

UC IPM

Pest Management Guidelines:

Olive

January 2008

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

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

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Authors

Insects and Mites: F. G. Zalom, Entomology, UC Davis; P. M. Vossen, UCCE Sonoma Co.; R. A. Van Steenwyk, Insect Biology, UC Berkeley

Diseases: L. Ferguson, Pomology, UC Davis; P. M. Vossen, UCCE Sonoma Co.

Nematodes: M. V. McKenry, Kearney Agricultural Center, Parlier

Weeds: W. T. Lanini, Weed Science/Plant Sciences, UC Davis

Fruit Spray Thinning: W. H. Krueger, UCCE Glenn Co.

Acknowledgment for contributions to the insects and mites section and the fruit spray thinning section:

G. S. Sibbett, UCCE Tulare Co.; L. Ferguson, Pomology, UC Davis

Acknowledgment for contributions to the disease section: B. L. Teviotdale, Kearney Agricultural Center, Parlier

Acknowledgment for contributions to the weed section: C. L. Elmore, Weed Science/Plant Sciences, UC Davis; D. W. Cudney, Botany and Plant Sciences, UC Riverside; D. R. Donaldson, UCCE Napa Co.

About this publication

Produced and edited by:

UC Statewide IPM Program

University of California, Davis

Guidelines Coordinator: B. Ohlendorf

Production: S. King/M. J. O'Neill



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- Online: <http://www.ipm.ucdavis.edu>
- UC Cooperative Extension County Offices
- University of California
ANR/Communication Services
6701 San Pablo Avenue, 2nd Floor
Oakland, CA 94608-1239
510-642-2431; 800-994-8849

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

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

To be used with UC ANR Publication 3353, *Olive Production Manual*

General Information

RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN OLIVES TO NATURAL ENEMIES AND HONEY BEES (1/08)

Common name (trade name and formulation)	Mode of action ¹	Selectivity ² (affected groups)	Predatory mites ³	General predators ⁴	Parasites ⁵	Honey bees ⁵	Duration of impact to natural enemies ⁶
carbaryl (Sevin) 80	1A	broad (insects, mites)	L/H	H	H	I	long
methidathion (Supracide)	1B	broad (insects, mites)	H	H	H	I	moderate to long
petroleum oil	—	broad (exposed insects, mites)	L ⁷	L	L	III	short to none
spinosad (GF-120 Fruit Fly Bait)	5	narrow (fruit flies)	L	L	L	IV	short to none
sulfur	—	narrow (mites and citrus thrips)	L/H	M/L	H	IV	short

H = high

M = moderate

L = low

— = no information

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

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

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

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

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

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

⁷ Rating depends on rate used.

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

Insects and Mites

AMERICAN PLUM BORER (1/08)

Scientific Name: *Euzophera semifuneralis*

DESCRIPTION OF THE PEST

The adult moth is gray with a wing expanse of 0.75 to 1 inch (19–25 mm) and brown and black markings on the wings. Adult females lay eggs near where callous tissue has developed, such as at pruning wounds, crown galls, or scaffold crotches. Larvae bore into the tree to feed on vascular tissue. Mature caterpillars are dusky white or pinkish and are about 1 inch long. American plum borer overwinters in a protective cocoon spun in a sheltered location on the tree; pupation takes place in spring. There are three to four generations each year.

DAMAGE

Larvae attack soft, spongy, calluslike tissue, which occurs at graft unions, tree wounds, and in olive knots. They can continue to feed into normal tissue, girdling limbs, which can cause small branches to break. Gummy frass and liquid exudate may occur around injured wood.

MANAGEMENT

Monitor trees in spring and summer for frass and gum pockets. The borer can be detected by brownish frass and webbing at feeding sites. If larvae are present, remove and destroy infested wood if possible. If wood cannot be removed, spray trees with a hand held sprayer from one foot above the scaffold crotch to one foot below, two to three times during the growing season. The first application should be mid- to late April and subsequent applications at 6-week intervals. Efficacy is improved if the trunk is painted immediately following a trunk spray with a latex paint to protect against sunburn. The paint helps to preserve the insecticide and give protection over a longer period of time.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A.	CARBARYL*		
	(Sevin) 80S	2.6–6.25 lb	12
	(Sevin) XLR Plus	2 qt	12
	MODE OF ACTION GROUP NUMBER ¹ : 1A		
	COMMENTS: Do not exceed 6.25 lb carbaryl 80S/acre/year or 10 lb carbaryl XLR Plus/acre/year.		

** Amounts per 100 gal water (except where otherwise stated), using 400–500 gal solution per acre.

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

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

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

BLACK SCALE (1/08)

Scientific Name: *Saissetia oleae*

DESCRIPTION OF THE PEST

Black scale adult females are about 0.2 inch (5 mm) in diameter and dark brown or black with a prominent H-shaped ridge on the back. Young scales are yellow to orange crawlers and are found on leaves and twigs of tree. A hand lens is usually needed to detect the crawlers. Black scales are in the soft scale family (Coccidae) and usually have one generation per year in interior valley olive-growing districts. In cooler, coastal regions multiple generations occur. Black scale prefers dense, unpruned portions of trees. Open, airy trees rarely support populations of black scale.

DAMAGE

Young black scales excrete sticky, shiny honeydew on leaves of infested trees. At first, affected trees and leaves glisten and then become sooty and black in appearance as sooty mold fungus grows on the honeydew. Infestations reduce vigor and productivity of the tree. Continued feeding reduces bloom the following year. Olive pickers are reluctant to pick olive fruits covered with honeydew and sooty mold.

MANAGEMENT

Biological control and pruning to open up closed canopies are key to managing black scale. Monitor to detect the presence of honeydew on leaves and track black scale population levels in olive groves. Control ants in the orchard because they disrupt biological control.

Biological Control

A number of parasites attack black scale, the most common are *Metaphycus helvolus*, *M. bartletti*, and *Scutellista caerulea* (= *S. cyanea*). These parasites, combined with proper pruning, provide sufficient control in northern and coastal orchards. In other regions, biological control is often ineffective because black scale's development pattern hampers parasite establishment.

Cultural Control

Pruning to provide open, airy trees discourages black scale infestation and is preferred to chemical treatment.

Organically Acceptable Methods

Biological and cultural control and certain oil sprays are acceptable to use in an organically certified crop.

Monitoring and Treatment Decisions

The first indication of black scale is usually the presence of honeydew on the leaves. Check 25 to 30 trees during April and October, the two periods of greatest honeydew accumulation, to get an idea of population levels.

Sample for adult scales in May, focusing on two to three areas in each block, particularly those that have had scale problems in the past. First, select 10 trees in each area. Count the number of adults on the terminal 18 inches of 10 branches on each tree; be sure to include the lower, inner, and outer sections of the tree. Sum the numbers of black scale in each 10-branch sample and divide by the number of branches sampled to determine the infestation level. Infestations fall into one of four levels: *light* (0 to fewer than an average of 1 per branch sampled), *moderate* (1 to 4), *heavy* (4 to 10), and *severe* (more than 10).

Light infestations typically do not require treatment in open-canopy orchards. Closed-canopy orchards should be pruned and an application of a dormant oil considered.

Moderate infestations may occur following a cool summer or within a closed orchard canopy. This level of scale infestation typically does not cause damage; however, it presents the potential for substantial damage and economic losses the next year. In trees with open canopies, the scale population should decrease or remain stable, depending on summer temperatures. If the summer is mild, apply a narrow range oil. If trees in the orchards have closed canopies, prune them and apply oil or an oil/insecticide combination treatment.

Heavy infestations can cause economic damage; if left untreated, the next generation will inflict substantial crop loss. Heavy infestations are rare in open canopies, but orchards with closed canopies must be pruned, chemically treated, or both.

Severe infestations occur in closed-canopy orchards in which treatment of moderate or heavy scale infestations is delayed. Economic loss can be extensive. Prune the orchard, removing severely damaged branches, and treat with an insecticide. The best application timing is after egg hatch to treat the crawlers (mid-July) but before August to avoid damage to the following year's crop.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

SUMMER (July 15–Harvest)

- | | | | | |
|----|--|-------------|----|----|
| A. | NARROW RANGE OIL # | Label rates | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing due to fruit spotting. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable. | | | |
| B. | NARROW RANGE OIL | 1.5 gal | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing due to fruit spotting. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. | | | |
| | ... PLUS ... (optional) | | | |
| | CARBARYL* | | | |
| | (Sevin) 80S | 1–1.25 lb | 12 | 14 |
| | MODE OF ACTION GROUP NUMBER ¹ : 1A | | | |
| | COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i. | | | |

POSTHARVEST (Postharvest until scale develops into rubber stage)

- | | | | | |
|----|--|-------------|----|---|
| A. | NARROW RANGE OIL # | Label rates | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable. | | | |
| B. | NARROW RANGE OIL | 1.5 gal | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. | | | |
| | ... PLUS ... | | | |
| | METHIDATHION* | | | |
| | (Supracide) 25WP | 2 lb | 48 | 0 |
| | MODE OF ACTION GROUP NUMBER ¹ : 1B | | | |
| | COMMENTS: Use with or without oil. Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. The application of this material should precede the application of fungicides containing lime. Do not apply more than 12 lb/acre/year. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i. | | | |

** Amounts per 100 gal water (except where otherwise stated), using 400–500 gal solution per acre.

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

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

Acceptable for use on organically grown crops.

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

BRANCH AND TWIG BORER (1/08)

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

DESCRIPTION OF THE PEST

The branch and twig borer adult is a 0.3 to 0.6 inch (7–15 mm) long beetle, mostly black with brown wing covers. The C-shaped, white larvae are covered with fine hair. There is one generation per year.

DAMAGE

Adults bore small, round holes at the base of buds or axils of twigs injured by sunburn. Eggs are laid at these locations in early May and grubs bore into the heartwood, where they live for a year or more. Twigs break at location of the injury. Madrone, oak, and grape are the preferred hosts; olive damage may occur when trees are located next to these sources.

MANAGEMENT

Prune out and burn infested wood. Prevent sunburn and other injury that predisposes trees to damage.

CALIFORNIA RED SCALE (1/08)

Scientific Name: *Aonidiella aurantii*

DESCRIPTION OF THE PEST

An armored scale, the California red scale is similar to olive scale and resembles a small encrustation on the plant. The adult female has a thin, circular shell, 0.10 inch (2.5 mm) in diameter. The reddish body color is visible through the shell. When mature, females produce 100 to 150 eggs. Crawlers hatch and emerge from under the female cover at a rate of two to three per day. Crawlers move around to find a suitable place to settle and can be spread about by wind, birds, or picking crews. There are several generations a year.

DAMAGE

California red scale does not discolor fruit, which distinguishes its damage from that of olive scale and oleander scale. All parts of the olive tree are infested. Infested fruit are rendered worthless.

MANAGEMENT

California red scale is effectively controlled by parasitic wasps in most areas of the state except the San Joaquin Valley. In areas where it causes damage, particularly where citrus is grown nearby, monitoring for this pest will help to determine if treatments are necessary.

Biological Control

California red scale parasites include *Aphytis melinus* and *Comperiella bifasciata*. *Aphytis* parasites leave small, round exit holes in the scale's cover whereas *Comperiella bifasciata* has a larger, more irregular exit hole.

Organically Acceptable Methods

Biological control and certain oil sprays are acceptable to use in an organically certified crop.

