A PEST MANAGEMENT STRATEGIC PLAN FOR CALIFORNIA PRUNE PRODUCTION

April 2002

RATIONALE

USEPA 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. USEPA ' s regulatory focus is on the organophosphate (OP), carbamate and suspected B_2 carcinogen pesticides. USEPA 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 USDA, USEPA, land-grant universities and the prune industry, working as a group, have pro-actively identified research and regulatory needs for reducing reliance on certain pesticides with effective alternatives if that should become necessary as a result of USEPA's regulatory actions.

Background

PRUNE FACTS

- Over 99% of the prunes grown in the United States are grown in California.
- California grows almost 70% of the total world production of dried prunes.
- Approximately 1200 growers farm 86,000 bearing and 15,000 non-bearing acres of prunes in California.
- In 2000 the crop totaled 214,802 dried tons valued at approximately $166 million.
- 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 $2740 in the Sacramento Valley to $2840 in the San Joaquin Valley.

The majority of the prunes (recently renamed dried plums) are grown in California's Sacramento Valley, with over 214,802 dried tons being produced in 2000. The other production areas in the San Joaquin Valley, primarily Tulare and Fresno counties, produced 28,833 dried tons with 353 dried tons being produced in coastal areas. Approximately 1% of the crop is sold as fresh fruit. The target market is primarily 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. Recently one newer selection, "Sutter," emanating from the University of California's prune breeding program, has been introduced. Selected cultivars are grafted onto rootstocks selected to accommodate local growing situations. Both 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 growing areas. Flood, furrow, sprinkler, drip, and micro-sprinkler systems are used throughout the industry with micro-sprinkler and flood being the most common.

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 some soils, especially in the northern Sacramento Valley 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/cover-crops grow. Continual cultivation of the orchard floor is becoming less common.

Essentially 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, spread on drying trays and dehydrated at $180^{o} - 185^{o}$ F until the desired moisture content is reached (~21%). Once dried, they are stored in bins to equalize moisture content between fruit then delivered to packers as "natural condition" prunes. Most prunes are sold pitted while about 33% of the crop is processed into prune juice, prune concentrate, prune puree and baby food.

A serious problem 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 than US 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/packaging labor to meet the final demand. Since California prunes are supplied to customers world wide, California growers and processors are at a distinct disadvantage trying to comply with the large volume of material restrictions by end users.

Recently, a market for fresh prunes has developed. However, less than 1 percent of prunes produced in California are marketed through this channel due to volatile market conditions

Prune marketing is regulated by the Prune Marketing Committee, which administers a federal marketing order under the authority of the U.S. Department of Agriculture. The PMC sets standards for quality, size, labeling and mandatory product inspection. The California Dried Plum Board administers a state marketing order under the authority of the California Department of Food and Agriculture. The CDPB funds advertising, public relations, nutrition research, production research and market research.

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 mid - March)

FARMING ACTIVITIES

The following farming activities take place during the dormant season: pruning and brush removal, dormant spraying, diseased tree removal, new tree planting, tree-site fumigation, and apply herbicides in the tree-row and mow 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. One of the following pre-emergent herbicides is applied from late fall through late winter: trifluralin (Treflan – for pre-plant), oxyfluorfen (Goal), oryzalin (Surflan), norflurazon (Solicam), and napropamide (Devrinol). Post-emergence herbicides include: glyphosate (Roundup), 2,4-D, and Paraquat. 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 that determines the weed species present; most herbicides are more effective against certain species than others. Only then can the best strategy be determined and the appropriate herbicide applied before weeds emerge; applying pre-emergence herbicides once some weeds are up requires an additional expense of including a post emergence herbicide. If one waits until all weeds have emerged, a translocated herbicide (e.g. glyphosate) and a contact (e.g. paraquat) must be used.

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

Research:
- Alternatives to oxyfluorfen.
- Develop materials for Fleabane and Horseweed control.
- Develop materials to counter potential glyphosate resistant rye grass.
- Develop materials to control and confine legumes planted as cover crops .

Regulatory:
- Oxyfluorfen as a suspected B_2 carcinogen.

Education:
- Grower education about mitigating surface runoff reduction.

INSECT AND MITE PESTS

Dormant sprays, that include oil combined with an organophosphate (OP), pyrethroid, or carbamate insecticide, are applied to control several insect and mite pests. Most prune orchards receive this dormant spray between February and early March. During this time there is no fruit or foliage on the tree.

Insect/mites controlled in the dormant season:

Scale insects: San Jose scale (SJS), European fruit lecanium scale (EFL): If left uncontrolled these pests reduce yield and plant vigor. SJS must be controlled in order for the fruit to be sold on the fresh market. All the OPs and carbamates have documented scale resistance in some areas of California.

Chemical controls

OP insecticides currently used:

- Chlorpyrifos + oil gives excellent control.
- Diazinon + oil* gives excellent control.
- Methidathion gives excellent control.
- Issues: Surface runoff potential exists for these OPs.

*Most commonly used.

Pyrethroid insecticides currently used

- Esfenvalerate + oil* gives poor control of SJS, excellent control of EFL.
- Issues:
  - Resistance.
  - Off-site movement, toxic to fish/amphibians.

*Most commonly used.

Others:

- Oil (narrow range gives good control of light infestations with 2 applications at bud-break.
- Carbaryl (PTB) gives poor control of SJS and EFL.

Non-chemical Aids Used:

- Monitoring dormant spur samples (scales and aphids).
- Alternate year dormant applications.

Potential Alternatives:

- Beneficials (must use sprays least harmful to these 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 are required. These can encourage other pests (e.g. spider mites) that require additional treatment.

Chemical controls

OP insecticides currently used:

- Chlorpyrifos + oil gives excellent control.
- Diazinon + oil* gives excellent control.
- Methidathion gives excellent control.
- Phosmet + oil gives good control.
- Issues: Surface runoff for all these OPs.

*Most commonly used.

Pyrethroid insecticides currently used

- Esfenvalerate + oil* - gives excellent control.
- Issues:
    - Resistance.
    - Off-site movement – toxic to fish and amphibians.

*Most commonly used.

Others:

- Oil (narrow range) – Unknown efficacy.
- *Bacillus thuringiensis* (Bt) provides good control when applied at bud-break (two applications required).
- Carbaryl – good control of PTB.
- Issues: Carbaryl can cause secondary mite outbreaks.

