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### The UC IPM Pest Management

#### Guidelines are available from:

- UC Cooperative Extension County  
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- World Wide Web  
(<http://www.ipm.ucdavis.edu>)
- University of California  
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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  
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# UC IPM Pest Management Guidelines: Pistachio

August 2004

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### Additional Information:

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1318 E. Shaw Avenue, Suite 420, Fresno, CA 93710  
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An illustrated version of this guideline is available on the World Wide Web at  
<http://www.ipm.ucdavis.edu/PMG/selectnewpest.pistachios.html>

## General Information

### RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN PISTACHIOS TO NATURAL ENEMIES AND HONEY BEES

(Updated 6/03)

Common name (trade name)	Chemical class <sup>1</sup>	Selectivity <sup>2</sup> (affected groups)	Predatory mites <sup>3</sup>	General predators <sup>4</sup>	Parasites <sup>4</sup>	Honey bees <sup>5</sup>	Duration of impact to natural enemies <sup>6</sup>
azinphosmethyl (Guthion)	OP	broad (insects, mites)	L/M	H	H	I	long
<i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i>	M	narrow (caterpillars)	L	L	L	IV	none
carbaryl (Sevin) 4F	C	broad (insects, mites)	-	-	-	I	long
carbaryl (Sevin) 80S	C	broad (insects, mites)	L/H	H	H	I	long
carbaryl (Sevin) XLR Plus	C	broad (insects, mites)	L	H	L	III	long
permethrin (Ambush, Pounce)	P	broad (insects, mites)	L	H	H	I	long
phosmet (Imidan)	OP	broad (insects, mites)	H	H	H	I	moderate to long
spinosad (Entrust, Success)	M	narrow (caterpillars, thrips, whiteflies, aphids, scales, leafminers)	L	L <sup>7</sup>	L	III	short
sulfur	I	narrow (mites and citrus thrips)	L/H	L	H	IV	short
tebufenozide (Confirm)	IGR	narrow (caterpillars)	L	L	L	II	short

H = high

M = moderate

L = low

— = no information

- 1 Chemical class: C = carbamate; I = inorganic; IGR = insect growth regulator; M = microbial; OP = organophosphate; P = pyrethroid.
- 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, 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 PNW518.
- 6 Duration: *short* means hours to days; *moderate* means days to 2 weeks; and *long* means many weeks or months.
- 7 Kills sixspotted thrips (spinosad)

Acknowledgments: This table was compiled based on research data and experience of University of California scientists working on a variety of crops.

### GENERAL PROPERTIES OF FUNGICIDES USED IN PISTACHIOS

(Updated 6/03)

Common name (trade name)	Chemical class	Activity	Mode of action	Resistance potential
azoxystrobin (Abound)	strobilurin	contact, systemic	single-site	high
iprodisone (Rovral)	dicarboximide	systemic (local)	multi-site	low
tebuconazole (Elite)	DMI <sup>1</sup> -triazole	systemic (local)	single-site	high
thiophanate-methyl (Topsin)	benzimidazole	systemic (local)	single-site	very high

1 DMI= demethylation (sterol) inhibitor

## *Insects and Mites*

### NAVEL ORANGEWORM

**Scientific Name:** *Amyelois transitella*

(Updated 6/03)

#### DESCRIPTION OF THE PEST

Young worms are reddish orange and later appear cream colored, although their diet can influence coloration. They have a crescent-shaped sclerite on each side of the second body segment behind the head. As the worm matures, the head becomes reddish brown. Adult moths have predominately gray forewings with black markings and a snoutlike projection at the front of the head. Females begin egg laying about 2 nights after emergence. Eggs are laid on mummy nuts or on new crop nuts.

#### DAMAGE

The navel orangeworm feeds on a variety of fruits and nuts and is the most damaging caterpillar in pistachio. Almonds, figs, and walnuts are also major hosts. The pistachio nut is susceptible to infestation as soon as hull split occurs. The first signs of an infestation are small, pinhole-size entrances into the nutmeat. As worms grow in size, the entire nut is fed upon and extensive amounts of webbing and frass are present. Infested pistachios will split early and can usually be seen by mid-July.

#### MANAGEMENT

Navel orangeworm is managed by the removal of unharvested nuts in fall, insecticide sprays aimed at the third generation eggs, and early harvest.

##### Biological Control

There are several parasites such as *Goniozus legneri* and *Copidosomopsis plethorica* that can reduce damage from navel orangeworm. *Goniozus legneri* is commercially available for release and serves as an alternative control in organically managed orchards.

##### Cultural Control

Navel orangeworm is a scavenger pest that survives from one season to the next on unharvested nuts left on the tree or on the ground. Because infestations of citrus flat mite can increase the number of nuts remaining on the tree after harvest, good citrus flat mite management is necessary for good navel orangeworm management.

In almonds it has been demonstrated that the removal and destruction of nuts that remain on the tree after harvest can dramatically reduce infestations in the next crop. This procedure is also recommended for pistachio. Although early nut harvest is more difficult to accomplish in pistachio orchards, harvest nuts as soon as possible to reduce exposure to egg-laying female moths.

##### Organically Acceptable Methods

Biological and cultural controls are acceptable for use on organically certified crops, including releases of the parasite *Goniozus legneri*.

##### Monitoring and Treatment Decisions

Generally only the third generation of navel orangeworm is treated in pistachio; timing of this treatment is critical because once the worm is in the nut, it cannot be controlled with insecticides. Use egg traps baited with a mixture of pressed almond meal and almond oil (3 to 5%) and degree-day calculations to time the treatment.

