A PEST MANAGEMENT STRATEGIC PLAN
FOR
CALIFORNIA PRUNE PRODUCTION

RATIONALE

The U.S. Environmental Protection Agency (EPA) is engaged in the process of re-registering pesticides under the requirements of the Food Quality Protection Act (FQPA). The Agency is examining dietary, ecological, residential, and occupational risks posed by certain pesticides. EPA’s regulatory focus is on the organophosphate (OP), carbamate and suspected B₂ carcinogen pesticides. EPA may propose to modify or cancel some or all uses for some chemicals on prunes. The additional regulatory studies that EPA requires registrants to complete may result in some companies voluntarily canceling certain registrations rather than incurring the additional costs of the required studies. In addition, continued focus on risks of pesticides may lead some prune processors to require growers not use certain chemistries. Here, the U.S. Department of Agriculture (USDA), EPA, land-grant universities and the prune industry, working as a group, have proactively identified and prioritized research, education and regulatory needs for reducing reliance on certain pesticides with effective alternatives if that should become necessary as a result of regulatory actions.

March 2018

Note: This document was revised in late 2017 and early 2018 from the 2002 PMSP for prunes produced in California to represent input from and strategy of the California prune industry for 2017 – 2026. The prune industry would like to thank the Western Integrated Pest Management Center for its support to make this update possible.
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Background

PRUNE FACTS

- Over 99% of the prunes grown in the United States are grown in California.
- California grows almost 40% of the total world production of dried prunes, which are also known as dried plums.
- Approximately 800 growers farm 44,000 bearing and 4,000 non-bearing acres of prunes in California.
- In 2015, the crop totaled 108,954 dried tons valued at approximately $223 million.
- Approximately 2% of the production is organic, which equals roughly 1,000 acres.
- Approximately 1% of the crop is sold fresh, primarily to the Asian market.
- The total cash costs for producing an acre of dried prunes varies from $4,884 in the Sacramento Valley to $5,288 in the San Joaquin Valley.

The majority of prunes (recently renamed dried plums) are grown in California’s Sacramento Valley, with 97,210 dried tons being produced in 2015. The other production areas in the San Joaquin Valley, primarily Madera, Tulare and Fresno counties, produced 11,687 dried tons. Approximately 1% of the crop is sold as fresh fruit, primarily to Asian countries where the sweet fruit are often referred to as “Sugar Plums.”

The prune industry has one primary variety, the “Improved French” (Prunus domestica, L.). It accounts for over 95% of the total prune acreage in the state. Selected cultivars are grafted onto rootstocks selected to accommodate local growing situations. Varieties and rootstocks vary in susceptibility to diseases, nematodes, and other stress factors.

Prunes grow and produce well in soils varying from deep, well-drained, fine-sandy loams to shallow clay-type soils. Prunes will not produce adequate commercial crops without irrigation in California. Flood, furrow, full-coverage sprinkler, drip, and micro-sprinkler systems are used throughout the industry with micro-sprinkler and drip being the most common. Many growers are now moving away from flood irrigation.

Most prune growers have moved away from organophosphate insecticide use, mostly due to issues with surface run-off. Newer dormant-spray regulations now prevent organophosphate spraying prior to rain events. Old organophosphates have been replaced with newer, reduced-risk, targeted pyrethroids in their dormant spray. Growers have also implemented Good Agricultural Practices (GAP), with well-planned, integrated management systems, such as planting filter strips and grass covers to mitigate run-off. The berms between rows are better managed. They are participating in the irrigated lands programs, as good irrigation practices lead to good tree vigor. New integrated pest management (IPM) techniques have been adopted. When spraying is needed, it is done with several “precision spray application” techniques. Growers have realized healthy trees are more resistant to pests. Growers also are keenly aware of bee health and have implemented pollinator protection techniques, such as night spraying, when the need arises to apply crop-care materials during the bloom period.
Nutrient management has been adopted by almost all growers. Leaf analyses are routinely conducted to assess orchard nutrient status. Most prunes in California receive annual applications of nitrogen. Generally, this is applied as an inorganic, commercial fertilizer, although manures and leguminous cover crops are used in some conventional and organic orchards. Potassium deficiency is common in prune production and either potassium nitrate sprays or soil-applied potassium sulfate or muriate of potash are used to correct this problem. Zinc deficiency is also common and corrected by foliar applications of zinc compounds applied in fall or spring.

Non-cultivation is the common orchard-floor management system as growers realize the cultural and economic benefits of non-tillage. For this system, tree rows are treated once annually with residual herbicides and as needed with contact herbicides. Row middles are mowed as weeds or cover-crops grow. Continual cultivation of the orchard floor is becoming less common.

All prunes used for drying are harvested by mechanically shaking the crop onto catching frames. They are then transported to dehydrators where they are washed and sanitized, spread on drying trays and dehydrated at 180–185°F until the desired moisture content is reached (~21%). This temperature threshold prevents food safety issues later in the dried fruit. Once dried, they are stored in bins to equalize moisture content between fruit and then delivered to packers as natural condition prunes. Most prunes are sold pitted while about 12% of the crop is sold for manufactured products, such as prune juice, prune concentrate, prune puree and other ingredients used in the food-processing industry.

A problem for growers is differing requirements of many domestic and international end-users regarding use of crop-protection materials and allowable residues. Several markets either do not allow certain materials or require lower residue tolerances (expressed as maximum residue limits, or MRLs) than U.S. legal limits. Further, some have altered requirements in the middle of a growing season when applications have already been made. Such practices are costly to processors and growers in segregation labor, warehousing, tracking, documentation and special processing and packaging labor to meet the final demand. Since California prunes are supplied to customers worldwide, California growers and processors are at a distinct disadvantage trying to comply with material restrictions by destination regulators, including MRLs that vary from country to country (especially for new crop-care products) and tariffs that importing countries may place on U.S. prunes but not on prunes from other countries.

Prunes are also vulnerable to numerous exotic diseases and pests that are not part of the normal seasonal practices or treatments that are made on an ongoing basis. These include Plum Pox Virus, Brown Marmorated Stink Bug, and Mediterranean Fruit Fly; although these pests are not currently found in prune orchards in California. There are also other exotic diseases and pests that have the potential to damage prunes. If useful, treatments depend on the disease or pest detected and the crop-care materials that have been registered or approved for that disease or pest.

Generic marketing and research activities are administered by the California Dried Plum Board, a state marketing order under the authority of the California Department of Food and Agriculture. The California Dried Plum Board funds advertising, public relations, nutrition
research, production research, market research and issues management on behalf of California’s prune growers and handlers.

**Critical Pest Management Needs for the California Prune Industry:**

The following list identifies the major needs for California prune pest management.

**Research:**

1. **A. Bacterial canker and blast or ring nematodes**
   - Understanding the disease and how to control it
   - Developing post-plant controls for nematodes and bacterial canker
   - New product efficacy and registration (including bactericides such as kasugamycin).

   **B. Phytophthora management** – register new modes of action.

   **C. New treatments for pruning wounds for protection against wood decay and canker fungi.**

2. **Replant problem and methyl bromide alternatives**
   - Soil microbiology
   - Resistant rootstocks

3. **Aphid, peach twig borer, scale research**
   - Threshold action levels
   - Improved monitoring techniques
   - New active ingredients and softer materials
   - Biological and parasitic controls (impact of existing parasites and new parasites)
   - Pheromones and mating disruption
   - Efficacy data and impact studies on beneficials and understanding the importance of naturally-occurring beneficiais.

4. **Economic thresholds for treatment of all prune pests**
   - Monitoring protocols to determine threshold action levels
   - Damage of vertebrate pests to prune orchards

5. **Soft technologies for pest control**
   - New or testing of existing reduced-risk pesticides for efficacy and risk to surface or ground water contamination. (alternatives to organophosphates, pyrethroids, neonicotinoids, biologicals/microbials)
   - Breeding for pest (and disease) resistance
   - Mitigate surface runoff for pyrethroids and neonicotinoids.

6. **Develop materials and programs to manage and avoid weed resistant species**

7. **Application technology especially for dormant sprays**

8. **Relationship between plant disease and nutrition**
   - Tree stress reduction and vigor management
   - Nutrition influence on disease development
   - Remote sensing for early detection of plant stress

9. **Pollinator protection-neonicotinoid usage & residue carryover to the pollen**

10. **Develop alternative rodenticides**
Regulatory:
1. Rapid registration of a “soft” aphicide once research is complete
2. New product registrations, including reduced-risk materials
   - Bactericide (e.g., antibiotic) registrations
   - New Phytophthora fungicides
   - New tree wound or pruning cut treatments for wood decay and canker fungi
   - Alternative rodenticide registrations
3. Streamline regulatory reporting and rules
4. Register alternatives to methyl bromide
   - Maintain adequate certification of nursery stock
5. Shorter PHIs for pesticides when appropriate
   - Minimize potential MRL issues for chemical applications
6. Equitable distribution of Telone cap
   - Concern for buffer zones and intent notifications
7. Crop protectants being listed as carcinogens and as air pollution contributors need to be based on science-driven findings.
8. Regulators evaluate possible off-target effects on prunes of new herbicide registrations
9. Concern about potential ban of anticoagulant rodenticides

Education:
1. Improve two-way communication between growers and pest control advisers (PCAs) and regulators
2. Continue educating growers on monitoring protocols to determine when and if treatment is necessary
   - Train growers to identify problematic pests and diseases
   - Train growers on canker wood rot management
3. Educate growers on precision spray application and calibration of sprayers
   - Educate growers regarding drift mitigation
4. Educate growers about alternative methyl bromide options and how to use them
   - Educate growers and pest control advisors on nematode biology
5. Educate growers about herbicide resistance
6. Continue to educate growers and Pest Control Advisers about “Integrated Prune Farming Practices” (IPFP)
7. Grower education about techniques for limiting non-target risk from burrow fumigant and anticoagulant rodenticide applications
8. Grower education on how to most effectively implement a frightening program for bird management

Foundation for Pest Management Strategic Plan

This document is an analysis of pest pressures during the various growth stages of prunes. Key control measures and their alternatives (current and potential) are discussed.

The Dormant Season (December through February)
FARMING ACTIVITIES
The following farming activities take place during the dormant season: pruning, dormant spraying, diseased tree removal, new tree planting, herbicide application in the tree-row and mowing of row middles.

WEED PESTS
Prune orchards are infested with numerous winter annual weeds. Effective control of most winter annuals is possible with a well-planned, integrated management system that includes proper use of pre- and post-emergence herbicides, in combination with timely orchard floor management practices. A selection of herbicides is available to growers. Pre-emergent herbicides typically are applied from late fall through late winter. Oxyfluorfen (Goal Tender) and oryzalin (Surflan) are common, but more recently registered materials including flumioxazin (Chateau), pendimethalin (Prowl H2O), rimsulfuron (Matrix), indaziflam (Alion) or penoxsulam/oxyfluorfen (Pindar GT) are also used.

Post-emergence herbicides include: glyphosate (Roundup), 2,4-D, paraquat (Gramoxone) and glufosinate (Rely 280). Several grass-specific herbicides including clethodim (Select Max), fluazifop (Fusilade) and sethoxydim (Poast) can be used in non-bearing prunes but, of these, only fluazifop can be used during bearing years. See appendix for efficacy ratings of all herbicides used in prunes. It is important for growers to have an on-going survey of their orchards to determine the weed species present since most herbicides are more effective against certain species than others. Based on scouting information and previous year’s records, an effective strategy can be determined. An appropriate pre-emergence herbicide can be applied before weeds emerge. If weeds are already emerged, a tankmix burndown partner or an additional post-emergence treatment may be required. If growers depend solely on post-emergence methods, multiple applications of translocated herbicides such as glyphosate and contact materials like paraquat or glufosinate are typically needed to ensure control of glyphosate-resistant weeds.

