UC IPM
Pest Management Guidelines:
Plum

Contents (Dates in parenthesis indicate when each topic was updated)

July 2017

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  Oakland, CA 94608-1239
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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 3389, IPM for Stone Fruits
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 plum. 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: Plum at http://www.ipm.ucdavis.edu/PMG.

<table>
<thead>
<tr>
<th>✓ Done</th>
<th>Dormant/delayed-dormant season activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Special issues of concern related to water quality: dormant sprays, drift, and rain runoff.</td>
</tr>
<tr>
<td></td>
<td>Survey weeds.</td>
</tr>
<tr>
<td></td>
<td>• Survey weeds after first rains and complete a late-fall weed survey form.</td>
</tr>
<tr>
<td></td>
<td>• Let resident vegetation grow between rows.</td>
</tr>
<tr>
<td></td>
<td>• Manage weeds in rows with pre- or postemergent herbicides, or nonchemically in organic orchards.</td>
</tr>
<tr>
<td></td>
<td>If aphids are a chronic problem, treat** in early November.</td>
</tr>
<tr>
<td></td>
<td>During pruning look for dead wood caused by shothole borer and pacific flathead borer. Prune and burn infested branches.</td>
</tr>
<tr>
<td></td>
<td>Knock off and destroy mummy fruit in cultivars susceptible to brown rot.</td>
</tr>
<tr>
<td></td>
<td>Take a spur sample for San Jose scale, mites, and aphids (if not treated in November).</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a monitoring form.</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMGs.</td>
</tr>
<tr>
<td></td>
<td>Delay treatment for peach twig borer until bloom time.</td>
</tr>
<tr>
<td></td>
<td>Keep a record of other pests you may see:</td>
</tr>
<tr>
<td></td>
<td>• Fruittree leafroller egg masses</td>
</tr>
<tr>
<td></td>
<td>• Italian pear scale</td>
</tr>
<tr>
<td></td>
<td>• Peach twig borer hibernacula</td>
</tr>
<tr>
<td></td>
<td>• American plum borer</td>
</tr>
<tr>
<td></td>
<td>• Voles</td>
</tr>
<tr>
<td></td>
<td>• Pocket gophers</td>
</tr>
<tr>
<td>✓ Done</td>
<td>Bloom season activities (green tip to petal fall)</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Special issues of concern related to water quality: drift.</td>
</tr>
<tr>
<td></td>
<td>On cultivars susceptible to brown rot, apply protective fungicide treatment** as a delayed-bloom application.</td>
</tr>
<tr>
<td></td>
<td>Place omnivorous leafroller pheromone traps in the orchard at bloom.</td>
</tr>
<tr>
<td></td>
<td>• Check twice weekly to establish biofix for the first flight.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>Monitor San Jose scale:</td>
</tr>
<tr>
<td></td>
<td>• Put up pheromone traps to monitor male flight.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>Monitor peach twig borer larvae:</td>
</tr>
<tr>
<td></td>
<td>• Time bloom treatments** according to PMG.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>Monitor for leafrollers, other caterpillars, and katydids.</td>
</tr>
<tr>
<td></td>
<td>Monitor codling moth in orchards with a history of codling moth problems.</td>
</tr>
<tr>
<td></td>
<td>Look for spider mites and predatory mites weekly on first emerging basal leaves of scaffolds. Map areas of concern for future monitoring.</td>
</tr>
<tr>
<td></td>
<td>During long, cool bloom periods, monitor for western flower thrips.</td>
</tr>
<tr>
<td></td>
<td>Keep records of other pests you may see:</td>
</tr>
<tr>
<td></td>
<td>• Ground squirrels</td>
</tr>
<tr>
<td></td>
<td>• Pocket gophers</td>
</tr>
<tr>
<td></td>
<td>• Voles</td>
</tr>
<tr>
<td></td>
<td>• Bacterial canker</td>
</tr>
<tr>
<td></td>
<td>• Armillaria root rot</td>
</tr>
<tr>
<td></td>
<td>• Phytophthora root and crown rot</td>
</tr>
<tr>
<td>✓ Done</td>
<td><strong>Fruit development period activities (petal fall to harvest)</strong></td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Special issues of concern related to water quality: runoff from irrigation, and drift.</td>
</tr>
<tr>
<td></td>
<td>Manage weeds.</td>
</tr>
<tr>
<td></td>
<td>• Mow or cultivate.</td>
</tr>
<tr>
<td></td>
<td>• Survey weeds in late spring and keep records on a late-spring weed survey form.</td>
</tr>
<tr>
<td></td>
<td>Monitor San Jose scale:</td>
</tr>
<tr>
<td></td>
<td>• Continue checking pheromone traps.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMG.</td>
</tr>
<tr>
<td></td>
<td>Monitor omnivorous leafroller:</td>
</tr>
<tr>
<td></td>
<td>• Continue checking pheromone traps.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMG.</td>
</tr>
<tr>
<td></td>
<td>Put up peach twig borer pheromone traps.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMG.</td>
</tr>
<tr>
<td></td>
<td>Monitor aphids from petal fall until July 15, or until a treatment is applied.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a degree-day monitoring form.</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMG.</td>
</tr>
<tr>
<td></td>
<td>Monitor webspinning spider mites weekly using a 5-minute search, starting June 1.</td>
</tr>
<tr>
<td></td>
<td>• Keep records on a monitoring form.</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMG.</td>
</tr>
<tr>
<td></td>
<td>Continue monitoring codling moth if it has been a problem in the past.</td>
</tr>
<tr>
<td></td>
<td>Keep a record of other pests you may see:</td>
</tr>
<tr>
<td></td>
<td>• Caterpillars</td>
</tr>
<tr>
<td></td>
<td>• Borers</td>
</tr>
<tr>
<td></td>
<td>• Katydidsl</td>
</tr>
<tr>
<td></td>
<td>• Diseases</td>
</tr>
<tr>
<td></td>
<td>• Birds</td>
</tr>
<tr>
<td></td>
<td>• Treat** if needed according to PMG.</td>
</tr>
</tbody>
</table>
Harvest activities

Special issues of concern related to water quality: none.

- Take a fruit damage sample to assess the overall effectiveness of the current year's IPM program and to determine next year's needs.
  - Keep records on a monitoring form.

- Store picked fruit below 40°C to prevent storage rot or ripe fruit rot.

Postharvest activities (Fall)

Special issues of concern related to water quality: none.

- Consider zinc sulfate application** to hasten leaf fall in order to disrupt aphid's life cycle.

- Consider planting cover crop.

- Plan for next year.

Pesticide application checklist

When planning for possible pesticide applications in an IPM program, consult the Pest Management Guidelines, and review and complete this checklist to consider practices that minimize environmental and efficacy problems.

Choose a pesticide from the Pest Management Guidelines for the target pest, considering:

- Impact on natural enemies and pollinators. For more information see Protecting Natural Enemies and Pollinators at http://www.ipm.ucanr.edu/mitigation/protect_beneficials.html.

- Potential for water quality problems using the UC IPM WaterTox database. See www.ipm.ucanr.edu/TOX/simplewatertox.html.

- Impact on aquatic invertebrates. For more information, see Pesticide Choice, UC ANR Publication 8161 [PDF], http://anrcatalog.ucdavis.edu/pdf/8161.pdf.

- Chemical mode of action, if pesticide resistance is an issue. For more information, see Herbicide Resistance: Definition and Management Strategies, UC ANR Publication 8012 (PDF), http://anrcatalog.ucdavis.edu/pdf/8012.pdf.


- Endangered species that may be near your site. Find out using the Department of Pesticide Regulation's PRESCRIBE program. (http://www.cdpr.ca.gov/docs/endspec/prescint.htm)

Before an application

- Ensure that spray equipment is properly calibrated to deliver the desired pesticide amount for optimal coverage. (See http://ipm.ucanr.edu/training/incorporating-calibration.html)

- Use appropriate spray nozzles and pressure to minimize off-site movement of pesticides.

- Avoid spraying during these conditions to avoid off-site movement of pesticides.
  - Wind speed under 3 mph and over 10 mph
  - Temperature inversions
  - Just prior to rain or irrigation (unless it is an appropriate amount, such as when incorporating a soil-applied pesticide)
  - At tractor speeds over 2 mph

- Identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding your application site.

- Review and follow labeling for pesticide handling, personal protection equipment (PPE) requirements, storage, and disposal guidelines.

- Check and follow restricted entry intervals (REI) and preharvest intervals ( PHI).

After an application
<table>
<thead>
<tr>
<th>✓ Done</th>
<th>Pesticide application checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Record application date, pesticide used, rate, and location of application.</td>
</tr>
<tr>
<td></td>
<td>• Follow up to confirm that treatment was effective.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>✓ Consider water management practices that reduce pesticide movement off-site.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Consult relevant publications:</td>
</tr>
<tr>
<td>• Consult the Department of Pesticide Regulation Groundwater Protection Program (GWPA) Web site for pesticide information and mitigation measures. (<a href="http://www.cdpr.ca.gov">http://www.cdpr.ca.gov</a>)</td>
</tr>
<tr>
<td>• Install an irrigation recirculation or storage and reuse system. Redesign inlets into tailwater ditches to reduce erosion. For more information, see these publications:</td>
</tr>
<tr>
<td>• Limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET). (For more information, see <em>Reducing Runoff from Irrigated Lands: Understanding Your Orchard’s Water Requirements</em>, UC ANR Publication 8212 (PDF), <a href="http://anrcatalog.ucanr.edu/pdf/8212.pdf">http://anrcatalog.ucanr.edu/pdf/8212.pdf</a>.)</td>
</tr>
<tr>
<td>• Consider using cover crops.</td>
</tr>
<tr>
<td>• Consider vegetative filter strips or ditches. (For more information, see <em>Vegetative Filter Strips</em>, UC ANR Publication 8195 (PDF), <a href="http://anrcatalog.ucanr.edu/pdf/8195.pdf">http://anrcatalog.ucanr.edu/pdf/8195.pdf</a>.)</td>
</tr>
<tr>
<td>• Use polyacrylamide (PAM) tablets in furrow irrigation systems to prevent off-site movement of sediments.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>✓ Consider practices that reduce air quality problems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• When possible, reduce volatile organic compound (VOC) emissions by decreasing the amount of pesticide applied, choosing low-emission management methods, and avoiding fumigants and emulsifiable concentrate (EC) formulations.</td>
</tr>
</tbody>
</table>

For more about mitigating the effects of pesticides, see the Mitigation page.
General Information

DORMANT SPUR SAMPLE (5/06)

Dormant spur sampling is used to determine the need for a dormant treatment to control San Jose scale, European fruit lecanium, European red mite, and brown mite. If mealy plum aphid and leaf curl plum aphid were not treated in early November, also record the presence of aphid eggs in the dormant spur sample. Spurs are the short shoots containing the flower buds. Dormant spur samples are taken once a year between mid-November and the end of January.

Use sampling form with detailed treatment threshold information for dormant spur sampling (available in the online version of this guideline).

HOW TO SAMPLE  (View photos online for identification.)
- Take a sample between mid-November and mid-January.
- Randomly select 35 to 50 trees from each orchard or plot to be sampled.
- Select 2 to 3 spurs randomly from the inside of each tree's canopy near the main scaffold. Continue until you have collected a total of 100 spurs. It is important to choose spurs on older wood because they are much more likely to be infested.
- Clip the spur off at the base, making sure to include some old spur wood along with the past season’s growth to detect parasite activities on scales.
- Using a hand lens or binocular microscope, examine the spurs and note the presence or absence of scales and parasitized scales, aphid eggs and mite eggs on the sampling form. It is not necessary to count the number of individual insects or mite eggs present, just identify the pest and record whether it is present or not.
- A parasitized scale can be distinguished from a live scale by a small hole in the top of the scale covering. Parasitized European fruit lecanium scales turn black. If a large number of scales have been parasitized, minimize the use of insecticides during the growing season, and use those that are not harmful to parasites so that naturally occurring parasite populations will not be destroyed.

DORMANT TREATMENT DECISION TABLE (% INFESTED SPURS)

<table>
<thead>
<tr>
<th>Pest</th>
<th>Treatment threshold</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>European fruit lecanium</td>
<td>24% and below</td>
<td>No spray</td>
</tr>
<tr>
<td></td>
<td>Over 24%</td>
<td>Oil only</td>
</tr>
<tr>
<td>Overwintering mite eggs (brown mite and European red)</td>
<td>Below 20%</td>
<td>No spray</td>
</tr>
<tr>
<td></td>
<td>20% and over</td>
<td>Oil only</td>
</tr>
<tr>
<td>Overwintering aphid eggs (mealy plum aphid or leaf curl plum aphid)</td>
<td>If any</td>
<td>See aphid PMGs for materials</td>
</tr>
</tbody>
</table>

**Harvested before June 15**
- Below 20% | No treatment
- 20-60% | Oil at 6 gal/acre
- Over 60% | Oil at 6 gal/acre plus insect growth regulator

**Harvested after June 15**
- Below 5% | No treatment
- 5-10% | Oil at 6 gal/acre
- Over 10% | Oil at 6 gal/acre plus insect growth regulator

1 See the San Jose scale section for more information about treatment choices according to infestation levels.

CHOICE OF INSECTICIDES
Oils alone are effective against the white cap and black cap stages of San Jose scale, which are present at this time, and will also control low-to-moderate populations of mite eggs and fruittree leafroller eggs. Other pests such as peach twig borer and obliquebanded leafrollers will not be controlled by oil alone during the dormant season. Environmentally sound insecticides such as Bacillus thuringiensis, spinosad (Entrust, Success), methoxyfenozide (Intrepid) and diflubenzuron (Dimilin), however, applied at bloom will control peach twig borer and leafroller caterpillars. The combination of these bloom time treatments along with a dormant oil application for scales, mite
eggs, and leafroller eggs is a good IPM strategy for many orchards. Organophosphates applied during the dormant season for peach twig borer are particularly vulnerable to run-off into waterways and should be avoided.
PHEROMONE TRAPS (4/09)

Pheromone traps are used to monitor the flights of certain pest moths and San Jose scale. Use pheromone traps to monitor San Jose scale, omnivorous leafroller, codling moth, and peach twig borer in all orchards. Only orchards that did not receive a dormant or bloom treatment require peach twig pheromone traps. Codling moth traps are needed only in those few orchards with a history of codling moth infestations.

The information obtained from trap catches can be used to schedule control actions when used in conjunction with degree-day calculations. The traps are used to establish a biofix—an identifiable point in the life cycle of the pest at which you can begin degree-day accumulation or take a management action. For example, the biofix for peach twig borer is the date that the first adult moth of each generation is caught.

GENERAL GUIDELINES FOR USING PHEROMONE TRAPS

- Place traps in each orchard for which you need to make pest management decisions.
- Traps should be placed in orchards by the dates indicated in the table below.
- Use at least 2 traps per block for moths, and 3 or 4 per block for San Jose scale.
- Distribute the traps uniformly throughout the orchard and use the same locations each year.
- Place additional traps in hot spots.
- Hang traps 6 to 8 feet high, 1 to 3 feet inside the canopy in the north quadrant of the tree, in the shade, and at least 5 trees in from the edge of the orchard.
- 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 a monitoring form.
- Replace trap bottoms monthly or when they become covered with debris.
- Follow manufacturer's recommendations for replacing pheromone dispensers.
- Store pheromone dispenser in a refrigerator or freezer.

WHEN TO PUT OUT TRAPS

<table>
<thead>
<tr>
<th>Insect pest</th>
<th>Trap placement date</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Jose scale</td>
<td>Feb 25</td>
<td>Determine biofix; excellent for monitoring beneficials.</td>
</tr>
<tr>
<td>omnivorous leafroller</td>
<td>February 20 (San Joaquin Valley)</td>
<td>Determine biofix to begin degree-day accumulation to predict onset of second flight.</td>
</tr>
<tr>
<td>codling moth</td>
<td>Soon after bud break or by March 15</td>
<td>To help detect first moth emergence and set biofix for degree-day accumulation to predict egg hatch.</td>
</tr>
<tr>
<td>peach twig borer</td>
<td>March 20 (San Joaquin Valley) April 1 (Sacramento Valley)</td>
<td>Determine biofix for each generation; use degree-days to determine caterpillar monitoring schedule.</td>
</tr>
</tbody>
</table>
SPRING/SUMMER MONITORING FOR APHIDS (5/06)

Monitor mealy plum aphid and leaf curl plum aphid in spring if a dormant spray was not applied or if only oil was applied during dormancy. Begin monitoring weekly at petal fall and continue until a treatment is applied. After treatment, monitor every other week through July 15. If aphid populations remain low during the first 8 weeks of weekly monitoring, monitoring can be reduced to every other week until a treatment is applied or until July 15.

Use sampling form with detailed treatment threshold information (available in the online version of this guideline).

WHERE TO MONITOR
Monitor trees at the outside edge of the orchard or in known or potential "aphid hot spots." Potential hot spots for aphid infestation are areas of the orchard that have windbreaks or adjacent areas of natural vegetation.

HOW TO MONITOR (View photos online for identification.)
Each sample begins with a search of 40 whole trees. Spend 10 minutes (about 15 seconds per tree) on this search, using a stopwatch or kitchen timer to time yourself. Look for the presence or absence of aphids and rate the population as significant or not.

1. Walk down a tree row and visually examine the half of the tree on your right and half of the tree on your left. These two halves constitute one whole tree for the purposes of this sample.
   - Look for signs of aphid presence, such as curled leaves, honeydew, waxy- or silvery-looking leaves, and the presence of bees, ants, and beneficial insects that prey on aphids.
   - If any of these symptoms are observed, closely examine branches and leaves for the presence of live, damaging aphids. (Damaging aphids are the young wingless aphids.) If leaves are curled, uncurl the leaf and examine up to 5 leaves per tree to verify the presence of live leaf curl plum aphids.

2. If either tree-half has live aphids, determine whether the aphid population is SIGNIFICANT.
   - Determine whether they are mealy plum aphids or leaf curl plum aphids.
   - If aphids (either species) occupy 10% or more of the tree's leaf surface as determined by a visual search, the population is SIGNIFICANT. Whether one or both halves of the whole tree has significant aphid populations, record the tree on the monitoring form as having a significant aphid population.

3. After you have sampled 40 whole trees in this manner, make a decision. The results of the sample will lead to a decision to treat, continue sampling, or stop sampling.

<table>
<thead>
<tr>
<th>If you find</th>
<th>Take action</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 12 trees have significant aphid</td>
<td>Stop the search and treat. See the mealy plum or leaf curl aphid sections for treatment choices.</td>
</tr>
<tr>
<td>populations,</td>
<td></td>
</tr>
<tr>
<td>Less than 4 trees with a significant aphid</td>
<td>Stop the search. Monitoring is over for the week and no treatment is needed.</td>
</tr>
<tr>
<td>population,</td>
<td></td>
</tr>
<tr>
<td>Less than 12 but more than 4 whole trees have a</td>
<td>Do an additional 5-minute search (see step 4 below).</td>
</tr>
<tr>
<td>significant population of aphids,</td>
<td></td>
</tr>
</tbody>
</table>

4. If you could not come to a final decision in step 3 above, conduct an additional 5-minute search that surveys 20 new trees. Up to two additional 5-minute searches may be required to reach a decision. Record results on the monitoring form.
After the first 5-minute search of 20 additional whole trees:

<table>
<thead>
<tr>
<th>If you find</th>
<th>Take action</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 16 trees from both searches have significant aphid populations,</td>
<td>Stop the search and treat. See the mealy plum or leaf curl aphid sections for treatment choices.</td>
</tr>
<tr>
<td>Less than 8 trees from both searches have significant aphid populations,</td>
<td>Stop the search. Monitoring is over for the week and no treatment is needed.</td>
</tr>
<tr>
<td>Less than 16 but more than 8 whole trees have a significant populations of aphids,</td>
<td>Do one additional 5-minute search (see step 5).</td>
</tr>
</tbody>
</table>

5. If you did not come to a final decision in step 4, a second 5-minute search is required:

<table>
<thead>
<tr>
<th>If you find</th>
<th>Take action</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 16 trees from all three searches have significant aphid populations,</td>
<td>Stop the search and treat. See the mealy plum or leaf curl aphid sections for treatment choices.</td>
</tr>
<tr>
<td>Less than 8 trees from both searches have significant aphid populations,</td>
<td>Stop the search. Monitoring is over for the week and no treatment is needed.</td>
</tr>
<tr>
<td>Less than 16 but more than 8 whole trees have a significant populations of aphids,</td>
<td>Do one additional 5-minute search.</td>
</tr>
</tbody>
</table>
FRUIT EVALUATION AT HARVEST (5/06)

Take a fruit damage sample at harvest to assess the effectiveness of the current year's IPM program and to determine the needs of next year's program.

Use sampling form with detailed treatment threshold information (available in the online version of this guideline).

HOW TO SAMPLE
During the sorting process in the orchard randomly examine 100 fresh fruit from each bin for each variety. Distinguish damage caused by peach twig borer, obliquebanded and omnivorous leafrollers, codling moth, and San Jose scale.

Look for the presence of:

- Larvae or larval feeding from peach twig borer, codling moth or other caterpillars.
  - Peach twig borer: shallow feeding holes; over time these may appear as scabs.
  - Codling moth: piles of frass at entrance holes; tunnel deep into fruit.
  - Leafrollers: tunneling into fruit; shallow holes or grooves in the fruit surface.

- Look for the presence of live or parasitized San Jose scale and halos or spots on the fruit surface.

Record on a sampling form (available on the online version) the number of fruit infested by larvae, type of larvae present or, if there are no larvae present, whether damage is surface feeding only or if the larvae penetrated the fruit. Record the number of fruit with live San Jose scale or parasitized San Jose scale. Note that you may also see signs of ripe fruit rot.
### Relative Impact of the Timing of Pesticide Applications on Natural Enemies (4/09)

#### Dormant - Bloom Time - In-Season

<table>
<thead>
<tr>
<th>Natural Enemy</th>
<th>Dormant</th>
<th>Bloom Time</th>
<th>In-Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil</td>
<td>Oil + pyrethroid&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Oil + OP&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>aphid parasites (Aphidius spp.)</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>caterpillar parasite (Copidosoma)&lt;sup&gt;9&lt;/sup&gt;</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>(Macrocentrus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lacewings</td>
<td>L</td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>lady beetles (Chilocorus spp.)</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>minute pirate bugs</td>
<td>L</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>predatory mites (Galendromus sp., Typhlodromus sp.)</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>scale parasites (Aphytis sp.)</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>spiders</td>
<td>L</td>
<td>L</td>
<td>M</td>
</tr>
</tbody>
</table>

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

1 pyrethroid (e.g. Asana, Warrior)
2 OP = organophosphate (e.g. Diazinon, Guthion, Imidan, Lorsban, Supracide)
3 IGR = insect growth regulator (Dimilin, Intrepid, Esteem, Seize)
4 Bt = Bacillus thuringensis
5 carbamate (e.g. Sevin)
6 NN = neonicotinoids (Actara, Provado)
7 Inseason use of OPs on aphid parasites: Diazinon = M, Imidan = L, Lorsban = no information
8 Inseason use of pyrethroids on aphid parasites: Asana = L, Warrior = no information
9 (= Paralitomastix)
## Relative Toxicities of Insecticides and Miticides Used in Plums to Natural Enemies and Honey Bees

### Table: Relative Toxicities of Insecticides and Miticides

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Mode of action</th>
<th>Selectivity (affected groups)</th>
<th>Predatory mites</th>
<th>General predators</th>
<th>Parasites</th>
<th>Honey bees</th>
<th>Duration of impact to natural enemies</th>
</tr>
</thead>
<tbody>
<tr>
<td>azadirachtin (Neemix)</td>
<td>un</td>
<td>broad (insects, mites)</td>
<td>M</td>
<td>L/M</td>
<td>L/M</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>Bacillus thuringiensis ssp. kurstaki</td>
<td>11A</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>none</td>
</tr>
<tr>
<td>bifenthrin (K专项)</td>
<td>un</td>
<td>narrow (spider mites)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>carbaryl (Sevin)</td>
<td>1A</td>
<td>broad (insects, mites)</td>
<td>L/H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>long</td>
</tr>
<tr>
<td>carbaryl (Sevin) XLR Plus</td>
<td>1A</td>
<td>broad (insects, mites)</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>long</td>
</tr>
<tr>
<td>diazinon–foliar</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate to long</td>
</tr>
<tr>
<td>diflubenzuron (Dimilin)</td>
<td>15</td>
<td>—</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>II</td>
<td>—</td>
</tr>
<tr>
<td>endosulfan (Thiodan)</td>
<td>2A</td>
<td>broad (insects, mites)</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>esfenvalerate (Asana)</td>
<td>3A</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>fenbutatin oxide (Vendex)</td>
<td>12B</td>
<td>narrow (pest mites)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>hexythiazox (Savey)</td>
<td>10A</td>
<td>narrow (mites)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>imidacloprid (Provado)</td>
<td>4A</td>
<td>narrow (sucking insects)</td>
<td>—</td>
<td>—</td>
<td>H</td>
<td>I</td>
<td>short to moderate</td>
</tr>
<tr>
<td>lambda-cyhalothrin (Warrior)</td>
<td>3A</td>
<td>broad (plant bugs, beetles, caterpillars)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>methidathion (Supractide)</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate to long</td>
</tr>
<tr>
<td>methoxyfenozide (Intrepid)</td>
<td>1B</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>none</td>
</tr>
<tr>
<td>neem oil (Triology)</td>
<td>un</td>
<td>broad (soft-bodied insects)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>petroleum oil</td>
<td>un</td>
<td>broad (exposed insects, mites)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short to none</td>
</tr>
<tr>
<td>phosmet (Imidan)</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate to long</td>
</tr>
<tr>
<td>pyriproxyfen (Esteem, Seize)</td>
<td>7C</td>
<td>narrow (scale, beetles)</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>II</td>
<td>long</td>
</tr>
<tr>
<td>spinosad (Entrust, Success)</td>
<td>5</td>
<td>caterpillars, thrips, whiteflies, aphids, scales, leafminers</td>
<td>L</td>
<td>M</td>
<td>L/M</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>sulfur</td>
<td>un</td>
<td>narrow (mites and citrus thrips)</td>
<td>L/H</td>
<td>L</td>
<td>H</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>thiamethoxam (Actara)</td>
<td>4A</td>
<td>narrow (sucking insects)</td>
<td>—</td>
<td>—</td>
<td>M</td>
<td>I</td>
<td>moderate</td>
</tr>
</tbody>
</table>

H = high  M = moderate  L = low  — = no information  un = unknown or uncertain mode of action

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.

2 Selectivity: Broad means it affects most groups of insects and mites; narrow means it affects only a few specific groups.

3 Generally, toxicities to western predatory mite, Galedromus 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 or allow to drift to plants that are flowering; II—Do not apply or allow to drift to plants that are flowering, except when the application is made between sunset and midnight if allowed by the pesticide label and regulations; III—No bee precaution, except when required by the pesticide label or regulations. For more information about pesticide synergistic effects, see Bee Precaution Pesticide Ratings (available online at http://ipm.ucdavis.edu/beeprcaution/).

6 Duration: Short means hours to days; moderate means days to 2 weeks; and long means many weeks or months.

7 Kills lady beetles.

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

9 May cause increase in spider mite populations.

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 Plums

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Chemical class (FRAC No.)</th>
<th>Activity</th>
<th>Mode of action</th>
<th>Resistance potential</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>azoxystrobin (Abound)</td>
<td>QoI&lt;sup&gt;3&lt;/sup&gt; (11)</td>
<td>contact, systemic</td>
<td>single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>bordeaux</td>
<td>inorganic (M1)</td>
<td>contact</td>
<td>multi-site</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>captan</td>
<td>phthalamide (M4)</td>
<td>contact</td>
<td>multi-site</td>
<td>low</td>
<td>highly toxic to honey bee larvae</td>
</tr>
<tr>
<td>chlorothalonil (Bravo)</td>
<td>chloronitrile (M5)</td>
<td>contact</td>
<td>multi-site</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>copper</td>
<td>inorganic (M1)</td>
<td>contact</td>
<td>multi-site</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>cyprodinil (Vanguard)</td>
<td>anilinopyrimidine (9)</td>
<td>mostly contact</td>
<td>single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>fosetyl-al (Aliette)</td>
<td>ethyl phosphonate (33)</td>
<td>systemic</td>
<td>unknown</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>fludioxonil (Scholar)</td>
<td>phenylpyrrole (12)</td>
<td>contact</td>
<td>few to multi-site</td>
<td>medium</td>
<td></td>
</tr>
<tr>
<td>iprodione (Rovral)</td>
<td>dicarboximide (2)</td>
<td>systemic (local)</td>
<td>single-site?</td>
<td>medium</td>
<td>toxic to honey bee larvae</td>
</tr>
<tr>
<td>mefenoxam (Ridomil Gold)</td>
<td>acylalanine (4)</td>
<td>contact, systemic</td>
<td>single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>myclobutanil (Rally)</td>
<td>DMI 2-triazole (3)</td>
<td>systemic (local)</td>
<td>single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>propiconazole (Bumper/Orbit)</td>
<td>DMI 2-triazole (3)</td>
<td>systemic (local)</td>
<td>single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>pyraclostrobin/boscalid (Pristine)</td>
<td>QoI&lt;sup&gt;3&lt;/sup&gt; / SDHI&lt;sup&gt;4&lt;/sup&gt; (11 / 7)</td>
<td>contact, systemic</td>
<td>single-site / single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>pyrimethanil (Scala)</td>
<td>anilinopyrimidine (9)</td>
<td>mostly contact</td>
<td>single-site</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>sulfur</td>
<td>inorganic (M2)</td>
<td>contact</td>
<td>multi-site</td>
<td>low</td>
<td></td>
</tr>
</tbody>
</table>

---

<sup>1</sup> 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.

<sup>2</sup> DMI = demethylation (sterol) inhibitor

<sup>3</sup> QoI = quinone outside inhibitor (strobilurin)

<sup>4</sup> SDHI = succinate dehydrogenase inhibitor

<sup>5</sup> MBC = methyl benzimidazole carbamate

FUNGICIDE EFFICACY (6/17)

Note: Spring brown rot and shot hole control is not necessary for most plum cultivars in California.

<table>
<thead>
<tr>
<th>Fungicide***</th>
<th>Resistance risk (FRAC#)¹</th>
<th>Brown rot Blossom²</th>
<th>Brown rot Fruit</th>
<th>Powdery mildew³</th>
<th>Shot hole⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bumper, Tilt</td>
<td>high (3)</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>ND</td>
</tr>
<tr>
<td>Elite, Tebucon**</td>
<td>high (3)</td>
<td>++++</td>
<td>++++</td>
<td>++</td>
<td>ND</td>
</tr>
<tr>
<td>Fontelas</td>
<td>high (7)</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>ND</td>
</tr>
<tr>
<td>Indar</td>
<td>high (3)</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Inspire Super</td>
<td>high (3/9)</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>ND</td>
</tr>
<tr>
<td>Luna Experience</td>
<td>medium (3/7)³</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>ND</td>
</tr>
<tr>
<td>Luna Sensation</td>
<td>medium (7/11)³</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Merivon</td>
<td>medium (7/11)³</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Pristine</td>
<td>medium (7/11)³</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Quadris Top</td>
<td>medium (3/11)³</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Quash</td>
<td>high (3)</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Quilt, Xcel, Avaris 2XS</td>
<td>medium (3/11)³</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Rovral + oil*</td>
<td>low (2)</td>
<td>++++</td>
<td>NL</td>
<td>----</td>
<td>ND</td>
</tr>
<tr>
<td>Scala⁵</td>
<td>high (9)</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Topsin-M, T-Methyl, Incognito, Cercobin³</td>
<td>high (1)³</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>ND</td>
</tr>
<tr>
<td>Vanguard</td>
<td>high (9)</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Elevate</td>
<td>high (17)</td>
<td>++++</td>
<td>++++</td>
<td>+</td>
<td>ND</td>
</tr>
<tr>
<td>Rally</td>
<td>high (3)</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Rhyme</td>
<td>high (3)</td>
<td>++++</td>
<td>++++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Rovral, Prodione, Nevada⁷</td>
<td>low (2)</td>
<td>++++</td>
<td>NL</td>
<td>----</td>
<td>ND</td>
</tr>
<tr>
<td>Abound</td>
<td>high (11)²</td>
<td>++</td>
<td>+</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Botran</td>
<td>medium (14)</td>
<td>++</td>
<td>++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Bravo, Chlorothalonil</td>
<td>low (M5)</td>
<td>++</td>
<td>++</td>
<td>----</td>
<td>ND</td>
</tr>
<tr>
<td>Echo, Equus¹¹¹²</td>
<td>low (M5)</td>
<td>++</td>
<td>++</td>
<td>----</td>
<td>ND</td>
</tr>
<tr>
<td>Captan¹²</td>
<td>low (M4)</td>
<td>++</td>
<td>++</td>
<td>----</td>
<td>ND</td>
</tr>
<tr>
<td>Gem</td>
<td>high (11)²</td>
<td>++</td>
<td>++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Oso</td>
<td>high (19)</td>
<td>++</td>
<td>++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Copper</td>
<td>low (M1)</td>
<td>+/-</td>
<td>+++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Sulfur¹²</td>
<td>low (M2)</td>
<td>+/-</td>
<td>++</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Quintec</td>
<td>high (13)</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>ND</td>
</tr>
</tbody>
</table>

Rating: ++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; +/- = minimal and often ineffective; ---- = ineffective; NL = not on label; and ND = no data

* Registration pending in California.
** Not registered, label withdrawn or inactive in California.
*** Postharvest fruit registrations in California include: Tebucon, Penbotec and Scholar.

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 Brown rot blossom blight is seldom observed on most plum cultivars and usually does not require treatment during bloom.

³ Powdery mildew seldom is observed on most plum cultivars and control usually is unnecessary.

⁴ Shot hole disease rarely occurs on plums in California. The small holes often observed on leaves in spring are caused by either a genetic disorder or by other agents including environmental factors.

⁵ To reduce the risk of resistance development, start treatments with a fungicide with a multi-site mode of action; rotate or mix fungicides with different mode-of-action FRAC numbers for subsequent applications, use labeled rates (preferably the upper range), and limit the total number of applications/season.

⁶ Registered for pre- and postharvest applications on plum.

⁷ Blossom blight only; not registered for use after petal fall.

⁸ Oil = "light" summer oil, 1-2% volume/volume.

⁹ High summer temperatures and relative humidity reduce efficacy.

¹⁰ Strains of the brown rot fungus Monilinia fructicola resistant to Topsin-M and T-Methyl are found in other stone fruit orchards in California. Brown rot is so seldom found in plum orchards that the resistance levels in plum orchards have not been assessed. Subpopulations of both Monilinia spp. have been shown to be resistant to AP (FRAC 9) fungicides on prune in CA.

¹¹ Do not use after jacket (shuck) split.

¹² Do not use in combination with or shortly before or after oil treatment.
TREATMENT TIMING FOR KEY DISEASES (6/17)

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

<table>
<thead>
<tr>
<th>Disease</th>
<th>Dormant</th>
<th>Green bud</th>
<th>Popcorn</th>
<th>Full bloom</th>
<th>Until pit hardening</th>
<th>Preharvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>brown rot ¹</td>
<td>—</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td>powdery mildew</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>—</td>
</tr>
<tr>
<td>shot hole ²</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Rating: +++ = most effective; ++ = moderately effective; + = least effective; — = ineffective

¹ One early application should suffice; a second treatment should not be needed.

² No treatment is recommended for shot hole because the shot holes found on plum leaves only rarely are caused by the shot hole fungus.

Insects and Mites

AMERICAN PLUM BORER (4/09)
Scientific Name: Euzophera semifuneralis

DESCRIPTION OF THE PEST
The forewings of the adult moth are gray with brown and black markings. The wingspan is about 0.75 inch. Young larvae are white with a large, dark brown head. Mature larvae are about 1 inch long, dusky white, pinkish or dull green in color. Reddish orange frass, webbing, and gum pockets indicate their presence. They overwinter as mature larvae in a cocoon within the tree. There are three to four generations each year.