Hang traps in the orchard in spring and check twice a week for egg-laying activity. Use a minimum of four traps per block. Egg-laying peak will be observed in May and from late June to early July, signaling

the first and second generations. If navel orangeworm populations are low during the first two generations, add another trap to each of the four trapping locations to increase trapping effectiveness. During late July examine the traps every 2 days. If egg laying increases on two consecutive readings, this signals the beginning of the laying of third generation eggs. Begin degree-day calculations when the first increase of third generation egg deposition is noted. Use a lower threshold of 55°F and an upper threshold of 94°F. (For assistance in calculating degree-days, see "Degree-Days" on the UC IPM Web site at <http://www.ipm.ucdavis.edu>.) Spray at 400 degree-days from the beginning of third-generation egg laying. If a large amount of acreage must be covered, begin to spray at 300 degree-days.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. AZINPHOSMETHYL* 50WP	4-5 lb	21
COMMENTS: Apply only one time/season. This material available for use under a supplemental label. Will be phased out in 2006.		
B. CARBARYL* 80S	3.75-6.25 lb	14
4F	3-5 qt	14
XLR Plus	3-5 qt	14
COMMENTS: XLR formulation is the least toxic to honey bees when direct application to bees is avoided and the spray residues have dried.		
C. PERMETHRIN* 3.2EC	8-16 oz	0
25WP	12.8-25.6 oz	
COMMENTS: No more than 0.8 lb a.i./acre/season.		
D. PHOSMET (Imidan) 70W	4 lb	14
COMMENTS: Do not apply more than 5.67 lb/acre/season as a foliar spray. Do not apply after hull split reaches 10%.		
E. TEBUFENOZIDE (Confirm) 2F	16 oz.	14
COMMENTS: Apply at initiation of egg hatch.		
F. GONIOZUS LEGNERI#	2,500-5,000	
COMMENTS: An alternative in organically managed orchards.		

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

# Acceptable for organically grown produce.

## OBLIQUEBANDED LEAFROLLER

**Scientific Name:** *Choristoneura rosaceana*

(Updated 6/03)

### DESCRIPTION OF THE PEST

Larvae of the obliquebanded leafroller are yellowish green caterpillars. When disturbed, they wiggle backwards and drop to the ground on a silken thread. Rolled leaves webbed together to form protective nests indicate the presence of leafroller larvae. Adult moths have dark brown bands running at oblique angles across their wings. Obliquebanded leafroller overwinters as second-instar larvae under bark scales of trees. There are three generations each year in the pistachio-growing areas of the state.

### DAMAGE

Obliquebanded leafroller larvae cause two types of damage to pistachios. When populations are high, leaves are tied together, which kills portions of leaves and reduces the overall photosynthetic capacity of the trees. The most important damage to the crop, however, is when larvae invade the clusters from June to August and feed on the peduncles (stems). This causes the peduncles to dry and shrivel, thus reducing crop yield.

### MANAGEMENT

Spring treatments of young caterpillars with *Bacillus thuringiensis* and monitoring with pheromone traps to time summer applications are the key approaches to monitoring this pest in pistachio. To time summer treatments, put out pheromone traps by mid-April (Kern and King counties) and April 25 from Fresno north. In addition, look for obliquebanded leafroller larvae when traps indicate adults have emerged. Examine trees for leaf rolls, leaves tied together, and live larvae. When male moths are first found in traps, begin degree-day calculations (upper threshold 90°F, lower threshold 43°F). For assistance in calculating degree-days, see "Degree-Days" on the UC IPM Web site at <http://www.ipm.ucdavis.edu>. Treat when 800 degree-days have accumulated.

#### Organically Acceptable Methods

Springtime sprays of *Bacillus thuringiensis* and summer spray of the Entrust formulation of spinosad are acceptable for use in an organically managed orchard.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
<b>SPRING</b>		
A. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)	Label rates	0
COMMENTS: Apply when trees are beginning to leaf out and small larvae first emerge from bark scales. Bt is a stomach poison and must be consumed by the caterpillar; therefore, it is most effective when applied during warm, dry weather when larvae are actively feeding. Most effective when larvae are young. May require more than 1 treatment; apply second application 7–10 days after the first. Can be used during bloom.		
<b>SUMMER</b>		
A. SPINOSAD (Entrust)#	1.25–3 oz	14
(Success)	4–6 oz	14
B. IMIDAN (Phosmet)	4–5 lb	14
COMMENTS: Do not apply more than 5.67 lb/acre/season as a foliar spray. Do not apply after hull split reaches 10%.		
C. TEBUFENOZIDE (Confirm) 2F	16 oz	

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
D. CARBARYL*		
80S	5 lb	14
XLR Plus	5 qt	14

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

# Acceptable for organically grown produce.

## CITRUS FLAT MITE

**Scientific Name:** *Brevipalpus lewisi*

(Updated 6/03)

### DESCRIPTION OF THE PEST

This mite is smaller than tetranychid (spider) mites. It is slow-moving, flat, and oblong in shape, being wider at the anterior end. Coloring ranges from red brown to more reddish.

Citrus flat mite is a warm season pest with populations increasing in June and peaking in late July and August, then gradually declining.

### DAMAGE

Mite feeding damages the stems (rachis) of clusters as well as nuts. Feeding on the stems causes a browning that gradually develops into a severely roughened, black area that resembles a scab. This feeding damage is usually on the inside or back portion of nut clusters. Under heavy population pressure, stems and nuts begin to shrivel. Damaged nuts remain on the tree and can provide an overwintering source for navel orangeworm. Close examination will reveal citrus flat mite. They are most easily observed around shriveled and damaged areas.

### MANAGEMENT

No precise guidelines are available to determine the need for treatment. Populations can be spotty, and in following years become more widespread in the orchard. Initiate treatments when flat mite populations in nut clusters can be easily detected, but before nut shriveling.

