorporate with rainfall or irrigation within 21 days. Mix with glyphosate or 2,4-D if emerged weeds are present at time of application.

G. SIMAZINE — 2–4 lb a.i. — 12 — 14
(Princep 4L, Princep Caliber 90, etc.)
WSSA MODE OF ACTION GROUP NUMBER[1]: 5
COMMENTS: Apply to the soil under vines older than 3 years anytime between harvest and early spring. Make only 1 application/year. Use the high rate for heavy soils. Simazine is frequently used in combination with other preemergent herbicides. On light soils, simazine often is used at rates of 0.5–1 lb/acre. Do not use on gravel, sand, or loamy sand soils. If an irrigation is applied immediately after application, limit water to 0.5 inch. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Residual period: 8–12 months.

Established weeds

A. GLYPHOSATE — 0.5–4 lb a.i. — 4 — 14
(Roundup, etc.)
WSSA MODE OF ACTION GROUP NUMBER[1]: 9
COMMENTS: Rates vary depending on the formulation used. Apply with controlled droplet applicator or with low-pressure, flat fan nozzles. For annual weed control, use 1 lb/acre in 10–40 gal water. For chemical mowing, consult label for exact timing and rates depending on weed size and species. Apply to young annuals or vigorous growing perennials. Avoid drift onto green bark or foliage or injury will result. Weeds should not be cultivated for 7–14 days after treatment for maximum control.

B. 2,4-D — Label rates — 48 — 40
WSSA MODE OF ACTION GROUP NUMBER[1]: 4
COMMENTS: Can control horseweed and hairy fleabane alone or in combination with glyphosate for broader weed control when grapes are established for at least 3 years. Apply before weeds bolt for most effective control. In areas where horseweed and fleabane emerge in fall or early winter, make an application in fall and again before bloom if weeds are present. Irrigation immediately before or after treatment reduces control and can increase the risk of crop injury. Use flat fan or other appropriate low pressure nozzles and a shield to prevent drift onto the grapes or other sensitive plants.

C. PARAQUAT — 0.6395–1 lb a.i. — 24 — 0
(Gramoxone Inteon)
WSSA MODE OF ACTION GROUP NUMBER[1]: 22
COMMENTS: Apply in 20–60 gal water/acre to young weeds. Use 0.5% nonionic surfactant. Repeat treatment as new growth occurs. Residual period: less than 1 month. Do not exceed 4 post-emergent directed applications/season.

Common name (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)
D. OXYFLUORFEN (Goal)	0.5–1 lb a.i.	24	14
WSSA MODE OF ACTION GROUP NUMBER[1]: 14 COMMENTS: Dormant application to young (4-leaf stage) weeds. May be combined with other post-emergent herbicides for specific weeds.			
E. FLUAZIFOP-P-BUTYL (Fusilade DX)	0.25–0.375 lb a.i.	12	365
WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: For use on nonbearing vines only. For selective control of grasses when they are 2–8 inches tall but before tillering and/or heading. Use a crop oil (1%) or nonionic surfactant (0.25%) to increase penetration and control. Do not apply to grass that is stressed or poor control may result.			
F. SETHOXYDIM (Poast)	0.28–0.46 lb a.i.	12	50
WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: Apply to young annual or perennial grasses. Repeat applications will be required for the control of perennial grasses. Add 2 pt crop oil concentrate to the spray solution. Do not apply to grass that is stressed or poor control may result. Residual period: less than 1 month.			
G. CLETHODIM (Select Max)	0.0954–0.1248 lb/acre	24	365
WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: For use on nonbearing vineyards only. Apply to rapidly growing grasses when they have reached the height recommended on label. Do not apply to drought stressed plants. Use a crop oil concentrate.			
H. GLUFOSINATE (Rely)	0.75–1.25 lb a.i.	12	14
WSSA MODE OF ACTION GROUP NUMBER[1]: 10 COMMENTS: For use in bearing and nonbearing vineyards. Applied at 20-50 gal/acre with a minimum pressure of 30 p.s.i. Good weed coverage is essential for control. Addition of ammonium sulfate at 5 lb/100 gal spray volume increases weed activity. Weeds should be less than 6 inches tall. Very effective on little mallow (cheeseweed), nettle, horseweed, and hairy fleabane.			

HERBICIDE COMBINATIONS

Combinations are most often used to broaden the weed control spectrum. Perennial weeds will not be controlled with these combinations. Other combinations can be used depending upon the weed spectrum present in the vineyard. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.