DAMAGE
Larvae bore into the tree leaving reddish orange frass and gum pockets. The boring is most damaging to the scaffold crotches or graft unions of young trees. Vigorous trees will heal over, but with heavy, prolonged infestations, scaffolds may break with wind or a heavy crop.

MANAGEMENT
Monitor young orchards in spring and summer for frass and gum pockets. If larvae are present, spray trees from 1 foot above the scaffold crotch to 1 foot below, two to three times during the growing season. The first application should be mid- to late April and subsequent applications at 6-week intervals to kill adults before they can lay eggs. Remove and destroy infested wood or heavily infested trees.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Diazinon* 50WP</td>
<td>1 lb/100 gal water</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>Mode of Action Group Number: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comments: Do not exceed 4 lb diazinon 50WP/acre.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Carbaryl* (Sevin) 80S</td>
<td>3.75–5 lb/acre</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Mode of Action Group Number: 1A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

+ 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.
· 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 (5/06)

Scientific Name: Melalgus (=Polycaon) confertus

DESCRIPTION OF THE PEST

The branch and twig borer is a slender brown beetle about 0.5 to 0.67 inch long. The body is cylindrical and the head and prothorax are narrower than the body proper. The beetle lays its eggs in the dead wood of a number of native and cultivated trees and shrubs outside the orchard or on dead plum limbs once an orchard becomes infested. Larvae bore into the heartwood of the host and feed within this area for a year or possibly longer. Pupation occurs within the wood, and adults emerge in early summer. They often fly from native vegetation to orchards where they bore into small branches on the trees. There is one generation per year.

DAMAGE

The adults bore into small twigs and branches, making round holes, commonly at the axil of a bud or fruit spur or at the fork of two branches. One of the branches frequently dies. Branch and twig borers seldom cause economic injury and are found only rarely in plums.

MANAGEMENT

These beetles do not prefer healthy, vigorous growing trees. Maintain a program of sunburn protection and proper irrigation and fertilization. Promptly destroy brush piles harboring these pests. Remove prunings and brush piles from orchard in early spring. Remove badly infested trees and branches from the orchard and destroy them by shredding or hauling them to the dump. There is no insecticide treatment currently recommended to control the larvae of these borers.
BROWN MITE (4/09)

Scientific Name: *Bryobia rubrioculus*

DESCRIPTION OF THE PEST

Brown mites can be recognized by their flattened bodies and long front legs. Adults are brownish green; nymphs are red at first. Brown mites overwinter as eggs on twigs and branches. Eggs hatch in spring and the young move out to leaves where they feed but do not produce webbing. Brown mites feed only during the cool parts of the day and migrate off the leaves during midday.

DAMAGE

Brown mites feed by sucking the contents out of leaf cells. Such leaf damage reduces tree vitality and can adversely affect fruit size. Leaf injury caused by brown mites begins as a mottling and browning of leaves. Trees can tolerate low to moderate populations of brown mite, but heavy populations can remove almost all the chlorophyll from leaves and entire trees will take on a pale yellow appearance.

MANAGEMENT

Predators will generally keep brown mite populations below damaging levels. Allowing low populations of brown mites in the orchard during spring enables mite predators to increase their population to levels that are more effective in controlling webspinning mites. Generally, hot weather and predators cause brown mite populations to decline in summer.

Biological Control

Several predaceous species feed on brown mite, including lacewings (*Chrysoperla* spp., *Chrysopa* spp., and *Hemerobius* sp.), damsel bugs (*Nabis* sp.), lady beetles (*Hippodamia convergens* and *Stethorus picipes*), and minute pirate bug (*Orius tristicolor*).

Organically Acceptable Methods

Oil sprays and naturally occurring predators serve as organically acceptable management tools.

Monitoring and Treatment Decisions

Monitor for brown mite eggs along with other pests when taking the dormant spur sample. See DORMANT SPUR SAMPLE for details and record results on a sampling form (available online). Use dormant sprays with oils at the high rate to help control the overwintering eggs if more than 20% of spurs have mite eggs. An insecticide can be added to control other pests. Miticides may be necessary in some orchards in spring or summer but only when mite populations begin damaging foliage (brown mites can be monitored using beating trays).

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (dilute)</th>
<th>P.H.I.+ (conc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6–8 gal</td>
<td>1.5–2 gal</td>
<td>4</td>
</tr>
</tbody>
</table>

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

DORMANT or DELAYED DORMANT (Preferred timing)

A. DORMANT OIL such as:

| MODE OF ACTION: | Contact including smothering and barrier effect. |

| COMMENTS: | Oil applications at this time to kill overwintering eggs may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products. |

SPRING and SUMMER

A. FENBUTATIN OXIDE* (Vendex) 50WP

| MODE OF ACTION GROUP NUMBER: | 12B |

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
COMMENTS: This material appears to be most effective if applied when temperatures are warm earlier in the season rather than later. Do not apply more than twice a season in not more than 400 gal water/acre. Do not apply more than 3 lb/acre/season.

B. NARROW RANGE OIL# 2% 4% 4 0

MODE OF ACTION: Contact including smothering and barrier effect.

COMMENTS: Oil used alone will only provide partial control; thorough coverage is essential. Always apply oils to well-watered trees and never when trees are stressed by hot (above 90°F), windy, dry (relative humidity lower than 20%) conditions or when such conditions are likely to occur within a few days after application. Additional applications may be needed at 2 week intervals, which may increase the potential for phytotoxicity. Do not apply oil within 2 weeks of captan or sulfur. Not all oil products are organically acceptable; be sure to check individual products.

** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.

* 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.

# Acceptable for use on organically grown produce.
CITRUS CUTWORM (4/09)

Scientific Name: Xylomyges curialis

DESCRIPTION OF THE PEST
Citrus cutworm has only one generation per year. The grayish citrus cutworm moths emerge from early January to the end of April, with peak emergence during March. After mating, female moths lay their round, milky white eggs mainly on the upper side of new leaves in clusters of 40 to 225. After a few days, eggs turn dark in color as larvae develop inside; they hatch in 5 to 10 days. Young larvae are usually light green in the first three instars and pinkish or brown in the fourth and fifth. All but the youngest larvae have a whitish stripe along each side of the body. The skin appears smooth to the naked eye; it does not have conspicuous hairs or tubercles. When disturbed, older larvae curl up and drop to the ground.

Larvae mature in 3 to 6 weeks: the greatest number of larvae are usually found from mid-March to the first of May. Mature larvae drop to the ground and pupate in soil. Pupae remain dormant until the following spring.

DAMAGE
Citrus cutworm move around while feeding, usually taking a few bites from numerous leaves, blossoms, or fruit. Young larvae feed mostly on the edges of tender leaves; older larvae eat holes through leaves and blossoms and into fruit. A smaller number of citrus cutworms cause more damage than larger numbers of other caterpillars because they are larger and move throughout the tree during feeding. Mature fruit are rarely attacked.

MANAGEMENT
Citrus cutworm is primarily a pest of plums in the San Joaquin Valley, but even there it is not a pest in all orchards or every year. Monitor carefully in spring in areas where it has been a problem.

Biological Control
Two parasites attack citrus cutworm larvae and are effective in reducing the next year’s population. Ophion sp., a parasitic wasp, attacks cutworms just before they are ready to mature. The parasitized larva pupates in the soil where it is consumed by the parasite larva. Another parasitic wasp, Banchus sp., also attacks cutworm larvae.

Organically Acceptable Methods
Biological control and sprays of Bacillus thuringiensis or the Entrust formulation of spinosad are organically acceptable management tools.

Monitoring and Treatment Decisions
Monitor orchards weekly from mid-bloom until after petal fall to determine if citrus cutworm is a problem. The most critical period is late bloom to post petal fall when cutworm larvae are attracted to the small developing fruit. If populations appear to be increasing, monitor weekly until the majority of the population has pupated. Either search for larvae or shake foliage vigorously while holding it over a sweep net to monitor this pest.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)</td>
<td>Label rates</td>
<td>—</td>
<td>4</td>
</tr>
</tbody>
</table>

MODE OF ACTION GROUP NUMBER: 11.B2
COMMENTS: Timing is important because of short residual period. Apply only during warm dry weather to control young actively feeding worms. Because larvae hatch over a period of 1–2 months, this material will have to be applied more than once. Good coverage is essential.

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
B. **SPINOSAD**
   (Entrust)#
   
   (Success)  6–8 oz  1.5–2 oz  4  7
   
   **MODE OF ACTION GROUP NUMBER:** 5
   **COMMENTS:** Most effective when applied at petal fall.

C. **PHOSMET**
   (Imidan) 70WP
   
   **MODE OF ACTION GROUP NUMBER:** 1B
   **COMMENTS:**

   **For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.**

   **+ 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 R.E.I. exceeds the P.H.I. The longer of two intervals is the minimum time that must elapse before harvest.**

   **# Acceptable for use on organically grown produce.**

   **— Not recommended or not on label.**

   **Modes of action are important in preventing the development of resistance to pesticides. 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. 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 is assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.**
CODLING MOTH (4/09)

Scientific Name: *Cydia pomonella*

DESCRIPTION OF THE PEST
Larvae are white to pinkish caterpillars with brown to black heads. Adult moths have gray wings with a copper spot on each wing tip. After overwintering as mature larvae in silken cells under loose bark on the tree, moths emerge from March to May. Adults mate and lay eggs; larvae feed on small fruit. A second generation appears in June and often a third one in August, depending on temperatures.

DAMAGE
Fruit feeding by the codling moth has resulted in a high percentage of unmarketable fruit in some orchards. Codling moth larvae usually tunnel all the way to the pits of fruit; extrusions of frass or excrement are often found at the entrance of the larval tunnels.

MANAGEMENT
Codling moth is a pest in plums in the San Joaquin Valley that can be controlled with a single treatment timed using pheromone traps and degree-days.

Biological Control
An important egg and larval parasite is the braconid wasp, *Ascogaster quadridentata*. Natural enemies do help control codling moth but are unable to keep it below economic injury because it spends most of its larval stage inside the fruit, where it is protected from predators and parasites.

Cultural Control
Remove abandoned or unsprayed apple, pear, plum, apricot, and walnut trees near the plum orchard.

Monitoring and Treatment Decisions
Pheromone traps, degree-days (DD), and twilight temperatures are used to monitor codling moth activity. Soon after bud break or by March 15, place pheromone traps in your orchards to determine first moth emergence. See PHEROMONE TRAPS for more details and record results on a sampling form (available online). The first biofix is the first date that moths are consistently found in traps and sunset temperatures have reached 62°F. To predict egg hatch, begin accumulating degree-days (DD) from the biofix, using a lower threshold of 50°F and an upper threshold of 88°F. (For assistance in calculating degree-days, see "Degree-days" on the UC IPM Web site at http://www.ipm.ucdavis.edu.) Remove trapped insects from the trap bottom after you count and record information on the monitoring form that is available in the online version of this guideline.

Population levels of codling moth vary greatly from one area to another and from one variety of plums to another. If codling moth has caused damage in previous years, consider treating for this pest.

First generation egg hatch. Time the first spray for the beginning of egg hatch to kill emerging larvae 250-300 DD after the first biofix.

Second and third generation egg hatch. Use pheromone trap catches to detect an increase in flight activity around 1060 DD from the previous biofix, which signals the start of the next moth flight. If treatment is warranted, a single application is usually sufficient. Make this application when 250 DD have accumulated from the second or third biofix.

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine the needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of the timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>Amount to Use** (dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. METHOXYFENOZIDE (Intrepid) 2F</td>
<td>10–16 fl oz</td>
<td>—</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 18A</td>
<td>COMMENTS: An insect growth regulator that provides 10 to 18 days of residual protection, depending on the rate of application and nut expansion. Kills young larvae but does not kill adult moths. It is a reduced risk insecticide that has little or no effect on beneficial insects and mites. Only use in orchards with low-to-moderate codling moth populations. Spray coverage is extremely important. Do not apply to large trees unless adequate spray coverage can be verified. Use no less than 100 gal water/acre for ground applications. Sprayer speed should not exceed 1.5 mph. The use of Latron B-1956, CS-7, or similar sticker/spreader is highly recommended. Apply at the beginning of egg hatch, which is earlier than organophosphate or carbamate insecticide timings. It is recommended that methoxyfenozide be applied at 200 DD after the first biofix. Do not apply more than 24 fl oz/acre/application or more than 64 fl oz/acre/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. PHOSMET (Imidan) 70WP</td>
<td>4.25 lb</td>
<td>1 lb</td>
<td>3 days</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. CARBARYL* (Sevin) 80S</td>
<td>3 lb</td>
<td>1 lb</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1A</td>
<td>COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.

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

- 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/.

- Not recommended or not on label.
ERIOPHYID MITES (4/09)

Scientific Names: Plum rust mite: *Aculus fockeui*
Big-beaked plum mite: *Diptacus gigantorhynchus*
and others in the genus *Eriophyes*

DESCRIPTION OF THE PESTS

Eriophyid mites are tiny, microscopic mites that have two pairs of legs near the anterior end of the body. They are yellow to pinkish white to purplish in color, and wedge-shaped with the widest part of the body being just behind the head.

DAMAGE

All species feed on leaves. Heavily infested leaves take on a silvery or bronze appearance, depending on the species. Severe infestations can interfere with photosynthesis, but research indicates that populations as high as 120 eriophyid mites per leaf do not impact yield during the year of infestation.

MANAGEMENT

Eriophyid mites are more likely to reach high densities in sprayed orchards where predaceous mites are destroyed.

Biological Control

Light to moderate populations are suppressed by predaceous mites.

Organically Acceptable Methods

Biological control and sulfur sprays are acceptable for use on organically certified produce.

Treatment Decisions

Treatments are only recommended in orchards with chronic infestations or when there is a danger of defoliation.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WETTABLE SULFUR# or SULFUR DUST#</td>
<td>Label rates</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

**MODE OF ACTION: Unknown. An inorganic insecticide.

**COMMENTS: Do not apply within 2 weeks of oil spray.

B. FENBUTATIN OXIDE* (Vendex) 50WP

| 1–2 lb | 0.5 lb | 48 | 14 |

**MODE OF ACTION GROUP NUMBER: 12B

**COMMENTS: Do not apply more than twice a season.

**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.

* 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.

• 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/.

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
**EUROPEAN FRUIT LECANIUM** (4/09)

**Scientific Name:** *Parthenolecanium corni*

**DESCRIPTION OF THE PEST**

European fruit lecanium, also known as the brown apricot scale, occurs throughout the Central Valley but is rarely a problem. The adult female's domed shell is shiny brown, about 0.4 inch in diameter. Eggs are laid in spring and hatch from May to July. The young develop through the remainder of the season and overwinter on twigs and small branches as partly grown crawlers. There is one generation each year.

**DAMAGE**

The chief injury is the production of honeydew that, in large amounts, can damage leaves and fruit. Sooty mold growing in the honeydew can cause blackened areas on leaves and fruit.

**MANAGEMENT**

Biological control is frequently effective; if treatment is needed, oil applied during dormancy or delayed dormancy is the most effective way to reduce populations of this pest and the least disruptive of biological control.

**Biological Control**

Fruit lecanium is frequently kept under control by parasitoids including *Aphytis* spp., *Coccophagus* spp., *Encarsia* spp., and *Metaphycus* spp. and predators including lady beetles and lacewings.

**Organically Acceptable Methods**

Biological control and oil sprays are acceptable in organically managed orchards.

**Monitoring and Treatment Decisions**

To determine if a dormant or delayed dormant treatment is warranted, see DORMANT SPUR SAMPLE. Look for parasitized scale during summer by lifting up scale covers as well as examining the covers for exit holes. If a large number of scales are parasitized, treatment may not be needed. Treatment is required only if 25% or more of spurs are infested with live, healthy scale. Generally oil alone is all that is needed.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> DORMANT OIL such as:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DORMANT FLOWABLE EMULSION</td>
<td>6 gal</td>
<td>1–1.5 gal</td>
<td>4</td>
</tr>
<tr>
<td>NARROW RANGE OIL#</td>
<td>4 gal</td>
<td>1.5 gal</td>
<td>4</td>
</tr>
<tr>
<td><strong>MODE OF ACTION:</strong> Contact including smothering and barrier effect.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Oil alone can control moderate populations of soft scales and is all that is necessary if organophosphates are not required to manage other pests; for instance, if Bt is to be applied at bloom for peach twig borer. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **B.** DORMANT OIL such as: |  |  |  |
| DORMANT FLOWABLE EMULSION | 6 gal | 1.5 gal | 4 | 0 |
| NARROW RANGE OIL | 4 gal | 1 gal | 4 | 0 |
| **MODE OF ACTION:** Contact including smothering and barrier effect. |  |  |  |
| **COMMENTS:** Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. |  |  |  |

**PLUS . . . (optional - add only for very high populations)**

| Diazinon* (Diazinon 50WP) | 3 lb | 1 lb | 24 | 21 |

*The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.*
For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.

* 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.

# Acceptable for use on organically grown produce.

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/.
EUROPEAN RED MITE (4/09)

**Scientific Name:** *Panonychus ulmi*

**DESCRIPTION OF THE PEST**
The European red mite is bright red and has a round body with white spots at the base of hairs on its back. The European red mite overwinters as eggs on twigs and branches; eggs hatch in spring and the young move out to leaves where they feed but do not produce webbing. During summer there are numerous overlapping generations, with eggs being laid on upper and lower surfaces of leaves during summer and on twigs or larger limbs in fall.

**DAMAGE**
European red mites feed by sucking the contents out of leaf cells. Such leaf damage reduces tree vitality and can adversely affect fruit size. Leaf injury caused by European red mite begins as a mottling and browning of leaves. Unless populations are very heavy, European red mite does not cause defoliation.

**MANAGEMENT**
Predators will generally keep European red mite populations at low levels. Allowing low populations in the orchard during spring enables predators populations to increase to levels that are more effective in controlling webspinning mites. Generally, hot weather and predators cause European red mite populations to decline in summer.

**Biological Control**
Several predaceous species feed on European red mite, including lacewings (*Chrysoperla* spp., *Chrysopa* spp., and *Hemerobius* sp.), damsel bugs (*Nabis* sp.), lady beetles (*Hippodamia convergens* and *Stethorus picipes*), and minute pirate bug (*Orius tristicolor*). Western predatory mites, *Metaseiulus (=Galendromus) occidentalis*, also feed on European red mite but are not as effective predators as they are on webspinning mites because of their inability to break through the egg shell of the European red mite.

**Cultural Control**
Minimize the potential for mite problems by reducing dusty conditions in the orchard and by keeping the trees well irrigated.

**Organically Acceptable Methods**
Biological and cultural controls as well as oil sprays are organically acceptable management tools.

**Monitoring and Treatment Decisions**
Monitor for European red mite eggs along with other pests when taking the dormant spur sample. See DORMANT SPUR SAMPLE for details and record results on a sampling form (available online). Use dormant sprays with oils at the high rate to help control the overwintering eggs if 20% or more of spurs have mite eggs. An insecticide can be added to control other pests. Miticides may be necessary in some orchards in spring or summer but only when mite populations begin damaging foliage.

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<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)(dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>6 gal</strong> 1–1.5 gal 4 gal 1.5 gal</td>
<td>4 4 0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

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

**DORMANT or DELAYED DORMANT (Preferred timing)**

A. DORMANT OIL such as:

- DORMANT FLOWABLE EMULSION 6 gal 1–1.5 gal 4 0
- NARROW RANGE OIL# 4 gal 1.5 gal 4 0
- MODE OF ACTION: Contact including smothering and barrier effects.

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products.

**SPRING AND SUMMER**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong></td>
<td><strong>FENBUTATIN OXIDE</strong>*</td>
<td>2 lb</td>
<td>0.5 lb</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>(Vendex) 50WP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong></td>
<td>12B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong></td>
<td>This material appears to be most effective when applied earlier in the season rather than later. Do not apply more than twice a season in not more than 400 gal water/acre.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B.</strong></td>
<td><strong>NARROW RANGE OIL</strong>#</td>
<td>2%</td>
<td>4%</td>
<td>4</td>
</tr>
<tr>
<td><strong>MODE OF ACTION:</strong></td>
<td>Contact including smothering and barrier effects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong></td>
<td>Oil used alone will only provide partial control. Always apply oil to well-watered trees and never when trees are stressed by hot (above 90°F), windy, dry (relative humidity lower than 20%) conditions or when such conditions are likely to occur within a few days after application. Additional applications may be needed at 2 week intervals, which may increase the potential for phytotoxicity. Do not apply oil within 2 weeks of captan. Not all oil products are organically acceptable; be sure to check individual products.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.**

**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.**
FALL CANKERWORM (4/09)
Scientific Name: Alsophila pometaria

DESCRIPTION OF THE PEST
Cankerworm larvae have three pairs of prolegs. They are greenish above, with three narrow, whitish stripes and one yellow stripe along the side of the body; underparts are light green. Cankerworms frequently stand on the posterior pair of prolegs in such a way that they resemble a small twig. Fall cankerworms pass the winter in the egg stage. Fall caterpillars hatch and feed on leaves in spring and summer, then pupate and develop into moths in fall. There is one generation per year.

DAMAGE
The larvae are primarily leaf feeders, tending to skeletonize leaves. Occasionally they feed on young fruit by biting deep holes, which later heal, but leave large scarred depressions similar to the injury caused by green fruitworms.

MANAGEMENT
Insecticide sprays applied for other pests often keep these leaf-eating caterpillars in check.

Cultural Control
On small trees, cut out and destroy infested twigs.

Organically Acceptable Methods
Cultural control and Bacillus thuringiensis (Bt) sprays are acceptable for use on organically certified produce.

Treatment Decisions
Bloom or postbloom treatments of Bacillus thuringiensis will control this pest when larvae are present.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td>(trade name)</td>
<td>(conc.)</td>
<td>(dilute)</td>
<td>(hours)</td>
</tr>
<tr>
<td>Bacillus thuringiensis ssp. Kurstaki#</td>
<td>Label rates</td>
<td>—</td>
<td>4</td>
</tr>
</tbody>
</table>

MODE OF ACTION GROUP NUMBER: 11.B2
COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.

+ 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.
— Not recommended or not on label.
‘ 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/.

When choosing a pesticide, consider information relating to impact on natural enemies and honey bees, impact of timing on beneficials, and environmental impact.
FALL WEBWORM (4/09)

Scientific Name: *Hyphantria cunea*

DESCRIPTION OF THE PEST

Larvae of the fall webworm are pale brown or gray caterpillars with long white hairs arising from black and orange spots. Fall webworms spend the winter as pupae on the tree trunk or ground litter. Moths emerge in late spring and lay eggs on undersides of leaves; eggs hatch in late summer. Larvae feed in webbed colonies on ends of branches. In the lower Sacramento Valley there are two complete generations per year, but in most other sections of the state only one generation occurs.

DAMAGE

From July to September, fall webworm caterpillars are found eating leaves (not veins) and forming silken tents on host trees.

MANAGEMENT

Insecticide sprays applied for other pests often keep these leaf-eating caterpillars in check.

Cultural Control

On small trees, cut out and destroy infested twigs.

Organically Acceptable Methods

Cultural control and *Bacillus thuringiensis* (Bt) sprays are organically acceptable management methods.

Treatment Decisions

If insecticide treatments are required, localized treatments on individual trees applied when evidence of caterpillars is first observed are generally all that is necessary. The addition of a wetting agent to increase penetration of the webbing by the insecticide enhances control.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(conc.)</td>
<td>(dilute)</td>
<td>(hours)</td>
</tr>
<tr>
<td>A. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)</td>
<td>Label rates</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>B. DIAZINON* 50WP 4EC</td>
<td>3 lb 3 pt</td>
<td>1 lb 1 pt</td>
<td>24 24</td>
</tr>
<tr>
<td></td>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: Avoid drift and runoff into surface waters. Where plums are grown near waterways, do not use diazinon.</td>
<td></td>
</tr>
</tbody>
</table>

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

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.

+ 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.

— Not recommended or not on label.

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/.
FRUITTREE LEAFROLLER (4/09)

Scientific Name: *Archips argyrospila*

**DESCRIPTION OF THE PEST**
The fruittree leafroller overwinters in egg masses on scaffold limbs and twigs and emerges in spring as larvae. Larvae are dark green caterpillars with black heads. When disturbed, they wiggle backwards and drop to the ground on a silken thread. Rolled leaves webbed together to form protective nests reveal the presence of leafroller larvae. Adult moths emerge in June or July and deposit overwintering eggs. There is one generation each year.

**DAMAGE**
During bloom, larvae feed on leaves and buds. Later in the season they can feed on the surface of fruit, causing severe damage. Fruit often becomes infected with brown rot at feeding wounds.

**MANAGEMENT**
Delayed dormant treatments and bloom time applications for other pests help keep leafroller populations under control. However, regular monitoring each season is important so that prompt action can be taken if damaging populations develop. In spring, watch for the presence of fruittree leafrollers while monitoring for other pests.

**Biological Control**
A number of general predators, such as lacewing larvae, assassin bugs, and parasites attack fruittree leafroller larvae. These natural enemies help keep fruittree leafroller populations at low, nondamaging levels, but occasional outbreaks occur.

**Organically Acceptable Methods**
Fruittree leafroller can be managed organically with oil sprays during the dormant season followed by bloom treatments of *Bacillus thuringiensis* or the Entrust formulation of spinosad. These treatments are also used to manage other leafrollers, peach twig borer, cankerworms, and green fruitworm.

**Monitoring and Treatment Decisions**
Although a separate treatment for fruittree leafroller control is seldom needed, inspect orchards during the dormant period for unusually large numbers of egg masses. Egg masses are about the size of a thumb-print and laid on smooth wood. Also check flower clusters during bloom for the presence of the fruittree leafroller and other larvae. If damaging populations are observed, a number of environmentally friendly chemicals are effective in controlling this pest, including *Bacillus thuringiensis*, spinosad (Entrust, Success), and methoxyfenozide (Intrepid).

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine the needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.

**DORMANT or DELAYED DORMANT**

A. **DORMANT OIL** such as:
   - **DORMANT FLOWABLE EMULSION**
     - Amount to Use: 6 gal (concentrate), 1.5 gal (dilute)
     - R.E.I.: 4 hours
     - P.H.I.: 0 days
   - **NARROW RANGE OIL**
     - Amount to Use: 4 gal (concentrate), 1 gal (dilute)
     - R.E.I.: 4 hours
     - P.H.I.: 0 days

   **MODE OF ACTION:** Contact including smothering and barrier effects.

   **COMMENTS:** Oil used alone will only provide partial control. Best when followed by an application of *Bacillus thuringiensis* or other environmentally sound insecticides at bloom. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products.

**BLOOM**

A. **BACILLUS THURINGIENSIS spp. KURSTAKI**
   - Common name: *Bacillus thuringiensis* spp. Kurstaki
   - Label rates:
     - Amount to Use: 1.71–2.5 oz (conc.), 0.43–0.6 oz (dilute)
     - R.E.I.: 4 hours
     - P.H.I.: 7 days

   **MODE OF ACTION GROUP NUMBER:** 11.B2

   **COMMENTS:** Make two applications during bloom: the first between popcorn and the beginning of bloom and the second 7–10 days later, but no later than petal fall. Compatible with fungicide sprays, and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80–100 gal water maximum) is preferred. If aerial applications must be made because conditions do not permit ground application, a concentrate rate (5 gal or less) is preferred. Fly material on at a height of about 20 ft over the canopy using appropriate nozzles to allow better deposition on the tree tops.

B. **SPINOSAD**
   - Common name: Spinosad
   - Mode of Action Group Number: 5
   - Label rates:
     - Amount to Use: 1.71–2.5 oz (conc.), 0.43–0.6 oz (dilute)
     - R.E.I.: 4 hours
     - P.H.I.: 7 days

   **MODE OF ACTION GROUP NUMBER:** 5

   **COMMENTS:** Most effective when applied at petal fall; apply only during late evening, night, or early morning to avoid injury to honey bees.

C. **METHOXYFENOZIDE**
   - Common name: Methoxyfenozide
   - Mode of Action Group Number: 18A
   - Label rates:
     - Amount to Use: 8–16 oz (conc.), 2–4 oz (dilute)
     - R.E.I.: 4 hours
     - P.H.I.: 7 days

   **MODE OF ACTION GROUP NUMBER:** 18A

   **COMMENTS:** Apply at petal fall. Use allowed under a supplemental label. Do not apply more than 16 fl oz/acre/application or 64 fl oz/acre/season.

D. **DIFLUBENZURON**
   - Common name: Diflubenzuron
   - Mode of Action Group Number: 15
   - Label rates:
     - Amount to Use: 12 oz (conc.), 3 oz (dilute)
     - R.E.I.: 12 hours
     - P.H.I.: 0 days

   **MODE OF ACTION GROUP NUMBER:** 15

   **COMMENTS:** Include vegetable oil at the rate of 1 qt/acre. Do not apply after petal fall. Do not exceed 2 applications in any given season. Allow 21 days between applications.

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**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.**

**+** 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.

**—** Not recommended or not on label.

**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/.
GREEN FRUITWORMS (4/09)

Scientific Names: Orthosia hibisci, Amphipyra pyramoides, and others.

DESCRIPTION OF THE PESTS
Green fruitworms include several species of caterpillars, all of which are pale green, often with whitish stripes down each side of the body and a narrow stripe down the middle of the back. Most species pass the winter as pupae or adults, and have one generation each year.

DAMAGE
Green fruitworms eat large holes in young leaves and fruit during late bloom and petal fall causing fruit to be scarred and misshapen as they grow.

MANAGEMENT
Dormant treatments and bloomtime applications for other pests help keep fruitworm populations under control. However, regular monitoring each season is important so that prompt action can be taken if damaging populations develop.

Biological Control
Certain parasitic wasps (Apanteles, Eulophus, Meteorus, and Ophion spp.) help keep green fruitworm populations under control.

Organically Acceptable Methods
Biological control and Bacillus thuringiensis sprays and sprays of the Entrust formulation of spinosad are organically acceptable methods of controlling these pests.

Monitoring and Treatment Decisions
If treatment is necessary, treat at late bloom to petal fall when larvae are present. A treatment threshold of 1 worm per 100 fruit clusters per 20-acre block or 1 worm per 50 beat-tray samples has been developed for pears and probably is applicable to stone fruits. Bacillus thuringiensis formulations are safe to use during bloom and are effective on small larvae. If you use other materials, make applications during or shortly after petal fall. Spot-treat localized infestations. Continue to monitor for the pest after treatment. If no more young larvae are found, no more control actions are necessary for the season.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillus thuringiensis ssp. Kurstaki# (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies. Make 2 applications during bloom: the first between popcorn and the beginning of bloom and the second 7–10 days later, but no later than petal fall. Compatible with fungicide sprays, and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80–100 gal water maximum) is preferred. If aerial applications must be made because conditions do not permit ground application, a concentrate rate (5 gal or less) is preferred. Fly material on at a height of about 20 feet over the canopy using appropriate nozzles to allow better deposition on the tree tops.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinosad (Entrust)#</td>
<td>1.71–2.5 oz 0.43–0.6 oz</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>SUCCESS</td>
<td>6–8 oz 1.5–2 oz</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>COMMENTS: Most effective when applied at petal fall; apply only during late evening, night, or early morning to avoid injury to honey bees. To avoid development of insect resistance, do not treat successive generations of the same pest with the same product.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.
** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.

+ 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.

— Not recommended or not on label.

| 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/; |
ITALIAN PEAR SCALE (4/09)

Scientific Name: Epidiaspis leperi

DESCRIPTION OF THE PEST
Italian pear scale covering is circular, shiny light gray, and has a brown exuvia slightly off center. The body under the scale covering is dark reddish purple. The scale is often found under moss and lichen on old plum trees; it is usually not a problem.

DAMAGE
This scale inflicts its sucking damage on the wood of the tree resulting in reduced tree vigor.

MANAGEMENT
Light populations of Italian pear scale do not harm trees; damaging infestations are rare in California.

Organically Acceptable Methods
Bordeaux treatments, oil sprays, or oil and lime sprays used during the dormant season on organically certified produce.

Treatment Decisions
Insecticide and oil sprays often have little effect on this scale because a large number of them overwinter in the adult stage and are concealed in the tree’s moss and lichens. If treatment is necessary, treat during the dormant and delayed dormant period for most effective control. Registered copper and lime sulfur sprays directed at moss and lichens on the tree bark will aid in control of this scale.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BUREAU</strong># 10-10-100 or FIXED COPPER#</td>
<td>Label rates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M1)</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: These materials control the growth of lichens, which provide protection to the scale. The removal of the lichens will aid in the control of the scale. This is a slow procedure requiring 1 or more years to be effective. Although the lichens are killed quickly, considerable weathering must occur before they are removed. Thorough coverage including trunks and limbs is essential. Not all copper compounds are approved for use in organic production; be sure to check individual products. For information on making Bordeaux mixtures, see UC IPM Pest Note: Bordeaux Mixture, ANR Publication 7481 (available online).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. DORMANT OIL such as:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DORMANT FLOWABLE EMULSION</td>
<td>6 gal</td>
<td>1.5 gal</td>
<td>4</td>
</tr>
<tr>
<td>NARROW RANGE OIL#</td>
<td>4 gal</td>
<td>1 gal</td>
<td>4</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): A contact fungicide with smothering and barrier effects. COMMENTS: Oil used alone will only provide partial control. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products. ** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows. + 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. # Acceptable for use on organically grown produce.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
KATYDIDS (4/09)

**Scientific Names:** Angularwinged katydid: *Microcentrum retinerve*
Forktailed bush katydid: *Scudderia furcata*

**DESCRIPTION OF THE PESTS**

Of the two species of katydids found in California stone fruit orchards, the forktailed katydid occurs most frequently. Angularwinged katydid nymphs and adults have a distinct humpbacked appearance. The forktailed bush katydid is smaller and is not humpbacked. Nymphs of both species have very long antennae that are banded black and white.

Katydid lay disc-shaped eggs in fall. The eggs of the angularwinged katydid are 0.125 to 0.15 inch long (3–6 mm), gray, and laid in two overlapping rows that form a long "tent" on the surface of twigs and branches. Forktailed bush katydid eggs are about 0.125 inch long (3 mm) and are inserted into the edges of leaves. Eggs of both species hatch in April and May. Adult katydids appear in midsummer and lay eggs in fall.

The angularwinged katydid emerges in May and has only one generation a year. Forktailed bush katydids emerge about a month earlier than the angularwinged species. Eggs are laid in June and July. Some of these eggs will hatch in July and August, whereas the rest will overwinter.

**DAMAGE**

Katydid occasionally become damaging pests in orchards that have not been treated with broad-spectrum pesticides. High populations of these pests also occur in cycles, and they may cause damage one year and not the next.

Nymphs feed on leaves or fruit. Katydid nymphs tend to take one bite out of a fruit before moving on to another feeding site. Hence, a few katydids may damage a large number of fruit in a short time. Feeding wounds heal over and enlarge into corky patches as the fruit expands. The most serious damage occurs when katydids feed on young fruit, which become severely distorted as they develop. Nymphs and adults also chew holes in foliage. Smaller nymphs feed in the middle of the leaf, creating small holes, whereas larger nymphs and adults feed on the leaf edge. Damage to fruit and foliage resembles that of green fruitworms.

**MANAGEMENT**

Look for katydid damage when monitoring for leafrollers in spring. From April to May, examine shoots in the center of the tree for feeding damage. Early in the season when katydids are small, they create small holes in the center of the leaf, whereas cutworms and other leaf feeders will be feeding on the leaf edge. If you find feeding damage, look for nymphs. Shaking foliage onto large beating sheets may be helpful; nymphs can be difficult to see on the tree because they jump readily when disturbed.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. SPINOSAD</strong> (Entrust)#</td>
<td>1.75–2 oz</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>(Success) 6 oz</td>
<td></td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Apply to young nymphs (1st and 2nd instars).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. AZADIRACHTIN#</strong> (Neemix) 4.5</td>
<td>0.25–1 pt</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

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

Katydids (4/09) 32
Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
MODE OF ACTION GROUP NUMBER: 18B
COMMENTS: Moderately effective on immature katydids. Must be contacted by spray so good coverage is essential.