List for weed management needs in prunes during the dormant season:

Research:
• Alternatives to oxyfluorfen.
• Develop additional materials for post-emergence control of fleabane and horseweed.
• Develop materials and programs to manage and avoid glyphosate-resistant species (Glyphosate-resistant rye grass, hairy fleabane, horseweed, junglerice, and bluegrass are already significant problems in prunes and other orchard crops.)
• Develop materials to control and confine legumes planted as cover crops.

Regulatory:
• Concerns and uncertainty about glyphosate (Roundup) being listed as a “probable carcinogen” by the International Agency for Research on Cancer and California, but not by U.S. EPA or the European Union.

Education:
• Grower education about mitigating surface water runoff.
• Grower education on precision spray application and calibration of sprayers to eliminate self-inflicted problems.
• Grower education about herbicide resistance (especially glyphosate resistance).

INSECT AND MITE PESTS
Dormant sprays, which commonly include oil combined with a pyrethroid insecticide, are applied to control several insect and mite pests. Most prune orchards receive this dormant spray through February. There is now a trend to pre-dormant sprays for aphid control being applied in November and December as this timeframe may mitigate pesticide runoff and is less problematic regarding orchard access (less mud). Growers have moved away from the use of diazinon and other organophosphates which contributed to runoff issues. During this time, there is no fruit or foliage on the tree.

Insect and mites controlled in the dormant season:
Scale insects: San Jose scale (SJS), European fruit lecanium scale (EFL): If left uncontrolled these pests can reduce yield and plant vigor and lead to orchard decline. SJS must be controlled in order for the fruit to be sold on the fresh market. Scale insects have documented resistance to organophosphates in some areas of California. In many cases, if natural enemies are not disrupted (due to pesticides applied for scale and other pest control during the growing season), naturally-occurring parasites and predators can keep low-to-moderate populations of scale below economically damaging levels, and scale pests may not require annual control treatments.

Chemical controls:
Organophosphate insecticides currently used:
• Chlorpyrifos (Lorsban) or diazinon + oil gives excellent control but there is concern for resistance as reported in other commodities.
• Issues: Surface runoff potential exists for these OPs, thus regulatory issues are a concern.

Pyrethroid insecticides currently used:
• Esfenvalerate (Asana) + oil gives poor control of SJS, excellent control of EFL. This tends to be the most commonly used, as the insecticide will also provide some control of other pests as noted below when applied during the dormant period. The main activity with oil + pyrethroid for SJS is due to the oil component.
• Lambda-cyhalothrin (Warrior) is used by some growers.
• Issues:
  • Resistance.
  • Off-site movement, toxic to fish and amphibians.

Others:
• Oil (narrow range at dormant or delayed dormant controls light-to-moderate scale infestations. Requires good coverage and high spray volumes (200-400 gpa) for best results.
• Oil + insect growth regulators, pyriproxyfen (Seize, Esteem) and buprofezin
(Centaur). IGRs are more expensive.

Non-chemical aids used:
- Monitoring dormant spur samples (for scales and aphids).
- Alternate-year dormant applications. If practiced, needs intense monitoring.

Potential Alternatives:
- Beneficials (must use in-season sprays least harmful to these beneficials). Rely on activity of natural-occurring parasite and predator populations. Not common to purchase and release beneficials.

**Peach twig borer (PTB):** If left uncontrolled PTB infests shoot tips, compromising vegetative growth, and fruit. Infested fruit are hosts to the brown rot fungus. Without control by a dormant spray, in-season sprays maybe required. These can encourage other pests (such as spider mites) that require additional treatment.

**Chemical controls**
**OP insecticides currently used:**
- Chlorpyrifos (Lorsban) + oil gives excellent control.
- Issues: Surface runoff for OPs; regulatory issues.

**Pyrethroid insecticides currently used:**
- Esfenvalerate (Asana) + oil is most commonly used and gives excellent control.
- Issues:
  - Resistance.
  - Off-site movement – toxic to fish and amphibians.

**Others:**
**Several selective pesticides provide excellent control of peach twig borer:**
- Spinosad (Success) and spinetoram (Delegate).
- Methoxyfenozide (Intrepid) applied at late dormant.
- Chlorantraniliprole (Altacor).

**Non-chemical aids used:**
- Beneficials (must use sprays least harmful to these beneficials). Rely on activity of natural-occurring parasite and predator populations. Not common to purchase and release beneficials.

**Pollinator Protection:**
- Bee monitoring – monitor flowers of weeds, primarily mustard, in the ground cover for bees.
- After January 31, there are restrictions in place on dormant spraying.

**Aphid eggs** [Mealy plum aphid (MPA), leaf curl plum aphid (LCPA) and black cherry aphid (BCA)]: If left uncontrolled these aphids infest shoot tips and leaves. MPA secretes large
amounts of honeydew that supports growth of the sooty mold fungus. This black fungus has been shown to reduce photosynthesis, compromising vegetative growth. LCPA & BCA severely curls leaves, Tree growth and fruit sugar content can both be reduced by these aphids. Fruit from trees infested by these aphids often show a preponderance of “side cracks” that render them worthless and promote brown rot. Without control from a dormant spray, in-season sprays may be required. These can encourage other pests (like spider mites) that will require additional treatment.

Chemical controls
OP insecticides currently used: (Note: No longer common for use during dormancy.)
- Chlorpyrifos (Lorsban) + oil – excellent control.
- Diazinon + oil – excellent control.
- Problems
  - Surface runoff potential exists for these OPs.
  - Worker safety requirements for applications need to be met.

Pyrethroid insecticides currently used:
- Esfenvalerate (Asana) + oil - good control. Remains the most common insecticide for the pre-dormant/dormant sprays for aphids. May be applied as pyrethroid only during this time. Oil added improves San Jose scale control.
- Several products are now available: lambda-cyhalothrin (Warrior), zeta-Cypermethrin (Mustang) and cyfluthrin (Baythroid).
- Problems:
  - Resistance.
  - Off-site movement – toxic to fish and amphibians.

Others:
- Oil (narrow range) – good for infestations, two applications at bloom. Note: Oil is not compatible with sulfur or captan/chlorothanil at bloom.

Non-chemical aids used:
- Monitoring dormant spur samples (scales and aphids).
- Beneficials (must use sprays least harmful to these beneficials). Rely on activity of natural-occurring parasite and predator populations. Not common to purchase and release beneficials.

Mite eggs [European red mite (ERM)]: Although European red mites can build up to high numbers, they seldom are considered to cause economic damage.

Chemical controls
OP insecticides currently used:
- None.

Pyrethroid insecticides currently used:
- None.
Others:
• Oil (narrow range) – Most commonly used; good efficacy against light infestations, apply at delayed dormant.

Non-chemical aids used:
• Alternate-year dormant applications.
• Beneficials (Select sprays least harmful to these beneficials based on monitoring). Rely on activity of natural-occurring parasite and predator populations. Not common to purchase and release beneficials.

Leafrollers (Fruit tree leafroller (FTLR) and Oblique-banded leafroller (OBLR): Leafrollers damage fruit causing direct loss and providing a site for development of the brown rot fungus.

Chemical controls
OP insecticides currently used:
• Chloryprifos (Lorsban) + oil gives excellent control.
• Issues:
  • Surface runoff potential exists for OPs.

Pyrethroid insecticides currently used:
• Esfenvalerate (Asana) + oil - Most commonly used; fair to good control.
• Issues:
  • Resistance.
  • Off-site movement – toxic to fish and amphibians.

Others:
• Oil (narrow range) – not efficacious.

Non-chemical aids used:
• Beneficials (must use sprays least harmful to these beneficials).

Needs for insect and mite management in prunes during the dormant season:

Research:
• Biology of peach twig borer, aphids, scale and other insect pests.
• Reduced-risk replacements for all materials except oils.
• Organic-approved materials and methods of control.
• Threshold action levels for these pests during the dormant period.
• Improved monitoring techniques to compare to threshold action levels.
• Efficacy of reduced-rate materials.
• Application technology, especially for dormant sprays.

Regulatory:
• Streamline regulatory reporting and rules. (This can be a burden on growers.)
Education:
• Continue to educate growers on monitoring.
• Improve communication between regulators, growers and Pest Control Advisers (runoff issues, irrigated lands program, etc.).
• Educate growers on improved sprayer application.

DISEASE PESTS
Diseases controlled in the dormant season:

**Bacterial canker and blast** (*Pseudomonas syringae* pathovars): Bacterial canker affects scaffolds and smaller branches and may kill buds, blossoms, shoot tips and entire trees. Young trees are most severely affected. Problems with bacterial canker can be reduced by carefully selecting planting sites, choosing the least-susceptible rootstock and following recommended cultural practices. No control actions are available that will prevent bacterial canker, but a number of cultural practices can be used to reduce the likelihood of the disease and its severity. Copper is registered for bacterial canker and other diseases and is used during the dormant season. Other cankers like ceratocystis, cystopore and *phytophthora* may use applications of myclobutanil (Rally) and thiopanate-methyl (Topsin) for pruning infections.

Chemical controls
• Copper – poor control.

Non-chemical aids used:
• Biologicals – weak- to-poor control.

Cultural Controls:
• Avoid planting a site that has had a history of bacterial canker.
• Rootstocks can help manage this disease. Lovell, Nemaguard and Viking peach are most resistant, and plum is the most susceptible.
• Scaffold budding or high grafting of susceptible scion wood may reduce susceptibility to infection.
• Biologicals – Serenade (pending in California), Regalia or Actinovate.
• Maintain appropriate nitrogen levels, as excessive levels can lead to elevated fruit disease problems.

**Crown gall** (*Agrobacterium tumefaciens*): Although crown gall can infect established orchards, the disease is most damaging to young trees. If left unchecked, the bacterial “gall” may progress around the crown, weakening and eventually girdling the tree. Young galls are smooth. They become rough and increase in size as they age. Old galls are dark, brittle and cracked. The pathogen usually infects through wounds. Young trees in nurseries are particularly prone to infection because of the many potential injuries that occur during digging. Secondary organisms such as wood decay organisms can use crown galls as infection sites.

Chemical controls:
• None during the dormant season.
Cultural control:
- A primary management technique for crown gall prevention is use of clean nursery stock. Nurseries fumigate with methyl bromide (special use for quarantine uses) prior to planting to rid the soil of the bacterium. At planting, a biological control agent, *Agrobacterium radiobacter*, is sprayed on root systems prior to planting. (Nurseries have addressed the issue and have significantly improved the situation by using containerized trees.) There may also be a need for fungal applications due to pruning practices. myclobutanil (Rally) and thiopanate-methyl (Topsin) could be used for pruning infections.

Needs for disease management in prunes during the dormant season:

Research:
- Bacterial canker control measures. Research on kasugamycin for managing bacterial canker and blast.
- Improved copper performance. Evaluate new materials for improving copper activity.
- Resistant rootstock research.
- Biological research. Evaluate new biological controls for the organic grower.
- Marker-assisted selection (MAS) for resistance trait identification (similar research as in walnuts).

Regulatory:
- Plant antibiotic registrations. Support registration of kasugamycin. According to recent research by Dr. Jim Adaskaveg, a plant pathologist with the University of California, use of antibiotics in plant agriculture does not lead to antibiotic resistance in human pathogens and is not analogous to antibiotic use in animal agriculture.
- Additional dormant or fall season treatments are needed including bacterial canker treatments such as kasugamycin and biological controls, and pruning wound protection materials including new fungicide treatments against wood decay and canker fungi.
- Streamline registration process of fungicides, bactericides, copper-enhancing compounds such as nano-copper, and alternatives to copper such as nano-zinc.

Education:
- Efficacy and usefulness of copper sprays.
- Cultural pruning time related to rain events.
- Use of biological controls such as Actinovate, Regalia and Serenade (pending in California).