Non-chemical Aids Used:

- Monitoring dormant spur samples (scales and aphids).
- Alternate year dormant applications.
- Beneficials (must use sprays least harmful to these beneficials).

Aphid eggs [Mealy plum aphid (MPA) and Leaf curl plum aphid (LCPA)]: 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 severely curls leaves, which reduces photosynthetic capacity. 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 are required. These can encourage other pests (e.g. spider mites) that will require additional treatment.

Chemical controls

OP insecticides currently used:

- Chlorpyrifos + oil – excellent control.
- Diazinon + oil* – excellent control.
- Methidathion – excellent control.
- Phosmet + oil – unknown efficacy.
- Problems

- Surface runoff potential exists for these OPs.

*Most commonly used.

Pyrethroid insecticides currently used

- Esfenvalerate + oil* - good control.
- Problems:
  - Resistance.
  - Off-site movement – toxic to fish/amphibians.

*Most commonly used.

Others:

- Oil (narrow range) – fair – good for light infestations, 2 applications @ bud-break.
- Carbaryl – poor control.

Non-chemical Aids Used:

- Monitoring dormant spur samples (scales and aphids).
- Fall trapping returning aphids to detect populations.
- Alternate year dormant applications.
- Beneficials (must use sprays least harmful to these 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) – good efficacy against light infestations, 2 applications @ bud-break*

*Most commonly used.

Non-chemical Aids Used:

- Alternate year dormant applications.
- Beneficials (must use sprays least harmful to these 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:

- Chlorpyrifos + oil - excellent control.

- Diazinon + oil* - excellent control.
- Methidathion – excellent control.
- Phosmet + oil – unknown efficacy.
- Issues:
    - Surface runoff potential exists for these OPs.

*Most commonly used.

Pyrethroid insecticides currently used

- Esfenvalerate + oil* - fair to good control.
- Issues:
    - Resistance.
    - Off-site movement – toxic to fish/amphibians.

* Most commonly used.

Others:

- Oil (narrow range) – not efficacious.
- *Bacillus thuringiensis* (Bt) – good control at bud-break (two applications required).
- Carbaryl – good control.
- Issues: Carbaryl can cause secondary mite outbreaks.

Non-chemical Aids Used:

- None.
- Beneficials (must use sprays least harmful to these beneficials).

List for insect/mite management needs in prunes during the dormant season:

Research:

- Cover crops to mitigate off-site movement of pesticides.
- Biology of Peach Twig Borer and aphids.
- 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.
- Efficacy of reduced rates of materials.

Regulatory:

- Streamline regulatory reporting and rules.

Education:

- Continue to educate growers on monitoring.
- Improve communication between regulators and growers (runoff issues etc.).

DISEASE PESTS

Diseases controlled in the dormant season:

Bacterial canker and "Blast" (*Pseudomonas syringae*)**:** Bacterial canker and blast affect 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. 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.

Chemical Control

- **Copper** – poor control

Cultural Controls

- Avoid planting a site that has had a history of bacterial canker.
- Rootstocks can help manage this disease. Lovell and Nemaguard peach are most resistant, and plum is the most susceptible.
- Scaffold budding or high grafting of susceptible scion wood may reduce susceptibility to infection.

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.

Chemical control:

- 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 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.

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

Research:

- Bacterial canker control measures.
- Efficacy of copper sprays.
- Resistant rootstock research.

Regulatory:

- None.

Education:

- Efficacy and usefulness of copper sprays.

NEMATODE PESTS

Root lesion nematode *(Pratylenchus spp)*, **Ring nematode** *(Criconemella 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 Control

- 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 1 or 2 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.
    - No rootstocks are known to be resistant to root lesion 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.

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

Research:

- Soil biology interactions with nematodes.
- Methyl bromide alternatives.
- Resistant rootstocks.
- Post-plant controls (chemical, cultural, and biological).

Regulatory:

- Maintain adequate certification of nursery stock.
- Equitable allocation/distribution of Telone.

Education:

- Educate growers on alternatives to methyl bromide and how to use them.
- Educate registrants on needs for methyl bromide alternatives.

The spring season [mid-March (bloom) – mid June]

FARMING ACTIVITIES

This period includes bloom (bud swell, "popcorn," full bloom and petal fall), and early shoot and fruit growth. The following farming activities take place during the spring season: moving bees in and out of the orchard, 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 Spring applications of one of the following pre-emergence herbicides: trifluralin (Treflan – for pre-plant), oxyfluorfen (Goal), oryzalin (Surflan), norflurazon (Solicam), and napropamide (Devrinol). Post-emergence herbicides commonly used include: glyphosate (Roundup), 2,4-D, and Paraquat. An herbicide program is effective in combination with timely orchard floor management practices.

List for weed management needs in prunes during spring:

Research:

- Alternatives to currently registered chemical options.
- Off-site drift mitigation.
- Cover crops for weed control.

Regulatory:

- Evaluate off-target drift potential and effects on prunes of new registrations for crops other than prunes.

Education:

- None.

INSECT/MITE PESTS

Insect/mites controlled in spring:

Dormant sprays control most insect pests and mites that develop on prunes during spring. These pests include aphids, San Jose scale, lepidopterous worms and caterpillars. In absence of the dormant spray, careful tree and fruit monitoring is required to avoid damaging populations of the pests below.

Aphids [Mealy plum aphid (MPA) and Leaf curl plum aphid (LCPA)]: 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 severely curls leaves reducing their photosynthetic capacity. 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:

- Phosmet – efficacy unknown.
- Azinphos-methyl – efficacy unknown.
- Chlorpyrifos – excellent control.
- Diazinon* - excellent control.
- Methidathion – excellent control.
    - Issues:
        - Surface runoff potential exists for these OPs.

* Most commonly used.

Non-OPs Currently Used:

- Oil (narrow range) – fair to good control when light infestations of aphids are present.

Non-chemical controls/aids Used:

- Tree monitoring to determine need for treatment.
- 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:

- Phosmet – efficacy unknown.
- Azinphos-methyl – excellent control.
- Chlorpyrifos – excellent control.
- Diazinon* – excellent control.
- Methidathion – excellent control.
- Issues: Surface runoff potential exists for these OPs.

*Most commonly used.

Non-OPs Currently Used:

- Oil (narrow range) – This control is good to excellent for light infestations of scale.