#### Organically Acceptable Methods

Sulfur sprays are acceptable for use in an organically managed orchard.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. SULFUR DUST 98% # COMMENTS: Best results are obtained by ground treatments; however, aerial treatments are effective. Use higher rates by air. Check label to confirm product is labeled for pistachio.	30–40 lb	0
B. WETTABLE SULFUR# COMMENTS: May be applied by ground or air. Check label to confirm product is labeled for pistachio.	12–24 lb	0

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

# Acceptable for organically grown produce.

## PLANT BUGS

**Scientific Names:** Western tarnished plant bug: *Lygus hesperus*

Also, *Neurocolpus longirostris*, *Calocoris norvegicus*, *Phytocoris* spp.  
(including *P. relativus* and *P. californicus*), and *Psallus vaccinicola*

(Updated 6/03)

### DESCRIPTION OF THE PESTS

A variety of plant bugs in the family Miridae attack pistachio. The particular species varies depending upon location and natural vegetation. All of these bugs have a small, triangular-shaped marking on the back.

*Neurocolpus* adults are straw colored, slightly hunched, and about 0.3 inch in length. They can overwinter as eggs—at the base of buds or leaf-petiole scars—on 1-year-old pistachio wood. The nymphs are greenish in color with brown markings on the back. Both stages are easily identified by the relatively long, hairy first antennal segment and brown and white bands on legs and antennae. Although *Neurocolpus* have been found only in orchards near California buckeye and *Rhamnus* spp., the native hosts for *Neurocolpus*, once established in a pistachio orchard, *Neurocolpus* will overwinter there.

*Lygus* bug adults are about 0.25 inch in length, and coloration varies from brownish to green. *Lygus* has a yellowish, triangular-shaped area on the back between the wings. They are most commonly found near alfalfa and beans, or plants such as clovers, Russian thistle, tarweed, London rocket, and lupine. *Lygus* usually migrate into a pistachio orchard from nearby weeds. When rainfall and spring temperatures are ideal for the growth of broadleaf weeds, *Lygus* populations can be severe. When *Lygus* moves into the orchard, they tend to locate in the cover crop and move into the trees when the cover crop becomes unsuitable.

*Calocoris* adults are about 0.25 inch in length with a green-colored body. The wings have a reddish brown tint and are black where they overlap. There are also two black dots on the thorax. *Calocoris* is usually found on mustard, wild radish, and vetch hosts and is most common in the northern San Joaquin and Sacramento valleys. *Calocoris* does not overwinter in pistachio trees but migrates into the orchards as native weed hosts dry or are cultivated in spring.

*Phytocoris* overwinters in the egg stage on pistachios as well as on other deciduous trees. Adults are about 0.25 inch long and are predominantly gray with flecks of black and white; they have long antennae and legs and can move rapidly when disturbed. The nymphs are also gray with white bands on the legs and antennae. Moderate populations of *Phytocoris* are not considered damaging and seldom require treatment. They are predators of other insects, especially immature adult soft scale in March and April and second-instar scales that are migrating from leaves to woody shoots in fall; they also feed on navel orangeworm eggs in spring.

The least common of these plant bugs is *Psallus vaccinicola*. The adults are about 0.13 inch long and are brownish red in color. They have been found predominantly near oaks in the Sacramento Valley.

### DAMAGE

These bugs are only damaging for a short period of time, from bloom (early April) through shell hardening (late May). They insert their mouthparts into the nut, causing damage known as epicarp lesion. This damage is done before shell hardening and, except for damage caused by *Neurocolpus*, is more random in occurrence than damage caused by leaftooted plant bugs and stink bugs. Damage to small nuts results in blackening and nut drop. As the nuts enlarge, the hull tissue turns brown and necrotic, and the outside will often become sunken. On the inside of the nut there will be a small black spot or irregular-shaped pit in the area where the bugs fed on soft shell tissues.

## MANAGEMENT

Careful attention to vegetation in and around orchards is the key to effective management of plant bugs. The general pattern of bug appearance and distribution in an orchard is that *Phytocoris* overwinters in the trees, and if *Neurocolpus* is present, it too may overwinter in the trees. *Calocoris* and *Lygus* overwinter on preferred weed hosts in the ground cover. As vegetation in the pistachio orchard or surrounding areas dries, these bugs can move into the orchard canopy where they damage the developing crop. Options to consider are (1) elimination of all herbaceous vegetation; (2) maintenance of monitoring strips; (3) use of trap crops with chemical treatment; and (4) use of cover crops that are not attractive to pest insects. Success or failure with each option will likely depend on the specific site and the species of bugs in the orchard.

### Organically Acceptable Methods

Careful cover crop management is an organically acceptable management strategy.

### Monitoring and Treatment Decisions

Starting in March, monitor both the cover crop with a sweep net for *Lygus* and *Calocoris* and the trees with a beating tray for *Neurocolpus* and *Phytocoris*. To use a beating tray, hold the tray under nut clusters while striking the limb sharply three times with a lightweight club. The insects drop onto the tray and can be easily examined. *Phytocoris* spp. can also be monitored with pheromone traps. It is also helpful to look for small damaged or blackened nuts.

There are currently no guidelines based on the number of plant bugs found. If populations are found uniformly throughout the orchard after bloom, initiate treatment. If insect numbers are low in the trees, but *Lygus* and *Calocoris* are present in the ground cover, consider just treating the ground cover. *Phytocoris* is not a problem after April, but *Lygus* and *Calocoris* can be if they move in the trees from drying vegetation. *Neurocolpus* can also be a problem in May if it is established in the orchard or migrates in. By early June or after the shell has hardened, these insects are no longer damaging.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. PERMETHRIN*		
3.2EC	8–16 oz	0
25WP	12.8–25.6 oz	0
COMMENTS: Do not apply more than 0.8 lb a.i./ acre/ season.		
B. CARBARYL*		
80S	3.75–6.25 lb	14
4F	3–5 qt	14
XLR Plus	3–5 qt	14
COMMENTS: XLR formulation is the least toxic to honey bees when direct application to bees is avoided and the spray residues have dried. Apply from late evening to early morning when bees are not foraging.		