C. PHOSMET
   (Imidan) 70WP
   4.25 lb
   3 days
   7
   MODE OF ACTION GROUP NUMBER: 1B
   COMMENTS: Effective against nymphs and adults. Apply with a buffer to lower solution pH to 5.0.

D. ESFENVALERATE*
   (Asana XL)
   10-12 fl oz
   12
   14
   MODE OF ACTION GROUP NUMBER: 3
   COMMENTS: Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations.

+ 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.

* 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/.

* Permit required from county agricultural commissioner for purchase or use.
LEAF CURL PLUM APHID (4/09)

Scientific Name: Brachycaudus helichrysi

DESCRIPTION OF THE PEST (View aphid identification photos online)
The leaf curl plum aphid is often found inside curled leaves. It is shiny and varies considerably in color from green to brownish green or brownish yellow. This aphid overwinters in the egg stage near the base of buds. In spring it rapidly builds populations on new foliage, causing affected spurs to develop tightly curled leaves. In May, the aphids migrate from the orchard to summer host plants in the family Asteraceae.

DAMAGE
Colonies of this pest cause leaves to curl tightly. Often only one limb or a portion of a limb is infested early in the year. Large amounts of honeydew are secreted by this aphid. Tree growth and fruit sugar content can both be reduced by populations of this aphid.

MANAGEMENT
Several natural enemies are important in the control of aphids in the orchard, but aphid populations often require treatment. The best indicator of populations is orchard history. The best time to treat is during the dormant or delayed dormant period. If aphids are a chronic problem in the orchard, apply a treatment early in dormancy; otherwise, sample during dormancy to determine the need to treat as described below. Spring treatments may also be made. After harvest, a zinc sulfate application will provide zinc to the trees as well as hasten leaf fall. Without the leaves on the tree, the aphid life cycle is disrupted. Zinc sulfate (36%) applied at 10-20 lb/acre can be applied in early to mid-October to help in this process.

Biological Control
There are many natural enemies that feed on leaf curl plum aphid; however, fruit size may still be reduced and curled leaves will not uncurl after aphids are suppressed. The recent introductions of Aphidius colemani has led to substantial levels of parasitism of this aphid. Important predators include: lady beetles, green lacewings, brown lacewings, syrphid flies, and soldier beetles.

Organically Acceptable Methods
Biological control and sprays of narrow range oil or neem oil are organically acceptable methods of controlling this pest.

Monitoring and Treatment Decisions
If aphids are a chronic problem, a treatment in late fall/early dormancy (November 1) is a very effective way to manage these pests and is less likely to create water quality problems caused by pesticide runoff than treatments applied during the rainier season in January and February. If leaves are still on trees at this time, aphids and parasites can be present. Oil treatments are not recommended at this time because they are very damaging to parasite populations and not effective for aphid control.

Dormant monitoring. If the November 1 treatment is not applied, be sure to monitor during dormancy. (For more information, see DORMANT SPUR SAMPLE.) If dormant monitoring indicates treatment is necessary, two applications of oil at bloom can be used in orchards where a dormant/delayed dormant treatment is not required to manage scale problem. Parasites are not active at bloom, and they are not affected by the bloom oil sprays.

Spring monitoring. If aphids have been a problem in the past or if a dormant or delayed dormant application was not applied, monitor leaf curl plum aphid in spring along with mealy plum aphid. Follow the monitoring guidelines in SPRING/SUMMER MONITORING to determine if treatment is necessary.
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of the timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.

**DORMANT**

A. **PHOSMET**  
   (Imidan) 70W  
   2.12 lb  
   1 lb  
   3 days  
   7  
   MODE OF ACTION GROUP NUMBER: 1B  
   COMMENTS: Apply with a buffer to lower solution pH to 5.0. Apply as early as November 1st even though all leaves may not be off trees. Has fewer impacts on beneficials and water quality than other materials listed. This low-label rate and early timing provide effective control and reduce the risk of runoff into waterways, mitigating concerns of surface water pollution. Early applications may not be effective for peach twig borer and are not effective for San Jose scale control.

B. **DIAZINON** 50WP  
   1 lb  
   0.5 lb  
   24  
   21  
   MODE OF ACTION GROUP NUMBER: 1B  
   COMMENTS: Apply as early as November 1st even though all leaves may not be off trees. This low-label rate and early timing provide effective control and reduce the risk of runoff into waterways, mitigating concerns of surface water pollution. Early applications may not be effective for peach twig borer and are not effective for San Jose scale control.

C. **ESFENVALERATE**  
   (Asana XL)  
   3 oz  
   1.5 oz  
   12  
   14  
   MODE OF ACTION GROUP NUMBER: 3  
   COMMENTS: Apply as early as November 1st even though all leaves may not be off trees. This lower-than-label rate and early timing provide effective control and reduce the risk of runoff into waterways, mitigating concerns of surface water pollution. Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations. Lower rates and/or early timing may not be effective for peach twig borer and are not effective for San Jose scale control.

**DELAYED DORMANT**

A. **THIAMETHOXAM**  
   (Actara)  
   3–4 oz  
   0.75–1 oz  
   12  
   14  
   MODE OF ACTION GROUP NUMBER: 4A  
   COMMENTS: Direct treatment or residues on blooming crops and weeds are highly toxic to bees. Remove (mow, disc, etc.) blooming ground cover before treatment. Apply prebloom or postbloom but not from swollen bud to petal fall. Do not apply less than 2 oz or more than 5.5 oz/acre/application or exceed 8 oz/acre/season. This chemical is listed on the EPA reduced risk to the environment. Repeat applications of any neonicotinoid insecticide (imidacloprid- Provado; thiamethoxam – Actara) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

B. **PHOSMET**  
   (Imidan) 70W  
   2.12 lb  
   1 lb  
   3 days  
   7  
   MODE OF ACTION GROUP NUMBER: 1B  
   COMMENTS: Apply with a buffer to lower solution pH to 5.0.

C. **IMIDACLOPRID**  
   (Provado) 1.6F  
   4–8 fl oz  
   2 fl oz  
   12  
   7  
   MODE OF ACTION GROUP NUMBER: 4A  
   COMMENTS: Repeat applications of any neonicotinoid insecticide (imidacloprid – Provado; thiamethoxam – Actara) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.
Leaf Curl Plum Aphid

Common name (trade name) | Amount to Use** (conc.) | R.E.I.+ (hours) | P.H.I.+ (days)  
--- | --- | --- | ---  

D. ESFENVALERATE* (Asana XL)  
MODE OF ACTION GROUP NUMBER: 3  
COMMENTS: Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations. Lower rates may not be effective for peach twig borer or San Jose scale control.

E. LAMBDA CYHALOTHRIN* (Warrior)  
MODE OF ACTION GROUP NUMBER: 3  
COMMENTS: Residues remaining on leaves and bark may continue to affect mite predators long after application, increasing potential for spider mite infestations.

BLOOM  
A. NARROW RANGE OIL#  
MODE OF ACTION: Contact including smothering and barrier effect.  
COMMENTS: Apply in 100 gal water/acre. Oil must contact aphids to provide control; if aphids are sheltered in curled leaves, oil alone will not control them. Apply at green tip or popcorn to kill the hatching aphids (hatch generally occurs in early March). May be tank mixed with bloom time treatments aimed at peach twig borer and brown rot. Make a second application 10 days later. This usually coincides with full bloom in most years. Plum trees tolerate oil treatments better in spring than during full dormancy. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment.

B. ENDOSULFAN* (Thionex) 50WP  
MODE OF ACTION GROUP NUMBER: 2A  
COMMENTS: Label says use 1 lb/100 gallons water or 4-5 lb/acre. Cannot be applied in any situations where runoff may occur.

SPRING  
A. DIAZINON* 50WP  
MODE OF ACTION GROUP NUMBER: 1B  
COMMENTS: Avoid drift and runoff into surface waters. Where plums are grown near waterways, do not use diazinon.

B. NARROW RANGE OIL#  
MODE OF ACTION: Contact including smothering and barrier effect.  
COMMENTS: Apply in 200 gal water/acre. Oil must contact aphids to provide control; if aphids are sheltered in curled leaves, oil alone will not control them. Harmful to parasitic wasps. Plum trees tolerate oil treatments better in spring than during full dormancy. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment.

C. NEEM OIL# (Trilogy) 70EC  
MODE OF ACTION: Unknown. A botanical insecticide.  
COMMENTS: Repeat applications may be necessary.

D. THIAMETHOXAM (Actara)  
MODE OF ACTION GROUP NUMBER: 4A  
COMMENTS: Direct treatment or residues on blooming crops and weeds are highly toxic to bees. Remove (mow, disc, etc.) blooming ground cover before treatment. Apply prebloom or postbloom but not from swollen bud to petal fall. May cause mite outbreaks. Do not apply less than 2 oz or more than 5.5 oz/acre/application or exceed 8 oz/acre/season. Repeat applications of any neonicotinoid insecticide (imidacloprid- Provado; thiamethoxam - Actara) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.
### Leaf Curl Plum Aphid

Common name | Amount to Use** | R.E.I.+ | P.H.I.+ |
--- | --- | --- | --- |
E. IMIDACLOPRID (Provado) 1.6F | 4–8 fl oz | 12 | 7 |
   | 2 fl oz | | |
**MODE OF ACTION GROUP NUMBER: 4A**
COMMENTS: Repeat applications of *any* neonicotinoid insecticide (imidacloprid- Provado; thiamethoxam – Actara) can lead to resistance to *all* neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

### SUMMER

**A. NEEM OIL#**
   (Trilogy) 70EC | 2% | — | 12 | 0 |
   **MODE OF ACTION: Unknown. A botanical insecticide.**
   **COMMENTS: Repeat applications may be necessary. Oil is harmful to parasitic wasps.**

**B. NARROW RANGE OIL#**
   | 6–8 gal | — | 4 | 0 |
   **MODE OF ACTION: Contact including smothering and barrier effects.**
   **COMMENTS: Apply in 200 gal water/acre. Oil must contact aphids to provide control; if aphids are sheltered in curled leaves, oil alone will not control them. Oil is harmful to parasitic wasps. Use a minimum of 6 to 8 gal of oil in 200 gal water. Good coverage (slow tractor speed) is essential for best results. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment or when temperatures are expected to exceed 95°F.**

**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.**

**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.**

**Not recommended or not on label.**

**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/ .**
MEALY PLUM APHID (4/09)

Scientific Name: *Hyalopterus pruni*

DESCRIPTION OF THE PEST *(View aphid identification photos online)*

Wingless mealy plum aphid adults are pale green or whitish green with three dark green longitudinal stripes on their backs. Their bodies are covered with a white mealy wax. The winged form has a dark thorax and transverse bands on the abdomen. Mealy plum aphids are often found inside the slightly curled-up plum leaves. After overwintering in the egg stage near the bases of buds, the aphids hatch during bloom and develop into wingless adults. They will have from three to thirteen generations on plums. Then winged adults appear in June and July as warm weather approaches and they migrate to reed grass or cattails. Wingless aphids that remain on vigorous growth of plum trees throughout the summer will not be capable of laying overwintering eggs in fall. Only the offspring of the winged adults that return to plum trees in fall lay the overwintering eggs.

DAMAGE

This aphid builds up in large numbers on the undersurface of leaves in spring and causes leaves to become slightly curled and stunted. High populations can devitalize the tree, retard growth, and reduce sugar content of fruit. Honeydew dropping on fruit can cause fruit cracking.

MANAGEMENT

Several natural enemies are important in the control of aphids in the orchard, but aphid populations often require treatment. The best indicator of populations is orchard history. The best time to treat is during the dormant or delayed dormant period. If aphids are a chronic problem in the orchard, apply a treatment early in dormancy; otherwise, sample during dormancy to determine the need to treat as described below. Spring treatments may also be made. After harvest, a zinc sulfate application will provide zinc to the trees as well as hasten leaf fall. Without the leaves on the tree, the aphid life cycle is disrupted. Zinc sulfate (36%) applied at 10-20 lb/acre can be applied in early to mid-October to help in this process.

Biological Control

There are many natural enemies that feed on leaf curl plum aphid; however, fruit size may still be reduced and curled leaves will not uncurl after aphids are suppressed. The recent introductions of *Aphidius transcaspicus* has led to substantial levels of parasitism of this aphid. Important predators include: lady beetles, green lacewings, brown lacewings, syrphid flies, and soldier beetles.

Organically Acceptable Methods

Biological control and sprays of narrow range oil or neem oil are organically acceptable methods of controlling this pest.

Monitoring and Treatment Decisions

If aphids are a chronic problem, a treatment in late fall/early dormancy (November 1) is a very effective way to manage these pests and is less likely to create water quality problems caused by pesticide runoff than treatments applied during the rainier season in January and February. If leaves are still on trees at this time, aphids and parasites can be present. Oil treatments are not recommended at this time because they are very damaging to parasite populations and not effective for aphid control.

Dormant monitoring. If the November 1 treatment is not applied, be sure to monitor during dormancy. (For more information, see DORMANT SPUR SAMPLE.) If dormant monitoring indicates treatment is necessary, two applications of oil at bloom can be used in orchards where a dormant/delayed dormant treatment is not required to manage scale problem. Parasites are not active at bloom, and they are not affected by the bloom oil sprays.

Spring monitoring. If aphids have been a problem in the past or if a dormant or delayed dormant application was not applied, monitor leaf curl plum aphid in spring along with mealy plum aphid. Follow the monitoring guidelines in SPRING/SUMMER MONITORING to determine if treatment is necessary.
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of the timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.

**DORMANT**

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(conc.)</td>
<td>(dilute) (hours)</td>
<td>(days)</td>
</tr>
</tbody>
</table>

A. **PHOSMET** (Imidan) 70W  
   MODE OF ACTION GROUP NUMBER: 1B  
   COMMENTS: Apply with a buffer to lower solution pH to 5.0. Apply as early as November 1st even though all leaves may not be off trees. Has fewer impacts on beneficials and water quality than other materials listed. This low-label rate and early timing provide effective control and reduce the risk of runoff into waterways, mitigating concerns of surface water pollution. Early applications may not be effective for peach twig borer and are not effective for San Jose scale control.

B. **DIAZINON* 50WP**  
   4EC  
   MODE OF ACTION GROUP NUMBER: 1B  
   COMMENTS: Apply as early as November 1st even though all leaves may not be off trees. This low-label rate and early timing provide effective control and reduce the risk of runoff into waterways, mitigating concerns of surface water pollution. Early applications may not be effective for peach twig borer and are not effective for San Jose scale control.

C. **ESFENVALERATE*** (Asana XL)  
   MODE OF ACTION GROUP NUMBER: 3  
   COMMENTS: Apply as early as November 1st even though all leaves may not be off trees. This lower-than-label rate and early timing provide effective control and reduce the risk of runoff into waterways. Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations. Lower rates and/or early timing may not be effective for peach twig borer and are not effective for San Jose scale control.

**DELAYED DORMANT**

A. **THIAMETHOXAM** (Actara)  
   MODE OF ACTION GROUP NUMBER: 4A  
   COMMENTS: Direct treatment or residues on blooming crops and weeds are highly toxic to bees. Remove (mow, disc, etc.) blooming ground cover before treatment. Apply prebloom or postbloom but not from swollen bud to petal fall. Do not apply less than 2 oz or more than 5.5 oz/acre/application or exceed 8 oz/acre/season. This chemical is listed on the EPA reduced risk to the environment. Repeat applications of any neonicotinoid insecticide (imidacloprid - Provado; thiamethoxam - Actara) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

B. **PHOSMET** (Imidan) 70W  
   MODE OF ACTION GROUP NUMBER: 1B  
   COMMENTS: Apply with a buffer to lower solution pH to 5.0.

C. **IMIDACLOPRID** (Provado) 1.6F  
   MODE OF ACTION GROUP NUMBER: 4A  
   COMMENTS: Repeat applications of any neonicotinoid insecticide (imidacloprid – Provado; thiamethoxam – Actara) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.
### Mealy Plum Aphid

**Common name** (trade name) | **Amount to Use** | **R.E.I.+** | **P.H.I.+**
---|---|---|---
**D. ESFENVALERATE*** (Asana XL) | 3 oz 1.5 oz | 12 14 | 14 14
**MODE OF ACTION GROUP NUMBER**: 3
**COMMENTS**: Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations. Lower rates may not be effective for peach twig borer or San Jose scale control.

**E. LAMBDA CYHALOTHRIN*** (Warrior) | 2.56–5.12 fl oz 0.64–1.28 fl oz | 24 14 | 14 14
**MODE OF ACTION GROUP NUMBER**: 3
**COMMENTS**: Residues remaining on leaves and bark may continue to affect mite predators long after application, increasing potential for spider mite infestations.

---

**BLOOM**

**A. NARROW RANGE OIL#** | 4 gal — | 4 0 | 0
**MODE OF ACTION**: Contact including smothering and barrier effects.
**COMMENTS**: Apply in 100 gal water/acre. Oil must contact aphids to provide control; if aphids are sheltered in curled leaves, oil alone will not control them. Apply at green tip or popcorn to kill the hatching aphids (hatch generally occurs in early March). May be tank mixed with bloom time treatments aimed at peach twig borer and brown rot. Make a second application 10 days later. This usually coincides with full bloom in most years. Plum trees tolerate oil treatments better in spring than during full dormancy. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment.

**B. ENDOSULFAN*** (Thionex) 50WP | See comments | 4 7 | 7
**MODE OF ACTION GROUP NUMBER**: 2A
**COMMENTS**: Label says use 1 lb/100 gallons water or 4-5 lb/acre. Cannot be applied in any situations where runoff may occur.

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**SPRING**

**A. DIAZINON*** 50WP 4EC | 1.5–3 lb 1 lb | 24 21 | 21 21
**MODE OF ACTION GROUP NUMBER**: 1B
**COMMENTS**: Avoid drift and runoff into surface waters. Where plums are grown near waterways, do not use diazinon.

**B. NARROW RANGE OIL#** | 6–8 gal — | 4 0 | 0
**MODE OF ACTION**: Contact including smothering and barrier effects.
**COMMENTS**: Apply in 200 gal water/acre. Oil must contact aphids to provide control; if aphids are sheltered in curled leaves, oil alone will not control them. Harmful to parasitic wasps. Plum trees tolerate oil treatments better in spring than during full dormancy. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment.

**C. NEEM OIL#** (Trilogy) 70EC | 2% — | 12 0 | 0
**MODE OF ACTION**: Unknown. A botanical insecticide.
**COMMENTS**: Repeat applications may be necessary.

**D. THIAMETHOXAM** (Actara) | 3–4 oz 0.75–1 oz | 12 14 | 14 14
**MODE OF ACTION GROUP NUMBER**: 4A
**COMMENTS**: Direct treatment or residues on blooming crops and weeds are highly toxic to bees. Remove (mow, disc, etc.) blooming ground cover before treatment. Apply prebloom or postbloom but not from swollen bud to petal fall. May cause mite outbreaks. Do not apply less than 2 oz or more than 5.5 oz/acre/application or exceed 8 oz/acre/season. Repeat applications of any neonicotinoid insecticide (imidacloprid- Provado; thiamethoxam - Actara) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

---

Illustrated version at [http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html](http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html)
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E. IMIDACLOPRID</strong>&lt;br&gt;(Provado) 1.6F</td>
<td>4–8 fl oz 2 fl oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 4A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Repeat applications of <em>any</em> neonicotinoid insecticide (imidacloprid- Provado; thiamethoxam - Actara) can lead to resistance to <em>all</em> neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUMMER**

A. **NEEM OIL#**<br>(Trilogy) 70EC | 2% | — | 12 | 0 |
| **MODE OF ACTION:** Contact including smothering and barrier effects. | | | |
| **COMMENTS:** Repeat applications may be necessary. Oil is harmful to parasitic wasps. | | | |

B. **NARROW RANGE OIL#**<br>6–8 gal | — | 4 | 0 |
| **MODE OF ACTION:** Contact including smothering and barrier effects. | | | |
| **COMMENTS:** Apply in 200 gal water/acre. Oil must contact aphids to provide control; if aphids are sheltered in curled leaves, oil alone will not control them. Oil is harmful to parasitic wasps. Use a minimum of 6 to 8 gal of oil in 200 gal water. Good coverage (slow tractor speed) is essential for best results. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment or when temperatures are expected to exceed 95°F. | | | |

**For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.**

**+ 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.**

**— Not recommended or not on label.**

**\* 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/.**
OBLIQUEBANDED LEAFROLLER (4/09)

Scientific Name: *Choristoneura rosaceana*

**DESCRIPTION OF THE PEST**

Larvae of the obliquebanded leafroller are yellowish green caterpillars. When disturbed, they wiggle backwards and drop to the ground on a silken thread. Rolled leaves webbed together to form protective nests reveal the presence of leafroller larvae. Adult moths have dark brown bands running at oblique angles across their wings. Obliquebanded leafroller overwinters as larvae under the bud scales of twigs; there are two to three generations each year in the Central Valley.

**DAMAGE**

On plums, larvae feed on leaves and buds during bloom and also on the surface of fruit in midsummer. In some cases they cause severe damage as well as contamination with their excrement.

**MANAGEMENT**

Delayed dormant treatments and bloom time applications for other pests help keep leafroller populations under control. However, regular monitoring each season is important so that prompt action can be taken if damaging populations develop. Throughout the season watch for the presence of leafrollers while monitoring for other pests. This is especially important in orchards where bloom time Bt sprays and pheromone confusion are used to control peach twig borer and oriental fruit moth.

**Biological Control**

Parasites of obliquebanded leafroller include *Macrocentrus iridescens* and *Glypta variegata*.

**Organically Acceptable Methods**

Dormant oil spray followed by bloom sprays of *Bacillus thuringiensis* or sprays of the Entrust formulation of spinosad can be used to control this pest on organically certified crops.

**Monitoring and Treatment Decisions**

Check the orchard in early spring (March-April) for the presence of larvae and feeding damage. The best timing for control of overwintering larvae is at full bloom or early petal fall.

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine the needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.) (dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>

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

**DELAYED DORMANT**

A  DORMANT OIL such as:

- **DORMANT FLOWABLE EMULSION** 6 gal 1.5 gal 4 0
- **NARROW RANGE OIL#** 4 gal 1 gal 4 0

**MODE OF ACTION:** Contact including smothering and barrier effects.

**COMMENTS:** Oil used alone will only provide partial control. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products.

B  DORMANT OIL such as:

- **DORMANT FLOWABLE EMULSION** 6 gal 1.5 gal 4 0
NARROW RANGE OIL
4 gal 1 gal 4 0

MODE OF ACTION: Contact including smothering and barrier effects.

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil.

PHOSMET
(Imidan) 70WP
4.25 lb 1 lb 3 days 7

MODE OF ACTION GROUP NUMBER: 1B

DIFFLBENZURON*
(Dimilin) 2L
12 oz 3 oz 12 0

MODE OF ACTION GROUP NUMBER: 15

COMMENTS: Include vegetable oil at the rate of 1 qt/acre. Do not apply after petal fall. Do not exceed 2 applications in any given season. Allow 21 days between applications.

SPINOSAD
(Entrust)#
1.71–2.5 oz 0.43–0.6 oz 12 7

METHOXYFENOZIDE
(Intrepid) 2F
8–16 oz 2–4 oz 4 7

MODE OF ACTION GROUP NUMBER: 18A

COMMENTS: Apply at petal fall. Use allowed under a supplemental label. Do not apply more than 16 fl oz/acre/application or 64 fl oz/acre/season.

ESFENVALERATE*
(Asana XL)
4–6 oz 0.5 oz 12 14

MODE OF ACTION GROUP NUMBER: 3

COMMENTS: Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations.

BLOOM

BACILLUS THURINGIENSIS ssp. KURSTAKI#

Label rates
4 0

MODE OF ACTION GROUP NUMBER: 11.B2
COMMENTS: Make two applications during bloom: the first between popcorn and the beginning of bloom and the second 7–10 days later, but no later than petal fall. Compatible with fungicide sprays, and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80–100 gal water maximum) is preferred. If aerial applications must be made because conditions do not permit ground application, a concentrate rate (5 gal or less) is preferred. Fly material on at a height of about 20 ft over the canopy using appropriate nozzles to allow better deposition on the tree tops.

SPINOSAD
(Entrust)#
1.71–2.5 oz 0.43–0.6 oz 4 7

METHOXYFENOZIDE
(Intrepid) 2F
8–16 oz 2–4 oz 4 7

MODE OF ACTION GROUP NUMBER: 18A

COMMENTS: Apply at petal fall. Use allowed under a supplemental label. Do not apply more than 16 fl oz/acre/application or 64 fl oz/acre/season.
**Obliquebanded Leafroller**

Illustrated version at [http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html](http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html)

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Rate</th>
<th>Modes of Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimilin 2L</td>
<td>12 oz</td>
<td>3 oz</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 15</td>
<td><strong>COMMENTS:</strong> Include vegetable oil at the rate of 1 qt./acre. Do not apply after petal fall. Do not exceed 2 applications in any given season. Allow 21 days between applications.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PETAL FALL and AFTER**

**A. SPINOSAD**

- (Entrust) # 1.71–2.5 oz 0.43–0.6 oz 4 7
- (Success) 6–8 oz 1.5–2 oz 4 7

**MODE OF ACTION GROUP NUMBER:** 5

**COMMENTS:** Do not apply more than 29 oz/acre/year of Success or 9 oz/acre/year of Entrust. Most effective when applied at petal fall. This product is toxic to bees for 3 hours following treatment; apply in late evening after bees have stopped foraging.

**B. METHOXYFENOZIDE**

- (Intrepid) 2F 8–16 oz 2–4 oz 4 7

**MODE OF ACTION GROUP NUMBER:** 18A

**COMMENTS:** Use allowed under a supplemental label. Do not apply more than 16 fl oz/acre/application or 64 fl oz/acre/season.

**C. BACILLUS THURINGIENSIS ssp. KURSTAKI**

- (various products) Label rates — 4 0

**MODE OF ACTION GROUP NUMBER:** 11.B2

**COMMENTS:** Timing is important because of short residual period; if larvae are small, Bt can effectively control them. Apply only during warm dry weather to control young actively feeding worms; may need to be applied more than once. Good coverage is essential.

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**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.**

**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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**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/](http://www.irac-online.org/).**
OMNIVOROUS LEAFROLLER (4/09)

Scientific Name: Platynota stultana

DESCRIPTION OF THE PEST
Omnivorous leafroller is a pest of plums primarily in the San Joaquin Valley. It occurs in the Sacramento Valley but seldom causes damage. Omnivorous leafrollers overwinter as immature larvae in mummy fruit and do not enter dormancy. Larvae are light colored with dark brown or black heads. When mature they are about 0.6 inch (1.5 cm) long and have two slightly raised, oblong, whitish spots on the upper surface of each abdominal segment. Abdominal segments may have a greenish brown tinge. They pupate inside a webbed shelter.

Adults of the overwintering generation emerge in March. They are small, dark brown moths, 0.375 to 0.5 inch (9–12 mm) long with a dark band on the wing and a long snout. Eggs are laid in overlapping rows that resemble fish scales. The first generation of eggs usually is laid on weed hosts, and adults from this generation emerge in May or June to lay eggs in orchards on leaves and fruit. Larvae that hatch from this generation of eggs can cause significant damage in stone fruits. All have the characteristic behavior of wriggling backward when disturbed and dropping from a silk thread attached to the leaf or fruit surface.

DAMAGE
Omnivorous leafroller larvae often web leaves into rolled, protective shelters while feeding. They feed on leaves and on the surface of fruit, sometimes webbing one or more leaves to the fruit for protection. They chew shallow holes or grooves in the fruit surface, often near the stem end.

Primary damage results from fruit feeding. Young fruit may be destroyed, and scars on older fruit will cause them to be culled or downgraded at harvest. Feeding injury also may increase the incidence of brown rot and other fruit decays.

MANAGEMENT
Omnivorous leafrollers do not usually appear in plum trees until early summer. Regular monitoring each season is important so that prompt action can be taken if damaging populations develop. Throughout the season, watch for the presence of leafrollers while monitoring.

Biological Control
A number of parasites, including species of Macrocentrus, Cotesia (Apanteles), and Exochus, attack omnivorous leafroller larvae. General predators such as green lacewings, Phytocoris bugs, assassin bugs, and minute pirate bugs may feed on eggs and larvae. Preservation of natural enemy populations is an important part of keeping leafroller numbers low. Use selective materials that are least disruptive of biological control when treating other pests.

Cultural Control
Remove fruit mummies and destroy both the fruit and potential overwintering weed hosts, such as horseweed, common lambsquarters, little mallow, curly dock, legumes, by clean cultivation.

Organically Acceptable Methods
Biological and cultural control along with applications of Bacillus thuringiensis are organically acceptable tools.

Monitoring and Treatment Decisions
Begin monitoring by placing pheromone monitoring traps (see PHEROMONE TRAPS) in the orchard during bloom (by February 20) in the San Joaquin Valley and check twice weekly to establish the biofix for the first flight; biofix is the first night moths are consistently caught in traps. First generation omnivorous leafrollers are most likely on weeds or cover crops; treatments for this first brood are probably not necessary and are likely ineffective for all but the earliest varieties. From the first biofix, accumulate degree-days (DD) to estimate when the onset of the second flight will occur. Use 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 at http://www.ipm.ucdavis.edu.) It takes about about 1168 DD for omnivorous leafroller to develop from egg to adult. As the start of the second flight

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
nears, be sure to have fresh trap liners and lures in place. When the second flight biofix is determined by trap catches, begin accumulating degree-days. Research in the central San Joaquin Valley indicates that the optimum single treatment timing is between 700 and 900 degree-days after the start of the flight. Monitor the fruit closely for signs of damage. No treatment threshold values are available.

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine the needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).

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

### A. BACILLUS THURINGIENSIS ssp. KURSTAKI#
(various products)

<table>
<thead>
<tr>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td>(conc.)</td>
<td>(dilute)</td>
<td>(hours)</td>
</tr>
<tr>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER:** 11.B2

**COMMENTS:** Must be applied when worms are small, before they have taken up shelter in rolled leaves. Does not destroy natural enemies. When using short-residual materials like *Bacillus thuringiensis*, two applications may be necessary for adequate control, one at 700 and one at 900 degree-days. Late season fruit varieties, which may be exposed to a third generation, may require additional treatments. However, considerable overlap in generations occurs by then so treatments may be needed earlier than 700 degree-days.

### B. SPINOSAD
(Entrust)#

<table>
<thead>
<tr>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td>(conc.)</td>
<td>(dilute)</td>
<td>(hours)</td>
</tr>
<tr>
<td>1.71–2.5 oz</td>
<td>0.43–0.6 oz</td>
<td>4</td>
</tr>
<tr>
<td>6–8 oz</td>
<td>1.5–2 oz</td>
<td>4</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER:** 5

**COMMENTS:** Make one application about 900 DD after the start of the flight. This product is toxic to bees for 3 hours following treatment; apply in the late evening after bees have stopped foraging. Do not apply more than 29 oz/acre/year of Success or 9 oz/acre/year of Entrust.

### C. METHOXYFENOZIDE
(Intrepid) 2F

<table>
<thead>
<tr>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
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</thead>
<tbody>
<tr>
<td>(conc.)</td>
<td>(dilute)</td>
<td>(hours)</td>
</tr>
<tr>
<td>8–16 oz</td>
<td>2–4 oz</td>
<td>4</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER:** 18A

**COMMENTS:** Use allowed under a supplemental label. Do not apply more than 16 fl oz/acre/application or 64 fl oz/acre/season.

**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.**

+ **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.**

- **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 (4/09)**

**Scientific Name:** *Argyrotaenia citrana*

**DESCRIPTION OF THE PEST**

The orange tortrix is only found in coastal areas. Its larvae are light green caterpillars with brown heads; they resemble obliquebanded leafroller caterpillars. When disturbed, the larvae wiggle backwards and drop to the ground on a silken thread. Adults are fawn or gray-colored moths with a darker mottling on the forewings. The orange tortrix overwinters as larvae and there are two to four generations each year in coastal areas.

**DAMAGE**

Larvae feed on leaves, buds, and the surface of fruit, causing severe damage as well as contamination with their excrement.

**MANAGEMENT**

Orange tortrix is a cyclical pest. In coastal orchards, natural enemies and treatments for other pests usually keep this pest controlled. In other areas treatment is not needed.

**Biological Control**

Several parasites and predators attack orange tortrix. Parasites include the wasps *Cotesia (Apanteles) aristolidae*, *Excclus* sp., and *Hormius basalis* and a tachinid fly (*Nemorilla pyste*). Predators include spiders and brown lacewing larvae (*Hemerobius pacificus*).

**Cultural Control**

Remove and dispose of mummy fruit to reduce overwintering orange tortrix. Also, remove weed hosts such as mustard. The use of grass cover crops helps reduce overwintering hosts.

**Organically Acceptable Methods**

Biological and cultural controls and sprays of *Bacillus thuringiensis* are organically acceptable controls.

**Monitoring and Treatment Decisions**

If you suspect orange tortrix is a problem and your orchard is located in coastal areas, sample fruit on a weekly basis for damage beginning in June to determine spray timing. Sample 20 fruit on 15 trees for a total of 300 fruit. Treat if between 1 and 2% damage occurs on fresh market fruit (check with cannery fieldman for damage acceptable for processing fruit).

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine the needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).

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<tr>
<td><strong>A. BACILLUS THURINGIENSISS ssp. KURSTAKI#</strong>&lt;br&gt;(various products)</td>
<td>Label rates</td>
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<td>4</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 11.B2</td>
<td><strong>COMMENTS:</strong> Timing is important because of short residual period. Apply only during warm dry weather to control young actively feeding worms; may need to be applied more than once. Good coverage is essential.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em><em>B. DIAZINON</em> 50WP</em>*</td>
<td>3 lb 1 lb</td>
<td>24 21</td>
<td></td>
</tr>
<tr>
<td>4EC 3 pt 1 pt</td>
<td>24 21</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 1B</td>
<td><strong>COMMENTS:</strong> Avoid drift and runoff into surface waters. Where plums are grown near waterways, do not use diazinon.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.

+ 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.

— Not recommended or not on label.

† 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 FLATHEADED BORER (4/09)
Scientific Name: Chrysobothris mali

DESCRIPTION OF THE PEST
Pacific flatheaded borer adults are generally present in May and June and are occasionally found in pheromone traps used to monitor other pests. When spring months are warm, adult beetles may be seen as early as March or early April. Adults are about 0.4 inch long and have a dark bronze body with coppery spots on the wing covers. The beetles lay eggs in injured or weakened areas on the tree, and larvae bore into the wood. A full-grown larva is light colored, with a prominent, flat enlargement of the body just behind the head. There is one generation each year.

DAMAGE
Pacific flatheaded borers are attracted to diseased or injured limbs, such as those affected by sunburn, scale insects, bacterial canker, mechanical injuries, or major pruning cuts. Larvae excavate large caverns just beneath the bark and bore tunnels deep into the tree’s cambium tissues. Excavations are usually filled with finely powdered sawdust. Injury by this borer will cause sap to flow, and the affected area will appear as a wet spot on the bark. Later, these areas may crack and expose the mines.

Feeding by Pacific flatheaded borers may cause a portion of the bark to die or may girdle and kill young trees or scaffold limbs.

MANAGEMENT
Flatheaded borers often invade sunburned areas on the trunk of newly planted, first-year trees. Wrap or paint the tree trunk from 2 feet above to 1 inch below the soil line with white, interior, water-based paint or whitewash to protect the trunk from sunburn and flatheaded borer invasions. One treatment may not be sufficient, especially on the side of the tree trunk exposed to the sun.