Non-chemical controls/aids Used:

- Monitoring sticky tapes for crawlers (scales).
- 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 OPs in the dormant stage. PTB infests shoot tips and damages developing fruit.

Chemical controls

OP insecticides currently used if needed:

- Phosmet – good to excellent control.
- Azinphos-methyl – good to excellent control.
- Chlorpyrifos – good to excellent control.
- Diazinon* – good to excellent control.
- Methidathion – good to excellent control.
- Problems - surface runoff potential exists for these OPs.

  * Most commonly used.

Non-OPs Currently Used:

- *Bacillus thuringiensis* (Bt): This provides good control.
- Spinosad (Success): Good control when timed correctly.

Non-chemical controls/aids Used:

- Tree monitoring to determine need for treatment (FTLR, OBLR).
- Beneficials.

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.

Chemical controls

OP insecticides currently used:

- Phosmet – excellent control.
- Azinphos-methyl – excellent control.
- Chlorpyrifos – excellent control.
- Diazinon* – excellent control.
- Methidathion – excellent control.
- Issues: surface runoff potential exists for these OPs.

  * Most commonly used.

Non-OPs Currently Used:

- *Bacillus thuringiensis* (Bt) – good control when population are first observed.

Non-chemical controls/aids used:

- Tree monitoring to determine need for treatment.
- Pruning out infested shoots.
- Parasites (red-humped caterpillar).
- Beneficials.

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.

Chemical controls

OP insecticides currently used

- Trunks painted with Diazinon and white latex paint for APB.

Non-OPs Currently Used:

- Endosulfan for peach tree borer.

Non-chemical controls/aids Used:

- Pruning, fertilizers to maintain tree vigor (shot hole borer).
- Trunk wraps (protectors) to protect from sunburn (flat headed borer).
- Removal of infested material (shot hole borer).

Potential alternatives:

- None.

List for insect/mite management needs in prunes during spring:

Research:

- Economic thresholds for treatment.
- Mating disruption for aphids.
- New parasites for aphids.

Regulatory:

- None.

Education:

- Continue to educate growers about "Integrated Prune Farming Practices" (IPFP).

DISEASE PESTS

Brown rot, Russet scab (a non-pathogenic disorder but treated as a disease), bacterial canker, and 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.

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.

Chemical controls

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

- Captan – fair control.

- Chlorothalonil (Bravo) – fair to good control.
- Iprodione (Rovral)* – good to excellent control.
- Myclobutanil (Rally) – fair control.
- Propiconazole (Break) – good to excellent control.
- Thiophanate-methyl (Topsin) – good to excellent control when combined with oil.
- Azoxystrobin (Abound) – good control.

  * Most commonly used.

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 (iprodione) 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 during bloom.

Biological control

- None.

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.

Chemical control

- Chlorothalonil (Bravo)* – fair to poor control.
- Captan – excellent control.

  * Most commonly used.

Cultural control

- None.

Biological control

- None.

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

- Methyl Bromide/Telone/Enzone: Fumigation of new planting sites eliminates Ring nematodes that predispose young trees to bacterial canker.

Cultural Control

- Late pruning and training during spring.
- Selecting planting sites – avoid sandy sites and those infested with ring nematode.

Non-chemical Aids Used:

- None.

Potential Alternatives:

- Unknown.

Phytophthora Root and Crown Rot: At least 11 different Phytophthora 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 *Phytophthora* 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. Phytophthora 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.
- Metalaxyl (Ridomil) is registered for use as a soil drench around the base of the trees.

Cultural Control

- Irrigation management.
- Avoid excess nitrogen.
- Improve internal drainage.

List for disease management needs in prunes during spring:

Research:

- Resistance management.
- Monitoring techniques.
- Economic thresholds.
- Models.
- Breeding for disease resistance.
- Nutrition influence on disease development.

Regulatory:

- None.

Education:

- None.

NEMATODE PESTS

Root lesion nematode *(Pratylenchus spp),* **Ring nematode** *(Criconemella 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

- Sodium tetrathiocarbonate (Enzone): Annual applications of Enzone are required for adequate nematode control. This treatment will not control endoparasitic nematodes such as root lesion nematode.

List for nematode management needs in prunes during spring:

Research:

- New techniques to rapidly test new control strategies.
- More cost effective control strategies.
- Alternative control measures for nematodes

Regulatory:

- Ease constraints on crop destruct destruction requirements for EUPs and state research authorizations.

Education:

- None.

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. 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).

WEED PESTS

Prune orchards become infested with numerous summer annual and perennial weeds, especially where spring or fall pre-emergence herbicides were not used. During the growing season weeds compete with trees for substantial water and nutrients resources. 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. Post emergence herbicides for use during the summer include: Glyphosate (Roundup), 2,4-D, and Paraquat. “Flaming” is a non-chemical potential for weed control in prunes.

List for weed management needs in prunes during summer:

Research:
- Alternatives to chemical weed control (e.g. flaming).

Regulatory:
- More reasonable PHI's (e.g. Glyphosate from 21 days to 3 days).
- Reduce PHI for 2,4-D from 60 days.

Education:
- None.

INSECT AND MITE PESTS

Oblique Banded Leafrollers (OBLR): OBLR directly damages fruit. Such fruit damage encourages Brown rot infection that provides innocula for further infecting sound ripening fruit.

Chemical controls

OP Insecticides Currently Used:
- Diazinon – excellent control.
- Phosmet – efficacy unknown.
- Issues: potential for surface runoff.

Non-OPs Currently Used:
- Bt. This is effective and commonly used. It is applied throughout this period as infestations are noted. Monitoring is essential. Bt application by air is not as effective as by ground although wet weather may prevent timely ground application.

Non-chemical aids used:
- Beneficials (naturally occurring).
- Fruit scouting.

Potential Alternatives:
- None.

Defoliating Insects: (Redhumped Caterpillar, Western Tussock Moth, Western Tent Caterpillar, Forest Tent Caterpillar, 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 - excellent control.
- Phosmet – unknown efficacy.
- Issues: potential for surface runoff.

Non-OPs Currently Used:

- Bt. This effective and is most commonly used. It is applied throughout this period as infestations are noted. Monitoring is essential. Bt application by air is not as effective as by ground although wet weather may prevent timely ground application.