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

## LEAFFOOTED PLANT BUGS

**Scientific Names:** *Leptoglossus clypealis*, *Leptoglossus occidentalis*  
(Updated 6/03)

### DESCRIPTION OF THE PESTS

The leaffooted plant bugs are relatively large insects, 0.75 to 1 inch in length. Both species are quite similar in appearance; they are brown in color with a narrow white band across the back. This band is less distinct in *L. occidentalis*. The head appears pointed, and the hind legs have an expanded area that superficially resembles a leaf, hence its name.

### DAMAGE

These insects are capable of causing two types of damage. The first type (epicarp lesion) is produced early in the season and is similar to that caused by other plant bugs. Nuts damaged during or shortly after bloom blacken and drop. If nuts are damaged during the period in which they are enlarging, the damaged tissue turns brown and necrotic and the outside will often become sunken. The internal lesions often develop a white, netted appearance in the shell tissue, with no deep pitting. After shell hardening in June, leaffooted bugs may cause a second type of damage called kernel necrosis, which is not obvious on the shell. Externally all that is evident is a brown pinpoint mark. With kernel necrosis, the nutmeat is darkened, often develops a sunken or distorted area, and may have an off-flavor.

Leaffooted plant bugs typically damage entire clusters.

### MANAGEMENT

Leaffooted bugs normally do not appear in orchards until late in the season (August and September). However, if they overwinter in or near pistachio, they may be found earlier, usually feeding on nut clusters. Sample for them using a beating tray. Hold the tray under nut clusters while striking the limb sharply three times with a lightweight club. The insects will drop onto the tray and can be easily examined. If the bugs are present (e.g., 1 bug per 15 or 20 beats), particularly early in the season, treatment may be necessary. Look for small, black nuts in clusters or on the ground in late April to early May for the first indication of bug presence in the orchard.

Common name (trade name)	Amount/Acre**	P.H.I.+ (days)
A. PERMETHRIN*		
3.2EC	8–16 oz	0
25WP	12.8–25.6 oz	0
COMMENTS: May be used on either early or late developing populations. Do not apply more than 0.8 lb a.i./acre/season.		
B. AZINPHOSMETHYL*		
50WP	4 lb	21
COMMENTS: Apply only one time/season. This material is available for use under a supplemental label.		

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

## STINK BUGS

**Scientific Names:** Redshouldered stink bug: *Thyanta pallidovirens*

Green plant bug: *Chlorochroa uhleri*

Green soldier bug: *Acrosternum hilare*

(Updated 6/03)

### DESCRIPTION OF THE PESTS

The redshouldered stink bug is somewhat triangular in shape and about 0.33 inch in length. It is predominantly green with a narrow red band across the shoulder; sometimes the band is absent. There is also a brown-colored phase, usually found in overwintering bugs. The green plant bug is dull to bright green and slightly larger (0.4–0.6 inch in length) and less common than the redshouldered stink bug. Green soldier bug nymphs are a mixture of green, black, and orange. Adult green soldier bugs are bright green with the entire lateral margin lined in yellow or orange.

Stink bugs often develop in weeds or field crops and move to pistachio, but they have also been found overwintering in orchards. Eggs of these stink bugs are laid in clusters, are barrel shaped, and have concentric dark rings at the top. Immature stages of these species have a wide range of color markings that are different from the adult.

Do not confuse these stink bugs with the rough stink bug, *Brochymena quadripustulata*, a predator that is speckled white and gray and quite common in pistachio orchards throughout the year. Nymphs of *Brochymena* are colored red, white, and blue.

### DAMAGE

After shell hardening in July, stink bugs may cause kernel necrosis, which is identical to damage caused by leaffooted plant bugs. Kernel necrosis is not obvious externally, but inside the nut, the nutmeat is darkened, often develops a sunken necrotic area, and has an off-flavor. In July and August, feeding damage is indicated by an external, brown pinpoint mark; no white netting is visible. Although stink bugs can cause epicarp lesion early in the season, damaging populations have usually not been observed until late in the season.

Stink bugs are capable of transmitting some pistachio diseases, such as Stigmatomycosis and panicle and shoot blight, making control of these pests important.

### MANAGEMENT

Stink bugs are primarily late season pests. During July and August, populations can become quite high. Although there is debate on the value of treating them, treatment will reduce kernel necrosis when populations are high. Stink bugs can be easily sampled with a beating tray. Time applications after the majority of eggs have hatched and nymphs are easily found.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. PERMETHRIN*		
3.2EC	8–16 oz	0
25WP	12.8–25.6 oz	0
COMMENTS: Do not apply more than 0.8 lb a.i./ acre/season. Highly toxic to honey bees.		
B. CARBARYL*		
80S	3.75–6.25 lb	14
4F	3–5 qt	14
XLR Plus	3–5 qt	14

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
C. AZINPHOSMETHYL* 50WP	4 lb	21
COMMENTS: Apply only one time/season. This material is available for use under a supplemental label.		

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

## SOFT SCALES

**Scientific Names:** Brown soft scale: *Coccus hesperidum*  
 Black scale: *Saissetia oleae*  
 Frosted scale: *Parthenolecanium pruinosum*  
 European fruit lecanium: *Parthenolecanium corni*

(Updated 6/03)

### DESCRIPTION OF THE PESTS

The brown soft scale is a mottled, yellow-brown color when young, becoming darker at maturity. It has three to five generations per year and is often found on the nut. It is flattened and elongated, resembling a football sliced in half. It is about 0.13 inch in length.

The black scale is dark brown to black, later becoming more mottled black and brown. It has an H-shaped ridge on the dorsum. There is generally only one generation per year in the Central Valley. However, in some years two generations have been detected.

The frosted scale is elongated, slightly humped, and has a waxy, white frostlike coating in spring. It is about 0.25 inch in length at maturity and has one generation per year. It is found in the warmer interior growing areas.

The European fruit lecanium is identical to the frosted scale but does not have the frosted coating. High temperatures early in summer will increase mortality of immature stages of European fruit lecanium.

