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

University of California
Division of Agriculture and Natural Resources

UC IPM

UC IPM Pest Management Guidelines:

Plum

December 1998

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To be used with UC/DANR Publication 3389,
Integrated Pest Management for Stone Fruits

General Information

TREATMENT TIMING FOR MOST EFFECTIVE CONTROL IN AN IPM PROGRAM

(Updated 12/98)

Dormant/Delayed Dormant

peach twig borer
San Jose scale*
European red mite*
brown mite*
fruittree leafroller*
obliquebanded leafroller*
mealy plum aphid*
leaf curl aphid*
Italian pear scale*
green fruitworm
European fruit lecanium*

Green Bud

fruittree leafroller
obliquebanded leafroller
green fruitworm

Bloom

brown rot*
peach twig borer*
western tussock moth
redhumped caterpillar

Petal Fall

fruittree leafroller
obliquebanded leafroller
thrips

Cover (May) Sprays

peach twig borer
San Jose scale
orange tortrix
mealy plum aphid
leaf curl aphid
webspinning mites
big beaked plum mite
plum rust mite
American plum borer
codling moth
tent caterpillar
fall cankerworm
fall webworm

Summer

rust
webspinning mites

Postharvest

ripe fruit rot

* Best treatment timing: least disruptive to beneficial insects and mites.

RELATIVE EFFECT OF THE TIMING OF PESTICIDE APPLICATIONS ON NATURAL ENEMIES

(Updated 12/98)

Natural Enemy	DORMANT Oil	DORMANT Oil + ppyrethroid	DORMANT Oil + OP	BLOOMTIME Bt	IN-SEASON OP	IN-SEASON Pyrethroid	IN-SEASON Carbamate
caterpillar parasite (*Paralitomastix*)	L	L	L	L	H	H	H
(*Macrocentrus*)	L	L	L	L	H	H	H
lacewings	L	L	M	L	M	L–M	H
lady beetles (*Chilocorus* spp.)	L	L	L	L	H	H	H
minute pirate bugs	L	M	M	L	H	H	H
predatory mites (*Galendromus* sp. and *Typhlodromus* sp.)	L	H	L	L	M	H	H
scale parasites (*Aphytis* sp.)	L	—	L	L	H	H	H
spiders	L	L	M	L	H	L	H

OP = Organophosphate Bt = *Bacillus thuringiensis*

H = High M = Moderate L = Low — = no information

RELATIVE TOXICITIES OF PESTICIDES USED IN PLUMS TO NATURAL ENEMIES AND HONEY BEES

(Updated 12/98)

Pesticide (commercial name)	Predatory Mites[1]	General Predators[2]	Parasites[2]	Honey Bee Adults	Honey Bee Larvae
azinphosmethyl (Guthion)	L/M	H	H	H	H
Bacillus thuringiensis	L	M	L	L	L
benomyl (Benlate)	L/H[3]	L	L	L	L
bordeaux	—	L	L	L	—
captan	L	L	L	L	H
carbaryl (Sevin)	L/H	H	H	H	H
chlorothalonil (Bravo)	L	L	L	L	—
chlorpyrifos (Lorsban)	M	H	H	H	H
diazinon	L	H	H	H	H
dicofol (kelthane)	—	—	—	L	L
endosulfan (Thiodan)	L	M	M	M	M
esfenvalerate (Asana)	H	M	H	H	H
fenbutatin-oxide (Vendex)	L	L	L	L	L
fixed copper	—	—	—	L	—
formetanate hydrochloride (Carzol)	L/H	H	H	M	L
iprodione (Rovral)	L	L	L	L	—
mefenoxam (Ridomil Gold)	L	—	—	L	—
methidathion (Supracide)	H	H	H	H	H
methyl parathion (Penncap—M)	H	M	H	H	H
myclobutanil (Rally)	L	—	—	L	—
oils	L	L	L	L	—
sulfur	L/H	L	H	L	L
thiophanate methyl (Topsin)	L	L	L	L	—

H = High M = Moderate L = Low — = no information

1 Toxicities to western predatory mite, *Galendromus occidentalis*. Where differences have been measured, these are listed as pesticide-resistant strain/native strain.

2 Toxicities are averages of reported effects and should be used only as a general guide. Actual toxicity of a specific chemical depends on the species of predator or parasite, environmental conditions, and application rate. For example, pyrethroids (esfenvalerate, permethrin) have low to moderate toxicity to lacewings, but high toxicity to predatory lady beetles.

3 Inhibits egg production by the native strain.

Insects and Mites

Caterpillars

PEACH TWIG BORER

Scientific Name: *Anarsia lineatella*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

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

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

Peach twig borer overwinters on the tree as a first or second instar larva within a tiny cell, called a hibernaculum, usually in crotches of 1- to 3-year-old wood, in pruning wounds, or in deep cracks in bark. The overwintering site is marked by a chimney of frass and is especially noticeable when first constructed or before winter rains set in. Larvae emerge in early spring, usually just before and during bloom, and migrate up twigs and branches where they attack newly emerged leaves and shoots. As shoots elongate, larvae mine the inside, causing the terminals to die back. Dead shoots are known as shoot strikes or flags. Adults from the overwintered generation usually begin emerging in April or early May. First generation larvae usually develop in twigs during May and June and give rise to the next flight of moths in late June or early July. Larvae from this and subsequent generations may attack either twigs or fruit depending on fruit maturity and population density.

DAMAGE

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

BIOLOGICAL CONTROL

Peach twig borer has about 30 species of natural enemies. Among those commonly found in California are the chalcid wasps, *Paralitomastix varicornis* and *Hyperteles lividus*, and the grain or itch mite, *Pyemotes ventricosus*. In some years these natural enemies destroy a significant portion of larvae, but by themselves they generally do not reduce twig borer populations below economically damaging levels.

ORGANICALLY ACCEPTABLE METHODS

The use of *Bacillus thuringiensis* sprays at bloom, preceded by a delayed dormant oil treatment for the control of scale and mite eggs. Also, the use of mating disruption.

WHEN TO TREAT

There are several options for managing peach twig borer. Dormant or delayed dormant insecticide sprays reduce populations of overwintering larvae and have traditionally been the preferred treatment time and are still used extensively in plum orchards. However, peach twig borer can also be controlled with two applications of *Bacillus thuringiensis* (Bt) applied at early bloom and 7 to 10 days later or with pheromone mating disruptants. These treatments pose less risk to raptors and other nontarget organisms. Bloom sprays can be timed by dissecting hibernacula regularly from late February through bloom. The increase in the number of empty hibernacula reflects the number of larvae that have emerged and can be controlled by Bt once foliage is present.

If dormant or bloom treatments are not used or if monitoring of twig strikes indicates an average of three or more strike per tree by mid-April, postbloom treatments will have to be made, using pheromone traps and degree-days to time the spray. To calculate degree-days for peach twig borer use a lower threshold of 50°F and an upper threshold of 88°F. Research has shown that best control can be achieved when a treatment is applied between 400 and 500 degree-days from the beginning of the flight. For additional information, see the degree-day section on the UC IPM World Wide Website (www.ipm.ucdavis.edu).

Pheromone Mating Disruption for Plum Orchards. Mating disruption with sex pheromones has been used successfully to control peach twig borer in plum orchards. This method is most effective in orchards with low moth populations that are not close to other, untreated peach twig borer hosts. It is also most effective when used on an areawide basis. Factors that reduce the efficacy of mating disruption include small orchard size, uneven terrain, reduced pheromone application rates, and improper timing.

Place pheromone dispensers in orchards in mid-March or when you begin to catch the first moths in pheromone traps. Follow the manufacturer's recommendations for placement, the number of dispensers to use, and replacement intervals. Use higher load rates and more dispensers for orchards with heavy infestations.

Reapply the pheromones at the recommended timing for the second flight. If you are catching more than 5 moths per pheromone trap per week within one generation of harvest, however, treat with an insecticide rather than replace dispensers.

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

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT

A. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1.5 gal	
NARROW RANGE OIL	4 gal	1 gal	

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . PLUS . . .

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
DIAZINON* 50WP	3 lb	1 lb	
4EC	3 pt	1 pt	

COMMENTS: Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

CHLORPYRIFOS (Lorsban) 4EC	2 pt	0.5 pt	

COMMENTS: Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

ESFENVALERATE* (Asana XL)	4–6 oz	0.5 pt	

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

B.	METHIDATHION* (Supracide) 2EC	4 qt	1 qt	

COMMENTS: Apply before blossoms open, or injury may occur. Do not graze treated areas or feed cover crops grown in treated areas to livestock.

. . . OR . . . (alternative treatment timing)

BLOOM

A.	BACILLUS THURINGIENSIS# (various products)	Label rates	—	

COMMENTS: Make two applications during bloom: the first between popcorn and the beginning of bloom and the second 7-10 days later, but no later than petal fall. Treatments can also be timed by examining larval emergence from hibernacula. In years when peach twig borer emergence is extended, a third application has been shown to give excellent control. Compatible with fungicide sprays, and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80-100 gallon water maximum) is preferred. If aerial applications must be made because conditions do not permit ground application, a concentrate rate (5 gal or less) is preferred. Fly material on at a height of about 20 feet over the canopy using appropriate nozzles to allow better deposition on the tree tops. Precede this treatment with a dormant oil spray to control San Jose scale, brown mite eggs, and European red mite eggs. San Jose scale, is normally controlled with organophosphate/oil combinations during the dormant or delayed dormant periods; populations of this pest may increase after the 1st year of treatment until San Jose scale parasites increase in the 2nd or 3rd year.

B.	MATING DISRUPTANTS# (Checkmate PTB, etc.)	200 dispensers		

MAY

A.	DIAZINON* 50WP	3 lb	1 lb	21
	4EC	3 pt	1 pt	21
B.	PHOSMET (Imidan) 70WP	4.25 lb	1.5 lb	7
C.	METHYL PARATHION* (Penncap-M)	—	Label rates	See label

COMMENTS: Will cause mite outbreaks, but generally not as severe as those caused by carbaryl. Very toxic to honey bees; do not apply when weeds or cover crops are in bloom or have flower buds and bees are foraging in areas to be treated.

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
D. ESFENVALERATE*			
(Asana XL)	10 oz	2.5 oz	14

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

E. CARBARYL*			
(Sevin) 50WP	4.5 lb	1.5–2 lb	1
(Sevin) 80S	4 lb	1.25 lb	1

COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.

F. AZINPHOSMETHYL*			
(Guthion) 50WP	1.5–2 lb	0.5 lb	15

COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

FRUITTREE LEAFROLLER

Scientific Name: *Archips argyrospila*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

BIOLOGICAL CONTROL

A number of general predators, such as lacewing and lady beetle larvae, and parasites feed on fruittree leafroller larvae. These natural enemies help keep fruittree leafroller populations at low, nondamaging levels, but occasional outbreaks occur.

ORGANICALLY ACCEPTABLE METHODS

Biological control and dormant oil spray followed by bloom sprays of *Bacillus thuringiensis.*

WHEN TO TREAT

Dormant to delayed dormant oil sprays help suppress overwintered populations of this pest. You can also treat effectively for leafroller during the green bud stage. Later treatments, such as a petal fall spray for thrips, will also control this pest. After petal fall, monitor this pest by looking for rolled leaves or leaves tied to fruit. If not insects are present in rolled leaves, do not treat. Using *Bacillus thuringiensis* at bloom to control peach twig borer will also control fruittree leafrollers.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT

A. DORMANT OIL such as:

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

COMMENTS: Oil used alone will only provide partial control. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

B. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1.5 gal	
NARROW RANGE OIL	4 gal	1 gal	

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . *PLUS* . . .

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
DIAZINON* 50WP	3 lb	1 lb	
4EC	3 pt	1 pt	

COMMENTS: Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

CHLORPYRIFOS (Lorsban) 4EC	2 pt	0.5 pt	

COMMENTS: Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

ESFENVALERATE* (Asana XL)	4–6 oz	0.5 pt	

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

BLOOM

A.	BACILLUS THURINGIENSIS# (various products)	Label rates		

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

POSTBLOOM

A.	DIAZINON* 50WP	3 lb	1 lb	21
	4EC	3 pt	1 pt	21
B.	CARBARYL*			
	(Sevin) 50WP	4.5 lb	1.5–2 lb	1
	(Sevin) 80S	4 lb	1.25 lb	1

COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.

C.	AZINPHOSMETHYL* (Guthion) 50WP	1.5–2 lb	0.5 lb	15

COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.

D.	BACILLUS THURINGIENSIS# (various products)	Label rates		0

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

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

\+ Preharvest interval. Do not apply within this many days of harvest.

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

\# Acceptable for use on organically grown produce.

OBLIQUEBANDED LEAFROLLER

Scientific Name: *Choristoneura rosaceana*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

ORGANICALLY ACCEPTABLE METHODS

Dormant oil spray followed by bloom sprays of *Bacillus thuringiensis*.

WHEN TO TREAT

Delayed dormant oil sprays generally help reduce populations as does a Bt program aimed at peach twig borer. When applying dormant oil or dormant oil plus an insecticide, wait until bud break in order to control larvae as they emerge from their overwintering site. You can also treat effectively with conventional insecticides (diazinon, carbaryl, azinphosmethyl) during the green bud stage. Put out pheromone traps by mid-April. Start monitoring for obliquebanded leafroller when traps indicate adults have emerged. Look for leaf rolls, leaves tied to fruit, and fruit damage. Time insecticide spray treatments to kill caterpillars when they occur in damaging numbers.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DELAYED DORMANT

A. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1.5 gal	
NARROW RANGE OIL	4 gal	1 gal	

COMMENTS: Oil used alone will only provide partial control. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

B. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1.5 gal	
NARROW RANGE OIL	4 gal	1 gal	

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . PLUS . . .

DIAZINON* 50WP	3 lb	1 lb	
4EC	3 pt	1 pt	

COMMENTS: Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
CHLORPYRIFOS			
(Lorsban) 4EC	2 pt	0.5 pt	

COMMENTS: Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

ESFENVALERATE*			
(Asana XL)	4–6 oz	0.5 pt	

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

BLOOM

A.	BACILLUS THURINGIENSIS#			
	(various products)		Label rates	

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

POSTBLOOM

A.	DIAZINON* 50WP	3 lb	1 lb	21
	4EC	2 pt	1 pt	21
B.	CARBARYL*			
	(Sevin) 50WP	4.5 lb	1.5–2 lb	1
	(Sevin) 80S	4 lb	1.25 lb	1

COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.

C.	AZINPHOSMETHYL*			
	(Guthion) 50WP	1.5–2 lb	0.5 lb	15

COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.

D.	BACILLUS THURINGIENSIS#			
	(various products)		Label rates	0

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

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

ORANGE TORTRIX

Scientific Name: *Argyrotaenia citrana*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

CULTURAL CONTROL

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

BIOLOGICAL CONTROL

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

ORGANICALLY ACCEPTABLE METHODS

Biological and cultural controls and sprays of *Bacillus thuringiensis*.

MONITORING and WHEN TO TREAT

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

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.			
A. DIAZINON* 50WP	3 lb	1 lb	21
4EC	3 pt	1 pt	21
B. CARBARYL*			
(Sevin) 50WP	4.5 lb	1.5–2 lb	1
(Sevin) 80S	4 lb	1.25 lb	1
COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.			
C. AZINPHOSMETHYL*			
(Guthion) 50WP	1.5–2 lb	0.5 lb	15
COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.			

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
D. BACILLUS THURINGIENSIS# (various products)		Label rates	0

COMMENTS: Timing is important because of short residual period. Apply only during warm dry weather to control young actively feeding worms; may need to be applied more than once. Good coverage is essential.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

CITRUS CUTWORM

Scientific Name: *Xylomyges curialis*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

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

DAMAGE

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

BIOLOGICAL CONTROL

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

ORGANICALLY ACCEPTABLE METHODS

Biological control and sprays of *Bacillus thuringiensis*.

MONITORING and WHEN TO TREAT

Citrus cutworm is primarily a pest of plums in the San Joaquin Valley, but even there it is not a pest in all orchards or every year. Monitor orchards weekly from early to mid-April through post petal fall to determine if citrus cutworm is a problem. The most critical period is late bloom to post petal fall when cutworm larvae are attracted to the small developing fruit. If populations appear to be increasing, monitor weekly until the majority of the population has pupated. Either search for larvae or shake foliage vigorously while holding it over a sweep net to monitor this pest.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

A. BACILLUS THURINGIENSIS#
(various products) Label rates
COMMENTS: Timing is important because of short residual period. Apply only during warm dry weather to control young actively feeding worms. Because larvae hatch over a period of 1–2 months, this material will have to be applied more than once. Good coverage is essential.

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
B. PHOSMET (Imidan) 70WP	4.25 lb	1.5 lb	7
C. AZINPHOSMETHYL* (Guthion) 50WP	1.5–2 lb	0.5 lb	15

COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

OMNIVOROUS LEAFROLLER

Scientific Name: *Platynota stultana*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

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

DAMAGE

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

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

BIOLOGICAL CONTROL

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

CULTURAL CONTROL

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

ORGANICALLY ACCEPTABLE METHODS

Biological and cultural control along with applications of *Bacillus thuringiensis*.

MONITORING and WHEN TO TREAT

Regular monitoring each season is important so that prompt action can be taken if damaging populations develop. Begin monitoring by placing pheromone monitoring traps in the orchard by mid-February in the San Joaquin Valley to establish the biofix for the first flight; biofix is the first night moths are consistently caught in traps. First generation omnivorous leafrollers are most likely on weeds or cover crops; treatments for this first brood are probably not necessary and are likely ineffective for all but the earliest varieties. From the first biofix, use degree-day calculations to estimate when the onset of the second flight will occur. With a 48°F lower threshold and an 87°F upper limit, it takes about about 1168 DD for omnivorous leafroller to develop from egg to adult. As the start of the second flight nears, be sure to have fresh trap liners and lures in place. When the second flight biofix is determined by trap catches, begin accumulating degree-days. Research in the central San Joaquin Valley indicates that the

optimum single treatment timing is between 700 and 900 degree-days after the start of the flight. When using short-residual materials like *Bacillus thuringiensis*, two applications may be necessary for adequate control, one at 700 and one at 900 degree-days. Late season fruit varieties, which may be exposed to a third generation, may require additional treatments. However, considerable overlap in generations occurs by then so treatments may be needed earlier than 700 degree-days. Monitor the fruit closely for signs of damage. No treatment threshold values are available.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS# (various products)		Label rates	0

COMMENTS: Must be applied when worms are small, before they have taken up shelter in rolled leaves. Does not destroy natural enemies.

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

\+ Preharvest interval. Do not apply within this many days of harvest.

\# Acceptable for use on organically grown produce.

GREEN FRUITWORMS

Scientific Names: *Orthosia hibisci, Amphipyra pyramidoides, Xylomyges curialis,* and others.
(Updated 12/98)

DESCRIPTION OF THE PESTS

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

DAMAGE

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

ORGANICALLY ACCEPTABLE METHODS

Bacillus thuringiensis sprays.

WHEN TO TREAT

Dormant or delayed dormant spray programs that contain organophosphates applied for other insects generally help reduce overwintered populations. If treatment is necessary, treat at late bloom to petal fall when larvae are present.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS# (various products),	Label rates	—	0

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

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for use on organically grown produce.

CODLING MOTH

Scientific Name: *Cydia pomonella*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

CULTURAL CONTROL

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

BIOLOGICAL CONTROL

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

MONITORING and WHEN TO TREAT

Pheromone traps, degree-days (DD), and twilight temperatures are used to monitor codling moth activity. Soon after bud break, place traps in your orchards to determine first moth emergence. In spring, begin accumulating degree-days on the first date that moths are consistently found in traps; this is the biofix point. Once moths are consistently present and sunset temperatures have reached 62°F, degree-day accumulation can be used to predict egg hatch.

First Generation Egg Hatch. Time the first spray to the beginning of egg hatch to kill emerging larvae 300 DD after the first biofix for moderate to heavy populations, and 400 to 500 DD for light populations.

Second Generation Egg Hatch. Use pheromone trap catches to detect an increase in flight activity around 1060 DD from the first biofix, which signals the start of the next moth flight. For low to moderate moth populations, a single application is usually sufficient; make this application when 250 DD have accumulated from the second biofix.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.			
A. PHOSMET (Imidan) 70WP	4.25 lb	1 lb	7
B. CARBARYL* (Sevin) 80S	3 lb	1lb	1

COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
C. AZINPHOSMETHYL* (Guthion) 50WP	1.5–2 lb	0.5 lb	15

COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.

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

+ Preharvest interval. Do not apply within this many days of harvest.

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

TENT CATERPILLARS

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

(Updated 12/98)

DESCRIPTION OF THE PESTS

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

DAMAGE

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

ORGANICALLY ACCEPTABLE METHODS

Bacillus thuringiensis sprays.

WHEN TO TREAT

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

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.			
A. BACILLUS THURINGIENSIS# (various products)	Label rates		0
COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.			
B. DIAZINON* 50WP	3 lb	1 lb	21
4EC	3 pt	1 pt	21
C. CARBARYL*			
(Sevin) 50WP	4.5 lb	1.5–2 lb	1
(Sevin) 80S	4 lb	1.25 lb	1
COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.			
D. AZINPHOSMETHYL* (Guthion) 50WP	1.5–2 lb	0.5 lb	15
COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.			

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

WESTERN TUSSOCK MOTH

Scientific Name: *Orgyia vetusta*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

ORGANICALLY ACCEPTABLE METHODS

Bacillus thuringiensis sprays.

WHEN TO TREAT

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

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS# (various products),		Label rates	0
COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.			

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
\+ Preharvest interval. Do not apply within this many days of harvest.
\# Acceptable for use on organically grown produce.

REDHUMPED CATERPILLAR

Scientific Name: *Schizura concina*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

CULTURAL CONTROL

On small trees, cut out and destroy infested twigs.

BIOLOGICAL CONTROL

A number of natural enemies attack redhumped caterpillars, frequently preventing them from becoming destructive pests. Most common are two parasitic wasps, *Hyposoter fugitivus*, and a species of *Apanteles*. Several general predators, including spiders, lacewings, bigeyed bugs, and damsel bugs, occasionally feed on caterpillar eggs and small larvae.

ORGANICALLY ACCEPTABLE METHODS

Cultural and biological control and *Bacillus thuringiensis* sprays.

WHEN TO TREAT

Insecticide sprays applied for other pests often keep these leaf-eating caterpillars in check. If insecticide treatments are required, localized treatments on individual trees applied when evidence of caterpillars is first observed are generally all that is necessary.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS# (various products)		Label rates	0

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

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for use on organically grown produce.

CANKERWORMS

Scientific Names: Fall cankerworm: *Alsophila pometaria*
Spring cankerworm: *Paleacrita vernata*
(Updated 12/98)

DESCRIPTION OF THE PESTS

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

DAMAGE

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

CULTURAL CONTROL

On small trees, cut out and destroy infested twigs.

ORGANICALLY ACCEPTABLE METHODS

Cultural control and *Bacillus thuringiensis* sprays.

WHEN TO TREAT

Insecticide sprays applied for other pests often keep these leaf-eating caterpillars in check. Bloom or postbloom treatments of *Bacillus thuringiensis* will control this pest when larvae are present. The Bt program used for peach twig borer control reduces cankerworm damage.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
BLOOM AND POSTBLOOM			
A. BACILLUS THURINGIENSIS# (various products)		Label rates	0

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

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for use on organically grown produce.

FALL WEBWORM

Scientific Name: *Hyphantria cunea*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

CULTURAL CONTROL

On small trees, cut out and destroy infested twigs.

ORGANICALLY ACCEPTABLE METHODS

Cultural control and *Bacillus thuringiensis* sprays.

WHEN TO TREAT

Insecticide sprays applied for other pests often keep these leaf-eating caterpillars in check. If insecticide treatments are required, localized treatments on individual trees applied when evidence of caterpillars is first observed are generally all that is necessary. The addition of a wetting agent to increase penetration of the webbing by the insecticide enhances control.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.			
A. BACILLUS THURINGIENSIS# (various products)	Label rates		0
COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.			
B. DIAZINON* 50WP	3 lb	1 lb	21
4EC	3 pt	1 pt	21
C. CARBARYL*			
(Sevin) 50WP	4.5 lb	1.5–2 lb	1
(Sevin) 80S	4 lb	1.25 lb	1
COMMENTS: May cause increased spider mite problems; not recommended for routine use, especially early in the season.			
D. AZINPHOSMETHYL* (Guthion) 50WP	1.5–2 lb	0.5 lb	15
COMMENTS: May increase spider mite problems. Restricted entry interval (REI) is 45 days if 1 lb or less or active ingredient is applied per acre and only 1 application is made per growing season; otherwise the REI is 50 days.			

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

Mites

BROWN MITE

Scientific Name: *Bryobia rubrioculus*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

BIOLOGICAL CONTROL

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

ORGANICALLY ACCEPTABLE METHODS

Oil sprays and naturally occurring predators.

WHEN TO TREAT

Maintain mite predators in order to keep pest mite populations at low levels. Determine the relative number of mite eggs present on branches or prunings during the dormant season. Use dormant sprays with oils at the high rate to help control the overwintering eggs. An insecticide can be added to control other pests. Miticides may be necessary in some orchards in spring or summer, but only when mite populations begin damaging foliage (brown mites can be monitored using beating trays). Allowing low populations of brown mites in the orchard during spring enables mite predators to increase their population to levels that are more effective in controlling webspinning mites. Generally, hot weather and predators cause brown mite populations to decline in summer.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT (Preferred timing)

A.	DORMANT OIL such as:		
	DORMANT FLOWABLE EMULSION#	6–8 gal	1.5–2 gal
	NARROW RANGE OIL#	6 gal	1.5 gal

COMMENTS: Oil applications at this time to kill overwintering eggs may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
SPRING AND SUMMER			
A. FENBUTATIN OXIDE (Vendex) 50WP	2 lb	0.5 lb	14
COMMENTS: This material appears to be most effective when applied earlier in the season rather than later. Do not apply more than twice a season in not more than 400 gal water/acre.			
B. NARROW RANGE OIL#	2%	4%	
COMMENTS: Oil used alone will only provide partial control. Always apply oils to well-watered trees and never when trees are stressed by hot (above 90°F), windy, dry (relative humidity lower than 20%) conditions or when such conditions are likely to occur within a few days after application. Additional applications may be needed at 2 week intervals, which may increase the potential for phytotoxicity. Do not apply oil within 2 weeks of captan.			

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for use on organically grown produce.

EUROPEAN RED MITE

Scientific Name: *Panonychus ulmi*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

CULTURAL CONTROL

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

BIOLOGICAL CONTROL

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

ORGANICALLY ACCEPTABLE METHODS

Cultural control and oil sprays.

WHEN TO TREAT

Maintain mite predators to keep mite populations at low levels. Determine the relative number of mite eggs present on branches or prunings during the dormant season. Use dormant sprays with oils at the high rate to help control the overwintering eggs. An insecticide can be added to control other pests. Miticides may be necessary in some orchards in spring or summer, but only when mite populations begin damaging foliage. Allowing low populations in the orchard during spring enables predators populations to increase to levels that are more effective in controlling webspinning mites. Generally, hot weather and predators cause European red mite poulations to decline in summer.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT (Preferred timing)

A. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1–1.5 gal	
NARROW RANGE OIL	4 gal	1.5 gal	

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
SPRING AND SUMMER			
A. FENBUTATIN OXIDE (Vendex) 50WP	2 lb	0.5 lb	14
COMMENTS: This material appears to be most effective when applied earlier in the season rather than later. Do not apply more than twice a season in not more than 400 gal water/acre.			
B. NARROW RANGE OIL#	2%	4%	
COMMENTS: Oil used alone will only provide partial control. Always apply oil to well-watered trees and never when trees are stressed by hot (above 90°F), windy, dry (relative humidity lower than 20%) conditions or when such conditions are likely to occur within a few days after application. Additional applications may be needed at 2 week intervals, which may increase the potential for phytotoxicity. Do not apply oil within 2 weeks of captan.			