Non-chemical controls:

- Beneficials (naturally occurring).
- Parasites (Red-humped caterpillar primarily).
- Pruning: caterpillars and webworms can be pruned out and destroyed.

Potential Alternatives:

- None.

Web-spinning spider mites (WSM): Twospotted Mite, Pacific Mite: Both two-spotted 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 two-spotted 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 period. Potential for direct damage decreases as the season progresses.

Chemical controls

OPs Currently Used:

- None.

Non-OP acaricides Currently Used:

- Fenbutatin-oxide (Vendex): Does not work well in cool weather.
- Formetamate Hydrochloride (Carzol): Kills predaceous mites and may aggravate European red mite.
- Propargite (Omite): Registered for non-bearing trees only.
- Hexythiazox (Savey).

Cultural Control

- Good water and fertilizer management to prevent tree 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:

- Predators: The western orchard predator mite, six-spotted thrips, the spider mite destroyer, and minute pirate bugs.
- Beneficials (naturally occurring).
- Fruit scouting.

Potential Alternatives:
- None.

List for insect and mite management needs in prunes during summer:

Research:
- Better economic thresholds and monitoring techniques.
- Alternatives to OPs.
- Cost effective way to track grower lots through processing (for insecticides/acaricides used for specific markets).

Regulatory:
- Retain use of Azinphos-methyl until alternatives are in place.

Education:
- None.

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 problem(s) 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 Rate effectiveness of each

Materials listed below are currently used for control of fruit brown rot.
- Captan – provides fair control
- Chlorothalonil (Bravo) – provides fair to good control.
- Iprodione (Rovral)* - provides good to excellent control.
- Myclobutanil (Rally) – provides fair control.
- Propiconazole (Break) – provides good to excellent control.
- Thiophanate-methyl (Topsin) – when combined with oil provides good to excellent control.
- Azoxystrobin (Abound) – provides good control.
- Issues: Resistance. 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 (iprodione) has been reported in California but is not common.
  * Most commonly used.

Cultural Control
- Close mowing ground cover to reduce humidity.

Non-chemical Aids Used:

- Mid-June fruit sampling to detect latent infection and need to apply treatment.

Potential Alternatives:

- None.

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.

Chemical controls

- Sulfur – provides good control.
- Wettable sulfur* - provides good control.
- Chlorothalonil – less reliable than sulfurs.

  * Most commonly used.

Cultural control

- None.

Biological control

- None.

Non-chemical Aids Used:

- Weekly tree monitoring to determine onset of rust and need for treatment.

Potential Alternatives:

- Azoxystrobin (Abound): Good reliable control.

List for disease management needs in prunes during summer:

Research:

- Brown rot detection methods and treatment thresholds.
- Tree vigor and disease management.

Regulatory:

- None.

Education

- Educate growers as to monitoring and thresholds for rust.

NEMATODE PESTS

Root lesion nematode *(Pratylenchus spp),* **Ring nematode** *(Criconemella 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 nematodes. Management techniques are limited for in-season nematode control in established prune orchards.

Chemical control

- Sodium tetrathiocarbonate (Enzone): Annual applications of Enzone are required for adequate nematode control. This treatment will not control endoparasitic nematodes such as root lesion nematode.

List for nematode management needs in prunes during summer:

Research:
- New techniques to rapidly test new control strategies.
- More cost effective control strategies.

Regulatory:
- Ease constraints on crop destruction requirements for EUPs and state Research Authorizations.

Education:
- None.

FALL [mid-September (Post Harvest) 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, fall pruning, aphid and scale monitoring, 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 ID weeds species), integrated management system that includes proper use of pre-and post-emergence herbicides in combination with timely orchard floor management practices.

Pre-emergent herbicide options that can be used in fall through late winter base upon the weed species present include: trifluralin (Treflan), Oxyfluorfen (Goal), and Oryzalin (Surflan), Napropamide (Devrinol), norflurazon (Solicam). Post emergence herbicides options include: Glyphosate (Roundup), 2,4-D, and Paraquat.

List for weed management needs in prunes during fall:

Research:

- Mitigate surface runoff.
- Alternatives to chemical weed control.
- Research efficacy and economics of corn gluten on weed control and its potential for surface and ground water pollution due to excessive N coincidently applied.

Regulatory:

- None.

Education:

- None.

INSECT PESTS

Aphids [Mealy plum aphid (MPA) and Leaf curl plum aphid (LCPA)]: MPA and PCPA 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 MPA and LCPA infestations may develop in spring, emanating from these returning aphids.

Chemical

OP insecticides currently used:

- None.

Pyrethroid insecticides currently used

- None.

Non-chemical Aids Used:

- None.

Potential alternatives:

- Fall defoliation is being researched to eliminate food source of returning aphids.

List for insect management needs in prunes during fall:

Research:

- Aphid defoliation studies.

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

- Methyl Bromide/Telone/Enzone: Fall fumigation of 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.

Non-chemical Aids Used:

- None

Potential Alternatives:

- None.

Armillaria Root Rot: The 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:

- Methyl Bromide: Has shown some promise for control at the rate of 300-600 lb. a.i. per acre applied by injection with tarping.

Cultural Control

- Rootstock selection (Marianna 2624 tolerant of some strains).
- Site selection – plant in non-infested ground.

Non-chemical Aids Used:

- None.

Potential Alternatives:

- None.

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

- None.

Cultural Control

- Site selection (well drained soils).
- Site preparation (improving internal drainage).

Non-chemical Aids Used:

- None

Potential Alternatives:

- None.

List for disease management needs in prunes during fall:

Research:

- Alternatives to methyl bromide.
- Copper efficacy against bacterial canker.
- New product efficacy against bacterial canker.

Regulatory:

- None.

Education:

- None.

NEMATODE PESTS

Lesion Nematode, Ring Nematode, Southern Root Knot Nematode, Lesion 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

- Methyl Bromide – pre-plant when replanting into soils previously in orchard crops. Excellent control
- 1,3 Dichloropropene (1,3-D) (Telone) – pre-plant. Fair control.
- Sodium tetrathiocarbonate (Enzone) – pre and post-plant. Fair control.

Biological Control

- None.

Cultural Control

- Site selection - selecting land not recently planted to orchard/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. Mariana 2624 and Myrobalan 29C are moderately resistant to root lesion but susceptible to ring nematode.