In older trees the best way to avoid infestations is to keep trees sound and vigorous. When pruning, consider tree structure as it relates to sunburn. Flattened, horizontal branches suffer significant sunburn. Prune out all badly infested wood, and shred or haul it to the dump before the growing season starts. Protect sunburned limbs with white latex paint. Grafts may also be a site of invasion. No insecticide treatments are recommended for this insect.
PEACHTREE BORER (4/09)

Scientific Name: *Synanthedon exitiosa*

DESCRIPTION OF THE PEST
Gum exuding from around the base of the trunk is evidence of peachtree borer. Larvae of the peachtree borer, found mainly in coastal areas and in the northern San Joaquin Valley, are white with brown heads. Adults are clear-winged moths with blue-black bodies having yellow or orange bands across the abdomen. The adult peachtree borer may be found from June to September, with larvae present in the tree the rest of the year. There is only one generation each year.

DAMAGE
This wood-boring insect can successfully attack healthy trees. The larval stage bores into the crown and trunk of the tree and mines the cambial layer. If this occurs for several years, the tree may eventually become girdled and die.

MANAGEMENT
Apply insecticides when adults emerge to help control peachtree borer adults. Pheromone traps are available to monitor adult emergence.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use**</th>
<th>R.E.I.+</th>
<th>P.H.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESFENVALERATE</strong>* (Asana XL)</td>
<td>4.8–14.5 fl oz</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td><strong>ENDOSULFAN</strong>* (Thionex) EC</td>
<td>2.66–3.33 qt</td>
<td>1 qt</td>
<td>4</td>
</tr>
</tbody>
</table>

*MODE OF ACTION GROUP NUMBER: 3
*MODE OF ACTION GROUP NUMBER: 2A
COMMENTS: Apply as a directed trunk and scaffold limb spray. Thorough coverage of trunk and scaffolds is required.

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

**For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ 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.

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/.
PEACH TWIG BORER (4/09)

**Scientific Name:** Anarsia lineatella

**DESCRIPTION OF THE PEST**

Small larvae of peach twig borer are almost white with a distinct black head. As larvae mature they become chocolate brown with alternating dark and light bands around the abdomen. The light, intersegmental membranes contrasted with the brown body distinguishes peach twig borer from other larvae found in stone fruits. Mature larvae are about 0.5 inch long.

Pupae are 0.25 to 0.4 inch long, brown in color and lack a cocoon. Pupation takes place in protected places on the tree and occasionally in the stem cavity of infested fruit.

Adult peach twig borer moths are 0.3 to 0.4 inch long with steel gray, mottled forewings. The long, narrow forewings are lightly fringed; the lighter gray hindwings are more heavily fringed. Prominent palpi on the head give the appearance of a snout. The bluntly oval eggs are yellowish to orange and are laid on twigs, leaves, or on the fruit surface.

Peach twig borer overwinters on the tree as a first- or second-instar larva within a tiny cell, called a hibernaculum, that is located in crotches of 1- to 3-year-old wood, in pruning wounds, or in deep cracks in bark. The overwintering site is marked by a chimney of frass and is especially noticeable when first constructed or before winter rains set in. Larvae emerge in early spring, usually just before and during bloom, and migrate up twigs and branches where they attack newly emerged leaves, blossoms, and shoots. As shoots elongate, larvae mine the inside, causing the terminals to die back. Dead shoots are known as shoot strikes or flags.

Adults from the overwintered generation usually begin emerging in April or early May. First generation larvae usually develop in twigs during May and June and give rise to the next flight of moths in late June or early July. Larvae from this and subsequent generations may attack either twigs or fruit depending on fruit maturity and population density.

**DAMAGE**

Peach twig borer can damage stone fruits by feeding in shoots and causing shoot strikes, or by feeding directly on the fruit. Shoot damage is most severe on the vigorous growth of young, developing trees because feeding kills the terminal growth and can result in undesirable lateral branching. As fruit matures, it becomes highly susceptible to attack; damage is most likely to occur from color break to harvest. Twig borer larvae generally enter fruit at the stem end or along the suture and usually feed just under the skin.

**MANAGEMENT**

Within an IPM program, the preferred management strategy for peach twig borer is well-timed treatments of environmentally sound insecticides around bloom time. These include *Bacillus thuringiensis*, spinosad (Entrust, Success), methoxyfenozide (Intrepid), and diflubenzuron (Dimilin). Bloom time applications integrate well with brown rot treatment, thus helping to cut application costs. Bloom sprays are preferred over in-season sprays in an IPM program because they have less adverse impact on beneficials and nontarget organisms.

Alternatively, peach twig borer can be controlled with a dormant spray of an organophosphate or pyrethroid insecticide plus oil to kill overwintering larvae in the hibernacula; however, these sprays pose surface water quality concerns and may pose some risks to raptors, aquatic invertebrates, beneficials, and other nontarget organisms. Dormant sprays of oil plus spinosad (Entrust, Success) or diflubenzuron (Dimilin) do not present these environmental problems. Dormant sprays of oil alone or oil combined with an insecticide, however, have the advantage of controlling some other stone fruit pests, especially mites and San Jose scale. (Oil alone does not control peach twig borer.) Mating disruption can also be used to supplement dormant sprays.

**Mating Disruption.** Mating disruption with sex pheromones can be used to supplement dormant or bloom time sprays. The main practical use for mating disruption is postbloom treatment in organic systems where other materials are not available. Mating disruption has not been reliable against...
peach twig borer when used alone. It is most effective in orchards with low moth populations that are not close to other untreated peach twig borer hosts or almond orchards. Efficacy is reduced by small orchard size, uneven terrain, reduced pheromone application rates, applying too low in the tree, improper timing, and high insect pressure. Follow timing guidelines given in the treatment table below.

**Biological Control**
Peach twig borer has about 30 species of natural enemies. The gray field ant, *Formica aerata*, preys on peach twig borer during spring and summer. In some years these natural enemies destroy a significant portion of larvae, but by themselves they generally do not reduce twig borer populations below economically damaging levels. Other commonly found natural enemies in California are the chalcid wasps, *Paralitomastix varicornis* and *Hyperteles lividus*, the braconid wasp *Macrocentrus ancylicorus*, and the grain or itch mite, *Pyemotes ventricosus*.

**Organically Acceptable Method**
Bloom time *Bacillus thuringiensis* sprays, sprays of the Entrust formulation of spinosad, and mating disruption are organically acceptable methods for peach twig borer management.

**Monitoring and Treatment Decisions**
- Monitor peach twig larvae during bloom and when shoots are emerging to determine that it is active. Look for the chewing damage they leave on buds.

- If larvae or their damage are observed at this time, two sprays of Bt or a single treatment of spinosad (Entrust, Success), methoxyfenozide (Intrepid), or diflubenzuron (Dimilin) can be applied. Bt sprays at bloom can also be timed by dissecting hibernacula regularly from late February through bloom. Look at young trees or 1- to 4-year-old wood near branch crotches to detect the tiny hibernacula. The increase in the number of empty hibernacula reflects the number of larvae that have emerged and can be controlled by Bt once foliage is present.

- Install pheromone traps in orchards in March 20 in the San Joaquin Valley and April 1 in the Sacramento Valley (see PHEROMONE TRAPS). Record results on a monitoring form (available online). If in-season sprays are necessary, you will need results from trap catches and degree-day accumulations to time them. Once the first moth has been trapped, begin accumulating degree-days (DD) using a lower threshold of 50°F and an upper threshold of 88°F. (For assistance in calculating degree-days, see Degree-days on the UC IPM Web site at http://www.ipm.ucdavis.edu.)

- Research has shown that best control can be achieved when treatments are applied about 400 DD from the beginning of the flight if the fruit is still green; if fruit has begun to color, however, treat at 300 DD. If *Bacillus thuringiensis* is used, however, two sprays should be applied: one at 300-350 DD and the other at 450-500 DD.

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine the needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre** (conc.)</th>
<th>Amount/Acre** (dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DELAYED DORMANT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. NARROW RANGE OIL</td>
<td>4-6 gal</td>
<td>1-1.5 gal</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

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

**Peach Twig Borer (4/09) 53**
Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . PLUS . . .

**SPINOSAD**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Entrust)#</td>
<td>1.25–2.5 oz</td>
<td>0.3–0.6 oz</td>
<td>4 &amp; 7</td>
<td>Apply with a narrow range oil to suppress overwintering mite and scale populations. To avoid development of insect resistance, do not treat successive generations of the same pest with the same product.</td>
</tr>
<tr>
<td>(Success)</td>
<td>4–8 oz</td>
<td>1–2 oz</td>
<td>4 &amp; 7</td>
<td></td>
</tr>
</tbody>
</table>

MODE OF ACTION GROUP NUMBER: 5

**MODE OF ACTION GROUP NUMBER: 5**

**DIFLUBENZURON**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Dimilin) 2L</td>
<td>12 oz</td>
<td>3 oz</td>
<td>12 &amp; 0</td>
<td>Apply in sufficient water to ensure good coverage. Apply with narrow range oil at 1.5% oil by volume.</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 15**

**PHOSMET**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Imidan) 70WP</td>
<td>4.25 lb</td>
<td>1 lb</td>
<td>3 days &amp; 7</td>
<td></td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 1B**

**DIAZINON**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Diazinon 50WP)</td>
<td>3 lb</td>
<td>1 lb</td>
<td>24 &amp; 21</td>
<td></td>
</tr>
<tr>
<td>(Diazinon 4EC)</td>
<td>3 pt</td>
<td>1 pt</td>
<td>24 &amp; 21</td>
<td></td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 1B**

**ESFENVALERATE**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Asana XL)</td>
<td>Label rates</td>
<td>12 &amp; 14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 3**

**BLOOM**

**A. BACILLUS THURINGIENSIS ssp. KURSTAKI**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(various products)</td>
<td>Label rates</td>
<td>—</td>
<td>4 &amp; 0</td>
<td>Treat when larva activity is detected by bud feeding or emergence from hibernacula.</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 11.B2**

**B. SPINOSAD**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Entrust)#</td>
<td>1.71–2.5 oz</td>
<td>0.43–0.6 oz</td>
<td>4 &amp; 7</td>
<td>Do not apply more than 29 oz/acre/year of Success or 9 oz/acre/year of Entrust. Most effective when applied at petal fall. This product is toxic to bees for 3 hours following treatment; apply in late evening after bees have stopped foraging.</td>
</tr>
<tr>
<td>(Success)</td>
<td>6–8 oz</td>
<td>1.5–2 oz</td>
<td>4 &amp; 7</td>
<td></td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 5**

**C. METHOXYFENOZIDE**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intrepid) 2F</td>
<td>8–16 oz</td>
<td>2–4 oz</td>
<td>4 &amp; 7</td>
<td></td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 18A**

**D. DIFLUBENZURON**

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution Range</th>
<th>Rate Range</th>
<th>Mode of Action Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Dimilin) 2L</td>
<td>12 oz</td>
<td>3 oz</td>
<td>12 &amp; 0</td>
<td></td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER: 15**
MODE OF ACTION GROUP NUMBER: 15
COMMENTS: Include vegetable oil at the rate of 1 qt/acre. Do not apply after petal fall. Do not exceed 2 applications in any given season. Allow 21 days between applications.

**POSTBLOOM**

A. SPINOSAD
(Entrust)#
1.71–2.5 oz 0.43–0.6 oz 4 7
(Success)
6–8 oz 1.5–2 oz 4 7

MODE OF ACTION GROUP NUMBER: 5
COMMENTS: Do not apply more than 29 oz/acre/year of Success or 9 oz/acre/year of Entrust. This product is toxic to bees for 3 hours following treatment; apply in late evening after bees have stopped foraging.

B. BACILLUS THURINGIENSIS ssp. KURSTAKI#
(various products)
Label rates — 4 0

MODE OF ACTION GROUP NUMBER: 11.B2
COMMENTS: Make two applications: one at 300-350 DD from biofix and the other at 450-500 DD. Compatible with fungicide sprays and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80–100 gal water maximum) is preferred.

C. METHOXYFENOZIDE
(Intrepid) 2F
8–16 oz 2–4 oz 4 7

MODE OF ACTION GROUP NUMBER: 18A
COMMENTS: Use allowed under a supplemental label. Do not apply more than 16 fl oz/acre/application or 64 fl oz/acre/season.

D. PHOSMET
(Imidan) 70 WP
4.25 lb 1 lb 3 days 7

MODE OF ACTION GROUP NUMBER: 1B

E. ESFENVALERATE*
(Asana XL)
4–6 oz 1.5–2 oz 12 14

MODE OF ACTION GROUP NUMBER: 3
COMMENTS: Use is not generally recommended on perennial crops in the San Joaquin Valley because high label rates can cause outbreaks of secondary pests. While low label rates reduce the potential for secondary outbreaks in the Sacramento Valley, they should only be used where resistance to organophosphates has not become a problem and other methods such as mating disruption are not feasible.

F. DIAZINON*
(Diazinon 50WP)
3 lb 1 lb 24 21

MODE OF ACTION GROUP NUMBER: 1B
COMMENTS: Avoid drift and tailwater runoff into surface waters. Where plums are grown near waterways, do not use diazinon.

G. MATING DISRUPTANTS#
(CheckMate PTB)
Label rates 4 0

COMMENTS: Mating disruptants have not provided reliable control when used alone. Used primarily in organic orchards to supplement bloom sprays. Place pheromone dispensers in orchards when you begin to catch the first moths in pheromone traps usually in April to May, depending on your location in the state. Apply in top one-third of canopy. Follow the manufacturer’s recommendations for placement, the number of dispensers to use, and replacement intervals. Reapply the pheromones at the recommended timing for later varieties. If you are catching more than 5 moths per pheromone trap per week within one generation of harvest, however, treat with an insecticide rather than replacing dispensers.

When using mating disruption, monitor the orchard regularly for shoots strikes at the end of each generation to verify that the technique is effective. Also monitor fruit from the tops of trees regularly for signs of larvae or damage; monitor more frequently during the final 4 weeks before harvest. Treat with insecticide if there are more than an average of 3 to 5 shoot strikes per tree after the first moth flight or if larvae are found in green fruit.

** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if label allows.
+ 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.

Peach Twig Borer (4/09) 55
Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
Acceptable for use on organically grown produce.

Not recommended or not on label.

- 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/.
REDHUMPED CATERPILLAR (4/09)

Scientific Name: Schizura concinna

DESCRIPTION OF THE PEST
The redhumped caterpillar is easily recognized because of its striking appearance: the main body color is yellow and is marked by longitudinal reddish and white stripes; the head is bright red; and the fourth abdominal segment is red and enlarged. Redhumped caterpillars pass the winter as full-grown larvae in cocoons on the ground. In spring and early summer, moths lay egg masses on the undersides of leaves. Eggs hatch into larvae that begin feeding on leaves. There are at least three generations each year in northern California.

DAMAGE
Redhumped caterpillars generally skeletonize leaves, leaving behind only leaf veins. They do not web leaves.

MANAGEMENT
Redhumped caterpillar can be a pest of plum orchards in the Central Valley. Biological control and pruning is often sufficient to manage the pest; use the monitoring guidelines below to determine need for treatment.

Biological Control
A number of natural enemies attack redhumped caterpillars, frequently preventing them from becoming destructive pests. Most common are two parasitic wasps: Hyposoter fugitivus, which forms a single pupal case that is white with a black band around the middle, and a species of Apanteles, which forms a fluffy white mass of pupal cases. Several general predators, including spiders, lacewings, bigeyed bugs, and damsel bugs, occasionally feed on caterpillar eggs and small larvae.

Cultural Control
On small trees, cut out and destroy infested twigs.

Organically Acceptable Methods
Biological and cultural control and Bacillus thuringiensis (Bt) sprays are acceptable for use in an organically certified crop.

Monitoring and Treatment Decisions
Begin looking for redhumped caterpillars in May, when eggs or larvae of the first generation may be present. Check trees throughout the orchard, looking at the undersides of leaves for egg masses or groups of small larvae. Skeletonized leaves that turn brown may indicate the presence of redhumped caterpillars. If you find larvae of the first generation, do not treat. Prune out and destroy localized infestations. Monitor again in July for second-generation larvae and for the presence of parasites before you make a treatment decision. Look for parasite pupae among larval colonies. If 80% or more of the larval population is parasitized, no treatment is needed. If parasitization is very low, prune out and destroy infestations or treat infested trees. Infestations tend to be very localized; so spot treatments usually suffice. Formulations of Bt are effective against the larvae.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Bacillus thuringiensis ssp. Kurstaki# (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

MODE OF ACTION GROUP NUMBER: 11.B2
COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.

** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.
+ 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.
— Not recommended or not on label.

* 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/.
SAN JOSE SCALE  (4/09)
Scientific Name: Diaspidiotus (Quadraspidiotus) perniciosus

DESCRIPTION OF THE PEST
San Jose scale, a major pest of fruit trees, is inconspicuous and usually not noticed until it builds up to large numbers on limbs. Limbs supporting large populations often ooze gum and exhibit rough bark and dieback. Dead leaves adhering to fruit spurs during dormant season indicate the presence of scale. Partially mature nymphs overwinter on limbs and trunks. In spring the nymphs develop into winged male and sessile female scale insects. Female scales have gray circular scale coverings. If the covering is removed, the lemon yellow body beneath can be seen. In May females lay eggs that hatch immediately and the young emerge from under the edge of the adult scale cover. The young crawlers settle on shoots where they feed and become adults or overwinter as partially grown scales. In California there are five overlapping generations each year. Crawlers first appear in late April and May, followed by continuous overlapping emergence from late June through December.

DAMAGE
San Jose scale can infest branches, shoots, leaves, and fruit. Adults and nymphs suck plant juices and cause considerable damage. They have been known to seriously weaken branches and main scaffold limbs, thus causing permanent injury to mature trees. Crawlers settling on fruit may cause fruit spotting.

MANAGEMENT
San Jose scale has many natural enemies that can frequently keep the pest under control if not disrupted by application of broad-spectrum insecticides. Many orchards that have not used broad-spectrum sprays for 2 or 3 years do not have San Jose scale problems. The best time to spray is during the dormant season when low-to-moderate populations can be managed with oil sprays, which don't destroy the scale parasites. The scale is monitored as part of the shoot sample during the dormant season and with pheromone traps in spring.

Biological Control (View photos of healthy and parasitized San Jose scale online.)
Natural enemies that feed on San Jose scale include two predaceous beetles: the twicestabbed lady beetle, Chilocorus orbus, and another small beetle Cybocephalus californicus. A number of small chalcid and aphelinid wasps, including Aphytis and Encarsia (Prospaltella) sp., parasitize this scale. These predators and parasites are helpful in reducing scale populations, but broad-spectrum insecticides used during the growing season for other pests disrupt this natural control, and scale populations can build as a result. Low winter mortality due to mild temperatures will also permit a buildup of scale populations.

Organically Acceptable Methods
Oil sprays and biological control by native scale parasites are acceptable in organically managed orchards.

Monitoring and Treatment Decisions
Dormant season. Monitor San Jose scale during the dormant season by collecting 100 spurs and examining them for live scale as well as for tiny emergence holes, which indicate parasite activity. For details on sampling, see DORMANT SPUR SAMPLING and the monitoring form in the online version of this guideline.

There is a correlation between infested spurs and infested plums, however, plums harvested in mid-June don't generally need a treatment. Expect more damage in late-harvested plums and treat them with oil at greenbud or popcorn if 3 spurs out of 100 are infested. If over 10% are infested, add an insect growth regulator (pyriproxyfen) to the oil sprays. Follow the guidelines below:

Dormant Treatment Decision Table (% infested spurs)

<table>
<thead>
<tr>
<th>Treatment threshold</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvested before June 15</td>
<td>Harvested after June 15</td>
</tr>
<tr>
<td>Below 20%</td>
<td>Below 5%</td>
</tr>
<tr>
<td>20-60%</td>
<td>5-10%</td>
</tr>
<tr>
<td>Over 60%</td>
<td>Over 10%</td>
</tr>
<tr>
<td></td>
<td>Oil at 6 gal/acre</td>
</tr>
<tr>
<td></td>
<td>Oil at 6 gal/acre plus insect growth regulator</td>
</tr>
</tbody>
</table>

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
Oil alone can be effective in controlling low-to-moderate populations (apply before January 21). If populations are high, include an insect growth regulator (pyriproxyfen-Esteem, Seize) with the oil. Organophosphates are available but are associated with environmental problems and should be avoided. When the dormant organophosphate and oil spray is first omitted, San Jose scale populations may increase the first year but by the second and third year parasite populations have increased to levels where they reduce San Jose scale populations and maintain them at low levels. If you notice parasitized scale in your dormant sample, be sure to only use an insect growth regulator during the growing season.

**Growing season.** Monitoring with pheromone traps during the growing season will help you keep track of the appearance and development of scale populations as well as the level of parasitism (*Aphytis* and *Encarsia*) but does not tell you if treatment is needed. It mainly tells you how to time treatment for best control in spring using degree-days and pheromone traps to predict the crawler stage or sticky traps to trap the crawlers. Need for treatment is better assessed during the dormant season. Delayed dormant sprays are the preferred timing for treatment.

If inadequate control is achieved with the dormant spray or the dormant spray is not applied, treatment is also effective when applied soon after the emergence of crawlers in May. Monitor scales by putting up pheromone traps around February 25 (see PHEROMONE TRAPS) and placing sticky tape in the trees in April. Record results on a monitoring form (available online). Place pheromone traps well within the canopy to keep them out of the wind. San Jose scale traps will attract both male San Jose scales and scale parasites (*Aphytis melinus* and *Enarsia perniciosi*). Adult male scales can be distinguished from the parasites by the presence of a dark line across their thorax where the wings attach. View photos of San Jose scale and natural enemies on the online version of this guideline.

When the traps begin to catch males consistently, start accumulating degree-days using a 51°F lower threshold and a 90°F upper threshold. If it is needed, apply a treatment for crawlers 600 to 700 DD after you catch the first males. Be aware that the traps may fail to catch any adults if weather is cold, rainy, or windy. Total generation time for San Jose scale is 1050 DD. (For assistance in calculating degree-days, see "Degree-days" on the UC IPM Web site at http://www.ipm.ucdavis.edu.)

If May sprays are required, use a high-volume (dilute) application at 400 gallons or more per acre for best coverage; do not use a low volume application.

Take a fruit damage sample at harvest to assess the effectiveness of the current year’s IPM program and to determine needs of next year’s program. See FRUIT EVALUATION AT HARVEST. Record results on a monitoring form (available in the online version of these guidelines).

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DORMANT OIL such as:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DORMANT FLOWABLE EMULSION</td>
<td>6 gal</td>
<td>1-1.5 gal</td>
<td>4</td>
</tr>
<tr>
<td>NARROW RANGE OIL#</td>
<td>4 gal</td>
<td>1.5 gal</td>
<td>4</td>
</tr>
</tbody>
</table>

**MODE OF ACTION:** Contact including smothering and barrier effects. COMMENTS: Cover all parts of the tree. Will control low-to-moderate infestations. See Dormant Treatment Decision Table for rate to use based on % infested spurs. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil. Not all oil products are organically acceptable; be sure to check individual products.

B. DORMANT OIL such as:

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DORMANT FLOWABLE EMULSION</td>
<td>6 gal</td>
<td>1-1.5 gal</td>
<td>4</td>
</tr>
<tr>
<td>NARROW RANGE OIL</td>
<td>4 gal</td>
<td>1.5 gal</td>
<td>4</td>
</tr>
</tbody>
</table>

**MODE OF ACTION:** Contact including smothering and barrier effects.
COMMENTS: Cover all parts of the tree. Use with an insecticide for high infestations. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Do not use oil sprays on water-stressed trees. Dormant flowable emulsion is less likely to cause burn. Some varieties, especially those that are weak growers or low in vigor because of soil or other location-related issues, can be especially sensitive to oil.

... PLUS ...

PYRIPROXYFEN
(Esteem) 0.86 EC 13–16 fl oz/acre 12 14
(Seize) 35WP 4–5 oz/acre 12 14

MODE OF ACTION GROUP NUMBER: 7C
COMMENTS: An insect growth regulator. Do not apply more than once per growing season. Good coverage is essential for good control. Preferred treatment of high populations of scale in an environmentally sound program. Use allowed under a supplemental label.

... or ...

DIAZINON* 50WP 4 lb 1 lb 24 21

MODE OF ACTION GROUP NUMBER: 1B
COMMENTS: Resistance may be found in areas of the southern and south central San Joaquin Valley. Avoid drift and runoff into surface waters or choose alternative materials. Diazinon has been found in surface waters at levels that violate federal and state water quality standards.

SPRING

A. PYRIPROXYFEN
(Esteem) 0.86 EC 13–16 fl oz/acre 12 14
(Seize) 35WP 4–5 oz/acre 12 14

MODE OF ACTION GROUP NUMBER: 7C
COMMENTS: Apply when scale crawlers first emerge. Do not apply more than once per growing season. Good coverage is essential for good control. Use allowed under a supplemental label.

B. NARROW RANGE OIL#
6–8 gal 1.5–2 gal 4 0

MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Use this option if bloom sprays are used for control of caterpillars. Plum trees tolerate oil treatments better in spring than during dormancy. Do not apply oil within 2 weeks of captan or within 30 days of a sulfur treatment. Not all oil products are organically acceptable; be sure to check individual products.

C. DIAZINON*
(Diazinon 50WP) 3 lb 1 lb 24 21
(Diazinon 4EC) 3 pt 1 pt 24 21

MODE OF ACTION GROUP NUMBER: 1B
COMMENTS: Resistance may be found in areas of the southern and south central San Joaquin Valley. Avoid drift and runoff into surface waters or choose alternative materials. Diazinon has been found in surface waters at levels that violate federal and state water quality standards. Where plums are grown near waterways, do not use diazinon.

** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, depending on the label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.

+ 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.

+ 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.

— Not recommended or not on label.

- 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/.
SHOTHOLE BORER (5/06)

Scientific Name: *Scolytus rugulosus*

DESCRIPTION OF THE PEST
Shothole borers are tiny brown or black beetles; their white legless grubs mine the tree’s cambium layer (sapwood). Adult females bore tiny holes in the bark and lay eggs in the cambium layer of the tree. When the eggs hatch, young larvae feed and excavate secondary galleries at right angles to the egg gallery. The outline of the gallery system resembles a centipede. There are from one to three generations each year.

DAMAGE
Normally a number of shothole borer adults invade a tree at the same time. Healthy trees exude resin, which usually kills the insects. If the tree has injured or weakened areas, this resin buildup does not develop and the invasion is successful. Ultimately the larvae may girdle the tree, or tree part, and cause its death.

MANAGEMENT
Shothole borers invade trees that have been previously damaged or weakened from disease. Maintain trees in a sound and vigorous condition, with sufficient fertilizers, water, and sunburn protection to prevent attack by this beetle. Prune to eliminate areas in older trees infested with shothole borer. Remove severely infested trees. Shred all infested wood or haul it to the dump before the growing season starts. Do not leave pruned limbs or stumps (healthy or infested) near orchards (for example, in woodpiles) as populations can emerge from these materials before they dry out, and beetles will then migrate into orchards. There are no insecticide treatments recommended for this insect.
TENT CATERPILLARS (4/09)

Scientific Names:  
Western tent caterpillar: *Malacosoma californicum*  
Forest tent caterpillar: *Malacosoma disstria*

DESCRIPTION OF THE PESTS
Tent caterpillars overwinter in the egg stage; eggs give rise to caterpillars in spring and early summer. The western tent caterpillar is hairy and dull yellow brown with a row of blue spots adjacent to orange spots on top of the body. The forest tent caterpillar is dusky gray, sparsely hairy, with fine yellow-brown stripes on the shoulder and side separated by a broad blue lateral stripe. Its most distinguishing feature is a series of white diamond or keyhole-shaped spots running along its back. Both caterpillars have one generation each year.

DAMAGE
Damage caused by tent caterpillars may be serious on individual trees. From April to June western tent caterpillars build large silken tents over leaves on which they feed. Forest tent caterpillars build mats of webbing rather than tents. They forage in all directions from these mats but return to the colony when not feeding. Tent caterpillars do not eat leaf veins.

MANAGEMENT
Populations of tent caterpillars tend to be concentrated in individual trees scattered throughout the orchard. Treatment is only occasionally required and can be limited to small areas of the orchard.

Organically Acceptable Methods
*Bacillus thuringiensis* sprays and pruning out infestations are organically acceptable management methods.

Treatment Decisions
On small trees, cut out and destroy infested twigs. Spray programs for other insects generally reduce populations. If insecticide treatments are required, localized treatments on individual trees and branches are generally all that is necessary. Treat when small caterpillars are first observed. The addition of a wetting agent to increase penetration of the webbing by the insecticide enhances control.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use**</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> BACILLUS <em>THURINGIENSIS</em> spp. KURSTAKI# (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>B.</strong> DIAZINON* 50 WP</td>
<td>3 lb</td>
<td>1 lb</td>
<td>24</td>
</tr>
<tr>
<td>4EC</td>
<td>3 pt</td>
<td>1 pt</td>
<td>24</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: Avoid drift and runoff into surface waters. Where plums are grown near waterways, do not use diazinon.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.
+ 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.
— Not recommended or not on label.
' 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/.

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of the timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.
WEBSPINNING SPIDER MITES (4/09)

Scientific Names:  Twospotted spider mite: *Tetranychus urticae*
 Pacific spider mite: *Tetranychus pacificus*

DESCRIPTION OF THE PESTS  (*View photos of pest mites and damage online.*)
Twospotted and Pacific spider mites are not easily distinguished: both have two black spots on their yellow-green bodies. In fall they turn orange red before overwintering. The twospotted mite is most common in the Sacramento Valley and the Pacific mite in the San Joaquin Valley. They overwinter as adult females under bark and on weeds. When weeds dry in spring, the mites move to trees and feed on lower leaves towards the middle of the tree first. They eventually become distributed over the entire tree. There are many overlapping generations each summer, with eggs being laid in a fine webbing on the undersurface of leaves.

DAMAGE
Webspinning spider mites are the most damaging mite species to plums. Spider mites feed by sucking the contents out of leaf cells. Such leaf damage reduces tree vitality and can adversely affect fruit size. Defoliation as a result of spider mite damage often allows the tree and fruit to become sunburned. Leaf injury caused by spider mites begins as a mottling and browning of leaves. Defoliation usually follows if control measures are not initiated. Both mites produce abundant webbing on both sides of the leaves.

MANAGEMENT
In many cases biological control keeps spider mites under control. Miticides may be necessary in some orchards in summer, but only when mite populations reach damaging levels, which often occurs after pesticides have been used that disrupt natural enemies. Use timed searches from June 1 to July 15 to assess need for treatment.

Biological Control  (*View natural enemy photos online*)
Predaceous mites, *Typhlodromus caudiglans* and *Galendromus* spp., and the sixspotted thrips, *Scolothrips sexmaculatus*, feed heavily on webspinning mites and may give complete control in the orchard. Control is most successful when the presence of predators and mites per leaf is close to a ratio of 1:1. The presence of these predators can be encouraged by avoiding the use of disruptive insecticides. These beneficials are also commercially available for release in the orchard. A narrow range oil (e.g., Superior) spray will suppress low levels of mites without harming these predators. When predatory mites are present, low rates of the selective miticide, fenbutatin oxide (Carzol), may be used to reduce spider mite populations and hopefully better balance predator/prey ratios.

Cultural Control
Vigorously growing trees are much more tolerant to mite attack than trees under stress. Maintain trees with *optimum irrigation* and fertilization. Reduce dusty conditions in orchards by oiling or watering roads and by maintaining a ground cover. Do not allow the ground cover to dry in mid-summer or mites will move up into the trees.

Organically Acceptable Methods
Biological and cultural control and oil sprays are organically acceptable management tools.

Monitoring and Treatment Decisions
Soon after bloom, start looking for spider mites and predatory mites on first emerging leaves on scaffolds. Use this information to map out areas of concern for future monitoring in the fruit development season.

Take weekly samples using the timed search method below, from June 1 to July 15 until the treatment threshold has been reached and a treatment has been applied. Record observations on a monitoring form (available online). If a treatment is applied on or after July 15, monitoring is no longer necessary. Continue to monitor untreated orchards until harvest.
How to Monitor

1. In each orchard up to 40 acres, conduct a 5-minute search in two separate areas of the orchard, for a total sampling time of 10 minutes.
2. For each 5-minute search, examine at least 2 to 3 leaves on 10 trees. Note presence or absence of spider mites or predators. Sample leaves from both inside and outside the tree.
3. If mite population is spotty, continue to do two 5-minute searches throughout the summer. If you determine the mite population is consistent throughout orchard, one 5-minute search is adequate.
4. Keep records of sample results on the monitoring form on the online version of this publication.
5. Use the guidelines below to determine need for treatment.

Mite Ratings (percent of leaves with one or more mites)
- low (1-20%) = an occasional mite on occasional leaf; hard to find.
- low/moderate (21-39%) = mites easier to find but no colonies or webbing and few eggs.
- moderate (40-60%) = some leaves without mites, other leaves with small colonies; eggs easy to find but very little webbing.
- moderate/high (61-79%) = mites on most leaves, colonies with eggs, and webbing on some leaves.
- high (80-100%) = lots of mites on most leaves; eggs and webbing abundant.

Predator Ratings
- low = hard to find; less than one predator per six leaves (only a few leaves will have predators).
- moderate = easier to find; one predator per three leaves (about half the leaves will have predators).
- high = one or more predators per leaf (most leaves will have predators).

Treatment Decisions (Treat if the rating from at least one 5-minute search indicates)
- low/moderate mite rating with low/moderate predator rating, or
- moderate/high mite rating with moderate/high predator rating

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>(dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. BIFENAZATE (Acramite) 50WS</td>
<td>0.75–1 lb</td>
<td>0.1875–0.25 lb</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Relatively safe for beneficial predaceous mites. Apply with ground equipment. Requires complete coverage of both leaf surfaces for effective control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. FENBUTATIN OXIDE* (Vendex) 50WP</td>
<td>2 lb</td>
<td>0.5 lb</td>
<td>48</td>
<td>14</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 12B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: This selective material appears to be most effective when applied earlier in the season rather than later. Do not apply more than twice a season in not more than 400 gal water/acre. Use reduced rates to balance predator and pest mite populations if sufficient numbers of predators are present but pest mite populations are approaching the threshold level.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. NARROW RANGE OILS#</td>
<td>4–6 gal</td>
<td>1–1.5 gal</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION: Contact including smothering and barrier effects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Oil used alone will only provide partial control for about a 2 week period. Always apply oil to well-watered trees and never when trees are stressed by hot (above 90°F), windy, dry (relative humidity lower than 20%) conditions or when such conditions are likely to occur within a few days after application. Additional applications may be needed at 2 week intervals, which may increase the potential for phytotoxicity. If fruit is present on the tree, treatment with oil may dull the fruit finish. Do not apply oil within 2 weeks of captan. Not all oil products are organically acceptable; be sure to check individual products.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, impact on natural enemies and honey bees, and impact of the timing on beneficials. When choosing a pesticide, also consider information relating to environmental impact.
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>Amount to Use** (dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. HEXITHIAZOX (Onager)</td>
<td>12–24 oz</td>
<td>3–6 oz</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>(Savy) 50 DF</td>
<td>3–6 oz</td>
<td>0.75–1.5 oz</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 10B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Apply after bloom but before adult mite buildup. Controls eggs and immatures that are sprayed or move onto treated surfaces; does not kill adult mites but will kill eggs laid on treated surfaces. Do not make more than 1 application/year.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| E. PYRIDABEN (Nexter) | 8.8–10.67 oz | 2.2–2.67 oz | 12 | 7 |
| **MODE OF ACTION GROUP NUMBER:** 21 |
| **COMMENTS:** Apply to each row for maximum protection when populations are building and most of the mites are in the immature stages. Do not make more than 2 applications/season or apply by air or through any type of irrigation system. |

**For dilute applications, rate is per 100 gal water to be applied in 300–500 gal water/acre, according to label; for concentrate applications, use 80–100 gal water/acre, or lower if the label allows.**

*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 R.E.I. exceeds the P.H.I. The longer of two intervals is the minimum time that must elapse before harvest.