NEMATODE PESTS

Ring nematode (*Mesocriconema spp*), Root lesion nematode (*Pratylenchus spp*), Southern root knot nematode (*Meloidogyne spp*): These plant parasitic nematodes feed on roots of the rootstocks used for prunes (plum and peach). Symptoms of nematode infestation include lack of
tree vigor, small leaves, twig dieback and a sparse root system, particularly lack of small feeder roots. Root galls are an indication of root knot nematode.

Chemical controls:
- No post-plant chemical control of nematodes is available. Pre-plant fumigants are applied prior in fall.

Cultural Controls:
- Planting on land where non-woody plants have grown for several years. Pre-plant fallowing for one or two years followed by pre-plant fumigation – this is efficacious for root knot nematode control, but efficacy is unknown for ring and root lesion control.
- Planting clean nursery stock from nurseries where methyl bromide was applied. Effective control.
- Select rootstocks resistant to or tolerant of various parasitic nematodes.
  - Nemaguard peach and the plum rootstocks Marianna 2624 and Myrobalan 29C are resistant to root knot nematodes.
  - Mariana 2624 and Myrobalan 29C are moderately resistant to root lesion but susceptible to ring nematode.

Biological controls:
- There are no known effective biological agents, deliverable to soil or root surfaces, which provide relief from endoparasites such as root lesion nematode.

Needs for nematode management in prunes during the dormant season:

Research:
- Soil ecology to manage nematodes.
- Resistant rootstocks.
- Post-plant controls (chemical, cultural, and biological).

Regulatory:
- Maintain adequate certification of clean nursery stock. (Very critical as there is concern about dirty material.)

Education:
- Educate growers on alternatives to methyl bromide and how to use them.
- Educate registrants on needs for methyl bromide alternatives.
- Educate growers and Pest Control Advisers on nematode biology (needs to be ongoing).

VERTEBRATE PESTS

Primary dormant season concerns stem from pocket gophers \((Thomomys bottae)\) and meadow voles \((Microtus)\) spp.). Pocket gophers will chew on root systems and girdle trees below ground. Voles generally girdle trees above ground, usually within 3-6 inches from the surface. Damage is most likely when trees are relatively young; damage to older trees rarely causes mortality.
The dormant season is the best time of the year to manage both of these pest species. Pocket gophers readily create new mounds during the dormant season; seasonal precipitation softens the ground thereby making digging easier for the gopher. This allows for easy identification of fresh mounds which is key for effective pocket gopher management. Trapping, burrow fumigation with aluminum phosphide (and to a lesser extent, pressurized exhaust machines such as the Pressurized Exhaust Rodent Controller [PERC] or the Gopher-X), and strychnine bait application are the most effective strategies for targeting pocket gophers.

Where voles are known to occur, growers should monitor for signs as well. Typical vole signs include numerous burrow openings about 1 to 1.5 inches in diameter. Burrow openings are often connected by runways of matted vegetation or bare soil. Vole populations and subsequent damage can often be managed by removing vegetation for two to three feet around the base of trees. Complete removal of vegetation from the orchard floor further reduces problems with voles. Where a consistent problem occurs, tree protectors made of hard plastic or wire mesh can be placed around the base of trees. These protectors need to be buried about six inches below ground to eliminate movement of voles inside the tree protectors. If they move inside tree protectors, damage can be greater than if they were not used. When removal efforts are needed, rodenticides can be used. Both first-generation anticoagulants (chloropacinone and dipheacinone) and zinc phosphide can be applied within orchards during the dormant season (after harvest up until green-up). Bait applications within orchards cannot occur once new spring growth occurs on the trees. Chlorophacinone and zinc phosphide are generally the most effective rodenticides for voles.

California ground squirrels (Otospermophilus spp.) cause extensive damage in almost all orchard crops, but they hibernate during the winter, so active management is not generally implemented at this time. However, ground squirrels will emerge from hibernation around February (exact timing will vary across years and locations). Burrow fumigation is a good tool to target ground squirrels once they become active above ground. Effective burrow fumigants include aluminum phosphide, gas cartridges, and pressurized exhaust machines (e.g., PERC machine and Gopher-X). Rodenticide application is not generally effective during the dormant season given that ground squirrels are not actively feeding on seeds at that time.

Rabbits (black-tailed jackrabbit [Lepus californicus], desert [Sylvilagus Audubon I] and brush cottontail rabbits [Sylvilagus bachmani]) and deer (Odocoileus hemionus) also cause browsing damage to young trees (usually five years of age or less). Various repellents can be sprayed on trees to minimize browsing damage. Repellents must be reapplied on new vegetative growth and following rainfall or irrigation events, thereby limiting their practicality in some settings. Fencing can also be used to keep both rabbits and deer out of orchards. Deer-proof fencing generally consists of eight-foot tall woven wire mesh, although fences may need to be taller in sloping terrain. When rabbits and deer co-occur, smaller mesh (mesh diameter of 1 inch or less) fencing can be added to the bottom of a deer-proof fence. Such rabbit-proof fencing should be at least three feet wide to allow the fencing to be buried about six inches below ground with an additional 6-inch section bent perpendicular away from the orchard. This will keep rabbits from digging under the fence. Although fencing can be expensive and difficult to implement, it can also be the most cost-effective management strategy in areas where consistent damage from
either species is expected. Along with fencing, tree protectors (often made out of hard plastic or wire mesh) are sometimes used to reduce girdling damage from rabbits. These are most practical for use on replants in an already established orchard.

Shooting can be an effective tool for reducing damage from a small population of rabbits. When rabbit numbers are substantial, toxic baits can be used. These toxic baits are used within self-dispensing feeders which are placed along the perimeters of orchards. Rabbit carcasses must be searched for and removed following bait application to limit secondary poisoning of non-target predators and scavengers.

House finches (*Carpodacus mexicanus*), crowned sparrows (*Zonotrichia* spp.), and house sparrows (*Passer domesticus*) can cause substantial damage to orchards by feeding on fruit buds during the dormant season or shortly before bloom. This kind of damage is usually heaviest within the first two to three rows of an orchard, where birds invade from adjacent wildland areas. This kind of damage is not common in orchards that are not surrounded by such wildlife habitats. The use of frightening devices such as propane cannons, electronic distress calls, and roving patrols of bird bombs and shell crackers are the primary tools for scaring birds from the desired area. The major problem with all frightening techniques is that, when used day-in and day-out, most birds become accustomed to them and their effectiveness diminishes with time. Their effectiveness also diminishes as more growers in the same general area use the same techniques. The grower with the most innovative frightening strategies has the advantage.

Needs for vertebrate management in prunes during the dormant season:

Research:
- Develop alternative rodenticides. [Currently concerns about potential ban of anticoagulant rodenticides (e.g., Assembly Bills 2596 and 1687)]
- Determine potential for damage from, and alternative management practices for, expanding eastern fox squirrel (*Sciurus niger*) populations which may become a greater problem for prune orchards in the future.
- Develop alternative strategies for reducing bird damage to prunes.
- Develop specific bait station for rabbits.
- Better assessment of damage of vertebrate pests to prune orchards.

Regulatory:
- Register alternative rodenticides.
- Register anthraquinone as a repellent for meadow voles.

Education:
- Grower education about techniques for limiting non-target risk from burrow fumigant and anticoagulant rodenticide applications.
- Grower education on how to most effectively implement a frightening program for bird management.
The Spring Season [March (bloom) – mid-June]

FARMING ACTIVITIES
This period includes bloom (bud swell, “popcorn,” full bloom and petal fall), early shoot and fruit growth. The following farming activities take place during the spring season: moving bees in and out of the orchard, implementing pollinator-protection techniques, applying bloom and in-season sprays, herbicide applications, fertilizer applications, irrigation, orchard floor discing and mowing, mechanical thinning, late pruning, pest scouting, and tree tying.

WEED PESTS
Prune orchards can become infested with numerous summer annual and perennial grass and broadleaf weeds. Weeds compete with the orchard trees for water and nutrients. Effective control of most weeds is possible with a well-planned (based upon on-going seasonal surveys to determine weed species present) integrated management system that can include winter or early-spring applications of a pre-emergence (PRE) herbicide. The most commonly used PRE herbicides include oxyfluorfen (Goal), indaziflam (Alion), rimsulfuron (Matrix), pendimethalin (Prowl H2O), flumioxazin (Chateau) and oryzalin (Surflan). More recently registered PRE materials include penoxsulam/oxyfluorfen (Pindar GT) and mesotrione (Broadworks) which are increasing in use.

Post-emergence herbicides commonly used include: glyphosate (Roundup), 2,4-D, paraquat (Gramoxone), glufosinate (Rely 280), carfentrazone (Shark), and pyraflufen (Venue). An herbicide program is effective in combination with timely orchard floor management practices. Absent an effective program, conditions could lead to vertebrate pest pressure that could interfere with harvest.

Needs for weed management in prunes during spring:

Research:
• Alternatives to currently registered chemical options that are safer or that address resistant weeds.
• Off-site drift mitigation.
• Cover crops for weed control.
• Evaluation of herbicide performance under micro-irrigation systems.
• Management of weed resistance to glyphosate, paraquat and other post-emergence herbicides.

Regulatory:
• Evaluate off-target drift potential and effects on prunes of new herbicide registrations in other crops.

Education:
• Grower education and alternative approaches for management of herbicide-resistant weeds.
• Education and IPM tool ([www.wric.ucdavis.edu](http://www.wric.ucdavis.edu)) for integrated weed management.
• Grower education regarding spray application technology and calibration issues.
• Grower education regarding drift mitigation.

INSECT/MITE PESTS

Dormant sprays control most insect pests and mites that develop on prunes during spring. These pests include aphids, San Jose scale, and lepidopterous larvae. In absence of the dormant spray, careful tree and fruit monitoring is required to avoid damaging populations of the pests below. No insecticides should be used at bloom, except *Bacillus thuringiensis* (Bt) for lepidopterous and oil for aphid, due to concerns for bee health.

Aphids [Mealy plum aphid (MPA), Leaf curl plum aphid (LCPA) and Black cherry aphid (BCA)]: If left uncontrolled these aphids infest shoot tips and leaves. MPA secretes large amounts of honeydew that supports growth of the sooty mold fungus. This black fungal complex has been shown to reduce photosynthesis, compromising vegetative growth. LCPA and BCA severely curl leaves. Tree growth and fruit sugar content can both be reduced by these aphids. Fruit from trees infested by MPA often show a preponderance of “end cracks” that render them worthless and promote brown rot.

Chemical controls
OP insecticides currently used:
• Diazinon - excellent control, but very rarely used in-season.
  • Issues:
    ▪ Surface runoff potential exists for this OP.

Non-OPs Currently Used*:
• Pyrethroids (esfenvalerate (Asana) or lambda-cyhalothrin (Warrior) or generics.)
• Neonicotinoids (Acetamiprid (Assail), thiamethoxam (Actara), generic imidacloprid (Provado).) Toxic to bees. Resistance concerns (for these and pyrethroids) when applied multiple times in a season, or repeatedly year after year. Used on a rotational basis.
• Spirotetramat (Movento) (growers are getting effective results with this material).
• Oil (narrow range) – fair-to-good control when light infestations of aphids are present in season. Two bloom applications with oil can provide good control. Coverage is critical for all oil uses. Oil can harm parasitoids when they are present.
• Biologicals. None noteworthy. Need testing on microbials and biological pesticides for control at this time.
*Most commonly used.

Non-chemical controls/aids Used:
• Tree monitoring to determine need for treatment.
• Beneficials, including lady beetles, lacewings and several species of parasitic wasps. Rely
on activity of natural-occurring parasite and predator populations. Not common to purchase and release beneficials. Select sprays least harmful to beneficials.

Scales [San Jose scale (SJS)]: Fruit infestation is insignificant but infestations on vegetative growth reduce tree vigor and can result in death of limbs and branches.