Potential Alternatives:

- Unregistered:
  - Ozone
  - Ditera
  - Iodomethane
  - Propargyl bromide

List for nematode management needs in prunes during fall:

Research:

- Soil microbiology interactions with nematodes.

Regulatory:

- Register alternative to methyl bromide.

Education

- None.

Critical Needs:

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

Research:

1. Aphid research
   - Thresholds
   - Soft materials
   - Biological controls
   - Pheromones
2. Economic thresholds for all prune pests
   - Monitoring protocols
3. Soft technologies for pest control
   - Breeding for pest resistance
4. Methyl bromide alternatives
5. Bacterial canker/ring nematodes
   - Understanding the disease and how to control it
   - Developing post plant controls for nematodes/bacterial canker
6. Relationship between plant disease and nutrition
7. Soil microbiology

Regulatory:

1. Streamline EUP (crop destruct)
    i. Allow time-limited tolerances for small scale test plots under federal EUPs and state research authorizations
2. Rapid registration of a "soft" aphicide once research is complete.
3. Streamline regulatory reporting and rules
4. Register alternative to methyl bromide
5. Reasonable PHIs for pesticides
6. Equitable distribution of Telone cap
7. Retain azinphos-methyl (Guthion) until alternatives are found
8. Regulators evaluate possible off target effects on prunes of new registrations.

Education:

1. Improve 2-way communication between growers and regulators
2. Continue educating growers on monitoring protocols to determine when and if treatment is necessary
3. Educate growers about alternative methyl bromide options and how to use them.

REFERENCES

1) **California Agricultural Statistics Service**
2) **Prune Crop Profile**
3) **U.C. Prune Pest Management Guidelines**
4) **Prune Production Manual**
5) **DPR list of registered pesticides**

The Work Group

The work group consists of 37 members. The makeup includes growers, commodity group representatives, regulators, University of California specialists, USDA, USEPA, CalEPA and other technical experts.

Members

	County	**First**	**Last Name**	**Affiliation**
Growers	Yolo	Joe	Turkovich	Grower
	Tulare	Dan	Aguair	Grower
	Sutter	John	Heier	Grower
	Merced	John	Colbert	Grower
	Butte	Dan	Bozzo	Grower
	Tulare	Don	Vossler	Grower

Assn./commodity

Group(s) reps.	Don	Vossler	Cal. Prune Board
	Rich	Peterson	Cal. Prune Board
	Gary	Obenauf	Cal. Prune Board
	Steve	Sibbett	Cal. Prune Board
	Mark	Dalrymple	Sunsweet
	Mark	Gilles	Sunsweet
	Mark	Kettman	Marianni
	Jan	Sharp	CA Strawberry Comm.
	Lori	Berger	CA Minor Crops Counc.
Government	Ken	Samoil	IR-4 project
	Rebecca	Sisco	U.C. IR-4 project
	Dennis	Kopp	USDA/CSREES
	Tom	Babb	CAL/EPA/DPR
	Ann	Thrupp	USEPA Reg. 9
	William	Gross	USEPA
	Wilfred	Burr	USDA
Crop consultants, PCA's	Larry	Whitted	PCA
	Fred	Thomas	Crop Consultant
	Robert	Sanders	PCA
University of California	Bill	Olson	U.C. Farm Advisor
	Rick	Buchner	U.C. Farm Advisor
	Carolyn	Pickel	UCIPM
	Nirmal	Sandhar	UCIPM
	Becky	Westerdahl	Ext. Nematologist
	Beth	Teviotdale	Ext. Plant Pathologist
	Clyde	Elmore	Ext. Weed Scientist
	Sean	Swezey	UC SAREP
	Nick	Mills	U.C. Entomologist
	Kieth	Warner	UCSC
	Rick	Melnicoe	W. Reg. Pest Mgmt.
	Linda	Herbst	W. Reg. Pest Mgmt.

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.

INSECT AND MITE PESTS 1/

MANAGEMENT TOOL		SJS	EFL	PTB	FTL	OBLR	GF	CM	WSM	MPA	LCPA
	Organophosphates registered on prunes										
	azinphos methyl (Guthion)	E	E	E	E	E	E	E	P	U	U
	chlorpyrifos (Lorsban)	E	E	E	E	E	E	G	P	E	E
	diazinon	E	E	E	G	G	G	G	P	E	E
	methidathion (Supracide)	E	E	E	E	E	E	E	P	E	E
	phosmet (Imidan)	U	U	G	U	U	U	G	P	U	U

MANAGEMENT TOOL		SJS	EFL	PTB	FTL	OBLR	GF	CM	WSM	MPA	LCPA
	Alternative Insecticides/Acaricides Registered on Prunes										
	azadirachtin (Azatin, Neemazad)	P	P	P	P	P	P	P	P	F	F
	Bt (*Bacillus thuringiensis*) (Biobit, Agree, Dipel, Javelin)	NE	NE	G	G	G	G	P-F	NE	NE	NE
	carbaryl (Sevin)	P	P	G	G	G	G	G	P	P	P
	Checkmate	NE	NE	?	?	?	?	U	NE	NE	NE
	cinnamaldehyde (Cinnacure)	U	U	U	U	U	U	U	F	NE	NE
	dicofol (Kelthane)	NE	NE	NE	NE	NE	NE	NE	G	NE	NE
	disrupt (Disrupt)	NE	NE	?	NE	NE	NE	?	NE	NE	NE
	endosulfan (Thiodan)	?	?	G	NE	NE	NE	NE	NE	E	E
	esfenvalerate (Asana)	P	E	E	G	F	F	E	P	G	G
	fenbutatin oxide (Vendex)	NE	NE	NE	NE	NE	NE	NE	G	NE	NE
	formetanate hydrochloride (Carzol)	NE	NE	NE	NE	NE	NE	NE	G	NE	NE
	Hercon disrupt CM extra	NE	NE	NE	NE	NE	NE	?	NE	NE	NE
	hexythiazox (Savey)	NE	NE	NE	NE	NE	NE	NE	G	NE	NE
	Isomate C	NE	NE	NE	NE	NE	NE	?	NE	NE	NE
	kaolin (Surround)	U	U	U	U	U	U	U	U	U	U

	neem oil (Trilogy)	P	P	P	P	P	P	P	P	F	F
	oxydemeton-methyl (Metasystox R)	U	U	U	U	U	U	U	P	G	G
	oxythioquinox (Morestan)	U	U	U	U	U	U	U	U	G	G
	Oils	G	G	?	NE	NE	NE	NE	G	F-G	F
	potash soap (M-Pede)	NE	NE	NE	NE	NE	NE	NE	P	P	P
	propargite (Omite)	NE	NE	NE	NE	NE	NE	NE	E	NE	NE
	pyrethrin	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	pyrethrin+diatomaceous earth (Diatech)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	pyrethrin+piperonyl butoxide (Pyrenone crop spray)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	pyridaben (Nexter, Pyramite) **N.R. ?**	NE	NE	NE	NE	NE	NE	NE	G-E	NE	NE
	rotenone/pyrethrins (Pyrellin EC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	spinosad (Success)	NE	NE	E	E	E	NE	F-P	NE	NE	NE
	sulfur	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