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

\+ Preharvest interval. Do not apply within this many days of harvest.

\# Acceptable for use on organically grown produce.

WEBSPINNING SPIDER MITES

Scientific Names: Twospotted spider mite: *Tetranychus urticae*
Pacific spider mite: *Tetranychus pacificus*
(Updated 12/98)

DESCRIPTION OF THE PESTS

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

DAMAGE

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

BIOLOGICAL CONTROL

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

CULTURAL CONTROL

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

ORGANICALLY ACCEPTABLE METHODS

Biological and cultural control and oil sprays.

WHEN TO TREAT

Miticides may be necessary in some orchards in summer, but only when mite populations reach damaging levels or when pesticides have been used that disrupt natural enemies and mite outbreaks are occurring. The presence-absence sampling plan developed to monitor webspinning mites in almonds also works well in plums. Consider the presence and relative abundance of both predatory and webspinning mites by monitoring the orchard at least once every 2 weeks from March to early May. Assess mite abundance by picking leaves from all sides and the center of trees, and determining the proportion of leaves infested with both spider mites and predator mites (presence-absence sampling). When using presence-absence sampling, it is not necessary to count the actual number of spider mites or mite predators on leaves but simply to observe whether or not a spider mite or mite predator is present. Pick a minimum of 15 leaves per tree (3 per side and 3 from the center) from 5 trees in each block or portion of the orchard that can be treated separately. Treat orchards that are not stressed by lack of water or some other factor and have predatory mites when presence-absence sampling indicates a 45% infestation of webspinning mites. Stressed orchards and those in which predatory mites have

not been detected may require treatment at lower webspinning spider mite densities. (See *Integrated Pest Management for Stone Fruits*, UC/DANR Publ. 3389 for details of the presence-absence methods and treatment guidelines.)

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

A. FENBUTATIN OXIDE
(Vendex) 50WP — 2 lb — 0.5 lb — 14
COMMENTS: This selective material appears to be most effective when applied earlier in the season rather than later. Do not apply more than twice a season in not more than 400 gal water/acre. Use reduced rates to balance predator and pest mite populations if sufficient numbers of predators are present but pest mite populations are approaching the threshold level.

B. NARROW RANGE OILS# — 4–6 gal — 1–1.5 gal
COMMENTS: Oil used alone will only provide partial control for about a 2 week period. Always apply oil to well-watered trees and never when trees are stressed by hot (above 90°F), windy, dry (relative humidity lower than 20%) conditions or when such conditions are likely to occur within a few days after application. Additional applications may be needed at 2 week intervals, which may increase the potential for phytotoxicity. If fruit is present on the tree, treatment with oil may dull the fruit finish. Do not apply oil within 2 weeks of captan.

C. FORMETANATE HYDROCHLORIDE
(Carzol SP) — 0.125 — — — 7
COMMENTS: Formetanate hydrochloride is not selective and can be very disruptive of natural enemies. Use only when resistance to other materials is a concern and oil is not an option.

D. DICOFOL
(Kelthane 35) — 3.5 lb — 0.8 lb — 7
COMMENTS: Use allowed under a 24(C) supplemental registration. Resistance is a concern in some growing areas. Research in other crops indicates mite resistance declines when a material is not used for several years. Renewed use of the material will usually provide control for 2 sprays before resistance returns.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for use on organically grown produce.

ERIOPHYID MITES

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

(Updated 12/98)

DESCRIPTION OF THE PESTS

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

DAMAGE

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

BIOLOGICAL CONTROL

Light to moderate populations are suppressed by predaceous mites.

ORGANICALLY ACCEPTABLE METHODS

Biological control and sulfur sprays.

WHEN TO TREAT

Eriophyid mites are more likely to reach high densities in sprayed orchards where predaceous mites are destroyed. Treatments are only recommended in orchards with chronic infestations or when there is a danger of defoliation.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.			
A. WETTABLE SULFUR# or SULFUR DUST#	Label rates	0	
COMMENTS: Do not apply within 2 weeks of oil spray.			
B. FENBUTATIN OXIDE (Vendex) 50WP	1–2 lb	0.5 lb	14
COMMENTS: Do not apply more than twice a season.			

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for use on organically grown produce.

Aphids

MEALY PLUM APHID

Scientific Name: *Hyalopterus pruni*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

BIOLOGICAL CONTROL

There are many natural enemies that feed on mealy plum aphid; however, fruit size may be reduced and fruit cracking may occur before natural enemies bring the aphids under control. Important predators include: lady beetles, green and brown lacewings, syrphid flies, and soldier beetles.

ORGANICALLY ACCEPTABLE METHODS

Biological control and sprays of oil or neem.

WHEN TO TREAT

Monitor aphids at 75% leaf fall. Examine leaves remaining on trees and those on the ground to determine the need for a dormant spray. Apply an insecticide during the delayed dormant period to kill eggs. If control has not been achieved with the delayed dormant treatment, apply an insecticide during April (if oil is used) or May (for other materials) when aphids are present and there is an average of more than three colonies/tree.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT (Preferred timing)

A. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1–1.5 gal	
NARROW RANGE OIL	4 gal	1.5 gal	

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . *PLUS* . . .

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
DIAZINON* 50WP	3 lb	1 lb	
4EC	3 pt	1 pt	
COMMENTS: Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.			
... *OR* ...			
CHLORPYRIFOS (Lorsban) 4EC	2 pt	0.5 pt	
COMMENTS: Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.			
... *OR* ...			
ESFENVALERATE* (Asana XL)	4–6 oz	1.5–2 oz	14
COMMENTS: Pyrethroid residues remaining on leaves and bark will continue to affect mite predators long after application, increasing potential for spider mite infestations.			
B. DORMANT OIL such as:			
DORMANT FLOWABLE EMULSION#	6 gal	1–1.5 gal	
NARROW RANGE OIL#	4 gal	1.5 gal	
COMMENTS: Oils applied alone during the dormant or delayed dormant period (as part of a *Bacillus thuringiensis* program) provide only partial control of mealy plum aphid (this timing is more effective against San Jose scale). Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.			
SPRING			
A. DIAZINON* 50WP	1.5–3 lb	1 lb	21
4EC	1.5–3 pt	1 pt	21
B. ENDOSULFAN* (Thiodan) 50WP	3 lb	1 lb	7
C. NARROW RANGE OIL#	4-6%	4%	
COMMENTS: Suppresses aphid populations. Apply at bloom with the *Bacillus thuringiensis* spray to kill the hatching aphids (hatch generally occurs in early March). If necessary, make a second application in April; plum trees tolerate oil treatments better in spring than during dormancy. Do not apply oil within 2 weeks of captan.			
D. FORMETANATE HYDROCHLORIDE (Carzol SP)	0.125	—	7
COMMENTS: Formetanate hydrochloride is not selective and can be very disruptive of natural enemies.			
E. NEEM OIL# (Trilogy 90 EC)	2%	—	
COMMENTS: Repeat applications may be necessary.			
SUMMER			
A. NEEM OIL# (Trilogy 90 EC)	2%	—	
COMMENTS: Repeat applications may be necessary.			

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

LEAF CURL PLUM APHID

Scientific Name: *Brachycaudus helichrysi*
(Updated 12/98)

DESCRIPTION OF THE PEST

The leaf curl plum aphid is often found inside curled leaves. It is shiny and varies considerably in color from green brownish to green or brownish yellow. This aphid overwinters in the egg stage near the base of buds.

DAMAGE

Colonies of this pest cause leaves to curl tightly. Often only one limb or a portion of a limb is infested early in the year. Fruit on infested limb may crack and split. Large amounts of honeydew are secreted by this aphid.

BIOLOGICAL CONTROL

There are many natural enemies that feed on leaf curl plum aphid; however, fruit size and fruit cracking may still occur and curled leaves will not uncurl after aphids are suppressed. Important predators include: lady beetles, green and brown lacewings, syrphid flies, and soldier beetles.

ORGANICALLY ACCEPTABLE METHODS

Biological control and sprays of oil or neem.

WHEN TO TREAT

Monitor aphids at 75% leaf fall. Examine leaves remaining on trees and those on the groung to determine the need for a dormant spray. Apply an insecticide during the delayed dormant period to kill eggs. If control has not been achieved with the delayed dormant treatment, apply an insecticide during April (if oil is used) or May (for other materials) when aphids are present and there is an average of more than three colonies/tree.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT (Preferred timing)

A. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1–1.5 gal	
NARROW RANGE OIL	4 gal	1.5 gal	

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . PLUS . . .

DIAZINON* 50WP	3 lb	1 lb	
4EC	3 pt	1 pt	

COMMENTS: Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

CHLORPYRIFOS (Lorsban) 4EC	2 pt	0.5 pt	

COMMENTS: Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
ESFENVALERATE* (Asana XL)	4–6 oz	1.5–2 oz	14

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

B. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1–1.5 gal	
NARROW RANGE OIL#	4 gal	1.5 gal	

COMMENTS: Oils applied alone during the dormant or delayed dormant period (as part of a *Bacillus thuringiensis* program) provide only partial control of leaf curl plum aphid (this timing is more effective against San Jose scale). Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

SPRING

A.	DIAZINON* 50WP	1.5–3 lb	1 lb	21
	4EC	1.5–3 pt	1 pt	21
B.	ENDOSULFAN* (Thiodan) 50WP	3 lb	1 lb	7
C.	NARROW RANGE OIL#	4-6%	4%	

COMMENTS: Suppresses aphid populations. Apply at bloom to kill the hatching aphids (hatch generally occurs in early March). May be tank mixed with Bt. If necessary, make a second application in April; plum trees tolerate oil treatments better in spring than during dormancy. Do not apply oil within 2 weeks of captan.

D.	FORMETANATE HYDROCHLORIDE (Carzol SP)	0.125	—	7

COMMENTS: Formetanate hydrochloride is not selective and can be very disruptive of natural enemies.

E.	NEEM OIL# (Trilogy 90 EC)	2%	—

COMMENTS: Repeat applications may be necessary.

SUMMER

A.	NEEM OIL# (Trilogy 90 EC)	2%	—

COMMENTS: Repeat applications may be necessary.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

Thrips

WESTERN FLOWER THRIPS

Scientific Name: *Frankliniella occidentalis*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

WHEN TO TREAT

Treat, if necessary, at petal fall based on monitoring and observing thrips in the flowers.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.			
A. FORMETANATE HYDROCHLORIDE (Carzol) SP	1 lb	0.25 lb	7
COMMENTS: Apply concentrate in at least 50 gal water/acre.			
B. DIAZINON* 50WP	1.5–3 lb	1 lb	21
4EC	2 pt	0.5 pt	21

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

Scales

SAN JOSE SCALE

Scientific Name: *Quadraspidiotus perniciosus*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

BIOLOGICAL CONTROL

Many parasites and predators have been observed feeding on San Jose scale. However, in situations where heavy scale populations exist, these parasites and predators cannot exert sufficient controlling pressure to prevent severe damage, so annual sprays are usually needed.

ORGANICALLY ACCEPTABLE METHODS

Oil sprays and biological control by native scale parasites.

MONITORING and WHEN TO TREAT

Monitor San Jose scale during the dormant season by collecting spurs with the past year's wood on them and examining them for scale as well as for tiny emergence holes, which indicate parasite activity. During the growing season, San Jose scale traps will attract both male San Jose scales and scale parasites (*Aphytis melinus* and *Prospaltella* sp.). Adult male scales can be distinguished from the parasites by the presence of a dark line across their thorax where the wings attach. Due to the damage potential of this pest, an annual dormant or delayed dormant oil spray is recommended in orchards that use in-season insecticides that are harmful to scale parasites. Control heavy populations by adding an organophosphate insecticide to the dormant oil spray. Some field populations of San Jose scale, however, have shown strong resistance to organophosphate insecticides.

If inadequate control is achieved with the dormant spray or the dormant spray is not applied, treatment is also effective when applied soon after the emergence of crawlers in May. Use pheromone traps in March to monitor male San Jose scale flights or double-sided sticky tape for monitoring crawlers in April and May. Using a 51°F lower and a 90°F upper threshold, time treatments for 600 to 700 degree-days (DD) after the beginning of the male flight, or 200 DD after crawler emergence begins.

If control of San Jose scale is a problem in the orchard, use a high volume (dilute) application at 400 gallons or more per acre for best coverage.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

DORMANT OR DELAYED DORMANT (Preferred timing)

A. METHIDATHION*
(Supracide) 2EC — 4 qt — 1 qt
COMMENTS: Preferred material for heavy infestations. Apply before blossoms open, or injury may occur. Do not graze treated areas or feed cover crops grown in treated areas to livestock.

B. DORMANT OIL such as:
DORMANT FLOWABLE EMULSION — 6 gal — 1.5 gal
NARROW RANGE OIL — 4 gal — 1.5 gal
COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.
. . . *PLUS* . . .
DIAZINON* 50WP — 3 lb — 1 lb
4EC — 3 pt — 1 pt
COMMENTS: Resistance to diazinon has been a problem in some populations of San Jose scale. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.
. . . *OR* . . .
CHLORPYRIFOS
(Lorsban) 4EC — 2 pt — 0.5 pt
COMMENTS: . Resistance to chlorpyrifos has been a problem in some populations of San Jose scale Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.
. . . *OR* . . .
CARBARYL*
(Sevin) 50 WP — — — 2 lb — 1
(Sevin) 80 S — — — 1.25 lb — 1
(Sevin) XLR PLUS — — — 1 qt — 1
COMMENTS: If resistance to diazinon or chlorpyrifos has been a problem, carbaryl is a good alternative. The best time to apply this material is about 2–3 weeks before bloom. Because carbaryl is so toxic to honey bees, do not apply it when there is any bloom in the orchard or in neighboring orchards or other crops. The XLR PLUS formulation is less toxic to honey bees than the other formulations. Apply it from late evening or early morning when bees are not foraging.

C. DORMANT OIL such as:
DORMANT FLOWABLE EMULSION# — 6 gal — 1–1.5 gal
NARROW RANGE OIL# — 4 gal — 1.5 gal
COMMENTS: If this spray is aimed primarily at San Jose scale, apply it in early to mid-January. Provides partial control; use for light infestations only and monitor scale on prunings in winter and again in spring when crawlers emerge to determine if populations are increasing. Use this option if *Bacillus thuringiensis* is to be applied at bloom for control of caterpillars. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

MAY (Second choice treatment timing)

A. NARROW RANGE OIL# — 2% — 4% — 0
COMMENTS: Do not use within 30 days of sulfur or lime sulfur treatment or apply to water-stressed trees. Do not apply oil within 2 weeks of captan.

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
B. DIAZINON* 50WP	3 lb	1 lb	21
4EC	3 pt	1 pt	21
C. CARBARYL*			
(Sevin) 50 WP	—	2 lb	1
(Sevin) 80 S	—	1.25 lb	1
(Sevin) XLR PLUS	—	1 qt	1
COMMENTS Will cause mite outbreaks when used at this time.			
D. METHYL PARATHION*			
(Penncap-M)	—	Label rates	See label

COMMENTS: Will cause mite outbreaks, but generally not as severe as those caused by carbaryl. This material is detrimental to parasites of San Jose scale. Very toxic to honey bees; do not apply when weeds or cover crops are in bloom or have flower buds and bees are foraging in area to be treated.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

EUROPEAN FRUIT LECANIUM

Scientific Name: *Parthenolecanium corni*
(Updated 12/98)

DESCRIPTION OF THE PEST

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

DAMAGE

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

ORGANICALLY ACCEPTABLE METHODS

Oil sprays.

WHEN TO TREAT

When treatment is necessary, treat when leaves are off during the dormant or delayed dormant period.

TREATMENT

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies.

A. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION	6 gal	1.5 gal
NARROW RANGE OIL	4 gal	1 gal

COMMENTS: Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

. . . PLUS . . .

DIAZINON* 50WP	3 lb	1 lb
4EC	3 pt	1 lb

COMMENTS: Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

. . . OR . . .

CHLORPYRIFOS (Lorsban) 4EC	2 pt	0.5 pt

COMMENTS: Apply chlorpyrifos only during dormant or delayed dormant period and do not allow meat or dairy animals to graze in treated orchards. Levels in surface waters of this material that are high enough to be toxic to certain aquatic invertebrates have occurred following rains in January and February; avoid runoff into surface waters.

B. DORMANT OIL such as:

DORMANT FLOWABLE EMULSION#	6 gal	1–1.5 gal
NARROW RANGE OIL#	4 gal	1.5 gal

COMMENTS: Oil is an option if *Bacillus thuringiensis* is to be applied at bloom for control of caterpillars. Oil applications at this time may cause some young shoots to burn or dieback, especially in years when trees are water-stressed, or have recently been subjected to freezing temperatures or to dry winds. Dormant flowable emulsion is less likely to cause burn. The Queen Ann variety is highly susceptible to oil injury.

** For dilute applications, rate is per 100 gal water to be applied in 300-500 gal water/acre, according to label; for concentrate applications, use 80-100 gal water/acre, or lower if the label allows.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

UC IPM

PEST MANAGEMENT GUIDELINES

MARCH, 1995

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

APPLE
PEST MANAGEMENT GUIDELINES

JULY, 1994

Insects and Mites: C. Pickel, R. S. Bethell, W. Barnett, J. Caprile
Diseases: B. L. Teviotdale, D. Gubler; **Nematodes:** U. C. Kodira, B. B.Westerdahl

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About this publication: These guidelines represent the best information currently available to the authors and are intended to help you in making the best decisions for an IPM program. Materials are listed either alphabetically or, where research data or field experience is available, according to preference for use within an IPM program. Not all registered materials are mentioned. Always check the label and with local authorities for the most up-to-date information regarding registration and restrictions on pesticide use. Check with agricultural commissioner for latest re-entry intervals.

TO BE USED WITH UC/ANR PUBLICATION 3340, *IPM FOR APPLES AND PEARS*

Produced and Edited by IPM Education and Publications, University of California, Davis
B. Ohlendorf, Guidelines Coordinator; M. L. Flint, Technical Editor; M. Brush, Production
University of California, Division of Agriculture and Natural Resources

INSECTS and MITES

CODLING MOTH (7/94)

Scientific Name: *Cydia pomonella*

DESCRIPTION OF THE PEST: Codling moth has a 0.5 to 0.75 inch wingspan. The tip of each forewing has a coppery tinged, dark brown band that distinguishes codling moth from other moths found in apple orchards. Females lay eggs singly on leaves, and sometimes on fruit later in the season. The eggs are smaller than a pinhead, disk-shaped, and opaque white when first laid. Just before hatching the black head of the larvae becomes visible. Newly hatched larvae are white with black heads. Mature larvae are 0.5 to 0.75 inch long, pinkish white, with mottled brown heads.

DAMAGE: Codling moth has the greatest potential for damage of any apple pest, yet it can be effectively controlled with properly timed treatments. It causes two types of fruit damage: stings and deep entries. Stings are entries where larvae bore into the flesh a short distance before dying. Deep entries occur when larvae penetrate the fruit skin, bore to the core, and feed in the seed cavity. Larvae may enter through the sides, stem end, or calyx end of the fruit. One or more holes plugged with frass on the fruit's surface is a characteristic sign of codling moth infestation. Calyx entries are difficult to detect without cutting the fruit.

CULTURAL CONTROL: Remove host trees in nearby abandoned orchards (apple, pear, plum, and walnut) to destroy reservoirs of codling moth. Also remove fruit from nearby unsprayed apple, pear, plum, apricot, and walnut trees, unpicked pollinizers and seedling trees in the orchard, as well as removing brush, props, boxes, and debris from the orchard. Prune tall, overly dense tree tops to improve spray coverage. Hand thin to remove all infested fruit and pick up dropped fruit.

BIOLOGICAL CONTROL: Alone, natural enemies are not able to keep codling moth populations below economic levels. However, augmentative releases of the tiny, naturally occurring parasitic wasp, *Trichogramma platneri*, can be used to supplement control with mating disruptants. *Trichogramma platneri*, which attacks codling moth eggs, are released on the borders of orchards treated with mating disruptants to help control eggs laid by mated female moths immigrating into the area from surrounding areas; or releases can be made throughout the orchard. Orchard-wide releases work best in orchards with medium to high codling moth populations, whereas border treatments are most effective when the orchard's codling moth population is low.

Time releases of *T. platneri* to the start of egg laying. Generally this occurs when moths are consistently caught in the traps and sunset temperatures are 62 F or higher. *Trichogramma platneri* are very susceptible to insecticides for codling moth; do not release them in areas where broad spectrum insecticides have been used during the current season.

ORGANICALLY ACCEPTABLE METHODS: Biological control in conjunction with mating disruptants, and sprays of oil or ryania.

MONITORING and WHEN TO TREAT: Effective codling moth control can be achieved with pheromone dispensers to disrupt mating or with insecticide sprays.

In orchards treated with pheromone dispensers, place dispensers in the upper third of the tree canopy before the first moth emergence in mid-March

Continued on next page.

Codling moth cont. (7/94)

to early April. A second application of pheromone is needed when the first expires. Timing of the second application varies depending on product used; follow the guidelines on the label for reapplication timing. A third application may be needed if the second application has expired before apples are harvested and/or the last generation of codling moth is still flying.

Mating disruption is most successful in uniform orchards on flat ground with relatively low codling moth populations. When codling moth populations are moderate to high, make the transition to a mating disruption program with a combination program first: begin by using chemical control in addition to mating disruption for the first year.

Pheromone-treated orchards must be carefully monitored for potential damage from codling moth that can move in from neighboring apple, pear, plum, or walnut orchards. Check fruit for damage during each generation, particularly near the end of the generation, and supplement the mating disruption treatment with a spray if damage has occurred. If a spray is applied, discontinue parasite releases for the remainder of the season.

Use pheromone traps to monitor the effectiveness and longevity of the mating disruptant. Hang traps with supercharged (10 mg) pheromone lures in trees at the same level as the pheromone dispenser to monitor development of the codling moth population. High counts of codling moths in these traps may indicate the codling moth population is too high to be effectively controlled by mating disruption. Pheromone traps with the regular (1 mg) lures should also be used; hang these traps in the trees at 6 to 8 feet. If moths are caught in these traps consistently for 2 consecutive weeks, the mating disruptant may have broken down or expired and chemical treatments may be necessary. Monitor traps on a weekly basis, changing trap lures at the frequency recommended by the manufacturer.

In orchards treated with insecticides, time all treatments to kill larvae soon after they emerge from eggs. Use pheromone traps, degree-days (DD), and twilight temperatures to monitor codling moth activity and determine when egg hatch occurs.

Soon after bud break, place traps in your orchards to determine first moth emergence. Traps should be placed on the SE quadrant of the tree about 6 to 7 feet high. To use the threshold levels given below, the Pherocon 1-CP type trap or the one-gallon trap should be used. In spring, begin accumulating degree-days on the first date that moths are consistently found in traps; this is the biofix point. Once moths are consistently present and sunset temperatures have reached 62 F, degree-day accumulation can be used to predict egg hatch. The degree-days given below are based on a lower threshold of 50 F (10 C) and an upper threshold of 88 F (31 C). Egg laying can be verified in the field by checking leaves for eggs on abandoned pear or apple trees. Consider past season trap counts and surrounding conditions in determining when to treat.

Codling moth has two to four generations a year. Continue monitoring the overwintered population and later summer generations with traps and continue accumulating degree-days until the crop is harvested or populations decline to below damaging numbers in September.

When using pheromone traps, keep in mind the many factors, such as tree size, trap density, type of trap, trap placement, brand of pheromone, as well as climatic conditions, that can affect trap counts.

Use the following table as a guideline for trap thresholds throughout the season.

Continued on next page.

Codling moth cont. (7/94)

THRESHOLDS FOR CHEMICAL MANAGEMENT		
Trap Counts*	**Population Levels**	**Comments**
10 moths/trap/week	High population	Requires heavy insecticide use. If left untreated, heavy damage will result.
3-10 moths/trap/week	Medium population	Sprays should be applied accurately for each generation.
2 moths/trap/week	Low population	Sprays are sometimes unnecessary, but be sure to monitor fruit for damage.

* using the Pherocon 1-CP or one-gallon type trap

First generation egg hatch: Time the first spray to the beginning of egg hatch to kill emerging larvae 250 to 300 DD after the first biofix for moderate to heavy populations, and 400 to 500 DD for light populations. In most orchards, more than one spray may be necessary to adequately control first generation codling moth–particularly if the orchard has a history of codling moth problems or the population is high. If significant moth catches continue after the first treatment, make a second application when the residual period of the first is over. If trap catches are low or the weather turns too cool for moth activity, you can delay treatment, but continue to monitor.

Near the end of the overwintered generation moth flight, trap catches may not be a reliable guide in determining the need for another spray. Females may have completed egg laying, even though males are still being trapped. To determine the need for another treament, inspect 100 fruit clusters for eggs on leaves, fruit, and cluster bases throughout the upper half of 10 trees. If any eggs or larval entries are found, treat.

Second generation egg hatch: Use pheronome trap catches to detect an increase in flight activity around 1060 DD from the first biofix, which signals the start of the next moth flight. In early maturing pears, a single application is usually sufficient; make this application when 200 to 250 DD have accumulated from the second biofix. In late districts or for late maturing pears, two treatments are usually necessary. Make the first at 1050 to 1150 DD from the first biofix. Apply the second when the residual of the previous spray ends.

Third generation egg hatch: A third generation of codling moth eggs does not occur every year in every location. Codling moth larvae normally go into diapause (winter dormant state) around August 22, but in warm years and warm locations they will have already started pupation prior to August 22, and these pupae will soon emerge as adults to produce a third generation. If 541 DD have accumulated from the second biofix before mid-August, most of the codling moth will not go into diapause but will pupate and emerge in late August and early September. If degree-day accumulation data indicates a third generation will occur, use pheromone traps to reestablish the biofix point. When flight activity increases around 1100 to 1200 DD from the second biofix, establish the third biofix. Apply a spray to late maturing varieties when 200 to 250 DD have accumulated from the third biofix.

Continued on next page.

Codling moth cont. (7/94)

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. TRICHOGRAMMA PLATNERI#	100,000/acre		

COMMENTS: Release this parasite to supplement mating disruption treatments. Treat entire orchard if codling moth populations are medium to high. For low populations, treating orchard borders may be adequate. Make releases at weekly intervals during the egg-laying periods. Parasites come on cards with 30 perforated square sections. Distribute the 30 sections evenly throughout the orchard or along the border. Staple the square to the underside of a leaf towards the center of the tree's canopy to protect the parasites from rain and sun. In sprinkler-irrigated orchards, be sure to place the squares on leaves above the spray line. Parasites can be set out any time of day, but wait until the wasps begin to emerge from the cards to minimize loss from predation.

B. MATING DISRUPTANTS#			
(Isomate-C) and others	400 dispensers/acre		

COMMENTS: Apply just before moth emergence in spring. Reapply once or twice at the interval recommended on the label. Monitor weekly with pheromone traps and check fruit after each generation. Most effective on larger blocks of 5-10 acres with trees of uniform size. Be sure to monitor for leafrollers (orange tortrix), stink bugs and lygus bugs, which are normally controlled by codling moth cover sprays.