Chemical controls
OP insecticides currently used:
• Chlorpyrifos (Lorsban) – excellent control, but rarely used in-season.
• Diazinon – excellent control, but seldom used.
  • Issues:
    ▪ Surface runoff potential exists for these OPs.
    ▪ Many packers have OPs on do-not-use lists for their growers due to importing countries’ MRL restrictions.

Non-OPs Currently Used:
• Buprofezin (Centaur) plus narrow range oil.
• Pyriproxyfen (Seize)* plus narrow range oil. Used to target in-season crawlers (which is the life stage of concern for control), as it is the least expensive of the growth regulators. (Sprays for SJS crawlers probably rare in-season.)
• Spirotetramat (Movento) plus narrow range oil.
• Oil (narrow range) – This control is good to excellent for crawlers.
• Neonicotinoids – Acetamiprid (Assail) and imidacloprid (Provado).
*Most commonly used.

Non-chemical controls or aids used:
• Monitoring sticky tapes for crawlers (scales).
• Beneficials – under low pressure only (monitoring degree of infestation can lead to a treatment). Rely on activity of natural-occurring parasite and predator populations. Not common to purchase and release beneficials.

Lepidopterous worms: Peach Twig Borer (PTB) Oblique Banded Leafroller (OBLR), Fruit Tree Leaf Roller (FTLR), Green Fruit Worm (GF), Prune and Plum Canker Worms, Citrus Cutworm: These are incidental secondary pests which are managed to some degree by the above dormant programs for PTB. They may become a primary pest in orchards that did not use an effective pesticide in the dormant or delayed dormant stage. PTB infests shoot tips and damages developing fruit, which then becomes an entry point for brown rot. There is also an issue for PTB on young trees regarding tree structure.

Chemical controls
OP insecticides currently used if needed:
• Currently not used in-season.

Non-OPs currently used:
• *Bacillus thuringiensis* (B.t.): This provides good control when timed correctly.
• Pyrethroids: Esfenvalerate (Asana) or lambda-cyhalothrin (Warrior) or generics.
• Chlorantraniliprole (Altacor), spinosad (Success), spinetoram (Delegate) or methoxyfenozide (Intrepid) can provide excellent control when timed correctly.
• Note for spinosad, spinetoram and pyrethroids: can be particularly destructive to spider mite natural enemies (predator mites and six-spotted thrips) in season; and can flare mites. Spinosad and spinetoram do not harm beneficial mites, but are toxic to six-spotted thrips. Pyrethroids harm beneficial mites and insects.

Non-chemical controls/aids used:
• Monitoring using traps and visual evaluations of trees and fruit to determine need for treatment (PTB, FTLR, OBLR).
• Beneficials – requires good orchard monitoring.
• Pheromones (Mating Disruption) – requires monitoring to make sure the product is working.

Caterpillars: (Red-humped caterpillar, Western tussock moth, Western tent caterpillar, Forest tent caterpillar, Fall webworm): Although none of these are considered serious pests, any of these species can occasionally cause severe defoliation and feed on fruit in localized sections within an orchard or in localized areas within a region. Their spotty occurrences can best be handled with spot treatments.

Chemical controls
OP insecticides currently used:
• Currently not used in-season.

Non-OPs currently used:
• Bacillus thuringiensis (Bt)* – good control when populations are first observed.
• Spinosad (Entrust) – can be used in organic orchards.
• Pyrethroids: (esfenvalerate (Asana) or lambda-cyhalothrin (Warrior) or generics.)
• Chlorantraniliprole (Altacor), spinetoram (Delegate) or methoxyfenozide (Intrepid) can provide excellent control.
* Most commonly used.

Non-chemical controls/aids used:
• Tree monitoring to determine need for treatment.
• Pruning out infested shoots.
• Beneficials – requires good orchard monitoring.
• Irrigation management – helps maintain good tree health and vigor.

Borers (Peach tree borer, American plum borer (APB), Shot-hole borer, Branch and twig borer, Pacific flat-headed borer): Borers damage various vegetative portions of the trees depending on the species. Good tree health and vigor helps minimize damage from these pests.

Chemical controls
OP insecticides currently used:
• Chlorpyrifos (Lorsban) – labeled for trunk and lower branches application, but not the full canopy.

Non-OPs Currently Used:
• Esfenvalerate (Asana) available.

Non-chemical controls/aids used:
• Pruning, fertilizers to maintain tree vigor and good irrigation management (shot hole borer).
• Trunk wraps (protectors) or white paint to protect from sunburn (flat headed borer).
• Removal of infested material (shot hole borer).

Potential alternatives:
• None.

Needs for insect and mite management in prunes during spring:

Research:
• Economic thresholds for treatment.
• Improved monitoring techniques to determine threshold action levels.
• New parasites for aphids.
• Impact of existing parasites on aphids.
• New or testing of existing reduced-risk pesticides for efficacy (alternatives to organophosphates, pyrethrroids and neonicotinoids).

Regulatory:
• None.

Education:
• Continue to educate growers and Pest Control Advisers about “Integrated Prune Farming Practices” manual available at UC Cooperative Extension offices.

DISEASE PESTS
Brown rot, Russet scab (a non-pathogenic disorder but treated as a disease), bacterial blast or canker, rust, Phytophthora root and crown rot are of concern during spring. These may cause serious problems in prunes depending on local weather conditions, cultural practices, and history of these disease problems in and around the orchard, particularly brown rot. Growers are moving to the use of reduced-risk materials.

Fertilization and irrigation practices may affect disease incidence. For example, high nitrogen can lead to increases in brown rot, blossom blight and fruit rot, as well as rust. Trees that have poor nutrition may have poor wound healing and are subject to infections by wood decay and canker fungi.
Brown rot blossom and twig blight: Brown rot is one of the most serious disease problems for prunes. Brown rot causes blight of blossoms and young shoots, and green and ripe fruit rot. Blossom and twig blight are most severe in years when mild, wet weather occurs during bloom. In prolonged wet springs, green fruit rot caused by *Monilina* spp., *Botrytis cinerea* and *Sclerotinia sclerotiorum* can be troublesome and brown rot quiescent infections may also occur on immature green fruit. Quiescent infections may develop into fruit rots as fruit mature and ripen over the season.

Chemical controls
Materials listed below are currently used during bloom for control of blossom and fruit brown rot.

**Single active ingredients:**
- Captan (FRAC Code 4) – fair control.
- Chlorothalonil (Bravo, FRAC Code M5) – fair to good control.
- Difenconazole (Inspire, FRAC Code 3) – good to excellent control.
- Dicloran (Botran, FRAC Code M14) – fair control.
- Fenbuconazole (Indar) good to excellent control.
- Flutriafol (Rhyme, FRAC Code 3) – good to excellent control.
- Iprodione (Rovral, FRAC Code 2) – good to excellent control when combined with oil.
- Metconazole (Quash, FRAC Code 3) – good to excellent control.
- Myclobutanil (Rally, FRAC Code 3) – fair control.
- Propiconazole (Bumper, Tilt, FRAC Code 3) – good to excellent control.
- Sulfur (FRAC Code M2) – fair control.
- Tebuconazole (Elite, Tebucon, Teb, Toledo, FRAC Code 3) – good to excellent control.
- Thiophanate-methyl (Topsin-M, T-Methyl, Incognito, FRAC Code 1) – good to excellent control when combined with oil.

**Single active ingredients – Reduced Risk**
- Azoxystrobin (Abound, FRAC Code 11) – good control.
- Cyprodinil (Vangard, FRAC Code 9) – good to excellent control.
- Fenhexamid (Elevate, FRAC Code 17) – fair to good control.
- Penthiopyrad (Fontelis, FRAC Code 7) – good to excellent control.
- Pyrimethanil (Scala, FRAC Code 9) – good to excellent control.
- Trifloxystrobin (Gem, FRAC Code 11) – good control.

**Single active ingredients – Reduced Risk Bio-pesticide**
- Polyoxin-D (Ph-D, Oso, FRAC Code 19) – fair to good control.

**Pre-mixtures of active ingredients:**
- Azoxystrobin/difenconazole (Quadric Top, FRAC Code 3/11) – good to excellent control.
- Azoxystrobin/propiconazole (Quilt Xcel, FRAC Code 3/11) – good to excellent control.
• Cypredonil/difenoconazole (Inspire Super, FRAC Code 3/9) - good to excellent control.
• Fluopyram/tebuconazole (Luna Experience, FRAC Code 3/7) - good to excellent control.

Pre-mixtures of active ingredients - Reduced Risk:
• Boscalid/pyraclostrobin* (Pristine, FRAC Code 7/11) – good to excellent control.
• Fluopyram/trifloxystrobin* (Luna Sensation, FRAC Code 7/11) - good to excellent control.
• Fluxapyroxad/pyraclostrobin* (Merivon, FRAC Code 7/11) - good to excellent control.

To delay resistance and increase efficacy, these materials are generally used only once during the season and only in combination with products of a different chemistry. Resistance to systemic dicarboximide fungicides (FRAC Code 2 – iprodione) and anilinopyrimidines (FRAC Code 9 – cyprodinil and pyriethanil) has been reported in California but is not common.

Cultural Control:
• Orchard sanitation practices: removing and destroying mummy fruit and blighted shoots.
• Close mowing ground cover before bloom (also provides other benefits).

Biological control:
• Regalia (a plant extract).
• Serenade Opti (a fermentation product) – pending registration in California.

Russet scab: Russet scab is a disorder that develops on the surface of prunes when heavy rains occur during bloom. Shiny areas develop on the surface of green fruit due to incomplete development of the waxy cuticle. The areas persist until fruit is harvested and if the spots are large they become russeted and are manifested as corky patches on the dried fruit surface. Growers practice pollinator protection and apply fungicide for this disease at night when spraying during the bloom period.

Chemical control:
• Chlorothalonil (Bravo) – Most commonly used; good to excellent control.

Cultural control:
• Pruning – for better air movement to dry the fruit after rain events.
• Nitrogen management – as healthy trees are more resistant.

Biological control:
• None.

Bacterial canker or blast (Pseudomonas syringae): Bacterial canker and blast affects scaffolds and smaller branches, and may kill buds, blossoms, shoot tips and even the entire tree. Young trees are most severely affected. Problems with bacterial canker can be reduced by carefully selecting planting sites, choosing the least susceptible rootstock and following recommended cultural practices. Promote tree health as stressed trees are most susceptible.
Controls: No control actions are available that will prevent bacterial blast or canker, but several practices can be used to reduce the likelihood of the disease and its severity. An adequate nitrogen program is needed to encourage tree vigor, as stressed trees are more prone to canker.

Chemical control:
- Telone/Choropicrin (C35): Fumigation of new planting sites eliminates ring nematodes that predispose young trees to bacterial canker and contributes to improved root health.
- Required buffer zones are problematic for growers when fumigating.

Cultural control:
- Late pruning and training during spring.
- Selecting planting sites – avoid sandy sites and those infested with ring nematode.
- Avoid frost injury to the tree.

Non-chemical aids used:
- None.

Potential alternatives:
- Avoid tree stress.

_Phyllophthora_ Root and Crown Rot: At least 11 different _Phylophthora_ species attack prune trees in California. The pathogen enters the tree either at the crown near the soil line, at the major roots or at the feeder roots, depending on the species. Trees affected with _Phylophthora_ first show small leaves, sparse foliage, and lack of terminal growth. Infected trees may decline for several years or die within the same growing season in which the foliage symptoms first appear. _Phylophthora_ can survive in the soil for many years and spreads and infects the trees during moist, cool-to-moderate temperatures and some infection may occur in the summer depending on species.

Chemical controls:
- Fosetyl-al (Aliette) is registered for nonbearing trees only. It is applied as foliar spray for control of crown and root rots. This chemical is causing MRL issues in the EU, due to systemic uptake and carryover to the fruit the following year. There are new potassium phosphite products (FRAC Code 33) registered for in-season use on bearing trees.
- Mefenoxam (Ridomil Gold) is registered for use as a soil drench around the base of the trees or can be applied through a drip system.