#Acceptable for use on organically grown produce.

*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 FLOWER THRIPS (4/09)

Scientific Name: Frankliniella occidentalis

DESCRIPTION OF THE PEST
Western flower thrips adults are yellow brown to straw colored and about 0.05 inch long. Adults have four wings that are long and narrow with a fringe of long hairs on the margins. Immatures resemble adults except they are smaller and lack wings. Western flower thrips overwinter as adults in trash and have many generations each year.

DAMAGE
Thrips nymphs damage to plums in the Central Valley can be serious, especially on thin-skinned varieties. In early warm seasons, plums suffer little damage; however, if the season is cool and bloom occurs over a long period of time, damage can occur. Damage consists of several types: holes or depressions with a halo around them, thrips egg punctures or pansy spots, and thrips scarring in large or small blotches. All three types of damage can result in fruit being culled.

MANAGEMENT
To reduce thrips migration to blossoms, avoid discing or mowing orchard cover crops or allowing them to dry out when trees are in bloom. Also avoid discing adjacent weedy areas or mowing alfalfa. Begin monitoring for thrips at the start of bloom. Check for presence of nymphs and adults by shaking or knocking flower clusters onto a light yellow painted board or clip board. To find nymphs, dissect flowers. Treat, if necessary, at petal fall based on monitoring and observing thrips in the flowers.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>Amount to Use** (dilute)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. SPINOSAD</strong> (Entrust)#</td>
<td>1.71–2.5 oz</td>
<td>0.43–0.6 oz</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>(Success)</td>
<td>6–8 oz</td>
<td>1.5–2 oz</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> To avoid development of insect resistance, do not treat successive generations of the same pest with the same product. Do not apply more than 29 oz/acre/year of Success or 9 oz/acre/year ofEntrust. This product is toxic to bees for 3 hours following treatment; apply in late evening after bees have stopped foraging.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em><em>B. DIAZINON</em> 50WP</em>*</td>
<td>1.5–3 lb</td>
<td>1 lb</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>4EC</td>
<td>2 pt</td>
<td>0.5 pt</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong></td>
<td>1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Avoid drift and runoff into surface waters. Where plums are grown near waterways, do not use diazinon.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ 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 KEI exceeds the PFI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
- 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 TUSSOCK MOTH (4/09)
Scientific Name: Orgyia vetusta

DESCRIPTION OF THE PEST
The full-grown western tussock moth larva is 1.5 to 2 inches in length, generally gray in color with numerous colored spots, four prominent white tufts of hair on its body, and two black tufts on its head and one on its posterior end. The adult female moth is wingless and light silver gray. Males are winged and also gray in color. Larvae appear in spring and become adults in May, June, and July. These adults produce caterpillars that feed for 40 to 60 days before they pupate. There are two generations of tussock moth in southern California, but only one in northern California.

DAMAGE
The caterpillars feed on foliage and young fruit, devouring large portions of leaves or entire leaves, and making irregular holes in the fruit.

MANAGEMENT
Natural enemies usually keep tussock moth under control.

Organically Acceptable Methods
Bacillus thuringiensis sprays and pruning out infestations are organically acceptable management methods.

Monitoring and Treatment Decisions
On small trees, cut out and destroy infested twigs. Spray programs for other insects generally reduce populations. If insecticide treatments are required, localized treatments on individual trees and branches are generally all that is necessary. Treat when small caterpillars are first observed. The addition of a wetting agent to increase penetration of the webbing by the insecticide enhances control.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use** (conc.)</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BACILLUS THURINGIENSIS spp. KURSTAKI# (various products)</td>
<td>Label rates —</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ 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 R.E.I exceeds the P.H.I. The longer of two intervals is the minimum time that must elapse before harvest.
# Acceptable for use on organically grown produce.
— Not recommended or not on label.
* 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) (4/09)
Pathogen: Armillaria mellea

SYMPTOMS
Roots infected with Armillaria mellea have white to yellowish fan-shaped mycelial mats between the bark and the wood. Dark brown to black rhizomorphs sometimes can be seen on the root surface.

COMMENTS ON THE DISEASE
The fungus survives on dead roots.

MANAGEMENT
Avoid planting plum orchards where forest or oak woodland has recently been cleared or where there is a history of Armillaria root rot. All stone fruit rootstocks are susceptible to Armillaria root rot but some, such as Marianna 2624, are less affected than others and may be useful in some situations. Maintain the vigor of the trees to help resist Armillaria attack. Infested sites can be fumigated, but often this procedure will not prevent recurrence of the disease. Physical barriers to contain infection centers have been used successfully in orchards. A 4-foot trench is dug around the infected trees and plastic tarp is laid inside the trench wall from bottom to top before the soil is replaced. The tarp prevents healthy roots from coming in contact with diseased ones, thus preventing spread of the disease.

Cultural Control
Research on other tree crops has indicated that exposing an infected crown and upper root area of a tree infected with Armillaria mellea may help to slow the development of the fungus into the crown area. Remove soil from around the base of the tree to a depth of 9-12 inches. Leave the trunk exposed and keep the upper roots and crown area as dry as possible. During winter, provide drainage so that rain doesn’t collect in the hole. Recheck the hole every few years to make sure it has not filled in with leaves, soil, and other matter; the hole must be kept open and the crown and upper roots exposed. Some rootstocks may produce suckers when exposed, and these will need to be removed.

Organically Acceptable Methods
Cultural controls are acceptable in organically managed orchards.

Chemical Control
Before fumigation, remove all infected trees, stumps, and as many roots greater than 1 inch in diameter as possible. Healthy-appearing trees adjacent to those showing symptoms are often infected also. Removal of these adjacent trees and inclusion of that ground in the soil fumigation may be advisable. Infected trees, stumps, and roots should be burned at the site or disposed of in areas where flood waters cannot wash them to agricultural lands. Complete eradication is rarely achieved, and retreatment may be necessary in localized areas. If the soil is wet or if it has extensive clay layers to the depths reached by the roots, fumigant treatment may not be successful. The greatest opportunity for eradication occurs on shallow soils less than 5 feet in depth. Fumigate from late summer to early fall.
When choosing a pesticide, consider information relating to environmental quality.

**PREPLANT**

A. **METHYL BROMIDE**

   Mode of Action: Label rates

   Comments: For preplant fumigation; must be applied under a Critical Use Exemption. Before fumigating, dry soil by withholding water during summer and using cover crops such as sudangrass or safflower. The drier the soil, the better for deep penetration. Deep-till the area after drying. If the soil is dusty, wait for an early rain before ripping and fumigation. Ripping a dry soil that is silty can result in large clods on the surface. Inject methyl bromide 18–30 inches deep with chisels and cover with gas-proof cover. Increasing the dose tends to increase the depth of penetration, but it cannot be relied upon to penetrate wet soils, especially if soils are high in clay. Do not remove the cover for at least 2 weeks and aerate 1 month before planting. 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)


   Comments: Trees must be in the ground at least 1 year before treatment or injury may occur. See label for treatment timing.

   + 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.

   * Permit required from county agricultural commissioner for purchase or use.
BACTERIAL CANKER (4/09)

Pathogen: *Pseudomonas syringae*

SYMPTOMS
Symptoms are most obvious in spring and include limb dieback with rough cankers and amber-colored gum. There may also be leaf spot or blast of flowers and young shoots. The sour sap phase of decline may not show gum and cankers, but the inner bark can be brown, fermented, and sour smelling. Flecks and pockets of bacterial invasion in bark occur outside canker margins. Frequently, infected trees sucker from near ground level; cankers do not extend belowground.

COMMENTS ON THE DISEASE
*Pseudomonas syringae* survives in or on plant surfaces, is spread by splashing rain, and is favored by high moisture and low temperatures in spring. The disease is worse in low or sandy spots in the orchard. Vigorous trees are less susceptible to bacterial canker. Young trees, 2 to 8 years old, are most affected. The disease rarely occurs in first year of planting and is uncommon in nurseries.

MANAGEMENT
Planting trees that are budded or grafted about 32 inches above the root crown can help suppress bacterial canker infections. Bacterial canker tends to mostly affect weak trees, so any management practice that improves tree vigor (e.g., lighter, more frequent irrigation, improved tree nutrition, nematode management, etc.) will help to reduce the incidence of this disease. Trees on Lovell peach rootstock are more resistant than others; those on plum rootstocks are most susceptible. Delayed pruning may help.

In light sandy soils and some heavy soils, successful control has been achieved with preplant fumigation for nematodes. Application of copper during dormancy has not been shown to protect against bacterial canker.

Chemical Control
Nematodes stress trees, which predisposes them to bacterial canker. Preplant fumigation for nematode control reduces the severity of bacterial canker in newly planted orchards. The benefits of preplant soil fumigation for control of bacterial canker usually lasts only a few years; in some areas only limited improvements in disease control occur following soil fumigation. For additional information, see the nematode section. Bactericide applications have no reliable effect on bacterial canker and their use is not recommended.

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

**PREPLANT**

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>METHYL BROMIDE*</td>
<td>300–600 lb</td>
<td>see label</td>
<td>see label</td>
</tr>
</tbody>
</table>

* 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.

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.
BROWN ROT BLOSSOM and TWIG BLIGHT (4/09)

Pathogens: *Monilinia laxa* and *Monilinia fructicola*

**SYMPTOMS**

Blossom and twig blight causes the collapse of young blossom spurs and associated leaves. A gummy exudate is present at the base of flowers. Gray-brown spore masses form on diseased flowers under high humidity.

**COMMENTS ON THE DISEASE**

*Monilinia* spp. survive on diseased twigs and mummified fruit. Its development is favored by moderate temperatures and moist-to-wet conditions during bloom or on mature fruit. The disease is not common on most plum cultivars because unlike peach and nectarine, many plums are less susceptible to brown rot blossom and twig blight, as well as fruit rot. For late-season cultivars, if an orchard has a history of the disease, or if rainfall occurs before harvest on mature fruit, protective fungicide treatments may be necessary to prevent brown rot of fruit. Late-season cultivars with harvest dates in August or September include Angeleno, Autumn Beaut, Betty Ann, Casselman, Howard Sun, and Rosemary.

**MANAGEMENT**

Sanitation includes removal and destruction of mummified fruit from trees and orchard floors after harvest and before bloom, as well as heavily thinned fruit from orchard floors that may be colonized by the pathogen and function as a source of inoculum during fruit maturation. On susceptible cultivars, apply a protective fungicide treatment as a delayed bloom application (20-40% full bloom). A second application may be necessary during protracted flowering or during foggy or rainy weather. Protective fungicide treatments to prevent fruit brown rot are usually not needed on early or mid-season varieties. As discussed above for late-season cultivars, if an orchard has a history of the disease, or if rainfall is forecasted on mature fruit in the harvest period, protective fungicide treatments may be necessary to prevent brown rot of fruit.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. PROPICONAZOLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Orbit) 3.6EC</td>
<td>4 fl oz/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Bumper) 41.8EC</td>
<td>4 fl oz/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Most effective when applied before a rainfall and allowed to dry. Apply at 5–10% bloom and make a second application at 80–100% bloom. Do not apply to &quot;Stanley&quot; type plums.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. IPRODIONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Rovral) 4F</td>
<td>1–2 lb/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Dicarboximide (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Addition of a narrow range oil (superior, supreme) at 1–2% increases the effectiveness of this material.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. THIOPHANATE Methyl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Topsin-M) 70WP</td>
<td>8 oz/100 gal water</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Methyl benzimidazole (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Strains of <em>Monilinia fructicola</em> resistant to thiophanate methyl have been found in California. If resistance has occurred in your orchard, do not use this fungicide. Use only 1 application of thiophanate methyl/year, and always apply with a fungicide of different chemistry.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. PYRACLOSTROBIN/BOSCALID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pristine)</td>
<td>10.5–14.5 oz/acre</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11) and Carboxamide (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. PYRIMETHANIL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Scala) 5C</td>
<td>18 fl oz</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Anilinopyrimidine (9)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy. When choosing a pesticide, also consider information relating to environmental quality.
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. CYPRODINIL</td>
<td>5 oz</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>(Vanguard) 75WG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Anilinopyrimidine (9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply more than 10 oz/acre/year for blossom blight control.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. MYCLOBUTANIL</td>
<td>2.5–6 oz</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Rally) 40W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply more than 2.75 lb/acre/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. CAPTAN 50WP</td>
<td>4–6 lb</td>
<td>4 days</td>
<td>0</td>
</tr>
<tr>
<td>(Various)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. CHLOROTHALONIL</td>
<td>3.125–4.125 pt/acre</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>(Echo 720, Bravo Weather Stik)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. AZOXYSTROBIN</td>
<td>12.3–15.4 fl oz</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>(Abound 2F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply more than 2 applications before alternating with a fungicide that has a different mode of action.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+ 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.

* 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.
CROWN GALL  (4/09)
Pathogen: Agrobacterium tumefaciens

SYMPTOMS
Rough, abnormal galls form on roots or trunk. Galls are not hard but soft and spongy. The centers of older galls decay. Young trees become stunted, older trees often develop secondary wood rots.

COMMENTS ON THE DISEASE
The bacteria survive in gall tissue and in soil. Crown gall is most damaging to young trees, either in the nursery or new orchard plantings.

MANAGEMENT
The incidence of crown gall can be reduced by planting noninfected, "clean" trees. It is also important to carefully handle trees to avoid injury as much as possible, both at planting and during the life of the tree in the orchard. Preplant, preventive dips or sprays with a biological control agent are available and may be helpful in some orchards. Generally, by the time crown gall is evident in a peach orchard, it is usually best to tolerate the problem for the few remaining years of orchard life, which is about 12-15 years, or just remove the orchard and start anew.

When replanting a previously affected site, remove as many of the old tree roots as possible, grow a grass rotation crop to help degrade leftover host material and reduce pathogen levels, and offset the new trees from the previous tree spacing to minimize contact of healthy new roots with any infested roots that may remain.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGROBACTERIUM TUMEFACIENS-84# (Galltrol)</td>
<td>Label rates</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>COMMENTS: Preventive preplant treatment only.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GALLEX</td>
<td>Label rates</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>COMMENTS: For removal of existing galls, apply winter through spring.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

A. AGROBACTERIUM TUMEFACIENS-84# (Galltrol)
   Label rates
   COMMENTS: Preventive preplant treatment only.

B. GALLEX
   Label rates
   COMMENTS: For removal of existing galls, apply winter through spring.

+ 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.
PHYTOPHTHORA ROOT AND CROWN ROT (4/09)
Pathogen: Phytophthora spp.

SYMPTOMS
Symptom expression depends upon how much of the root or crown tissues are affected and how quickly they are destroyed. Generally, crown rots advance rapidly and trees collapse and die soon after the first warm weather of spring. Leaves of such trees wilt, dry, and remain attached to the tree. Chronic infections, usually of the roots, cause reduction in growth and early senescence and leaf fall. These trees may be unthrift for several years before succumbing to the disease. Phytophthora infections typically kill young trees because their root systems and crown areas are small compared to those of mature trees.

COMMENTS ON THE DISEASE
Periods of 24 hours or more of saturated soil favor Phytophthora infections. Conversely, good soil drainage and more frequent but shorter irrigations reduce the risk of root and crown rot. Rootstocks vary in susceptibility to the different Phytophthora species; none are resistant to all pathogenic species of the fungus. Thus, the success of a rootstock may depend in part upon the species of Phytophthora present in the orchard. In general, plum rootstocks are more resistant than are peach or apricot.

MANAGEMENT
The most effective ways to manage Phytophthora root and crown rot are to select a good planting site, select an appropriate rootstock, and properly manage irrigation water. Avoid overirrigating in spring and fall when soil temperatures are most conducive to disease development and water use by the tree is low. Plum rootstocks are less susceptible to Phytophthora infections than peach rootstocks, so plums grown on plum rootstock seldom have this disease. Fungicides are also available to treat soil around newly planted trees. If there is a history of Phytophthora root rot in the orchards and problems are anticipated, treatments may be warranted.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. FOSETYL-AL (Aliette)</td>
<td>5 lb/100 gal</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on nonbearing trees only. Apply as a foliar spray at 60-day intervals.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. MEFENOXAM (Ridomil Gold EC)</td>
<td>Varies with method of application and size of tree</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Phenylamide (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Applications are made in early spring and fall. Do not apply to trees within 90 days of planting.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

+ 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 PHL. The longer of two intervals is the minimum time that must elapse before harvest.

- 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.
POWDERY MILDEW (4/09)

**Pathogens:** *Sphaerotheca pannosa* and *Podosphaera tridactyla*

**SYMPTOMS**
Areas of white powdery fungal growth, roughly circular in shape, develop on the fruit in spring. These infected areas later become scabby and dry. In late summer and fall, similar fungal growth appears on leaves. Occasionally, symptoms may develop on fruit and leaves in spring.

**COMMENTS ON THE DISEASE**
*Sphaerotheca pannosa* attacks the plum fruit whereas *Podosphaera tridactyla* attacks the foliage. An unidentified species, possibly of *Podosphaera*, attacks fruit and leaves of certain plum varieties (Red Beautil and Black Beautil) in spring; other varieties may be affected in some years as well.

*Sphaerotheca pannosa* is known to survive as mycelium on roses and in infected buds of peach trees, and these plants may serve as a source of inoculum for plum trees. This pathogen is not known to overwinter on plum, but recently cleistothecia were discovered on peach trees, which suggests that this pathogen may also produce cleistothecia and survive on plum trees.

*Podosphaera tridactyla* overwinters as special spore-forming structures called cleistothecia on the surface of shoots, on dead leaves on the orchard floor, and on bark. Spores are produced from these structures during spring rains, and they infect the developing foliage on plum trees. Growth of the pathogen is favored by cool, moist nights and warm days.

**MANAGEMENT**
Watching for the disease during routine monitoring helps to determine the need for possible action the following year, but by the time it appears on the fruit it is too late to spray during the current season. If there are roses infected with powdery mildew near the orchard, these bushes are potential sources of inoculum, and it may be beneficial to control the disease on the roses or to remove them.

**Chemical Control**
Apply a fungicide at full bloom and make additional applications on a 10- to 14-day interval as needed. The fruit is thought to be resistant to infection after pit hardening. It is important to alternate fungicides of a different chemistry to prevent the development of resistance.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. PROPICONAZOLE (Orbit) 3.6 EC</td>
<td>4 fl oz/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Bumper) 41.8 EC</td>
<td>4 fl oz/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td>COMMENTS: A DMI-triazole fungicide. Do not apply to “Stanley” type plums. Do not apply more than 8 oz/acre/crop from early bloom through petal fall and 8 oz/acre/crop from petal fall to harvest.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. THIOPHANATE METHYL (Topsin-M) 70W</td>
<td>8 oz/100gal</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Methyl benzimidazole (1)</td>
<td>COMMENTS: A benzimidazole fungicide. Do not apply more than two applications before alternating with a fungicide that has a different mode of action.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. PYRACLOSTROBIN/BOSCALID (Pristine)</td>
<td>10.5–14.5 oz/acre</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11) and Carboxamide (7)</td>
<td>COMMENTS: A strobilurin/carboxyanilide fungicide.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Powdery Mildew

**Common name (trade name)**

**Amount to Use**

**R.E.I.** (hours)  **P.H.I.** (days)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D. MYCLOBUTANIL (Rally) 40W</td>
<td>2.5–6 oz/acre</td>
<td>24  0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. SULFUR DUST#</td>
<td>50 lb/acre</td>
<td>24  0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. WETTABLE SULFUR#</td>
<td>5–10 lb/100 gal water</td>
<td>24  0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. WETTABLE SULFUR#</td>
<td></td>
<td>24  0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIQUID LIME SULFUR#</td>
<td>Label rates</td>
<td>24  0</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NAME (NUMBER):**

- **Demethylation inhibitor (3)**
- **Multi-site contact (M2)**
- **Multi-site contact (M2)**
- **Multi-site contact (M2)**

**COMMENTS:**

- A DMI-triazole fungicide. Do not apply more than 2.75 lb/acre/season.
- Do not apply within 3 weeks of an oil application.
- Do not apply within 3 weeks of an oil application.
- Do not apply within 3 weeks of an oil application.

**+** 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 (for more information, see [http://www.frac.info/](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.
RIPE FRUIT ROT (4/09)

**Pathogens:** mostly *Monilinia fructicola* and *Rhizopus stolonifer*

**SYMPTOMS**
Fruit in storage infected with *Monilinia fructicola* may develop visible decay within 24 hours at 72°F, and will produce spores in 30 hours. Decaying tissue changes from light brown to gray to black. Rotted tissue is firm and difficult to distinguish from healthy tissue.

*Rhizopus stolonifer* causes fruit to turn mushy and leaky in storage containers. The disease spreads rapidly from fruit to fruit. Infected tissue can be readily distinguished from healthy tissue.

**COMMENTS ON THE DISEASE**
*Monilinia* is the most common fruit decay organism. Fruit that has been injured and infected before storage provides the inoculum for the spread of *Monilinia*. *Rhizopus* produces many spores at low humidity, but in fruit packages, where humidity is high, spores are scarce and mycelia abundant.

**MANAGEMENT**
Fungicides are preventive, not eradicative; they must be applied to uninjured fruit before infections occur. Injured fruit cannot be protected from rot caused by *Monilinia* or *Botrytis* with the use of preharvest sprays. After harvest, *Rhizopus* can be controlled by storing the crop at temperatures below 40°F. Preharvest sprays for *Monilinia* should be applied as needed during the last 4 weeks before harvest. Where *Rhizopus* fruit rot is a problem, treat 10 days to 1 day before harvest.

Take a fruit sample at harvest to assess the effectiveness of current year's IPM program and to determine needs for next year's program. See FRUIT EVALUATION AT HARVEST and record your results on a monitoring form (available online).

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PREHARVEST</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. PROPICONAZOLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Orbit) 3.6 EC</td>
<td>4 fl oz/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Bumper) 41.8 EC</td>
<td>4 fl oz/acre</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Most effective when applied before a rainfall and allowed to dry. Do not apply to &quot;Stanley&quot; type plums. Maximum of 2 preharvest sprays.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. PYRIMETHANIL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Scala) SC</td>
<td>18 fl oz</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Anilinopyrimidine (9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply more than 2 applications of Group 9 fungicides within 30 days of harvest.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. CYPRODINIL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Vanguard) WG</td>
<td>10 oz</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Anilinopyrimidine (9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: High summer temperatures and relative humidity reduces efficacy. Apply a maximum of 2 applications during preharvest. Do not apply more than 20 oz/acre/year.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. PYRACLOSTROBIN/BOSCALID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pristine)</td>
<td>10.5–14.5 oz/acre</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11) and Carboxamide (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. MYCLOBUTANIL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Rally) 40W</td>
<td>2.5–6 oz</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply more than 2.75 lb/acre/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The following materials are listed in order of usefulness in an IPM program, taking into account efficacy. When choosing a pesticide, also consider information relating to environmental quality.*
### POSTHARVEST

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to Use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. FLUDIOXONIL (Scholar) 50WP</strong></td>
<td>8 oz/100 gal water</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Phenylpyrrole (12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Treats 200,000 lb fruit using a spray-application system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. THIOPHANATE METHYL (Topsin-M) 70W</strong></td>
<td>8 oz/100 gal water</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Methyl benzimidazole (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENT: Sporadic control may occur if fruit treated is infected with spores of benzimidazole-resistant strains of <em>Monilinia</em> spp. If resistance has occurred in your orchard, do not use this fungicide.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+ 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.

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.
**Nematodes** (4/09)

**Scientific Names:**  
- Ring nematode: *Mesocriconema (=Criconemella) xenoplax*  
- Dagger nematode: *Xiphinema americanum*  
- Root lesion nematode: *Pratylenchus vulnus*  
- Root knot nematode: *Meloidogyne incognita, M. javanica, and M. arenaria*

**DESCRIPTION OF THE PESTS**

Plant parasitic nematodes are microscopic, unsegmented roundworms. Those that parasitize plums are obligate plant parasites that live in soil and/or roots. Two or more species may occur in the same orchard. They feed on other plants in addition to plums. Pin nematodes (*Paratylenchus* sp.) are another group that are frequently found in prune and plum orchards, but they are not thought to cause problems in these orchards.

**DAMAGE**

Ring nematodes spend their lives in soil feeding on roots. Feeding by ring nematodes, particularly on small feeder roots, predisposes trees to bacterial canker (*Pseudomonas syringae*). Dagger nematodes reduce tree vigor with their feeding but mostly are important because they vector tomato ringspot viruses. Root lesion nematodes damage roots by moving through cortical tissues and feeding in these areas. Root knot nematodes take up a single feeding site within a root where they remain for their lifetime.

**SYMPTOMS**

The symptoms described below are indicative of a nematode problem but are not diagnostic because they could result from other problems as well.

**Belowground.** Nematodes puncture and remove the contents of plant cells. This activity stunts root growth and reduces the tree’s ability to take in water and nutrients. Because of this, nematode-infested trees may have poorly developed root systems. With root knot nematodes in particular, feeding reduces the overall energy of the tree. Nematode feeding also creates entry points for other disease organisms.

**Aboveground.** Lack of vigor, small leaves, dieback of twigs, and yield reduction are typical symptoms of nematode damage. Nematodes are usually distributed unevenly throughout an orchard resulting in patches of low vigor trees. Orchards infested with high population levels of ring nematodes frequently exhibit symptoms associated with bacterial canker including blighted buds, blossoms, and leaves, and cankers that occur on and can result in the girdling and death of limbs and/or trees. Trees on plum rootstocks tend to host higher population levels of ring nematode than those on Nemaguard peach rootstocks.

**FIELD EVALUATION**

To make management decisions, it is important to determine which nematode species are present. If a previous orchard or crop had problems with one of the nematodes listed as a pest of plums, it is likely a subsequent orchard will have problems as well. If species present have not previously been determined, soil samples should be taken and sent to a diagnostic laboratory for identification.

Visually divide the orchard site into sampling blocks that represent differences in soil texture, drainage patterns, or cropping history, but are no larger than five acres in size. Take a separate sample from each block so that each can be managed separately. In a fallow field, collect subsamples from several locations within the sampling block. In an established orchard collect separate subsamples from the soil around trees that show symptoms and from the soil around adjacent, healthy looking trees for comparison. Subsamples should include feeder roots, when possible, and be taken in frequently wetted zones at the edge of the tree canopy. Samples should be taken from within the root zone of the tree. Mix subsamples well and place about 1 quart of soil and roots in a plastic bag. Seal bag, place label on outside of bag, keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Inform the laboratory that you want to know if the nematodes listed as pests above are present so that they can use appropriate extraction techniques. Request a species diagnosis if root lesion nematodes are found.
CULTURAL CONTROL
Whenever possible, plant new orchards in land that has previously been planted in nonwoody crops for several years. California-bred alfalfa cultivars can be a good choice except where ring nematode develops well (i.e. highly porous soils). Root lesion nematodes survive well within dead root tissue or soil, with 5% lasting 5 years after tree removal.

Prevention. The following measures will help to prevent spread of nematodes to uninfested fields:
1. Use certified planting stock.
2. Clean soil from equipment before moving between orchards.
3. Do not reuse irrigation tail water.

RESISTANT ROOTSTOCKS
Consider the use of resistant rootstocks. Because rootstocks for plums differ in response to various plant parasitic nematodes, it is important to select rootstocks that are resistant to the species of nematode present in your soil. Nemaguard peach rootstock is resistant to root knot nematodes but susceptible to root lesion and ring nematodes. Plum rootstocks (Marianna 2624 and Myrobalan 29C) tend to be least damaged by root lesion nematodes but are susceptible to damage by ring nematode.

MANAGEMENT
Preplant preparations. For a nematode-infested location that is to be planted with prunes or plums following a previous orchard or vineyard, a year-long procedure is suggested to prepare the area for fumigation with methyl bromide. Beginning in summer/fall, remove trees or vines along with as many residual roots as possible, destroy plant residues, deep cultivate, and break up cultivation pans and soil layering. Also, sample for nematodes and obtain an accurate identification of the plant parasitic species present. Next, leave sandy soils fallow during the year but finer-textured soils may need a summer crop of sudangrass to enable deep-drying in preparation for soil fumigation.

If you will be planting in a field following an annual crop, a shorter procedure can be used to prepare the area for fumigation. Plant the annual crop in spring, use it to dry the soil, and harvest it in summer. Sample for nematodes and obtain an accurate identification of the plant parasitic species present.

Following harvest of either the grass or annual crop, level the land (if necessary), cultivate, and do other operations required for planting. Finally, in late summer/fall, rip the soil at least to a minimum of 24 inches. If the subsurface soil is dry, surface clods are a problem, and you are in an area where light rains (less than 1 inch) occur in summer/fall, you may wish to wait to fumigate until after a light rain that would help to break up surface clods. The label for Telone requires that the field surface be moist at the time of fumigation. Either wait for early fall rains or sprinkler irrigate; do not use furrow irrigation to meet this requirement. Complete Telone fumigation before November 15. If surface clods are not a problem, fumigate in September or October when soils are very dry. Soil should be warm (50° to 80°F) to a 12-inch depth before application of dichloropropene or methyl bromide. Observe the waiting period on the fumigant container label before planting. Consider planting young trees on resistant rootstocks.

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

PREPLANT
A. METHYL BROMIDE* 300–600 lb/acre see label see label
COMMENTS: Must be applied under a Critical Use Exemption. Use methyl bromide for fine-textured soils. Apply methyl bromide: as a broadcast fumigation using tarps; by fumigating the soil with 300 lb/acre, inverting the top 12 inches of soil, and re-fumigating in 14 days with 150 lb/acre; or by fumigating a 10- or 11-foot strip down each planting row where soil is too moist to effectively apply Telone and there is resistance to the prevailing nematodes in the new rootstock. 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. 1,3-DICHLOROPROPENE*  
(Telone II)  
**Common name**  
B. 1,3-DICHLOROPROPENE*  
**Amount to Use**  
33.7 gal/broadcast acre  
**R.E.I.+**  
5 days  
**P.H.I.+**  
NA  
**COMMENTS:** This restricted use product is applied only by professional fumigation companies. It is effective at 33.7 gal/acre rate (top label rate for broadcast applications) if applied to dried sandy soils or sandy loam soils with no more than 12% soil moisture content anywhere in the surface 5 feet of soil profile. In California the applications must be applied to soils having a moist surface; this task is difficult to achieve without use of sprinklers unless there is a fortunate rainfall. Do not flood irrigate prepared lands to achieve this surface moisture requirement. Broadcast apply where nematode resistance is unavailable for prevailing nematodes. Strip applications are permitted at higher treatment rates and effective where resistant rootstocks are available, the clay loam soil profile contains no more than 19% soil moisture, the field has been pre-ripped to 4- or 5-foot depth, and the delivery shank is winged to limit off-gassing. 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.

### C. METAM SODIUM*  
(Vapam HL, Sectagon, etc.)  
**Common name**  
C. METAM SODIUM*  
**Amount to Use**  
75 gal/acre  
**R.E.I.+**  
48  
**P.H.I.+**  
NA  
**COMMENTS:** Metam sodium can effectively reduce populations of nematodes to 5-foot depth if applied properly as a drench in large volumes of water, but it does not penetrate and kill plant roots deeper than 3.5 feet. This product is best applied in springtime or to pre-moistened soil. Its usefulness is limited to sandier soils or soils that infiltrate 6 to 8 inches of water within 12 hr or less. Can be applied via a series of small level basins (e.g., one tree row at a time) if there is adequate water supply for complete filling of the basins within 1-2 hours. But, for best tree growth, do not replant any *Prunus* spp. within one year after the drenching of the basins. 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.

### POSTPLANT  
A. SODIUM TETRATHIOCARBONATE  
(Enzone)  
**Common name**  
A. SODIUM TETRATHIOCARBONATE  
**Amount to Use**  
750–1,000 ppm  
**R.E.I.+**  
4 days  
**P.H.I.+**  
NA  
**COMMENTS:** Liberates carbon bisulfide soon after soil contact and its half-life may not exceed 24 hours. Thus, performance is limited to soils that quickly infiltrate 2 to 3 inches of water within several hours. Enzone is quite effective against nematodes external to the roots, particularly ring and dagger nematodes in coarse textured soils applied via low volume during a 4 hour irrigation. Apply during cooler months before May 1 or after October 15 and no more than twice per year. Fall applications can halt bacterial canker incidence the following spring.

+ 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.

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

INTEGRATED WEED MANAGEMENT (4/09)

Integrated weed management involves using all available strategies to manage weed populations in an economically and environmentally sound manner. Such strategies include cultural, mechanical, chemical, and biological methods. Plum orchards are infested with numerous annual and perennial weeds. These weeds compete with plum trees for water, nutrients, and light (in young orchards). The competition for these resources is of greater concern in young orchards because weeds can reduce the growth, vigor, and productivity of the trees. Weeds continue to cause problems in older orchards because they can increase the risk of frost damage early in the season, harbor pests and pathogens of the plum trees, interfere with irrigation systems, compete for water and nutrients, and cause problems at harvest. There are several components to a good orchard weed management program. These include preventive strategies, orchard floor management, and weed monitoring. It is equally important to design a weed management program based on the irrigation system and soil type of the orchard. Further, proper use of pre- and postemergent herbicides and timely discing and cultivation is necessary for a well-functioning integrated weed management system.

Integrated weed management strategies vary from orchard to orchard. Location in the state, climatic conditions, soils, irrigation practices, topography, and grower preferences influence orchard floor management decisions and the tools used. Weeds are commonly controlled either chemically or mechanically in a 4- to 6-foot-wide strip in the tree row. The area between the tree rows may be chemically treated, mechanically mowed, or tilled. Mulches, subsurface irrigation, flamers, and geese can also be used to control weeds in orchards. Often several weed management options are used in an orchard depending on the types of weeds present, age of the trees, soil conditions, and grower preference.

PREVENTION

A good weed management strategy in plum orchards begins with prevention. Prevention is the most effective method of weed management. Keep irrigation canals, ditch banks, and the irrigation system free of weeds and weed seeds. A good drainage system is also essential as a preventive tactic. Leakages in the irrigation system and accumulation of water in low spots should be prevented because such sites can encourage weed emergence and growth. Also control weeds on the orchard margins because they produce seeds that may disperse into the orchard. Weeds that produce wind-dispersed seeds (e.g., marestail, hairy fleabane) may be a greater concern in field margins. Be sure to control weeds in the field margins before they set seeds. Clean the undercarriage and tires of vehicles and equipments before entering the orchards because seeds and reproductive parts of weeds can be transported along with them.

MONITORING

Detection of new weeds and weed escapes is essential for preventing weed establishment or shifts in weed populations. Regular monitoring is a very important component of an integrated weed management program. For weed monitoring to be effective, the weed species present in and around the orchard must be properly identified. Identify weeds in the seedling stage because it is easier to control annual weeds with chemical or mechanical tools when they are small and have not become established. Perennial weeds are more vulnerable to control at the early bud stage or during fall when the plants begin to go dormant. Herbicides applied at these stages can be translocated to the roots or rhizomes to better kill the weed.

Most herbicides are only effective against certain weed species. Regular monitoring will determine if your treatments are working. Weeds often grow in patches so it may not be necessary to spray postemergent herbicides or cultivate the whole orchard to manage them. A spot treatment may save time and money while achieving good weed control. A handheld GPS unit is useful for marking patches of troublesome weeds for spot treatment and subsequent monitoring.