C. AZINPHOSMETHYL*			
(Guthion) 50WP	1-2 lb	0.25-0.5 lb	7

COMMENTS: At the low rate, azinphosmethyl is one of the least disruptive chemicals to beneficials. Use the low rate when no more than 2 weeks residual control is required, or no more than 10 moths/trap have been caught before first moth treatment and seasonal trap catches the previous season did not exceed 30 moths/trap. In areas where resistance to azinphosmethyl is present in the codling moth population, even high label rates of this material may not be effective.

D. CARBARYL*			
(Sevin) 50WP	4 lb	1 lb	1
(XLR Plus)	1.5 qt	0.5 qt	1

COMMENTS: Will thin apples up to 30 days after full bloom. May cause severe outbreaks of spider mites. One application per season does not cause mite increase in coastal areas.

E. PHOSMET			
(Imidan) 50WP	6 lb	1.5 lb	7

COMMENTS: May be harmful to beneficials.

Continued on next page.

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for organically grown produce.

Codling moth cont. (7/94)

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
F. DIAZINON 50WP	4 lb	1 lb	14

COMMENTS: A shorter residual material. Can be applied around living quarters.

G. NARROW RANGE OIL# (Supreme)	–	1-2 gal	when dry

COMMENTS: Oils are mildly effective against codling moth and need to be reapplied frequently during egg hatch. They may be phytotoxic if used within a few weeks of a sulfur spray or if applied at higher rates during hot weather. Effectiveness may be enhanced with more dilute applications (i.e. 200-400 gal water/acre). May be used to maintain lower populations in mating disrupted orchards.

H. RYANIA# (Ryan 50)	–	10 lb	when dry

COMMENTS: Ryania is mildly effective against codling moth and needs to be reapplied frequently during egg hatch. It is viscous and may clog spray nozzles. Effectiveness may be enhanced with more dilute applications (i.e. 200-400 gal water/acre). May be used to maintain lower populations in mating disrupted orchards.

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre, or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for organically grown produce.

ORANGE TORTRIX (7/94)

Scientific Name: *Argyrotaenia citrana*

DESCRIPTION OF THE PEST: Orange tortrix, also called apple skinworm, is a pest in California coastal areas. The moths are 0.5 inch long with tan to rusty brown forewings. The fully grown larvae are about 0.5 inch long, straw colored to green, with light brown heads. They are active and quickly wiggle backwards when disturbed, dropping to the ground or spinning down a silken thread.

DAMAGE: The principal damage caused by orange tortrix larvae is feeding on the surface of fruit, where they leave shallow, irregular scars. Generally they feed within a fruit cluster; occasionally they tie a leaf to the fruit's surface and feed under it.

BIOLOGICAL CONTROL: Several parasites and predators attack orange tortrix. Two parasitic wasps, *Apanteles aristolilae* and *Exochus* sp., are the most common. *Hormius basalis*, an external parasite, also occurs. Brown lacewing, *Hemerobius pacificus*, is a general feeder on orange tortrix.

CULTURAL CONTROL: Thin fruit to one or two fruit per cluster to reduce available habitat and to increase exposure of larvae to parasites, predators, and insecticides. Remove and dispose of mummy fruit to reduce overwintering orange tortrix. Orange tortrix feeds on many weeds found in orchards, such as mustard. Plant low-growing, grass cover crops to reduce overwintering hosts of orange tortrix.

ORGANICALLY ACCEPTABLE METHODS: Biological and cultural controls.

MONITORING and WHEN TO TREAT: Monitor orange tortrix with pheromone traps. Place traps in orchards by January 1 to monitor moth flights. In February, flight activity will reach its lowest point. Start accumulating degree-days (DD) using 43 F for the lower limit and 78 F for the upper limit. When 1000 DD have accumulated, begin sampling fruit for damage to determine spray timing. Sample 20 fruit on 15 trees for a total of 300 fruit on a weekly basis. Orange tortrix prefers the top half of trees, and twice as much damage occurs on the top half as on the bottom half. The following thresholds have been adjusted for sampling the lower portion of the trees. Treat if more than 2% damage (6 fruits) is evident for fresh market apples, or 4% (12 fruits) for processing. To monitor the second generation, start accumulating degree-days from the lowest moth catch in May. When 1000 degree-days have accumulated, again sample fruit for damage (normally this is in July). Treat if damage exceeds 4% (12 apples) for fresh market, or 6% (18 apples) for processing.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. CHLORPYRIFOS (Lorsban) 50WP	3 lb	0.5-1 lb	28

COMMENTS: Chlorpyrifos sprays for orange tortrix cannot be relied on to provide adequate control of damaging populations of codling moth because the period of effectiveness is only 14 days.

Continued on next page.

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

+ Preharvest interval. Do not apply within this many days of harvest.

Codling moth cont. (7/94)

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
B. METHYL PARATHION* (Penncap-M)	4 pt	1 pt	14

NOTE: Various pyrethroids are also registered for orange tortrix control in Califoria, but are not recommended because they can cause severe mite problems and are not worth the control provided for orange tortrix.

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

APPLE PANDEMIS (7/94)

Scientific Name: *Pandemis pyrusana*

DESCRIPTION OF THE PEST: Apple pandemis is primarily a pest in central coast orchards and has two generations a year. It overwinters as first instar larvae in apple buds. Larvae become active in spring as the buds open up. Larvae are green caterpillars with a straw or gold colored head. The larvae are difficult to distinguish from obliquebanded leafrollers, which are similar in appearance, type of damage, and life history, and from orange tortrix, which are similar in appearance but only occur in the orchard with apple pandemis during the month of July. Apple pandemis moths are difficult to distinguish from obliquebanded leafroller moths.

DAMAGE: Overwintered larvae feed on blooms and on the surface of young fruit, causing them to drop or resulting in scarring and distortion. Summer generation larvae feed on leaf tissue and cause windowpaning. This windowpane can be used to distinguish between apple pandemis and orange tortrix. When apple pandemis tie leaves to fruit, they cause shallow feeding scars. Sometimes they feed for only a short time and produce several small circular holes in fruit. This damage is similar to that caused by obliquebanded leafroller.

MONITORING and WHEN TO TREAT: The delayed dormant oil spray and recommended organophosphates applied at bud break will control overwintering first instar larvae. If delayed dormant sprays (including recommended organophosphates) are not applied, sample for apple pandemis between green tip and pink bud; examine 100 fruit clusters per block for larvae. Treat at the pink bud stage if there are any apple pandemis larvae in the sample. Begin sampling again in mid-June to determine egg hatch; examine 100 fruits weekly. The second generation usually hatches between the last 2 weeks of June and the fourth of July. Sprays should be timed for the beginning of egg hatch or when weekly sampling shows between 6 to 10% damage in the top half of the trees or 3 to 5% damage in the bottom half.

The threelined leafroller (*Pandemis limitata*) pheromone trap can be used to monitor apple pandemis. Although this can give you an idea of when moths are flying, it will not provide an accurate assessment of populations in an individual block because traps draw moths in from native vegetation as well as from orchard trees.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Delayed Dormant (Preferred timing)			
A. NARROW RANGE OIL (Superior, Supreme)	4-6 gal	1-1.5 gal	
...PLUS...			
1. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	
COMMENTS: Gives best control.			
...or...			
2. DIAZINON 50WP	4 lb	1 lb	

Continued on next page

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

+ Preharvest interval. Do not apply within this many days of harvest.

Apple pandemis cont. (7/94)

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Tight Cluster			
A. CHLORPYRIFOS (Lorsban) 50WP	3 lb	0.75 lb	
COMMENTS: Apply before pink bud and placement of bees in orchards.			
Summer			
A. CHLORPYRIFOS (Lorsban) 50WP	3 lb	0.75 lb	28
B. METHYL PARATHION* (Penncap-M)	4 pt	1 pt	14

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

+ Preharvest interval. Do not apply within this many days of harvest.

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

FRUITTREE LEAFROLLER (7/94)

Scientific Name: *Archips argyrospilus*

DESCRIPTION OF THE PEST: Fruittree leafroller overwinters in the egg stage in irregular masses of 30 to 100 eggs cemented over with a secretion. Young larvae are light green caterpillars with black heads and are first seen at bud break. The mature larva is about an inch long and has a green body and black head. The black head helps distinguish fruittree leafroller from other leafrollers. There is one generation per season.

DAMAGE: The fruittree leafroller feeds principally on leaves, but also feeds on blossoms, flower buds, and fruits during bloom. Tiny larvae work their way into opening leaf buds to feed. Once the tree has leafed out, larvae tie up leaves and live within leafrolls, feeding on leaves or fruit. Larvae damage fruit in much the same way as green fruitworms, resulting in shallow cavities in the fruit. Damaged fruits that remain on the tree develop deep bronze-colored scars with roughened, netlike surfaces.

ORGANICALLY ACCEPTABLE METHODS: Applications of narrow range oil and *Bacillus thuringiensis*.

MONITORING and WHEN TO TREAT: Fruittree leafroller usually is effectively controlled by a dormant oil spray. Make an application thorough enough to cover egg masses. Check results by sampling for leafrollers at green tip. Examine 100 fruit clusters per block. If no worms are found, resample in 1 week. If more than one worm is found, treatment prior to pink bud may be necessary to prevent damage. Often infestations are usually confined to small localized areas of the orchard and can be spot treated.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant			
A. NARROW RANGE OIL# (Superior, Supreme)	8 gal	2 gal	
Delayed Dormant (Preferred timing)			
A. NARROW RANGE OIL (Superior, Supreme)	4 gal	1.5 gal	
...PLUS...			
1. DIAZINON 50WP	4 lb	1 lb	
...or...			
2. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	
B. METHIDATHION* (Supracide) 2EC	3 qt	1 qt	

Continued on next page

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for organically grown produce.

Fruittree leafroller cont. (7/94)

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Pink Bud to Petal Fall			
A. CHLORPYRIFOS (Lorsban) 50WP	3 lb	12 oz	28
COMMENTS: Best to apply around pink bud. Apply before bees are placed or after they are removed. Only controls small caterpillars.			
B. Diazinon 50WP	4 lb	1 lb	14
COMMENTS: Best to apply around pink bud. Apply before bees are placed or after they are removed. Only controls small caterpillars.			
C. BACILLUS THURINGIENSIS# (Thuricide) HPC	1 qt	0.25 qt	0
(Dipel) 2X	0.25-0.5 lb	0.12-0.25 lb	0
COMMENTS: Least harmful to beneficials. Most effective against young larvae. Requires more than 1 treatment.			

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for organically grown produce.

OMNIVOROUS LEAFROLLER (5/89)

Scientific Name: *Platynota stultana*

DESCRIPTION OF THE PEST: Omnivorous leafroller larvae are creamy to brownish green caterpillars with brown or black head capsules, and have small, white tubercules at the base of each bristle along its back and sides. Orchards may be infested by omnivorous leafroller moths that develop on host plants outside the orchards. Infestations are often spotty, making monitoring difficult. This pest has two to four generations per year depending on climatic conditions.

DAMAGE: Although omnivorous leafroller larvae feed on both fruit and foliage, leaf-feeding damage is minor. Larvae feed on fruit surfaces, leaving irregular, shallow scars similar to orange tortrix. Larvae feed where fruit are touching, so entire clusters can be damaged.

MONITORING and WHEN TO TREAT: Sample 100 fruit clusters during pink stage for larvae. Population damage guidelines have not been developed and sprays for other worms usually control this pest. Once the first codling moth spray is applied, this pest is generally kept under control for the remainder of the season.

OBLIQUEBANDED LEAFROLLER (7/94)

Scientific Name: *Choristoneura rosaceana*

DESCRIPTION OF THE PEST: Obliquebanded leafroller overwinter as third instar larvae under bark scales. Larvae are yellowish green with brown to black heads. As they mature, larvae construct tubular shelters from a single leaf. Periodically, localized infestations of obliquebanded leafroller occur and can cause serious damage in July and August.

DAMAGE: Larvae feed on flower parts and on fruit early in the season, causing deep depressions that eventually become rough and russeted by harvest. Damage from the summer generation is usually more serious and results in superficial skin tunnels or small holes near the stem portion of the fruit.

ORGANICALLY ACCEPTABLE METHODS: Sprays of *Bacillus thuringiensis*.

MONITORING and WHEN TO TREAT: Sample 100 fruit clusters at pink bud for larvae. If orchards have experienced damage from this pest in previous years, also take fruit and leaf cluster samples in July and August. Tentative thresholds are two or more larvae in a 100 fruit cluster sample in spring, and four or more in summer.

The best time to treat obliquebanded leafrollers is in spring, around pink bud, before the larvae are sheltered under leaves and between fruit clusters. Apply materials before bees are placed in orchards or after they are removed.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. CHLORPYRIFOS			
(Lorsban) 50WP	3 lb	0.75 lb	28
COMMENTS: Only controls small worms.			
B. AZINPHOSMETHYL*			
(Guthion) 50WP	1-2 lb	0.25-0.5 lb	7
C. DIAZINON 50WP	4 lb	1 lb	14
D. BACILLUS THURINGIENSIS#			
(Thuricide) HP	Label rates		0
(Dipel) 2X	Label rates		0
COMMENTS: Least harmful to beneficials. Must be applied when worms are small. A second treatment may be required.			

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for organically grown produce.

WESTERN TUSSOCK MOTH (7/94)

Scientific Name: *Orgyia vetusta*

DESCRIPTION OF THE PEST: Western tussock moth has one generation a year. Wingless females lay 125 to 300 eggs in a single mass on the empty pupal case. Overwintering eggs hatch when spring growth is expanding. Young larvae are black caterpillars with long bristles; mature larvae have numerous red and yellow spots and four median dorsal tufts.

DAMAGE: A heavy infestation will destroy all spring growth. Larvae take shallow bites out of newly set, young fruit; these injured areas eventually scab over and russet. Infestations are spotty and may be isolated in certain areas of an orchard.

ORGANICALLY ACCEPTABLE METHODS: Sprays of *Bacillus thuringiensis.*

MONITORING: During winter look for western tussock moth egg masses on props or tree trunks. Monitor during bloom by examining 100 fruit clusters for larvae.

WHEN TO TREAT: Spot treat infested areas in the orchard. Applications made at night during bloom will minimize damage to bees. This insect is usually controlled by sprays for other pests.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. DIAZINON 50WP	4 lb	1 lb	14
B. CHLORPYRIFOS (Lorsban) 50WP	3 lb	0.75 lb	28
C. AZINPHOSMETHYL* (Guthion) 50WP	1-2 lb	0.25-0.5 lb	7
D. BACILLUS THURINGIENSIS#			
(Thuricide) HPC	1 qt.	0.25 qt	0
(Dipel) 2X	0.25-0.5 lb	0.12-0.25 lb	0

COMMENTS: Least harmful to beneficials. Most effective against young larvae. Requires more than 1 application.

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for organically grown produce.

GREEN FRUITWORMS (7/94)

Scientific Names: Speckled green fruitworm: *Orthosia hibisci*
Humped green fruitworm: *Amphipyra pyramidoides*

DESCRIPTION OF THE PEST: Immature larvae of both species are light green caterpillars. Mature green fruitworms have green bodies and green heads. Speckled green fruitworms have cream-colored lines down the back and sides of the body. Humped green fruitworms are distinguished by a prominent hump on the last segment, bright yellow lines on the side, and less distinct white lines on the back. They have only one generation a year. Egg hatch extends from pink bud to after petal fall.

DAMAGE: Young green fruitworm larvae feed on leaves. Fruit feeding usually begins about petal fall and continues until larvae have completed their development. At harvest, these fruit are misshapen and have large, roughened, russeted cavities.

ORGANICALLY ACCEPTABLE METHODS: Sprays of *Bacillus thuringiensis*.

MONITORING and WHEN TO TREAT: Delayed dormant treatments containing organophosphates may control green fruitworms. Populations of green fruitworm are often spotty within an orchard, so blocks should be thoroughly sampled. Three sampling methods may be used: (1) Inspect 100 fruit clusters for presence of worms; (2) Take 50 beating-tray samples, especially around petal fall when larvae are easy to dislodge; (3) Inspect a block for a half hour looking for damaged foliage and clusters. When one or more larvae per 100 clusters or 50 beating tray samples are found, treatment may be necessary after petal fall.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS#			
(Thuricide) HPC	1 qt	0.25 qt	
(Dipel) 2X	0.25-0.5 lb	0.12-0.25 lb	0
COMMENTS: Least harmful to beneficials. Can be used before or during bloom. Most effective against young larvae. Requires more than 1 application.			
B. AZINPHOSMETHYL* (Guthion) 50WP	1 lb	0.25 lb	7
C. DIAZINON 50WP	2 lb	0.5 lb	14
D. CHLORPYRIFOS (Lorsban) 50WP	3 lb	0.75 lb	28

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for organically grown produce.

LEAFMINERS (7/94)

Scientific Name: *Phyllonorychter* sp.

DESCRIPTION OF THE PEST: Low levels of leafminer populations are present in most orchards every year; populations are usually kept at low levels by several species of parasites. Adults are small, golden brown moths with white bands or spots that give them a silvery appearance when they fly in sunlight. In spring eggs are laid in young leaves during the period from the tight cluster bloom stage through petal fall. Larvae develop within the leaf tissue. The first three instars feed on sap within the leaves and are called **sap-feeders**. Sap-feeders have a white, flat, legless body with a brown wedge-shaped head. They form snakelike mines in the leaf that are visible only on the lower surface of leaves. Fourth and fifth stage larvae are known as **tissue-feeders** because feeding is concentrated more on leaf tissue than on sap. Tissue feeders have both legs and prolegs and a round head. These older larvae tie the sides of the leaf together with silk to form tents.

Leafminers overwinter within mines in leaves on the orchard floor.

DAMAGE: Leafminer damage is restricted to foliage. In a heavy infestation, over 60 percent of the leaf tissue can be destroyed. Larvae feed on cells between upper and lower epidermal layers of the leaf, leaving only the thin epidermal layers. The upperside of the leaf takes on a light, spotted appearance. Infestations greater than an average of 5 to 10 mines per leaf may cause premature defoliation. Even if trees are not defoliated, leaf function is impaired and fruit may fail to size or color.

BIOLOGICAL CONTROL: Parasitic wasps are very important in controlling tentiform leafminers. Leafminer parasites lay eggs in the leaf mines when the leafminers have reached the tissue-feeding stage. After hatching, parasitic larvae attach themselves to the outside of tissue-feeding larvae. The parasite grows rapidly and consumes the leafminer by its fifth instar. It then pupates within the leaf mine about the same time the leafminer would have. The parasite resembles the leafminer pupa in size and color, but it has a larger head and eyes, and it is flat and naked in the leafmine, whereas leafminer pupa are inside a silk cocoon. Although adult parasites are very small, they are easy to spot if populations are abundant because they fly in groups that hover near infested trees.

ORGANICALLY ACCEPTABLE METHODS: Biological control.

WHEN TO TREAT: Outbreaks of this pest occasionally occur primarily because of chemical disruptions of the parasites. To determine treatment needs, monitor both the number of sap-feeding mines and parasitization levels of the tissue- feeding stage. First generation larvae normally do not require treatment in California. It is only necessary to monitor parasitism levels of this generation in April. Collect 50 mines with tissue-feeding larvae and examine the larvae for parasites. Sample again in May as soon as sap-feeding mines appear. Randomly collect four leaves from 25 trees. Use the parasitization rate from the first generation sample in conjunction with the number of sap-feeding mines in the current generation to make a treatment decision. Treat if leaves average more than five mines/leaf, or if two or more mines/leaf were present and less than 10% of the first generation was parasitized.

If more than 10% of the first generation was parasitized, delay treatment and reevaluate the level of parasites as soon as the current generation reaches the tissue-feeding stage. At this time, examine leafminer larvae in 50 mines for the presence of parasites.

Continued on next page.

Leafminers cont. (7/94)

To determine if treatment is necessary for the third generation, sample sap-feeding larvae as soon as they appear in June. Collect four leaves from 25 trees. Treat if the leaves are averaging more than five mines/leaf or if parasitization was less than 30% when parasite levels were reevaluated in the previous sample. Generally, treatment is not recommended for fourth generation larvae unless parasite levels are low or sap-feeding mines exceed an average of five per leaf.

Leafminer pheromone traps are available and can be used to monitor flights of this pest. Although no correlation has been developed between number of moths trapped and the occurrence of leaf mines, the traps can help pinpoint the start of the different generations.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Second and Third Generation			
A. OXAMYL* (Vydate) L	--	0.5 pt	14

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

+ Preharvest interval. Do not apply within this many days of harvest.

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

EUROPEAN RED MITE (7/94)

Scientific Name: *Panonychus ulmi*

DESCRIPTION OF THE PEST: European red mites overwinter as eggs; eggs hatch in spring when trees bloom. With the use of a hand lens, look for overwintering eggs in roughened bark at bases of buds and spurs on smaller branches and twigs, or in wounds. They are globular and red with a slender stalk (stipe) rising from the top center and many grooves extending from top to bottom. During the growing season, eggs are laid on leaves. There are three instars before the adult stage. Immature mites are bright red, except just after molting when they appear bright green. The green color turns to red after the mites resume feeding. Adults are dark red and have six to eight white spots at the base of hairs on the back.

DAMAGE: Severe mite infestations can cause bronzing of leaves, and may lead to small, poorly colored fruit and reduced bloom the following year. Damage is relatively less severe on wide leaf varieties such as Yellow Newton and more severe on narrow leaf varieties such as Red Delicious.

CULTURAL CONTROL: Minimize the potential for mite problems by reducing dusty conditions within the orchard and keeping the trees well irrigated.

BIOLOGICAL CONTROL: If European red mite populations are managed at low levels by treating with a dormant oil, predators can effectively help to maintain low levels throughout the season. Minimize the use or dosages of materials disruptive to mite predators. Avoid spraying with materials such as lime sulfur which kill the apple rust mite. When apple rust mites are allowed to survive, the predaceous mites feed on them and can build up large enough populations to control European red mites in some areas of California.

ORGANICALLY ACCEPTABLE METHODS: Cultural and biological controls and narrow range oil sprays.

MONITORING and WHEN TO TREAT: Anytime during winter collect 25 to 100 fruit spurs from trees throughout the block. If less than 10 percent of the spurs are infested, European red mite probably will not become a problem that season. If more than 10 percent of the spurs are infested, an oil spray should be applied before bloom. Control improves the closer eggs are to hatching. If summer control becomes necessary, the thresholds range from 10 to 30 mites per leaf depending on the age, variety, and condition of the tree, and the abundance of the mite predators.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Delayed Dormant (Preferred timing)			
A. NARROW RANGE OIL# (Superior, Supreme)	6 gal	1.5 gal	

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

\+ Preharvest interval. Do not apply within this many days of harvest.

\# Acceptable for organically grown produce.

European red mite cont. (7/94)

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Foliage Spray			
A. FENBUTATIN-OXIDE			
(Vendex) 4L	1-3 pt	0.25-0.5 pt	14
(Vendex) 50WP	1-3 lb	4-8 oz	14
COMMENTS: The liquid formulation gives better control in cooler climates.			
B. PROPARGITE			
(Omite) 30WP	8 lb	2 lb	7
COMMENTS: Product is sold in 1.5 lb soluble bags. Make appropriate calculations based on acreage to be covered.			

WEBSPINNING SPIDER MITES (7/94)

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

DESCRIPTION OF THE PEST: Adult female mites are larger and more elongated than European red mites and are green to yellow. Feeding mites have a dark spot on either side of the body which may enlarge to cover most of the body. Overwintering females are orange, and hibernate under bark scales on the tree and in trash on the ground. They move up the tree in late March and April, feeding on leaves. Rapid reproduction occurs in hot, dry weather and the infestation peaks in July and August. The tiny, spherical, colorless to straw-colored eggs are distributed over the infested area.

DAMAGE: Mites feed upon leaves, removing the cell contents and gradually giving leaves a finely stippled appearance. Heavy infestations result in severe bronzing of foliage and premature defoliation. Fruits on heavily infested trees fail to color and size properly and fruit production for the following year may be lowered.

RESISTANT VARIETIES: Varieties such as Red Delicious, Golden Delicious, Rome Beauty, and Jonathan are more susceptible to mite injury, while Gravenstein and Yellow Newtown show less evidence of leaf damage from moderate populations.

BIOLOGICAL CONTROL: The western predator mite, *Metaseiulus occidentalis,* is an excellent predator of webspinning mites. Predator mites have been developed that are resistant to carbaryl and most organophosphates used in apples. One predator to 10 webspinning mites is necessary for the predators to keep control of the pest mites. Use lower rates of miticides to minimize destruction of predators and allow some spider mites to survive. The apple rust mite is an alternative food source for the predator mite. Avoid sprays containing lime sulfur, which will kill rust mites. When alternative food sources are allowed to survive, the predaceous mites can build up large enough numbers to control webspinning mite populations.

CULTURAL CONTROL: Grass cover crops and sprinkler irrigation help to minimize dust in orchards. Provide adequate irrigation to avoid water stress.

ORGANICALLY ACCEPTABLE METHODS: Biological and cultural control.

MONITORING and WHEN TO TREAT: From July to August, or if you encounter high mite populations earlier in the season, collect five spur leaves at spaced intervals from one lateral branch located at eye level from each of 20 marked trees that have been established as representative trees in a block. Brush leaves in a mite brushing machine and count mites but not eggs. Sample every 1 to 3 weeks. Treat when mite populations reach an average of 10 mites per leaf. Count predatory mites along with webspinning mites. If you find one predatory mite per 10 mites you may not need a miticide application, but continue sampling to be sure pest mite populations do not increase.

Continued on next page.

Webspinning spider mites cont. (7/94)

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. PROPARGITE (Omite) 30WP	4-8 lb	1-2 lb	7
COMMENTS: Product is sold in 1.5 lb soluble bags. Make appropriate calculations based on acreage to be covered.			
B. FENBUTATIN-OXIDE (Vendex) 4L	1-3 pt	0.25-0.5 pt	14

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

+ Preharvest interval. Do not apply within this many days of harvest.

ROSY APPLE APHID (7/94)

Scientific Name: *Dysaphis plantaginea*

DESCRIPTION OF THE PEST: Newly hatched rosy apple aphids are dark green and are found on new growth in early spring. Mature rosy apple aphids, clustering in curled leaves or on young fruits in spring, are purplish and covered with a waxy, powdery bloom. Winged forms develop on apple trees in late spring and migrate to plantain, where they are found in summer. In fall, winged forms develop and migrate back to the apple trees. Overwintering eggs are laid on fruit spurs and shoots of the apple trees; they are shiny, black, and elongated.

DAMAGE: This is potentially the most damaging aphid species on apples. Rosy apple aphids cluster on leaves of fruit spurs and growing shoots where they cause severe leaf curling. Fruits on heavily infested fruit spurs fail to properly develop and become misshapen.

BIOLOGICAL CONTROL: There are many natural enemies that feed on rosy apple aphids; however, fruit size may be reduced before natural enemies bring the aphids under control. Among the important predators are lady beetles, green and brown lacewings, syrphid fly larvae, and soldier beetles.

ORGANICALLY ACCEPTABLE METHODS: Biological control and oil sprays.

MONITORING and WHEN TO TREAT: During the dormant season collect 25 to 100 fruit spurs from various parts of trees throughout the block. Using a hand lens, examine the spurs for rosy apple aphid eggs. This can be done in conjunction with the dormant European red mite sample. Any eggs found require a dormant treatment, as aphid colonies may quickly spread over the tree. Treat nonbearing trees to prevent stunting of terminal shoots. Because overwintering eggs are located on the bark, delayed dormant application will greatly reduce populations. Young trees need to be treated when terminals are infested; mature trees can tolerate more damage. Codling moth sprays should be chosen with aphid control in mind.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant and Delayed Dormant (Preferred timing)			
A. DORMANT EMULSIVE OIL#	10-12 gal	4 gal	
...or...			
DORMANT EMULSION OIL#	8 gal	5 gal	

COMMENTS: Organic growers should apply dormant oil spray during January to get any control of rosy apple aphid.