Cultural control:
- Irrigation management: water may be applied through the precision water placement system as long as the drippers or sprinklers are not too close to the trunk.
- Avoid excess nitrogen.
- Improve internal soil drainage. Set up the orchard when young so the trees are on berms.

Needs for disease management in prunes during spring:
Research:
- Resistance management (material rates, timing, and rotation, especially for new materials.)
- Tree stress reduction management.
- Monitoring techniques for the various rots/blights.
- Economic thresholds for the major diseases.
- Disease Prediction Models.
- Breeding for disease resistance, both fruit scions and rootstocks.
- Nutrition influence on disease development.
- New active ingredients especially for Phytophthora management (four new modes of action).

Regulatory:
- Fumigation Management Plans – concern for current buffer zones and notification of intent.
- Registrations for new active ingredients.
- Township cap limitation issues in regards to the use of Telone are not consistently applied across commodities for fumigation purposes.
- MRL issues for chemical applications in the spring.

Education:
- Resistance management.
- Cultural application management.
- Accurate identification of problematic pests and diseases.
- School site plans, which are now a new regulatory requirement for growers producing near school locations, need explanation and a review of required paperwork.
- Updated disease information needs to be provided to growers regarding fumigants, irrigation, nutritional, resistance management and disease identification.

NEMATODE PESTS
Ring nematode (Mesocriconema spp.), Root lesion nematode (Pratylenchus spp.), Southern root knot nematode (Meloidogyne spp.): These plant parasitic nematodes feed on roots of the rootstocks used for prunes (plum and peach). Symptoms of nematode infestation include lack of tree vigor, small leaves, twig dieback and a sparse root system, particularly lack of small feeder roots. Root galls are an indication of root knot nematode. Management techniques are limited for in-season nematode control in established prune orchards.

Chemical control:
- DiTera – a toxin produced by the fungus Myrothecium verrucaria.
- Monterey Nematode Control – an extract of the soapbark tree Quillaja.
- Spirotetramat (Movento).
- Melocon – the fungus Paecilomyces lilacinus.
• Ecozin -includes similar product Azadirachtin, extracts from the Neem tree.

Needs for nematode management in prunes during spring:

Research:
• New techniques to rapidly test new control strategies.
• Resistant rootstocks.
• More cost-effective control strategies.
• Alternative control measures for nematodes.
• Efficacy data for new products.

Regulatory:
• New product registrations.

Education:
• Educate growers and Pest Control Advisers on new products and nematode biology, including movement through the soil. Methyl bromide alternatives don’t have the broad control that methyl bromide had.

VERTEBRATE PESTS
California ground squirrels become the primary mammalian pest species as spring progresses. Ground squirrels will feed on green fruit, consume new vegetation, girdle trees, damage drip lines, and their burrow systems can lead to uneven water distribution following irrigation. When the soil is moist, burrow fumigation with aluminum phosphide, gas cartridges, and pressurized exhaust machines are often the most effective and practical solution. If soil is dry, burrow fumigants will no longer be effective. As vegetation senesces, ground squirrels will switch from eating green vegetation to eating seeds. The use of toxic baits becomes effective at this time. The first-generation anticoagulants chlorophacinone and diphacinone are generally the most effective options, although zinc phosphide can also be a good option. Anticoagulants can be applied via spot treatment, broadcast application, or through the use of bait stations, while zinc phosphide can only be applied via spot treatments and broadcast applications. Spot treatments and broadcast applications are limited to the field borders; such applications cannot occur within an orchard during the growing season. If bait application within an orchard during the growing season is required, the only option is chlorophacinone or diphacinone used within a bait station. A number of restrictions apply to the use of rodenticides. A variety of traps can also be used to reduce ground squirrel numbers in an area including body-gripping traps and live cage traps. Trapping tends to be labor intensive and is often not as effective as baiting or burrow fumigation. Therefore, it is usually used for small ground squirrel populations or as a follow-up approach to other management strategies.

Pocket gophers and voles will continue to cause damage during the spring season. Management options remain the same as those used in the dormant season, although burrow fumigants will become ineffective as soil dries out. Also, it bears noting that probing activities needed for locating pocket gopher burrow system becomes more difficult as soils become dry and hard. As
such, it is most efficient to perform the bulk of pocket gopher removal activities during the dormant season. The hot, dry seasons are most efficiently relegated to maintenance activities for pocket gophers (removing reinvaders). Rabbit and deer damage can continue to occur during the spring season; management actions are similar to the dormant season.

House finch, crowned sparrows, and house sparrows may continue to feed on buds, and house finches may remove flower petals of the bloom and feed on the embryonic fruit. Management actions are similar to those listed during the dormant season.

Needs for vertebrate management in prunes during the spring season:

Research:
• Same as dormant season.

Regulatory:
• Same as dormant season.

Education:
• Same as dormant season.

The Summer Season [mid June – mid September (through harvest)]

FARMING ACTIVITIES
During this period, shoot and fruit growth are continuing. Fruits are maturing and accumulating sugar for harvest. Trees are developing their fruit buds for the next season. The following farming activities take place during the summer season: pest scouting, applying in-season and pre-harvest sprays, herbicide applications, fertilizer applications, irrigation, orchard floor discing or mowing, tree propping, and harvest (mechanical for dried product and hand for fresh).

All prunes used for drying are harvested by mechanically shaking the crop onto “catching frames”. They are then transported to dehydrators where they are washed and sanitized, spread on drying trays and dehydrated at 180°–185° F until the desired moisture content is reached (~21%). This temperature threshold prevents food-safety issues later in the dried fruit. Once dried, they are stored in bins to equalize moisture content between fruit, then delivered to packers as “natural condition” prunes. These prunes are stored in a manner to prevent pest re-infestation until they are placed into their final packaging. Most prunes are sold pitted, while about 33% of the crop is processed into prune juice, prune concentrate, prune puree and other ingredients used in the food processing industry.

WEED PESTS
Prune orchards become infested with numerous summer annual and perennial weeds, especially if spring or fall pre-emergence herbicides were not used. During the growing season weeds
compete with trees for substantial water and nutrients resources, and physically interfere with irrigation and other cultural practices. Effective control of summer weeds is accomplished with a well-planned, integrated management system that includes proper use of post-emergence herbicides in combination with timely orchard floor mechanical management practices such as mowing. Absent an effective program, conditions could lead to vertebrate pest pressure that could interfere with harvest. Post-emergence herbicides for use during the summer include: glyphosate (Roundup), glufosinate (Rely 280), 2,4-D, carfentrazone (Shark), pyraflufen (Venue) or paraquat (Gramoxone).

List for weed management needs in prunes during summer:

Research:
- Alternatives to chemical weed control (such as flaming).
- Develop additional post-emergence materials and use patterns.
- Additional nonchemical or organic approaches to post-emergence weed control.
- Alternatives to glyphosate- and paraquat-based post-emergence programs to combat resistance.
- New mechanical control machines.

Regulatory:
- Shorter postharvest intervals (PHIs), for example glyphosate from 17 days to 3 days.
- Reduce PHI for 2,4-D from 40 days.

Education:
- Grower education and alternative approaches for management of herbicide resistant weeds.
- Education and decision support tools for integrated weed management.

INSECT AND MITE PESTS
Oblique banded leafrollers (OBLR): OBLR directly damages fruit. Such fruit damage encourages brown rot infection that provides inocula for further infecting sound ripening fruit.

Chemical controls
OP Insecticides: Currently not used in-season.

Non-OPs currently used:
- B.t. (Dipel, Javelin) This is effective and commonly used. It is applied throughout this period as infestations are noted. Monitoring is essential. B.t. application by air is not as effective as by ground although wet weather may prevent timely ground applications.
- Esfenvalerate (Asana) and Lambda-cyhalothrin (Warrior), can provide good control. In-season use can flare mites.
- Chlorantraniliprole (Altacor) or methoxyfenozide (Intrepid) can give effective control and are less disruptive to beneficial insects and mites.
Non-chemical aids used:
• Beneficials (naturally occurring).
• Fruit monitoring.

Potential alternatives:
• Pheromone mating disruption.

Defoliating Insects: (redhumped caterpillar, western tussock moth, western tent caterpillar, forest tent caterpillar and fall webworm). Although none are considered serious pests, any of these species can occasionally cause severe defoliation and feed on fruit in localized sections within an orchard or in localized areas within the state.

Chemical controls
OP Insecticides Currently Used:
• Diazinon - available for use if needed.
  ▪ Issues: potential for surface runoff.

Non-OPs currently used:
• B.t.: This is effective and is most commonly used. It is applied throughout this period as infestations are noted. Monitoring is essential. B.t. application by air is not as effective as by ground although wet weather may prevent timely ground applications.
• Pyrethroids: Esfenvalerate (Asana) or lambda-cyhalothrin (Warrior) can provide good control. In-season use can flare mites.
• Chlorantraniliprole (Altacor), or methoxyfenozide (Intreprid) can provide good control. Can give effective control and are less disruptive to beneficial insects and mites.

Non-chemical controls:
• Beneficials (naturally occurring).

Potential alternatives:
• None.

Web-spinning spider mites (WSM): twospotted spider mite and Pacific mite: Both twospotted and Pacific mites can cause almost complete defoliation. Defoliation exposes trees and fruit to sunburn, reduces fruit size and sugar, and can interfere with harvest. Severe defoliation early in the season can cause a 25% reduction in yield. Pacific mite is the dominant species in the San Joaquin Valley and twospotted mite predominates in the Sacramento Valley. However, over the years Pacific mite has become more common in the Sacramento Valley, possibly due to the use of synthetic pyrethroids during the dormant and spring periods. Potential for direct damage decreases as the season progresses.

Chemical controls
OPs Currently Used:
- None.

Non-OP acaricides currently used:
- Abamectin (Agri-Mek).
- Bifenazate (Acramite, Banter, Vigilant).
- Hexythiazox (Onager).
- Hexythiazox (Savey).
- Fenpyroximate (Fujimite)
- Spirodiclofen (Envidor).
- Oil alone can provide some control for short periods (reapplication needed after two weeks typically). Use of oils at this time can dull fruit finish.

Cultural control:
- Good water management to prevent drought stress.
- Roads watered or oiled, or treated with material such as “Dustoff“ (a proprietary material that is applied to road surfaces to bind dust) to minimize dust.

Non-chemical aids used:
- Beneficials: The western predatory mite, sixspotted thrips, the spider mite destroyer, minute pirate bugs, lacewings and ladybugs.
- Select sprays least harmful to these beneficials based on monitoring (including sprays targeted at other pests in-season).
- Leaf monitoring.

Potential Alternatives:
- There are now several organic materials and biologicals including the bioinsecticide Grandevo, and cinnamon oil.

Needs for insect and mite management in prunes during summer:

Research:
- Remote sensing for early detection to plant stress.
- Cost-effective way to track grower lots through processing (for insecticides and acaricides used for specific markets).
- Efficacy of new materials (including biologicals and microbials).
- Impacts of materials on beneficials.
- Importance of naturally occurring beneficials.

Regulatory:
- None.

Education:
• Grower and Pest Control Adviser training on better economic thresholds and monitoring techniques (per Integrated Prune Farming Practices manual management protocols).

DISEASE PESTS
There is one fruit disease, brown rot, and one foliage disease, prune rust, of concern as fruit mature. These may cause serious problems in prunes depending on local weather conditions, cultural practices and history of disease problems in and around the orchard.

**Fruit brown rot:** Brown rot is one of the most serious disease problems in prunes. Brown rotted fruit are worthless and are costly to remove.

Chemical controls with effectiveness rating of each:
Materials listed below are currently used for control of fruit brown rot.