Soft scales molt twice before they reach maturity. The stage just before the adult one is frequently referred to as the rubber stage. In this stage, the scales remain soft, somewhat translucent and are still susceptible to parasitism. Upon molting to adults, the shell hardens and becomes opaque.

### DAMAGE

In spring, soft scales produce heavy amounts of honeydew, which can affect photosynthesis. Moderate to high scale populations can also retard shoot growth and shell splitting. Scales are most common on vigorously growing trees.

### MANAGEMENT

These scales are normally kept under control by native parasites. Because of the increase in chemical treatment in pistachio, natural enemies of scales are more frequently destroyed, and soft scales are becoming more prevalent.

#### Biological Control

An effective parasite of soft scales is a tiny parasitic wasp, *Metaphycus luteolus*, which destroys the scale in its early instars before it can reproduce or cause substantial injury. This parasite produces several generations. In addition, other parasites as well as the predacious lady beetle, *Rhyzobius (Lindorus) lophanthae*, prey on these scales.

There is a strong, indirect relationship between *Phytocoris* plant bugs and populations of soft scales. Where *Phytocoris* plant bugs are plentiful, scale populations are commonly low. During March and April, immature adult soft scales and eggs are a primary food source for *Phytocoris*. In fall, *Phytocoris* feeds on second-instar scales that are migrating from the leaves to the woody shoots.

#### Organically Acceptable Methods

Biological control and oil sprays in the dormant period are acceptable for use in an organically certified crop.

**Treatment Decisions**

Apply a dormant treatment from mid-November through December before the scales reach the rubber stage of development.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. CARBARYL*		
80S	5-6.25 lb	14
XLR Plus	4-5 qt	14
...PLUS...		
SUPREME OIL (Volck)	4-6 gal	
COMMENTS: Best results are obtained with the addition of the oil to the spray. When dormant oil is applied in January or February, trees bloom somewhat earlier in spring, and they become more susceptible to frost damage. If dormant oil applications are made earlier (Nov.-Dec.), the effect on bloom timing is minimized.		

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

## WESTERN TUSSOCK MOTH

**Scientific Name:** *Orgyia vetusta*

(Updated 6/03)

### DESCRIPTION OF THE PEST

Western tussock moth overwinters in the egg stage, and larvae begin emerging in March and April. Immature larvae are hairy and black. Mature western tussock moth larvae are large (almost 2 inches in length) caterpillars with numerous red and yellow spots and long tufts of hair. There are four white tufts of hair on the top of the first four abdominal segments, two black tufts on the head, and many grayish tufts over the body. Adult females are large, wingless, and predominantly gray. The males are winged moths. There is only one generation per year.

### DAMAGE

As the tree begins to leaf out, larvae feed on the foliage. Localized heavy populations can completely defoliate trees.

### MANAGEMENT

Visually search trees for black caterpillars feeding on terminal growth and look for cocoons on major scaffolds. Insecticides applied for plant bug control will reduce western tussock moth populations.

#### Organically Acceptable Methods

Sprays of *Bacillus thuringiensis* are acceptable for use in an organically managed orchard.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)	Label rates	0

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

# Acceptable for organically grown produce.

## FALSE CHINCH BUG

**Scientific Name:** *Nysius raphanus*

(Updated 6/03)

### DESCRIPTION OF THE PEST

The adult false chinch bug is a small bug, about 0.12 inch or 3 mm long. It is gray to light brown in color and looks somewhat like a small lygus bug. The nymph is gray with a reddish brown abdomen.

False chinch bugs breed in high numbers on weeds within or adjacent to pistachio orchards. The eggs are laid randomly on the soil or within soil cracks. The false chinch bug spends the winter primarily in the immature stage (nymph). As weeds dry in spring or are destroyed, chinch bugs migrate to pistachio trees where they feed. Nymphs predominate during migration but adults may also be present. Important weeds that serve as hosts include wild mustard, wild radish, shepherd's-purse, and London rocket. The most serious infestations result from spring migrations; however, fall migrations can also occur. Movement occurs primarily in early morning or evening.

### DAMAGE

False chinch bugs can be a serious problem on newly planted pistachio trees. Their feeding can cause young trees to wilt and die. Feeding on older trees can cause leaves to drop.

### MANAGEMENT

On newly planted trees, if bugs are so numerous that wilting is evident, a treatment is warranted. Treat either in the evening or early morning when chinch bugs are active.

Common name (trade name)	Amount/ Acre**	P.H.I.+ (days)
A. PERMETHRIN*		
3.2EC	8–16 oz	0
25WP	12.8–25.6 oz	0
COMMENTS: Do not apply more than 0.8 lb a.i./ acre/season.		

\*\* Unless otherwise noted, apply with enough water to ensure adequate coverage.

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

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

## PISTACHIO SEED CHALCID

**Scientific Name:** *Megastigmus pistaciae*

(Updated 6/03)

### DESCRIPTION OF THE PEST

The pistachio seed chalcid overwinters as a diapausing larva in infested nuts. In spring the larva pupates, and the pupa transforms to an adult that chews a tiny (1 mm) exit hole through the hard nut shell and emerges as the adult wasp. Female wasps lay their eggs in the hardening shells of maturing nuts in May and June, and the second adult generation emerges in mid- to late-summer. Some of the larvae of this generation do not emerge as adults the same year but remain in the nuts as mature larvae until the following spring. Adult female wasps that do emerge in August and September are able to oviposit through the hard shells of mature nuts, producing overwintering larvae.

### DAMAGE

Although the seed chalcid is not a pest of commercial plantings of pistachios in California, it does occur throughout the Central Valley and is a pest in other areas of the world where pistachios are grown. Growers should be aware of this insect because it feeds directly on the pistachio nut and has the potential to reduce yields. It has become a serious pest in some areas of California where *Pistacia* seeds are produced for nursery rootstocks and in ornamental pistachios planted in urban areas.