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

\+ Preharvest interval. Do not apply within this many days of harvest.

\# Acceptable for organically grown produce.

Rosy apple aphid cont. (7/94)

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
B. NARROW RANGE OIL (Superior, Supreme)	4-6 gal	1-1.5 gal	
...PLUS...			
1. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	
COMMENTS: This is the best material to use if apple pandemis is also present. Follow restrictions on supplemental label.			
...or...			
2. DIAZINON 50WP	2-4 lb	0.5-1.0 lb	
Foliage Spray			
A. DIAZINON 50WP	4 lb	1 lb	14
COMMENTS: Foliage treatments are important for young trees with severe infestations. Applications made during the foliage season are harmful to beneficials. Codling moth sprays will normally control aphids.			

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

+ Preharvest interval. Do not apply within this many days of harvest.

GREEN APPLE APHID (7/94)

Scientific Name: *Aphis pomi*

DESCRIPTION OF THE PEST: Overwintering eggs are found on twigs of the previous season's growth and on fruit spurs. They are identical in appearance to rosy apple aphid eggs: shiny, black, and football shaped. Newly hatched apple aphids are dark green. Mature aphids on apple foliage in spring and summer have a bright, yellow green abdomen with darker green lateral spots.

DAMAGE: Green apple aphids infest succulent terminal growth, and when infestations are severe will also be found on fruits. High populations on young trees may seriously retard normal growth and result in irregular shoot growth. On bearing trees, heavy infestations of aphids may cover the fruit and foliage with honeydew on which a black, sooty mold develops. The mold can hinder leaf function and lower fruit grade.

BIOLOGICAL CONTROL: There are many natural enemies which feed on aphids. Among the most important are lady beetles, green and brown lacewings, and syrphid fly larvae.

ORGANICALLY ACCEPTABLE METHODS: Biological controls.

WHEN TO TREAT: A delayed dormant spray will prevent early injury and should eliminate the need for further sprays. If more than 45% of the tree's shoots are infested during the summer, assess the abundance of predators. Treatment may be warranted if 60% or more of the tree's terminals are infested. Spring treatments may also be necessary for young trees with severe infestations.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Delayed Dormant (Preferred timing)			
A. NARROW RANGE OIL (Superior, Supreme)	4-6 gal	1-1.5 gal	
...PLUS...			
1. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	
COMMENTS: This is the best material to use if apple pandemis is also present.			
...or...			
2. DIAZINON 50WP	2-4 lb	0.5-1.0 lb	
Foliage Spray			
B. DIAZINON 50WP	4 lb	1 lb	14
COMMENTS: Applications made during the foliage season are harmful to beneficials.			

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

+ Preharvest interval. Do not apply within this many days of harvest.

WOOLLY APPLE APHID (7/94)

Scientific Name: *Eriosoma lanigerum*

DESCRIPTION OF THE PEST: Woolly apple aphids are a major pest in coastal counties, infesting roots, trunks, limbs, shoots, and occasionally fruit. The bodies of these bark-feeding aphids are completely covered by masses of white, woollike, waxy materials. This aphid is found in colonies on the aerial portions of the tree and on roots during winter. The nymphs migrate up or down the trunk of infested trees during summer and fall.

DAMAGE: The main injury to young and mature trees is stunting due to the formation of root galls. If populations are high, honeydew and sooty mold will also be problems, and aphids may enter the calyx end of fruit.

RESISTANT VARIETIES: Winter Banana is one of the most susceptible varieties to aerial galls. Yellow Newtown fruit frequently has aphids in the calyx end. The Malling series of rootstock with numbers over 100 are reported resistant to this pest.

BIOLOGICAL CONTROL: *Aphelinus mali* is a parasite that can completely control aerial colonies. In the absence of this parasite there can be large increases of aerial colonies and woolly aphids may be found in the calyx of the apple. Outbreaks of woolly apple aphid are most common following the use of pyrethroids, which destroys its natural enemies.

ORGANICALLY ACCEPTABLE METHODS: Resistant varieties and biological control.

WHEN TO TREAT: The delayed dormant application should control woolly apple aphids. A summer application (late July to August) will only be required if the parasites are disrupted. Foliage treatments may be necessary for young trees with severe infestations.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Delayed Dormant (Preferred timing)			
A. NARROW RANGE OIL (Superior, Supreme)	4-6 gal	1-1.5 gal	
...PLUS...			
1. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	
...or...			
2. DIAZINON 50WP	2-4 lb	0.5-1.0 lb	
Foliage Spray			
B. DIAZINON 50WP	4 lb	1 lb	14
COMMENTS: Applications made during the foliage season are harmful to beneficials.			

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

+ Preharvest interval. Do not apply within this many days of harvest.

LEAFHOPPERS (7/94)

Scientific Names: White apple leafhopper: *Typhlocyba pomaria*
Rose leafhopper: *Edwardsiana rosae*

DESCRIPTION OF THE PEST: There are two generations of white apple leafhopper per year. Eggs of this species overwinter in the apple trees and hatch shortly after bloom. Adults of the first generation appear in the last part of May to early June. Nymphs of the second generation develop in July and August.

Rose leafhoppers do not overwinter in apple trees; instead they overwinter on plants of the rose family such as blackberries. In spring, the first generation develops on the overwintering host; adults then migrate to other hosts, including apples. The second generation and apparently a third generation may be spent on apples. This species often reaches great abundance near to or after apple harvest.

The adults of both species are white, about 0.12 inch long and cannot be readily distinguished from one another. Rose leafhopper populations can be identified by the presence of black spots at the base of thoracic setae on older nymphs; these spots are not found on older nymphs of the white apple leafhoppers.

DAMAGE: Leafhoppers feed by sucking on leaf tissue. Their feeding causes a white stippling on leaves. In heavy infestations, fruit may be reduced in size and buds may be weakened. Excrement dropped by leafhoppers will appear as black specks on apples. These specks are easily removed by washing. Leafhoppers also produce honeydew, which forms into sticky droplets around the calyx end after rainfall or overhead sprinkling, and is not easily removed.

MONITORING and WHEN TO TREAT: Treatment for control of white apple leafhopper is most effective during the first four nymphal instars of the first generation and is best in the fourth instar. This occurs from petal fall to the first codling moth spray. Start monitoring for this leafhopper at petal fall. At weekly intervals sample four leaves per tree from 25 trees dispersed throughout the orchard. Peak nymphal emergence typically occurs 3 to 4 weeks after the first nymphs are found. Treatment is warranted when populations exceed an average of 0.5 nymphs per leaf or when 30% of the leaves are infested. Rose leafhopper is a concern when high populations of nymphs exist near harvest; treatment of nymphs may be warranted at this time.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. CARBARYL* (Sevin) 50WP	6 lb	1.5 lb	1
COMMENTS: Will thin apples up to 30 days after full bloom. May cause severe outbreaks of spider mites. One application per season does not cause mite increase in coastal areas.			
B. ENDOSULFAN* (Thiodan) 50WP	4 lb	1 lb	21
C. DIAZINON 50WP	3-4 lb	0.75-1 lb	14
COMMENTS: Apply when nymphal stages are present.			

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

SAN JOSE SCALE (7/94)

Scientific Name: *Quadraspidiotus perniciosus*

DESCRIPTION OF THE PEST: Female San Jose scales give birth to living young that emerge from under the edge of the scale covering. These tiny yellow crawlers wander in a random fashion until they find a suitable place to settle. Immediately upon settling, the crawlers insert their mouthparts into the host plant and begin feeding and secreting a white waxy material (white cap stage); eventually the waxy covering turns black and is known as the black cap stage. Later the covers turn various shades from gray to black.

San Jose scales overwinter predominantly in the black cap stage, although in mild years some adult mated females may also survive. In late January, these nymphs resume their growth. Immature male and female scales are indistinguishable until the first molt. At this time, the male scale covering begins to elongate, while the female's remain circular. Males molt a total of four times. Following the final molt, adult male scales emerge from the scale covering as tiny, yellow winged insects. They mate with the females who remain under the scale covering. After about two months, crawlers begin to emerge from the females, usually in April; peak emergence is generally in early May. There are usually four generations a year. Summer generations overlap and crawlers are present throughout summer and fall.

DAMAGE: If heavy scale infestations are left unchecked, trees may be seriously damaged, resulting in reduced vigor, thin foliage, cracked or dying branches, and the eventual death of the tree. Young trees may be killed before fruiting. Infested fruit develop a reddish purple ring surrounding each spot where a scale settles.

BIOLOGICAL CONTROL: Natural enemies that feed on San Jose scale include two predaceous beetles: the twice stabbed lady beetle, *Chilocorus orbus,* and another small beetle, *Cybocephalus californicus.* A number of small chalcid and aphelinid wasps parasitize this scale. These predators and parasites may be helpful in reducing scale populations, but insecticides used during the growing season for other pests disrupt this natural control and scale populations increase rapidly.

ORGANICALLY ACCEPTABLE METHODS: Biological control and oil sprays.

MONITORING and WHEN TO TREAT: Monitor for San Jose scale during the dormant period by checking prunings to make sure scale hasn't developed in tree tops. Also check fruit at harvest for the presence of scale.

Due to the damage potential of this pest, annual dormant sprays are recommended in most areas. Control heavy populations of San Jose scale by applying an organophosphate insecticide plus oil spray during the delayed dormant period.

If inadequate control is achieved with the dormant spray, treatments are also effective when applied soon after the emergence of the crawlers in May. Use pheromone traps in March to monitor for male San Jose scale flights and double-sided sticky tape for monitoring crawlers in April and May. Time a treatment, using a 51 F lower threshold and 90 F upper threshold, for 600-700 degree-days (DD) after the beginning of the male flight or 200 DD after crawler emergence begins.

Continued on next page.

San Jose scale cont. (7/94)

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Delayed Dormant (Preferred timing)			
A. NARROW RANGE OIL# (Superior, Supreme)	6 gal	1.5 gal	
B. NARROW RANGE OIL (Superior, Supreme)	6 gal	1.5 gal	
...PLUS...			
1. DIAZINON 50WP	3-4 lb	0.75-1 lb	
...or...			
2. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	
C. METHIDATHION* (Supracide) 2EC	6-12 pt	0.75-1.5 pt	
COMMENTS: Apply before blossoms open or injury may occur.			
Crawler Treatment			
A. DIAZINON 50WP	4 lb	0.75-1 lb	
B. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for organically grown produce.

ITALIAN PEAR SCALE (7/94)

Scientific Name: *Epidiaspis leperii*

DESCRIPTION OF THE PEST: Italian pear scale overwinters mostly as a mature scale. The cover is circular, about 0.06 inch in diameter, and light gray, but with a brown peak slightly off-center. Underneath the covering, the female's body is reddish purple.

DAMAGE: This scale does not attack fruit, but feeds directly on the wood of the tree, affecting tree vigor and causing reduced fruit size. Apple trees can tolerate fairly high populations of this scale without any apparent damage.

ORGANICALLY ACCEPTABLE METHODS: Lime treatments.

WHEN TO TREAT: Generally, dormant sprays applied for other scales keep Italian pear scale under control unless limbs are heavily covered with moss and lichens. Because Italian pear scale live only under moss and lichens, a dormant treatment of hydrated lime to kill the lichens and moss will effectively control this pest.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant			
A. HYDRATED LIME#		10 lb	
COMMENTS: Dilute application only; to control moss and lichens.			
Delayed Dormant			
A. NARROW RANGE OIL (Superior, Supreme)	6 gal	1.5 gal	
...PLUS...			
1. DIAZINON 50WP	3-4 lb	0.75-1 lb	
...or...			
2. CHLORPYRIFOS (Lorsban) 4EC	4 pt	1 pt	

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for organically grown produce.

STINK BUGS (7/94)

Scientific Names: Consperse stink bug: *Euschistus conspersus*
Conchuela: *Chlorochroa ligata*
Redshouldered plant bug: *Thyanta pallidovirens*

DESCRIPTION OF THE PEST: Stink bugs and other plant bugs occur in all of California but only reach damaging numbers sporadically. Although they may differ in color and size, stink bugs have the same overall shield-shaped body. The consperse stink bug is the most common. Adult consperse stink bugs have gray brown to green bodies with yellow to orange legs and antennae that have darkened tips. The body and legs are covered with small black specks and the undersurface of the body varies from gray to green. Consperse stink bug eggs are laid in clusters on twigs and leaves. They are barrel-shaped, pearly white when first laid, turning pink before hatching. The conchuela is a large black stink bug with a reddish marginal border and a reddish spot in the middle of the back. Redshouldered plant bugs are green or brown stink bugs that may have a red line across the shoulder.

DAMAGE: Stink bugs damage the crop directly by feeding on fruit. Early season feeding results in dimples or irregularly depressed areas on mature fruit. If the feeding occurs after maturity there is little external evidence other than excrement, which appears as small, brown, tear-shaped drops. Internally, stink bug feeding produces white, pithy areas that turn brown when fruit is peeled. If the spots are the result of stink bug feeding, these pithy areas will be concentrated near the stem end of the fruit. If they resulted from lygus bug feeding, they may be located anywhere on the fruit surface. Adult stink bugs move from tree to tree and can puncture large numbers of fruit. If they are migrating into the orchard, fruits on trees in outside rows will show the most damage. Frequently, damage by these pests is limited to specific areas in the orchard. If the infestation is very heavy, however, the entire crop can be damaged.

MONITORING and WHEN TO TREAT: Monitor for stink bugs in March or April by inspecting host plants located inside and along borders of sampling blocks. Spend about an hour checking the bases of plants for overwintered adult bugs. Favored host plants are mullein, mustard, and dock. If these are not present, bugs may be found on plantain, milkweed, mallow, morningglory, thistles, vetch, velvetgrass, breadgrass, bushberries, everlasting peas, and other broadleaf plants. If more than five bugs are found during the hour, spray the weeds with an insecticide immediately. Depending on the distribution of the bug population, a spot treatment may be adequate. If two to five bugs are found and bug damage has been experienced previously in the orchard, spraying the weeds might be advisable. If fewer than two bugs are found, resample in 7 to 10 days. Sample for adults or damaged fruit in June and July. Take a 50-tray beating sample for each 20-acre block, taking most of the samples from border trees to locate bugs flying in from adjacent fields. If one or more bugs are collected, inspect fruit for feeding damage. Either examine fruit on the tree for the presence of bugs, excrement, or visible damage, or collect fruit from the lower half of the tree and peel it. If more than three fruits per half hour of inspection show feeding damage, spots of excrement, or active bugs, or there is one damaged fruit per 100 peeled, treatment probably is required to avoid economic loss by end of harvest.

CULTURAL CONTROL: Eliminate weed host plants listed above both within and adjacent to the orchard to minimize stink bug problems.

Continued on next page.

Stink bugs cont. (7/94)

TREATMENT: Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
Pink Bud to Bloom			
Note: Apply as a thorough, drenching ground spray; use 100-300 gal water/acre.			
A. DIMETHOATE E267		1 pt	28
COMMENTS: Do not apply during bloom. Harmful to beneficial mites.			
B. FORMETANATE (Carzol) SP		4 oz	7
C. ENDOSULFAN* (Thiodan) 3EC		1.33 pt	30
COMMENTS: Do not apply near bodies of water containing fish. Stink bugs may be resistant to endosulfan.			
May/June to Preharvest			
NOTE: Apply to trees.			
A. DIMETHOATE E267	4 pt	1 pt	28
B. ENDOSULFAN* (Thiodan) 50WP	4 lb	1 lb	21
COMMENTS: See comment for endosulfan above.			

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

LYGUS BUGS (7/94)

Scientific Name: *Lygus hesperus* and *Lygus elisus*

DESCRIPTION OF THE PEST: Lygus bugs vary in color from pale green to yellowish brown with reddish brown to black markings, but can be distinguished by a prominent triangle in the center of the back. The lygus bug adult is about 0.25 inch long and 0.1 inch wide, flattened on the back. Nymphs resemble adults, but are smaller and do not have wings.

DAMAGE: Lygus bug damage may occur in all major apple districts and sometimes is severe. Lygus attack is more frequent in orchards that have a permanent cover crop and in orchards adjacent to crops or vegetation that host lygus.

Lygus bugs may feed on developing flower buds early in spring, causing the buds to exude gum and shrivel up. Usually this damage is not serious unless a very heavy infestation is present. Lygus cause their most serious damage by feeding directly on fruit. Midseason feeding results in round pits, and late season feeding causes irregularly-shaped depressions that are similar to stink bug damage.

CULTURAL CONTROL: Eliminate or suppress weed host plants before fruit forms on trees and thereafter throughout the growing season to minimize lygus populations. Yellow star thistle, Russian thistle, tarweed, sweet clover, wild mustard, and vetch are important hosts.

BIOLOGICAL CONTROL: The role of predators and parasites in controlling lygus in orchards has not been investigated, but in cotton, beneficials have been shown to be important.

ORGANICALLY ACCEPTABLE METHODS: Cultural and biological control.

MONITORING and WHEN TO TREAT: After fruit has formed, sample the cover crop with a sweep net to determine if lygus bugs are present in the orchard. If they are, or if an orchard has had a history of lygus injury, take fruit samples at least every 2 weeks starting soon after petal fall and continue until harvest. Lygus bugs may be present in the orchard but not feeding on the fruit, so you need to check the fruit for damage. Examine a minimum of 100 fruits from trees throughout the block. Because lygus damage is often spotty in distribution, check each block thoroughly. Lygus may migrate into the orchard at any time during the growing season and damage frequently appears first along orchard borders. One damaged apple in 100 is significant for concern and calls for further sampling and evaluation of control needs. When sampling fruit for other pests, also look for the presence of lygus bugs on fruit or in the trees to determine if they are still present in the orchard. Because the bugs move quickly and may be difficult to see, the number seen will depend on the skill of the observer. When lygus are migrating into an orchard, periodic spraying of border trees will hold down numbers and reduce damage.

Continued on next page.

Lygus bugs cont. (7/94)

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. DIMETHOATE E267	4 pt	1 pt	28
B. FORMETANATE (Carzol) SP	1 lb	4 oz	7

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

+ Preharvest interval. Do not apply within this many days of harvest.

APPLE MAGGOT (5/91)

Scientific Name: *Rhagoletis pomonella*

DESCRIPTION OF THE PEST: Apple maggot is a native pest of the eastern United States and Canada. In 1979 it was discovered in Oregon and has since moved into California, Washington, and other Western states. Hawthorn and apples are favored host plants, but cherries, pears, and other fruits have been attacked. Adult flies are somewhat smaller than houseflies and have clear wings with characteristic black bands, a pronounced white spot on the back of the thorax, and a black abdomen with light-colored crossbands. Female flies have four crossbands on the abdomen, and males have three. The apple maggot is closely related to the walnut husk fly and cherry fruit fly. It can be distinguished from these other pests by the banding on its wings. However, it is difficult to distinguish apple maggot from snowberry maggot, a close look-alike that occurs throughout California, but which does not attack apples and pears. Larvae are cream colored maggots with a blunt posterior and a tapered front end that contains two black mouth hooks.

DAMAGE: Female apple maggot adults deposit eggs singly under the apple skin. Damage is caused when larvae burrow and feed on apple flesh. Browning of the trails occurs as the apple responds to this injury and bacteria associated with maggots cause fruits to rot internally.

BIOLOGICAL CONTROL: Because the apple maggot feeds within fruit, biological control agents have not been very effective.

MONITORING and WHEN TO TREAT: Emergence and dispersal of adult flies must be carefully monitored to effectively time treatments. Sticky traps, including yellow rectangles and red spheres, are both used in other areas to monitor adults and time treatments. Unfortunately, only provisional economic thresholds are available for apple maggots, even in areas where it has long been a pest. You can detect the first emergence of adults by hanging yellow sticky traps in abandoned orchards or unsprayed apple trees in infested areas. To detect the beginning of egg laying, hang red sticky spheres in apple trees, then treat as soon as the first fly is found. In Oregon, where some orchards are now being treated regularly for apple maggots, the first maggot spray is applied 7 to 10 days after the first fly has emerged. Later sprays follow at 10 to 14 day intervals as long as adults are active and are being caught in traps.

TREATMENT:

Pesticide (commercial name)	Amount to use** (conc.)	(dilute)	P.H.I.+ (days)
A. AZINPHOSMETHYL* (Guthion) 50WP	2 lb	0.5 lb	7
B. PHOSMET (Imidan) 50WP	4 lb	1 lb	7
C. DIAZINON 50WP	4 lb	1 lb	14

** For dilute application, rate is per 100 gal of water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

DISEASES

EUROPEAN CANKER (7/94)

Pathogen: *Nectria galligena*

SYMPTOMS: In fall or spring European canker causes reddish brown lesions to appear on small branches just below leaf scars. These elongate into cankers with concentric ridges, and may cause dieback of shoots in spring. Calyx rot of fruits can occur in years when rain precedes harvest. Pruning wound infections are seen occasionally (especially on the Delicious cultivar). On superficial examination, such infections may be confused with fire blight.

COMMENTS ON THE DISEASE: This fungus survives in old bark cankers and produces spores that enter fresh leaf scars during fall rains. The Delicious variety is most susceptible, followed by Gravenstein and Rome Beauty. This disease is worse in the Sebastopol area of Sonoma County in years with prolonged fall rains.

COMMENTS ON CONTROL: Cankers should be pruned out of trees as they ultimately kill branches and also serve as sources of inoculum. Because infection occurs through leaf scars and leaves fall over a long period, two treatments are necessary each fall to protect new leaf scars.

ORGANICALLY ACCEPTABLE METHODS: Treatment with Bordeaux or fixed copper materials.

WHEN TO TREAT: Just prior to leaf fall (before autumn rains), and at mid- to late leaf fall.

TREATMENT:

Pesticide (commercial name)	Amount to use
A. BORDEAUX MIXTURE# 10:10:100	Label rates
B. FIXED COPPER#	Label rates

Acceptable for organically grown produce.

FIRE BLIGHT (7/94)

Pathogen: *Erwinia amylovora*

SYMPTOMS: Fire blight causes blossom clusters to wilt and collapse in late spring. A brownish, sticky exudate is produced from diseased tissue. Infections do not usually cause extensive branch killing as in pear. Young succulent shoots are occasionally infected.

COMMENTS ON THE DISEASE: *E. amylovora* overwinters in twig and branch cankers, is spread by rain splash and insects, and favored by warm, humid weather during bloom. Overhead sprinklers may aggravate the problem, especially in fire blight susceptible cultivars.

ORGANICALLY ACCEPTABLE METHODS: Treatment with Bordeaux or fixed copper materials.

COMMENTS ON CONTROL: Remove holdover cankers by cutting back to healthy wood. Apply one of bactericides listed below. This disease can be difficult to control.

WHEN TO TREAT: Bloom. The first application is made when the daily mean temperature during bloom approaches 62 F (March), 60 F (April), and 58 F (May). Make applications every 3 to 5 days until the end of bloom. Rain or hail requires immediate re-spray of the orchard.

TREATMENT:

Pesticide (commercial name)	Amount to use	P.H.I.+ (days)

NOTE: Application of copper-containing materials beginning at or about green tip may cause fruit russetting on some cultivars, including Granny Smith.

A. STREPTOMYCIN SULFATE# — 60 ppm — 50
COMMENTS: Streptomycin-resistant strains of fire blight bacteria are present in some areas.

B. BORDEAUX MIXTURE# 0.5:0.5:100 — Label rates

C. FIXED COPPER# — Label rates

+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for organically grown produce.

POWDERY MILDEW (7/94)

Pathogen: *Podosphaera leucotricha*

SYMPTOMS: Powdery mildew is distinguished by superficial, white powdery growth on leaves and shoots that results in the stunting and distortion of young growth. Infected fruit are stunted and russetted, and fruit set may be reduced.

COMMENTS ON THE DISEASE: This is a major foliage disease of apples. The fungus overwinters in mildewed terminal buds, and is favored by warm days and cool, moist nights.

COMMENTS ON CONTROL: Remove infected shoot tips at pruning. Chemical control of powdery mildew is done in conjunction with controls for scab. Timing and choice of material may vary from orchard to orchard. Resistance to benomyl and thiophanate methyl may develop if these materials are used repeatedly. It is important to alternate these materials with materials of a different chemistry.

ORGANICALLY ACCEPTABLE METHODS: Treatments with lime and sulfur.

WHEN TO TREAT: Preferred timing is an application at pink bud. If powdery mildew continues to be a problem in the orchard, additional treatments can be applied until terminal growth ceases.

TREATMENT:

Pesticide (commercial name)	Amount to use	P.H.I.+ (days)
Pink Bud (Preferred timing)		
A. TRIADIMEFON (Bayleton) 50WP	2-8 oz/acre	
COMMENTS: Do not apply more than 24 oz/acre/season. Do not graze livestock in treated orchards.		
B. FENARIMOL (Rubigan) 1EC	9-12 oz/acre	
C. MYCLOBUTANIL (Rally) 40WP	1.25-2.5 oz/100 gal water/acre (dilute application)	
COMMENTS: Continue applications through the second cover spray at 7 to 10 day intervals. Use high label rate if disease was present in previous years. For application by ground equipment only.		
D. TRIFORINE (Funginex) 1.6EC	36-40 fl. oz in 50-200 gal water/acre	
COMMENTS: Do not apply after petal fall.		

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\+ Preharvest interval. Do not apply within this many days of harvest.
\# Acceptable for organically grown produce.

Powdery mildew cont. (7/94)

Pesticide (commercial name)	Amount to use	P.H.I.+ (days)
E. LIQUID LIME SULFUR#	2 gal/100 gal dilute spray	
...PLUS... WETTABLE SULFUR#	4-5 lb/100 gal	
COMMENTS: Do not use after bloom begins.		
F. LIQUID LIME SULFUR#	2-3 gal/100 gal dilute	
G. BENOMYL (Benlate) 50WP	2-3 oz/acre in 200 to 500 gal water	
COMMENTS: Include 1 qt spray oil/100 gal water for very susceptible cultivars. Use in combination with a fungicide of different chemistry.		
H. THIOPHANATE METHYL (Topsin M) 70WP	1-1.5 lb/acre	
Postbloom		
A. TRIADIMEFON (Bayleton) 50WP	2-8 oz/acre	45
COMMENTS: Do not apply more than 24 oz/acre/season. Do not graze livestock in treated orchards.		
B. FENARIMOL (Rubigan) 1EC	9-12 oz/acre	30
C. MYCLOBUTANIL (Rally) 40WP	1.25-2.5 oz/ 100 gal water/acre (dilute application)	14
COMMENTS: Additional sprays beyond the second cover spray may be needed on susceptible varieties or under heavy disease pressure. Do not apply more than 5 lbs/acre/ season or graze or feed cover crops grown in treated areas to livestock. For application by ground equipment only.		

+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for organically grown produce.

APPLE SCAB (7/94)

Pathogen: *Venturia inaequalis*

SYMPTOMS: Superficial, velvety dark-olive-to-black spots on fruits and leaves are the initial symptoms of apple scab. These fruit spots become scablike with age and tissues may become misshapen.

COMMENTS ON THE DISEASE: The fungus survives in dead leaves on the ground. Primary spores are discharged during spring rains and infect young leaves and fruits during prolonged moisture. Secondary spores may spread disease from established infections on trees. A lack of spring rains in most years reduces its importance in California in the southern Central Valley, but as a rule, this disease requires yearly treatments in coastal and foothill districts. Ornamental crab apples are also hosts. As plant parts mature and the weather gets warmer, susceptibility to this disease decreases, but pinpoint scab can occur during extended periods of moisture during summer.