MANAGEMENT TOOL	**SJS**	**EFL**	**PTB**	**FTL**	**OBLR**	**GF**	**CM**	**WSM**	**MPA**	**LCPA**
Potential Alternative Insecticides/acaricides Not Registered on Prunes										
abamectin (Agri-Mek)	NE	NE	NE	NE	NE	NE	NE	E	NE	NE
clofentezine (Apollo)	NE	NE	NE	NE	NE	NE	NE	G - E	NE	NE
imidacloprid (Provado, Admire)	U	U	U	U	U	U	U	F	E	E
methoxyfenozide (Intrepid)	NE	NE	?	U	U	U	G	NE	NE	NE
pymetrozine (Fulfill)	NE	NE	NE	NE	NE	NE	NE	NE	P	P
pyriproyfen (Esteem)	E	U	NE	NE	NE	NE	P	NE	NE	NE
tebufenozid (Confirm)	NE	NE	G	G	G	U	F	NE	NE	NE
thiamethoxam (Actara)	U	U	U	U	U	U	U	NE	G	G
biprofusan (Applaud)	E	U	NE	NE	NE	NE	NE	NE	NE	NE
Thiacloprid	U	U	U	U	U	U	U	U	U	U

MANAGEMENT TOOL		SJS	EFL	PTB	FTL	OBLR	GF	CM	WSM	MPA	LCPA
	Non-chemical Aids to IPM (not stand alone) 2/										
	Cover crops	N	N	N	N	N	N	N	Y	N	N
	Habitat management	N	N	Y	N	N	N	N	Y	N	N
	Mating disruption	N	N	N	N	N	N	N	N	N	N
	Monitoring/use of action thresholds	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Natural enemies	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
	Nutrition	N	N	N	N	N	N	N	Y	Y	Y
	Sanitation	N	N	N	N	N	N	N	N	N	N
	Soil/dust management	N	N	N	N	N	N	N	Y	N	N
	Use of models	Y	N	Y	N	Y	N	Y	N	N	N
	Water management	N	N	N	N	N	N	N	Y	N	N
	Weed control	N	N	N	N	N	N	N	Y	N	N

1/ SJS= San Jose scale, EFL= European fruit lecanium, PTM=peach twig borer, FTL=fruit tree leaf roller, OBLR-oblique banded leaf roller, GF= green fruit worm, CM= codling moth, WSM= web spinning mites, MPA=mealy plum aphid, LCPA=leaf curl plum aphid

2/ Efficacy rating symbols: E=Excellent, G=Good, F=Fair, P=Poor, ?= No data but suspected of being efficacious, blank= not used and not suspected of being efficacious, res= some resistance in pest population. U = Unknown, NE = Not Efficacious

3/ Efficacy rating symbols: The Y (Yes) and N (No) designation regarding non-chemical aids to IPM refer to whether the non-chemical aid is used as a toll against a specific pest.

DISEASE PESTS

MANAGEMENT TOOL 2/		BR	RS	R	BC	ARR	PC&RR	CG
	Fungicides/bacteriocides registered on prunes							
	Agrobacterium radiobactor (Galltrol)	NE	NE	NE	NE	NE	NE	?
	Ampelomyces quisqualis (Ag 10 Biofungicide)	U	U	U	U	U	U	U
	azoxystrobin (Abound)	G	NE	G	NE	NE	NE	NE
	captan (Captan) - bloom only	F	E	NE	NE	NE	NE	NE
	chlorathalonil (Bravo) (bloom only - can't use in summer)	F-G	F-P	(G)	NE	NE	NE	NE
	chlorine (Chlorine) - post harvest use only	G	NE	NE	NE	NE	NE	NE
	copper ammonium complex (Copper Count N)	P,?	NE	NE	P	NE	NE	NE
	copper hydroxide (Kocide)	P,?	NE	NE	P	NE	NE	NE
	copper oxide (Chem Copp)	P,?	NE	NE	P	NE	NE	NE
	copper oxychloride (COC)	P,?	NE	NE	P	NE	NE	NE
	copper oxychloride+copper sulfate (COCS)	P,?	NE	NE	P	NE	NE	NE
	copper oxychloride sulfate (Oxycop)	P,?	NE	NE	P	NE	NE	NE
	copper sulfate (Basicop)	P,?	NE	NE	P	NE	NE	NE
	cyprodinil (Vangard)	E	NE	U	NE	NE	NE	NE
	fenbuconazole (Indar)	G	NE	NE	NE	NE	NE	NE
	fludioxonil (Medallion/Scholar)	F,?	NE	NE	NE	NE	NE	NE
	fosetyl-al (Aliette)	NE	NE	NE	NE	NE	?	NE
	gallex (Gallex)	NE	NE	NE	NE	NE	NE	G
	iprodione (Rovral) +Oil = shown in ( )	G (E)	NE	P (G)	NE	NE	NE	NE
	mefenoxam (Ridomil)	NE	NE	NE	NE	NE	?	NE
	myclobutanil (Rally)	F	NE	P	NE	NE	NE	NE
	propiconazole (Orbit/Break)	E-G	NE	NE	NE	NE	NE	NE
	sulfur	P,?	NE	G	NE	NE	NE	NE
	thiophanate methyl (Topsin) + oil ( ) +OIL=E	G-(E)	NE	NE	NE	NE	NE	NE