Monitoring and Treatment Decisions

In the San Joaquin Valley, monitor red scale by examining fruit, twigs, and leaves for scales, or by applying double-sided sticky tape to branches and examining it for crawlers. Treat the first brood in late May and June or the second brood in late July and August. Apply first brood treatment when scale crawlers are seen moving on to the fruit. Treating scales between broods in early July is not recommended. A postharvest treatment is also effective.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

Postbloom (Late May through June when crawlers are present)

- | | | | | |
|----|--|-------------|---|---|
| A. | NARROW RANGE OIL # | Label rates | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable. | | | |
| B. | NARROW RANGE OIL | 1.5 gal | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. | | | |
| | ... PLUS ... | | | |

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
CARBARYL* (Sevin) 80S MODE OF ACTION GROUP NUMBER ¹ : 1A COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1–1.25 lb	12	14
SUMMER (July 15–August)			
A. NARROW RANGE OIL# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing because of the risk of fruit spotting. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.	Label rates	4	0
B. NARROW RANGE OIL MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing due to fruit spotting. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. ... PLUS ... CARBARYL* (Sevin) 80S MODE OF ACTION GROUP NUMBER ¹ : 1A COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1.5 gal 1–1.25 lb	4 12	0 14
POSTHARVEST (October–November)			
A. NARROW RANGE OIL# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.	Label rates	4	0
B. NARROW RANGE OIL MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. ... PLUS ... METHIDATHION* (Supracide) 25WP MODE OF ACTION GROUP NUMBER ¹ : 1B COMMENTS: Use with or without oil. Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. The application of this material should precede the application of fungicides containing lime. Do not apply more than 12 lb/acre/year. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1.5 gal 2 lb	4 48	0 0
** Amounts per 100 gal water (except where otherwise stated), using 400-500 gal solution per acre.			
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.			
* Permit required from county agricultural commissioner for purchase or use.			
# Acceptable for use on organically grown crops.			
¹ Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/ .			

GREEDY SCALE and LATANIA SCALE (1/08)

Scientific Names: Greedy scale: *Hemiberlesia rapax*
 Lantania scale: *Hemiberlesia lataniae*

DESCRIPTION OF THE PESTS

Greedy scale and latania scale are armored scales and similar in size to adult olive scale and oleander scale. However, the waxy shell covering of these two species is more conical with a small black spot or nipple to one side of the center. If the shell is removed, the female body is yellow, unlike the reddish purple body of the olive scale. The male scale body is much smaller and elongated. It is difficult to distinguish between latania and greedy scales without a microscope, but management for the two species is the same. There are usually several generations a year.

DAMAGE

These scales feed on leaves, bark, and fruit. Infested fruit have a dark purple spot with a distinct outline. The scale is located in the center of the spot. Fruit with scale are rendered worthless.

MANAGEMENT

Biological control plays a significant role in the management of greedy and latania scales. If the previous year's crop had an economic infestation of either of these scales, treatments may be warranted.

Biological Control

Several species of *Aphytis*, including *A. melinus*, are parasites of these scales.

Organically Acceptable Methods

Biological control and certain oil sprays are acceptable to use in an organically certified crop.

Monitoring and Treatment Decisions

If treatment is necessary, treat the first brood in late May and June or the second brood in late July and August. Double-sided sticky tape wrapped around tree branches is useful in determining when crawlers are present. Apply first brood treatment when scale crawlers are seen moving on to the fruit. Treating scales between broods in early July is not recommended. A postharvest treatment is also effective.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
<i>When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.</i>			
POSTBLOOM (Late May through June when crawlers are present)			
A. NARROW RANGE OIL #	Label rates	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
B. NARROW RANGE OIL	1.5 gal	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day.			
... PLUS ...			
CARBARYL* (Sevin) 80S	1–1.25 lb	12	14
MODE OF ACTION GROUP NUMBER ¹ : 1A			
COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.			

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
SUMMER (July 15–August)			
A. NARROW RANGE OIL#	Label rates	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing because of the risk of fruit spotting. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
B. NARROW RANGE OIL	1.5 gal	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing due to fruit spotting. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
... PLUS ...			
CARBARYL*			
(Sevin) 80S	1–1.25 lb	12	14
MODE OF ACTION GROUP NUMBER ¹ : 1A			
COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.			
POSTHARVEST (October–November)			
A. NARROW RANGE OIL#	Label rates	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
B. NARROW RANGE OIL	1.5 gal	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day.			
... PLUS ...			
METHIDATHION*			
(Supracide) 25WP	2 lb	48	0
MODE OF ACTION GROUP NUMBER ¹ : 1B			
COMMENTS: Use with or without oil. Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. The application of this material should precede the application of fungicides containing lime. Do not apply more than 12 lb/acre/year. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.			
**	Amounts per 100 gal water (except where otherwise stated), using 400–500 gal solution per acre.		
+	Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.		
*	Permit required from county agricultural commissioner for purchase or use.		
#	Acceptable for use on organically grown crops.		
¹	Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/ .		

OLEANDER SCALE (1/08)

Scientific Name: *Aspidiotus nerii*

DESCRIPTION OF THE PEST

The adult female oleander scale is an armored scale that is about 0.1 inch (2.5 mm) long and oval. It has a waxy covering that is whiter than olive scale with a yellow or light brown spot near the center. The adult male scale is elongate. If the coverings are removed, the female body is yellow, while the male scale is brownish yellow. This scale is most common on leaves in the lower part of the tree. There are several generations a year.

DAMAGE

The oleander scale infests olive fruit and delays maturity at the spot where it feeds. Thus, damage is seen as prominent green spots on purple fruit, in direct contrast to the dark spots caused by olive scale. Heavy infestations seriously deform fruit, and fruit spotting renders the olive worthless. Extremely heavy infestations reduce oil content by as much as 25%. Leaf and twig damage also result in lost production.

MANAGEMENT

Oleander scale can be effectively controlled by natural enemies and does not usually cause economic damage. Preserve these natural enemies by selecting insecticides for other pests that do not kill beneficial insects. Chemical treatment is rarely needed for oleander scale unless biological control is disrupted by treatments applied for other pests.

Biological Control

Several species of *Aphytis*, including *A. melinus*, are important parasites of oleander scale.

Organically Acceptable Methods

Biological control and certain oil sprays are acceptable methods in an organically certified crop.

Treatment Decisions

If treatments are necessary, treat the first brood in late May and June or the second brood in late July and August. Apply the first brood treatment when young scales are observed moving onto fruit. Treating scales in early July, between broods, is not recommended. Although efficacy data are not available, postharvest treatments should also be effective.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

POSTBLOOM (Late May through June when crawlers are present)

A.	NARROW RANGE OIL#	Label rates	4	0
	MODE OF ACTION: Contact including smothering and barrier effects.			
	COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
B.	NARROW RANGE OIL	1.5 gal	4	0
	MODE OF ACTION: Contact including smothering and barrier effects.			
	COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day.			
	... PLUS ...			
	CARBARYL*			
	(Sevin) 80S	1–1.25 lb	12	14
	MODE OF ACTION GROUP NUMBER ¹ : 1A			
	COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.			

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
SUMMER (July 15–August)			
A. NARROW RANGE OIL#	Label rates	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing because of the risk of fruit spotting. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
B. NARROW RANGE OIL	1.5 gal	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing due to fruit spotting. Spray at night or early morning if temperatures are expected to exceed 90°F during the day.			
... PLUS ...			
CARBARYL*			
(Sevin) 80S	1–1.25 lb	12	14
MODE OF ACTION GROUP NUMBER ¹ : 1A			
COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.			
POSTHARVEST (October–November)			
A. NARROW RANGE OIL#	Label rates	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.			
B. NARROW RANGE OIL	1.5 gal	4	0
MODE OF ACTION: Contact including smothering and barrier effects.			
COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day.			
... PLUS ...			
METHIDATHION*			
(Supracide) 25WP	2 lb	48	0
MODE OF ACTION GROUP NUMBER ¹ : 1B			
COMMENTS: Use with or without oil. Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. The application of this material should precede the application of fungicides containing lime. Do not apply more than 12 lb/acre/year. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.			
**	Amounts per 100 gal water (except where otherwise stated), using 400–500 gal solution per acre.		
+	Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.		
*	Permit required from county agricultural commissioner for purchase or use.		
#	Acceptable for use on organically grown crops.		
¹	Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/ .		

OLIVE FRUIT FLY (1/08)

Scientific Name: *Bactrocera oleae*

DESCRIPTION OF THE PEST

Olive fruit fly poses a serious threat to the California table olive and olive oil industries. Olives grown by homeowners for home curing or oil are equally at risk. A native of eastern Africa, it is considered the most damaging pest of olives in southern Europe, North Africa, and the Middle East. The olive fruit fly was first detected in North America infesting olive fruits on landscape trees in Los Angeles County in November 1998. It can now be found throughout the state.

The adult olive fruit fly is about 0.2 inch (4–5 mm) long with clear wings containing dark veins and a small dark spot at the wing tip. The head, thorax, and abdomen are brown with darker markings, and the thorax has several white or yellow patches on each side. The end of the male fly's abdomen is blunt, whereas females have a large black ovipositor at the end of their abdomen that is visible to the naked eye. Larvae are yellowish white maggots with a pointed head. Mature larvae pupate in fruit in summer; in fall they leave the fruit and pupate in the soil under the tree. Larvae produced during late fall pupate in the soil, where they spend the winter.

Although the olive fruit fly does not have a true diapause, development is sufficiently slowed during the winter that pupae produced in late fall do not emerge until the following spring. Olive fruit fly also overwinters as larvae in fruit and to a lesser extent as adults and eggs.

In spring, early emerging adults lay eggs in unharvested fruit from the previous year's crop whereas later emerging (May-June) flies can lay eggs directly into new fruit. Olive fruit flies that do develop in unharvested fruit from the previous year emerge to mate and lay eggs on the new olive crop (July and August.) It is not necessary to have unharvested fruit on trees, however, to get considerable damage by mid-summer. It is believed that at least three, possibly four, generations of olive fruit flies could develop in various areas of California. In southern and coastal areas such as San Diego County, development may be continuous throughout the year.

DAMAGE

Olive fruit fly larvae are the main stage causing damage and feed exclusively in olive fruits. Damage by olive fruit fly includes oviposition "stings" on the fruit surface, fruit drop, or direct pulp destruction rendering fruits useless for canning. Larval feeding allows microorganisms to invade the fruit, causing rot and lower oil quality.

In areas of the world where olive fruit fly is established and not controlled, its damage has been responsible for losses of up to 80% of oil value because of lower quantity and quality, and in some varieties of table olives, this pest is capable of destroying 100% of the crop. Some European districts cannot grow table olives because control of olive fruit fly is not economical. The expense of treatments and the likely crop damage have the potential for eliminating olive culture in home orchards or as a viable commercial industry in California.

MANAGEMENT

Removing and destroying fruit left on the tree following harvest is somewhat important in managing this pest. Examine fallen fruit in late winter for the presence of olive fruit fly. Monitor populations in spring with McPhail or yellow sticky traps and apply bait sprays when traps indicate populations are increasing in early summer.

Biological Control

No native parasites are known to attack olive fly at this time. Preliminary releases of *P. concolor*, a parasite that can be raised in culture and has been released for other fruit flies including the Mediterranean fruit fly, have been attempted in California with limited success to date.

Cultural Control

Sanitation is important in reducing overall fly densities. Remove old fruit remaining on trees following harvest and destroy all fruit that are on the ground by either burying at least 4 inches deep or taking to the landfill. Extremely high fly populations can occur in fruited varieties of landscape trees and in

unmaintained ornamental situations. These can be a significant source for invasion of commercial groves. Prevent fruiting on landscape trees in spring by using a chemical like "Fruit Stop" or destroy fruit on the ground in fall to reduce this invasion pathway. An areawide approach is needed to reduce olive fly densities where commercial plantings are near ornamental or unmaintained trees.

Organically Acceptable Methods

Cultural controls, the use of GF-120 Fruit Fly Bait, sprays of kaolin clay, and mass trapping are acceptable for use in an organically certified crop.

Monitoring and Treatment Decisions

Surveying fruit for infestation can give some indication of the severity of an infestation. Looking for maggots infesting fruit that has fallen from trees in late winter and spring is useful as it will give some indication of overwintering olive fly densities. Adult fruit flies can be monitored with McPhail traps or with yellow sticky traps. McPhail traps have proven to be more effective than yellow sticky traps in catching larger numbers of olive fruit flies and catching them earlier in the season.