COMMENTS ON CONTROL: The key to success in scab control is exact timing and full coverage to prevent primary infection. Wet periods, temperature, and relative humidity are important factors, as well as choice of materials. Because scab control often is part of a combination treatment aimed at other diseases and insect control, choice of materials and timing are extremely important. Do not use Captan or sulfur preceding, with, or closely following oil sprays. Resistance to benomyl and thiophanate methyl may develop if these materials are used repeatedly. It is important to alternate these materials with materials of a different chemistry.

ORGANICALLY ACCEPTABLE METHODS: Treatments with lime or sulfur.

MONITORING: Apple scab outbreaks can be predicted based on temperature and moisture conditions. The table listed below, derived from research by Mills and La Plante, gives hours needed at various temperature levels under constantly wet conditions for primary spores (ascospores) to cause infection in spring. This system for forecasting scab and timing sprays has been validated for apple growing regions in the northern areas of California, but not for the central and southern San Joaquin Valley where temperatures tend to be higher in spring than those in the table.

Example: Figure the average temperature for the rain period by adding the maximum and the minimum temperatures and dividing by 2. If wet periods are intermittent, their durations are totaled until there is a period of at least 6 hours of continuous dryness. You will need a wetness recorder to do this efficiently. If the dry period is sunny, and drying is quick and thorough, it is assumed that 6 hours after the trees have dried, the danger is passed. If drying is slow, and humidity remains high, then the 6 hour dry period is extended by a safety margin of 3 to 4 hours.

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Apple scab cont. (7/94)

HOURS OF WETTING REQUIRED FOR INFECTION

Average temperature (deg. F)	From primary inoculum (ascospores)	From secondary inoculum (conidia)
78	13	8.7
77	11	7.3
76	9.5	6.3
61 to 75	9	5.9
60	9.5	6.3
57 to 59	10	6.6
55 to 56	11	7.3
54	11.5	7.7
52 to 53	12	7.9
51	13	8.7
50	14	9.3
49	14.5	9.7
48	15	9.9
47	17	11.3
46	19	12.6
45	20	13.3
44	22	14.6
43	25	16.5
42	30	19.9
33 to 41	*	*

*not known

WHEN TO TREAT: Unless wetness periods are being monitored as outlined in the section above, apply protective fungicides at regular intervals beginning with green tip. Be sure to monitor wetness periods throughout the spring to insure that trees are adequately protected.

Fungicide	PERIOD OF EFFECTIVENESS: When used as protectant (days)	When used as kickback++ (hours)
Benlate	10	36 to 48
Captan	10	26
Funginex	7	120
Lime sulfur	5	36 to 72
Rally	4	96
Rubigan	3-4	96
Topsin M	10	36 to 48

++ Eradicant fungicides have systemic action. They are translocated within the host tissue and are able to kill the scab fungus up to a certain length of time after infection occurs. This is called the kickback period.

Continued on next page.

Apple scab cont. (7/94)

TREATMENT:

Pesticide (commercial name)	Amount to use	P.H.I.+ (days)
A. TRIFORINE (Funginex) 1.6EC	36-40 fl oz/acre in 50 to 200 gal water/acre	
COMMENTS: Do not apply after petal fall.		
B. FENARIMOL (Rubigan) 1EC	9-12 oz/acre	30
C. MYCLOBUTANIL (Rally) 40WP	1.25-2 oz/ 100 gal water/acre (dilute application)	14
COMMENTS: During periods favorable for scab development, use high rate at a 7 day application interval. For postbloom control, can be used in combination with another protectant fungicide. Do not apply more than 5 lbs/acre/season or graze or feed cover crops grown in treated areas to livestock. For application by ground equipment only.		
D. CAPTAN 50WP (Various)	2 lb/100 gal water (dilute spray)	
E. BENOMYL (Benlate) 50WP	2-3 oz/100 gal	30
COMMENTS: Alternate with a fungicide water (dilute spray) of a different chemistry.		
F. THIOPHANATE METHYL (Topsin M) 70WP	1-1.5 lb/acre	
G. LIQUID LIME SULFUR#	2 gal/100 gal dilute spray	
...PLUS... WETTABLE SULFUR#	4-5 lb/100 gal	
COMMENTS: Use wettable sulfur alone after full bloom as lime sulfur may burn foliage if applied during warm weather.		
H. LIQUID LIME SULFUR#	2-3 gal/100 gal dilute	
COMMENTS: May burn foliage if applied during warm weather.		
I. MICRONIZED SULFUR# (Thiolux, Microthiol Special, etc.)	Label rates	
COMMENTS: Can be applied after bloom.		

+ Preharvest interval. Do not apply within this many days of harvest.
# Acceptable for organically grown produce.

PHYTOPHTHORA ROOT AND CROWN ROT (11/91)

Pathogen: *Phytophthora* spp.

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

COMMENTS ON THE DISEASE: Periods of 24 hours or more of saturated soil favor Phytophthora infections. Conversely, good soil drainage and more frequent but shorter irrigations reduce the risk of root and crown rot. Rootstocks vary in susceptibility to the different *Phytophthora* species; none are resistant to all pathogenic species of the fungus. Thus, the success of a rootstock may depend in part upon the species of *Phytophthora* present in the orchard. In general, MM 104 and MM 106 are more susceptible than are M 9 and M 26.

TREATMENT:

Pesticide (commercial name)	Amount to use
A. FOSETYL-AL (Aliette)	2.5-5.0 lb/100 gal
COMMENTS: NONBEARING TREES ONLY. Foliar spray, 30-60 day interval	
B. METALAXYL (Ridomil 2E)	Varies with method of application and size of tree
COMMENT: Applications made in early spring and fall.	

NEMATODES (7/94)

Scientific Names: Root lesion: *Pratylenchus vulnus* and *P. penetrans*
Root knot: *Meloidogyne incognita, M. hapla, M. javanica,* and *M. arenaria*
Dagger: *Xiphinema americanum*

DESCRIPTION OF THE PESTS: Plant parasitic nematodes are microscopic roundworms that feed on plant roots. They live in soil and plant tissues. Of the many genera of plant parasitic nematodes detected in soils from apple orchards, two species of lesion nematode, four species of root knot and the dagger nematode are believed to be the most economically important ones in California. Both species of root lesion nematodes, *Pratylenchus vulnus* and *P. penetrans* are widely distributed throughout the state. *Meloidogyne hapla* is found throughout the state in association with crops such as alfalfa. *Meloidogyne incognita, M. javanica,* and *M. arenaria* occur throughout the warmer apple growing regions, with *M. incognita* having the most common occurrence. Dagger nematodes occur throughout the state but are believed to be more widespread in the northern part.

DAMAGE: Root lesion nematodes penetrate into roots and cause damage by feeding and migrating through the cortical tissues. Interaction of root lesion nematodes with other soilborne organisms can increase injury to roots. They are occasionally associated with the apple replant disease, which is characterized by poor growth of young trees after transplanting. Feeding by root knot nematodes can impair root functions such as uptake of nutrients and water. Dagger nematodes feed from outside the roots, but can reach the vascular tissues with their long stylet. They are capable of suppressing growth of young trees, but the major problem caused by them is transmission of tomato ringspot virus, which causes apple union necrosis and decline, especially on the variety/rootstock combination Red Delicious and M106 rootstock.

SYMPTOMS: The symptoms described below are indicative of a nematode problem, but are not diagnostic as they could result from other causes as well. Damaged trees generally occur in a circular area within the orchard. Aboveground symptoms of nematode damage are lack of vigor, twig dieback, and decline in growth and yield. Infestation of older trees also results in chlorosis or yellowing of leaves, orange bark, fruit sunburn or sunscald typical in green varieties, and small fruit. Heavy infestation on young trees may result in stunting, and sometimes death. Nematode infestations may occur without inducing any aboveground symptoms.

Belowground symptoms include poor growth of feeder roots or main roots and soil adhering to roots. Root knot nematode infestation will produce characteristic swelling of roots, called galls.

FIELD EVALUATION: To make management decisions, it is important to know the nematode species present and their population densities. If a previous orchard or crop had problems caused by the same species of nematodes that are listed as pests of apple, population levels may be high enough to cause damage to young trees. If nematode species have not previously been identified, soil samples should be taken and sent to a diagnostic laboratory for identification.

Soil samples should be taken from within the root zone (6-36 inch depth). Take subsamples from the frequently wetted zones at the edge of the tree canopy, and include some feeder roots when possible. Divide the field into sampling blocks of not more than five acres each that represent cropping history, crop injury, or soil texture. Take several subsamples randomly from

Continued on next page.

Nematodes cont. (7/94)

a block, mix them thoroughly and make a composite sample of about one quart (1 liter) for each block. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, and the current/previous crop and the crop you intend to grow. (See *IPM for Apples and Pears*, UCANR publication 3340, for more details.) Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Request a species identification if either root lesion or dagger nematodes are found. Contact your farm advisor for more details about sampling, to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

MANAGEMENT:

Cultural practices. Remove old roots and plant green manure cover crops resistant to lesion nematodes (such as the oat cultivar Saia) for 1-2 years, or grow alfalfa for 3 years followed by 1 year sudangrass, or fallow the site for 4 years. If *Pratylenchus vulnus* is present, maintain a poor host for this nematode, such as tall fescue, red fescue, or perennial rye grass as orchard ground cover. These crops are hosts for *Pratylenchus penetrans* and should not be used if this species of lesion nematode is present. Use certified rootstocks or seedlings to establish new orchards. Improve soil tilth and drainage and control other pests. Proper irrigation and fertilizer application will also reduce stress on trees.

Rootstock selection. Most standard rootstocks and some dwarfing rootstocks are believed to have some tolerance to *P. penetrans*, the lesion nematode species that is frequently found in apple orchard soils in northern California. However, the dwarfing rootstocks are considered to be susceptible to *P. vulnus*, which is common in the orchard soils of the San Joaquin Valley.

Always buy trees from California nurseries, which are certified nematode-free; do not purchase trees from out-of-state nurseries.

Chemical. Trees planted in infested orchard sites that have been fumigated generally have improved growth and yields compared to those on nonfumigated sites.

TREATMENT:

Pesticide (commercial name)	Amount/Acre	P.H.I.+ (days)
Preplant		
A. METHYL BROMIDE*	300-600 lb	
COMMENTS: Use the higher rates for fine textured soils. Apply methyl bromide as a broadcast fumigation using tarps, or fumigate the soil with 300 lb/acre, after 10 to 14 days invert the top 12 inches of soil, and refumigate in 14 days with 150 lb/acre.		
B. METAM SODIUM* (Vapam, Soil Prep)	100 gal	
COMMENTS: Metam sodium can effectively control nematodes if applied properly, but it is not usually applied properly, resulting in poor penetration of plant roots and difficulty in getting it to penetrate 4-5 feet down from the surface. Before applying this material, thoroughly cultivate the area to be treated to break up clods and deeply loosen the soil. After cultivation and about one week before treatment, preirrigate the field with 6-8 acre-inches of water in flood irrigation in basins. After treatment, do not plant for 30 days, or 60 days if soil is high in organic matter or cold (below 50 F).		

Continued on next page.

+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

Nematodes cont. (7/94)

Pesticide (commercial name)	Amount/Acre	P.H.I.+ (days)
Postplant		
A. FENAMIPHOS (Nemacur 3)	3 gal	72

COMMENTS: Spray solution should be directed toward the base of the tree, where it will not come in contact with any leaf surface. Irrigate immediately with sprinklers or microsprinklers. Read product use and chemigation booklet.

+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

PRECAUTIONS FOR USING PESTICIDES

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

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

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

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

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

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

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

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

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

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

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

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

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APRICOT
PEST MANAGEMENT GUIDELINES

FEBRUARY, 1994

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

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INSECTS and MITES

PEACH TWIG BORER (7/93)

Scientific Name: *Anarsia lineatella*

DESCRIPTION OF THE PEST: The peach twig borer is widely distributed throughout California and is found on several hosts. The adult moth is about 0.3 to 0.5 inch long, with steel gray, mottled forewings. Young larvae are almost white with black heads. Mature larvae are about 0.5 inch long and have black heads and brownish bodies with white portions between each body segment, giving the appearance of stripes. The peach twig borer overwinters as a larva in a tiny cell called a hibernaculum, located in limb crotches of 1- to 4-year-old wood. There may be three to four generations each year, but the later generations occur after apricot harvest.

DAMAGE: This pest damages in two ways. Larvae burrow down tender shoots and kill the tip, which may cause problems in training young trees. They also feed on fruit, primarily at the stem end. Either feeding damage or the presence of larvae will cause a fruit to be offgrade.

WHEN TO TREAT: Dormant or delayed dormant insecticide sprays will reduce populations of overwintering larvae. When control has not been achieved by delayed dormant treatment (the preferred timing), an insecticide should be applied at petal fall or shortly thereafter for coastal apricots. For Central Valley apricots, optimum timing is between 400 and 500 degree-days after the first male is trapped in April. To calculate degree-days for peach twig borer use a lower threshold of 50 F and an upper threshold of 88 F.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant or Delayed Dormant			
A. METHIDATHION* (Supracide) 2EC	4 qt	1 qt	
COMMENTS: Apply before blossoms open, or injury may occur. Do not graze treated areas or feed cover crops grown in treated areas to livestock. Spray must include oil to control European red mite eggs.			
B. NARROW RANGE OIL (Superior, Supreme)	4-8 gal	1.5-2 gal	
...PLUS...			
DIAZINON 50WP	3 lb	1 lb	
COMMENTS: Organophosphate insecticides used during delayed dormancy are very toxic to honey bees. Remove bees from orchard if cover crops or weeds are in bloom. Oil sprays may injure trees that are water stressed. It is advisable to postpone an oil application to water-stressed trees until winter rains have replenished soil water and the tree bark is noticeably moist.			

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**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

Peach twig borer cont. (7/93)

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
Petal Fall or May			
A. AZINPHOSMETHYL*			
(Azinphos-M) 50WP	3 lb	0.5-0.75 lb	21
COMMENTS: May increase spider mite problems.			
B. DIAZINON 50WP	3 lb	1 lb	10
C. PHOSMET			
(Imidan) 50WP	6 lb	1.5 lb	14
D. CARBARYL*			
(Sevin) 80S	5 lb	1.25 lb	3
(Sevin) 50WP	8 lb	2 lb	3
COMMENTS: May increase spider mite problems. Do not apply more than 7.5 lb of Sevin 80S or 12 lb Sevin 50WP per acre per season.			

** For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
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FRUITTREE LEAFROLLER (7/93)

Scientific Name: *Archips argyrospila*

DESCRIPTION OF THE PEST: The fruittree leafroller overwinters in the egg stage on twigs; eggs hatch in early spring. Larvae are dark green with black heads and are about 0.6 inch long when fully grown. Adult moths emerge in June or July and deposit overwintering eggs. Adults appear bell-shaped when at rest and have dark brown bands running at oblique angles across their wings, which are mottled with gold and white flecks. There is one generation each year.

DAMAGE: Larvae feed on leaves and buds, webbing them together to form a protective case. Fruit damage is usually shallow and superficial and often occurs when leaves and fruit are webbed together.

WHEN TO TREAT: Check the orchard in early spring (March-April) for presence of larvae and feeding damage. When necessary, apply an insecticide at petal fall or shortly thereafter.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. CARBARYL*			
(Sevin) 80S	5 lb	1.25 lb	3
(Sevin) 50WP	8 lb	2 lb	3
COMMENTS: May cause increased spider mite problems. Do not apply more than 7.5 lb of Sevin 80S or 12 lb Sevin 50WP per acre per season.			
B. AZINPHOSMETHYL*			
(Azinphos-M) 50WP	3 lb	0.5-0.75 lb	21
C. DIAZINON 50WP	3 lb	1 lb	10
D. PHOSMET			
(Imidan) 50WP	6 lb	1.5 lb	14

** For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

GREEN FRUITWORM (7/93)

Scientific Names: *Orthosia hibisci, Amphipyra pyramidoides, Xylomyges curialis,* and others.

DESCRIPTION OF THE PEST: Larvae are pale green caterpillars, often with whitish stripes down each side of the body and a narrow stripe down the middle of the back. The adult of one common species is a grayish moth with a 1-inch wingspan. Most species overwinter as adults and have one generation each year.

DAMAGE: Green fruitworms eat large holes in young leaves and fruit.

WHEN TO TREAT: Check the orchard in early spring (March-April) for the presence of larvae and feeding damage. Spray programs for other insects generally help reduce populations. When necessary apply an insecticide at petal fall or shortly thereafter.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. CARBARYL*			
(Sevin) 80S	5 lb	1.25 lb	3
(Sevin) 50WP	8 lb	2 lb	3
COMMENTS: May cause increased spider mite problems. Do not apply more than 7.5 lb of Sevin 80S or 12 lb Sevin 50WP per acre per season.			
B. AZINPHOSMETHYL*			
(Azinphos-M) 50WP	3 lb	0.5-0.75 lb	21
C. DIAZINON 50WP	3 lb	1 lb	10
D. PHOSMET			
(Imidan) 50WP	6 lb	1.5	14

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.

+ Preharvest interval. Do not apply within this many days of harvest.

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

ORANGE TORTRIX (7/93)

Scientific Name: *Argyrotaenia citrana*

DESCRIPTION OF THE PEST: The orange tortrix is found mainly in coastal areas. The larvae are straw to light green caterpillars with brown heads. When disturbed, they wiggle backward and drop to the ground on a silken thread. Adults are fawn or gray moths with darker mottling on the forewings. The orange tortrix overwinters as larvae, and there are two to four generations each year in coastal areas.

DAMAGE: Larvae feed on leaves and buds, and tunnel throughout the fruit, causing severe damage as well as contamination with their excrement. Leaves webbed together to form protective cases indicate their presence.

WHEN TO TREAT: Spray programs for other insects generally help reduce populations. The timing for peach twig borer is also effective for orange tortrix.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. CARBARYL*			
(Sevin) 80S	5 lb	1.25 lb	3
(Sevin) 50WP	8 lb	2 lb	3
COMMENTS: May cause increased spider mite problems. Do not apply more than 7.5 lb of Sevin 80S or 12 lb of Sevin 50WP per acre per season.			
B. AZINPHOSMETHYL*			
(Azinphos-M) 50WP	3 lb	0.5-0.75 lb	21
C. DIAZINON 50WP	3 lb	1 lb	10
D. PHOSMET			
(Imidan) 50WP	6 lb	1.5 lb	14

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.

+ Preharvest interval. Do not apply within this many days of harvest.

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

REDHUMPED CATERPILLAR (7/93)

Scientific Name: *Schizura concinna*

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

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

WHEN TO TREAT: On small trees, cut out and destroy infested twigs. Insecticide sprays applied for other pests often keep these leaf-eating caterpillars in check. If insecticide treatments are required, localized treatments on individual trees applied when evidence of caterpillars is first observed are generally all that is necessary.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS# (Dipel, Javelin, etc.)	Label rates		0
COMMENTS: Most effective on small caterpillars. Does not destroy natural enemies.			
B. DIAZINON 50WP	3 lb	1 lb	10
4EC	2-4 pt	1 pt	10
C. CARBARYL* (Sevin) 80S	4-5 lb	1.25 lb	3
COMMENTS: May cause increased spider mite problems.			
D. AZINPHOSMETHYL* (Azinphos-M) 50WP	2-3 lb	0.5-0.75 lb	21
COMMENTS: May cause increased spider mite problems.			

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

EUROPEAN EARWIG (7/93)

Scientific Name: *Forficula auricularia*

DESCRIPTION OF THE PEST: Earwigs are about 0.5 inch long, shiny brown and have a pair of forceps-like structures at the back end of the abdomen. They are nocturnal and their presence or damage may go unnoticed until harvest. There are two generations per year.

DAMAGE: Earwigs feed on fruit and foliage. Foliage feeding is of little concern in mature trees. However, shoot-tip feeding on young trees may stunt normal growth. Earwig feeding results in shallow, irregular feeding areas on the fruit surface.

CULTURAL CONTROL: Remove weeds from around the base of trees. Keep orchard clear of prunings or other debris under which earwigs could nest. Remove tree limbs that come in contact with soil to prevent alternate access to trees.

MONITORING and WHEN TO TREAT: Place boards or rolled-up newspapers in the orchard in early spring and monitor weekly for earwigs that hide under the boards or in newspapers. Treat at the beginning of spring activity when earwigs are found.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. CARBARYL*			
(Sevin) 80S	5 lb	1.25 lb	3
(Sevin) 50WP	8 lb	4 lb	3

COMMENTS: Spray on trunks and crotches of trees at the beginning of spring activity. Once high populations are found in trees such an application will no longer be effective, and a foliar spray is necessary. Do not apply more than 7.5 lb of Sevin 80S or 12 lb Sevin 50WP per acre per season. May cause increased spider mite populations.

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

WESTERN TUSSOCK MOTH (7/93)

Scientific Name: *Orgyia vetusta*

DESCRIPTION OF THE PEST: The western tussock moth is an occasional pest in coastal apricot orchards. A mature larva is 0.5 to 1 inch long with a gray background color and numerous red, blue and yellow spots. Four white tufts of hair emerge from its back as well as two black tufts from its head and one from its tail end. Larvae emerge in March and mature in May. The wingless female moths mate in early summer and lay eggs in felt-like masses on old cocoons. Only one generation is produced each year.

DAMAGE: The larvae are insignificant foliar feeders but may feed on the surface of fruit sufficiently in some years to warrant control measures. Feeding results in shallow, scabby, depressed areas at harvest.

WHEN TO TREAT: Petal fall sprays to control other spring caterpillar problems will control this pest. Later instars are difficult to control. This pest is cyclic and often is controlled by parasitic wasps.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. CARBARYL*			
(Sevin) 80S	5 lb	1.25 lb	3
(Sevin) 50WP	8 lb	2 lb	3
COMMENTS: May increase spider mite problems. Do not apply more than 7.5 lb of Sevin 80S or 12 lb Sevin 50WP per acre per season.			
B. AZINPHOSMETHYL*			
(Azinphos-M) 50WP	3 lb	0.5-0.75 lb	21
C. DIAZINON 50WP	3 lb	1 lb	10
D. PHOSMET			
(Imidan) 50WP	6 lb	1.5 lb	14

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.

BROWN MITE (7/93)

Scientific Name: *Bryobia rubrioculus*

DESCRIPTION OF THE PEST: The brown mite can be an economic pest of apricots. It is the largest in size of all apricot pest mites. Brown mite eggs hatch in early spring and the newly hatched mites are red with six legs. After the first molt they are brown with eight legs and resemble the adult. Adults are flattened with long front legs. The mites feed only during the cool parts of the day, and migrate off the leaves during midday. They are not active during hotter periods of the summer. There are two to three generations per year between February and June.

DAMAGE: Mite feeding causes chlorosis, but leaves rarely drop. Infestations are generally confined to a few trees or localized.

BIOLOGICAL CONTROL: The western predatory mite and brown lacewing are both effective predators, but alone may not control brown mite populations. Nevertheless, it is important to avoid insecticides which will kill these natural enemies.

WHEN TO TREAT: These mites are generally controlled by a dormant spray. Occasionally there may be an infestation during a cool spring when dormant treatments were inadequate.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant			
A. NARROW RANGE OIL# (Superior, Supreme)	4-8 gal	1.5-2 gal	

COMMENTS: Cover all parts of the tree. Oil alone will control low to moderate infestations. Do not apply oil to water-stressed trees.

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.

+ Preharvest interval. Do not apply within this many days of harvest.

Acceptable for use on organically grown produce.

WEBSPINNING SPIDER MITES (7/93)

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

DESCRIPTION OF THE PEST: These two spider mites are very similar looking as adults, have similar life histories, and are controlled in the same manner. Overwintering female mites are red or orange and are found under rough bark, in ground litter, and on winter weeds. During the season they range from yellow to green to black depending on age and host food. Both have dark spots. Adult males do not overwinter and are smaller than females. Eggs are laid on the foliage. Early in the season mites are found in the lower to central areas of the tree. The mites reproduce rapidly during warm weather between June and September. Under favorable conditions, mites develop within seven days, with 8 to 10 generations per season.

DAMAGE: Mites damage foliage by sucking cell contents from leaves. The damage begins with leaf stippling and leaves can turn yellow and drop off.

High populations cover tree terminals with webbing. Crop reduction shows up the year after damage occurs.

BIOLOGICAL CONTROL: Several species play a large role in mite control, including the western predatory mite, *Metaseiulus occidentalis*, the sixspotted thrips, the spider mite destroyer, the brown lacewing, and the green lacewing. The western predatory mite is the most reliable mite predator. It is the same size as spider mites, but lacks spots and ranges in color from cream to amber red. This predator maintains good control unless the proportion of leaves with spider mites is higher than the proportion of leaves with predatory mites.

CULTURAL CONTROL: Reduce dusty conditions in orchards by oiling or watering roadways and maintaining a groundcover. Prevent water stress, as this condition results in higher mite densities and intensified damage.

WHEN TO TREAT: Predators are important in managing mites. Low pest mite populations are necessary to maintain predator populations in the orchard. No treatment threshold has been established for apricots. Treat when mites are present on the majority of leaves.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
Spring-Summer			
A. PROPARGITE* (Omite) 30WP	2-8 lb	0.5-2 lb	14
COMMENTS: Re-entry: 21 DAYS. Do not apply more than twice per season. Do not apply 40 days after or 30 days before an oil application.			
B. NARROW RANGE OIL# (Superior, Supreme)	4-8 gal	1.5-2 gal	
COMMENTS: Do not apply during the same growing season with propargite. Be sure that trees are well watered.			

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

EUROPEAN RED MITE (7/93)

Scientific Name: *Panonychus ulmi*

DESCRIPTION OF THE PEST: European red mites overwinter as eggs located at the base of buds and spurs on smaller branches or in wounds. Eggs are red with a slender stalk arising from the center. Newly hatched mites are green, but with feeding turn red with a white spot at the base of each hair. These mites have 5 to 10 generations per year.

DAMAGE: European red mites cause leaf stippling. Prolonged feeding causes leaves to pale and appear bronzed and burned at the tips and margins. Leaf drop can occur at high infestation levels (in excess of 100 mites per leaf for extended periods). At low levels, this mite can be beneficial; it serves as an alternative food for predators.

WHEN TO TREAT: Monitor orchards once a week during the growing season when monitoring for other pests. No treatment thresholds have been established, but trees are able to tolerate greater numbers of European red mites than webspinning mites per leaf. A dormant oil spray is the preferred treatment and is intended to control European red mite eggs.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant			
A. NARROW RANGE OIL# (Superior, Supreme)	4-8 gal	1.5-2 gal	
COMMENTS: Cover all parts of the tree. Oil alone will control low to moderate infestations. Do not use oil sprays on water-stressed trees.			
Spring			
A. PROPARGITE* (Omite) 30WP	2-8 lb	0.5-2 lb	14
COMMENTS: Re-entry: 21 DAYS. Do not apply more than twice a season. Do not apply less than 40 days after or 30 days before an oil application.			
B. NARROW RANGE OIL# (Superior, Supreme)	4-8 gal	1.5-2 gal	
COMMENTS: Do not apply during the same growing season as propargite. Be sure that trees are well watered.			