A. GLYPHOSATE (Roundup, etc.)	0.5–1 lb a.i. in 20–40 gal water/acre	4	14
WSSA MODE OF ACTION GROUP NUMBER[1]: 9			
. . . PLUS . . .			
OXYFLUORFEN (Goal)	0.1–1 lb a.i.	24	
WSSA MODE OF ACTION GROUP NUMBER[1]: 14 COMMENTS: For broad-spectrum control of emerged weeds in vineyards. Helps increase control of little mallow (cheeseweed), filaree, chickweed, and grasses. The effectiveness of glyphosate is increased with low water volume; oxyfluorfen is more effective at the higher volume. Avoid drift and follow directions for application period of oxyfluorfen.			
B. GLYPHOSATE (Roundup, etc.)	1 lb a.i.	4	35
WSSA MODE OF ACTION GROUP NUMBER[1]: 9			
. . . PLUS . . .			
ORYZALIN (Surflan AS)	4 lb a.i.	24	
WSSA MODE OF ACTION GROUP NUMBER[1]: 3			
. . . or . . .			

	Common name (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
	NAPROPAMIDE (Devrinol 50 DF)	4 lb a.i.	12	35
	WSSA MODE OF ACTION GROUP NUMBER[1]: 15			
	COMMENTS: Combines post- and preemergent control of most annual weeds with residual control up to 6 months. Combination choice depends on weed spectrum and how rapid incorporation will occur following application. Napropamide needs irrigation within 7 days, oryzalin within 21 days.			
C.	PARAQUAT (Gramoxone Inteon)	0.6375 lb a.i.	24	0
	WSSA MODE OF ACTION GROUP NUMBER[1]: 22			
	. . . PLUS . . .			
	OXYFLUORFEN (Goal)	0.5–1 lb a.i.	24	14
	WSSA MODE OF ACTION GROUP NUMBER[1]: 14			
	COMMENTS: Broad-spectrum postemergent control. Avoid drift and follow directions for application period of oxyfluorfen.			
D.	ORYZALIN (Surflan AS)	4 lb a.i.	24	0
	WSSA MODE OF ACTION GROUP NUMBER[1]: 3			
	. . . PLUS . . .			
	OXYFLUORFEN (Goal)	1 lb a.i.	24	14
	WSSA MODE OF ACTION GROUP NUMBER[1]: 14			
	COMMENTS: Combined to give broad-spectrum control. Applied preemergent or combined with paraquat or glyphosate if weeds have emerged. Activate within 21 days.			
E.	SIMAZINE (Princep, etc.)	1–2 lb a.i.	12	14
	WSSA MODE OF ACTION GROUP NUMBER[1]: 5			
	. . . PLUS . . .			
	DIURON (Karmex)	1–1.6 lb a.i.	12	0
	WSSA MODE OF ACTION GROUP NUMBER[1]: 7			
	. . . PLUS . . .			
	GLYPHOSATE (Roundup, etc.)	1 lb a.i.	4	14
	WSSA MODE OF ACTION GROUP NUMBER[1]: 9			
	COMMENTS This combination is effective on a broad range of weed species. Add glyphosate only when weeds have emerged and are actively growing. Use lower rates of simazine and diuron on light soils and high rates on heavy, fine-textured soils. Simazine and diuron are considered to be ground water contaminants and require a use permit within Ground Water Protection Areas. Residual period for diuron and simazine: 8–12 months. Glyphosate has no biological residual.			

* Permit required from county agricultural commissioner for purchase or use.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

[1] Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode of action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://www.hracglobal.com.

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PRECAUTIONS FOR USING PESTICIDES

Pesticides are poisonous and must be used with caution. READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER. Follow all label precautions and directions, including requirements for protective equipment. Apply pesticides only on the crops or in the situations listed on the label. Apply pesticides at the rates specified on the label or at lower rates if suggested in this publication. In California, all agricultural uses of pesticides must be reported. Contact your county agricultural commissioner for further details. Laws, regulations, and information concerning pesticides change frequently. This publication reflects legal restrictions current on the date next to each pest's name.

Legal Responsibility. The user is legally responsible for any damage due to misuse of pesticides. Responsibility extends to effects caused by drift, runoff, or residues.

Transportation. Do not ship or carry pesticides together with food or feed in a way that allows contamination of the edible items. Never transport pesticides in a closed passenger vehicle or in a closed cab.

Storage. Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.

Container Disposal. Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your county agricultural commissioner for correct procedures for handling and disposal of large quantities of empty containers.

Protection of Nonpest Animals and Plants. Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. Take precautions to protect nonpest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.

Posting Treated Fields. For some materials, *restricted entry intervals* are established to protect field workers. Keep workers out of the field for the required time after application and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your county agricultural commissioner for latest restricted entry interval.

Preharvest Intervals. Some materials or rates cannot be used in certain crops within a specified time before harvest. Follow pesticide label instructions and allow the required time between application and harvest.

Permit Requirements. Many pesticides require a permit from the county agricultural commissioner before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of this publication.

Processed Crops. Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before applying a pesticide.

Crop Injury. Certain chemicals may cause injury to crops (phytotoxicity) under certain conditions. Always consult the label for limitations. Before applying any pesticide, take into account the stage of plant development, the soil type and condition, the temperature, moisture, and wind. Injury may also result from the use of incompatible materials.

Personal Safety. Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift, and contamination of clothing. NEVER eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care IN ADVANCE as required by regulation.