Hang traps as high as possible at least 12 inches from foliage on the south side of trees from October to April and on the north side of trees from May to September. Place traps in trees that have a good fruit load or in trees with an abundance of fallen fruit on the ground where larvae and pupae are expected to be present. Adult olive fruit flies can be identified in the traps by their yellow or white scutellum and the distinct, single black spot at the tip of each wing.

Preliminary research indicates that applications of bait sprays should begin when trap captures begin to increase in early summer (late June in the Central Valley). Once initiated, continue to apply bait sprays according to label directions to protect the crop until harvest.

McPhail traps. McPhail traps are plastic or glass containers with a reservoir for liquid baits. Flies enter from the bottom of the trap through an opening and drown in the solution. Recommended baits to use in these traps are torula yeast or NuLure bait with or without a pheromone. To count trapped flies, empty the trap contents into a sieve so that the liquid drains out and the flies can be identified and counted. (Be sure to remove the used liquid from the orchard.)

Yellow sticky traps. Yellow sticky traps are baited with a sex pheromone (spiroketal) and/or ammonium bicarbonate attractant. The sex pheromone attracts the males whereas ammonium bicarbonate attracts both males and females. Both lures can be combined in one trap. Replace the yellow sticky traps once a month or more often if they get wet, contaminated with non-target insects, or dusty such that they are no longer sticky. Replace spiroketal lures every 4 months and ammonium bicarbonate packets every 2 weeks. The spiroketal lure must be pierced with a pin (e.g., a small map pin or insect pin) before using. Some types of ammonium bicarbonate packets must be pierced with something larger than a pin to produce an opening of at least 1 mm so that sufficient vapors will escape. Ammonium bicarbonate packets made by PaCoast have a peel-off cover that exposes a release area on one side. Examine the packets before using to make sure that they do not have broken seals on the sides and are leaking powder—these packets should be thrown away because the amount of ammonium bicarbonate remaining is unknown.

Common name (trade name)	Amount to Use	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

BAITS FOR MCPHAIL TRAPS

- | | | | |
|----|--|---|---|
| A. | TORULA YEAST
COMMENTS: Available from Great Lakes IPM Tel. 800-235-0285 | 0 | 0 |
| B. | NULURE BAIT
COMMENTS: Available from some John Taylor fertilizer stores or from Wilbur Ellis 1-800-426-3491 | 0 | 0 |

HARVESTED TREES

- | | | | |
|----|---|---|---|
| A. | SPINOSAD
(GF-120 Fruit Fly Bait)# 10–20 fl oz / acre or 1–3 fl oz / tree
MODE OF ACTION GROUP NUMBER ¹ : 5
COMMENTS: In table olives, apply weekly to every other row or every other week to every row from pit hardening (mid-June) until harvest (mid-Sept). Olives grown for oil production, which are harvested later than table olives, may require additional applications. Dilute one part of product with 1.5–4 parts of water (e.g., with 4 gal of product, use from 6–16 gal water for a total of 10–20 gal spray solution.) | 4 | 0 |
| B. | KAOLIN CLAY#
(Surround) 12.5–50 lb
COMMENTS: Provides suppression only. | 4 | 0 |

UNHARVESTED TREES

- | | | | |
|----|---|---|---|
| A. | NAPHTHALENEACETIC ACID
(Olive Stop) 4 fl oz / 10 gal water
COMMENTS: Use to treat olive trees that will not be harvested to eliminate or reduce fruit set. To ensure proper coverage, add 0.5–1 fl oz of nonionic wetting agent to each 10 gal of spray mix. Apply when olives are in full bloom but before fruit set. During periods of extended bloom, more than one spraying will be necessary. Warm temperatures immediately following application will improve results. | 0 | 0 |
|----|---|---|---|

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

Acceptable for use on organically grown crops.

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

OLIVE MITE (1/08)**Scientific Name:** *Oxyenus maxwelli***DESCRIPTION OF THE PEST**

The olive mite occurs throughout all commercial olive districts in California. The olive tree, *Olea europaea*, is the preferred host. Commercial varieties, listed from high to low susceptibility, are Ascolano, Sevillano, Manzanillo, and Mission.

Olive mite is an eriophyid mite and is difficult to see without magnification. The mite is yellowish to dark tan, slow moving, and has a wedge-shaped body that is typical of many eriophyid species.

DAMAGE

As a rule, this pest is not a major problem. Olive mites feed on succulent stem and bud tissues and on the upper surface of leaves. Gross symptoms of mite damage include sickle-shaped leaves, dead vegetative buds in spring, discoloration of flower buds, bud drop, blossom blasting, inflorescence abscission, and reduced shoot growth.

MANAGEMENT

Olive mite is generally not managed in olives unless fruit set and crop have been below normal for several years. If crop yield has been increasingly poor for several years in a row, examine shoot tips and developing flower buds in spring for the presence of olive mites. Treat before bloom if large populations are present.

Organically Acceptable Methods

Sulfur sprays are acceptable for use on organically certified crops.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

PREBLOOM

A.	WETTABLE SULFUR#	2 lb	24	0
	MODE OF ACTION: Unknown. An inorganic miticide			
	COMMENTS: Application in temperatures above 90°F may result in damage to crop.			
B.	DUSTING SULFUR#	70 lb	24	0
	MODE OF ACTION: Unknown. An inorganic miticide			
	COMMENTS: Dusting sulfur is less damaging than wettable sulfur in hot temperatures.			

** Amounts per 100 gal water (except where otherwise stated), using 400-500 gal solution per acre.

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

Acceptable for use on organically grown produce.

OLIVE SCALE (1/08)Scientific Name: *Parlatoria oleae***DESCRIPTION OF THE PEST**

Olive scale is an armored scale and like all armored scales, resembles a small encrustation on the plant. The adult female scale is about 0.10 (2.5 mm) inch long, with a grayish, oval, waxy covering. The male scale is more elongate with a black spot at one end. If the coverings are removed, the scale bodies of both sexes are reddish purple. Olive scale feeds on twigs, leaves, and fruits. However, it is most often noticed at harvest; dark purple spots occur on otherwise green to yellowish fruit where the scale has settled. There are several generations a year.

DAMAGE

Early in the growing season (late May and June) first brood olive scale feed on and consequently deform young, rapidly growing fruit. A later brood, in July and August, causes the pronounced purple spotting of green fruit, rendering it worthless for most markets except perhaps black ripe process. Heavy olive scale infestations will also occur on branches, twigs, and leaves. Such infestations substantially reduce the productivity of a tree.

MANAGEMENT

Olive scale can be effectively controlled by natural enemies and does not usually cause economic damage. Preserve natural enemies by selecting insecticides for other pests that do not kill beneficial insects. Chemical treatment is rarely needed for olive scale unless biological control is disrupted by treatments applied for other pests.

Biological Control

Olive scale is effectively controlled by two parasites *Aphytis maculicornis* and *Coccophagoides utilis*.

Organically Acceptable Methods

Biological control and certain oil sprays are acceptable to use in an organically certified crop.

Monitoring and Treatment Decisions

If olive scale was detected in the previous season or if disruptive chemicals are used in the orchard or on nearby crops, watch closely to detect crawlers moving onto fruit in spring and summer. Double-sided sticky tape can be applied to branches to help detect the presence of crawlers. If treatments are needed, control the first brood in late May and June or the second brood in late July and August. Apply first brood treatment when scale crawlers are seen moving on to the fruit. Treating scales in early July, between broods, is not recommended. A postharvest treatment is also effective. One of these treatments is usually all that is needed.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

POSTBLOOM (Late May through June when crawlers are present)

- | | | | | |
|----|--|-------------|---|---|
| A. | NARROW RANGE OIL# | Label rates | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable. | | | |
| | | | | |
| B. | NARROW RANGE OIL | 1.5 gal | 4 | 0 |
| | MODE OF ACTION: Contact including smothering and barrier effects. | | | |
| | COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. | | | |
| | ... PLUS ... | | | |

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
CARBARYL* (Sevin) 80S MODE OF ACTION GROUP NUMBER ¹ : 1A COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1–1.25 lb	12	14
SUMMER (July 15–August)			
A. NARROW RANGE OIL# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing because of the risk of fruit spotting. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.	Label rates	4	0
B. NARROW RANGE OIL MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Do not apply any oil between August 20 and harvest to olives used for Spanish or green-ripe processing due to fruit spotting. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. ... PLUS ... CARBARYL* (Sevin) 80S MODE OF ACTION GROUP NUMBER ¹ : 1A COMMENTS: Do not exceed 2 applications/year. This material is very destructive to most natural enemies. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1.5 gal 1–1.25 lb	4 12	0 14
POSTHARVEST (October–November)			
A. NARROW RANGE OIL# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Effective against light to moderate infestations, especially when used in conjunction with pruning to open the orchard canopy. Most effective when applied against the crawler stage. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. Check with certifier to determine which products are organically acceptable.	Label rates	4	0
B. NARROW RANGE OIL MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: For heavy to severe infestations, add the following insecticide to the oil spray. Spray at night or early morning if temperatures are expected to exceed 90°F during the day. ... PLUS ... METHIDATHION* (Supracide) 25WP MODE OF ACTION GROUP NUMBER ¹ : 1B COMMENTS: Use with or without oil. Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. The application of this material should precede the application of fungicides containing lime. Do not apply more than 12 lb/acre/year. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1.5 gal 2 lb	4 48	0 0
** Amounts per 100 gal water (except where otherwise stated), using 400–500 gal solution per acre.			
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.			
* Permit required from county agricultural commissioner for purchase or use.			
# Acceptable for use on organically grown crops.			
¹ Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/ .			

WESTERN FLOWER THRIPS (1/08)

Scientific Name: *Frankliniella occidentalis*

DESCRIPTION OF THE PEST

Western flower thrips is the most widely distributed thrips species, occurring throughout all olive-growing districts in California. It has a wide host range, feeding on grasses, field and forage crops, vegetables, and fruit crops.

Western flower thrips are tiny insects about 0.05 inch (1 mm) long, with two pair of fringed wings. Adults vary in color from white to yellow with slight brown spots on the top of the abdomen, to yellowish with an orange thorax and brown abdomen, to completely dark brown. Different color forms predominate according to the time of year.

Eggs are inserted into leaves, flower parts, and fruit. First-instar nymphs are light yellow, turning golden yellow after the first molt. When they are ready to pupate, nymphs drop to the ground and pupate in protected places.

DAMAGE

Western flower thrips migrate into olives after adjoining grasses dry up in spring, causing serious damage to fruit. Ascolano is most susceptible, although other cultivars can be damaged. Developing fruit is scarred and dimpled by thrips feeding. Damaged fruit is culled before processing. Olive groves adjoining drying grain fields are most susceptible to damage.

MANAGEMENT

Managing vegetation in and around olive groves is important in reducing the potential for damage from western flower thrips. Avoid disking orchard cover crops while trees are in bloom. Disc open areas adjacent to groves as early as possible to prevent thrips' development and migration to olive trees. There is no current California registration for any chemical treatment. In years when this pest is particularly damaging and a special local need registration is approved, apply treatments at full bloom if thrips are migrating to olives and their presence has been noted in the bloom.

Diseases

ARMILLARIA ROOT ROT (Oak Root Fungus) (1/08)

Pathogen: *Armillaria mellea*

SYMPTOMS

Infected trees have slowly thinning canopies and appear weak. This symptom often develops first on one side of the tree and then progresses over several years to involve the whole tree. The bark and outer wood of the upper roots and crown show discoloration. Roots infected with *Armillaria mellea* have white to yellowish fan-shaped mycelial mats between the bark and the wood. Dark brown to black rhizomorphs sometimes can be seen on the root surface.

In other crops, mushrooms may appear at the base of *Armillaria*-infected trees during cool, rainy weather in fall, but this is rarely observed with olive trees.

COMMENTS ON THE DISEASE

Armillaria root rot is not generally a serious disease of olive trees in California, although it occasionally attacks olives and sometimes can eventually kill trees. It is more prevalent following wet winters. The fungus survives on dead roots in the soil and can survive for decades if not subjected to desiccation.