### MANAGEMENT

Examine nuts for small holes that indicate a seed chalcid has emerged from the nut. Adults can also be monitored by the use of yellow sticky traps that are placed in orchards in early August. Control of this pest consists primarily of orchard sanitation: remove and destroy nuts left on the tree following harvest as well as those that have fallen on the ground.

## *Diseases*

### **BLOSSOM AND SHOOT BLIGHT**

**Pathogen:** *Botryotinia fuckeliana*; conidial stage: *Botrytis cinerea*  
(Updated 6/03)

#### **SYMPTOMS**

Botrytis blossom and shoot blight occurs in early spring. The first symptom to be observed is wilting of tender shoots; later leaves shrivel and dry. Young shoots die and the leaves remain attached, a symptom called flagging.

Blossom blight is more severe in male than female trees, especially in the 02-16 and 02-18 cultivars. The fungus enters the flower and invades the wood where it causes cankers on current or two-year-old shoots. Cankers can coalesce and measure up to 10 inches (25 cm) long. When cool, wet weather prevails, diseased blossoms and basal portions of shoots are generally covered by buff-colored masses of spores. Large circular lesions can develop, and portions of the leaf blade (usually a V-shaped area near the terminal) may also be infected and killed by the fungus.

#### **COMMENTS ON THE DISEASE**

Infections occur in spring on succulent current-season growth. Most Botrytis cankers occur at the base of shoots. Shoots wilt and form a shepherd's crook. Inflorescences, especially in male trees, are also attacked.

Blighted shoots provide inoculum during the current growing season and in the following spring. Under humid conditions, the fungus colonizes and sporulates on male flowers that are on the tree or already dropped to the ground. Other sources of inoculum include infected weeds or other crops neighboring the pistachio orchard. The disease is prevalent during cool, wet springs and causes damage by killing current season shoots, thus reducing fruiting wood for the following season.

#### **MANAGEMENT**

Orchard sanitation may help reduce the incidence of Botrytis blight. By pruning blighted shoots and removing them from the orchard the level of inoculum in the orchard may be reduced. Also, by pruning the blighted shoots and shoots with cankers, the potential for invasion of the tree by *Botryosphaeria dothidea* is reduced.

If spring weather is cool and wet during bloom, consider treating for this disease.

Common name (trade name)	Amount/ Acre	P.H.I.+ (days)
A. THIOPHANATE-METHYL (Topsin) M WSB	1.5–2 lb	
COMMENTS: Apply at bloom. Restricted entry interval is 3 days. Do not apply more than 2 lb/acre/season.		
B. CHLOROTHALONIL (Echo 720)	6 pt	14
COMMENTS: Apply when trees begin to blossom and repeat applications at 4-week intervals. Use the high rate when abnormally wet weather conditions prevail.		
+ Preharvest interval. Do not apply within this many days of harvest.		

## PANICLE AND SHOOT BLIGHT

**Pathogen:** *Botryosphaeria dothidea*; conidial stage: *Fusicoccum* sp.  
(Updated 6/03)

### SYMPTOMS

Vegetative and flowering buds that were killed during the previous fall or winter do not emerge in spring. In mid-spring (end of May to June) buds that were partially infected the previous season produce fruit clusters and shoots that develop blight from the fungus in buds. The rachises of these blighted clusters turn black as do the shoots. When temperatures increase in May through July, the fungus moves into shoots of the previous year, causing blighting of fully developed clusters. These blighted shoots, leaves, and clusters turn brown.

Secondary infections of clusters originate where the rachises branch; they start as small black lesions that later coalesce and cause fruit blight. In late August through September, infected fruit are covered with pycnidia (black flasklike structures containing the fungus spores).

Infections on leaves also start as small black lesions that later coalesce and cause leaf blight. From August through October, large necrotic lesions with pycnidia in the center develop on leaves of male and female trees. Infection of petioles start as longitudinal black areas and cause blight of the entire leaf or of individual leaflets. Scars of abscised buds or leaves can also be infected, resulting in sunken cankers above and below the scars. Infected rachises usually hang on the tree for 3 to 4 years, providing inoculum for the following growing season(s). On branches, lenticels can also be infected, but the infections remain small and do not invade the shoot.

### COMMENTS ON THE DISEASE

Sources of inoculum for this disease are rachises, shoots, and petioles killed during the previous growing season that remain on the trees. Cankers can also provide inoculum for as long as 6 years. Spores from these sources cause primary infections on the vegetative and flowering buds. Secondary infections subsequently occur on shoots, rachises, fruit, and leaves. The pathogen can cause latent infections on both leaves and fruit. Symptoms of the disease are triggered to develop by temperatures over 86°F (30°C).

Spores are spread in water from spring and summer rains, via water from sprinkler irrigation, or other means (birds, insects, etc.). The optimum temperature range for disease development is 80° to 86°F, and the disease can become very severe during late spring to summer when temperatures and relative humidity in pistachio orchards are high.

### MANAGEMENT

Reduction of this disease is possible either by lowering the sprinklers so that water does not reach the tree canopy or by shortening the duration of irrigation from 48 to 24 hours. Irrigating only during the daytime for 12 hours in 2 consecutive days reduces the disease significantly.

If your orchard has a history of *Botryosphaeria* blight and blighted shoots, plan to treat for this disease when panicles appear in spring. When disease incidence is low, pruning the blighted shoots and panicles during summer can help reduce or eliminate this disease for a few years. When the disease is severe, both pruning and fungicide use are suggested.