Single active ingredients:
- Captan (FRAC Code 4) – fair control.
- Dicloran (Botran, FRAC Code M14) - fair control.
- Difenoconazole (Inspire, FRAC Code 3) - good to excellent control.
- Fenbuconazole (Indar) - good to excellent control.
- Flutriafol (Rhyme, FRAC Code 3) - good to excellent control.
- Metconazole (Quash, FRAC Code 3) - good to excellent control.
- Myclobutanil (Rally, FRAC Code 3) – fair control.
- Propiconazole (Bumper, Tilt, FRAC Code 3) – good to excellent control.
- Sulfur (FRAC Code M2) - poor control.
- Tebuconazole (Elite, Tebucon, Teb, Toledo, FRAC Code 3) - good to excellent control.
- Thiophanate-methyl (Topsin-M, T-Methyl, Incognito, FRAC Code 1) – good to excellent control when combined with oil.

Single active ingredients – Reduced Risk
- Azoxystrobin (Abound, FRAC Code 11) – fair to good control.
- Cyprodinil (Vanguard, FRAC Code 9) – fair to good control (less effective under high temperatures).
- Fenhexamid (Elevate, FRAC Code 17) – fair to good control.
- Penthiopyrad (Fontelis, FRAC Code 7) – good to excellent control.
- Pyrimethanil (Scala, FRAC Code 9) – fair to good control (less effective under high temperatures).
- Trifloxystrobin (Gem, FRAC Code 11) – fair to good control.

Single active ingredients – Reduced Risk Bio-pesticide
- Polyoxin-D (Ph-D, Oso, FRAC Code 19) – fair to good control.

Pre-mixtures of active ingredients:
- Azoxystrobin/difenoconazole (Quadris Top, FRAC Code 3/11) - good to excellent control.
• Azoxystrobin/propiconazole (Quilt Xcel, FRAC Code 3/11) - good to excellent control.
• Cyprodonil/difenoconazole (Inspire Super, FRAC Code 3/9) - good to excellent control.
• Fluopyram/tebuconazole (Luna Experience, FRAC Code 3/7) - good to excellent control.

Pre-mixtures of active ingredients - Reduced Risk:
• Boscalid/pyraclostrobin (Pristine, FRAC Code 7/11) – good to excellent control.
• Fluopyram/trifloxystrobin (Luna Sensation, FRAC Code 7/11) - good to excellent control.
• Fluxapyroxad/pyraclostrobin (Merivon, FRAC Code 7/11) - good to excellent control.

To delay resistance and increase efficacy, these materials are generally used only once during the season and only in combination with products of a different chemistry. Resistance to anilinopyrimidines (FRAC Code 9 – cyprodinil and pyrimethanil) has been reported in California but is not common.

Cultural control:
• Use good farming cultural practices, including nitrogen and water management.
• Early mowing of ground cover to reduce humidity.
• Recognize disease potential; keep micro sprinklers off of the foliage and use precision application of water.

Non-chemical aids used: None currently.

Potential Alternatives:
• Several biological products available, such as Botector and Actinovate AG.

Prune rust: Rust infects prune leaves and causes defoliation. Excessive defoliation occurring before three weeks from harvest lowers fruit sugar content and raises the fresh-to-dry fruit ratio, reducing yield. It also affects fruit bud development for the following year’s crop. Defoliation at harvest and afterwards will not cause much effect. There is also a need to be aware of sunburn issues up to July 15.

Chemical controls: [Products now available, Single active ingredients:
• Sulfur – serves as a preventative, need to apply pre-rust symptoms.
• Difenoconazole (Inspire, FRAC Code 3) - good to excellent control.
• Fenbuconazole (Indar) - good to excellent control.
• Flutriafol (Rhyme, FRAC Code 3) - good to excellent control.
• Metconazole (Quash, FRAC Code 3) - good to excellent control.
• Myclobutanil (Rally, FRAC Code 3) – fair control.
• Propiconazole (Bumper, Tilt, FRAC Code 3) – good to excellent control.
• Sulfur (FRAC Code M2) - poor control.
• Tebuconazole (Elite, Tebucon, Teb, Toledo, FRAC Code 3) - good to excellent control.

Single active ingredients – Reduced Risk
• Azoxystrobin (Abound, FRAC Code 11) – fair to good control.
• Fenhexamid (Elevate, FRAC Code 17) – fair to good control.
• Trifloxystrobin (Gem, FRAC Code 11) – fair to good control.
• Wettable sulfur - provides some control.

Single active ingredients – Reduced Risk Bio-pesticide
• Polyoxin-D (Ph-D, Oso, FRAC Code 19) – fair to good control.

Pre-mixtures of active ingredients:
• Azoxystrobin/difenoconazole (Quadris Top, FRAC Code 3/11) - good to excellent control
• Azoxystrobin/propiconazole (Quilt Xcel, FRAC Code 3/11) - good to excellent control.
• Cyproconazole/difenoconazole (Inspire Super, FRAC Code 3/9) - good to excellent control.
• Fluopyram/tebuconazole (Luna Experience, FRAC Code 3/7) - good to excellent control.

Pre-mixtures of active ingredients - Reduced Risk:
• Boscalid/pyraclostrobin (Pristine, FRAC Code 7/11) – good to excellent control.
• Fluopyram/trifloxystrobin (Luna Sensation, FRAC Code 7/11) - good to excellent control.
• Fluxapyroxad/pyraclostrobin (Merivon, FRAC Code 7/11) - good to excellent control.

Cultural control:
• Use good agricultural practices to minimize.

Biological control:
• No products currently available.

Non-chemical aids used:
• Weekly tree monitoring to determine onset of rust and need for treatment. This is critical from May 1 to July 15 and can be combined with mite monitoring.

Potential alternatives:
• Many alternatives are available (see above). Rotating between FRAC Codes is essential for resistance management. Sulfur is available for organic production and must be applied frequently.

Needs for disease management in prunes during summer:

Research:
• Brown rot detection methods and treatment thresholds.
• Tree vigor and disease management.

Regulatory:
• New material registrations, including reduced-risk materials and biological controls.
Education

- Educate growers as to monitoring and thresholds for rust.

NEMATODE PESTS

Ring nematode (*Myrothecium* spp), root lesion nematode (*Pratylenchus* spp), root knot nematode (*Meloidogyne* spp): These plant parasitic nematodes feed on roots of the rootstocks used for prunes (plum and peach). Symptoms of nematode infestation include lack of tree vigor, small leaves, twig dieback and a sparse root system, particularly lack of small feeder roots. Root galls are an indication of root knot nematodes. Management techniques are limited for in-season nematode control in established prune orchards.

Chemical control:
- Management techniques are limited for in-season nematode control in established orchards.

Needs for nematode management in prunes during summer:

Research:
- New techniques to rapidly test new control strategies.
- More cost-effective control strategies.
- Alternative control measures for nematodes.
- Efficacy data for new products.

Regulatory:
- Ease constraints on crop destruction requirements for EUPs and state Research Authorizations.
- Equitable allocation/distribution of Telone across township caps.
- New product registrations.

Education:
- Educate growers and Pest Control Advisers on new products and nematode biology, including movement through the soil. Methyl bromide alternatives don’t have the broad control that methyl bromide had.

VERTEBRATE PESTS

Ground squirrels continue to be the primary mammalian pest during summer, with the same forms of damage as those listed during the spring season. Management actions are the same as those listed during the spring season. Pocket gophers, voles, rabbits, and deer can still cause some problems, but damage is less during summer than during other seasons. If active management is required, actions should follow those listed for the spring and dormant seasons.

Scrub jays (*Aphelocoma californica*) and yellow-billed magpies (*Pica nuttalli*) will feed on ripening prunes. Scrub jays feed singly or in pairs, while yellow-billed magpies feed in small
flocks of a few birds to several dozen. Crows (*Corvus brachyrhynchos*) are more gregarious and often feed in large numbers, moving from orchard to orchard. European starlings (*Sturnus vulgaris*) usually feed in sizeable flocks, as well. Frightening devices outlined in the dormant season section are the primary tools used to manage birds in the summer season. Shooting can also be used to reduce population size for resident bird species. Depredation permits are required for lethal removal of some bird species.

Needs for vertebrate management in prunes during the summer season:

Research:
- Same as dormant season.

Regulatory:
- Same as dormant season.

Education:
- Same as dormant season.

The Fall Season [mid-September (Postharvest) to December]

FARMING ACTIVITIES
Fruit have been harvested and trees are going dormant. The following farming activities take place during the fall season: herbicide applications, foliar zinc applications, cover-crop planting, orchard floor discing or mowing, postharvest irrigation, potassium fertilizer applications, fall pruning, aphid and scale monitoring, fall aphid spraying (if necessary), tree removal, pre-plant tree site and orchard fumigation and brown rot “mummy” removal.

WEED PESTS
Prune orchards are infested with numerous winter annual and perennial weeds. Effective control of most weeds is possible with a well-planned (based on annual orchard surveys to identify weeds species), integrated management system that includes proper use of pre-and post-emergence herbicides in combination with timely orchard floor management practices.

A pre-emergent herbicide typically is applied from late fall through late winter. Oxyfluorfen (Goal Tender), and/or oryzalin (Surflan) are common, but more recently registered materials including flumioxazin (Chateau), pendimethalin (Prowl H2O), rimsulfuron (Matrix), indaziflam (Alion) or penoxsulam/oxyfluorfen (Pindar GT) are also used. Post-emergence herbicides include: glyphosate (Roundup), 2,4-D, paraquat (Gramoxone) and glufosinate (Rely 280). Several grass specific herbicides including clethodim (Select Max), fluazifop (Fusillades) and sethoxydim (Poast) can be used in non-bearing prunes but, of these, only fluazifop can be used during bearing years.

Needs for weed management in prunes during fall:
Research:
- Mitigate surface runoff.
- Alternatives to chemical weed control.
- Evaluate rates and timings of recently registered pre-emergence materials and combinations.
- Evaluate efficacy and economics of pre-emergence herbicide programs in light of herbicide resistant biotypes and changing irrigation practices.

Regulatory:
- None.

Education:
- Grower education and alternative approaches for management of herbicide resistant weeds.
- Education and decision support tools (www.wric.ucdavis.edu) for integrated weed management.

INSECT PESTS
Aphids [Mealy plum aphid (MPA), Leaf curl plum aphid (LCPA) and Black cherry aphid (BCA)]: MPA, PCPA and BCA migrate in the fall from their summer alternate hosts to prune trees to over-winter. If a dormant OP/oil spray is not applied, damaging infestations of each of these aphids may develop in spring, emanating from these returning aphids. Growers are now using earlier applications of controlling protectants. This strategy has reduced OP and pyrethroid runoff in the dormant season.

Chemical
OP insecticides currently used:
- None.

Pyrethroid insecticides currently used:
- Esfenvalerate (Asana) - Use before rains in late October - early November at low level rates.
- Lamba-cyhalothrin (Warrior) – Use before rains in late October - early November at low level rates.
- Cyfluthrin (Baythroid) – Use before rains in late October - early November at low level rates.

Neonicitinoids:
- Thiamethoxam (Actara) and imidacloprid (Provado) are effective before natural leaf drop begins.

Non-chemical Aids Used:
- Use zinc sulfate as a defoliant.
Potential alternatives:
• None.

Needs for insect management in prunes during fall:

Research:
• Mating disruption for aphids.
• Economic thresholds for treatment.
• Improved monitoring techniques to determine threshold action levels.
• New parasites for aphids.
• New or testing of existing reduced-risk pesticides for efficacy (alternatives to organophosphates, pyrethroids and neonicotinoids).

Regulatory:
• None.

Education:
• None.

DISEASE PESTS
Bacterial canker: Bacterial canker affects scaffolds and smaller branches, and may kill buds, blossoms and shoot tips. Young trees are most severely affected. Problems with bacterial canker can be reduced by carefully selecting planting sites, choosing the least susceptible rootstock and following recommended cultural practices.

Controls: No control actions are available that will prevent bacterial canker, but several practices can be used to reduce the likelihood of the disease and its severity.