MANAGEMENT

Armillaria root rot is most likely to be present in soils where oak trees previously grew. Avoid planting olive groves where forest or oak woodlands have recently grown or where there is a history of *Armillaria* root rot. If trees are infected, the growth of the fungus may be slowed by drying out the crown and upper root area of the tree. No olive rootstocks are resistant, and infected trees cannot be cured.

Cultural Control

Although research has not been conducted on olive trees, in other tree crops exposing an infected crown and upper root area of a tree infected with *Armillaria mellea* may help restrict the fungus to individual roots and allow the tree to regrow. Remove soil from around the base of the tree to a depth of 9-12 inches. Leave the trunk exposed and keep the upper roots and crown area as dry as possible. During winter, provide drainage if necessary so that rain doesn't collect in the hole. Recheck the hole every few years to make sure it has not filled in with leaves, soil, and other matter; the hole must be kept open and the crown and upper roots exposed.

LEAF SPOT (1/08)

Pathogen: *Mycocentrospora (=Cercospora) cladosporioides*

SYMPTOMS and DAMAGE

Leaf spot causes the leaves to appear slightly chlorotic (some varieties show more chlorosis than others). The undersides of some leaves become discolored with the conidial stage of the fungus, which appear to be covered with black dust. These leaves may fall, causing some defoliation in some cases. Fruit can also develop small, brown lesion spots and not mature uniformly.

COMMENTS ON THE DISEASE

This disease has been documented in coastal areas with humid growing conditions. The disease cycle seems to be similar to that of peacock spot.

Outbreaks are sporadic, and the disease may take several years before it becomes serious enough to cause economic damage. Not all infected leaves fall from the tree, and the fungus survives in those that remain on the tree. Leaf lesions on these infected leaves have a white, crusty appearance. The margins of these lesions enlarge in fall, and a new crop of spores develops there. New infections are associated with rainfall and mostly occur during winter. By summer, most diseased leaves have fallen from the trees, leaving partially defoliated shoots with mostly healthy foliage remaining. High temperatures restrict spore germination and growth, thus the disease is inactive during the warm, dry summers in California.

MANAGEMENT

In coastal areas of Europe, where experience with this disease has been greater than in California, leaf spot is more difficult to control than peacock spot and requires more stringent treatment. In cool, wet areas, apply preventive treatments to olive trees after harvest but before winter rains begin and again in spring if wet, rainy weather persists.

Common name (trade name)	Amount to Use	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to environmental impact.

CAUTION: Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. Apply methidathion before fungicides containing lime are applied.

- | | | | | |
|----|--|-------------|------------|------------|
| A. | BORDEAUX MIXTURE# | Label rates | see labels | see labels |
| | MODE OF ACTION GROUP NAME (NUMBER ¹): Multi-site contact (M1) | | | |
| | COMMENTS: For information on making Bordeaux mixtures, see UC IPM Pest Note: Bordeaux Mixture, ANR Publication 7481 (<i>available online</i>). When used on organically grown produce, all ingredients must be certified organic. Observe the most restrictive label precautions and limitations of all products used. | | | |
| B. | FIXED COPPER# | Label rates | 24 | see labels |
| | (Various) | | | |
| | MODE OF ACTION GROUP NAME (NUMBER ¹): Multi-site contact (M1) | | | |
| | COMMENTS: Not all copper compounds are approved for use in organic production; be sure to check individual products. | | | |

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

Acceptable for use on organically grown produce.

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

OLIVE KNOT (1/08)

Pathogen: *Pseudomonas syringae* pv. *savastanoi*

SYMPTOMS

Olive knot appears as rough galls or swellings about 0.5 to 2 inches in diameter on twigs, branches, trunks, roots, leaves, or fruit stems. Small shoots may be defoliated and killed. Galls also form at trunk or limb wounds.

COMMENTS ON THE DISEASE

Olive knot can kill trees if infections occur on and girdle the trunks of young trees through injury by mechanical harvesters. It reduces tree productivity by girdling twigs and branches and causing dieback. Bacteria survive in the knots and are readily spread by water at all times of the year. Infection occurs at low temperatures, usually in fall or spring. Openings are necessary for penetration of bacteria, and these are provided by leaf scars, pruning wounds, or bark cracks made by freezing. All cultivars are susceptible, and damage can be severe when weather favors disease.

MANAGEMENT

Olive knot is difficult to control and requires preventive fungicide applications to protect leaf scars and other wounds. It is also helpful to carefully prune during the dry season (July to August) to remove galls on twigs and branches. Because the bacteria may be carried on pruning shears, be sure to disinfect them frequently if pruning at other times during the year. Galls on limbs and/or trunks of small trees or on newly established grafts can be treated with Gallex.

Treatment Decisions

A minimum of two applications each year is needed for control. Make the first application in fall after harvest. Apply other applications in spring from March through May. Because leaf scars are susceptible when fresh, time treatment to protect as many leaf scars as possible.

Common name (trade name)	Amount to Use	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to environmental impact.

CAUTION: Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. Apply methidathion before fungicides containing lime are applied. Also, copper may injure trees in areas of low rainfall.

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|----|--|-------------|------------|------------|
| A. | FIXED COPPER#
(Various) | Label rates | 24 | see label |
| | MODE OF ACTION GROUP NAME (NUMBER ¹): Multi-site contact (M1) | | | |
| | COMMENTS: Not all copper compounds are approved for use in organic production; be sure to check individual products. | | | |
| B. | BORDEAUX MIXTURE# | Label rates | see labels | see labels |
| | MODE OF ACTION GROUP NAME (NUMBER ¹): Multi-site contact (M1) | | | |
| | COMMENTS: For information on making Bordeaux mixtures, see UC IPM Pest Note: Bordeaux Mixture, ANR Publication 7481 (<i>available online</i>). When used on organically grown produce, all ingredients must be certified organic. Observe the most restrictive label precautions and limitations of all products used. | | | |
| C. | GALLEX | Label rates | none | none |
- + Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
- # Acceptable for use on organically grown produce.
- ¹ Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see <http://www.frac.info/>). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode of action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode of action Group number.

PEACOCK SPOT (1/08)**Pathogen:** *Spilocaea oleaginea***SYMPTOMS and DAMAGE**

Peacock spot appears on leaves as sooty blotches that develop into black, circular spots about 0.1 to 0.5 inch (2.5–12 mm) in diameter. There may be a yellow halo around the spot. The pathogen also infects fruit and fruit stems, but lesions are observed most often on upper leaf surfaces of leaves low in the tree canopy. Leaves fall prematurely. When significant defoliation occurs, strong bloom fails to develop and crop production is substantially reduced. Twig death may occur as a result of defoliation, and productivity is eventually further reduced.

COMMENTS ON THE DISEASE

This disease occurs throughout California's olive-growing regions. Cultivars vary in their susceptibility to this disease, but all are subject to infection.

Outbreaks are sporadic, and the disease may take several years before it becomes serious enough to cause economic damage. Not all infected leaves fall from the tree, and the fungus survives in those that remain on the tree. The margins of these lesions enlarge in fall, and a new crop of spores develops there. New infections are associated with rainfall and mostly occur during fall and winter. By summer, most diseased leaves have fallen from the trees, leaving partially defoliated shoots with mostly healthy foliage remaining. High temperatures restrict spore germination and growth, thus the disease is inactive during the warm, dry summers in California.

MANAGEMENT

If olive trees exhibit peacock spot leaf symptoms, it is important to treat for it yearly. Apply a treatment in late October before winter rains begin.

Common name (trade name)	Amount to Use	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to environmental impact.

CAUTION: Application of methidathion with, or closely following, a fungicide containing lime will negate the insecticide's effectiveness. Apply methidathion before fungicides containing lime are applied.

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|----|--|---------------------------|------------|
| A. | BORDEAUX MIXTURE #
MODE OF ACTION GROUP NAME (NUMBER ¹): Multi-site contact (M1)
COMMENTS: For information on making Bordeaux mixtures, see UC IPM Pest Notes: Bordeaux Mixture, ANR Publication 7481 (<i>available online</i>). When used on organically grown produce, all ingredients must be certified organic. Observe the most restrictive label precautions and limitations of all products used. | Label rates
see labels | see labels |
| B. | FIXED COPPER #
(Various)
MODE OF ACTION GROUP NAME (NUMBER ¹): Multi-site contact (M1)
COMMENTS: Not all copper compounds are approved for use in organic production; be sure to check individual products. | Label rates
24 | see label |

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

Acceptable for use on organically grown produce.

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

VERTICILLIUM WILT (1/08)

Pathogen: *Verticillium dahliae*

SYMPTOMS

Symptoms of Verticillium wilt appear when leaves on one or more branches of the tree suddenly wilt early in the growing season; this process intensifies as the season progresses. Death of mature trees infected with Verticillium is possible. Darkening of xylem tissue, a key symptom for distinguishing Verticillium wilt in many crops is frequently not apparent in olives.

COMMENTS ON THE DISEASE

The fungus survives from season to season in the soil and probably in the roots of infected trees. In early summer the fungus can be readily isolated from diseased tissue in infected trees. Verticillium wilt tends to be most troublesome in the southern San Joaquin Valley.

MANAGEMENT

The most effective management strategies to protect trees from Verticillium wilt are those taken before planting. When considering a new site for an olive grove, avoid land that has been planted for a number of years to crops that are highly susceptible to Verticillium wilt, such as cotton, cucurbits, eggplant, peppers, potato, or tomato. The Verticillium wilt pathogen is usually present in these soils.

Inoculum levels can be reduced before planting by soil solarization, flooding the fields during summer, growing several seasons of grass cover crops (especially rye or sudangrass) or a combination of these treatments. Whether any of these practices are sufficient to make much of a difference is unknown.

Verticillium microsclerotia (resistant spores) have been documented to survive for at least 30 years in the soil. When replanting in an area where susceptible perennials were previously grown, remove as many roots of the trees or vines as possible. A resistant rootstock is not available, although some tolerance has been reported in the cultivar Ascolano.

After trees have been planted, there is no reliable method of control. Soil solarization has provided inconsistent control in established plantings.

Soil Solarization. Beginning in late spring cover the surface of an entire block with transparent plastic that has a UV-inhibitor additive. Leave the plastic on throughout the summer and as long as practical. Inferior plastic will break down and render the treatment ineffective. Solarization gives inconsistent results when used in replant spots. For more information, see *Soil Solarization: A Nonpesticidal Method for Controlling Diseases, Nematodes, and Weeds*, UC ANR Publication 21377.

Nematodes (1/08)

DESCRIPTION OF THE PESTS

Nematodes are true roundworms that are microscopic and must be identified by a nematologist. Root galling is associated with root knot nematodes only.

DAMAGE

Root knot or citrus nematodes may be damaging to the root system if relatively high soil populations are present. Trees become slightly weaker, especially in sandy areas, and fruit size on infected trees is reduced.

MANAGEMENT

Management of nematodes with soil fumigation must be done before planting. Proper water and cover crop management can help to avoid damage from these nematodes in established plantings.

Cultural Control

Irrigate infested, weakened trees with greater frequency to avoid plant stress. Most cover crops will host root knot nematode and root lesion nematode.