Common name (trade name)	Amount/Acre
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- |   |          |
|---|----------|
| A. THIOPHANATE-METHYL<br>(Topsin) M WSB   | 1.5–2 lb |
| COMMENTS: Apply at bloom. Restricted entry interval is 3 days. Do not apply more than 2 lb/acre/season. |          |

Common name (trade name)	Amount/ Acre	P.H.I.+ (days)
B. TRIFLOXYSTROBIN (Flint) 50WDG	2.0–3.0 oz	60
COMMENTS: Apply at 2- to 3-week intervals beginning at late May to early June. Do not apply more than 3 consecutive times or more than 4 times/season. Do not apply more than 12 oz/acre/season. Use allowed under a supplemental label.		
C. AZOXYSTROBIN (Abound) 2EC	12.3–15.4 fl oz	28
COMMENTS: Apply at 2- to 3-week intervals beginning late May to early June. Do not apply more than 3 consecutive times or more than 4 times/season.		
D. CHLOROTHALONIL (Echo 720)	6 pt	14
COMMENTS: Apply when trees begin to blossom and repeat applications at 4-week intervals. Use the high rate when abnormally wet weather conditions prevail.		

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

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

## ALTERNARIA LATE BLIGHT

**Pathogen:** *Alternaria alternata*, other *Alternaria* spp., and *Stemphyllium* spp.  
(Updated 6/03)

### SYMPTOMS

Alternaria late blight occurs as black angular or circular lesions on leaves of both male and female trees. When the pistachio fruit are maturing, lesions appear on hulls. Black spores develop in the center of the leaf lesions. Rubbing the leaf lesions with a finger will blacken the finger. In contrast, rubbing a finger on a lesion cause by *Botryosphaeria dothidea* does not blacken fingers because there are no spores produced on the surface of these lesions. However, late in the season both fungi can be present in the same lesion. Leaf infections can cause severe premature defoliation.

Black lesions are also present on petioles and main veins of leaf blades. On immature fruit the symptoms appear as small black lesions about 1 mm in diameter. On mature fruit, both small (1–2 mm) and large (5 mm) black lesions are present on the epicarp, usually surrounded by a reddish purple margin. Multiple lesions on leaves and fruit cause leaf blight and deterioration of hulls. Deterioration of hulls results in shell staining.

### COMMENTS ON THE DISEASE

Alternaria is a problem in orchards irrigated by sprinklers or flooding, although it can also be a problem in orchards with low soil infiltration and those irrigated with microsprinklers, particularly in lower areas in these orchards where relative humidity can be high and dew formation frequent during late August and September. The pathogen causes latent infections on leaves and fruit. The disease is more severe on leaves from fruit-bearing shoots than those without fruit.

Losses occur mainly because of fruit staining and from early defoliation, which can be severe enough to cause difficulties during harvest. In addition, the fungus can colonize the inner surface of the shell and endocarp, causing moldy nuts. Leaf and fruit lesions are common on both Kerman and Red Aleppo cultivars, as well as on the leaves of Peters, 02-16, and 02-18 male cultivars.

### MANAGEMENT

Early August to mid-September is the critical period for disease development. Orchards with cover crops have more Alternaria blight than disced orchards. Sunburned fruit become more susceptible to Alternaria blight than nonsunburned fruit.

Alternaria blight is difficult to control and requires a combination of management approaches. If the disease is serious, adjust the irrigation schedule so the period from August 1 to 10 is irrigation-free. Subsurface irrigation can reduce this disease significantly. However, disease severity must be weighed against the impact of deficit irrigation on shell splitting. Avoid delaying harvest of mature nuts.

Common name (trade name)	Amount/ Acre	P.H.I.+ (days)
A. AZOXYSTROBIN (Abound) 2EC COMMENTS: Apply at 2- to 3-week intervals beginning late May to early June. Do not apply more than 3 consecutive times or more than 4 times/season.	12.3–15.4 fl oz	28
B. TRIFLOXYSTROBIN (Flint) 50WDG COMMENTS: Apply at 2- to 3-week intervals beginning at late May to early June. Do not apply more than 3 consecutive times or more than 4 times/season. Do not apply more than 12 oz/ acre/season. Use allowed under a supplemental label.	2.0–3.0 oz	60

Common name (trade name)	Amount/ Acre	P.H.I.+ (days)
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C. CHLOROTHALONIL (Echo 720)	6 pt	14
COMMENTS: Apply when trees begin to blossom and repeat applications at 4-week intervals. Use the high rate when abnormally wet weather conditions prevail.		

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

# Acceptable for use on organically grown produce.

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

## STIGMATOMYCOSIS

**Pathogens:** *Nematospora coryli* and *Aureobasidium pullulans*  
(Updated 6/03)

### SYMPTOMS

Stigmatomycosis of pistachio is characterized by the wet, smelly, rancid, slimy appearance of the kernel. There are three major symptoms of stigmatomycosis: small kernels that are dark in color and not fully developed; kernels that develop normally and fill the shell cavity but are partially or totally wet, smelly, rancid, and dark colored; and kernels that fill the shell cavity but look abnormal—white and jellylike.

### COMMENTS ON THE DISEASE

The yeasts that caused stigmatomycosis are associated with hemipteran insects (true bugs) in the families Pentatomidae (stink bugs) or Coreidae. Hemiptera are common pests in pistachio orchards. Switching from sprinkler irrigation to drip, microjets, or flood irrigation reduces damage from bugs as well as stigmatomycosis. Feeding by plant bugs can also damage the kernel, causing kernel necrosis, a brown-to-black distinct lesion that sometimes shows concentric rings.

### MANAGEMENT

Fungicide applications are not effective in controlling stigmatomycosis; however, a spray to control stinkbugs and leaffooted bugs has been shown to reduce the incidence of stigmatomycosis as well.

## FRUIT MOLDS

**Pathogens:** *Alternaria alternata*, *Stemphyllium* sp., *Cladosporium herbarum*, *Aspergillus flavus*,  
*A. melleus*, *A. niger*, *A. ochraceus*, and *A. parasiticus*  
(Updated 6/03)

### SYMPTOMS

If humid conditions prevail during the maturation period of pistachio fruit, several fungi can colonize and decay pistachios.