MANAGEMENT TOOL			BR	RS	R	BC	ARR	PC&RR	CG
	Non-chemical aides to IPM of diseases								
	Pruning/canopy management		Y	N	N	Y	N	N	N
	Irrigation management		Y	N	Y	Y	N	Y	N
	Natural enemies		N	N	N	N	N	N	N
	Weed control		Y	N	Y	N	N	N	N
	Sucker removal		N	N	N	N	N	N	N
	Cover crops		N	N	N	N	N	N	N
	Discing		N	N	N	N	N	N	N
	Sanitation		Y	N	N	N	N	N	N
	Nutrition		Y	N	N	Y	N	N	N
	Rootstock selection		N	N	N	Y	Y	Y	N

1/ BR = Brown Rot, RS = Russet Scab, R = Rust,
BC = Bacterial Canker, ARR = Armillaria Root Rot, PC&RR = Phytophthora Crown and Root Rot, CG = Crown Gall

2/ Efficacy rating symbols: E=Excellent, G=Good, F=Fair, P=Poor, ?= No data but suspected of being efficacious, blank= not used and not suspected of being efficacious, res= some resistance in pest population. U = Unknown, NE = Not Efficacious

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NEMATODE PESTS (pre - or post plant)

MANAGEMENT TOOL		R				RK		RL		BC
		Pre	Post			Pre	Post	Pre	Post	
	Organophosphates Registered on Prunes									
	1.3-D + chloropicrin (Telone C15)	E-G	NR			E-G	NR	E-G	NR	P
	dazomet (Basamid) (3)	U	NR			U	NR	U	NR	U
	metam sodium (Vapam) (4)	G-F	NR			G-F	NR	G-F	NR	G-F
	methyl bromide (meth-o-gas) (5)	E	NR			E	NR	E	NR	E
	sodium tetrathiocarbonate (Enzone) Preplant(6)	G	G			G	G	G	G	G-F
	sodium tetrathiocarbonate (Enzone) Post-plant (7)	G	G			F	F	F	F	G-F
	Myrothecium verrucaria (Ditera ES)	NR	?			NR	?	NR	?	

MANAGEMENT TOOL									
	Non-chemical aids to nematode IPM								
	Fallow (8) - fallow 2-3 years weed free	?				Y		?	
	Monitoring-soil samples (9)	Y	Y			Y	Y	Y	Y
	Cover crops	N	N			N	N	N	N
	Soil/water/nutrient management	?	?			?	?	?	?
	Resistant rootstocks (10)	?				Y		N	

1/ R=Ring,
RK=Root Knot,
RL=Root Lesion,
BC=Bacterial Canker

2/ Efficacy rating symbols: E=Excellent, G=Good, F=Fair, P=Poor, ?= No data but suspected of being efficacious,

blank= not used and not suspected of being efficacious, res= some resistance in pest population. U = Unknown,
NR = Not Registered

3/ Efficacy rating symbols: The Y (Yes) and N (No) designation regarding non-chemical aids
to IPM refer to whether the non-chemical aid is used as a toll against a specific pest,
?= No data but suspected of being efficacious, blank= not used and not suspected of being efficacious

(3) Pre-plant registration only - Only effective to depth of incorporation so depth of efficacy likely to be less than Telone or methyl bromide.
(4) 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 or methyl bromide.
(5) Only registered for pre-plant use.
(6) Must be applied in irrigation water to be effective. Yearly post-plant applications required following pre-plant use.
(7) 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.
(8) Length of fallow period required is not known for Root Lesion and Ring. Two years following decay of roots needed for Root Knot.
(9) Will not kill any nematodes except those removed in the sample.
(10) Myrobalan, Marianna and Nemaguard

EFFICACY OF SOIL APPLIED HERBICIDES REGISTERED FOR PRUNES

Management Tool

Weed species	benefin + oryzalin (XL 26)	dichlobenil (Casaron)	isoxaben (Gallery)	isoxaben + trifluralin (Snapshot)	nor-flurazon (Solicam)	oxy-fluorfen (Goal)	prodiamine (Barricade)	ory-zalin (Surflan)	thia-zopyr (Visor)	trifluralin (Treflan)
Annual grasses										
Annual blue grass	C	P	N	C	C	P	C	C	C	C
Barnyard grass	C	N	N	C	P	P	C	C	C	C
Bristlegrass	C	N	N	C	P	N	C	C	C	C
Bromegrass	C	P	N	C	C	P	C	C	C	C
Canarygrass	C	P	N	C	C	P	C	C	C	C
Crabgrass	C	P	N	C	P	P	C	C	C	C
Fescues	C	P	N	C	C	P	C	C	C	C
Lovegrass	C	N	N	C	P	P	C	C	C	C
Rabbitfootgrass	C	P	N	C	C	P	C	C	C	C
Ryegrass	C	P	N	C	C	P	C	C	C	C
Sandbur	C	N	N	C	P	N	C	C	C	C
Wild barley	C	P	N	C	C	P	C	C	C	C
Wild oats	C	P	N	P	C	P	C	P	C	P
Witchgrass	C	N	N	C	P	P	C	C	C	C

Annual broadleaves										
Cheeseweed	N	P	P	P	P	C	N	N	P	N
Chickweed	C	C	C	C	C	P	C	C	C	C
Clovers	N	C	P	P	C	P	N	N	P	N
Cocklebur	N	C	P	P	C	N	N	N	P	N
Cudweed	N	C	P	P	C	C	N	N	C	N
Fiddleneck	C	C	C	C	C	C	P	C	C	C
Filaree	N	P	C	C	P	C	N	N	C	P
Flaxleaf fleabane	N	P	P	P	P	P	N	N	P	N
Goosefoot	C	C	C	C	C	C	C	C	C	C
Groundcherry	P	C	C	C	C	C	P	P	C	N
Groundsel	N	C	C	C	P	C	N	N	C	N
Henbit	P	C	C	C	C	C	P	P	C	P
Horseweed	N	P	P	P	P	P	N	N	P	N
Knotweed	C	P	C	C	C	C	C	C	C	C
Lambsquarters	C	C	C	C	P	C	C	C	C	C
London rocket	N	P	C	C	C	C	N	N	C	N
Miners lettuce	C	C	C	C	C	C	C	C	C	C
Mustard	N	P	C	C	C	C	N	N	P	N
Nettle	P	C	C	C	C	C	P	P	C	P
Nightshade	N	C	C	C	C	C	N	N	C	N
Pigweed	C	C	C	C	P	C	P	C	P	C
Pineapple weed	N	C	C	C	C	C	N	N	C	N
Prickly lettuce	N	C	P	P	P	C	N	N	P	N
Punctureviné	P	P	P	P	C	P	P	P	P	P
Purslane	C	C	C	C	P	C	C	C	C	C
Redmaids	C	C	C	C	C	C	C	C	C	C
Russian thistle	C	P	P	P	C	P	P	P	C	P