How to Monitor

Survey your orchard for weeds in late fall and again in late spring. Keep records on a survey form that includes a map. Pay particular attention to perennial weeds and other problem weeds and note their location on the map. Record weeds found in rows and middles separately. Weeds in tree rows must be managed, but annual weeds in row middles may be beneficial as a cover crop. Also keep records of weed
management actions including timing, rates and dates of herbicide applications and cultivations. Survey information collected over a period of years tells you how weed populations may be changing and how effective your management operations have been over the long term.

**Late fall weed survey.** Survey your orchard after the first rains of the fall when winter annuals have germinated. Monitoring weeds in fall accomplishes several tasks. It will identify any summer species and perennial weeds that escaped the previous year’s weed control program. Adjustments can be made to control these species in the next year. Fall monitoring will also identify any winter species that are emerging. Record your observations on the fall weed survey form (available online) and use the map to show areas of problem weeds.

**Late spring weed survey.** Survey your orchard in late spring or early summer, after summer annuals have germinated. By surveying weeds at this time, you can identify any species that escape control from earlier management and know what perennials are present. If herbicides were used, monitoring identifies any need for changing to another herbicide. Pay particular attention to perennials and check for their regrowth a few weeks after cultivation. Record your observations on the late spring weed survey form (available online) and use the map to show areas of problem weeds.

**ORCHARD FLOOR MANAGEMENT**

A well-managed orchard cover between the tree rows has several benefits. It provides a stable surface upon which machinery can be operated under moist conditions that otherwise would be prevented access to the orchard. The cover plants develop root channels that improve soil structure and water infiltration. Improvement in infiltration rates also reduces the risk of off-site movement of pesticides. Further, plant cover reduces soil compaction and the potential for erosion. On the other hand, tall cover crops or weeds increase the risk of frost damage in spring. Mowing or discing the orchard floor, however, will reduce this risk.

Although resident orchard-floor vegetation has several benefits, it must not be allowed to invade the tree rows. Invasion into the tree rows is a serious problem if the invading plants are difficult to control with herbicides. For example, hairy fleabane, which is difficult to control with the preemergent herbicides registered in plums and is susceptible to postemergent sprays only when small, is a prolific production of wind-borne seed that allow it to quickly invade tree rows. Planting a cover crop instead of using resident vegetation between the tree rows is an alternative. Choose a cover crop mix with known properties such as mowing height and frequency requirements, time to seed set, and time to senescence. (For more information on choosing a cover crop, consult UC ANR Publication 21471, *Covercrops for California Agriculture*). Properly managed cover crops can prevent invasion of the orchard by weeds that cause problems.

**Management Based on Irrigation System**

Weed management programs must be adjusted to fit the irrigation system. For example, the dissipation of preemergent herbicides is slow in furrow and basin flood systems with berms because the irrigation water does not come in contact with the herbicide. However, in sprinkler, microsprinkler, and drip-irrigated orchards the irrigation water contacts the herbicide, thus increasing its dissipation. Consequently, weed control provided by the preemergent herbicides breaks down sooner around the sprinklers or emitters than in the rest of the orchard, and these areas require additional weed control measures, such as a postemergent herbicides or hand hoeing. The use of sensor-controlled sprayers that apply herbicides only to areas of weed growth can reduce postemergent herbicide use by 50% or more by treating only the weed-infested areas.

**Management Based on Soil Type**

Consider soil type when selecting a weed management strategy. Sandy loams to loamy sands require less herbicide for effective weed control than clay loams. Labels for some preemergent herbicides have specific application rates for different soil textures. Applying an amount of herbicide suggested for a clay loam soil to loamy sand not only wastes herbicide but may also cause crop injury. Timing of cultivation is more flexible on loams and loamy sands than on soils high in clay because equipment moves more easily over these soils when they are moist than over moist clay soils.

**WEED MANAGEMENT BEFORE PLANTING**

Perennial weeds are easiest to control before the orchard is planted. Perennial weeds not controlled before planting can cause problems for newly planted trees and are much more expensive to control.
Established weeds can be controlled either chemically or mechanically. Annual weeds should also be clipped or controlled so that they do not produce seeds. Perennial weeds can be mechanically controlled by repeated discing in summer or controlled with herbicides. A good time to control weeds such as dallisgrass, bermudagrass, and johnsongrass is the summer before planting. Apply glyphosate when the grasses are actively growing. This should be followed with cultivation 2 weeks after the herbicide is applied. Many underground plant structures can be controlled by cultivation alone, which brings them to the surface and causes them to desiccate. The soil must be dry for root systems of the perennial plants to completely desiccate and die. Many other weeds, including nutsedges, can be effectively controlled by cultivating with soil-inverting plows.

Grade the orchard site to ensure even drainage. Low spots within the orchard promote perennial weed growth that can be difficult to control. Also, proper drainage prevents formation of wet areas within the tree row. Constant wetting accelerates the dissipation of herbicides, which leads to weed growth.

To control weeds in future tree rows, incorporate a preemergent herbicide like trifluralin into the soil before planting. When planting the trees, place untreated soil directly around the roots and then cover it with a surface layer of treated soil. Maintain a weed-free strip that is at least 30 inches from trunk on each side of the tree to prevent weeds from competing with the developing tree. If planting holes are dug with an auger, use glyphosate before planting and then follow planting with an application of preemergent herbicide.

**WEED MANAGEMENT IN NEWLY PLANTED ORCHARDS**

Weeds can significantly reduce young tree growth if not managed/controlled. Once trees are planted, disturb the soil as little as possible. For furrow irrigation, establish one or two narrow furrows along the planted trees. Perennial grasses can be controlled with sethoxydim (Poast) or fluazifop-p-butyl (Fusilade). Glyphosate can be used to suppress nutsedges and perennial broadleaf weeds. Avoid spraying plum foliage or trunks with glyphosate. Wrappers may help to protect trunks from herbicides but there is no guarantee that injury will not occur. Regular preemergent and postemergent treatments during the establishment years remove much of the competition from weeds and facilitate irrigation and other cultural practices.

**WEED MANAGEMENT IN ESTABLISHED ORCHARDS**

If vegetation (either resident vegetation or cover crop) has been maintained in the orchard middles, it can either be mechanically managed by mowing or chemically managed by applying low rates of a postemergent herbicide that stunt the plants. An alternative to mowing is to let the cover crop grow until it is nearly mature and then roll it with a ring-roller to press the vegetation down. This accelerates the senescence process but allows for some seeds to mature. In addition, the intact mulch blocks light, which may prevent weed seeds from germinating. Manage cover crops and resident vegetation by mowing or discing to reduce the risk of early spring frost damage to the crop.

Within the tree row, preemergent and postemergent herbicides are common management tools. For best results, most preemergent herbicides need to be sprayed onto the soil just before an irrigation or rainfall so that the water carries the chemical into the soil where the weed seeds are located. Check the pesticide label for specific details. Preemergent herbicides can provide control for up to a year, depending on the solubility of the material, adsorption of the material to soil, the weed species present, and the dosage applied. Herbicide leaching is greater on sandy than on clay soils. Prolonged moist conditions during winter, in furrow bottoms, or around low-volume emitters during irrigation favor breakdown and leaching of herbicides.

Postemergent herbicides are used on established weeds. They act either by contact or by translocation throughout the plant. Contact herbicides, such as paraquat, kill those parts of the plant that are actually sprayed, making good coverage and wetting essential. A single spray kills susceptible annual weeds. Retreatment is necessary if perennials that regrow from underground roots or other underground structures are present or if annual weeds reestablish. Translocated herbicides, such as glyphosate, move into the plant and are translocated to the underground portions of the plant and kill them. Glyphosate, however, does not translocate into mature nutedge tubers. Complete coverage with translocated herbicides is not essential but does improve control. Complete control of established perennials is often difficult, as root structures are often extensive compared to the top growth.
WEED MANAGEMENT IN ORGANIC ORCHARDS (4/09)

Weed control in organically managed orchards requires special attention to preventing weed problems before they start. Cover crops planted in middles and mechanical control of weeds in the tree row is key components of an organic weed management program.

**Before planting.** It is critical to have minimum or no weed competition at the time of planting new trees 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. If most of the weed seeds on the site are located in the surface 4 inches, a soil-inverting plow such as a Kverneland plow can be used to bury them to depths where they cannot emerge; a moldboard plow will not sufficiently invert the soil to be effective.

*Soil solarization.* Soil solarization of the planned tree 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. All sides of the plastic must be buried 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 the 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.

**After planting—tree-row management.** Similar to many conventionally managed orchards, weeds in the middles of organic orchards are commonly managed with cover crops and/or mowing. However, weeds in the tree row must be managed nonchemically with in-row cultivation, cross discing, mulches, hand hoeing or flaming. The choice of method depends in part on the type of irrigation system.

*Furrow-irrigated orchards.* Furrow-irrigated orchards are amenable to in-row cultivation. Several companies make cultivation equipment. Trip mechanisms on orchard cultivators prevent damage to the trees. Cross discing of young trees is also possible but requires furrowing after each discing. Weeds close to the trunk of the tree can be removed by hand hoeing, flaming, or an organic herbicide.

*Sprinkler-irrigated orchards.* In-row cultivators move in and out of the tree row to control weeds and they may damage sprinkler systems. In-row cultivation or mowing may be possible if extra protection is provided to ensure proper operation of the trigger mechanism on the cultivator so that the cultivator moves away from the sprinkler as it does for the tree.

*Microsprinkler-irrigated orchards.* Few options are available in organic orchards with microsprinklers. In-row cultivators may damage irrigation lines and emitters. Surface lines can be suspended in the trees or on stakes to allow for in-row mowing, cultivation, or flaming underneath. The microsprinklers are suspended upside down. Hand weeding and possibly flaming could be used for weed control. Flaming may be effective on weeds that are typically smaller than 8 leaves. When flaming is used repeatedly, grasses will eventually become the dominant weeds because their growing points are close to the ground. Also, perennial weeds are not controlled with flaming. Protect trunks of young trees from flamers to avoid injury to the cambium layer of the tree; 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 weeding.

*Drip-irrigated orchards.* Weed control options for drip-irrigated orchards are similar to those available for micro-sprinklers. However, if subsurface drip irrigation is used, free moisture near the soil surface is limited and summer annual weed will not germinate, assuming rainfall does not occur. Cultivation, flaming, or mulches can all be used with a subsurface drip system.

Geese can often be used to manage grass weeds in orchards. 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 Website for further information on geese:
http://www.metzerfarms.com/weeder.htm

After planting—middles management. Consider planting a cover crop in the area between tree 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 tree 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 (4/09)

JOHNSONGRASS. This weed can be a serious problem, especially in young orchards. Johnsongrass can be controlled by repeated tillage during the dry summer months. However, the soil must be fairly dry; otherwise the rhizome buds may sprout. Repeated applications of selective postemergent herbicides (fluazifop-p-butyl [Fusilade] or glyphosate) will often be required for control of johnsongrass. Geese are also effective at controlling johnsongrass in organic orchards. In new plantings, trifluralin (Treflan) or norflurazon (Solicam) will control seedling johnsongrass, but not established (rhizomatous) johnsongrass.

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. It frequently becomes a problem in mowed orchards because mowing increases the amount of light that the stolons receive, thus stimulating their growth. This grass is very competitive with the trees for moisture and nutrients. Seedlings can be controlled with preemergent herbicides. If bermudagrass develops in localized areas, immediately spot treat it with postemergent herbicides such as glyphosate (Roundup, Touchdown, etc.). In organic orchards, geese have been used to control grasses, including bermudagrass. If confined to an area containing bermudagrass, they will dig up the rhizomes, and completely consume the plant.

DALLISGRASS. Dallisgrass is a common perennial weed found in orchards. It can be highly competitive in newly planted orchards. Dallisgrass seedlings germinate in spring and summer and form new plants on short rhizomes that develop from the original root system. Dallisgrass seedlings can be controlled with cultivation or with preemergent herbicides. The mature plant has a clumpy growth habit that gives it a bunchgrass appearance. Like bermudagrass, it tends to become dominant in mowed areas because mowing stimulates seed set. It also grows in areas with standing water. The plants are heavy seed producers. Treatment with glyphosate (Roundup, Touchdown, etc.) has been successful in controlling dallisgrass infestations. For organic orchards, consider using geese because they eat grasses preferentially.

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 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 orchard, spot treat with high label rates of glyphosate (Roundup, Touchdown, etc.). Another alternative is a modest rate of glyphosate plus 2, 4-D. In organic orchards, cultivation at 2- to 3-week intervals during the growing season will eventually deplete the root system and starve the plant.

HAIRY FLEABANE. Hairy fleabane is an annual plant that normally emerges in February, but it can emerge in December if winter temperatures are warmer than average. This plant can withstand several mowings and still produce seed. In addition, it can interfere with moving sprinkler and drip irrigation lines. Paraquat (Gramoxone Max) and glyphosate (Roundup) both can control this species when it is small, but once plants bolt (sending up flowering stalks), they will not control it. Glyphosate at 1 lb a.i./acre will control plants up to 13 leaves; for plants with 14 to 19 leaves 2 lb a.i./acre is required. Plants larger than 19 leaves are not adequately controlled. Hairy fleabane and a close relative, horseweed, have developed resistance to glyphosate. Thus, it is critical to monitor control efforts and follow up with hand hoeing to prevent escape of any plants that might be resistant.

HORSEWEED (MARE’S TAIL). This annual weed has a woody stalk and can grow up to 10 feet tall. It can interfere with harvesting practices if not controlled. Like hairy fleabane, this weed can withstand mowing and cause similar problems. Control measures are also similar to hairy fleabane.

YELLOW 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 the plant is destroyed by cultivation or an herbicide, then a new bud is
activated. In established orchards, if nutsedge develops, spot treat it with glyphosate (Roundup, Touchdown, etc.). Repeat treatments are often necessary to control late germinating plants.

**COMMON PURSLANE.** Common purslane is a prostrate summer annual that reproduces from seed, which germinates in April to early May. Common purslane grows into a plant with fleshy stems, which can root and continue to grow after cultivation or mowing if moisture is present. This weed predominates in sunny areas of the orchard, especially if low rates of translocated herbicides (e.g., glyphosate) are used as preharvest sprays. If problems develop with this weed, use higher rates of glyphosate to control it. A low rate preemergent herbicide program can also effectively manage this weed and reduce the need for preharvest treatments. Oryzalin (Surflan) at 1 qt/acre applied with glyphosate in April to the area between the tree rows in the orchard can provide season-long control.
### COMMON AND SCIENTIFIC NAMES OF WEEDS (4/09)

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<thead>
<tr>
<th>Common Names</th>
<th>Scientific Names</th>
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<tr>
<td>barley, hare</td>
<td><em>Hordeum leporinum</em></td>
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<td>barnyardgrass</td>
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*Continued on the next page . . .*
Common and Scientific Names of Weeds, continued

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<tr>
<td>starthistle, yellow</td>
<td>Centaurea solstitialis</td>
</tr>
<tr>
<td>thistle, Russian</td>
<td>Salsola tragus</td>
</tr>
<tr>
<td>willowerb, panicle-leaf</td>
<td>Epilobium brachycarpum</td>
</tr>
<tr>
<td>witchgrass</td>
<td>Panicum capillare</td>
</tr>
</tbody>
</table>
### SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL (4/09)

<table>
<thead>
<tr>
<th>ANNUAL WEEDS</th>
<th>Preemergent</th>
<th>Postemergent</th>
<th>Comb.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FLM  ISO  NAP ORY OXY PEN PRO TRI CLE FLU GLY MSM OXY PAR* SET 24D* ORY GLY* OXY OXY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>barley, hare</td>
<td>— N C C C P C C C C</td>
<td>C C C N P P C N P C</td>
<td>—</td>
</tr>
<tr>
<td>bluegrass, annual</td>
<td>C N C C C P C C C C</td>
<td>C N C C P P N N C C</td>
<td>—</td>
</tr>
<tr>
<td>brome, downy</td>
<td>— N C C C N C C C C</td>
<td>C P C P N P N P C C</td>
<td>—</td>
</tr>
<tr>
<td>brome, ripgut</td>
<td>— N C C C — C C C C</td>
<td>C P C P N P C N P C</td>
<td>—</td>
</tr>
<tr>
<td>canarygrass</td>
<td>— N C C C P C C C C</td>
<td>C C C N P P C N — C</td>
<td>—</td>
</tr>
<tr>
<td>clovers</td>
<td>P C P N N P N N N C</td>
<td>N N P N P N P N P C</td>
<td>—</td>
</tr>
<tr>
<td>cudweeds</td>
<td>— P C C N N N N N C</td>
<td>N N C N P N N P N C</td>
<td>—</td>
</tr>
<tr>
<td>fiddleneck</td>
<td>— C C C C C C C C</td>
<td>C N N N C N N P — C</td>
<td>—</td>
</tr>
<tr>
<td>filarees</td>
<td>C C P N C N N P C</td>
<td>N P P N C P N P P C</td>
<td>—</td>
</tr>
<tr>
<td>groundsel, common</td>
<td>C C P N C N N N C</td>
<td>N N C N C C N P C C</td>
<td>—</td>
</tr>
<tr>
<td>henbit</td>
<td>C C N P P C C C C C</td>
<td>N N C N C N C N P C C</td>
<td>—</td>
</tr>
<tr>
<td>mallow, little</td>
<td>P P P P C N P N P</td>
<td>N N P N C N N N C C</td>
<td>—</td>
</tr>
<tr>
<td>miner’s lettuce</td>
<td>— C — C C C — P C N</td>
<td>N N C N — C N N — C</td>
<td>—</td>
</tr>
<tr>
<td>mustards</td>
<td>C C P N C N C N P</td>
<td>N N C N P C N C P C</td>
<td>—</td>
</tr>
<tr>
<td>nettle, burning</td>
<td>C C C C P C P P P P</td>
<td>C N N N P N N P P P</td>
<td>—</td>
</tr>
<tr>
<td>oat, wild</td>
<td>C N C P P P P P P C</td>
<td>C C C N N P C N P C</td>
<td>—</td>
</tr>
<tr>
<td>pineapple-weed</td>
<td>— C C P N C N N N C</td>
<td>N N C N — P N — C</td>
<td>—</td>
</tr>
<tr>
<td>polypogon, rabbitfoot</td>
<td>— N — C C N — — C C</td>
<td>C C C N — P C N — C</td>
<td>—</td>
</tr>
<tr>
<td>radish, wild</td>
<td>— C N P N C N P N N</td>
<td>N N C N P N N C P C</td>
<td>—</td>
</tr>
<tr>
<td>redmaids (desert rockpurslane)</td>
<td>C C — C C C C — C C</td>
<td>C N N C — C C N C C C</td>
<td>—</td>
</tr>
<tr>
<td>rocket, London</td>
<td>— C C P N C N C N P</td>
<td>N N C N C N C N C C</td>
<td>—</td>
</tr>
<tr>
<td>ryegrasses</td>
<td>— N C C C N C C C C C</td>
<td>C C C 2 P N P C N N C</td>
<td>—</td>
</tr>
<tr>
<td>shepherd’s–purse</td>
<td>C C P P N C C C N C</td>
<td>N N C N P C N C P C</td>
<td>—</td>
</tr>
</tbody>
</table>

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

CLE = clethodim (Select Max)  OXY = oxyfluorfen (GoalTender)
FLU = flumioxazin (Chateau)  PEN = pendimethalin (Prowl H20)
GLY = glyphosate (Roundup)  PRO = pronamide (Kerb)
ISO = isoxaben (Gallery)  SET = sethoxydim (Poast)
MSM = MSMA (MSMA 6 Plus)  THI = thiazopyr (Visor)
NAP = napropamide (Devrimol)  TRIF = trifluralin (Trelfan)
NOR = norflurazon (Solicam)  24D = 2,4-D* (Orchard Master)
ORY = oryzalin (Surflan)

* Permit required from county agricultural commissioner for purchase or use.
1 At rates used for annual weeds, control of perennials is less than expected with high label rates.
2 Some populations in California are known to be resistant.
## SUSCEPTIBILITY OF SPRING/SUMMER WEEDS TO HERBICIDE CONTROL (4/09)

<table>
<thead>
<tr>
<th>ANNUAL WEEDS</th>
<th>Preemergent</th>
<th>Postemergent</th>
<th>Comb.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FLM ISO</td>
<td>NAP ORY OXY</td>
<td>PEN</td>
</tr>
<tr>
<td>barnyardgrass</td>
<td>P N C P C</td>
<td>C C C C C C</td>
<td>C P C N N P C N C</td>
</tr>
<tr>
<td>chickweed, common</td>
<td>C C C P C N C C C</td>
<td>C N C P C N P C</td>
<td>C</td>
</tr>
<tr>
<td>cockleburs</td>
<td>C P C C N N N N C</td>
<td>N N N C C N C C</td>
<td>C</td>
</tr>
<tr>
<td>crabgrass</td>
<td>P N C P C N C C C</td>
<td>C C C P C C N C</td>
<td>C</td>
</tr>
<tr>
<td>cleane, hairy</td>
<td>P N P N P N P N N C</td>
<td>N N N P P N P P C</td>
<td>P</td>
</tr>
<tr>
<td>foxtail</td>
<td>P N C C C N C C C C</td>
<td>C C C — N C C N C</td>
<td>C</td>
</tr>
<tr>
<td>cudweeds</td>
<td>— P C C N N N N N C</td>
<td>N N C N P N N P P C</td>
<td>P</td>
</tr>
<tr>
<td>filarees</td>
<td>C C C P C N N N P C</td>
<td>N N N N P C N P P C</td>
<td></td>
</tr>
<tr>
<td>goosefoot, nettleleaf</td>
<td>— C C C C P C C C C</td>
<td>C C C N P C N C C</td>
<td>C</td>
</tr>
<tr>
<td>goosegrass</td>
<td>P N C C C C C C C C C</td>
<td>C C C C C N P — N — C</td>
<td></td>
</tr>
<tr>
<td>groundcherrys</td>
<td>— C N C P C N C N C</td>
<td>N N C P C N C C C</td>
<td>C</td>
</tr>
<tr>
<td>horseweed</td>
<td>C P N P N P N N P N</td>
<td>N N C N P N P N P C</td>
<td>P</td>
</tr>
<tr>
<td>junglerice</td>
<td>P N C C C P C C C P C</td>
<td>C P C — N P C N C</td>
<td>P</td>
</tr>
<tr>
<td>knotweed, common</td>
<td>— C C P C P C C C P C</td>
<td>N N P N P C N P C</td>
<td>P</td>
</tr>
<tr>
<td>lambsquarters, common</td>
<td>C C P C C C C C C C C C</td>
<td>N N C N C C N C C</td>
<td>C</td>
</tr>
<tr>
<td>lettuce, prickly</td>
<td>— C C P N C N N N N C</td>
<td>N N C N C P N C C</td>
<td>C</td>
</tr>
<tr>
<td>lovegrass</td>
<td>P N C P C C P C C C C</td>
<td>C C C P N P C N C</td>
<td>C</td>
</tr>
<tr>
<td>nightshades</td>
<td>C C N C N N C N N —</td>
<td>N N C P C C N C C</td>
<td>C</td>
</tr>
<tr>
<td>pigweeds</td>
<td>C C C P C C C C C N P</td>
<td>N N C N C C N P C</td>
<td>C</td>
</tr>
<tr>
<td>puncturevine</td>
<td>— C P N C P C C C N P P</td>
<td>N N C P P C N C P</td>
<td>P</td>
</tr>
<tr>
<td>purslane, common</td>
<td>C C C C C C C C C C C C</td>
<td>N N P P C C N C C P</td>
<td>P</td>
</tr>
<tr>
<td>sandburs</td>
<td>— N C P C N C — C C C C P P N P N P</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>sowthistles</td>
<td>C C C P N C N P N C</td>
<td>N N C N C P N C C</td>
<td>C</td>
</tr>
<tr>
<td>sprangletops</td>
<td>— N C P C N C C C P —</td>
<td>C P C N P P P N C</td>
<td>N</td>
</tr>
<tr>
<td>spurge, spotted</td>
<td>C C N P P C P P C P P</td>
<td>N N C N N C N C P C</td>
<td>C</td>
</tr>
<tr>
<td>starthistle, yellow</td>
<td>— — — N C N N N —</td>
<td>N N C N N C N C C</td>
<td>C</td>
</tr>
<tr>
<td>thistle, Russian</td>
<td>C P C C P P P P P P</td>
<td>N N C P P C N P P C</td>
<td>C</td>
</tr>
<tr>
<td>willowherb, panicule-leaf</td>
<td>C P N P C P C — — —</td>
<td>N N P — N N N C C P</td>
<td>P</td>
</tr>
<tr>
<td>witchgrass</td>
<td>— N — C P C C C C C C C</td>
<td>C C C P N C N C C</td>
<td>C</td>
</tr>
</tbody>
</table>

## PERENNIAL WEEDS

| bermudagrass (Se) | — N C C C N C N N N  | C C C N N P C N C  | C  |
| bermudagrass (Pr) | — N N P N N N N N P  | P P N N N P N N P  | P  |
| bindweed, field (Se) | — C N N P P N P P C  | N N C N N P N C P  | P  |
| bindweed, field (Pr) | — C N N N N N N N P  | N N P N N N P N P  | P  |
| blackberries | — — N N N N N — N N  | N N C N N N P — C  |  |
| dallisgrass (Se) | — N C N C N C C C C  | C C C C C N N P C  | C  |
| dallisgrass (Pr) | — N N N N N N N N N P  | P P P C N N P N P  | P  |
| dandelion (Se) | — — C N P N — — — P  | N N C N N P N C P  | C  |
| dandelion (Pr) | — N N N N N N N N N  | N N P N N N N C — P  |  |
| dock, curly (Se) | — C P N P C C C C C  | N N C N C P N C C  | C  |
| dock, curly (Pr) | — N N N N N N N N N  | N N P N N N N P N N  | N  |
| fleeces | — N — C C P — C C C C  | P C N P N P N C C  | P  |
| fluvellins | — — — — — — — — — —  | N N P — N N P — P  |  |
| johnsongrass (Se) | C N C C C C N C C C C  | C C C C N C N C C  | C  |
| johnsongrass (Pr) | — N N P N N N N N N  | P P N N N P N N P  | P  |
| nutseed, yellow | P N P N N N N N P N  | N N P C N N N N P  | P  |
| nutseed, purple | N N N N N N N N N P  | N N P C N N N N P  | P  |
| oxalis, buttercup | — C N — P C P — P C  | N N C P — P P N — C  |  |
| plantain, buckhorn (Se) | P N N N N N N N N N  | N N N N C — C N C  | C  |
| plantain, buckhorn (Pr) | P N N N N N N N N N  | N N N N P — N N P  | P  |

C = control  P = partial control  N = no control  — = no information  Se = seedling  Pr = perennial plant  
CLE = clethodim (Select Max)  NAP = napropamide (Devrimol)  PRO = pronamide (Kerb)  
FLU = fluazipold-p-butyl (Fusilade)  NOR = norflurazon (Solcim)  SET = sethoxydim (Poast)  
FLM = flumioxazin (Chateau)  ORY = oryzalin (Surfian)  THI = thiazopyr (Visor)  
GLY = glyphosate (Roundup)  OXY = oxyfluoren (GoalTender)  TRI = trifluralin (Treflan)  
ISO = isoxaben (Gallery)  PAR = paraquat* (Gramoxone)  24D = 2,4-D* (Orchard Master)  
MSM = MSMA (MSMA 6 Plus)  PEN = pendimethyl (Prowl H20)  

* Permit required from county agricultural commissioner for purchase or use.  
1 At rates used for annual weeds, control of perennials is less than expected with high label rates.

Susceptibility of Spring/Summer Weeds to Herbicide Control (4/09) 94  
Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
### HERBICIDE TREATMENT TABLE (4/09)

<table>
<thead>
<tr>
<th>Common name (Trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PREPLANT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preemergent (before weeds germinate)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. TRIFLURALIN (Treflan, Trilin)</td>
<td>0.5–1 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER</strong>: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Broadcast preplant in 5 to 40 gallons of water per acre. Trifluralin must be incorporated immediately after application to avoid loss of activity. Plant tree roots below treated soil. Do not place treated soil near roots during planting. Controls many annuals and is helpful in suppressing perennial weeds. Residual period: 2–12 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Postemergent (after weeds emerge)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. GLYPHOSATE (Roundup UltraMax, Touchdown etc.)</td>
<td>1–4 lb a.i.</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER</strong>: 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Apply with a controlled applicator or with low-pressure flat fan nozzles. For annual weed control use 1 lb/acre in 3–10 gal water. Ammonium sulfate can also be added (1 to 2% by weight or 8.5 to 17 lbs per 100 gallon of water) to the spray solution, and significantly improves control in areas with hard water. It is important to add the ammonium sulfate to the water prior to adding the herbicide. Apply to young annuals or vigorously growing perennials in flowering stage. Some perennials require the 4 lb/acre rate for control. May be used on young weeds in the planting row followed by planting into the dead weeds. New weeds usually do not establish for a month or more, as a result of the no-till effect. Do not use more than 10.6 lb/year.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NEWLY PLANTED ORCHARDS (nonbearing trees)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preemergent (before weeds germinate)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. FLUMIOXAZIN (Chateau)</td>
<td>0.19–0.38 lb a.i.</td>
<td>12</td>
<td>365</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER</strong>: 14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Apply as a uniform broadcast application to the orchard floor or as a uniform band at the base of the trunk. Should not be applied through any type of irrigation system or on frozen soil. Mechanical incorporation is not encouraged as it will reduce residual weed control. Should not be applied to trees established less than one year, unless protected from spray by a tree collar. Do not apply within 1 year of the first harvest. Flumioxazin also has postemergent activity. When applied postemergence, always add crop oil concentrate or methylated seed oil. Ammonium sulfate can also be added to enhance weed control, at the rate of 2 to 2.5 lbs of ammonium sulfate per treated acre. Ammonium sulfate does not replace crop oil or methylated seed oil in the mixture. Use allowed under a supplemental label.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. ISOXABEN (Gallery T&amp;V)</td>
<td>0.5–1 lb a.i.</td>
<td>12</td>
<td>365</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER</strong>: 21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Wait until soil has settled around newly planted trees before applying. Controls broad-leaf weeds only before they have germinated; will not control emerged weeds. If weeds are emerged, lightly cultivate or add a postemergent herbicide. Requires incorporation for activation, either by light cultivation (1 to 2 inches) or rainfall (minimum of 0.5 inches) within 21 days after application. Sprinkler or flood irrigation can also be used for incorporation. Apply in at least 10 gal/acre of water.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. TRIFLURALIN (Treflan, Trilin etc.)</td>
<td>1–2 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER</strong>: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Preemergent selective herbicide for annual grasses. Apply prebloom by ground as a directed spray and mechanically incorporate, taking care not to injure the trees with the incorporation. Trifluralin must be incorporated immediately after application to avoid loss of activity. Used on new plantings or established orchards as a strip treatment. Suppresses bermudagrass, johnsongrass, and dallisgrass rhizomes. Only one application per year. Residual period: 2–12 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common name (Trade name)</td>
<td>Amount/Acre</td>
<td>R.E.I. (hours)</td>
<td>P.H.I.+ (days)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>D. Oryzalin (Surflan, Farmsaver Oryzalin etc.)</td>
<td>2–6 lb a.i.</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Preemergent selective herbicide for annual grasses. Apply to the soil surface in 20–40 gal water/acre. 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. Most effect on annual grasses and numerous broadleaf annuals. Very safe for young or newly planted trees and on sandy or sandy loam soils. Used to maintain control in strips down the row. The higher rates give the longest soil residual. Usually used at 4 lb a.i./acre. Residual period: 4–10 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Napropamide (Devrinol 50DF)</td>
<td>4 lb a.i.</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use is being dropped from label. Read label carefully to be sure crop is listed on label of product used. Apply to the soil surface in 20–60 gal water/acre. Use only once per season. Must be incorporated within either mechanically or with sprinkler irrigation or rainfall, within 21 days of application between November and February, or within 24 hours the remainder of the year. Effective on annual grasses and several annual broadleaves. Effective in maintaining weed-free strips down the row. Needs to be combined with a postemergent herbicide if weeds have emerged. Residual period: 4–10 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Pendimethalin (Prowl H20)</td>
<td>2–4 lb a.i.</td>
<td>24</td>
<td>365</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on dormant nonbearing trees only. Apply in 10 or more gal water/acre to soil under trees. Do not apply on newly planted trees unless soil is firm and there are no cracks in soil around base of trees. Best control is achieved when irrigation or rainfall occurs within 7 days. Will not control emerged weeds. Residual period: 4–10 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Thiazopyr (Visor) 2E</td>
<td>0.5–1 lb a.i.</td>
<td>12</td>
<td>1 year</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on nonbearing trees only. Apply in 20 or more gal water/acre. Provides nustedge and marestail suppression on coarse textured soils with low organic matter. Best control is achieved when irrigation or rainfall occurs within 7 days of application. Will not control emerged weeds. Residual period: 4-10 months. Use allowed under a SLN registration.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Postemergent (after weeds emerge)**

A. Clethodim (Select Max) | 0.095–0.125 lb a.i. | 24 | 1 year |
| WSSA MODE OF ACTION GROUP NUMBER: 1 | | | |
| COMMENTS: For use on nonbearing trees only. Apply to young perennial grasses. Repeat applications will be required for the control of perennial grasses. Apply in 5 to 40 gal water/acre. Add 0.25% v/v nonionic surfactant to the spray solution. Spray pressure should be between 30 and 60 PSI, with higher pressures used when weed density is high. Do not apply a broadleaf herbicide within one day following a clethodim application or reduced grass control may occur. Residual period: less than one month. |

B. Sethoxydim (Poast) | 0.19–0.47 lb a.i. | 12 | 1 year |
| WSSA MODE OF ACTION GROUP NUMBER: 1 | | | |
| COMMENTS: For use on nonbearing trees only. Apply to young perennial grasses. Repeat applications will be required for the control of perennial grasses. Add 2 pt/acre of a non-phytotoxic crop oil concentrate to the spray solution. Residual period: less than one month. |

C. MSMA (MSMA 6 Plus etc.) | 2–4 lb a.i. | 12 | 1 year |
| WSSA MODE OF ACTION GROUP NUMBER: 17 | | | |
| COMMENTS: For use in nonbearing trees only. Apply in 50 gallons of water per acre to insure adequate coverage. Can be applied up to three times per year. Apply as a directed spray or in such a way as to avoid contact with the foliage of prunes. |
### Herbicides Treatment Table