Common name (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
A. 1,3-DICHLOROPROPENE* (Telone II or Telone C35)	Label rates	5 days	N.A.
COMMENTS: Dry the soil by withholding water during summer and using cover crops such as sudangrass or safflower in finer-textured soils. This will usually require one year of field preparation time when following a nematode-infected perennial crop. The drier the soil, the better for deep penetration. Deep-tilling the area can aid the drying process. Surface moisture is required at the field surface before application. Apply no more than 1.5-acre-inches of surface moisture; this can be accomplished by waiting for a fall rain or by sprinkler application. Apply before mid-November. Inject 18-30 inches deep with chisels. Increasing the dose or depth will increase the depth of penetration but 47 gal/acre for Telone C35 and 33.7 gal/acre for Telone II is currently the maximum California rate (i.e., 332 lb a.i./acre). This treatment rate applied broadcast will provide adequate control unless the soil exceeds 12% soil moisture content within the surface 5 feet of depth. In clay loam soils with moisture contents up to 19%, increase the application rate and apply only in 8- to 12-foot-wide planting strips rather than as a broadcast application. Strip applications will only enable 1 year of nematode relief, whereas broadcast applications can provide 6 years of nematode relief. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.			
B. METAM SODIUM* (Vapam, Sectagon, etc.)	Label rates	48	N.A.
... or ... METAM POTASSIUM* (K-Pam, etc.)	Label rates	48	N.A.
COMMENTS: For adequate results, apply sufficient quantities of water to saturate the soil, and be sure all the water applied to the field during treatment has some of the product mixed into it. It is important to add product to the water at a point in the irrigation system where turbulence allows mixing. Apply to soils during springtime when soil moisture is at field capacity but not saturated. After application, wait 14-21 days before planting if soil is coarse to medium in texture, well drained, and warm. When soil is cold (below 60°F), wet, fine textured, or high in organic matter, a waiting period of 30-60 days may be necessary. Water-mediated applications can be effective as deep as the water penetrates into the soil. These treatments will not kill old roots below 3 ft of depth whereas 1,3-D can kill roots at 4-foot depth. In fields where soil is commonly too moist for a 1,3-D application, metam sodium or metam-potassium can be used. In finer textured soils, apply in 6- to 8-acre-inches of water across the field surface. Top label rate is 75 gal/acre for Vapam, Sectagon, etc. and 60 gal/acre for K-Pam. Fumigants such as metam sodium are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.			

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

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

N.A. Not applicable.

Weeds

INTEGRATED WEED MANAGEMENT (1/08)

Weed control in olive orchards enhances the development of newly planted trees and improves the growth and yield of established trees. Growers have many weed management tools available to achieve these objectives; however, the best strategy for employing these tools will vary from year to year and from orchard to orchard, according to local conditions.

Weed management is part of an overall orchard management system; plants on the orchard floor can influence other pests such as insects, mites, nematodes, and diseases. A weed management program should start before trees are planted because the more difficult-to-control weeds (particularly perennials) are easier to manage before planting. Weeds reduce tree growth and yields by competing for water, nutrients, and sunlight. Competition is most severe during the first 5 years of the tree's life or where root growth is limited. Weeds around the tree trunk not only compete directly with tree growth, but provide a good habitat for field mice or voles, which can girdle and kill young trees. Gophers are most prevalent in nontilled orchards and are common where broadleaf weeds, such as field bindweed and perennial clovers, predominate. They feed on the roots and weaken or kill young trees. Dry weed growth is a fire hazard. For optimum yields and tree health, control weed growth, especially within 3 feet of a young tree's trunk.

After about the fourth year, the effect of competition from weeds is somewhat lessened as trees become established and shading from the orchard canopy reduces weed growth. In older orchards, however, weeds result in colder orchard conditions, increased frost hazards, and the potential for olive knot. Weeds also increase humidity, making trees more susceptible to infection by the peacock spot fungus. In addition, weed growth can interfere with cultural practices and harvest. For example, weeds can disrupt the application pattern of water from sprinklers and low-volume spray emitters. Olive trees are shallow rooted and frequent cultivation near trees can injure tree trunks and promote suckering. Tree trunk injuries can result in crown gall or olive knot infections.

Orchard floor management decisions and the management methods used are significantly influenced by location in the state, climatic conditions, soils, irrigation practices, topography, and grower preferences. Weeds are commonly controlled either chemically or mechanically in a 2- to 5-foot-wide strip in the tree row. The area between tree rows may also be chemically treated or mechanically mowed or tilled. Alternatively, mulches, subsurface irrigation, and flammers can be used. Often several weed management techniques are combined.

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

The irrigation method, amount of water applied, and pattern of rainfall affects the frequency and timing of cultivation as well as the selection of chemicals and their residual activities. Frequent wetting of the soil promotes more rapid herbicide degradation in the soil. Herbicide degradation is generally faster in moist, warm soils than in dry, cold soils. Degradation is also more rapid under drip emitters or microsprinklers than under furrow or sprinkler irrigation. The first irrigation following an herbicide application is the most critical in terms of how far the preemergent herbicide is moved into the soil; subsequent irrigation is less important to the movement of the herbicide. The optimum amount of water for herbicide activity is from 0.5 to 1 inch. Greater amounts of water (3–6 inches) could move the herbicide far enough into the soil, especially in sandy areas, that it is absorbed by the tree's roots.

When properly used, herbicides registered for use in olives can control most weed species. In many orchards, combinations and/or sequential applications of herbicides are required to provide effective, economical control. Before using any herbicide, identify the weed species to be controlled, then read and follow product label directions carefully.

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

Preemergent herbicides. Preemergent herbicides are applied to bare soil and are leached into the soil with rain or irrigation where they are active against germinating weed seeds. If herbicides remain on the soil surface without incorporation, some will degrade rapidly from sunlight. Weeds that emerge while the herbicide is on the surface, before it is activated by rain or irrigation, will not be controlled. Also, large weed seeds, such as wild oat, may germinate in the soil below the herbicide zone and still be able to emerge. Herbicides such as napropamide (Devrinol), and oryzalin (Surflan) are safe to use as a directed spray in newly planted olive orchards. Additional products are available for use in established orchards (see Herbicide Treatment Table).

Postemergent herbicides. Postemergent herbicides are applied to control weeds already growing in the orchard. They may be contact herbicides, such as paraquat and oxyfluorfen, or a translocated, systemic herbicide such as glyphosate, sethoxydim, and others. Contact herbicides are most effective on young weeds, whereas translocated herbicides are effective on both young and older weeds. No herbicide is effective on old, dusty mature weeds.

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

In most orchards, herbicides are used only on a narrow strip of soil centered on the orchard row; thus, the area treated with herbicides in these orchards is 20 to 30% of the total orchard area.

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

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

MONITORING

Many different species of summer and winter annual and perennial weeds are found infesting California olive orchards. Weeds vary from area to area and year to year, even within orchards, so conduct weed surveys at least twice each year: once in late winter and again in late spring or summer to determine the spectrum of weeds present. These surveys are the basis for weed management decisions about herbicide choice or cultivation equipment and practices. Keep written records of survey results noting date and species observed. Use the pictures linked to the COMMON AND SCIENTIFIC NAMES table in the web version of this publication (<http://www.ipm.ucdavis.edu>), the *Weeds of California and Other Western States* (UC ANR Publication 3488), or *Weeds of the West*, University of Wyoming, to help identify local weeds. The SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL tables will help you determine the best herbicide or combinations of herbicides to use for optimum control of individual weed species.

WEED MANAGEMENT BEFORE PLANTING

To reduce the competition from weeds during orchard establishment, control annual and perennial weeds before orchards are planted. It is especially important to control established stands of perennial weeds before trees are planted so that potential injury to young trees from herbicides can be avoided. Perennial weeds that can be especially troublesome are field bindweed, johnsongrass, dallisgrass, bermudagrass, and nutsedge.

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

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

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

Seedlings of perennials can be controlled with repeated cultivation.

Soil solarization is a nonpesticidal method of controlling soilborne pests by placing clear plastic sheets on moist soil during periods of high ambient temperature. The plastic sheets allow the sun's radiant energy to be trapped in the soil, heating the upper levels. Solarization during the hot summer months can increase soil temperature to levels that kill many disease-causing organisms (pathogens), nematodes, and weed seeds. It leaves no toxic residues and can be easily used on a small or large scale. Soil solarization also improves soil structure and increases the availability of nitrogen (N) and other essential plant nutrients. (For additional information see UC ANR Publication 21377, *Soil Solarization: A Nonpesticidal Method for Controlling Diseases, Nematodes, and Weeds*, available at your University of California Cooperative Extension or at <http://anrcatalog.ucdavis.edu>)

Herbicides. Weed seedlings and established annual weeds can be controlled either with preemergent or postemergent herbicides before planting. Use a preemergent herbicide before planting an orchard only in conjunction with a rotation crop. Make sure the residual period of the herbicide is not long enough to preclude planting the trees. Postemergent herbicides generally have a short soil residual and are safer to use before planting trees. To avoid possible exposure of newly planted trees to herbicides in the backfill soil, many growers prefer to use preemergent herbicides only after trees have been planted.

WEED MANAGEMENT IN NEW ORCHARDS

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

Cultivation. Some growers prefer to manage weeds without herbicides for the first year or two after planting. This usually requires hoeing, cultivating, or using weed knives (less than 2 inches deep) around trees several times during spring and summer as well as cultivating or mowing between tree rows. This is best accomplished when weeds are still in the seedling stage; it becomes more difficult when weeds are allowed to get large. Hand tools are generally used close to the tree to minimize injury from mechanical cultivators, particularly when the trees are young. Mechanical cultivators available for use in the tree row include: weed knives, spyder cultivators, and rotary tillers. Rotary tillers such as a Weed Badger, Kimco, or Clements Hoe are most effective if used on loose soil that is not rocky. Hand-held mechanical flails

(e.g., Weed Eaters) may be used, but can injure tree trunks. Disks, tillers, or mowers can be used between the rows. Mechanical control of weeds must be done repeatedly when weeds are immature. The equipment should be set to cut shallowly, to minimize damage to tree roots. As weeds mature, they are difficult to control, may clog equipment, and produce seed. *When using any mechanical equipment around trees, be careful not to injure the feeder roots or trunk.*

Cover crops. Planted cover crops can also be used to reduce weed populations between tree rows. With cover crops, the species selected and management will differ from one area of the state to another. Be sure to select a cover crop such as fall-seeded cereal crops (wheat, oat, cereal rye, or barley), Blando brome grass, Zorro fescue, rose clover, or subterranean clovers that will not become competitive with the trees. Examples of invasive cover crops include white clover, strawberry clover, and bermudagrass. Cultivation in preparation for planting a winter annual cover crop will also reduce weed growth. To preserve surface cover, mow the cover crop to the correct height recommended for that crop.

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

Herbicides. To control weeds with herbicides after trees are planted and before bearing, apply a preemergent herbicide (e.g., oryzalin, napropamide, or oxyfluorfen) to either a square or circle around each tree (at least 4–6 feet across) or as a band down the tree row. Herbicides can also be applied to control weeds after they emerge. Selective herbicides are available for annual grass control and suppression of perennial grasses (e.g., sethoxydim, fluzifop, and clethodim), but to be effective they require the addition of an adjuvant (either a nonionic surfactant or a nonphytotoxic oil). These materials do not control nutsedge or broadleaf weeds and clethodim is the only one that will control annual bluegrass. Paraquat can be used to control weeds near young trees protected with shields or wraps. The nonselective herbicide glyphosate can control broadleaf weeds after emergence, but it should be used only around mature trees with brown bark and should not be allowed to contact tree leaves.

In conjunction with the use of herbicides in the tree row, mow or cultivate the weeds between the rows. Mow weeds when they get 6 to 8 inches high, usually about four to eight times a year. Cultivation is required when weed seeds germinate following each irrigation.

WEED MANAGEMENT IN ESTABLISHED ORCHARDS

It takes 3 to 4 years for an orchard to become established under normal growing conditions. Established trees are more tolerant of many herbicides than newly planted trees, thus increasing the options available for weed control. Generally weeds are controlled between tree rows by discing or mowing and a basal treatment of herbicide is applied around each tree or in a strip application down the tree row. For a detailed discussion of orchard floor management, see UC ANR Publication 8202, *Orchard Floor Management Practices to Reduce Erosion and Protect Water Quality* (available online).

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

Flaming. Flaming is a method that can be used to control very young weed seedlings in established orchards. Use either a single flame that is directed to the base of the tree or several burners on a boom to flame the weeds between the tree rows. Flaming is effective only on newly emerged weed seedlings. Do not use flaming around young trees because it may damage the thin, green bark. Adjust equipment speed for desired weed injury without damaging the tree trunks. In mature orchards annual broadleaf weeds

can be controlled with flaming but grasses are somewhat tolerant. Flaming is not intended to burn the weeds, but rather to kill the tiny seedling with heat. Never use flaming where there is dry, dead vegetation, leaves, or duff around the base of the tree. This material may ignite, causing a fire that girdles the trees. Flaming may also damage or ignite mulches in the orchard.