** For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.
+ Preharvest interval. Do not apply within this many days of harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

MEALY PLUM APHID (7/93)

Scientific Name: *Hyalopterus pruni*

DESCRIPTION OF THE PEST: Wingless adult aphids are pale green with three dark green longitudinal stripes on their backs. Their bodies are covered with a white, mealy wax. The winged form has a dark thorax and transverse bands on the abdomen. After overwintering in the egg stage near the bases of buds, eggs hatch during bloom and wingless adults develop. Winged adults appear in June and July, as warm weather approaches, and migrate to reed grass or cattails. In fall, winged adults return to apricot trees where wingless females develop and mate with winged male aphids; the overwintering eggs are laid soon after.

DAMAGE: Vegetative growth on the trees may be stunted by high populations, but the principal damage caused by mealy plum aphid is the development of the black sooty mold that grows on the aphid's honeydew.

WHEN TO TREAT: Eggs are easily killed by insecticide sprays. The delayed dormant period is the preferred time to make spray applications. When control has not been achieved with the delayed dormant treatment, it can be achieved during early May when aphids are present. Chemical control of the mealy plum aphid on apricot is seldom necessary.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
Dormant or Delayed Dormant			
A. NARROW RANGE OIL (Superior, Supreme)	4-8 gal	1.5-2 gal	
...PLUS...			
DIAZINON 50WP	3 lb	1 lb	
COMMENTS: Organophosphate insecticides used during delayed dormancy are very toxic to honey bees. Remove bees from orchard if cover crops or weeds are in bloom. Oil sprays may injure trees that are water stressed. It is advisable to postpone an oil application to water-stressed trees until winter rains have replenished soil water and the tree bark is noticeably moist.			
Spring			
A. DIAZINON 50WP	3 lb	1 lb	10

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.

+ Preharvest interval. Do not apply within this many days of harvest.

EUROPEAN FRUIT LECANIUM (7/93)

Scientific Name: *Parthenolecanium corni*

DESCRIPTION OF THE PEST: The European fruit lecanium, also known as the brown apricot scale, occurs throughout California but is rarely a problem. This scale has one generation a year. It overwinters as a nymph on twigs and small branches. In spring, it grows rapidly and secretes large amounts of honeydew. The adult cover is domed, shiny brown, and about 0.4 inch in diameter with several ridges along the back. After mating in late spring, the females lay many eggs, filling the entire space beneath the covers, and die after egg production.

DAMAGE: The European fruit lecanium sucks juices from leaves and twigs. Low to moderate populations apparently are not damaging, but heavy populations reduce terminal growth and vigor. The chief injury is caused by the production of large amounts of honeydew; sooty mold growing on the honeydew can blacken areas on leaves and fruit.

WHEN TO TREAT: Apply treatments during the dormant or delayed dormant period before rapid scale growth begins in early spring. High populations of soft scales often result from the use of chemicals that are disruptive to parasites and predators. If a high degree of parasitization is observed, treatments may be delayed until late spring after crawlers emerge. Treat during the dormant or delayed dormant period if, during the previous year, scale populations or sooty mold were observed.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. NARROW RANGE OIL (Superior, Supreme)	4-8 gal	1.5-2 gal	
...*PLUS*...			
DIAZINON 50WP	3 lb	1 lb	10

COMMENTS: Organophosphate insecticides used during delayed dormancy are very toxic to honey bees. Remove bees from orchard if cover crops or weeds are in bloom. Oil sprays may injure trees that are water stressed. It is advisable to postpone an oil application to water-stressed trees until winter rains have replenished soil water and the tree bark is noticeably moist.

** For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label.

+ Preharvest interval. Do not apply within this many days of harvest.

CRIBRATE WEEVIL (7/93)

Scientific Name: *Otiorhynchus cribricollis*

DESCRIPTION OF THE PEST: Adults are black, compact weevils about 0.4 to 0.6 inch long with a pitted or rough surface. They are flightless and nocturnal, hiding at the base of fruit or under dirt clods during the day and crawling up the tree at night to feed. Larvae are white, legless grubs that feed on tree roots. There is one generation per year.

DAMAGE: Adults feed on foliage, giving it a ragged appearance. Under high population pressure, only the midvein of the leaf will remain. Mature trees can withstand attack without apparent damage. Replanted, young trees may be severely defoliated and die. No damage has been associated with larval feeding.

WHEN TO TREAT: Apply treatment in May when first adult feeding is observed.

TREATMENT: Application of a 3 to 4 inch band of Stickem on the trunk of young trees to trap crawling adults will prevent most infestations. Reapply Stickem when it becomes dirty or loses its effectiveness. No insecticidal treatments for this insect have proven effective.

PACIFIC FLATHEADED BORER (7/93)

Scientific Name: *Chrysobothris mali*

DESCRIPTION OF THE PEST: Pacific flatheaded borer adults are generally present in May and June. When spring months are warm, they may be seen as early as March or early April. The adult beetle is about 0.4 inch long with a dark bronze body and coppery spots on the wing covers. A fully grown larva is light-colored, with a prominent, flat enlargement of the body just behind the head. There is one generation each year.

DAMAGE: Pacific flatheaded borers are attracted to diseased or injured limbs, such as those affected by sunburn, scale insects, bacterial canker, or major pruning cuts. The beetles lay eggs in the injured area. Eggs hatch and the larvae excavate large caverns just beneath the bark and bore tunnels deep into the heartwood of the tree. Excavations are usually filled with finely powdered sawdust. Injury by this borer will cause the sap to flow, and the affected area will appear as a wet spot on the bark. Later, these areas may crack and expose the mines. Feeding by Pacific flatheaded borers may cause a portion of the bark on older trees to die, or it may girdle and kill young trees.

CULTURAL CONTROL: Flatheaded borers often invade sunburned areas on the trunk of newly planted trees. At planting time, wrap or paint the tree trunk above and 1 inch below the soil line with white, water-based paint or whitewash to protect the trunk from sunburn and flatheaded borer invasions. In older trees the best way to avoid infestations is to keep the trees sound and vigorous. Prune out all badly infested wood and burn or remove it from the orchard before the growing season starts. Spraying for this insect is not recommended.

PEACHTREE BORER (7/93)

Scientific Name: *Synanthedon exitiosa*

DESCRIPTION OF THE PEST: Peachtree borer eggs are laid during the summer on the bark of trees. Larvae overwinter in the tree trunk. They feed in the crown area and burrow up into the tree. At maturity, a larva is about 1 inch long, and has a light-colored body and a dark head. In late spring, larvae pupate near the entrance of their burrows or in the soil. Adults emerge from May through September; they are steel blue to black moths with a 1-inch wing span.

DAMAGE: Peachtree borers can girdle and kill young trees. Older trees can withstand the damage unless there are many larvae or the tree is attacked several years in a row.

WHEN TO TREAT: Make protective treatments prior to female moth egg laying. Two treatments are necessary, the first in mid-May and the second in mid-July after harvest. This timing covers the emergence period and oviposition of the moth. Apply the insecticide with a hand-held sprayer to the tree trunk from the juncture of the main scaffold limbs to the soil line. Cover the trunk thoroughly, using enough spray material so it will run off to form a small puddle at the base of the tree. Use from 0.5 to 1.5 gallons per tree, depending upon the size of the trunk. Remove weeds or suckers, which might interfere with spray coverage, from around trees. Clear away any excess soil piled against the trees during discing operations. No control is available after the larvae have entered the tree.

TREATMENT:

Pesticide (commercial name)	Amount to Use** (conc.)	(dilute)	P.H.I.+ (days)
A. ENDOSULFAN* (Thiodan) 50WP	1 lb	0.25 lb	30

COMMENTS: Fruit contamination must be avoided. Confine the spray to the tree trunk and reduce pump pressure to below 150 PSI to avoid splashing.

**For concentrate applications, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal of water to be applied in 300 to 400 gal water/acre, according to label

\+ Preharvest interval. Do not apply within this many days of harvest.

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

BRANCH AND TWIG BORER (7/93)

Scientific Name: *Polycaon confertus*

DESCRIPTION OF THE PEST: The branch and twig borer is a slender brown beetle about 0.5 to 0.66 inch long. The body is cylindrical and the head and prothorax are narrower than the body proper. The beetle lays its eggs in the dead wood of a number of native and cultivated trees and shrubs outside the orchard. The larvae bore into the heartwood of the host and feed within this area for a year or possibly longer. Pupation occurs within the wood and adults emerge in early summer. They often fly to orchards where they bore into small branches on the trees. There is one generation per year.

DAMAGE: Adults bore into small twigs and branches, making round holes, commonly at the axil of a bud or fruit spur or at the fork of two branches. One of the branches frequently dies. Branch and twig borer seldom causes economic injury and is found only rarely in apricots.

CULTURAL CONTROL: These beetles do not prefer healthy, vigorous growing trees. Provide sunburn protection and a good irrigation and fertilization program to keep trees in good health. Promptly destroy brush piles which harbor these pests. Remove badly diseased or borer-infested trees and branches from the orchard each winter and destroy them before spring. Spraying for this insect is not recommended.

SHOTHOLE BORER (7/93)

Scientific Name: *Scolytus rugulosus*

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

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

CULTURAL CONTROL: Shothole borers invade trees that have been previously damaged. The nature of this damage dictates the course of preventive action. To prevent attack by this beetle, maintain trees in a sound and vigorous condition, with sufficient fertilizers, water, and sunburn prevention to keep uninfested tree limbs from becoming damaged. Pruning can be helpful in eliminating areas in older trees infested with shothole borer. Severely infested trees should be removed. Burn or remove all infested wood from the orchard before the growing season starts. Do not leave pruned limbs or stumps (healthy or infested) near orchards (for example, in woodpiles) as beetles can emerge from these materials before they dry out and migrate into orchards. Spraying for this insect is not recommended.

DISEASES

BROWN ROT BLOSSOM AND TWIG BLIGHT (7/93)

Pathogen: *Monilinia laxa* and *Monilinia fructicola*

SYMPTOMS: The blossom and twig blight phase begins with the death of young blossoms and their associated spurs and leaves. Infection moves from flowers into twigs to form small cankers. Gum exudes at the base of infected flowers. Cankers on blighted twigs have tan centers with dark margins. In high humidity gray brown spore masses form on diseased flower parts and twig cankers.

COMMENTS ON THE DISEASE: The fungus survives on diseased twigs and mummified fruits, either on the tree or on the ground. Brown rot fungus spores are airborne and are also spread by rain splash and insects. Moderate temperatures and moist weather during bloom favor blossom blight.

COMMENTS ON CONTROL: Two or three bloom applications are often necessary to control brown rot blossom and twig blight. Because apricot sepals, in addition to other flower parts, are susceptible, the application at red bud is most important.

Because strains of *M. fructicola* resistant to benomyl and thiophanate methyl have been found in California, only one of the three bloom applications (preferably the one at red bud) should be benomyl or thiophanate methyl. If resistance has occurred in your orchard, do not use either fungicide.

WHEN TO TREAT: Treat at red bud and, when necessary, at popcorn and full bloom.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
A. BENOMYL (Benlate) DF	1-1.5 lb
COMMENTS: Apply only once (at red bud) a year and use in combination with a fungicide of different chemistry. If this material is used during bloom, do not use for control of ripe fruit rot. Check with your processor before using this material.	
B. CAPTAN 50WP (Various)	5 lb
COMMENTS: Do not use Captan with or closely following oil sprays. Check with your processor before using this material.	
C. CHLOROTHALONIL (Bravo) 500	4.5-8 pt
COMMENTS: May cause an allergic skin reaction in some people.	
D. IPRODIONE 50WP (Rovral) 1-2 lb	
E. THIOPHANATE METHYL (Topsin M) 70WP	0.5 lb/100 gal water up to 1.5 lb/acre
COMMENTS: Only one application a year. If this material is used during bloom, do not use later for control of powdery mildew or ripe fruit rot. Check with your processor before using this material.	
F. TRIFORINE (Funginex) 1.6EC	36-48 fl oz in 50-200 gal water
G. VINCLOZOLIN (Ronilan) 50DF	1.5-2 lb

POWDERY MILDEW (2/94)

Pathogen: *Sphaerotheca pannosa* and *Podosphaera tridactyla*

SYMPTOMS: Powdery mildew appears as weblike white growth on fruit, leaves, and stems. Older lesions on fruit are scabby.

COMMENTS ON THE DISEASE: *Sphaerotheca pannosa* causes mildew on fruit and leaves in spring; *Podosphaera tridactyla* attacks leaves in summer and fall. *S. pannosa* does not overwinter on apricot; primary inoculum comes from infected roses in spring. Remove nearby roses to reduce sources of inoculum.

WHEN TO TREAT: Treat during bloom through pit hardening; early applications are most effective.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
A. BENOMYL	
(Benlate) WP	1.5-2 lb
COMMENTS: Apply at red bud. If blossoming is prolonged or conditions favorable to the disease persist, make a second application 14 days later.	
B. THIOPHANATE METHYL	
(Topsin M) 70W	1.5 lb
COMMENTS: Apply at red bud; make a second application at full bloom.	

RIPE FRUIT ROT (7/93)

Pathogen: *Monilinia fructicola, Monilinia laxa*

SYMPTOMS: Dark brown, firm, circular spots spread rapidly over fruit, and tan spore masses form in the centers of spots. Ripening fruit is most susceptible. Diseased fruits may remain on the tree until the next season.

COMMENTS ON THE DISEASE: Fruit rot is not as important as blossom blight in California apricots. Warm rains near harvest can lead to fruit rot infection in a few hours. At 67 F, fruit rot symptoms will appear within 48 hours of rain.

COMMENTS ON CONTROL: The need for preharvest treatment depends upon the weather; the threat of rain or heavy dews may signal the need for protection. Strains of *M. fructicola* resistant to benomyl and thiophanate methyl have been found in California apricot orchards. If resistance has occurred in your orchard, do not use either fungicide. Otherwise, one application of these materials is usually sufficient.

WHEN TO TREAT: Two or three weeks before harvest, depending on the weather.

TREATMENT:

Pesticide (commercial name)	Amount/Acre	P.H.I.+ (days)
A. BENOMYL		
(Benlate) DF	1.5-2 lb	
COMMENTS: Apply only once a year and always apply with a fungicide of a different chemistry. If benomyl was used earlier for brown rot control, do not use it for control of ripe fruit rot. Check with your processor before using this material.		
B. CAPTAN 50WP		
(Various)	5 lb	
COMMENTS: Check with your processor before using this material.		
C. IPRODIONE		
(Rovral) 50WP	1-2 lb	
D. THIOPHANATE METHYL		
(Topsin M) 70WP	0.5 lb/100 gal water up to 1.5 lb/acre	1
COMMENTS: Apply only once a year. If thiophanate methyl was used earlier for brown rot or powdery mildew control, do not use it for control of ripe fruit rot. Check with your processor before using this material.		
E. TRIFORINE		
(Funginex) 1.6 EC	36-48 fl oz in 50-200 gal water	

+ Preharvest interval. Do not apply within this many days of harvest.

SHOT HOLE DISEASE (7/93)

Pathogen: *Wilsonomyces carpophilus*

SYMPTOMS: Shot hole disease may kill buds during winter, and cause spots on fruit and leaves in spring. If severe, leaf drop may occur in spring. Fruit lesions are light brown with dark purple margins and usually are clustered on the upper sides of fruit. Fruit spotting can be severe, and as fruits mature, spots become scablike and may flake off, leaving roughened areas beneath. Leaf spots fall out (shot hole).

COMMENTS ON THE DISEASE: The fungus survives within infected buds and on twigs. Spores are rain splashed, and disease increases during the rainy season. Fruit infection is favored by wet spring weather.

COMMENTS ON CONTROL: Buds can be protected from blighting during winter by a fungicide application before the long winter rains begin. One application should be sufficient. The number of bloom applications needed depends upon the amount of rain.

WHEN TO TREAT: During the dormant season (mid-November to mid-December), and at red bud, full bloom, or petal fall, depending on the amount of rain.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
Dormant	
A. BORDEAUX MIXTURE# 10:10:100	Label rates
B. FIXED COPPER#	4 lb metallic copper
Red Bud, Full Bloom, and Petal Fall	
A. CAPTAN 50WP	5 lb
COMMENTS: Check with your processor before using this material.	
B. CHLOROTHALONIL (Bravo) 500	4.5-6 pt
C. ZIRAM 76WDG	8 lb

Acceptable for use on organically grown produce.

CROWN GALL (7/93)

Pathogen: *Agrobacterium tumefaciens*

SYMPTOMS: Crown gall disease results in rough, abnormal galls on roots or trunk. Galls are soft and spongy, not hard. The centers of older galls decay. Young trees become stunted, older trees often develop secondary wood rots.

COMMENTS ON THE DISEASE: Crown gall bacteria survive in gall tissue and in the soil. They enter the tree only through wounds. Crown gall is most damaging to young trees, either in the nursery or in new orchard plantings.

COMMENTS ON CONTROL: Crown gall is best prevented by purchasing trees from a reputable nursery and by careful handling to avoid injury as much as possible, both during planting and during the life of the tree in the orchard. Preplant treatment is for prevention only. Galltrol and Norbac are preparations of the biological control agent *Agrobacterium radiobacter-84*. It is effective only as a preventive treatment and is used as a root dip prior to heeling in or planting. It does not eradicate existing galls.

Strains of A. *tumefaciens* resistant to Galltrol and Norbac have been reported. Their occurrence is not widespread, but failure to control crown gall with these materials should be reported. Eradication involves removal of existing galls and topical application of Gallex. Carefully follow label instructions for exposing crown and roots and removing large galls.

TREATMENT:

Pesticide (commercial name)	Amount to Use
A. *Agrobacterium radiobacter-84*# (GALLTROL)	Label rates
COMMENTS: Preplant treatment only. This is a living organism; store according to directions on label and do not mix with disinfectants.	
B. GALLEX	Label rates
Comments: For removal of existing galls, apply winter through spring.	

Acceptable for use on organically grown produce.

ARMILLARIA ROOT ROT (Oak Root Fungus) (7/93)

Pathogen: *Armillaria mellea*

SYMPTOMS: Roots infected with *Armillaria mellea* have white to yellowish fan-shaped mycelial mats between the bark and the wood. Dark brown to black rhizomorphs can be seen on the root surface. All stone fruit rootstocks are susceptible to Armillaria root rot. The plum rootstock Marianna 2624 has some tolerance and may be useful in some situations.

COMMENTS ON THE DISEASE: The fungus survives on dead roots.

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

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

TREATMENT:

Pesticide (commercial name)	Amount to Use
Preplant	
A. METHYL BROMIDE*	Label rates

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

PHYTOPHTHORA ROOT AND CROWN ROT (7/93)

Pathogen: *Phytophthora* spp.

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

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

TREATMENT:

Pesticide (commercial name)	Amount to Use
A. FOSETYL-AL (Aliette)	5 lb/100 gal
COMMENTS: FOR USE ON NONBEARING TREES ONLY. Apply as a foliar spray, at 60-day intervals.	
B. METALAXYL (Ridomil 2E)	Varies with method of application and size of tree
COMMENTS: Applications made in early spring and fall.	

NEMATODES (7/93)

Scientific Names: Lesion: *Pratylenchus vulnus*
Dagger: *Xiphinema americanum*
Ring: *Criconemella xenoplax*
Root knot: *Meloidogyne* sp.

DESCRIPTION OF THE PESTS: Nematodes are microscopic roundworms that live in diverse habitats. Plant parasitic nematodes live in soil and plant tissues and feed on plants by puncturing and sucking the cell contents with a spearlike mouthpart called a stylet.

DAMAGE: Damage caused by nematodes is likely to first become evident during the first year after planting. Feeding by nematodes can impair root functions such as uptake of nutrients and water. Lesion nematodes penetrate into the roots and cause damage by feeding and migrating through the cortical tissues. Dagger nematodes feed from outside the roots, but can reach the vascular tissues with their long stylet and are capable of reducing vigor and yield of trees. *Xiphinema americanum* also transmits strains of tomato ringspot virus to apricots, but the disease is less severe and the symptoms less obvious than on peaches and almonds. Feeding by ring nematode increases the incidence of trees affected by bacterial canker (*Pseudomonas syringae*). Feeding by root knot nematode produces root galls, which disrupt root functions.

SYMPTOMS: The symptoms described below are indicative of a nematode problem but are not diagnostic as they could result from other causes as well. Lack of vigor, small leaves, dieback of twigs, and yield reduction are typical symptoms of nematode damage. Lesion nematodes may cause reddish brown lesions on roots that later turn dark and ultimately black. Orchards infested with ring nematode may exhibit symptoms of bacterial canker and trees with root knot nematodes may have galls on roots.

FIELD EVALUATION: It is critical to know the nematode species present and to estimate their population to make management decisions. If a previous orchard or crop had problems caused by nematodes that are also listed as pests of apricots, expect population levels to be high enough to cause damage to the young trees.

If nematode species have not previously been identified, take soil samples and send then to a diagnostic laboratory for identification. Divide the field into sampling blocks of not more than five acres each that are representative of cropping history, crop injury, or soil texture. Within each block, take several subsamples randomly from the frequently wetted zones at the edge of the tree canopy. Take samples from within the root zone (6 to 36 inch depth) and include some feeder roots when possible. Mix the subsamples thoroughly and make a composite sample of about one quart (1 liter) for each block. Place the samples in separate plastic bags, seal them and place a label on the outside with your name, address, location, and the current/previous crop and the crop you intend to grow. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor for more details about sampling, to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

MANAGEMENT:
Cultural practices: Before fumigating, remove old trunks and large roots brought up by ripping and fallow or plant green manure cover crops for 1-2 years. Do not use cover crops that are known hosts of the rootstock you plan

Continued on next page.

Nematodes cont. (7/93)

to plant; contact your farm advisor for additional information. Use certified nematode-free rootstocks or seedlings to establish new orchards. When the orchard is developed, use procedures that improve soil tilth and drainage to help reduce nematode damage.

Rootstock selection: Use certified nematode-free rootstocks. Among peach rootstocks, Nemaguard is known to be resistant to root knot nematodes, but it is susceptible to ring and lesion nematodes. Lovell is somewhat resistant to ring nematode but susceptible to root knot and lesion nematodes. The apricot rootstock Royal (Blenheim) seedling is resistant to lesion nematode but susceptible to ring nematode. Most apricot rootstocks are nonhosts for root knot nematode. Plum rootstocks Myrobalan 29C and Marianna 2624 are resistant to root knot nematode, but susceptible to ring and lesion nematode. Contact your local farm advisor for additional information on rootstock selection.

When To Treat: Trees planted on fumigated orchard sites are generally known to have improved growth and yields compared to those on nonfumigated sites. Preplant fumigate in fall when soils are dry and warm. For an indepth discussion on soil fumigation, see *Integrated Pest Management for Apples and Pears*, UC ANR Publication 3340, or the *Phytonematology Study Guide* (Rev. 1985) UC ANR Publication 4045.

Threshold levels for postplant treatment have not been established. Yield and vigor increases may not become evident for 6 to 18 months following treatment with fenamiphos. To help determine the effectiveness of postplant treatments, leave several trees or rows of trees untreated for comparison with treated trees.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
Preplant	
A. METHYL BROMIDE*	300-600 lb
COMMENTS: Use the higher rates for fine textured soils. Apply methyl bromide in a broadcast fumigation using tarps, or fumigate the soil with 300 lb/acre, invert the top 12 inches of soil, and refumigate in 14 days with 150 lb/acre.	
B. METAM SODIUM (Vapam, Soil Prep)	100 gal
COMMENTS: Metam sodium can reduce populations of nematodes if applied properly but it does not penetrate plant roots very well and it is very difficult to get 4-5 feet down from the surface. Before applying this material, thoroughly cultivate the area to be treated to break up clods and deeply loosen the soil. After cultivation and about one week before treatment, preirrigate the field with 6-8 acre-inches of water in flood irrigation in basins. After treatment, do not plant for 30 days, or 60 days if soil is high in organic matter or cold (below 50 F).	
Postplant	
A. FENAMIPHOS* (Nemacur 3)	1.5-3 gal: band application 1 qt-1 gal: low pressure irrigation
COMMENTS: For use on nonbearing trees only. Registered for band or low pressure irrigation applications. See label for details. Irrigate as soon as possible after application to move the material into the root zone. See label for information on application via low pressure irrigation.	

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

PRECAUTIONS FOR USING PESTICIDES

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

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

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

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

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

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

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

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

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

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

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

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

The University of California, in compliance with Titles VI and VII of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Sections 503 and 504 of the Rehabilitation Act of 1973, and the Age Discrimination Act of 1975, does not discriminate on the basis of race, religion, color, national origin, sex, mental or physical handicap, or age in any of its programs or activities, or with respect to any of its employment policies, practices, or procedures. Nor does the University of California discriminate on the basis of ancestry, sexual orientation, marital status, citizenship, medical condition (as defined in section 12926 of the California Government Code) or because individuals are special disabled veterans or Vietnam era veterans (as defined by the Vietnam Era Veterans Readjustment Act of 1974 and Section 12940 of the California Government Code). Inquiries regarding this policy may be addressed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland, California 94612-3560. (510) 987-0097.

CARROT
PEST MANAGEMENT GUIDELINES

APRIL, 1994

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

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University of California, Division of Agriculture and Natural Resources

INSECTS

PALESTRIPED FLEA BEETLE (4/94)

Scientific Name: *Systena blanda*

DESCRIPTION OF THE PEST: Flea beetle adults are small (about 0.12 inch long), shiny, beetles with enlarged hind legs that allow them to jump like fleas. The palestriped flea beetle has a broad white stripe down each brown wing.

DAMAGE: Adult flea beetles do most of the damage by feeding on the undersides of leaves, leaving small pits or irregularly shaped holes on the leaves. Large populations can kill or stunt seedlings. Older plants rarely suffer economic damage although their older leaves may be damaged. In the Imperial Valley, larvae feeding on roots has caused serious damage on occasion. This damage is easily confused with cavity spot symptoms.

CULTURAL CONTROLS: Remove weeds along field margins and deeply disk plant residue in infested fields after harvest.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

MONITORING AND WHEN TO TREAT: Check newly emerged seedlings twice weekly for flea beetle damage until plants are well established. Relatively low populations can cause economic damage when plants are in the cotyledon or first leaf stages. Treat if you find several damaged rows; spot treatment of outside rows or borders may be sufficient. Baits are not effective.

Once plants have several true leaves, they can tolerate several beetles per plant without damage. Older plants are even more tolerant. Insecticide treatment should rarely be required, but if it is, one application should suffice. However, chemical treatment may disrupt biological control of aphids and whiteflies.

TREATMENT:

Pesticide (commercial name)	Amount/Acre**	P.H.I.+ (days)
A. ESFENVALERATE*		
(Asana XL)	5.8-9.6 fl oz	7
COMMENTS: Lower rate should suffice. Do not exceed 0.5 lb a.i./acre/season.		
B. CARBARYL*		
(Carbaryl) 4F or XLR Plus	1-2 pt	0
(Carbaryl) 80S or 80WP	0.66-2.5 pt	0
C. DIAZINON		
(Diazinon) 50W	0.5-1 lb	10
(Diazinon) AG500	0.5-1 pt	10

** See label for dilution rates.
+ Preharvest interval. Do not apply within this many days of harvest.
* Restricted use material. Permit required for purchase or use.

WILLOW CARROT APHID (4/94)

Scientific Name: *Cavariella aegopodii*

DESCRIPTION OF THE PEST: The wingless summer form of the willow carrot aphid is pale green with the cornicles, cauda (tail-like structure), and legs pale to slightly dusky. They are medium-sized aphids with rather elongate oval-shaped bodies that are flattened front to back. The upper surface of the body may be roughened by numerous small depressions. The wingless forms have a second tail-like process called the supracaudal process directly above the cauda giving the aphid the appearance of having twin tails when viewed with a hand lens. This supracaudal process may be triangular or fingerlike in shape.