#### ESTABLISHED ORCHARDS  
**Preemergent (before weeds germinate)**

<table>
<thead>
<tr>
<th>Common name (Trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I. (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. TRIFLURALIN</strong> (Treflan, etc.)</td>
<td>1–2 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Preemergent selective herbicide for annual grasses. Apply prebloom by ground as a directed spray and mechanically incorporate, taking care not to injure the tree. Trifluralin must be incorporated immediately after application to avoid loss of activity. Frequently used as a strip treatment. Suppresses bermudagrass, johnsongrass, and dallisgrass rhizomes. Only one application per year. Residual period: 2–12 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **B. ORYZALIN** (Surflan, Farmsaver Oryzalin etc.) | 2–6 lb a.i. | 24 | 0 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 3 | |
| **COMMENTS:** Apply to the soil surface in 20–40 gal water/acre. If rain does not occur within 21 days, sprinkle irrigate with 0.5–2 inches of water. Most effect on annual grasses and numerous broadleaf annuals. Very safe for sandy or sandy loam soils. Used to maintain control in strips down the row. May be combined with a postemergent herbicide if weeds are present. The higher rates give the longest soil residual. Usually used at 4 lb a.i./acre. Residual period: 4–10 months. |

| **C. NAPROPAMIDE** (Devrinol) 50DF | 4 lb a.i. | 12 | 35 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 15 | |
| **COMMENTS:** Use is being dropped from label. Read label carefully to be sure crop is listed on label of product used. Apply to the soil surface in 20–60 gal water/acre. Use only once per season. Must be incorporated within either mechanically or with sprinkler irrigation or rainfall, within 21 days of application between November and February, or within 24 hours the remainder of the year. Effective on annual grasses and several annual broadleaves. Effective in maintaining weed-free strips down the row. Needs to be combined with a postemergent herbicide if weeds have emerged. Residual period: 4–10 months. |

| **D. NORFLUROSON** (Solicam DF) | 1.97–3.93 lb a.i. | 12 | 60 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 12 | |
| **COMMENTS:** Similar to oryzalin, but is effective on more annual broadleaf and grass species. Can suppress yellow nutseed or bermudagrass when used year after year. Apply to soil as a directed spray from fall to early spring under trees established for at least 2 years. If no rainfall occurs within four weeks, incorporate with sprinkler or flood irrigation. Existing weeds must be removed with cultivation or a postemergent herbicide, as norflurazon has no postemergent activity. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Do not use in the Coachella Valley. Apply in 20–100 gal water/acre. Residual period: 6–12 months. |

| **E. OXYFLUORFEN** (GoalTender) | 0.5 – 2 lb a.i. | 24 | 0 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 14 | |
| **COMMENTS:** For use on dormant trees only. Apply following harvest up to February 15 (February 1 in the Coachella Valley). Apply by ground one time per season in 40–100 gal water/acre on firm soil. Must not be mechanically disturbed or poor weed control will result. Effective as a pre-and postemergent herbicide. Effective on little mallow (cheeseweed). Useful combined with other postemergent herbicides, such as glyphosate or in combination with preemergent herbicides, such as oryzalin, simazine, or thiazopyr. Check label for use period. Residual period: 4–10 months. |

| **F. PRONAMIDE** (Kerb) 50W | 1-4 lb a.i. | 24 | 0 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 3 | |
| **COMMENTS:** Do not apply to trees less than 1 year old. Selective herbicide for control of winter annual and perennial grasses. Apply in Fall after fruit harvest. Apply in 40-50 gal water/acre to the soil at the base of the trees. Pronamide must be applied before weed emergence as it will not control emerged weeds. Rainfall or irrigation is essential after application for effective weed control. Residual period: 4-8 months. |
## Herbicides Treatment Table

<table>
<thead>
<tr>
<th>Common name (after weeds emerge)</th>
<th>Amount/Acre</th>
<th>R.E.I. (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. GLYPHOSATE</strong></td>
<td>1–4 lb a.i.</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>(Roundup Ultra Max, Touchdown etc.) WSSA MODE OF ACTION GROUP NUMBER: 9 Comments: Apply with controlled droplet application or with low-pressure, flat-fan nozzles. For annual weed control, use 1 lb a.i./acre in 3–10 gal water. Ammonium sulfate can also be added (1 to 2% by weight or 8.5 to 17 lbs per 100 gallon of water) to the spray solution, and significantly improves control in areas with hard water. It is important to add the ammonium sulfate to the water prior to adding the herbicide. For chemical mowing, consult label for exact timing and rates, depending on weed size and species. Apply to young annuals or vigorously growing perennials. Some perennials require the 4 lb a.i./acre rate for control. A good herbicide for perennial weeds, but doesn't eradicate field bindweed or nutsedge. Not effective on some broadleaf weeds at older stages of growth (little mallow and filaree). Avoid drift onto green bark or foliage of tree or injury will result. It is important to monitor treated areas for escaped weeds, as glyphosate resistant weeds have been observed in orchards where glyphosate has been used repeatedly for several years.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. PARAQUAT</strong></td>
<td>0.625–1 lb a.i.</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>(Gramoxone Inteon) WSSA MODE OF ACTION GROUP NUMBER: 22 Comments: Nonselective postemergent, contact herbicide used for quick top kill of most weed species. Less effective against perennials that will regrow (bermudagrass, dallisgrass, johnsongrass and field bindweed). Most effective when used in late winter or early spring on small annual grass species in combination with preemergent herbicides. Apply in 10–60 gal water/acre to young weeds. Use 0.25% v/v nonionic surfactant or 1.0% v/v of a crop oil concentrate. Repeat treatment as new growth occurs. Residual period: less than one month. A restricted use pesticide.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. OXYFLUORFEN</strong></td>
<td>0.5–2 lb a.i.</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Goal 2 XL etc.) WSSA MODE OF ACTION GROUP NUMBER: 14 Comments: Dormant application to young (4-leaf-stage) weeds. Effective on little mallow (cheese weed). Useful combined with glyphosate or oryzalin. May be combined with other postemergent herbicides for specific weeds. Apply following harvest up to February 15 (February 1 in the Coachella Valley). Apply by ground one time per season in 40–100 gal water/acre on firm soil. Must not be mechanically disturbed or poor weed control will result. Effective as a pre-and postemergent herbicide. Residual period: 4–10 months.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. 2,4-D</strong></td>
<td>0.95–1.425 lb a.i.</td>
<td>48</td>
<td>40</td>
</tr>
<tr>
<td>(Orchard Master etc.) WSSA MODE OF ACTION GROUP NUMBER: 4 Comments: For use on established trees one year or older. Effective on most broadleaf annual weeds. Provides partial control of field bindweed. Apply as a directed spray to weeds, using low-pressure, flooding nozzles between the tree rows. Best results are obtained when applied a few days after an irrigation. Do not allow drift onto the trees or injury may result. No more than two applications allowed during the growing season. Residual period: 4–6 weeks.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E. FLUAZIFOP-P-BUTYL</strong></td>
<td>0.125–0.375 lb a.i.</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>(Fusilade DX) WSSA MODE OF ACTION GROUP NUMBER: 1 Comments: For control of annual and perennial grass weeds. A crop oil concentrate at 0.5 to 1% v/v or a nonionic surfactant at 0.25 to 0.5% v/v must be added to the spray solution. Diammonium phosphate (10-34-0) can also be added to the spray solution, and improves control in areas with hard water. Add the diammonium phosphate to the water prior to adding the herbicide and surfactant. Avoid contact of spray with foliage of trees. Apply in 5-40 gal water, with spray pressures of 30 to 60 psi. Best results are obtained when applied within 7 days after irrigation. Do not apply to grass that is stressed or poor control may result. Repeat applications may be required for johnsongrass and bermudagrass. Residual period: less than 1 month.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.plum.html
### Herbicides Treatment Table

**Herbicide combinations**

*Note:* Combinations are most often used to broaden the weed control spectrum. At the rates recommended below, perennial weeds will not be controlled. Other combinations can be used depending upon the weed spectrum present in the orchard.

<table>
<thead>
<tr>
<th>Common name (Trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. GLYPHOSATE</strong>&lt;br&gt;(Roundup etc.)</td>
<td>0.5–1 lb a.i.</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td>PLUS...</td>
<td>OXYFLUORFEN&lt;br&gt;(GoalTender)</td>
<td>0.1–1 lb a.i.</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 14</td>
<td>COMMENTS: For broad-spectrum control of emerged weeds. Apply in a minimum of 10 gal water/acre in dormant trees. Helps increase control of cheeseweed, filaree, chickweed, and grasses. Glyphosate effectiveness is increased with low-water volume and oxyfluorfen is more effective at the higher volume. Avoid drift and follow directions for application period of oxyfluorfen.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. GLYPHOSATE</strong>&lt;br&gt;(Roundup etc.)</td>
<td>0.5–1 lb a.i.</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td>PLUS...</td>
<td>ORYZALIN&lt;br&gt;(Surflan etc.)</td>
<td>4 lb a.i.</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td>... or ...</td>
<td>NAPROPAMIDE&lt;br&gt;(Devrinol 50DF)</td>
<td>4 lb a.i.</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 15</td>
<td>COMMENTS: Use is being dropped from Devrinol label. Read label carefully to be sure crop is listed on label of product used. Combines pre- and postemergent control of most annual weeds with residual up to 6 months. Combination choice depends on weed spectrum and how rapid incorporation will occur. Napropamide needs irrigation within 7 days, oryzalin within 21 days. Apply post-directed to small seedlings when cotton is at least 8 inches tall.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. ORYZALIN</strong>&lt;br&gt;(Surflan etc.)</td>
<td>4 lb a.i.</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 3</td>
<td>PLUS...</td>
<td>OXYFLUORFEN&lt;br&gt;(GoalTender)</td>
<td>2 lb a.i.</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 14</td>
<td>COMMENTS: Combined to give broad-spectrum control. Apply preemergence or combined with paraquat or glyphosate if weeds have emerged. Irrigate within 21 days if rain has not occurred.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. GLYPHOSATE</strong>&lt;br&gt;(Roundup etc.)</td>
<td>0.5 lb a.i.</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td>PLUS...</td>
<td>2,4-D*&lt;br&gt;(Orchard Master CA etc.)</td>
<td>0.5 lb a.i.</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 4</td>
<td>PLUS...</td>
<td>SURFACTANT&lt;br&gt;(0.5–1%)</td>
<td>COMMENTS: Combined to give broad-spectrum control. Apply postemergence to young, growing weeds. Avoid drift or contact with leaves.</td>
</tr>
</tbody>
</table>

+ 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.

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.

Familiar commercial pesticide names are included to help readers recognize active ingredients, and do not represent all the labeled products that contain that chemical. For current registrations of herbicides consult a licensed, registered, Pest Control Advisor or the pesticide label.
Vertebrates

MANAGING VERTEBRATES (7/16)

Bird and mammal pests are found in and around virtually every cropping system in the state, although they may not always present a significant problem. In some crops, damage caused by birds generally results in a loss of a portion of the current crop but does not decrease future yield potential. Some pests, however, can cause major problems by feeding on fruit and on tree bark, shoots, and roots, which can stunt growth or kill plants. Injury to trees by rodents or rabbits, for example, is often serious, killing the tree outright or causing permanent damage that lowers yields for years following the initial feeding.

Some pests will chew or destroy flexible irrigation lines and emitters. Other pests will dig holes through the soil surface, thereby channeling surface irrigation water to undesired areas. Food safety also becomes an issue if pest residues come into contact with the marketable commodity.

Manage your fields in order to keep pest numbers low and to discourage new invasions so that significant damage does not occur.

- Before planting, remove vertebrate pests and destroy habitats (such as burrows) within the field boundaries. Preventive measures cost less and are more successful before planting, when one can easily see the pests or their habitats.
- Be aware of the location, as vertebrate pests can easily reinvade if the field is adjacent to rangeland, waterways, or unmanaged areas. It is much easier to manage vertebrate pests by implementing controls on the perimeter versus inside.
- Baiting, fencing, fumigating burrows, shooting, and trapping are easier and usually more effective if employed before you plant instead of after.
- Where feasible, deep plow and disc to destroy burrows, disperse or kill resident populations, and reduce the risk of reinvasion by pocket gophers, voles, and (to a lesser extent) ground squirrels.

Guidelines for reducing vertebrate pest problems and making control more economical:

- Correctly identify the species causing the problem using damage signs, burrows or habitat, tracks, feces, etc.
- If feasible, alter the habitat to make the area less favorable to the pest species (e.g., eliminate cover crops and weeds or keep them mowed low.)
- Take early action and use the control methods appropriate for the crop and time of year. Consider the environment and nontarget species when choosing a control method.
- Establish a monitoring system to detect reinestation so you can determine when additional corrective measures or controls are necessary.

A successful pest management program requires good records and regular monitoring. Some vertebrate pest populations can easily “explode” because of high reproductive rates and abundant food. Keep a record of the management procedures you use and their effectiveness. Good records will help you plan and improve future control strategies.

For most vertebrate pests, there is more than one control option for reducing numbers and damage. The following table summarizes the various control measures appropriate for common vertebrate pests. Details on how to use these controls are given in the individual pest sections.
Vertebrate control equipment and supplies (baits, fumigants, propane exploders, traps, etc.) are available at local retail outlets such as farm supply and hardware stores. In addition, some county agricultural commissioner's offices make certain rodenticides and fumigants available to growers. For further information or sources of special control materials, consult your local Cooperative Extension advisor or agricultural commissioner's office.

### Legal aspects of vertebrate pest management

Under the California Fish and Game Code, if California ground squirrels, meadow voles, pocket gophers, eastern fox squirrels, roof rats, black-tailed jackrabbits, cottontail rabbits, American crows, house sparrows, starlings, and yellow-billed magpies are causing or are anticipated to cause crop depredation, the owner or tenant of a property may use lethal methods to remove them at any time.

For other pests such as deer, wild pigs, western gray squirrels, and most bird species, depredation permits are required for removal. However, these regulations can change at any time, so it is always a good idea to check current California Fish and Game Code (http://leginfo.legislature.ca.gov/faces/codes.xhtml) to ensure removal of a particular species is legal.

### Pesticides

Only pesticides that are registered with the California Department of Pesticide Regulation (DPR) can legally be used for vertebrate pest control. Registered materials are listed in DPR's databases that are available online (http://www.cdpr.ca.gov/). You may also contact your county agricultural commissioner for current product registrations and the latest information on legal pesticide use, including current information on restrictions that apply to pest control activities in order to protect endangered species. Follow label directions carefully and understand the hazards when using poison baits and fumigants.

The U.S. Environmental Protection Agency (EPA) has placed restrictions on most rodenticides used to control vertebrates in agricultural production. The applicator must have a permit to purchase and use the product. These products will be identified with an asterisk (*).
Trapping
Trapping is often used to control vertebrate pests. Mark all traps clearly with the owner’s name and contact address or phone number. In California, trapping mammals, even for pest purposes, requires a trapping license issued by the California Department of Fish and Wildlife. However, rats, mice, moles, voles, and pocket gophers do not have this requirement. Additionally, you do not need a trapping license for ground squirrels or rabbits if trapping on your own property for pest control purposes. However, if trapping either of these species for profit (e.g., pest control operator), a trapping license is required.

Protected species
In some areas of California, crop fields are located within the range of federally- and state-protected threatened or endangered species. Species likely to be of concern include the San Joaquin kit fox, several species of kangaroo rats, and, where burrow fumigants are used, the blunt-nosed leopard lizard, California red-legged frog, and California tiger salamander.

Typical guidelines
Special guidelines apply to the use of toxic baits and fumigants for vertebrate pest control in these areas. These include

- Modification of ground squirrel bait stations to exclude protected species
- Restrict broadcast applications of bait
- Prohibit fumigation at certain locations or during some times of the year
- Require that applications be supervised by someone trained to avoid harming endangered species

Your county agricultural commissioner has the latest detailed maps that show the ranges of endangered species and the latest information on restrictions that apply to pest control activities in those areas. You can also get more information on endangered species regulations from the DPR website (http://www.cdpr.ca.gov/docs/endspec/).

For more information on vertebrate management, see the Vertebrate Pest Control Handbook online (http://vpcrac.org/about/vertebrate-pest-handbook/).
Birds (7/16)

Common Name: Scientific Name:
Crow: Corvus brachyrhynchos
Crowned sparrow: Zonotrichia spp.
European starling: Sturnus vulgaris
House finch: Carpodacus mexicanus
House sparrow: Passer domesticus
Scrub-jay: Aphelocoma californica
Yellow-billed magpie: Pica nuttalli

DESCRIPTION OF THE PEST

Several bird species may cause serious problems in plum and prune production in California.

Crow

The crow is chunky, black, 17 to 21 inches long with a thick, black bill and feet. They are easy to recognize by their loud caw caw caw sound. Crows are gregarious and often feed in large numbers, moving from orchard to orchard.

California Fish and Wildlife regulations allow crows to be taken only by landowners or tenants, or by persons authorized in writing by such landowners or tenants, when crows are committing or about to commit depredations (damage to crops).

European starling

Starlings are dark colored birds with light speckling on the feathers. They are about 7.5 to 8.5 inches long with a short tail. They have a long, slender yellow bill in summer and a dark one during the winter. Starlings have a wide habitat range but prefer areas with trees. If their excrement or droppings contact the fruit, it will cause unsightly blemishes and may transmit diseases.

Starlings are an invasive, exotic species and can be lethally removed at any time.

House finch

House finches are highly adapted to human environments. House finches are typically 5 to 6 inches long and feed in small flocks. Male finches have a rosy-red or orange head, rump, and breast with brownish wings and back, and a brown streak on their sides. Females have the brown body and wings, but lack the red or orange coloration.

House finches are migratory, nongame birds, and can only be lethally removed with a depredation permit from the U.S. Fish and Wildlife Service or under supervision of the local county agricultural commissioner.

Magpie

Yellow-billed magpies are noisy birds, 16 to 20 inches long. Adults have bold, distinct markings; they are mostly black with white stripes and a white belly. Their black wings and tails have a metallic blue green iridescent hue. The bill and the skin around the eyes are yellow. They feed in small flocks of a few birds to several dozen. They may be abundant locally.

A federal permit is not required to control magpies when they are found committing or about to commit depredations (damage to crops). However, you should always consult with state and local authorities before taking magpies as legal mandates can change.

Scrub-jay

Scrub-jays are aggressive birds, 10 to 12 inches long, and are distinguished by their crestless head, olive-gray back, and white throat with a blue outline. Their head, tail, and wings are blue. Scrub-jays are usually solitary birds but occasionally feed in pairs. Where jay habitat is adjacent
to an orchard, however, several dozen may invade the trees daily, forming almost continuous lines moving to and from trees.

Scrub-jays are classed as a migratory nongame bird and may only be removed under permit from the U.S. Fish and Wildlife Service.

**Sparrow**

White-crowned and golden-crowned sparrows cause damage in California. Both are about 6 to 7 inches long. White-crowned sparrows have a distinct pink or yellowish bill, erect posture, gray throat and breast, and a visible crown streaked with black and white. Their call is a clear whistle. Golden-crowned sparrows are similar, except they have no white head stripes. A golden-yellow central crown stripe is prominent with black borders. Their call is three to five clear whistles. Overall, golden-crowned sparrows are less numerous and cause fewer problems than white-crowned sparrows.

Crowned sparrows are migratory, nongame birds, and can only be lethally removed with a depredation permit from the U.S. Fish and Wildlife Service or under supervision of the local county agricultural commissioner.

The house sparrow is a small (approx. 6 inches), stocky songbird with short legs and a thick bill. Male house sparrows have a black throat and white cheeks. The male has a reddish back and black bib, while the female is distinctly brown. The house sparrow is an invasive, exotic species, and as such, can be lethally removed at any time.

**DAMAGE**

**Tree fruit (except citrus) and nut crops**

Several bird species including scrub-jays, magpies, sparrows, house finches, crows, and starlings may cause substantial damage by feeding on ripening fruit or developing nuts. In general, scrub-jays and magpies feed in smaller numbers. However, they can congregate in larger flocks when orchards are found adjacent to perennial, thick vegetation. Crows and starlings typically fly in larger flocks. Bird species that congregate in large flocks are more difficult to control.

Sparrows and house finches can also damage fruit buds during the dormant season. Bird damage usually is most severe in areas that are adjacent to wild or brushy areas or power line poles where birds find refuge, breeding sites, and other sources of food. This damage will often go undetected until the trees are in full bloom unless the trees are observed closely during bud break or the birds are caught in the act. This leads to loss of fruit production and can be the most significant form of bird damage for some growers.

**MANAGEMENT**

**Biological Control**

Natural predators such as raptors and bobcats will feed on some of the smaller bird species, although these numbers mean little for controlling such bird pests.

**Cultural Control**

**Habitat modification**

Always consider habitat modification as a first step for controlling bird pests.

- Look for and eliminate brush or pruning piles, stacks of irrigation pipes, piles of boxes, etc., where birds may rest and nest.
- Consider removing roosting trees along perimeters to reduce bird invasion into fields. However, there are few situations when habitat modification can be used to control high bird numbers. As such, alternative control methods will likely be needed.

**Monitoring and Treatment Decisions**

Count birds weekly to help you determine when damage will occur so you can take action early. This is particularly important to reduce damage to fruiting buds and newly sprouted row crops.
1. Watch for bird movement into or within the field.
2. Keep track of species, numbers, and location if you have had substantial damage in the past.
3. As fruit begins to ripen or as the nuts develop, look for fruit or nuts that are damaged or that have been knocked from the tree or vine. These records will help you plan control strategies in advance and assess the effectiveness of previous control actions.

**Frightening devices**

Frightening devices can deter some species (e.g., crowned sparrows, crows, magpies, starlings), but are less effective for others (e.g., house finches, house sparrows, scrub-jays).

The most effective way to frighten birds from a field is to use a combination of noisemakers and visual repellents such as mylar streamers and "scare-eye" balloons. For example, scare-eye balloons may be attached to trees or posts that are next to electronic distress call devices. This combination may increase effectiveness over using either approach by itself. For maximum effectiveness, rotate from one type of frightening device to another and do not use one combination of devices for more than a week; otherwise, birds will become used to it.

Common noisemakers include roving patrols of bird bombs and shell crackers. Stationary devices such as gas cannons and electronic distress calls also provide relief. These stationary devices are most effective when you have at least 1 device per 5 acres and when they are elevated above the canopy.

Regardless of the approach used, pay attention to bird responses when using frightening devices. When birds no longer respond negatively to a specific approach, you must switch to a different frightening tactic to continue to scare birds out of the field. At best, an appropriate rotation of frightening devices will control bird pests for a few weeks. Therefore, only use these scare-tactics when needed to prevent birds from habituating to these auditory and visual repellents. Additionally, once birds become accustomed to feeding in a field, frightening tactics become much less effective. Therefore, have frightening devices ready to implement before damage occurs so that birds can be deterred right at the onset of damage.

**Shooting**

Birds that invade orchards in small numbers, such as scrub-jays and magpies, can often be controlled by shooting. Check with California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and county agricultural commissioner officials before shooting any birds as depredation permits are often needed.

Where permissible, occasionally shooting at a few birds will increase the effectiveness of your noisemaking techniques, especially if noise makers go off at the same times as the actual shots, because birds will begin associating loud noises with the real hazards of firearms.

**Trapping**

Trapping can be an effective way to control house finches, house sparrows, crowned sparrows, and starlings, especially if conducted over a relatively large area such as several orchards or vineyards. The most effective trap for these species is the modified Australian crow trap.

Successful trapping must take into account the behavior patterns of the birds being controlled. These traps use live birds as decoys to attract additional birds. Therefore, place traps in suitable locations with adequate food, water, shade, and roost locations to keep the trapped birds alive.

Trapping is best carried out by someone experienced with the technique. For house finches and crowned sparrows, trapping must be conducted under supervision of the county agricultural commissioner.
Trapped birds are usually euthanized through the use of a CO₂ chamber. Leave some birds alive to serve as future decoys.

**Repellents**  
Chemical repellents rely on objectionable tastes, odors, or learned aversions to deter birds from consuming or damaging fruit.

Commercial repellents containing the active ingredient methyl anthranilate are currently registered for use in some crops. This repellent has been shown to effectively reduce bird damage to several fruit species in some studies, while showing little efficacy in others. Efficacy is likely influenced by the availability of alternative food sources and ability of the user to apply the repellent following the label recommendations. In some situations, methyl anthranilate may provide some relief for small orchards although overall efficacy is uncertain. If you decide to use methyl anthranilate, be sure to carefully read the label as California restrictions are different than most other states.
California Ground Squirrels

Scientific Name: *Otospermophilus beecheyi* and *O. douglasii*

**DESCRIPTION OF THE PEST**

The adult California ground squirrel:
- Head and body 9 to 11 inches long
- Somewhat bushy tail is about as long as its body
- Fur is mottled dark and light brown or gray

Ground squirrels live in colonies that may grow very large if left uncontrolled. They are active during the cooler times on hot days and sunny periods during the cooler months; they are usually most active in morning and late afternoon. In periods of high winds, ground squirrels retreat to their burrows.

California ground squirrels live in underground burrows and form colonies of 2 to 20 or more animals. Each ground squirrel burrow system can have several openings with scattered soil in front. Individual ground squirrel burrow systems may be 5 to 30 feet long, 2.5 to 4 feet below the surface, and about 4 to 6 inches in diameter. Burrows provide the ground squirrels a place to retreat, sleep, hibernate, rear their young, and store food. Ground squirrels often dig their burrows along ditches and fencerows around buildings, within and bordering many agricultural crops, and on other uncultivated land. They tend to avoid flood irrigated areas, thick chaparral, dense woods, very moist areas, and lands that are under complete and frequent cultivation. They will travel 100 yards or more to feed in adjacent crops. When uncontrolled, they frequently move into perennial crops, such as orchards and vineyards, and dig burrows beneath the trees or vines.

The California ground squirrel can be active throughout the year in coastal areas of Southern California. Ground squirrels in the southern San Joaquin Valley become much less active during the winter, but seldom truly hibernate. Especially in hot locations, adult ground squirrels become temporarily dormant (estivate) when food is scarce or temperatures are extreme, primarily in late summer. Winter hibernation and summer estivation are more typical among ground squirrels in inland areas where temperature variations are more extreme. Regardless of location, young ground squirrels tend to be active all summer.

Ground squirrels that do hibernate generally emerge around January when weather begins to warm. In late winter and spring, they feed on green vegetation but switch to seeds and fruit in late spring and early summer as the vegetation dries up. Females have one litter, averaging 8 young, in spring. Young ground squirrels emerge from their burrow when about 6 weeks old; they do not estivate their first summer, and many may not hibernate during their first winter.

**DAMAGE**

California ground squirrels are responsible for major damage throughout the state. Their damage is most prevalent in crops adjacent to uncultivated areas where ground squirrels are not controlled.
- They easily climb trees and vines and feed on fruit and nuts from set to maturity and through harvest. Adult ground squirrels often cache seeds and nuts in their burrows, especially in the late summer and early fall. During this period, crop losses greatly exceed the amount the ground squirrels have consumed. Ground squirrels also consume vegetative crops (e.g., alfalfa, cole crops, and lettuce) and berries.
- Ground squirrels also gnaw fruit and bark, girdle trunks and scaffold limbs, and are capable of girdling and killing trees or vines in a relatively short time.
- In addition to above ground damage, they can damage roots, enabling fungal pathogens to infect trees.
- They often chew plastic irrigation lines, and their burrows can contribute to soil erosion.
- When digging burrows, ground squirrels bring soil and rock to the surface and deposit it in mounds near burrow openings. They enlarge burrow systems each year by constructing new tunnels and creating more entrances, so the longer the ground squirrels occupy the burrow, the more extensive it becomes. They create more entrances to serve a growing population.
Large and numerous burrow openings and soil mounds are hard on equipment and can make mechanical harvesting especially difficult.

- The burrows of ground squirrels can divert irrigation water and have been known to cause severe damage to levees and other water retention systems.
- In some areas, ground squirrels can also pose a health risk to humans through the spread of sylvatic plague.

**MANAGEMENT**

The management action needed for ground squirrels depends on their activity pattern and feeding preferences during the time of year when action is taken. The choice of tactics is also influenced by the location of the infestation and number of ground squirrels present. For more detailed information on managing ground squirrels, see Ground Squirrel Best Management Practices (available online at http://www.groundsquirrelbmp.com/management-cgs.html).

**Biological Control**

Predators such as coyotes and hawks are usually not sufficient to effectively control ground squirrels. These predators consume a number of ground squirrels, but usually not enough to keep populations at sufficiently low numbers to eliminate the need for additional control measures.

**Cultural Control**

**Habitat modification**

Ground squirrels often burrow beneath long-standing piles of prunings, wood, or rock, or use them as harborage. Removing such piles may make the area somewhat less desirable to them, but the base of trees, fence lines, and ditch banks still offer burrowing sites. Peripheral cleanup may somewhat reduce the potential for ground squirrels. In addition, it makes burrow detection and monitoring easier and improves access to burrows during control operations. Ground squirrels are extremely adaptable so habitat modification has limited benefit in a management program. Squirrels may quickly reinvade abandoned burrow systems. Deep plowing (ripping) along field perimeters will destroy burrow entrances and will help slow the rate of invasion. Burrow fumigants, toxic baits, and traps currently are the most effective control methods.

**Monitoring and Treatment Decisions**

To make it easier to monitor and help reduce numbers, remove brush piles, debris, and stumps in and around the crop fields. Monitor for ground squirrels year round, even in winter, especially during midmorning when they feed most actively. Monitor within the crop field during routine activities. Mid morning is usually the best time of day to observe squirrel activity.

To monitor:

1. Observe feeding grounds and watch for other signs of activity especially the appearance of burrows.
2. Check the perimeter of the crop fields at least once a month during the times of year when ground squirrels are active.
3. Periodically monitor areas from which ground squirrels are likely to invade, such as along ditch or road banks or in crops adjacent to your field.

Keep records and use them as the basis for future management decisions, noting:

- When ground squirrels emerge from hibernation
- When the first young are seen above ground
- Approximate number of ground squirrels you see and the location and number of burrows
- Changes in the general number of ground squirrels
- Management actions implemented, dates of use, and their effect

**Treatment options**

When even one or two ground squirrels are present in or immediately adjacent to the crop field, be prepared to take action. Treatment options for ground squirrels include the use of fumigants.
(e.g., gas cartridges, aluminum phosphide,* and carbon monoxide-producing devices) and baiting with multiple-dose anticoagulants (e.g., chlorophacinone* and diphacinone*) or zinc phosphide*. These are restricted-use pesticides that require a permit from the county agricultural commissioner for purchase or use.

Select the control method best suited for the time of year.

- The most effective time to control ground squirrels is in late winter or early spring when adults have emerged from their burrows but before they reproduce. For best control, use burrow fumigation about 2 to 3 weeks after the first ground squirrels emerge from hibernation.
- Because ground squirrels feed almost exclusively on green vegetation early in the season, poisoned grain baits are generally not effective until late spring or early summer.
- Trapping can be used year round but is most effective when numbers are low.
- In late spring or summer, at locations where squirrels are moving from adjacent lands into the crop field to feed, baiting or trapping along the perimeter offers the most effective control if access to the neighboring property is not possible.

**Fumigants**

Fumigation can be very effective against ground squirrels. The best time to fumigate is late winter or early spring when the ground squirrels are active and soil is moist. Fumigation is also possible later in the year as long as sufficient soil moisture is present, although it is not effective when ground squirrels are hibernating or estivating: at those times, they seal themselves off from within their burrows. When the soil is dry, fumigation is much less effective because more of the toxic gas escapes from burrows through cracks in the soil.

When using a fumigant, make sure to treat all active burrow systems in and around the crop field. Recheck all areas a few days after fumigation and re-treat any that have been reopened. For safety’s sake, do not fumigate burrow systems that are adjacent to buildings or may open under structures.

A relatively easy way to fumigate is with the use of gas cartridges. They are available commercially and from some county agricultural commissioners’ offices. Use one or two cartridges for each burrow that shows signs of activity. A large burrow system may require more than two.

1. Quickly shove the ignited cartridge into the burrow using a shovel handle or stick and seal the burrow entrance with soil.
2. Watch nearby burrow entrances; treat and seal any that begin to leak smoke.
3. If smoke is observed escaping from other entrances, it means the burrows are connected. If the burrow is believed to be small, this additional entrance only needs to be sealed. If the burrow appears to be large, an additional cartridge may need to be inserted following the above-outlined protocol.

The larger and more complex the burrow system, the more smoke it takes to be effective.

Aluminum phosphide* is also a highly effective burrow fumigant. In fact, studies of this material for ground squirrel management indicate an efficacy of 95 to 100%. When aluminum phosphide* tablets come into contact with moist soil and air in the burrow they produce phosphine gas, which is highly toxic to any animal (never add water directly to the burrow to increase moisture as spontaneous combustion can occur if the product contacts water). When using aluminum phosphide*, treat every active burrow, fill the entrance with a wad of newspaper, and cover with soil. In addition to being somewhat more effective than gas cartridges, aluminum phosphide* is also much cheaper to apply. However, aluminum phosphide* is a highly restricted-use material, and these restrictions are frequently changing. Be sure to understand the current restrictions in place before using for ground squirrel control.

Application personnel should be trained in the material’s proper use and on its potential hazards.
As of 1 January 2012, pressurized exhaust machines can now be used to apply carbon monoxide to burrow systems. As of 2014, the author is aware of two commercial products available: the Pressurized Exhaust Rodent Controller (PERC®) machine and the Cheetah rodent control machine. Initial research into the efficacy of these devices has indicated that the PERC® is moderately effective for California ground squirrels, although results were highly variable. The Cheetah rodent control machine did not prove to be effective. Plans are in place to further test these devices in the future.

**Baiting**

Poison bait is usually the most cost-effective method for controlling ground squirrels, especially when numbers are high. Bait consists of grain or pellets treated with a poison registered for ground squirrel control. To be effective, bait must be used at a time of year when ground squirrels are feeding on seeds and will readily accept baits such as in late spring or early summer. In fall, ground squirrels store a lot of the seed instead of eating them, so it may require more bait to control the population.

Before you use baits, place a small amount of untreated grain, such as breakfast oats, near burrows in the morning and check in the late afternoon to see if the ground squirrels have taken it (this ensures that nocturnal animals have not eaten the grain). If the grain is taken during the day, proceed with baiting. If it is not taken, wait several days or a week and try again. Remember: bait is only effective if eaten by the target pest. If in a nut orchard, once squirrels begin feeding on nuts, they no longer show much interest in grain baits. Therefore, baiting programs must be initiated before this time to ensure effective control of ground squirrels. When using poison baits, make sure to follow label directions carefully to reduce hazards to nontarget species.

Multiple-dose anticoagulant baits (e.g., chlorophacinone* and diphacinone*) can be applied in bait stations, as spot treatments near burrows, or broadcast over larger infested areas. Check the label to make sure that the bait you plan to use is registered for the method you intend to use. For a multiple-dose bait to be effective, animals must feed on it over a period of 3 to 5 days so if spot or broadcast treatments are used, 2 or 3 applications may be necessary.

Zinc phosphide* is an acute toxicant that can also be use to control ground squirrels. It kills ground squirrels after a single feeding, so it can reduce numbers more quickly than anticoagulants. However, zinc phosphide* has a distinctive odor and taste that many ground squirrels seem to avoid. Likewise, ground squirrels will occasionally consume a sublethal dose of zinc phosphide* that will cause individuals to get sick but will not kill them. This leads to bait shyness in a ground squirrel population. These problems with bait acceptance and bait shyness sometimes result in greater control of ground squirrels when using anticoagulant baits. Pre-baiting the area with untreated grain 2 to 3 days prior to the application of zinc phosphide* may reduce the chances of bait shyness and improve the effectiveness of baiting programs. Control with zinc phosphide* is usually achieved within 48 hours of the bait application.

**Baits applied as broadcast or spot treatments**

When specified on the label, zinc phosphide* and anticoagulant baits* can be applied as spot-treatments, which are economical and effective for small populations. Reapply according to label directions to make sure there is no interruption in exposure to the bait. Scattering the bait takes advantage of the ground squirrels’ natural foraging behavior and minimizes risks to nontarget species that are not as effective at foraging for seeds. Never pile the bait on the ground because piles increase the hazard to livestock and certain nontarget wildlife.

When ground squirrel populations are larger or cover a broader area, broadcast applications of zinc phosphide* or anticoagulants* may be used. This can be an effective and economical method for controlling this species over a large area. Usually squirrels retreat back to burrows when sick and will die there, although up to 20 to 30% of ground squirrels may die aboveground.

**Baits applied in bait stations**

Various kinds of bait stations are commonly used with diphacinone* and chlorophacinone* 0.005% baits; all are designed to let ground squirrels in but to exclude larger animals.
types of stations must be used within the ranges of the San Joaquin kit fox or endangered kangaroo rats to ensure that these species are excluded. Consult your local agricultural commissioner or the California Department of Pesticide Regulation website (http://www.cdpr.ca.gov/docs/endspec/) for the latest recommendations on use of poison baits in areas that are within the range of endangered species.

1. Place bait stations near runways or burrows and secure them so they cannot easily be tipped over. If ground squirrels are moving into the crop field from adjacent areas, place bait stations along the perimeter of the field where ground squirrels are invading, one station every 100 feet. Use shorter intervals between stations when the number of ground squirrels is high.