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

Herbicides. Preemergent herbicides can be applied either alone, in combinations of herbicides in fall after harvest, split into two applications (fall and spring), or in winter with a postemergent (foliar) herbicide. It may be most beneficial to delay the preemergent application in winter until most weeds have germinated. Then add a postemergent herbicide. This allows longer weed control into the summer yet does not allow much competition from weeds to the tree. For greatest safety, direct herbicide sprays only at the soil or at weed foliage, not at the tree leaves or 1- to 2-year-old wood. In orchards where tree rows are mulched or sprayed, there are often few weeds to treat and a visual-seeking sprayer can be used to reduce herbicide use.

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

Cover crops. Cover crops are planted in some orchards to replace the resident weed vegetation on the orchard floor. These winter annual cover crops are fall-seeded cereal crops (wheat, oat, cereal rye, or barley), Blando brome grass, Zorro fescue, rose clover, or subterranean clovers. These are seeded into a prepared seedbed between tree rows in late September through mid-November. Most plants will reseed themselves if mowed in January or early February and then allowed to regrow into April and May. Mowing after the seeds mature ensures seeds for the next season. Avoid invasive plants such as white clover and bermudagrass in a ground cover. Sometimes larger-seeded cover crops such as bell bean, purple or common vetch, or crimson clover are planted in orchards and tilled in as green manure. Perennial grasses (tall fescue, Berber orchardgrass, or perennial ryegrass) may also be grown but will require summer irrigation and may compete with tree growth. Keep cover crops away from the trees. Changing cover crop species reduces the potential for buildup of disease pathogens, weeds, rodents, and insect pests. For more information on cover crops, consult UC ANR Publication 21471, *Covercrops for California Agriculture*, or UC ANR Publication 3338, *Cover Cropping in Vineyards: A Grower's Handbook*.

SPECIAL WEED PROBLEMS (1/08)

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

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

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

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

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

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

BLACKBERRY. Blackberries (Himalayan and California) are vigorous perennial vines that are often found around orchard margins and sometimes around the trunks of trees. They interfere with all cultural operations, especially pruning and harvest. For best control, spot treat with glyphosate at the flower stage or after fruiting when there is good soil moisture and the plants aren't stressed. A re-treatment may be required on large clumps if regrowth occurs. If blackberry is growing near or up into an olive canopy, pull the vines out before treating so the herbicide will not get into the tree.

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

COMMON AND SCIENTIFIC NAMES OF WEEDS (1/08)

Common Name	Scientific Name	Common Name	Scientific Name
asparagus	<i>Asparagus officinalis</i>	speedwells	<i>Veronica</i> spp.
barley, hare	<i>Hordeum murinum</i> ssp. <i>leporinum</i>	sprangletop	<i>Leptochloa</i> spp.
barnyardgrass	<i>Echinochloa crus-galli</i>	starthistle, yellow	<i>Centaurea solstitialis</i>
bermudagrass	<i>Cynodon dactylon</i>	thistle, Russian	<i>Salsola tragus</i>
bindweed, field	<i>Convolvulus arvensis</i>	velvetleaf	<i>Abutilon theophrasti</i>
blackberries	<i>Rubus</i> spp.	willowherb, panicle-leaf	<i>Epilobium brachycarpum</i>
bluegrass, annual	<i>Poa annua</i>	witchgrass	<i>Panicum capillare</i>
bromeograsses	<i>Bromus</i> spp.		
canarygrass	<i>Phalaris canariensis</i>		
catsear, common	<i>Hypochaeris radicata</i>		
chickweed, common	<i>Stellaria media</i>		
clovers	<i>Trifolium</i> or <i>Medicago</i> spp.		
cocklebur	<i>Xanthium</i> spp.		
crabgrasses	<i>Digitaria</i> spp.		
cudweeds	<i>Gnaphalium</i> spp.		
dallisgrass	<i>Paspalum dilatatum</i>		
dandelion	<i>Taraxacum officinale</i>		
dock, curly	<i>Rumex crispus</i>		
fiddlenecks	<i>Amsinckia</i> spp.		
filarees	<i>Erodium</i> spp.		
fleabane, hairy	<i>Conyza bonariensis</i>		
fluvellins	<i>Kickxia</i> spp.		
foxtails	<i>Setaria</i> spp.		
goosefoot, nettleleaf	<i>Chenopodium murale</i>		
groundcherries	<i>Physalis</i> spp.		
groundsel, common	<i>Senecio vulgaris</i>		
henbit	<i>Lamium amplexicaule</i>		
johnsongrass	<i>Sorghum halepense</i>		
knotweed, prostrate	<i>Polygonum arenastrum</i>		
lambquarters, common	<i>Chenopodium album</i>		
lettuce, miner's	<i>Claytonia perfoliata</i>		
lettuce, prickly	<i>Lactuca serriola</i>		
lovegrasses	<i>Eragrostis</i> spp.		
mallow, little (cheeseweed)	<i>Malva parviflora</i>		
mullein	<i>Verbascum</i> sp.		
mustards	<i>Brassica</i> spp.		
nettles	<i>Urtica</i> spp.		
nightshades	<i>Solanum</i> spp.		
nutsedge, yellow	<i>Cyperus esculentus</i>		
oat, wild	<i>Avena fatua</i>		
pigweeds	<i>Amaranthus</i> spp.		
pineapple-weed	<i>Chamomilla suaveolens</i>		
poison-oak, Pacific	<i>Toxicodendron diversilobum</i>		
polypogon, rabbitfoot	<i>Polypogon monospermiensis</i>		
puncturevine	<i>Tribulus terrestris</i>		
purslane, common	<i>Portulaca oleracea</i>		
radish, wild	<i>Raphanus raphanistrum</i>		
redmaids (desert rockpurslane)	<i>Calandrinia ciliata</i>		
rocket, London	<i>Sisymbrium irio</i>		
ryegrass, Italian	<i>Lolium multiflorum</i>		
sandburs	<i>Cenchrus</i> spp.		
shepherd's-purse	<i>Capsella bursa-pastoris</i>		
sorrel, red	<i>Rumex acetosella</i>		
sowthistles	<i>Sonchus</i> spp.		

SUSCEPTIBILITY OF SPRING/SUMMER WEEDS TO HERBICIDE CONTROL (1/08)

	PREEMERGENCE							POSTEMERGENCE							COMBINATIONS				
	DIU	FLM	ISO	NAP	ORY	OXY	SIM	CAR	CLE	FLU	GLY	OXY	PAR*	SET	OXY ORY	GLY OXY	PAR* OXY	GLY ORY	GLY SIM ORY
ANNUAL GRASSES																			
barnyardgrass	C	—	N	C	C	P	P	N	C	C	C	N	P	C	N	C	C	C	C
crabgrasses	C	P	N	C	C	P	N	N	C	C	C	P	C	C	P	C	C	C	C
foxtails	C	—	N	C	C	N	C	N	C	C	C	N	C	C	P	C	C	C	C
lovegrasses	C	—	—	C	C	P	—	N	C	C	C	N	C	C	P	C	C	C	C
sandburs	C	—	N	C	C	N	P	N	C	C	C	N	P	C	P	C	C	C	C
sprangletops	N	—	N	C	C	P	N	N	C	C	C	N	C	C	N	C	C	C	C
witchgrass	P	—	—	C	C	P	C	N	C	C	C	N	C	C	N	C	C	C	C
ANNUAL BROADLEAVES																			
cocklebur	C	—	—	C	N	C	C	P	N	N	C	C	C	N	C	C	C	C	C
cudweeds	C	—	C	C	N	N	C	—	N	N	C	P	N	N	P	C	P	C	C
fleabane, hairy	C	C	C	N	N	P	C	N	N	N	C	P	C	N	P	C	C	P	C
fluvellins	P	—	—	N	N	P	P	—	N	N	P	P	P	N	P	C	C	P	P
goosefoot, nettleleaf	C	C	C	C	C	C	C	—	N	N	C	C	C	N	C	C	C	C	C
groundcherries	C	C	C	N	C	C	C	C	N	N	C	C	C	N	C	C	C	C	C
knotweeds	C	C	C	C	C	C	C	—	N	N	C	P	P	N	P	C	P	P	C
lambsquarters, common	C	C	C	C	C	C	C	—	N	N	C	C	P	N	C	C	C	C	C
lettuce, prickly	C	C	C	C	N	C	C	—	N	N	C	C	C	N	C	C	C	C	C
mallow, little (cheeseweed)	C	C	C	P	P	C	N	C	N	N	P	C	N	N	C	C	C	P	C
nightshades	C	C	C	N	N	C	C	C	N	N	C	C	C	N	C	C	C	C	C
pigweeds	C	C	C	C	C	C	C	C	N	N	C	C	C	N	C	C	C	C	C
puncturevine	C	—	C	P	P	C	P	—	N	N	C	C	C	N	P	C	C	C	C
purslane, common	C	C	C	C	C	C	C	N	N	N	C	C	C	N	P	C	C	C	C
speedwells	P	—	—	C	P	C	C	N	N	N	C	P	C	N	P	C	C	C	C
starthistle, yellow	C	C	—	P	N	C	C	N	N	N	C	C	P	N	P	C	C	C	C
thistle, Russian	P	—	C	P	P	P	P	—	N	N	C	P	C	N	P	C	P	C	C
velvetleaf	C	—	C	N	P	C	C	C	N	N	C	N	P	N	N	C	C	C	C
willowherb, panicle-leaf	C	C	P	—	C	C	C	—	N	N	C	—	P	N	C	C	C	C	C
PERENNIALS (SEEDLINGS)																			
bermudagrass	C	—	N	C	C	N	P	N	C	C	C	P	C	P	C	C	C	C	C
bindweed, field	P	—	C	N	P	C	P	C	N	N	C	P	C	N	C	C	C	C	C
dallisgrass	C	—	N	P	C	N	C	N	C	C	C	N	C	C	P	C	C	C	C
dandelion	C	—	C	P	N	C	C	—	N	N	C	C	C	N	—	—	—	—	—
dock, curly	C	—	C	C	P	C	C	—	N	N	C	C	N	N	—	—	—	—	—
johnsongrass	C	—	N	P	P	N	P	N	C	C	C	N	C	C	P	C	C	C	C
ESTABLISHED PERENNIALS																			
asparagus	N	—	—	N	N	N	N	—	N	N	P	N	N	N	N	P	N	P	P
bermudagrass	N	—	N	N	N	N	N	N	P	P	C	N	P	P	N	N	N	N	N
bindweed, field	N	N	C	N	P	N	N	P	N	N	P	N	P	N	P	N	N	P	P
blackberries	N	—	—	N	N	N	N	—	N	N	C	N	N	N	N	N	N	N	N
catsear, common	N	—	—	N	N	N	N	—	N	N	P	N	N	N	N	P	N	N	N
clovers	N	—	—	N	N	N	N	—	N	N	P	N	N	N	N	N	P	P	N
dallisgrass	N	—	N	N	N	N	N	N	N	P	C	N	N	N	N	N	N	P	N
dandelion	N	—	C	N	N	N	N	—	N	N	C	N	N	N	N	P	N	N	N
dock, curly	N	—	N	N	N	N	N	—	N	N	P	N	N	N	N	P	N	N	N
johnsongrass	N	—	N	N	N	N	N	N	N	P	C	N	N	N	N	N	N	N	N
nutsedge, yellow	N	P	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	N	N
poison-oak, Pacific	N	—	—	N	N	N	N	—	N	N	C	N	N	N	N	N	N	N	N
smartweeds	N	—	—	N	N	N	N	—	N	N	C	N	N	N	N	P	N	N	N
sorrel, red	N	—	—	N	N	N	N	—	N	N	P	N	N	N	N	P	N	N	N

CAR = carfentrazone (Shark)

CLE = clethodim (Prism)

DIU = diuron (Karmex, etc.)