Chemical Control:
• Telone/Chloropicrin: Fall fumigation of replant and new planting sites eliminates ring nematodes that predispose young trees to bacterial canker.

Cultural Control:
• Avoid planting sites with a history of bacterial canker.
• Resistant rootstocks can help manage this disease. Lovell and Nemaguard peach are most resistant, and plum most susceptible.
• Late pruning and training during spring.
• Manage orchard for tree vigor and healthy trees.

Non-chemical Aids Used:
• None.

Potential Alternatives:
• There is an active research program to develop potential alternatives, for example, anaerobic digestion products.

Armillaria Root Rot: The soilborne pathogen invades roots, crown and basal trunk, eventually girdling the crown region and destroying the entire root system causing tree death. It can survive for many years in dead roots of many different species of trees.

Chemical control:
• Chloropicrin: Has shown some promise for control, may be more feasible for small areas.

Cultural control:
• Rootstock selection (Marianna 2624 and Krymsk are tolerant of some strains).
• Site selection – plant in non-infested ground.

Non-chemical aids used:
• None.

Potential alternatives:
• Chloropicrin at high rates – needs more research.

Phytophthora root and crown rot: Phytophthora can survive in the soil for many years and spreads and infects the trees during moist, cool-to-moderate temperatures. Some infection may occur in the summer depending on species. The pathogen enters the tree’s crown near the soil line, major roots or feeder roots. Trees affected with Phytophthora first show small leaves, sparse foliage, and lack of terminal growth during the growing season. Infected trees may decline for several years or die within the same growing season in which the foliage symptoms first appear.

Chemical control:
• In the fall, apply fosetyl-al (Aliette), which is registered for nonbearing trees only. It is applied as foliar spray for control of crown and root rots. This chemical is causing MRL issues in the European Union due to systemic uptake and carryover to the fruit the following year. There are new phosphite products being registered for in-season use on bearing trees.

Cultural control:
• Site selection (well drained soils).
• Site preparation (improving internal drainage), developing orchard berms.
• Irrigation management including applications of nitrogen.

Non-chemical aids used:
• None.

Potential Alternatives:
• New fungicides which might be effective but need registration.
• Pruning out potential diseased wood in the fall.

Needs for disease management in prunes during fall:

Research:
• Alternatives to methyl bromide.
• Improvement of copper efficacy against bacterial canker.
• New product efficacy against bacterial canker.
• Improving chloropicrin and other potential fumigants, possibly at high concentrations.
• Fungicides and biologicals efficacy on pruning wounds.
• Develop new phytophthora products.
• Wood decay organisms management for fungal and canker control.

Regulatory:
• New methyl bromide alternative materials with streamlined registration process.

Education:
• Canker wood rot management.

NEMATODE PESTS
Ring nematode, root lesion nematode and root knot nematode: Plant parasitic nematodes are microscopic roundworms that feed on plant roots of most plants including prunes. Symptoms of a nematode infestation include lack of vigor, small leaves, dieback of twigs and a sparse root system, particularly the lack of small feeder roots. Root galls are an indication of root-knot nematode.

Chemical controls:
• 1,3 Dichloropropene (1,3-D) (Telone) – pre-plant. Fair control.
• Chloropicrin.

Starve-and-switch tactic:
• Starve – Kill root system with systemic herbicide. Wait one year before replanting.
• Switch – Replant with a rootstock with strikingly different parentage from the previous rootstock.
• Spot or strip treatments – May need to do spot or strip treatments to provide pest and disease resistance for six months after planting. (Examples: Soil steaming or fuming products with reduced VOC issues.)

Biological control:
• Ditera
• Milicon

Cultural control:
• Site selection - selecting land not recently planted to orchard or vineyard crops.
• Clean, certified nursery stock.
• Rootstock selection. Nemaguard peach and the plum rootstocks Marianna 2624 and Myrobalan 29C are resistant to root knot nematodes. Marianna 2624 and Myrobalan 29C are moderately resistant to root lesion but susceptible to ring nematode.

Potential alternatives:
• None.

Needs for nematode management in prunes during fall:

Research:
• Soil microbiology interactions with nematodes.
• Cover crop management techniques and data, such as for mustard.
• Anaerobic Soil Disinfestation (ASD) technique

Regulatory:
• Register alternatives to methyl bromide.

Education:
• None.

VERTEBRATE PESTS
Following harvest, rodenticides can again be applied via broadcast and spot treatment applications within orchards. This is particularly important for ground squirrel management, as rodenticides can be broadcast to knock down populations before hibernation. This can save time and finances compared to burrow fumigation during late winter or early spring the following year. These same rodenticides can be applied for vole control. Proactive vole management actions are recommended given the extreme reproductive potential of this species. It is best to knock these populations back before they enter their primary reproductive period in winter or spring.

Burrow fumigation again becomes an effective management tool for pocket gophers as rainfall returns in late fall or early winter. Trapping and strychnine application continue to be good options for pocket gopher management as well. Rabbit and deer management remains the same as that listed during the dormant season.

Birds do not generally cause damage during the fall season.

Needs for vertebrate management in prunes during the fall season:

Research:
• Same as dormant season.

Regulatory:
• Same as dormant season.

Education:
• Same as dormant season.

REFERENCES

California Agricultural Statistics Service (https://www.cdfa.ca.gov/Statistics/)
Prune Crop Profile (https://ipmdata.ipmcenters.org/documents/cropprofiles/CAprunes.pdf)
U.C. Prune Pest Management Guidelines
(http://www.ipm.ucdavis.edu/PMG/selectnewpest.prune.html)
Integrated Prune Farming Practices manual (available in UCCE offices)
California Department of Pesticide Registration list of registered pesticides
(http://www.cdpr.ca.gov)
The California Prune Work Group

The work group consists of 22 members. The makeup includes growers, commodity group representatives, University of California specialists, and other technical experts.

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The use of trade names does not imply endorsement by the workgroup or any of the organizations represented. Trade names are used as an aid in identifying various products.
APPENDICES
Glossary

acaricide. A pesticide that kills mites; a miticide.
active ingredient. The compound in a pesticide that kills a pest.
adjuvant. Any solid or liquid added to a substance such as a fluid pesticide or fertilizer to increase its effectiveness.
adsorption. Adhesion of ions or molecules to a solid body.
air-carrier sprayer. Sprayer using air velocity to carry pesticide, plant growth regulator, or nutrient to a target.
algaline. Soils that have a pH above 7.0, containing sodium salts sufficient to damage plants.
anaerobic. An environment or condition that lacks oxygen.
anticoagulant. A substance that hinders blood clotting.
antifoaming agent. A liquid substance that minimizes foaming in a spray tank.
antioxidant. Organic compound that prevents or neutralizes an oxidizing agent.
Ascomycete. A group of fungi producing their sexual spores, ascospores, with asci.
ascospores. A sexually produced spore borne in an ascus.
asexual spores. Minute fragments of the mycelium that separate into spores without any nuclear change.
atomization. Reduced to fine particles or a fine spray.
bacteria. Large, widely distributed group of typically one-celled organisms, chiefly parasitic or saprophytic.
basidiospore. A sexually produced spore borne on a basidium.
basidium. A club-shaped structure on which basidiospores are borne.
biocontrol. Pest control by natural means.
blight. Result of a disease characterized by general and rapid killing of leaves, flowers, and branches.
bud. A plant structure at the base of the leaf axil or the tip of a shoot from which a shoot, flower, or flower cluster develops.
cambium. Plant tissue between the xylem and phloem of most vascular plants that produces new cells and is responsible for secondary growth.
canopy. The periphery or upper structure of a tree.
carbohydrates. Organic compounds produced by plants that contain chemically bonded energy composed of carbon, hydrogen, and oxygen.
carrier. An inactive accessory substance combined with an active ingredient in a spray material formulation.
cation. An atom or group of atoms that carry a positive electrical charge.
chlamydospore. A thick-walled spore formed from the cell of a fungal hypha.
chlorophyll. Green pigments mainly in leaves, which, under the stimulus of light, manufacture carbohydrates used in plant growth and fruit development.
cleistothecia. Spherical closed structures of certain Ascomycete fungi where one or more asci and ascospores are formed.
conidia. Asexual fungal spores formed by fragmentation or budding at the tip of a specialized hypha.
conidiophores. Special hyphae in some fungi that produce conidia.
cornell donut. A metal attachment on a spray machine that restricts air intake.
cover crop. A second crop grown to improve the production of a primary crop, e.g., grasses or legumes grown in orchards to improve soil conditions.
dehydrator. Facility that dries prunes.
dieback. Progressive death of branches or shoots beginning at the tips, characteristic of unhealthy prune trees.
diffusion. The process whereby particles of liquids, gases, or solids intermingle as the result of thermal agitation and move from a region of higher to lower concentration.
diluent. A material that reduces the concentration of a solution.
dipper. A tank through which freshly harvested prunes are conveyed to separate leaf and stem material prior to dehydration.
dormancy. A physical or physiological state in which a plant is not actively growing.
drosophilids. Insects in the order Diptera (flies), family Drosophilidae, including pomece flies and small fruit flies.
electrostatic attraction. Attraction of a negatively charged body to a positively charged body.
emulsifiable concentrate. A liquid concentrate that is added to water to create a pesticide solution.
endoparasitic nematode. A nematode that lives inside the host.
exuvia. The cast skins of previous growth stages found on armored scale insects such as San Jose scale.
fixed-wing aircraft. A heavier-than-air aircraft capable of flight whose lift is generated not by wing motion relative to the aircraft, but by forward motion through the air.
flowable. Pesticide formulation in which the pesticide is a liquid toxicant uniformly dispersed throughout a stable emulsified system, allowing for long periods of storage and redispersal with mild agitation.
frass. A mixture of feces and food fragments produced by an insect from feeding.
fumigation. Gas-based chemical treatments to kill or reduce soilborne pathogens or insects in fruit storage facilities.
fungicide. A pesticide that kills fungi.
fungus (pl., fungi). A multicellular lower organism, such as mold, mildew, rust, or smut, whose body normally consists of mycelia.
green tip. Stage of spring flower bud swell in which expanding sepals appear as green tips at the terminal end of the bud; also known as green bud.
habitat. An ecological or environmental area that is inhabited by a particular animal or plant species.
herbicide. A chemical substance that kills plants.
hypha (pl., hyphae). The branching elements of a mycelium.
in vitro. In a culture; in a controlled environment outside the host.
incubation. Time between penetration of a host by a pathogen and the first appearance of symptoms.
ingestion. The act of taking a pesticide into the body by mouth (eating).
inoculant. A bacterial substance topically introduced onto seed or soil to ensure atmospheric nitrogen fixation.
inoculum. Any part or stage of a pathogen, such as spores or virus particles, that can infect a host.
instar. Form assumed by insects between successive molts.
interveinal. Area of a leaf between the veins.
invertebrate. An animal having no internal skeleton.
larva (pl., larvae). The immature form of an insect that hatches from an egg, feeds, and enters a pupal stage.
lesion. A localized area of diseased tissue, such as a canker or leaf spot.
lichen. A fungus, usually of the class Ascomycetes, that grows symbiotically with algae, resulting in a composite organism that characteristically forms a crustlike or branching growth on rocks or tree trunks.
metabolite. Any substance produced by metabolism or by a metabolic process.
metamorphosis. Change in form during development of an insect.
miticide. A pesticide that kills mites; acaricide.
mummy. Dried, shriveled fruit remaining on a tree; often the dried remains of a prune decayed by brown rot.
mycelium (pl., mycelia). Mass of hyphae that make up a fungus.
mycophagous. Fungus eating.
mycorrhiza. A symbiotic, beneficial association of a soilborne fungus with plant roots.
necrotic. Dead or dying tissue of a plant part.
nematicide. Chemical compound or physical agent that kills or inhibits nematodes.
nematode. Nonsegmented microscopic roundworms that live in soil and parasitize roots.
nitidulids. Insects in the order Coleoptera (beetles), family Nitidulidae, including sap-feeding beetles.
nocuid. Insects in the order Lepidoptera (butterflies and moths), family Noctuidae, including the citrus cutworm and green fruitworm.
nonbearing trees. Young trees that have not yet become reproductive.
no-till. Leaving orchard floors uncultivated throughout the growing season.
parasite. An organism that spends all or some of its life cycle in or on the body of a larger living organism (its host) from which it derives food without killing the host directly.
pathogen. Any disease-producing organism.
perithecia. Globular or flask-shaped structures produced by certain Ascomycete fungi, within which asci and ascospores are formed.
pesticide. A synthetic, natural, or biological material used to kill pests.
pH. Hydrogen ion concentration or activity of a soil or water; lower pH is acidic, higher pH is alkaline.
pistil. Female part of the flower consisting of a stigma, style, and ovary.
popcorn bloom. The stage of bloom in which most prune flowers are about to open; the white unopened flowers resemble popcorn.
postemergent herbicide. An herbicide designed to kill weeds after they have emerged.
predator. An organism that attacks and feeds on other organisms (prey), usually consuming all of the prey and consuming many prey during its lifetime.
preemergent herbicide. An herbicide designed to kill weeds before or as they germinate, prior to emergence.
prepupa. A quiescent instar between the end of the larval period and the pupal period.
proliferating mass. A dividing cluster of cells, such as callus.
prune. Variety of European plum (Prunus domestica L.) that is high in sugar and can be satisfactorily dried whole without fermenting at the pit.
PTO. Power take off accessory on a tractor.
pupa. The nonfeeding inactive stage between larva and adult in insects with complete
metamorphosis.
pycnidia. Small spherical or flask-shaped structures formed by certain types of fungi, inside which asexual spores are produced.
radiated. Sent out in the form of rays or waves.
radiation frost. Frost that occurs on cold nights when the air is clear and dry and heat is radiated from the earth’s surface into the atmosphere.
raptor. A carnivorous predatory bird.
replant. Replacement tree in an established orchard.
residual herbicide. Plant-killing chemical applied before weed seeds germinate or emerge that remains active in the soil after application.
residue. Material remaining after completion of a chemical or physical process, such as environmental degradation or evaporation.
rhizomorph. A rootlike structure produced by the fungus Armillaria mellea that grows from the root of an infected host plant to the root of an uninfected host plant.
rotary-wing. An aircraft that uses a moving wing to generate lift, such as a helicopter.
russetting. Brownish, roughened areas on the skin of fruit.
saline. Soil or water containing excessive salts that can reduce crop productivity.
saprophyte. An organism that lives off the dead body or nonliving products of another plant or animal.
scaffold. Larger branch arising from the central portion or trunk of a tree; the primary branching structure of a tree.
sod culture. Managing an orchard floor by mowing (not cultivating) native weeds or planted vegetation.
solubility. The degree to which a substance can be dissolved in water.
sporangia. A structure containing asexual spores.
sporulation. Formation of spores.
spot-treat. To apply pesticide to a single target, such as a clump of weeds.
spreader-sticker. An adjuvant that enables pesticides to flow and stick more readily, increasing effectiveness.
spur. Small stubby branch on which fruit is borne.
stamen. Male part of a flower, consisting of an anther on a filament, which produces pollen.
stigma. Top of pistil where pollen grains germinate.
style. Region of the pistil connecting ovary and stigma.
stylet. Insect mouthpart used for penetrating tissue for feeding.
subtending wood. Wood underneath the bark when a bud is removed for budding.
surfactant. Materials that lower the surface tension of a liquid, allowing improved spreading.
tortricids. Insects in the order Lepidoptera (butterflies and moths), family Tortricidae, including the fruittree leafroller.
translocate. To move water and other dissolved substances through the vascular system of a plant.
vascular. Relating to system of plant tissues that conducts water, mineral nutrients, and photosynthates through a plant.
vascular cambium. A cylinder of meristematic tissue that lies between the wood and the bark.
vector. Organism that carries and transmits disease-causing microorganisms.
venturi. A short tube with a tapering constriction at the center that increases fluid velocity and decreases fluid pressure.
vertebrate. Organisms in the phylum Chordata, having backbones or spinal columns.
virus. Submicroscopic infectious agent consisting of nucleic acid and a protein coat that can reproduce only within the living cells of a host.
volutilization. Conversion of a chemical substance from a liquid or solid state to a gaseous or vapor state.
volute. Metal or plastic covering over the fan of a spray machine that channels air to increase velocity and direct spray placement.
water amendment. A chemical added to water to improve quality.
water-soluble concentrate. Concentrated pesticide that can be dissolved in water.
weed. A plant that is not valued where it is growing.
wettable powder. Pesticide material that will not dissolve in water but remains suspended in it.
wetting agent. A chemical substance that increases the spreading and penetrating power of a liquid.
woody perennial. A tree or shrub that lives 3 or more years and flowers at least twice.
xylem. Woody portion of a tree located inside the cambium containing nonliving vascular tissues that conduct water and nutrients from the roots to the leaves.
zoospore. A swimming asexual spore.
zygote. The diploid cell formed by the union of the male nucleus and the egg.