Sheperd's purse	P	C	C	C	C	C	N	N	P	N
Sowthistle	C	C	C	C	P	C	N	N	C	N
Speedwell	C	C	C	C	C	C	P	P	C	P
Spurge	C	C	C	C	P	P	P	P	C	N
Wild radish	P	N	C	C	C	C	N	N	P	N
Perennial grasses										
Bermuda grass	N	N	N	N	P	N	N	N	N	N
Johnson grass	N	N	N	N	P	N	N	N	N	N
Dallisgrass	N	N	N	N	N	N	N	N	N	N
Perennial broadleaves										
Blackberry	N	N	N	N	N	N	N	N	N	N
Curly dock	N	N	N	N	N	N	N	N	N	N
Dandelion	N	N	N	N	N	N	N	N	P	N
Field bindweed	P(seed)	P	N	N	N	N	N	P(seed)	P	N
Nutsedge	N	P	N	N	P	N	N	N	P	N

1/ C = controlled, P = partially controlled, N = not controlled

EFFICACY OF FOLIAR APPLIED HERBICIDES REGISTERED FOR PRUNES

Management Tool

Weed species	2,4-D	clethodim (Prism)	diquat dibromide (Diquat)	fluazifop-butyl (Fusilade)	glyphosate isopropyl-amine salt (Roundup)	glyphosate + oxy-fluorfen (Fire Power)	glyphosate tri-mesium (touch-down)	MSMA (Bueno)	nonanoic acid (Scythe)	setho-xydim (Poast)
Annual grasses										
Annual blue grass	N	C	P	N	C	C	C	C	P	N
Barnyard grass	N	C	P	P	C	C	C	N	P	C
Bristlegrass	N	C	P	C	C	C	C	P	P	C
Bromegrass	N	C	P	P	C	C	C	P	P	P
Canarygrass	N	C	P	C	C	C	C	N	P	C
Crabgrass	N	C	P	C	C	C	C	C	P	C
Fescues	N	P	P	P	C	C	C	N	P	P
Lovegrass	N	C	P	C	C	C	C	P	P	C
Rabbitfootgrass	N	C	P	C	C	C	C	N	P	C
Ryegrass	N	C	P	C	C	C	C	P	P	C
Sandbur	N	C	P	P	C	C	C	P	P	P
Wild barley	N	C	P	C	C	C	C	N	P	C
Wild oats	N	C	P	C	C	C	C	N	P	C
Witchgrass	N	C	P	N	C	C	C	P	P	C

			Knockdown – kills seedlings						Knockdown – kills seedlings	
Annual broadleaves										
Cheeseweed	N	N	N	N	C	P	C	N	P	N
Chickweed	P	N	C	N	C	C	C	C	C	N
Clovers	N	N	N	N	C	P	C	N	N	N
Cocklebur	P	N	P	N	C	C	C	P	P	N
Cudweed	N	N	P	N	C	C	C	N	N	N
Fiddleneck	P	N	C	N	C	C	P	N	P	N
Filaree	P	N	P	N	P	P	C	N	N	N
Flaxleaf fleabane	N	N	N	N	C	P	C	N	N	N
Goosefoot	C	N	P	N	C	C	C	N	P	N
Groundcherry	C	N	C	N	C	C	C	P	C	N
Groundsel	P	N	C	N	C	C	C	N	P	N
Henbit	P	N	C	N	C	C	C	N	P	N
Horseweed	C	N	N	N	C	P	C	N	N	N
Knotweed	P	N	P	N	C	C	C	N	N	N
Lambsquarters	C	N	C	N	C	C	C	N	C	N
London rocket	C	N	C	N	C	C	C	N	C	N
Miners lettuce	N	N	C	N	C	C	C	N	C	N
Mustard	C	N	P	N	C	C	C	N	P	N
Nettle	C	N	P	N	C	C	C	N	P	N
Nightshade	C	N	P	N	C	C	C	P	P	N
Pigweed	C	N	P	N	C	C	C	N	P	N
Pineapple weed	N	N	P	N	C	C	C	N	P	N
Prickly lettuce	C	N	P	N	C	C	C	N	P	N
Puncturevine	C	N	C(seedling)	N	C	C	C	P	N	N
Purslane	P	N	C	N	C	C	C	P	N	N

Redmaids	P	N	C	N	C	C	C	P	C	N
Russian thistle	P	N	P	N	C	C	C	N	P	N
Shepard's purse	C	N	C	N	C	C	C	N	C	N
Sowthistle	C	N	P	N	C	C	C	N	P	N
Speedwell	N	N	P	N	C	C	C	N	P	N
Spurge	C	N	C	N	C	C	C	N	P	N
Wild radish	C	N	c	N	C	C	C	N	P	N

Perennial grasses

Bermuda grass	N	N	N	P	C	P	C	N	N	P
Johnson grass	N	N	N	P	C	P	C	P	N	P
Dallisgrass	N	N	n	P	C	P	C	C	N	P

Perennial broadleaves

Blackberry	P	N	N	N	C	N	C	N	N	N
Curly dock	P	N	N	N	P	N	P	N	N	N
Dandelion	C	N	N	N	P	N	P	N	N	N
Field bindweed	P	N	N	N	P	N	P	P	N	N
Nutsedge	P	N	N	N	P	N	P	P	N	N

1/ C = controlled, P = partially controlled, N = not controlled

EFFICACY OF NON-CHEMICAL AIDS FOR WEED CONTROL IN PRUNES

MANAGEMENT TOOL	Annual Weeds	Perennial weeds
Non-chemical aids to IPM		
Cultivation	G	P
Animals (e.g. sheep/geese)	F (some)	P
Cover crops	F to P	P
Soil/water management	F	F to P
Flaming	G (broadleaf) P (grass)	P
Mow and blow	G (if enough)	P

1/ G = good, F = fair, P = poor; G, F, or P + E = good, fair, poor but expensive