FLM = flumioxazin (Chateau)

FLU = fluzifop-p-butyl (Fusilade DK)

GLY = glyphosate (Roundup, etc.)

ISO = isoxaben (Gallery T&V)

NAP = napropamide (Devrinol)

ORY = oryzalin (Surflan)

OXY = oxyfluorfen (Goal)

PAR = paraquat* (Gramoxone Inteon)

SET = sethoxydim (Poast)

SIM = simazine (Princep, etc.)

C = control

P = partial control

N = no control

— = no information

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

SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL (1/08)

	PREEMERGENCE							POSTEMERGENCE							COMBINATIONS				
	DIU	FLM	ISO	NAP	ORY	OXY	SIM	CAR	CLE	FLU	GLY	OXY	PAR*	SET	OXY ORY	GLY OXY	PAR* OXY	GLY ORY	GLY SIM ORY
ANNUAL GRASSES																			
barley, hare	C	—	N	C	C	P	C	N	C	C	C	P	C	C	P	C	C	C	C
bluegrass, annual	C	—	N	C	C	P	C	N	P	N	C	P	C	N	C	C	C	C	C
bromegrasses	C	—	N	C	C	P	C	N	C	C	C	N	C	C	P	C	C	C	C
canarygrass	C	—	N	C	C	P	—	N	C	C	C	N	C	C	N	C	C	C	C
oat, wild	P	C	N	C	P	P	C	N	C	C	C	N	C	C	P	C	C	C	C
polypogon, rabbitfoot	C	—	—	C	C	P	—	N	C	C	C	—	C	C	N	C	C	C	C
ryegrass, Italian	C	—	N	C	C	P	C	N	C	C	C	N	C	C	N	C	C	C	C
ANNUAL BROADLEAVES																			
chickweed, common	C	C	C	C	C	P	C	P	N	N	C	P	C	N	P	C	C	C	C
clovers	P	—	—	P	N	P	P	—	N	N	C	P	P	N	P	P	C	P	P
fiddlenecks	C	C	C	C	C	C	C	C	N	N	C	C	C	N	C	C	C	C	C
filarees	C	C	C	C	N	C	C	—	N	N	P	C	C	N	P	C	C	P	C
groundsel, common	N	C	C	P	P	C	C	—	N	N	C	C	C	N	C	C	C	C	C
henbit	C	C	C	P	P	C	C	—	N	N	C	C	C	N	C	C	C	C	C
lettuce, miner's	C	C	C	C	C	C	C	—	N	N	C	C	C	N	C	C	C	C	C
mustards	C	C	C	P	N	C	C	P	N	N	C	P	C	N	P	C	C	C	C
nettles	C	C	C	P	P	C	C	C	N	N	P	C	P	N	P	C	C	C	C
pineapple-weed	P	C	—	C	N	C	C	N	N	N	C	P	P	N	P	C	C	C	C
radish, wild	C	—	C	P	N	C	C	P	N	N	C	P	P	N	P	C	C	C	C
redmaids (desert rockpurslane)	C	C	—	N	C	C	C	—	N	N	C	C	C	N	C	C	C	C	C
rocket, London	C	—	C	C	P	C	C	C	N	N	C	C	C	N	P	C	C	C	C
shepherd's-purse	C	C	C	P	N	C	C	P	N	N	C	P	C	N	P	C	C	C	C
sowthistles	C	C	C	C	P	C	C	N	N	N	C	C	C	N	P	C	C	C	C

CAR = carfentrazone (Shark)

CLE = clethodim (Prism)

DIU = diuron (Karmex, etc.)

FLM = flumioxazin (Chateau)

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ORY = oryzalin (Surflan)

OXY = oxyfluorfen (Goal)

PAR = paraquat* (Gramoxone Inteon)

SET = sethoxydim (Poast)

SIM = simazine (Princep, etc.)

C= control

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N = no control

— = no information

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HERBICIDE TREATMENT TABLE (1/08)

Herbicide (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)
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When choosing a pesticide, consider information relating to environmental impact.

SITE PREPARATION**Established weeds**

- | | | | | |
|----|--|-----------------|----|----|
| A. | GLYPHOSATE
(Roundup, etc.) | 0.5–4 lb a.i. | 12 | 17 |
| | WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 | | | |
| | COMMENTS: Apply with a controlled applicator or with low pressure flat fan nozzles. For annual weed control use 10–40 gal water/acre with 1 lb/acre. Apply to young annuals or vigorously growing perennials in flowering stage. Some perennials require the high label rate for control. May be used on young weeds in strip that will be the tree row, followed by planting into the dead weeds. Weeds should not be cultivated for 7–14 days after treatment to obtain maximum control. New weeds usually do not establish for a month or more, due to the no-till effect. Do not use more than 10.6 lb a.i./acre/year. | | | |
| | ... or ...
(Touchdown) | 1–3.75 lb a.i. | 12 | 17 |
| | WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 | | | |
| | COMMENTS: For annual weed control use 1 lb when weeds are less than 12 inches in height. For perennial weeds use 1.5–3.75 lb in 10–30 gal water/acre. Use flat fan nozzles at 30–50 psi, not flood jets. A nonionic surfactant may be used up to 0.25% volume per volume. | | | |
| | | | | |
| B. | PARAQUAT*
(Gramoxone Inteon) | 0.625–1 lb a.i. | 12 | 0 |
| | WSSA MODE OF ACTION GROUP NUMBER ¹ : 22 | | | |
| | COMMENTS: Apply in 20–60 gal water/acre to young weeds. Use 0.5% nonionic surfactant. Repeat treatment as new growth occurs. | | | |

AFTER PLANTING**Before weeds emerge**

Note: Whenever tank mixes are used, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.

- | | | | | |
|----|--|---------------------|----|-----|
| A. | FLUMIOXAZIN
(Chateau SW) | 0.188–0.376 lb a.i. | 12 | 365 |
| | WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 | | | |
| | COMMENTS: For use on dormant nonbearing trees only. Apply in 10 or more gal water/acre to soil under trees when completely dormant. Do not apply on newly planted trees unless soil is firm and there are no cracks in soil around base of trees. Best control is achieved when irrigation or rainfall occurs within 21 days. Can be mixed with other pre- or postemergent herbicides. It will not provide adequate control of emerged weeds, unless mixed with a postemergent herbicide. Residual period: 3–6 months. | | | |
| | | | | |
| B. | ISOXABEN
(Gallery T&V) | 0.5–0.9975 lb a.i. | 12 | 365 |
| | WSSA MODE OF ACTION GROUP NUMBER ¹ : 21 | | | |
| | COMMENTS: For use on nonbearing trees only. Wait until soil has settled around newly planted trees before applying. Controls broadleaf weeds only before they have germinated; will not control emerged weeds. If weeds are emerged, lightly cultivate or add a postemergent herbicide. Requires incorporation for activation, either by light cultivation (1 to 2 inches) or rainfall (minimum of 0.5 inches) within 21 days after application. Sprinkler or flood irrigation can also be used for incorporation. Apply in at least 10 gal/acre of water. | | | |
| | | | | |
| C. | ORYZALIN
(Surflan AS)
(FarmSaver) | 2–6 lb a.i. | 24 | 0 |
| | WSSA MODE OF ACTION GROUP NUMBER ¹ : 3 | | | |
| | COMMENTS: Nonbearing and bearing trees. Apply to the surface in 20–60 gal water/acre. Best if irrigated after application or applied before rainfall. If rain does not occur within 21 days, sprinkle irrigate with 0.5–2 inches of water. May be combined with a postemergent herbicide if weeds are present. The higher label rate give the longest soil residual. Usually used at 4 lb a.i./acre. Residual period: 6–12 months. | | | |

Herbicide (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
D. NAPROPAMIDE (Devrinol 50 DF) WSSA MODE OF ACTION GROUP NUMBER ¹ : 15 COMMENTS: Nonbearing and bearing trees. Apply to the surface in 20–60 gal water/acre. Must be incorporated within 7 days of application or sprinkler irrigated. A second application of 4 lb can be made during any one growing season. May be combined with a postemergent herbicide if weeds have emerged. Residual period: 4–10 months	4 lb a.i.	12	35
E. OXYFLUORFEN (Goal) WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 COMMENTS: Nonbearing and bearing trees. Apply in 20–60 gal water/acre on firm soil. Must not be mechanically disturbed or poor weed control will result. Often combined with oryzalin. Check label for use period, cut-off dates, and restrictions. Residual period 4–10 months	1–2 lb a.i.	24	0
F. DIURON (Karmex, Direx) WSSA MODE OF ACTION GROUP NUMBER ¹ : 7 COMMENTS: Make a split application in fall and spring. Direct spray to the soil under trees at least 3 years of age. Do not apply more than 3.2 lb a.i./acre/season. Diuron is sometimes combined with other preemergent herbicides to broaden spectrum of weeds controlled. These combination treatments frequently use lower rates of diuron. Do not apply to tree trunks less than 1.5 inches in diameter. Note: Pay special attention to soil texture/rate adjustments; do not use on soils with less than 1% organic matter. Residual period: 8–12 months.	1.6 + 1.6 lb a.i.	12	0
G. SIMAZINE (Princep 4L, Princep Caliber 90, etc.) WSSA MODE OF ACTION GROUP NUMBER ¹ : 5 COMMENTS: Apply to the soil under trees older than 3 years anytime between harvest and early spring. Make only 1 application/year. Use the high rate for heavy soils. Simazine is frequently used in combination with other preemergent herbicides. On light soils, simazine often is used at rates of 0.5–1 lb/acre. Do not use on gravel, sand, or loamy sand soils. If an irrigation is applied immediately after application, limit water to 0.5 inch. If simazine has been found in groundwater in your area, your orchard may be in a designated pesticide Monitoring Zone (PMZ), and there may be restrictions on its use. Residual period: 8–12 months.	2–3.96 lb a.i.	12	0
Established weeds			
A. GLYPHOSATE (Roundup, Roundup Ultra) WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 COMMENTS: Rates vary depending on the formulation used. Apply with controlled droplet applicator or with low pressure flat fan nozzles. For annual weed control, use 1 lb/acre in 10–40 gal water. For chemical mowing, consult label for exact timing and rates depending on weed size and species. Apply to young annuals or vigorous growing perennials. Avoid drift onto green bark or foliage, or injury will result. Weeds should not be cultivated for 7–14 days after treatment for maximum control. ... or ... (Touchdown) WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 COMMENTS: For annual weed control use 1 lb a.i. when weeds are less than 12 inches in height. For perennial weeds use 1.5–3.75 lb a.i. in 10–30 gal water/acre. Use flat fan nozzles at 30–50 psi, not flood jets. Do not apply more than 4 lb a.i./acre/year. Do not apply within the year when a crop will be harvested. Avoid drift onto green bark or foliage or injury will result.	0.54 lb a.i.	see label	17
B. PARAQUAT* (Gramoxone Inteon) WSSA MODE OF ACTION GROUP NUMBER ¹ : 22 COMMENTS: Apply in 20–60 gal water/acre to young weeds. Use 0.5% nonionic surfactant. Repeat treatment as new growth occurs. Do not exceed 4 postemergent directed applications/season.	0.625–1 lb a.i.	12	13
C. OXYFLUORFEN (Goal) WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 COMMENTS: Dormant application to young (4-leaf stage) weeds. May be combined with other postemergent herbicides for specific weeds.	0.5–1 lb a.i.	24	0