The winged forms have a black head and thorax. The abdomen is pale green with dark areas on the sides and dark bands on the top. The antennae are black. The legs are pale in color and black at the tips. The cornicles are somewhat swollen near the tip.

DAMAGE: Willow carrot aphid is primarily of concern because of its efficiency in vectoring a number of serious virus diseases. It transmits carrot motley dwarf, carrot red leaf, and parsnip yellow fleck. It is also a vector of celery mosaic, sugarbeet mosaic, and cauliflower mosaic virus. It seldom reaches numbers that trigger the need for chemical intervention.

CULTURAL CONTROL: Sanitation is important in curbing the spread of the viruses that this insect vectors. Disc all crop residues under as soon as harvest is complete. Keeping fields, ditch banks, and fence lines weed free may also help in reducing virus inoculum.

BIOLOGICAL CONTROL: Little is known regarding the parasites of willow carrot aphid. The presence of bloated mummies indicates parasite activity. Predators such as green lacewing larvae, ladybird beetles, and syrphid fly larvae prey on this aphid as well as on other aphid species.

ORGANICALLY ACCEPTABLE METHODS: Biological and cultural controls.

WHEN TO TREAT: No treatment thresholds have been established. Chemical treatments are not effective in preventing virus transmission and this aphid rarely builds up in numbers high enough to cause economic damage by direct feeding.

BEAN APHID (4/94)

Scientific Name: *Aphis fabae*

DESCRIPTION OF THE PEST: Bean aphid is a dark olive green to black colored aphid. It is most easily confused with the cowpea aphid. Bean aphid has a dull, mattelike appearance while the cowpea aphid is shiny. The cauda (tail-like structure) of the bean aphid has more hairs than that of the cowpea aphid and thus appears bushy. Except for the presence of wings, the winged form of the bean aphid is similar in appearance to the wingless forms.

DAMAGE: Bean aphid may transmit celery mosaic but little is known in this regard. Bean aphid only occasionally builds up on carrots and little is known regarding economic thresholds and damage.

CULTURAL CONTROL: No cultural control strategies are presently available for managing bean aphids in carrots.

BIOLOGICAL CONTROL: Bean aphids are attacked by a variety of common aphid predators and parasites. Lady beetles, green lacewing larvae, and syrphid fly larvae are frequently found associated with aphid colonies. Note the presence of these predators and their impact on aphid populations during routine monitoring. Bean aphid is also attacked by a very prolific parasitic wasp, *Lysiphlebus testaceipes*. Parasitized aphids become bloated and their bodies turn tan in color. Bean aphid is also attacked by a fungus disease that leaves the aphid body flattened and with the appearance of being glued to the leaf.

ORGANICALLY ACCEPTABLE METHODS: Biological and cultural controls.

WHEN TO TREAT: Treatment is rarely required. No thresholds have been established for the treatment of bean aphid on carrots. Chemical treatments are not effective in preventing virus transmission and this aphid rarely causes economic damage.

TREATMENT:

Pesticide (commercial name)	Amount/Acre**	P.H.I.+ (days)
A. DIAZINON 50 WP	1 lb	10
B. MALATHION 8	1.5-2 pt	7

** See label for dilution rates.
+ Preharvest interval. Do not apply within this many days of harvest.

COTTON/MELON APHID (4/94)

Scientific Name: *Aphis gossypii*

DESCRIPTION OF THE PEST: Cotton/melon aphid is a small to medium-sized aphid. It is highly variable in color, ranging from lemon yellow to blackish green in different individuals, often within the same colony. The aphid is commonly lighter in color during the hotter times of the year and darker during cooler periods, but both color forms may be found throughout the year.

DAMAGE: Cotton/melon aphid is known to transmit more than 50 viruses, some of which affect carrots. It does not generally build up large populations on carrots but may occasionally cause some feeding injury. Injury is typical of aphid feeding with curled and distorted leaves. If populations are large enough, honeydew accompanied by sooty mold may be produced.

CULTURAL CONTROL: Carrots planted adjacent to infested cotton or melons are at risk of becoming infested with this aphid particularly in fall following cotton defoliation or termination of the melon crop. Carrots should be planted a safe distance from both, if possible.

BIOLOGICAL CONTROL: Cotton/melon aphid is attacked by the common aphid predators including green lacewing, lady beetles, and syrphid fly larvae. Several parasites of this aphid are present in California and can provide effective control. Parasitized aphids can be identified by their tan color and bloated appearance.

ORGANICALLY ACCEPTABLE METHODS: Cultural and biological controls.

WHEN TO TREAT: Treatment not normally required. No thresholds for cotton/melon aphid on carrots have been established. Chemical treatments are not effective in preventing virus transmission and this aphid rarely causes economic damage.

TREATMENT:

Pesticide (commercial name)	Amount/Acre**	P.H.I.+ (days)
A. DIAZINON 50WP	1 lb	10
B. MALATHION 8	1.5-2 pt	7

** See label for dilution rates.
+ Preharvest interval. Do not apply within this many days of harvest.

HONEYSUCKLE APHID (4/94)

Scientific Name: *Hyadaphis foeniculi*

DESCRIPTION OF THE PEST: The wingless forms of the honeysuckle aphid are small to medium sized, predominantly grayish green with dark antennae, legs, cornicles, and cauda (tail-like structure). The body may be variably dusted with a fine white wax. The winged forms have a green abdomen mottled with darker green and a dark patch around the base of each cornicle.

DAMAGE: Like other aphids this one also serves as a vector of a number of viruses. It may occasionally build up on carrots but injury is generally not common.

CULTURAL CONTROL: No cultural control strategies are available for the management of this aphid.

BIOLOGICAL CONTROL: Honeysuckle aphid is attacked by the common aphid predators such as green lacewing, lady beetles, and syrphid fly larvae. Little is known about the parasites of this aphid.

ORGANICALLY ACCEPTABLE METHODS: Biological controls.

WHEN TO TREAT: Chemical control of this aphid is generally not recommended.

GREEN PEACH APHID (4/94)

Scientific Name: *Myzus persicae*

DESCRIPTION OF THE PEST: Green peach aphid is most common in spring and fall but may be found at any time throughout the year. It is a medium-sized aphid and the wingless forms are uniformly pale green in color. At times, a pinkish form may be present. During cool weather, individuals of both color forms may be slightly darker than those found during hotter times of the year. Both winged and wingless forms have prominent cornicles that are markedly swollen and clublike in appearance. The frontal tubercles at the base of the antennae are very prominent and are convergent. The winged forms have a distinct dark patch on the top of the abdomen; wingless forms lack this dark patch.

DAMAGE: The green peach aphid vectors more plant viruses than any other aphid, transmitting over 100 different virus diseases. It does not, however, vector carrot motley dwarf or carrot red leaf virus. Virus-infested leaves are distorted and curled. If populations are high enough, stunting may occur. Infestations on young plants are more serious than those on older plants.

CULTURAL CONTROL: Field sanitation is important in reducing the number of aphids in and around carrots.

BIOLOGICAL CONTROL: Green peach aphid is attacked by a number of common predators and parasites and is susceptible to the fungus disease that commonly attacks aphids. Common predators include green lacewing, lady beetles, and syrphid fly larvae.

ORGANICALLY ACCEPTABLE METHODS: Cultural and biological controls.

WHEN TO TREAT: Small colonies occasionally develop on carrot leaves and may reach treatable levels, but no treatment thresholds for green peach aphid on carrots have been established. Green peach aphid has developed a high level of resistance to many chemicals and may be hard to control.

TREATMENT:

Pesticide (commercial name)	Amount/Acre**	P.H.I.+ (days)
A. ENDOSULFAN* 3EC	1.33 qt	7

COMMENTS: Do not use treated tops for food. See label for application limits.

** See label for dilution rates.
+ Preharvest interval. Do not apply within this many days of harvest.
* Restricted use material. Permit required for purchase or use.

CROWN AND ROOT APHIDS (4/94)

Scientific Names: Hawthorn parsley aphids: *Dysaphis foeniculus* and *D. apiifolia*
Tulip bulb aphid: *D. tulipae*
Hawthorn carrot aphid: *D. crataegi*

DESCRIPTION OF THE PESTS: These aphids form colonies near the top of the root and at the base of the stems. They occasionally form colonies on the root slightly below ground. All are similar in appearance with the wingless forms being pale yellow to gray green in color and covered with a powdery wax. The tulip bulb aphid is covered with a white waxy powder while the wax covering the hawthorn parsley aphid is grayish white. The hawthorn carrot aphid is yellowish gray to greenish gray with a very light dusting of wax. All three species, when present, are usually attended by ants. The presence of ants around the base of the plants is usually a good clue to the presence of these aphids.

DAMAGE: These aphids occur infrequently and only occasionally cause injury. High populations may stunt growth, but more serious is that the tops may be weakened by their feeding and break off during harvest, leaving the carrot in the ground.

CULTURAL CONTROL: Sanitation and crop rotation to nonhost crops is important in reducing the buildup of these aphids and their injury.

BIOLOGICAL CONTROL: Because of their location near and below the soil line, predators and parasites have a difficult time finding these aphids. The attendance by ants also discourages the activity of predators and parasites.

ORGANICALLY ACCEPTABLE METHODS: Cultural controls.

WHEN TO TREAT: No treatment thresholds have been established for these aphids.

WHITEFLIES (4/94)

Scientific Names: Greenhouse whitefly: *Trialeurodes vaporariorum*
Iris whitefly: *Aleyrodes spiraeoides*
Sweetpotato whitefly: *Bemisia tabaci*
Silverleaf whitefly: *Bemisia argentifolii*

DESCRIPTION OF THE PESTS: Whiteflies are small insects that are about 0.04 inch (1 mm) long. The body and wings of adults are covered with a fine, whitish powdery wax that is opaque in appearance. Whiteflies colonize the underside of leaves; adults and eggs are commonly found on the lower surface of younger leaves and the scalelike nymphal stages on somewhat older leaves. Distinguishing whitefly species is difficult; use a hand lens to examine both immatures and adults. Adult silverleaf whiteflies hold their wings somewhat vertically tilted like the peaked roof of a house, instead of flat over their bodies like the greenhouse whitefly. During the last part of the fourth larval stage, often called the pupa, the whitefly develops red eyes and stops feeding. This is the stage that is easiest to identify silverleaf whitefly; pupae have no waxy filaments around their edges as do most other species of whiteflies.

DAMAGE: Extremely dense populations of silverleaf whitefly may immigrate into late August or September plantings of carrots in the low deserts of southern California and damage seedlings. In light to moderate infestations, leaves show no distinctive symptoms as a result of whitefly feeding; however, copious quantities of honeydew are deposited on leaves, resulting in a shiny, sticky appearance.

BIOLOGICAL CONTROL: Several parasitic wasps, including species in the *Encarsia* and *Eretmocerus* genera, control whiteflies. Whitefly nymphs are also preyed upon by bigeyed bugs, lacewing larvae, and lady beetles. The lady beetles, *Delphastus pusillus* and *Serangium parcesetosum*, are being introduced into southern California to assist in biological control. Encourage buildup of beneficial insects by avoiding the use of harsh chemicals and by protecting their habitat.

CULTURAL CONTROL: Remove field bindweed and other weeds in and adjacent to the crop field as well as crop residues. Host free periods are valuable for controlling several of the whitefly species. Contact your Cooperative Extension Office for a list of hosts that harbor the silverleaf whitefly.

ORGANICALLY ACCEPTABLE METHODS: Biological and cultural controls, as well as soap sprays.

WHEN TO TREAT: *Carrots are not a preferred host of whiteflies and treatment with insecticides is rarely justified.* However, when dense populations of adult silverleaf whitefly are migrating, monitor seedling carrot fields at least twice weekly and treat if necessary. Occasionally dense colonies of silverleaf whitefly nymphs can necessitate treatment of bunching carrots to prevent honeydew and sooty molds from severely contaminating the carrot tops.

Whiteflies can be very difficult or almost impossible to control with insecticides. Natural or introduced biological methods provide the best long-term solution to keeping whitefly numbers at a minimum along with reducing host plants in areas of heavy infestation. If you treat for silverleaf whitefly, make applications before pests build up and contaminate carrot tops with honeydew. Combinations of a pyrethroid insecticide (esfenvalerate) with either methomyl or endosulfan provide superior control over applications of a

Continued on next page.

Whiteflies cont. (4/94)

single insecticide. Rotate pyrethroid treatments with a treatment of insecticidal soap to help slow development of insecticide resistance. There is some evidence of endosulfan resistance in populations of silverleaf whitefly in the Imperial Valley. Insecticidal soaps control all immature stages of whiteflies, including eggs, whereas the other materials control first instar nymphs and adults only; thus, treatment timing is critical. Emergency registrations may be in effect in some areas for new materials. Check with your local county agricultural commissioner.

TREATMENT:

Pesticide (commercial name)	Amount/Acre**	P.H.I.+ (days)
A. INSECTICIDAL SOAP#		
(M-Pede)	1 percent solution or less	
COMMENTS: This material has no residue and requires frequent applications and thorough coverage. Does not kill adults.		
B. ENDOSULFAN*		
(Endosulfan) 3EC	1.33 qt	
(Thiodan) 3EC	1.33 qt	7
(Thiodan) 50WP	2 lb	
COMMENTS: Do not feed tops. Do not make more than one application per year. Do not exceed a maximum of 1 lb a.i./acre per year. Use only in combination with a pyrethroid.		
C. METHOMYL*		
(Lannate) 90WSP	0.5-1 lb	1
D. ESFENVALERATE*		
(Asana) XL	5.8-9.6 fl oz	7
COMMENTS: Apply as needed for control, but do not exceed 0.5 lb a.i.(3 qt of formulation)/acre/season. Use ground application only.		

** See label for dilution rates.
+ Preharvest interval. Do not apply within this many days of harvest.
* Restricted use material. Permit required for purchase or use.
# Acceptable for use on organically grown produce.

SALTMARSH CATERPILLAR (4/94)

Scientific Name: *Estigmene acrea*

DESCRIPTION OF THE PEST: Saltmarsh caterpillar larvae are hairy and gray when first hatched, then darken to yellow, brownish, or almost black with yellow lines. They are covered with reddish or black hairs, and can be up to 2 inches long when fully grown. Eggs are spherical, whitish, somewhat flattened, about 0.03 inch in diameter, and found in clusters on the undersurface of leaves.

DAMAGE: In the southern San Joaquin Valley saltmarsh caterpillars are occasional pests that feed on foliage. They are primarily a problem in fall when neighboring cotton fields are defoliated.

CULTURAL CONTROLS: Ditch or trench around the edges of fields that border cotton.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

WHEN TO TREAT: In fall, if saltmarsh caterpillars are migrating into carrots, a treatment may be necessary.

TREATMENT:

Pesticide (commercial name)	Amount/Acre**	P.H.I.+ (days)
A. CARBARYL* (Sevin) 80S	1.25-2.5 lb	0
COMMENTS: Ground or air application.		

** See label for dilution rates.
+ Preharvest interval. Do not apply within this many days of harvest.
* Restricted use material. Permit required for purchase or use.

DISEASES

POWDERY MILDEW (4/94)

Pathogen: *Erysiphe polygoni*

SYMPTOMS: Older leaves and leaf petioles of plants with powdery mildew may be covered with a white, powdery growth. Young leaves develop small, circular, white, powdery spots that slowly enlarge to cover the leaflets. A slight chlorosis or yellowing may appear on leaves infected by the fungus.

COMMENTS ABOUT THE DISEASE: The fungus survives on and is spread by contaminated seed. Foliage symptoms usually do not appear until leaves are mature, and leaves can survive even with heavy infections. Fungal infection and disease development are favored by high humidity during evening and morning hours, and temperatures between 55 and 90 F.

CULTURAL CONTROL: Use seed that is not contaminated with the fungus (i.e., produced where powdery mildew is not found).

ORGANICALLY ACCEPTABLE METHODS: Cultural control and sulfur sprays.

WHEN TO TREAT: Chemical controls are not recommended, unless infections appear very early in the growing season.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
A. SULFUR# (Microthiol Special, Thiolux)	3-10 lb

COMMENTS: Apply at first sign of disease and repeat at 14 days as needed to maintain control.

Acceptable for use on organically grown produce.

CERCOSPORA LEAF BLIGHT (4/94)

Pathogen: *Cercospora carotae*

SYMPTOMS: Cercospora blight can occur on any aboveground carrot tissue. However, symptoms are usually most severe and obvious along leaflet margins. Infection sites initially appear as a brown spot with a dark brown margin. A chlorotic halo often develops around these spots. As the disease progresses, the leaflets become yellowed and curl at the margins. Lesions on leaf petioles, stems, and flower parts are usually elongated and dark brown. Under heavy disease pressure, severe loss of foliage may occur.

COMMENTS ABOUT THE DISEASE: Cercospora blight is usually of minor importance in California and occurs in coastal carrot-growing regions. *Cercospora carotae* can be seedborne, but also survives between crops on plant debris or in the soil. Infection occurs over a wide range of temperatures with an optimum at 82 F.

CULTURAL CONTROLS: Use seed not known to be contaminated with the fungus or treat seed with fungicides before planting. Destroy diseased crop refuse by plowing it under to insure decomposition and practice 2- to 3-year crop rotations.

ORGANICALLY ACCEPTABLE METHODS: Cultural controls and copper hydroxide sprays.

WHEN TO TREAT: In fields with a history of Cercospora leaf blight, start fungicide applications when conditions are conducive to disease development or when disease is observed.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
Seed Treatment	
A. THIRAM 50 WP	8 oz/100 lb seed
COMMENTS: Treated seed must not be used for or mixed with food or animal feed. Treat only enough for immediate use; do not store excess treated seeds beyond planting time.	
After Planting	
A. CHLOROTHALONIL (Bravo 720)	1.5-2 pt
COMMENTS: Apply in sufficient water to obtain good coverage. Repeat applications at 7 to 10-day intervals as needed to maintain control. May be applied by sprinklers. Check the product label for specific application requirements.	
B. COPPER HYDROXIDE# (Champion, Kocide)	1-2 lb
(Champ)	2.66 pt
COMMENTS: Repeat applications at 7- to 14-day intervals, depending on disease severity.	

Acceptable for use on organically grown produce.

COTTONY SOFT ROT (4/94)

Pathogen: *Sclerotinia sclerotiorum*

SYMPTOMS: *Sclerotinia* infection may occur at any stage of growth, and extensive root decay may occur before symptoms of wilt and collapse appear on the upper part of the plant. Infection is always accompanied by a characteristic cottony, white mycelium that appears on the surface of the infected area. On or inside the white mycelium appear black, round-to-irregular-shaped structures about 0.1-0.4 inch (3 to 10 mm) wide called sclerotia, which are inactive forms of the fungus. The fungi *Pythium* or *Rhizoctonia* may also produce cottony growth, but will not produce sclerotial bodies in the mycelium. Sclerotinia soft rot is usually soft and watery compared to Rhizoctonia rot, which tends to be firm and dry. Bacterial soft rot tends to be slimy and malodorous and is often secondary to Sclerotinia and other fungal rots.

COMMENTS ON THE DISEASE: *Sclerotinia* is most active when soil temperatures are 55 to 77 F. Moist soils are necessary for fungal activity. However, once infection is established, moisture from the carrot root tissue is sufficient to maintain fungal growth.

CULTURAL CONTROLS: Deep plowing once per year to bury sclerotia 8 to 10 inches into the soil will reduce disease incidence, but not eliminate it completely because spores may be blown in from other fields. A 3-year rotation to cereals, corn, or cotton will also help reduce sclerotial populations in the soil.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: Begin applications when disease first appears and conditions favor disease development.

TREATMENT:

Pesticide (commercial name)	Amount/Acre	P.H.I.+ (days)
A. BENOMYL (Benlate) 50DF	0.25-1 lb	4

COMMENTS: Use allowed under a supplemental label. Do not tank mix benomyl with lime or alkaline sprays such as Bordeaux mixture or lime sulfur.

+ Preharvest interval. Do not harvest within this many days of harvest.

CAVITY SPOT (4/94)

Pathogen: *Pythium violae*

SYMPTOMS: Cavity spot is characterized by elliptical to irregularly shaped, depressed lesions oriented across the mature carrot tap roots. Individual lesions are usually less than 0.5 inch (1.3 cm) in diameter, but can be much larger, especially on processing varieties. Infections occur anywhere along the tap root, but lesions tend to be more abundant on the upper third of the root. Lesions begin as pinpoint, sunken spots and generally enlarge as roots mature.

COMMENTS ON THE DISEASE: The causal fungus is favored by cool soil temperatures; in culture it grows best at 58 F. The incidence of the disease is probably dependent on the number of thick-walled oospores (overwintering spores) in the soil. *Pythium violae* also causes lesions on alfalfa roots. Infections of other hosts such as celery, blackeye beans, wheat, cucumber, and beets may not result in symptoms. Nonhosts include tomato, cotton, watermelon, corn, and potato.

CULTURAL CONTROL: Practice 3-year crop rotations with crops other than alfalfa or carrots. Do not overirrigate. Harvest carrots soon after they mature because older carrots are more susceptible to infection. All carrot varieties are susceptible.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: Apply metalaxyl in fields with histories of severe cavity spot.

TREATMENT:

Pesticide (commercial name)	Amount/Acre	P.H.I.+ (days)
A. METALAXYL		
(Ridomil) 2E	see comments	7

COMMENTS: Apply 4-8 pt/acre as a preplant incorporated treatment or as a soil surface spray immediately after planting. Postplant use is allowed under a special local needs permit. Make a second application of 12 fl oz/acre 40-50 days after planting. If needed, a third application of 12 fl oz/acre can be applied 14-21 days after the second application. Do not exceed more than 11.2 pt/acre/crop season.

+ Preharvest interval. Do not harvest within this many days of harvest.

ROOT DIEBACK (FORKING AND STUBBING) (4/94)

Pathogen: *Pythium ultimum* and *Pythium irregulare*

SYMPTOMS: Root dieback of carrots produces excessively branched or stubbed roots. The fungus kills young tap roots less than 2 weeks after seed germination, reducing root length and/or stimulating multiple root formation. *Pythium* spp. can also cause damping-off of carrots. Forking and stubbing can also be caused by hardpans, nematodes, and excessive water, among other factors.

COMMENTS ON THE DISEASE: Only very young tissue is susceptible. The severity of the disease may be dependent on the density of thick-walled *Pythium* oospores (overwintering spores) or sporangia (a structure that encloses spores) in field soils. The pathogens are spread in water and soil. Very wet soil conditions favor the disease.

CULTURAL CONTROL: Avoid overwatering and provide good drainage. Rotating to small grains might reduce soil populations of some *Pythium* spp.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

WHEN TO TREAT: In fields with a history of *Pythium*-related problems, make a preplant treatment.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
A. METALAXYL (Ridomil) 2E	4-8 pt
COMMENTS: Preplant application. Do not apply more than 11.2 pt/acre/crop.	

BLACK ROT (BLACK CROWN) (4/94)

Pathogen: *Alternaria radicina*

SYMPTOMS: Black rot starts in the carrot crown at the point of leaf attachment, beginning with the outermost petiole; eventually all the leaves can be killed. The upper part of the carrot root will show a dark rot, which occasionally may continue into the lower part of the carrot root. Leaves weakened or rotted by black rot may break off when gripped by mechanical harvesters, resulting in roots being left in the ground. Black rot can also be a problem in storage.

Under certain conditions, the fungus also can cause a leaf blight, which is characterized by dark brown lesions along the leaf margins. The fungus can also cause a pre- and postemergence damping-off of carrot seedlings.

COMMENTS ON THE DISEASE: The fungus is favored by sprinkler irrigation or rainy weather and high temperatures, which may predispose tissue to infection. *Alternaria radicina* is seedborne and may be spread on carrot seed. It also survives in carrot debris and in the soil for several years. Black rot is important only in certain areas or regions in California. It may be common in coastal mountain valleys, e.g. the Cuyama Valley.

CULTURAL CONTROL: Plant *Alternaria*-indexed seed; this is especially important in fields where black rot has not been identified or carrots have not been grown. An alternative would be to soak seeds in hot water (50 C) for 25 minutes. Do not soak longer or seeds could be damaged.

Furrow rather than sprinkler irrigation may reduce disease development. Crop rotation is highly recommended to prevent buildup of the fungus in the soil. Deep tillage may provide some control by burying inoculum of the fungus away from the carrot crown.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: Foliar applications of fungicides to control black rot are not effective, but seed treatment may give good control.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
Seed Treatment	
A. IPRODIONE	
(Rovral) 50WP	0.5 lb/6 gal water
COMMENTS: Soak seeds for 24 hours at 30 C in a solution of iprodione and water. Use 6 gal of solution for 3 lb of carrot seed.	
...or...	
(Rovral) 50WP	16 oz/100 lb seed
COMMENTS: Apply as a slurry with enough water to ensure complete coating of seed.	

ALTERNARIA LEAF BLIGHT (4/94)

Pathogen: *Alternaria dauci*

SYMPTOMS: Alternaria leaf blight symptoms appear as dark brown to black irregularly shaped lesions on leaf blades and petioles. Spots are initially surrounded by a yellow margin and often begin on the older leaves. Leaves can be killed when spots grow together. Lesions that develop on petioles may kill entire leaves. Leaves weakened by blight may break off when gripped by mechanical harvesters, resulting in the roots being left in the ground.

The pathogen also causes damping-off of carrot seedlings.

COMMENTS ON THE DISEASE: The disease is favored by rainy weather and/or overhead irrigation. The pathogen, *Alternaria dauci*, is seedborne and survives on and is spread on carrot seed. It can also survive in carrot debris and on volunteer carrots. Spores are dispersed in air and splashing water. The optimum temperature for growth and infection is 82 F with some infection occurring at temperatures as low as 57 F and as high as 95 F. Although the fungus survives on carrot debris left in the field after harvest, once the crop residue decomposes, the fungus dies.

CULTURAL CONTROL: Planting *Alternaria*-indexed seed is very important. An alternative would be to soak seeds in hot water (50 C) for 25 minutes. Do not soak longer or seeds could be damaged. Turn under carrot residue by tillage or plowing to hasten decomposition of debris. Practice 2-year rotations: avoid continuous carrot culture. Do not plant new fields near existing fields with blight symptoms.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: Seed treatments should effectively control *Alternaria dauci*. If seed are not treated, apply fungicides when the first blight symptoms appear, at biweekly intervals, and/or when conditions are favorable for disease development.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
Seed Treatment	
A. IPRODIONE	
(Rovral) 50WP	0.5 lb/6 gal water
COMMENTS: Soak seeds for 24 hours at 30 C in a solution of iprodione and water. Use 6 gal of solution for 3 lb of carrot seed.	
...or...	
(Rovral) 50WP	16 oz/100 lb seed
COMMENTS: Apply as a slurry with enough water to ensure complete coating of seed.	
Foliar Treatment	
A. IPRODIONE	
(Rovral) 50WP	1-2 lb
COMMENTS: Do not make more than 4 applications of iprodione per season.	
B. CHLOROTHALONIL	
(Bravo 500)	2.25-2.75 pt
COMMENTS: Repeat applications at 7- to 10-day intervals if necessary to maintain control.	

BACTERIAL LEAF BLIGHT (4/94)

Pathogen: *Xanthomonas campestris* pv. *carotae*

SYMPTOMS: Bacterial leaf blight symptoms appear as irregular brown spots on leaves, often beginning on their margins. Lesions initially have an irregular, yellow halo and may appear watersoaked. Spots coalesce and cause a leaf blight and dark brown streaks develop on leaf petioles. Floral parts may also be blighted. Dark brown streaks develop on leaf petioles. A sticky bacterial exudate, which is a diagnostic sign of the disease, may be observed flowing downward on petioles and flower stalks.