2. Check bait stations daily at first, then as often as needed to keep the bait replenished. If bait feeding is interrupted, the bait's effectiveness will be greatly decreased. Make sure to pick up any bait that spills and to replace bait that is wet or moldy. Successful baiting usually requires 2 to 4 weeks. Continue to supply bait until feeding ceases and you observe no ground squirrels; then remove and properly dispose of unused bait if there is not a threat on continued reinvasion.

3. Zinc phosphide* cannot be used in bait stations.

After treatment, pick up and dispose of any carcasses whenever possible to prevent secondary poisoning of dogs or other scavengers. Burial is a good method for disposal as long as the carcasses are buried deep enough to discourage scavengers. Do not touch dead animals with bare hands.

Assess the potential hazard to humans, livestock, and nontarget wildlife before you use baits; if it is risky, use another method for ground squirrel control.

**Trapping**

Because trapping is time-consuming, it is most practical for small infestations any time of year when ground squirrels are active. Trapping is especially effective from mid-spring through fall. Ground squirrel traps include Conibear traps and modified gopher box traps. As with all traps, take precautions to minimize trapping of nontarget wildlife and pets.

**Conibear traps**

Conibear kill traps are usually placed unbaited in the burrow entrance, where ground squirrels are trapped as they pass through. Trap effectiveness can be increased by putting a tunnel of roofing paper (24 inches long) at the entrance of the burrow. The ground squirrel will mistake the light at the end of the tunnel for the burrow opening and run full speed through the trap. The tunnel also minimizes any sun reflection off the metal trap.

If you are using this type of trap within the range of the San Joaquin kit fox, you must place the trap in a covered box with an entrance no larger than 3 inches wide to exclude the fox, or you must spring the traps at dusk and reset them again in the morning.

**Box traps**

Modified wooden pocket gopher box traps consist of a pair of box traps that have been joined together by removing the backs, connecting the two traps with wire mesh, and then to a board. Another very effective trap is a single wooden box trap. The single wooden box trap (Critter GetterDK-3) is larger than the pocket gopher box trap (DK-2) and has a pull trigger rather than the push type for pocket gophers. The traps are baited with foods such as almonds, barley, melon rinds, oats, or walnuts. Place bait in traps well behind the trigger or tied to the trigger without setting the traps for several days, until the ground squirrels become used to taking the bait. Then put in fresh bait and set the traps. With the single pull trap, secure the bait to the trigger and wire the trap to a stake, fence, or other stationary object. Place traps so that nontarget animals are not likely to be caught. For example, place traps inside a larger box with no openings no larger than 3 inches wide, just large enough to allow ground squirrels to enter.
Live traps
Live-traps, such as wire-cage and multiple-capture traps, can also be used to capture ground squirrels. The Black Fox repeating live trap has proven to be very effective in catching several individuals at one time. This 24”x 24” x 4” heavy gauge wire trap has doors that are wired open for several days for pre-baiting. When the self-closing doors are dropped down after pre-baiting, the ground squirrel pushes to get in but cannot get out. As with box traps, pistachios, almonds, walnuts, oats, barley, and many fruits and vegetables are all effective baits. Because these traps keep ground squirrels alive after capture, they are useful in areas where nontarget captures are a concern (e.g., areas with pets, children, etc.). However, ground squirrels must be euthanized by the trapper upon capture as translocation of ground squirrels is illegal unless in possession of a permit issued by the California Department of Fish and Wildlife, unloads your problem on others, and can spread disease such as sylvatic plague. It is this extra step that limits the utility of live-trapping for some growers. Methods considered humane by the American Veterinary Medical Association include: gassing with carbon dioxide and shooting. Drowning is not an approved method of euthanasia and is illegal in California. Traps need to be checked once daily, and any animals found must be removed and should be euthanized.

Gas explosive device
The use of a gas explosive device that combines propane with oxygen has been used to kill ground squirrels through concussive force. This device has the added benefit of destroying part or all of the ground squirrel’s burrow system, thereby potentially slowing reinvasion rates. This control method carries with it a substantial fire hazard. To date no scientific studies have shown this method to be overly effective at ground squirrel control.

Repellents
No repellents have proven effective at substantially reducing damage caused by ground squirrels.

Frightening devices
No frightening devices have proven effective at substantially reducing damage caused by ground squirrels.

* User must be a certified applicator or be under the supervision of someone who is. Some products also require a permit from the county agricultural commissioner for purchase or use.
POCKET GOPHERS (7/16)
Scientific Name: Thomomys spp.

DESCRIPTION OF THE PEST
Pocket gophers are stout-bodied rodents with short legs. Adults:
- 6 to 8 inches long
- brown, gray, or yellowish
- large clawed front paws
- small ears and eyes
- a short, scantily haired tail
On each side of the mouth pocket gophers have external cheek pouches or “pockets” used extensively for carrying food.

Pocket gophers are rarely seen above ground. They live almost entirely underground spending most of their time in a tunnel system they construct 6 to 12 inches beneath the soil surface. A single burrow system can cover several hundred square feet and consists of main tunnels with lateral branches used for feeding or for pushing excavated soil to the surface. Because gophers are extremely territorial, you rarely find more than one gopher per burrow system, unless it is during the breeding season or females are tending their young.

The conspicuous, fan-shaped soil mounds over tunnel openings are the most obvious sign of a gopher infestation. These tunnel openings are almost always closed with a soil plug unless the gopher is actively excavating a tunnel.

Gophers feed primarily on the roots of herbaceous plants. They may also come aboveground to clip small plants within a few inches of the tunnel opening and pull vegetation into the burrow to eat.

Gophers breed throughout the year on irrigated land, with a peak in late winter or early spring. Females bear as many as three litters each year, although typically only one or two per year, each averaging five young. Once weaned, the young gophers travel to a favorable location to establish their own burrow system. Some take over previously vacated burrows. The buildup of gophers in crop fields is favored by extensive weed growth, including nutsedge, or the presence of many cover crops, especially perennial clovers and legumes.

DAMAGE
Pocket gophers can be serious pests. They are active throughout the year and if uncontrolled and food is plentiful, can increase to 30 to 40 gophers per acre.

While herbaceous cover crops are their preferred food, pocket gophers also feed on the bark of tree crowns and roots, particularly when cover crops or weeds dry up. Bark consumption may be extensive enough to girdle and kill young vines or trees or reduce the vigor of older vines or trees. Usually gophers feed on trees from underground so the damage may not be evident until they show signs of stress. Pocket gophers also feed on the roots of vegetable and berry plants. Plants with more fibrous root systems often suffer minimal damage; plants with large taproots are most susceptible. Gophers sometimes gnaw on plastic irrigation lines. These holes lead to uneven water distribution, with some areas receiving too much water, and other parts not receiving any. Fixing pocket gopher punctures of subsurface drip tape can be time-consuming and quite expensive. Tunnel systems often lead to a loss or diversion of irrigation water and may lead to severe erosion.

MANAGEMENT
Persistent efforts can control pocket gophers and even eliminate them. Pocket gopher damage typically occurs belowground; therefore, it often goes undetected until individual plants or trees exhibit stress. By that time the tree or plant may be beyond saving. Gopher activity is readily
detected, however; just look for fresh mounds of soil. Gophers make the greatest numbers of fresh mounds in the spring and fall, when the soil is amply moist.

Take action as soon as you see any sign of gopher activity. Common control methods include trapping, aluminum phosphide* fumigation, or hand-applied poison bait. Trapping and hand-baiting can be used at any time of year, but they are easier when the soil is moist and not dry and hard; aluminum phosphide* must be used when the soil is moist. Control of vegetative cover can reduce the attractiveness of fields to gophers by removing preferred food sources (e.g., nutsedge, clovers, and legumes). In addition, consider managing gophers in adjacent areas to reduce the potential for gopher reinvasion.

Gopher control is best done in late fall through late winter when mounding activity is high. Additionally, because numbers are usually lowest during early winter, management during this time of year can be more effective than after gophers have reproduced.

**Biological Control**
Snakes, owls, and hawks are usually not sufficient to effectively control gophers. These predators consume a number of gophers but usually not enough to keep populations at low enough numbers to eliminate the need for additional control measures.

**Cultural Control**
**Flood irrigation**
If flood irrigation is possible, it can help control gophers; they are not aquatic. This type of irrigation often drives gopher activity to the edges of the field where they are more easily located to control, if not killed by flooding. Growers and their dogs can also actively seek out voles at this time to further reduce population size.

**Tilling**
When taking a field out of production, deep tilling of soil will kill some gophers and destroy most or all burrow systems in a field. This can slow reinvasion rates and provides more time to get gopher populations under control.

**Monitoring and Treatment Decisions**
The best times to monitor for gopher activity are after irrigation and when mound building peaks in fall and spring.
- Monitor monthly.
- Pay close attention to field perimeters to determine whether gophers are invading the field from adjacent property.
- Monitor closely in weedy areas such as roadsides and in young orchards with extensive weed growth or ground cover. This type of vegetation is more likely to support gophers, and low-growing vegetation makes signs of burrowing activity more difficult to see.
- Look for darker-colored mounds, which indicate newly removed, moister soil.
- If you find mounds, trees or vines showing signs of stress, or both, look for girdling of roots or crowns at or below the soil.

**Treatment options**
The preferred control methods are baiting with multiple-dose anticoagulants, strychnine* or zinc phosphide*, trapping, and burrow fumigation. Neither chemical nor mechanical repellents have been found effective against pocket gophers. Remove vegetative cover and preferred food sources (e.g., clovers and legumes) to reduce the attractiveness of cover crops in orchards and vineyards to gophers. Often, a single approach is not sufficient to effectively control gophers. An integrated approach that uses more than one control option should provide greater control.

Strychnine*, zinc phosphide*, anticoagulants*, and aluminum phosphide* are currently restricted materials that require a permit from the county agricultural commissioner for purchase or use in agricultural fields. Be aware that restrictions for use of baits and fumigants around buildings may exist. However, restriction criteria of baits and fumigants often change, so it is best to consult...
your local agricultural commissioner before using any baits or fumigants to assure full compliance with current laws and regulations.

All treatment options require access to the main tunnel, located about 6 to 12 inches belowground. Finding the main tunnel takes practice, skill, and the use of a probing device. To find a main tunnel:

1. Locate a fresh gopher mound. The key is to look for mounds that contain moist dirt.
2. Start by finding the plug of the mound.
3. Begin probing anywhere from 4 to 12 inches behind this plug.
4. You will know you have found the tunnel when you feel a drop in the probe (i.e., less resistance) of a couple of inches. Tunnels typically run in only one or two directions. Occasionally you will have tunnels running in three or more directions.

**Baiting**

While multi-dose anticoagulants (e.g., chlorophacinone* and diphacinone*) are available for gopher control, single-dose acute baits (e.g., strychnine* and zinc phosphide*) have historically been the most effective.

Gophers often back-fill old tunnels with loose soil and these backfilled tunnels can feel like open tunnels to inexperienced bait applicators. Applying bait in these backfilled tunnels will greatly limit the efficacy of this management approach; gophers will not find bait placed here.

Before initiating a baiting program, train all bait applicators to identify backfilled tunnel systems. An effective way to conduct this training is to:

1. Have novice bait applicators probe for open (non-back-filled) tunnel systems.
2. Once they have found a tunnel, they dig down into these tunnel systems to verify whether they are open or backfilled.
3. Repeat until the bait applicator successfully identifies open tunnel systems with at least 90% accuracy.

Following these methods should result in consistently more efficacious control efforts when using baits and burrow fumigants.

Apply bait below ground. For small infestations or where the use of a mechanical burrow builder is not feasible, use a probe to find the main tunnel next to a fresh mound or between two fresh mounds. Once you find the main tunnel,

1. Enlarge the probe opening by rotating the probe back-and-forth
2. Place a small amount of grain or pelletized bait in the burrow; a funnel can also be used to pour the bait into the tunnel.
3. Place a dirt clod, stone, or another covering over the hole to keep out light and prevent soil from falling onto the bait.

Place bait in two or three places along the tunnel. This hand-application method can be used for single-dose or multiple-dose baits.

If gophers have infested a large area, reservoir-type hand probes designed to deposit single-dose baits are available. Bait application is faster with these devices because they eliminate the need to stop and place the bait by hand. Once you have located a tunnel using the probe, a trigger releases a measured amount of bait into the tunnel. It is important to check the probe periodically to make sure that it has not been clogged with soil. Generally, strychnine* or zinc phosphide* bait is used with such an applicator because it can dispense only a small quantity of bait at a time. Anticoagulant* baits are less toxic and require greater volumes of bait to be effective, thereby limiting the utility of bait probes for these baits.

A mechanical burrow builder can also be effective and economical for infestations that cover large areas. This device is pulled behind a tractor to construct artificial gopher tunnels into which it places bait. Artificial burrows either intercept some of the gopher’s natural burrows, or the gopher will soon discover the artificial burrow and consume the bait. Prior to using this
application device, it is important to know the average depth of active pocket gopher burrows before setting up the burrow builder. Use a probe to find burrows and a shovel to verify they are active (open). After starting the application, use a shovel to occasionally open a small section of the artificial burrow and inspect its depth and condition. It is also important that the compaction drive wheels properly compact the soil over the burrow. Soil moisture is important, as tunnels created in dry soil will cave in, while tunnels created in wet soil may not form properly. Soil moisture must be intermediate to produce a well-formed, smooth, artificial burrow. Follow the manufacturer’s manual to properly set the depth and calibration of bait application. All baits used in burrow builders are restricted-use materials. Use of a mechanical burrow builder may be feasible in situations such as unplanted borders or between widely spaced young trees when the terrain is relatively level and the soil is not too rocky or before planting a field. However, because the burrow builder creates an extensive network of burrows, only use it when gopher numbers are high as these new burrows will increase the speed with which gophers can invade new areas.

**Trapping**

Traps are effective against small numbers of gophers but are labor intensive. As such, they can be relatively expensive to use over large acreage. However, trapping often results in greater control of gophers than baiting, so the cost may be offset by effectiveness. Use either pincher traps (most common) or box-type kill traps. The smaller size and lower cost of pincer traps typically makes them a more practical choice in a field setting. Pincher traps such as the Macabee, Cinch, or Gophinator have a vertical metal or wire pan which the gopher triggers by pushing against it. Studies have shown the Gophinator and Cinch traps to be more effective than other tested traps.

Pincher-type traps can be placed in the main tunnel of a gopher burrow system or in lateral tunnels. Setting traps in lateral tunnels is quicker and easier than trapping in the main tunnel. However, trapping in lateral tunnels may be less effective at certain times of the year (e.g., summer) and for more experienced gophers (e.g., adult males).

To place traps in the main tunnel find a fresh mound and probe as described in the Treatment Decisions section. When found, clear out the tunnel until the opening is just wide enough to insert the traps. Place traps in the main tunnel, one facing each direction the tunnel goes.

1. Set traps and place them entirely into the tunnels. The number of traps required will depend on the number of tunnels present.
2. Stake the traps by fastening wire, light cable, or twine to the trap and stake to prevent predators from carrying away traps with catches. Stakes also serve as markers to indicate trap location.
3. You can cover up the trap-hole with sod, plywood, canvas, or some other material to keep light from entering the tunnel system. However, a recent study has shown that covering trap-holes has only a minor effect on capture success. When trapping a large area, leave trap-holes uncovered to save substantial time; however covering trap-holes may keep children and pets out of traps, if this is a concern.
4. If there is no evidence that a gopher has visited the trap within 24 hours, move it to a new location.

To place traps in lateral tunnels, remove the plug from a fresh mound and place the trap entirely into the lateral tunnel. In many areas, the plugs in these lateral tunnels are quite extensive; in these situations, trapping laterals becomes counterproductive given the extensive period of time required to remove these plugs.

**Fumigants**

Most fumigants, such as gas cartridges, are not effective because gophers quickly seal off their tunnels when they detect the smoke or poison gases. However, aluminum phosphide* can be effective if applied underground into tunnels during a time of year when soil is moist enough to retain the toxic gas, typically in late winter to early spring, or year round in irrigated crops. In fact, burrow fumigation with aluminum phosphide* is typically the most consistently efficacious option for gopher control as long as sufficient soil moisture is present.

Application of aluminum phosphide* is similar to hand-baiting.
1. Use a probe to locate the main tunnel.
2. Once the tunnel has been found, wiggle the probe to enlarge the hole large enough to dispense the aluminum phosphide* tablets into the tunnel.
3. Follow label instructions on the number of tablets to place into the tunnel.
4. Cover the probe hole with a rock or dirt clod, being careful not to bury the tablets under loose dirt.
5. Treat each tunnel system twice.

When using aluminum phosphide*, be sure to carefully follow all label directions and safety instructions.

As of 1 January 2012, the use of pressurized-exhaust machines that inject carbon monoxide into burrow systems has become a legal technique for controlling burrowing mammals in California. The California Department of Pesticide Regulation is now developing regulations for use of this method of control. This approach appears to be somewhat effective at controlling pocket gophers, although early studies have not shown it to be as effective as burrow fumigation with aluminum phosphide* or trapping.

Gas explosive device
The use of a gas explosive device that combines propane with oxygen has been used to kill gophers through a concussive force. This device has the added benefit of destroying part or all of the gopher’s tunnel system, potentially slowing reinvasion rates. Exercise caution when using these devices because of the potential for unintended damage to property, injury to users and bystanders, potential for starting fires in dry environments, and destruction of turf. Additionally, these devices can be quite loud, making them unsuitable in residential areas. Studies on the efficacy of this device have not been positive. Alternative options such as burrow fumigation, trapping, and baiting appear to be more effective.

Repellents
No scientific data has been reported to show that chemical repellents effectively keep gophers from inhabiting fields, orchards, or vineyards. A new repellent for use in subsurface drip tape has been developed that may offer some promise although it has yet to be sufficiently tested to verify efficacy.

Frightening devices
Frightening gophers with sound or vibrations also does not appear to be effective.

* User must be a certified applicator or be under the supervision of someone who is. Some products also require a permit from the county agricultural commissioner for purchase or use.
RABBITS (7/16)

Scientific Names:  Black-tailed Jackrabbit: *Lepus californicus*  
                  Cottontail and Brush Rabbits: *Sylvilagus* spp.

DESCRIPTION OF THE PEST

Although jackrabbits are the most common of the rabbit-type pests, they are technically classified as a hare. Jackrabbits:

- About the size of a large house cat
- Very long ears
- Short front legs
- Long hind legs

Jackrabbits live in open areas of the Central Valley, coastal valleys, and foothills and are active all year from early evening to early morning. They are seldom found in dense brush or woodlands. A good sign that jackrabbits are present is their coarse, circular fecal droppings or pellets found scattered over an area.

They make a depression underneath bushes or other vegetation where they remain secluded during the day. Jackrabbits breed from early spring to late summer.

Females may produce more than one litter a year, especially where irrigated crops are available. The average litter contains four pups, which are born fully haired, open eyed, and become active within a few hours.

Cottontail and brush rabbits are smaller than jackrabbits and have shorter ears. They nest where thick shrubs, woods, or rocks and debris provide dense cover. Their young are born naked and blind and stay in the nest for several weeks.

Rabbits are active all year. Jackrabbits frequently damage crops bordering open areas, such as grassy fields and rangeland. Cottontail and brush rabbits prefer crops near brushy habitats, ravines, riparian areas, and woodlands favored by these species.

What rabbits eat is variable depending on location and the availability of appropriate plants. They prefer succulent green vegetation; grasses and herbaceous plants typically make up the bulk of their diet. Feeding usually begins during the evening hours and continues throughout the night into the early morning. Rabbits do not need to drink water.

If food and other necessary resources are found in one place, rabbits will stay in the area. If food and areas for shelter are separated, they will move between these areas in the morning and evening. Daily travel by jackrabbits of 1 to 2 miles round trip between these areas can occur. These travels are habitually made on the same trails every day, producing noticeable paths through herbaceous vegetation.

DAMAGE

Jackrabbits, cottontails, and brush rabbits may damage young trees and vines. Rabbits may chew and remove bark and clip off branches within their reach to eat buds and young foliage. Trunk girdling is usually higher on the trunk than damage caused by meadow voles. The damage appears as vertical lines or grooves in the bark. Rabbits usually do not present a serious problem for older trees and vines. Rabbits may also gnaw on drip irrigation lines. They often live outside of orchards, vineyards, and crop fields, moving in to feed from early evening to early morning. They damage plants primarily in winter and early spring, when other sources of food are limited.

Jackrabbits can carry tularemia, otherwise known as rabbit fever. This disease is relatively rare in humans but can be contracted by handling an infected rabbit with bare hands or by eating insufficiently cooked rabbit meat. Do not handle rabbits with bare hands.
**MANAGEMENT**
Rabbits are active all year but damage trees and vines primarily in winter and early spring when other sources of food are limited. Manage rabbits before severe damage occurs. Common control methods for rabbits include fencing, trunk guards, repellants, baiting, trapping, and shooting depending on the species and crop. Unfortunately, habitat control and trapping are not typically effective for jackrabbits given their ability to cover great distances between forage and shelter locations. The choice of control method should depend on the urgency of the problem and the situation.

**Biological Control**
Predators such as coyotes and hawks are usually not sufficient to effectively control rabbits. Although these predators consume a number of rabbits, it is usually not adequate to keep populations low enough to eliminate the need for additional control measures.

**Cultural Control**

**Fencing**
Rabbit-proof fencing prevents damage to young fields, orchards, or vineyards.
1. Make the fence at least 3 feet tall using woven wire or poultry netting with a mesh diameter of 1 inch or less.
2. Bend the bottom 6 inches of mesh at a 90-degree angle and bury it 6 inches deep, facing away from the area to be protected, to keep rabbits from digging under the fence.

If you are building a fence to exclude deer, and rabbits are a potential problem, it is a good idea to add rabbit-proof fencing along the bottom. Unless you are already building a deer fence, the cost of a rabbit fence may be prohibitive for a large orchard or vineyard when you are only going to need it for a few years. Individual tree guards are a good alternative, particularly if damage to vines and trees is focused on the perimeters of orchards and vineyards.

**Tree Guards**
Tree guards are useful when planting new orchards or vineyards or replanting trees or vines in established areas. Cylinders made from wire mesh or some hard plastics provide the best protection against rabbits. Cardboard or heavy paper can also be used, but rabbits may chew through these.
1. Make the cylinders at least 2.5 feet tall to keep jackrabbits from reaching foliage and limbs by standing on their hind legs.
2. Secure the tree guards with stakes or wooden spreaders.

Use smaller-mesh wire and bury the bottom few inches of the cylinder if you also need protection against voles.

**Habitat modification**
Rabbits often invade from adjacent fields, but unless the land is under the grower’s direct management, habitat modification of the outlying habitat is usually impractical. The removal of preferred foods such as cover crops and weeds may reduce the number of rabbits that visit the crop and make them easier to detect. However, removal of vegetative cover may temporarily increase damage as the desired crop would be the only food source left for rabbits. Therefore, except for removal of old prunings and brush piles, habitat modification to reduce damage is rarely practical.

**Monitoring and Treatment Decisions**
Rabbits often breed, bear young, and live outside fields, orchards, and vineyards. They move in to feed at night so you may not see them during daylight hours. Therefore, monitor in the early morning, late evening, or at night (using a spotlight):

- Inspect young trees and vines periodically for feeding on bark to catch a problem early.
- Look for clipping of small, low branches and leaves as tree breaks dormancy.
If you find damage:

- Look for droppings and tracks that indicate rabbits may be the cause. Voles also chew the bark from the trunk, but the bark damage caused by rabbits extends higher on the tree and the tooth marks are distinctly larger.
- Monitor the perimeters in early morning or late evening to see where rabbits are entering and to get an idea of how many are involved.
- Estimate the number of jackrabbits at night by using a spotlight and looking for "eye shine."

**Baiting**

Poison baits may be practical for controlling large numbers of rabbits in large areas. Before baiting, consult the county agricultural commissioner for restrictions related to endangered species. Follow label directions carefully.

Only multiple-dose anticoagulant baits (i.e., chlorophacinone* and diphacinone*) are registered for use against rabbits. These baits are available from many county agricultural commissioners’ offices. All field-use anticoagulant baits are now **restricted use materials**; you will need to be certified to use these baits for rabbit control. They come in grain formulations that may be used along field edges, but not within the field itself.

Multiple-dose baits for rabbit control must be placed in bait stations specifically designed for rabbits.

1. Place bait stations containing bait near trails and secure them so they cannot easily be tipped over.
2. Use as many stations as necessary to ensure that all rabbits have easy access to bait, spacing them 50 to 200 feet apart along the perimeter where rabbits are entering the field.
3. Inspect the bait stations every morning for the first several days to keep bait supplies replenished; it may take this long before the rabbits become accustomed to feeding at the stations. Increase either the amount of bait in the stations or the number of stations if all the bait is consumed in a single night.
4. Replace any bait that becomes wet or moldy.
5. Continue baiting until feeding ceases and you no longer observe any rabbits.

It usually takes 2 to 4 weeks or more before results are seen with multiple-dose baits.

Bait should be covered or removed during daylight hours to prevent consumption by diurnal seed-eating birds. Make sure to take precautions to prevent domestic animals and wildlife from having access to the bait. Dispose of unused bait properly at the end of the baiting program. When baiting for rabbits, you should remove all aboveground carcasses by burying them underground, or by bagging and disposing them in the trash. This will reduce potential secondary poisoning hazards.

**Shooting**

Shooting, applying repellents, and trapping may provide effective control for low numbers of rabbits or may be used to temporarily reduce damage until other measures such as fences or tree guards are installed.

- When low numbers of rabbits are present and causing damage, shooting can be an effective control if shooting is allowed in your area. If only a small number is involved, shooting may be all that is necessary to prevent significant damage while crops are susceptible. For best results, patrol systematically in the early morning or at dusk.
- Keep in mind that lead ammunition is being phased out across the state. Additional information on this lead ban can be found at Department of Fish and Game website [https://www.wildlife.ca.gov/hunting/nonlead-ammunition](https://www.wildlife.ca.gov/hunting/nonlead-ammunition).
Repellents
Repellents are occasionally effective at deterring rabbit damage to some crops, particularly orchard and vine crops. However, no effective rabbit repellents are available for use in most vegetable and forage crops. To apply repellents in orchard and vineyard crops, spray or brush the repellent on trunks during the dormant season or on foliage or trunks during the growing season. Labels specify the proper application method, rate, and timing. Repeat applications as needed to protect new growth and to replenish any repellent that is washed off by rain or sprinkler irrigation. Effectiveness of repellents often is dependent on availability of alternative food sources. If additional food sources are abundant, repellents sprayed on target plants may be effective. If additional food sources are scarce, repellents may have little effect.

Trapping
Trapping generally is ineffective against jackrabbits because they do not readily enter traps. Box-type traps, especially the Critter Getter DK-3 baited with apple slices or dried apricots, can provide effective control of cottontails or brush rabbits when populations are small. Pre-baiting with a small amount of bait has been found to improve results.

* User must be a certified applicator or be under the supervision of someone who is. Some products also require a permit from the county agricultural commissioner for purchase or use.
Voles (Meadow Vole, Meadow Mice) (7/16)

Scientific Name: Microtus spp.

DESCRIPTION OF THE PEST
Voles are also called meadow mice. Adults:

- Larger than house mice but smaller than rats
- Blunt-nosed stocky rodents
- Full grown length is 4 to 6 inches
- Small ears and eyes
- Short legs
- Short tails
- Coarse fur is usually dark gray or grayish brown

Compared to deer mice, voles have a more robust body, less obvious ears, and a relatively shorter tail. Vole ears are at least partly obscured by the hair in front of them and their tails are about one-half to one-quarter the length of their head and body combined. Deer mice have relatively large and prominent, fleshy ears, white belly and feet, and their tail is bi-colored and more than 70% the length of their head and body.

Voles live in colonies and are active both day and night, all year round. Females bear 5 to 10 litters per year, with peaks of reproduction in spring and fall. Because voles mature rapidly and bear multiple litters yearly, numbers can increase quickly reaching as high as hundreds of voles per acre. In many areas, populations peak every 4 to 8 years, and then decline fairly rapidly. Voles live in areas such as irrigated pastures, fencerows, or weedy ditchbanks, where the soil is suitable for burrowing and where vegetation provides cover. Grasses and other dense ground cover provide food and shelter that favor the buildup of vole populations. They usually avoid sandy soils. The soil of the Tulelake Basin of Northern California is a location that is highly favorable for voles.

You can recognize vole activity by the narrow runways in grass or other ground cover, connecting numerous shallow burrows with openings about 1-1/2 inches in diameter. Voles seldom travel far from their burrows and runways, usually less than 10 feet (3 m) from the nest. Droppings are about 0.18 inch (4.5 mm) long and greenish when fresh, turning brown or gray with exposure to the environment. Sometimes fresh leaves or other cuttings are found in these trails.

Five species of voles, genus Microtus, occur in California. The most widespread species in the state is the California vole (Microtus californicus), which occurs in the Central Valley and throughout the length of the coast range. In potatoes, most damage occurs in the Klamath Basin, where the montane vole (M. montanus) is found.

DAMAGE
In orchards and vineyards
Voles can cause severe damage in orchards and vineyards by feeding on bark. Characteristic damage is complete or partial girdling of trunks from just below the soil line to usually no more than 5 inches high. In rare situations, voles climb higher on young trees or vines.

In addition to bark, voles also feed around the root crown, and sometimes chew holes in irrigation lines. Young trees or vines are more readily fed upon and most susceptible to being completely girdled and killed by voles. Large trees or vines can be damaged, but this is uncommon and rarely ends in death. For instance, after severe pruning, sufficient light penetrates the canopy for vegetation to grow near trunks, providing cover and food for voles. Voles live in areas where grass or other permanent vegetative cover remains year-round. Orchards or vineyards that have cover crops or those in which grass and herbaceous plants are left to grow next to trunks are most susceptible to damage.

MANAGEMENT
The best management programs for voles keep numbers at low levels; once vole numbers reach high levels, control becomes much more difficult and costly. Vegetation management and the proper use of exclusion keep damage to a minimum. Poisonous bait (either multiple-dose anticoagulants* or zinc...
phosphide*) can control voles that reach harmful numbers. All field-use rodenticides for voles are restricted use materials that require the applicator to be a private or commercial certified applicator or to be under the supervision of a certified applicator. Some require a permit from the county agricultural commissioner for purchase or use.

**Biological Control**

Predators such as coyotes, foxes, badgers, weasels, owls, and hawks feed on meadow voles; however, predation is rarely, if ever, a major factor in controlling a rapidly increasing vole population.

**Cultural Control**

**Habitat Management**

Cultural practices can significantly affect meadow vole numbers. Because voles travel only a few feet from their burrows to obtain food, any destruction of vegetation will make the area less favorable to them and results in burrow abandonment and/or mortality. Physically removing vegetation, using herbicides or other methods to keep an area about 3 feet out from the trunks free of vegetation, has been proven to reduce damage. If you maintain ground cover or resident weeds in the row middles, keep it mowed fairly short (< 2 inches) to be less attractive to voles.

Maintaining weed-free fencerows, roadsides, and ditch banks is also an important preventive measure. A vegetation-free zone 30 to 40 feet wide between a field and adjacent areas helps reduce the potential for invasion by voles, but such a wide area is rarely practical; bare soil borders may be undesirable where off-site movement of contaminated soil and water must be prevented with a vegetative border to filter runoff.

**Exclusion**

Cylindrical wire or plastic trunk guards to protect young trees or vines from voles are widely used. An effective guard can be a 24-inch-tall cylinder made of ¼ - or ½ -inch mesh hardware cloth that is of sufficient diameter to allow several years' growth without crowding the tree or vine. Bury the guards' bottom edge at least 6 inches below the soil surface, but note that voles may dig beneath them.

Plastic, heavy cardboard, or other fiber materials, such as milk cartons, can also be used to make trunk guards. These materials are less expensive, also provide sunburn protection, and are more convenient to use; however, they provide less protection against vole damage since the voles can chew through them and sometimes use them as a harborage.

Regularly check beneath tree guards for evidence that voles are burrowing underneath them to gnaw on the tree trunk, looking also for the presence of other pests such as snails. If voles take up residence inside the cover, the damage is often greater than if the covers were not used. Good weed control around trunks improves the effectiveness of trunk guards.

Exclusionary fencing consisting of aluminum flashing can be used along field borders. The fencing should be buried at least 6 inches below ground and should extend 12 inches above ground. Drive rebar or wooden stakes into the ground every 15 feet to provide support for the fencing. The efficacy of such fencing is greatly increased if bare soil is present around the base of the fence. Be aware that equipment must frequently move in and out of fields, thereby limiting sites where fencing is practical. Fencing is expensive, so significant damage should be expected to justify the cost of installation.

**Flood irrigation**

Where still feasible, flood irrigation can help control vole populations. When a field is flooded, the voles must come to the surface or drown. When at the surface, they can be picked off by a number of predators; growers and their dogs can also actively seek out voles at this time to further reduce population size.

**Monitoring and Treatment Decisions**

It is important to monitor for voles carefully. Otherwise, you may not notice damage until it is too late to prevent significant injury.

Make sure to check ditch banks, fencerows, roadsides, and other areas where permanent vegetation favors the buildup of voles. Dense grass is their preferred habitat.
Starting in midwinter, monitor monthly in cover crops, weedy areas, and alfalfa fields looking for:

- Active runways: 1- to 2-inch wide surface paths that lead to silver dollar-sized burrow openings.
- Place snap traps in runways to detect pests. Scatter around the field to identify active areas needing baiting. Use expanded trigger traps to avoid having to use bait.
- Fresh vole droppings and short pieces of clipped vegetation, especially grass stems, in runways.
- Burrow openings around the bases of orchard trees or vines. Burrows frequently have numerous openings to the surface. They are relatively shallow and contain food and nesting chambers.

If you find burrows in orchard or vine crops, remove the soil from around the base of the tree or vine and look for bark damage. Voles usually start chewing on bark about 2 inches below the soil line and then move upward to about 5 inches aboveground.

**Baiting**

If you find damaging infestations or numbers increasing within orchard, vineyard, or vegetable crops, poison baits can be used during the dormant season to greatly reduce vole numbers. Baiting can also reduce voles in adjacent areas before they have a chance to invade. Single- and multiple-dose baits are available, but there may be baiting restrictions in some areas to protect endangered species. It is imperative that you understand and follow the label directions for use. In particular, please note that poison baits cannot be applied within orchard, vineyard, or vegetable crops from green up (spring) until after harvest occurs.

For small infestations, scatter the bait in or near active vole runways and burrows according to the label directions. For larger areas and where the label permits, you can make broadcast applications using a belly grinder-type seeder or a vehicle with a tailgate seeder. Broadcast application rates vary, depending upon estimated numbers of voles and type of toxicant. Both single-dose (e.g., zinc phosphide*) and multiple-dose (e.g., first-generation anticoagulants, chlorophacinone* and diphacinone*) poisons are used for meadow vole control in orchard, vineyard, and vegetable crops. These are restricted-use pesticides that require a permit from the county agricultural commissioner for purchase or use.

In ditchbanks and other non-cropland sites, bait should be applied in fall or spring before the voles’ reproduction peaks to slow or prevent populations from expanding into the crop. However, application within an orchard, vineyard, or vegetable field is restricted to the nonbearing season, so timing is key to prevent a population explosion during the growing season. Bait acceptance will depend on the amount and kind of other food available. When baiting for voles with anticoagulants, you should remove all aboveground carcasses by burying them underground, or by bagging and disposing them in the trash. This will reduce potential secondary poisoning hazards.

**Trapping**

Trapping is not typically practical as voles often number in the thousands over even relatively small areas.

**Fumigants**

Fumigation is not typically effective because of the shallow, open nature of vole burrow systems and the large number of voles. However, it is occasionally used in artichokes given the deeper structure of vole burrow systems in the crop.

**Repellents**

Repellents are not effective in preventing damage.

*User must be a certified applicator or be under the supervision of someone who is. Some products also require a permit from the county agricultural commissioner for purchase or use.*
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.