Table 1. Insect and Mite Pests

<table>
<thead>
<tr>
<th>Product</th>
<th>Trade Name</th>
<th>San Jose scale</th>
<th>European fruit lecanium</th>
<th>Peach twig borer</th>
<th>Fruit tree leaf roller</th>
<th>Oblique banded leaf roller</th>
<th>Green fruit worm</th>
<th>Codling moth</th>
<th>Web spinning mites</th>
<th>Mealy plum aphid</th>
<th>Leaf curl plum aphid</th>
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## Rating System
E=Excellent, G=Good F=Fair, P=Poor, U=Unknown, NE=Not Efficacious, ?=No data but suspected of being efficacious. The Y (yes) and N (no) designations regarding non-chemical aids to IPM refer to whether the non-chemical aid is used as a toll against a specific pest.

### Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

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### Management Tool
Non-chemical Aids to IPM (not stand alone)

<table>
<thead>
<tr>
<th>Non-chemical Aids to IPM (not stand alone)</th>
<th>San-Jose scale</th>
<th>European fruit lecanium</th>
<th>Peach twig borer</th>
<th>Fruit tree leaf roller</th>
<th>Oblique banded leaf roller</th>
<th>Green fruit worm</th>
<th>Codling moth</th>
<th>Web spinning mites</th>
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Table 2. Disease Pests

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<th>Management Tool</th>
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<th>Russet scab</th>
<th>Rust</th>
<th>Bacterial</th>
<th>Armilleria root</th>
<th>Phytophthora crown &amp; Root</th>
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<td>[G]</td>
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<td>FRAC code</td>
<td>Brown Rot</td>
<td>Russet scab</td>
<td>Rust</td>
<td>Bacterial canker</td>
<td>Armilleria root rot</td>
<td>Phytophthora crown &amp; Root rot</td>
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<td>tebuconazole (Elite, Tebucon, Teb, Toledo)</td>
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<td>thiophanate methyl (Topsin-M, T-Methyl, Incognito) + oil = shown in [ ]</td>
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<td>trifloxystrobin* (Gem)</td>
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**Management Tool**

Fungicides/bactericides registered on prunes – Pre-mixtures

<table>
<thead>
<tr>
<th>Management Tool</th>
<th>FRAC code</th>
<th>Brown Rot</th>
<th>Russet scab</th>
<th>Rust</th>
<th>Bacterial canker</th>
<th>Armilleria root rot</th>
<th>Phytophthora crown &amp; Root rot</th>
<th>Crown gall</th>
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<tbody>
<tr>
<td>Azoxystrobin/difenconazole (Quadris Top)</td>
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<td>G-E</td>
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<tr>
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<td>boscalid/pyraclostrobin* (Pristine)</td>
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<td>G-E</td>
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<td>G-E</td>
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<td>cyprodonil/difenconazole (Inspire Super)</td>
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<td>NE</td>
<td>G</td>
<td>NE</td>
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<tr>
<td>fluopyram/tebuconazole (Luna Experience)</td>
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<tr>
<td>Fluxapyroxad/pyraclostrobin* (Merivon)</td>
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<td>G-E</td>
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<td>G</td>
<td>NE</td>
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</tbody>
</table>

**Rating System**
E=Excellent, G=Good F=Fair, P=Poor, U=Unknown, NE=Not Efficacious, ?=No data but suspected of being efficacious. The Y (yes) and N (no) designations regarding non-chemical aids to IPM refer to whether the non-chemical aid is used as a toll against a specific pest. A single * is a reduced risk material, a double ** is a reduced risk bio-pesticide.

<table>
<thead>
<tr>
<th>Management Tool</th>
<th>Brown Rot</th>
<th>Russet scab</th>
<th>Rust</th>
<th>Bacterial canker</th>
<th>Armilleria root rot</th>
<th>Phythophthora crown &amp; Root</th>
<th>Crown gall</th>
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</thead>
<tbody>
<tr>
<td>Non-chemical aids to IPM of diseases</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>Pruning/canopy management</td>
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<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
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Table 3. Nematode Pests (Pre- or Post plant)

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<tr>
<th>Management Tools</th>
<th>Non-chemical aids for nematode IPM control for prunes</th>
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<td><strong>Product</strong></td>
<td><strong>Ring Pre Plant</strong></td>
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<tr>
<td>1,3-D + chloropictin</td>
<td>Telone C15</td>
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<td>dazomet [1]</td>
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<td>chloropicrin</td>
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<table>
<thead>
<tr>
<th>Management Tools</th>
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<tr>
<td><strong>Product</strong></td>
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<td>Monitoring – soil samples [6]</td>
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<td>Cover crops</td>
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<td>Resistant rootstocks [7]</td>
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</table>
Rating System
E=Excellent, G=Good F=Fair, P=Poor, U=Unknown, NE=Not Efficacious, ?=No data but suspected of being efficacious. The Y (yes) and N (no) designations regarding non-chemical aids to IPM refer to whether the non-chemical aid is used as a toll against a specific pest. A single * is a reduced risk material, a double ** is a reduced risk bio-pesticide.

[1] Pre-plant registration only. Only effective to depth of incorporation so depth of efficacy likely to be less than Telone.
[2] Only registered for pre-plant use. Must be applied in irrigation water to be effective. May not penetrate deeply enough to provide efficacy similar to Telone.
[4] Must be applied in irrigation water to be effective. Yearly post-plant applications required. Root Knot and Root Lesion have stages within roots which will not be killed.
[5] Length of fallow period required is not known for Ring and Root Lesion. Two years following decay of roots needed for Root Knot.

Table 4. Weed Pests

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<th>Weed Species</th>
<th>Flumioxazin (Chateau)</th>
<th>isoxaben (Trellis)</th>
<th>nonflurazon (Solicam)</th>
<th>oxyfluorfen (Goal Tender)</th>
<th>oxynil (Surflan)</th>
<th>trifluralin (Treflan)</th>
<th>2,4-D</th>
<th>fluazifop-butyl (Fusilade)</th>
<th>glyphosate (Roundup)</th>
<th>sethoxydim (Poast)</th>
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**Perennial grasses**

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**Perennial broadleaves**

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**Rating System**

C=control, P=partial control, N=no control, - = no information

1) Link to IPM Prune Pest Management Guidelines:
   (http://www.ipm.ucdavis.edu/PMG/selectnewpest.prune.html)

2) Link to Susceptibility of Weeds to Herbicide Control Tables:
   (http://ipm.ucanr.edu/PMG/r606700311.html)
Table 5. Efficacy of non-chemical aids for weed control in prunes

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<td>Cultivation</td>
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<td>Cover crops</td>
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<td>Soil/water management</td>
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<td>Flaming</td>
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<td>Mow and blow</td>
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**Rating System**
G=Good  F=Fair,  P=Poor