COMMENTS ON THE DISEASE: *Xanthomonas campestris* pv. *carotae* is seedborne and survives on and is spread with carrot seed. The bacteria also survives in carrot debris but cannot survive in the soil in the absence of debris. Rain or sprinkler irrigation is required for optimum disease development. Warm weather favors infection and disease development. Optimum temperatures are between 77 and 86 F; infection does not occur below 65 F. The pathogen is dispersed in splashing water.

CULTURAL CONTROL: Plant *Xanthomonas*-indexed seed. Use furrow irrigation rather than sprinklers. Turn under carrot residue to hasten decomposition. Avoid continuous carrot culture by using a 2- to 3-year crop rotation scheme.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: The benefits of spraying bactericides such as copper compounds or antibiotics are questionable because bacterial blight, although common in California, does not usually cause significant yield reductions.

SOUTHERN BLIGHT (4/94)

Pathogen: *Sclerotium rolfsii*

SYMPTOMS: Southern blight is characterized by a soft and watery decay of the taproot at or near the soil line. The disease develops rapidly, resulting in wilting and yellowing of the carrot top. White mats of mycelium develop on the carrot root and in the adjacent soil. Tan to brown, round sclerotia (resting structures) about 0.1 inch (3 mm) in diameter develop on mycelial mats. The abundant sclerotia are a good diagnostic feature of southern blight.

COMMENTS ON THE DISEASE: High temperatures favor the disease. The fungus attacks a wide range of plants and survives for long periods in the soil as sclerotia. However, southern blight is usually a minor disease of carrots.

CULTURAL CONTROL: Rotation to nonhosts such as corn or small grains for at least 2 years reduces numbers of sclerotia. Burying plant refuse helps destroy sclerotia.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: Chemical control is not recommended.

BACTERIAL SOFT ROT (4/94)

Pathogen: *Erwinia carotovora*

SYMPTOMS: Bacterial soft rot appears as a soft, watery, and slimy decay of the taproot. The decay rapidly consumes the core of the carrot, often leaving the epidermis intact. A foul odor may be associated with soft rot. Aboveground symptoms include a general yellowing and wilting of the foliage.

COMMENTS ON THE DISEASE: *Erwinia carotovora* is a common soilborne bacterium that attacks a wide range of fruits and vegetables. The bacterium enters carrots through various kinds of wounds. In the field, soft rot is most often associated with warm temperatures and standing water due to poor drainage, low areas, or leaky irrigation pipes.

CULTURAL CONTROL: In the field, maintain good drainage and avoid practices that could wound roots. In the packinghouse, handle carrots carefully to avoid bruising and store them under cool conditions.

DISEASES CAUSED BY MYCOPLASMALIKE ORGANISMS (4/94)

Pathogens: Beet Leafhopper Transmitted Viresence Agent
Aster Yellows Mycoplasma

SYMPTOMS: *Beet leafhopper transmitted viresence agent.* Leaves of infected plants are reddish purple. Infected plants often bolt prematurely. Flower parts are malformed; petals that would normally be white are green and the flowers proliferate to form multiple, compound, leafy umbels. Diseased plants have woody, unmarketable roots with an excessive number of lateral rootlets.

Aster yellows mycoplasma. Leaves of infected plants are twisted, stunted, and yellow. Leaflets may be reduced to short scales. Flower parts are severely distorted and malformed; umbels are stunted and yellow green. Most infected plants develop a dense cluster of dwarfed, chlorotic, upright, adventitious shoots. Infected plants show increased lateral rootlet development.

COMMENTS ON THE DISEASE: The beet leafhopper transmitted viresence agent is transmitted by the beet leafhopper, *Circulifer tenellus.* Aster yellows mycoplasma is transmitted by several species of leafhoppers. Both mycoplasmalike organisms have wide host ranges. The level of infection in carrot fields is dependent on the population of vectors. Disease incidence may be greater if carrots are planted near areas where weeds and other plants provide a reservoir for the mycoplasmalike organisms and their vectors.

CONTROL: None practiced.

CARROT THIN LEAF (4/94)

Pathogen: Carrot thinleaf potyvirus

SYMPTOMS: Symptoms on plants infected with carrot thinleaf potyvirus can vary. In general, leaflets appear thinner than normal, giving the plant an overall unusual appearance. Some leaves may have leaflets that are distorted and show a mosaic pattern. Leaflets of plants infected at a young stage may be extremely thin, hence the name of the virus. The virus has not been shown to cause yield losses in California.

COMMENTS ON THE DISEASE: Carrot thinleaf potyvirus is only transmitted from plant to plant by aphid vectors. Aphids transmit the viruses during the probing phase of aphid visitation to plants; transmission does not occur during aphid feeding. Aphids only retain the ability to transmit these viruses for very short periods of time (minutes to a few hours). Thus, spread is often very rapid and occurs in local areas of a field. Many aphid species can spread carrot thinleaf potyvirus. Field spread of carrot thinleaf potyvirus, and potyviruses in general, occurs when aphid activity in fields is high.

Carrot thinleaf potyvirus has a very limited plant host range; in nature it seems to be largely limited to carrots. In California, carrot thinleaf potyvirus is primarily found in the Central Valley, mostly in the lower San Joaquin Valley carrot production area. Some fields have been found to have a significant incidence of carrot thinleaf potyvirus, but have not suffered economic loss. However, in Washington State, where it sometimes coinfects plants with other carrot viruses, disease losses can result. Carrot thinleaf potyvirus oversummers in volunteer carrots that survive from previous carrot plantings.

CULTURAL CONTROL: No cultivar resistance is known. A likely cultural control strategy would be to eliminate volunteer carrots during the late summer as newly planted seedlings are emerging; aphid activity is high at this time, and the virus can be spread to new fields.

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: No effective pesticide strategies are effective. Insecticides directed at controlling the aphid vectors are ineffective because they cannot kill the aphids before transmission occurs.

CARROT MOTLEY DWARF (4/94)

Pathogens: Carrot redleaf luteovirus and carrot mottle virus

SYMPTOMS: Carrot motley dwarf is caused by the combined infection of carrots by two viruses: carrot redleaf luteovirus and carrot mottle virus. Plants infected in the seedling stage will be severely stunted, and yellow to red in color. Plants appear as if they are suffering a nutritional deficiency. When plants are infected at later stages of growth, plants may or may not have stunted growth, but some leaves will be red or yellow, or a combination of red and yellow. Some leaves on infected plants may remain green.

COMMENTS ON THE DISEASE: Carrot motley dwarf only occurs in the cooler carrot production areas of California such as in the Salinas Valley and in the Ventura area. It is not known to occur in the San Joaquin or Imperial Valley growing regions. In some years, spring carrots are severely affected. Carrot redleaf luteovirus and carrot mottle virus are transmitted from plant-to-plant only by the willow carrot aphid, *Cavariella aegopodii*. Both viruses are carried together by the aphid and are then transmitted to plants as the aphid feeds. Once aphids acquire the viruses, they transmit them for the remainder of their lives. Disease development is associated with nearby carrot motley dwarf-affected fields and willow carrot aphids. The host ranges of the carrot motley dwarf viruses are relatively narrow and largely limited to carrot, parsley, and cilantro. The host range of willow carrot aphid is also narrow. Cilantro is not an aphid host, and although it is a virus host, it is not a likely source for subsequent virus spread. Carrots appear to be the best host for both viruses and the aphid vector, and overwintered carrots are the most important inoculum source for subsequent spring carrot motley dwarf development.

CULTURAL CONTROL: Some resistance, but not immunity, is available in certain carrot cultivars. Typically, Danvers types are most susceptible whereas Imperator types are most resistant. CVC 14 is a good resistant cultivar. Control also can be achieved by avoiding overwintering carrots. As overwintered carrots are the most important source of spring inoculum, attempt should be made to eliminate overwintered fields. If overwintered carrots are present, avoid planting early spring (December-January) carrots within close proximity (about 5 miles).

ORGANICALLY ACCEPTABLE METHODS: Cultural control.

CHEMICAL CONTROL: Insecticides are ineffective if used to control virus transmission to new crops. However, some evidence suggests that if overwintered fields are sprayed to kill overwintering aphids, this reduces the spread of the virus to early spring fields.

NEMATODES (4/94)

Scientific Names: Root knot nematode: *Meloidogyne arenaria, M. javanica, M. hapla,* and *M. incognita*
Stubby root nematode: *Paratrichodorus* sp.
Needle nematode: *Longidorus africanus*

DESCRIPTION OF THE PESTS: Nematodes are microscopic roundworms that live in diverse habitats. Plant parasitic nematodes live in soil and plant tissues and feed on plants by puncturing and sucking the cell contents with a needle-like mouthpart called a stylet. Nearly 90 species of nematodes have been reported in association with carrots.

Among nematodes that affect carrot, root knot nematodes are the most important in California. They are widely distributed throughout California. Root knot nematodes enter the roots as second stage juveniles where they remain to feed. Second stage juveniles are motile but the other stages are sedentary. After feeding in carrot roots, adult females become swollen and produce an egg mass just outside the root or just beneath the root surface. Root knot nematodes and their egg masses are visible at 10X magnification.

Needle nematode is important in the Imperial Valley, whereas stubby root nematode is found statewide. Both of these nematodes are migrating ectoparasites (i.e., they feed on but do not penetrate into the roots) and lay eggs singly in soil. They go through four molts and all juvenile stages probably feed on roots. Both needle nematode and stubby root nematode are smaller than root knot nematode and required greater magnification to be seen.

DAMAGE: Root knot nematodes can cause substantial damage and are of major concern in California. They can stunt the plants and cause stand and yield reduction. Heavy infestations of stubby root and needle nematodes can also reduce the stand and produce various sized patches of stunted, chlorotic plants.

SYMPTOMS: The symptoms described below are suggestive of a nematode problem but are not diagnostic as they can result from other causes as well. Carrots affected by nematodes often exhibit forking of the tap root, stubbing and fasciculation (bunching) of the roots, and a predisposition to wilting. In addition, root knot nematodes induce characteristic galls on feeder roots; small, hard-to-see galls are generally associated with *Meloidogyne hapla,* whereas, relatively large, conspicuous galls are usually associated with other *Meloidogyne* species. The stubby root nematode causes short roots with a stubby appearance. Needle nematode feeding causes cessation of root elongation, root branching, swelling of root tips, and sometimes root tip necrosis.

FIELD EVALUATION: If a previous crop had problems caused by nematodes that can affect carrots, the nematode population may be high enough to cause damage to a carrot crop that follows. It is critical to know the nematode species present to make management decisions. If nematode species have not previously been identified, take soil samples and send them to a diagnostic laboratory for identification of nematodes.

The following sampling procedure may be used. Divide the field into sampling blocks of not more than five acres each that are representative of cropping history, crop injury, or soil texture. Take the soil samples from within the root zone (6-18 inches deep). Take several subsamples randomly from a block, mix them thoroughly and make a composite sample of about one quart (1 liter) for each block. Place the samples in separate plastic bags along with symptomatic plants, seal them, and place a label on the outside with your name, address, location, and the current/previous crop and the crop

Continued on next page.

Nematodes cont. (4/94)

you intend to grow. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor for more details about sampling, locating laboratories that process nematode samples, and interpreting sample results.

MANAGEMENT:

Cultural practices. Crop rotation is usually not effective for control of root knot nematodes because of their wide host range. Most crops grown in the Imperial Valley, except cabbage and cauliflower, are susceptible to needle nematode. To avoid infesting new fields, clean machinery and equipment with water and prevent movement of infested soil.

Resistant cultivars. None.

Date of planting. The root knot nematodes *M. incognita, M. javanica,* and *M. arenaria* become inactive at soil temperatures below 64 F. Planting when soil temperatures are below this level will minimize forking of tap roots due to nematode feeding by these three species. *M. hapla,* however, is still active below 64 F.

When to Treat. Damage thresholds have not been established. Treatment is warranted whenever root knot, needle, or stubby root nematodes are present. No materials are registered for postplant use on carrots and once tap roots are damaged, control would not be feasible.

TREATMENT:

Pesticide (commercial name)	Amount/Acre
Preplant	
A. METAM SODIUM (Vapam, Soil Prep, Sectagon II)	50-100 gal
COMMENTS: Contact your farm advisor for advice on the most effective application method for a particular situation.	
B. METHYL BROMIDE*	
COMMENTS: Contact your local county agricultural commissioner to determine the availability of a Section 18 permit for the nontarped use of this chemical.	

*Restricted use material. Permit required for purchase or use.

WEEDS

INTEGRATED WEED MANAGEMENT (4/94)

Carrot is a slow-growing crop that suffers severe yield loss from weed competition. Its thin, feathery leaves do not shade out competing plants and its long growing season creates an opportunity for successive flushes of weeds throughout the growing season. The first 4 weeks of crop growth is an especially critical period for weed control. At harvest weeds also present problems when they become entangled in the equipment and in the crop.

An integrated weed management program is essential for carrot production because registered herbicides do not control many problem weeds in carrots; mechanical cultivation and hand hoeing are not feasible because of the high crop plant populations; and carrots are not competitive against weeds. A weed management program that combines good cultural practices with the use of herbicides will control many weed pests of carrots. However, the limited number of herbicides available and the diversity of weeds that grow in carrot fields make it difficult to maintain adequate control throughout the growing season. Generally more than one herbicide is necessary to effectively control the different weed species. Usually a preplant or preemergence herbicide is applied followed by one or more postemergence treatments.

The choice of herbicide depends upon the weed species that are expected to occur. Plantback restrictions need to be considered when selecting herbicides because soil residues of some products can limit the growth of sensitive rotational crops. Herbicide labels are the best source of plantback restrictions.

Nonchemical options are limited and when used without herbicides are not usually very successful in carrot production because of the very high density that carrots are planted at. Carrots are planted with 4 to 6 seedlines on the top of a 40 to 42 inch bed. Since the bed top is only 22 to 24 inches wide, there is no room to cultivate the planted area. Only the shoulders and furrows are cultivated. Additionally, because of the high density planting, hand weeding is not practical and can seriously damage the crop by removing carrots with the weeds.

MONITORING: Monitor fields and keep records of the weed species that occur in each field during the period of the year when the crop will be grown. Records of weeds occurring at planting time are especially important. Not only are these records valuable in planning which fields to use to grow carrots, they also help track the occurrence of hard-to-control weeds. Avoid fields with high populations of certain weeds such as sowthistle, shepherdspurse, nightshades, and nutsedge.

MANAGEMENT BEFORE PLANTING: Avoid planting carrots in fields last planted to cereals or in fields with known infestations of perennial weeds: available herbicides do not effectively control perennial weeds. To prevent the buildup of weed seed in the soil, cultivate weeds before they set seed in rotation crops. After harvest of the rotation crop, clean cultivate the field or plant a green manure crop to prevent weed infestations. In a typical farm mix of crops, carrots should be planted in the most weed-free fields.

Soil solarization can be used to control most weeds in carrots. It will also control or suppress some other important pests, such as nematodes. Soil solarization requires a summer fallow season for treatment; it fits in best with a fall-planted crop.

To control nutsedges, EPTC can be used during the fallow season under a Special Local Need (24c) registration in Imperial, Riverside, and San Bernardino counties. Apply it in summer before a fall carrot crop to reduce nutsedge

Continued on next page.

Integrated weed management cont. (4/94)

tuber populations. Be sure to use it according to label directions: the herbicide must be applied 90 days before carrot sowing, and the field must be irrigated 30 days before planting.

About 2 weeks before planting carrots, preirrigate the field to germinate weed seedlings and cultivate to destroy them. Carry out this operation as close to planting time as possible to assure that soil temperature and climatic conditions are similar to those that will occur during the crop germination period, thus maximizing the number of weeds controlled. Cultivate as shallowly as possible to avoid bringing up dormant weed seed from deeper soil layers.

Herbicides that are available to use preplant in carrots include paraquat (Gramoxone) and glyphosate (Roundup). These products can be used to control emerged weeds just before planting or before the crop emerges. Be sure the crop has not emerged, however, because emerged plants will be killed if contacted by these herbicides. Glyphosate has been particularly helpful in controlling perennial weeds when used as a preplant treatment.

Trifluralin is a commonly used preplant incorporated herbicide in carrots. It will control many annual weeds when used for the entire carrot production season.

MANAGEMENT AFTER PLANTING: Weeds must be controlled in a carrot field throughout the growing season and require some postplant control measures. Close cultivation and hand hoeing are not practiced because the injury to the crop is generally greater then the benefit received. An herbicide is generally applied before or after the crop emerges, depending on the weed species to be controlled.

Preemergence. Trifluralin can also be used as a preemergence herbicide in carrots. Sprinkler irrigation is required for incorporation and activation of the material if it is applied after planting. This method of use will increase the activity on shallowly emerging weeds, such as common purslane, but will limit soil longevity and effectiveness on weeds germinating from deeper in the soil.

Linuron (Lorox) is allowed in the counties of Kern, Monterey, Riverside, San Luis Obispo, Santa Barbara, and Ventura for preemergence application under a Special Local Need (24c) registration. Crop safety is marginal; be careful not to exceed label recommendations on rate. This herbicide will control annual broadleaf weeds better then trifluralin, particularly nightshade, mustards, and sowthistle.

Postemergence. Following crop emergence, fluazifop-P-butyl (Fusilade) can be applied for grass control and linuron (Lorox) for annual broadleaf weeds and yellow nutsedge. Fluazifop-P-butyl is effective in controlling small seedling annual grasses and some perennial grasses. Effectiveness is reduced when grasses are under moisture stress. Later growth stages of annual grasses are more difficult to control. Follow label instructions regarding the use of adjuvants with fluazifop-P-butyl. This herbicide will not control annual bluegrass.

Linuron can also be used as a postemergence herbicide in carrots. It is applied over the top of the crop when the carrots are 3 inches tall. It controls emerged weeds and also has soil residual activity against later emerging weeds. Linuron will control (suppress) yellow nutsedge, but has little to no effect on purple nutsedge. A repeat application is allowed, but a total of 3 lb a.i./A is the limit per season. Some carryover can occur under certain conditions, creating a plantback problem. Consult the herbicide label before application.

SPECIAL WEED PROBLEMS (4/94)

Sowthistle, little mallow, and nightshade. Sowthistle, little mallow, and nightshade are annual weeds that are difficult to control in carrots. The registered herbicides will not control these weeds very well. Avoid growing carrot crops in fields known to be heavily infested with these weeds.

Nutsedge. Nutsedge is a serious weed in spring- and summer-planted crops. Yellow and purple nutsedge are perennial weeds that reproduce from underground tubers, which can survive for several years in the soil. Each tuber contains several buds that are capable of producing plants. Only one bud at a time germinates to form a new plant; however, if that bud is destroyed by cultivation or an herbicide, then a new bud is activated. Control is best achieved by continuous cultivation during a summer fallow period or by rotating to crops where effective herbicide and cultural control methods can be used. For fall-planted carrots, plant after October 15 to avoid serious yield loss in carrots from competition by nutsedges.

COMMON AND SCIENTIFIC NAMES OF WEEDS (4/94)

COMMON NAME	SCIENTIFIC NAME
annual bluegrass	*Poa annua*
annual morningglory	*Ipomoea* spp.
barnyardgrass	*Echinochloa crus-galli*
bermudagrass	*Cynodon dactylon*
bindweed	*Convolvulus arvensis*
black nightshade	*Solanum nigrum*
canarygrass	*Phalaris canariensis*
chickweed	*Stellaria media*
clover	*Trifolium* spp.
crabgrass	*Digitaria* spp.
cudweed	*Gnaphalium spp.*
dock	*Rumex* spp.
fall panicum	*Panicum dichotomiflorum*
fiddleneck	*Amsinckia* spp.
filaree	*Erodium* spp.
flaxleaf fleabane	*Conyza bonariensis*
foxtail	*Setaria* spp.
goosefoot	*Chenopodium murale*
groundcherry	*Physalis* spp.
groundsel	*Senecio vulgaris*
hairy nightshade	*Solanum sarrachoides*
henbit	*Lamium amplexicaule*
horseweed	*Conyza canadensis*
johnsongrass	*Sorghum halepense*
knotweed	*Polygonum* spp.
lambsquarters	*Chenopodium album*
London rocket	*Sisymbrium irio*
lovegrass	*Eragrostis* spp.
malva	*Malva parviflora*
mustards	*Brassicae* spp.
nettle	*Urtica* spp.
pigweed	*Amaranthus* spp.
prickly lettuce	*Latuca serriola*
puncturevine	*Tribulus terrestris*
purple nutsedge	*Cyperus rotundus*
purslane	*Portulaca oleracea*
Russian thistle	*Salsola iberica*
ryegrass	*Lolium* spp.
shepherdspurse	*Capsella bursa-pastoris*
sowthistle	*Sonchus* spp.
sunflower	*Helianthus* spp.
wild barley	*Hordeum* spp.
wild oats	*Avena fatua*
wild radish	*Raphanus raphanistrum*
yellow nutsedge	*Cyperus esculentus*

SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL (4/94)

	HERBICIDES							
	PAR*	SET	GLY	TRI	MET	EPT*	FLU	LIN
ANNUALS								
annual bluegrass	C	N	C	C	C	C	N	P
annual morningglory	P	N	C	N	P	-	N	P
barnyardgrass	C	C	C	C	C	C	C	C
black nightshade	C	N	C	N	C	C	N	P
canarygrass	C	C	C	C	C	C	C	C
cereals	C	C	C	C	C	C	C	P
chickweed	C	N	C	C	C	C	N	C
clover	P	N	P	N	N	N	N	N
crabgrass	C	C	C	C	C	C	C	C
cudweed	N	N	C	N	C	P	N	P
dock	P	N	C	P	-	P	N	P
fall panicum	-	-	C	C	C	C	-	C
fiddleneck	P	N	C	C	C	C	N	C
filaree	P	N	P	N	C	P	N	-
flaxleaf fleabane	C	N	C	N	C	C	N	C
foxtail	C	C	C	C	C	C	C	C
goosefoot	C	N	C	C	C	C	N	C
groundcherry	C	N	C	N	C	C	N	C
groundsel	C	N	C	N	C	C	N	P
hairy nightshade	C	N	C	N	C	C	N	C
henbit	C	N	C	C	C	C	N	C
horseweed	P	N	C	N	C	C	N	P
knotweed	P	N	C	C	C	P	N	P
lambsquarters	P	N	C	C	C	C	N	C
London rocket	C	N	C	N	C	C	N	C
lovegrass	P	-	C	C	C	C	C	C
malva	N	N	P	N	N	N	N	C
mustards	C	N	C	N	C	N	N	C
nettle	P	N	N	N	C	C	N	C
pigweed	C	N	C	C	P	C	N	C
prickly lettuce	P	N	C	N	C	C	N	C
puncturevine	C	N	C	P	C	N	N	-
purslane	C	N	C	C	C	C	N	C
Russian thistle	C	N	C	P	C	P	N	-
ryegrass	P	C	C	C	C	C	C	N
shepherdspurse	C	N	C	N	C	P	N	C
sowthistle	P	N	C	N	C	C	N	P
sunflower	P	N	C	N	C	P	N	C
wild barley	P	C	C	C	C	C	C	C
wild oats	C	C	C	P	C	C	C	C
wild radish	C	N	C	N	C	N	N	C

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

PAR = paraquat* (Gramoxone)
SET = sethoxydim (Poast)
GLY = glyphsoate (Roundup)
TRI = trifluralin (Treflan)
MET = metam (Vapam)
EPT = EPTC*
FLU = fluazifop-P-butyl (Fusilade)
LIN = linuron (Lorox)

* Restricted use material. Permit required for purchase or use.

Susceptibility of weeds to herbicide control cont. (4/94)

	HERBICIDES							
	PAR*	SET	GLY	TRI	MET	EPT*	FLU	LIN
PERENNIALS								
bermudagrass	N	P	C	N	P	N	P	N
bermudagrass (seedling)	P	C	C	C	C	C	C	N
bindweed	N	N	P	P	P	N	N	N
bindweed (seedling)	P	N	C	P	P	N	N	N
johnsongrass	N	C	C	N	P	N	C	N
johnsongrass (seedling)	C	C	C	C	C	C	C	N
purple nutsedge	N	N	P	N	P	C	N	N
yellow nutsedge	N	N	P	N	P	C	N	P

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HERBICIDE TREATMENT TABLE: (4/94)

Pesticide (commercial name)	Amount/Acre
PREPLANT	
A. PARAQUAT* (Gramoxone Extra)	0.5-0.94 lb a.i.
COMMENTS: A nonselective foliar herbicide that kills emerged weeds. Can be used before planting or after planting, but before the crop emerges. Any crop plants exposed to the spray will be killed, even germinating seed in the crook stage. No soil residual activity. Use the lower rate on small broadleaf weeds, the higher rate on larger weeds and grasses. Highly toxic if ingested, inhaled, or through dermal contact; wear protective clothing. More active on warm, sunny days.	
B. GLYPHOSATE (Roundup 4AS)	1-4 lb a.i. 1-4 qt
COMMENTS: A nonselective, foliar herbicide applied to premade beds before planting to kill emerged weeds. Allow 3 days after treatment before planting. Use the lower rate for annual grasses and weeds, the higher rate on perennial weeds. Consult the label for specific recommendations on particular weed species. Do not apply to weeds stressed for moisture. For perennial weeds, allow 7 days after application before cultivating.	
C. TRIFLURALIN (Treflan EC, Treflan 5, Trilin 5EC)	0.5-1.0 lb a.i.
COMMENTS: Controls annual grasses and broadleaf weeds. Incorporate mechanically into the top 2-3 inches of the final seedbed. The lower rates are recommended on sandy soil; however, crop tolerance is excellent.	
D. EPTC* (Eptam 7E)	3.065-6.125 lb a.i. 3.5-7 pt
COMMENTS: Allowed under a Special Local Need (24c) registration for fallow season suppression of nutsedge in the counties of Imperial, Riverside, and San Bernardino. Must be applied 90 days before carrot sowing and must be irrigated 30 days before planting.	
POSTPLANT	
Preemergence to crop	
A. TRIFLURALIN (Trilin 5EC)	0.5-1 lb a.i.
COMMENTS: Apply after sowing to prevent weed germination. Incorporate with irrigation water. See label for plantback restrictions.	
B. LINURON (Lorox 50DF)	1.5 lb a.i.
COMMENTS: Apply after planting, incorporate with sprinklers. Will control many broadleaf weeds and annual grasses. A postemergence treatment is also allowed, but must not exceed a total of 3 lb a.i./A of linuron per season.	

Continued on next page.

* Restricted use material. Permit required for purchase or use.

Herbicide treatment table cont. (4/94)

Pesticide (commercial name)	Amount/Acre
Postemergence to crop	
A. LINURON (Lorox 50DF)	1.5 lb a.i.

COMMENTS: May be applied twice, first when the crop is 3 inches tall. Good control of emerged broadleaf weeds, small grasses, and suppression of yellow nutsedge. Total per season must not exceed 3 lb a.i./A.

B. FLUAZIFOP-P-BUTYL	6 oz a.i.
(Fusilade 2000)	16-48 fl oz

COMMENTS: A selective, foliar herbicide for control of grasses. A surfactant (crop oil concentrate or nonionic surfactant) is recommended. Safe to the crop. Not effective on drought stressed grasses or on certain species (e.g. annual bluegrass, sprangletop). Preharvest interval is 45 days.

PRECAUTIONS FOR USING PESTICIDES

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

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

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

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

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

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

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

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

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

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

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

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

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