Herbicide (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
D. FLUAZIFOP-P-BUTYL (Fusilade DX) WSSA MODE OF ACTION GROUP NUMBER ¹ : 1 COMMENTS: For use on nonbearing trees only. For selective control of grasses when they are 2–8 inches tall but before tillering and/or heading. Use a crop oil (1%) or nonionic surfactant (0.25%) to increase penetration and control. Do not apply to grass that is stressed or poor control may result.	0.25–0.375 lb a.i.	12	365
E. SETHOXYDIM (Poast) WSSA MODE OF ACTION GROUP NUMBER ¹ : 1 COMMENTS: For control of annual and perennial grasses in nonbearing trees only. Apply to young annual or perennial grasses. Repeat applications will be required for the control of perennial grasses. Add 2 pt crop oil concentrate to the spray solution. Do not apply to grass that is stressed or poor control may result. Residual period: less than 1 month.	0.28–0.46 lb a.i.	12	365
F. CLETHODIM (Prism) WSSA MODE OF ACTION GROUP NUMBER ¹ : 1 COMMENTS: For use on nonbearing trees only. Apply to rapidly growing grasses when they have reached the height recommended on label. Do not apply to drought stressed plants. Use a crop oil concentrate. Do not apply within 1 year of harvest.	0.0954–0.2496 lb a.i.	24	365
G. CARFENTRAZONE (Shark) WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 COMMENTS: A postemergent, contact herbicide used for quick top kill of most broadleaf weed species. Can be applied anytime during the season, but if fruit are present, it should either be avoided or applied with extreme care to avoid drift. It can also be used for sucker control. Apply in a minimum of 20 gal water/acre to weeds less than 6 inches tall. Repeat treatment as new growth occurs; do not apply at less than a 14-day interval. Do not use more than 0.096 lb a.i./acre/season. Use 0.25% volume per volume nonionic surfactant, 1.0% volume per volume of a crop oil concentrate, or a silicone or MSO surfactant.	0.008–0.031 lb a.i.	12	3

Herbicide combinations

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

A. GLYPHOSATE (Roundup, etc.) WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 ... PLUS ... OXYFLUORFEN (Goal) WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 COMMENTS: For broad-spectrum control of emerged weeds in olives. Helps increase control of little mallow (cheeseweed), filaree, chickweed, and grasses. The effectiveness of glyphosate is increased with low water volume; oxyfluorfen is more effective at the higher volume. Avoid drift and follow directions for application period of oxyfluorfen. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	0.5–1 lb a.i. in 20–40 gal water/acre	12	17
B. GLYPHOSATE (Roundup, etc.) WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 ... PLUS ... ORYZALIN (Surflan AS) WSSA MODE OF ACTION GROUP NUMBER ¹ : 3 ... OR ...	1 lb a.i. 4 lb a.i.	see label 24	see label 0

Herbicide (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
NAPROPAMIDE (Devrinol 50 DF) WSSA MODE OF ACTION GROUP NUMBER ¹ : 15 COMMENTS: Combines post- and preemergent control of most annual weeds with residual control up to 6 months. Combination choice depends on weed spectrum and how rapid incorporation will occur following application. Napropamide needs irrigation within 7 days, oryzalin within 21 days. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	4 lb a.i.	12	35
C. PARAQUAT* (Gramoxone Inteon) WSSA MODE OF ACTION GROUP NUMBER ¹ : 22 ... PLUS ...	0.625 lb a.i.	12	13
OXYFLUORFEN (Goal) WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 COMMENTS: Broad-spectrum postemergent control. Avoid drift and follow directions for application period of oxyfluorfen. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	0.5–1 lb a.i.	24	0
D. ORYZALIN (Surflan AS) WSSA MODE OF ACTION GROUP NUMBER ¹ : 3 ... PLUS ...	4 lb a.i.	24	0
OXYFLUORFEN (Goal) WSSA MODE OF ACTION GROUP NUMBER ¹ : 14 COMMENTS: Combined to give broad-spectrum control. Applied preemergence or combined with paraquat or glyphosate if weeds have emerged. Activate within 21 days. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1 lb a.i.	24	0
E. SIMAZINE (Princep, etc.) WSSA MODE OF ACTION GROUP NUMBER ¹ : 5 ... PLUS ...	1–2 lb a.i.	12	0
DIURON (Karmex) WSSA MODE OF ACTION GROUP NUMBER ¹ : 7 ... PLUS ...	1–1.6 lb a.i.	12	0
GLYPHOSATE (Roundup, etc.) WSSA MODE OF ACTION GROUP NUMBER ¹ : 9 COMMENTS: This combination is effective on a broad range of weed species. Add glyphosate only when weeds have emerged and are actively growing. Use lower rates of simazine and diuron on light soils and high rates on heavy, fine-textured soils. Residual period for diuron and simazine: 8–12 months. Glyphosate has no biological residual. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.	1 lb a.i.	12	17
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.			
¹ Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode of action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://www.plantprotection.org/HRAC/ .			
* Permit required from county agricultural commissioner for purchase or use.			

Fruit Spray Thinning (1/08)

GENERAL INFORMATION

Olive trees are alternate bearing: under normal conditions, they produce heavy crops one year and a light one the next. Alternate bearing creates problems for growers; thinning is recommended to produce a more consistent yearly crop, larger and higher quality fruit, earlier maturity dates, and lower harvest costs.

- **More consistent yearly crops.** Fruit thinning allows for better shoot growth, which results in increased bloom and crop load the following year.
- **Larger fruit.** Overloaded trees bear small, low-value fruit. Thinning the crop by removing excess olives during the fruit's early growing period will cause the remaining fruit to grow larger. Larger fruit command a higher price that more than offsets any reduction in total yield and can bring otherwise substandard-sized olives up to canning sizes.
- **Higher-quality fruit.** Olives harvested from spray-thinned trees have a greater flesh-to-pit ratio and a higher oil content than do fruit from untreated trees.
- **Early maturity.** A moderate crop matures earlier than a heavy crop. Early crops get to the handler first, have less competition for harvest labor, are less likely to fall victim to cold weather in the early fall, and ensure a good bloom for the next year.
- **Lower harvest costs.** Olive picking costs are figured on a per-ton basis, so the per-acre harvest costs for a moderate crop are less than for a heavy crop.

The greatest obstacle to chemically thinning is variable thinning responses related to temperatures following application. Thinning response can vary from very little with unseasonably cool temperatures to almost complete crop removal with excessive temperatures. The benefits, however, outweigh potential risks. To evaluate the effectiveness of the spray thinning, it is a good idea to always leave some unsprayed trees.

SPRAY THINNING WITH NAA

The synthetic plant growth regulator, naphthaleneacetic acid (NAA), is used to effectively thin fruit. It is absorbed into the leaves and fruit and then translocated to the fruit stems where an abscission layer forms within 2 weeks of application, causing some of the fruit to drop.

There are two NAA ammonium salt products currently available for use on olive in California: Fruit Fix Concentrate 800 (AMVAC Corp.) and Liqui-Stik Concentrate (Platte Chemical Co.). Fruit Fix is formulated with 800 grams of active ingredient (a.i.) per gallon, whereas Liqui-Stik has 200 grams.

Precautions when using NAA:

If used as directed and at moderate temperatures, NAA will not damage fruit or retard fruit growth. Label registrations for NAA cover the period from full bloom to 2.5 weeks after bloom. NAA applications after that point are both illegal and ineffective. Too early an application can overthin; too late an application will yield unsatisfactory results. An application during bloom can eliminate the crop.

Sometimes NAA does kill or curl young, tender tip growth on some new shoots, but this has no lasting effect. The effects of NAA depend upon dose, temperature at time of application and for about one week after, and tree condition.

- **Dose.** The greater the amount of NAA applied, the greater the thinning activity. You can further increase NAA activity by adding oils to the application mix.
- **Temperature.** As temperatures rise, NAA activity increases. High temperatures (i.e., in excess of 100°F) within 1 week after application may result in overthinning.
- **Tree condition.** Spraying water-stressed trees may result in excessive thinning. Trees to be sprayed with NAA must be well watered both as bloom develops and after spraying to mitigate any negative effects related to high temperatures.

Complete fruit removal. Occasionally it is desirable to remove the entire crop, as when olives are used in ornamental plantings and ripe olives would otherwise drop and create a nuisance and contribute to the buildup of olive fly populations. For complete crop removal, a solution of 150 ppm NAA is applied in

two sprays, the first 2 to 3 days before full bloom and the second a week later. If the bloom period is short, a second spray may not be necessary. A single spray may be applied at full bloom, but often crop removal is incomplete. For large trees, a power sprayer is required; 5 to 10 gallons of solution per tree may be required to give good coverage. Although NAA is not normally used to thin Sevillano variety, treatments as described will result in complete or near complete fruit removal of this variety as well as the other common varieties. Note that spraying with NAA when the temperature exceeds 100°F (38°C) may injure new growth and may also cause some leaf drop. Tender ornamentals nearby should be covered, and drift should be avoided by spraying only under calm conditions and by using moderate pressure to apply a coarse spray.

APPLICATION

Timing. Timing is critical to the effectiveness of a thinning spray. Treatments are applied between 12 and 18 days after full bloom. There are two methods of spray timing: one based on the fruit size and the other based on full bloom date. Both methods are acceptable under normal springtime weather conditions, but if abnormally cool weather delays fruit growth, use the fruit-size method. With both methods, treatments are applied as dilute sprays (300-500 gallons per acre.)

1. **Fruit size method.** When the average size of young fruit is between 1/8 and 3/16 inch in diameter, apply 150 ppm NAA. With this method, the time of application will vary from 12 to 18 days after full bloom, depending on weather. Include a wetting agent or spreader-sticker, according to the NAA manufacturer's recommendation, or a spray oil.

Concentration to use. If you spray without a spray oil, apply a concentration of 150 ppm NAA with a wetting agent or spreader-sticker, used according to the chemical manufacturer's recommendation. The commercially available NAA formulations do not contain a wetting agent.

If you use a spray oil, mix 100 ppm NAA with a light or light-medium summer oil emulsion at a rate of 1.5 gallons of oil per 100 gallons of spray mix. Do not use a wetting agent if you use oil. Do not use oil with NAA when daytime temperatures are 90°F or higher or when soil moisture is low. Failure to observe these precautions may result in leaf and shoot burn, defoliation, fruit injury, and excessive thinning.

2. **Days after full bloom.** Determine the date of full bloom, which is defined as the time when 80% of the flowers are open, 10% of the flowers are not open, and 10% of the flowers have petals falling. Petals are white (not brown), and pollen is shedding. To see whether pollen is shedding, you can run your hand down the full length of a shoot in bloom. Yellow pollen in your hand indicates shedding. Record the date of full bloom, and apply NAA 12 to 18 days after that date. This method is appropriate if weather and rate of fruit development are normal between bloom and the spray date.

Concentration to use. Adjust the rate of NAA upward by 10 parts per million (ppm) for each day following full bloom. For example, if the treatment is applied 15 days after full bloom use a concentration of 150 ppm.

Spray volume. To be effective, the spray must cover the undersides of leaves on fruiting branches, but a heavy drenching application such as is used for scale control is usually unnecessary and wasteful. NOTE: For effective thinning do not apply less than 72 ounces of Liqui-Stik Concentrate (200 grams a.i. per gallon) per acre or 18 ounces of Fruit Fix 800 (800 grams a.i. per gallon) per acre. See Table 1 for the amount of NAA to mix in various amounts of water per acre to obtain various spray concentrations.

Apply treatments with either an air blast sprayer or a high-pressure hand-gun sprayer. When most trees bear a heavy crop, an air blast sprayer will do the best job of covering the whole tree. For good spray distribution, drive a properly adjusted air blast sprayer at 1.5 to 2 miles per hour. If only some trees in an orchard are overloaded with fruit, use a high-pressure, hand-gun sprayer with number 8 discs at 200 to 400 pounds per square inch (psi) pressure. If only certain limbs in each tree require thinning, spot spraying may be effective. It is a good idea to leave some unsprayed check areas to help gauge the effectiveness of spray thinning.

Table 1. Amount of Napthalene Acetic Acid (NAA) Products Required for Various Application Rates.

Water (gal)/acre	Concentration (ppm)	NAA 200¹(fl oz)/ 100 gal water	Total NAA 200¹(oz/acre)	NAA 800¹(fl oz)/ 100 gal water	Total NAA 800¹(oz/acre)
300	100	24	72	6	18
300	150	36	108	9	27
400	100	24	96	6	24
400	150	36	144	9	36

¹ Grams of active ingredient per gallon of product

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PRECAUTIONS FOR USING PESTICIDES

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

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

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

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

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

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

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

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

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

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

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

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

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