*Alternaria* causes deterioration of fruit epicarp. Small or large black lesions develop that may expand over the entire hull surface. Depending on the degree of colonization, *A. alternata* can invade the kernel, causing kernel discoloration and decay. Whether or not the kernel is infected, *Alternaria* can damage the quality of the nut by causing brown to black stain marks on the shells.

*Aspergillus niger* causes a blight that turns the hulls light beige to yellow. If hulls are removed, the black, powdery sporulation of the fungus is evident in the hull and on the surface of the shell.

### COMMENTS ON THE DISEASE

Colonization of nuts by *Aspergillus* molds is often associated with insect infestations. Contamination of the nuts by *A. flavus* may result in the production of aflatoxin. Dry, hot weather favors infection by *Aspergillus* spp.

### MANAGEMENT

Take preventive measures during the period that the fruit are maturing. Avoid water stress during mid-May when the shell is growing rapidly to reduce the incidence of early shell split and control infestations of navel orangeworm.

## **POWDERY MILDEW**

**Pathogens:** *Oidium* sp.  
(Updated 6/03)

### **SYMPTOMS**

Powdery mildew causes leaves to yellow, then brown and die. Infected tissues may be distorted and misshapen. Similar symptoms can be found on rachises, fruit stems, petioles, underside of leaf blades, and young shoots.

### **COMMENTS ON THE DISEASE**

The disease commonly occurs on the Trabonella cultivar. Red Aleppo is more susceptible than the Kerman cultivar.

### **MANAGEMENT**

The occurrence of powdery mildew on pistachio trees is uncommon and sporadic. No control measures are recommended.

## VERTICILLIUM WILT

**Pathogen:** *Verticillium dahliae*

(Updated 6/03)

### SYMPTOMS

Generally Verticillium wilt causes a rapid desiccation and death of one or more scaffolds or the entire tree, usually in late spring or early summer. The first symptoms are interveinal patches of yellowing or scorching of the leaves on affected branches. In some instances, however, it may also cause a condition known as thin leaf decline in which the disease develops slowly over several years before the tree becomes economically unproductive or dies. Thin leaf decline is characterized by slow loss of vigor, reduction in growth and yield, and gradual thinning of the canopy until most of the remaining leaves are clustered in tufts at the ends of branches and shoots.

### COMMENTS ON THE DISEASE

Verticillium wilt affects a large number of herbaceous and woody species. The causal fungus, *Verticillium dahliae*, infects susceptible plants through the roots and plugs the water-conducting tissues. Pistachio trees of any age are subject to attack. The disease is more common in the southern half of the San Joaquin Valley than in other areas of the state and has been most destructive where pistachio trees were grown in fields previously planted to other susceptible crops such as tomato, cotton, melons, or peppers.

The fungus survives as microscopic, black resting structures (microsclerotia) capable of surviving in soil for many years. When a susceptible plant is grown in soil infested with the fungus, the microsclerotia germinate and infect the plant. It invades and colonizes the plant's vascular system, plugging the xylem and preventing or reducing the transport of water from the roots to the above ground portion of the tree. If dead or dying branches are cut in cross section, a darkened ring of plugged xylem tissue can be seen.

Verticillium wilt is favored by cool temperatures. Extended spring weather and mild summers often are accompanied by severe losses to this disease. The fungus apparently is eliminated from aboveground portions of trees in hot summer weather. Repeated attacks of wilt apparently represent new infections each year.

### MANAGEMENT

The best defense against Verticillium wilt is the use of the resistant rootstock Pioneer Gold, *Pistacia integerrima*, or UCB I (a *P. atlantica* x *P. integerrima* hybrid). *Pistacia atlantica* and *P. terebinthus* rootstocks are very susceptible and should be avoided where *Verticillium* is present.

When choosing an orchard site, have the inoculum level in the soil determined by a private laboratory. Preplant or planting site fumigation can reduce soil inoculum levels but will not eradicate the fungus or prevent its re-establishment. To prepare the soil for fumigation, dry it by withholding water during summer and using cover crops such as sudangrass. The drier the soil, the better for deep penetration of methyl bromide\*. Deep-till the area after drying. If the soil is dusty, wait for an early rain before ripping and fumigation. Ripping a dry soil that is silty can result in large clods on the surface. Inject methyl bromide 18 to 30 inches deep with chisels and cover with gas-proof cover. Increasing the dose tends to increase the depth of penetration, but it cannot be relied upon to penetrate wet soil, especially if soils are high in clay. Do not remove the cover for at least 2 weeks and aerate 1 month before planting. Treatments may be made from late summer to early fall. In tree crops, methyl bromide often gives inconsistent control.

Placing plastic mulches on fallow soil for several weeks in summer also lowers inoculum levels through 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. Application of plastic mulches to established pistachio orchards is limited in effectiveness and does not work well in shade.

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

## ARMILLARIA ROOT ROT (Oak Root Fungus)

**Pathogen:** *Armillaria mellea*  
(Updated 6/03)

### SYMPTOMS

Roots infected with *Armillaria mellea* have white to yellowish fan-shaped mycelial mats between the bark and the wood. Dark brown to black rhizomorphs can sometimes be seen on the root surface. Although pistachio is susceptible to Armillaria root rot, the disease is infrequently reported. The relative susceptibility of pistachio rootstocks is unknown.

### COMMENTS ON THE DISEASE

The fungus survives on dead roots.

### MANAGEMENT

Armillaria root rot is only occasionally a problem in pistachio orchards. Management of this disease can be difficult and resistant rootstock may offer the best protection. Research indicates that *Pistacia terebinthus* and *P. atlantica* × *P. integerrima* hybrids are tolerant but *P. atlantica* and *P. integerrima* are susceptible. However, because pathogenicity and virulence in the natural population of the pathogen ranges from weak to severe, disease response may vary with different combinations of rootstocks and pathogen. Exposing an infected crown may help individual trees with the disease. Soil fumigation as a preplant treatment can slow progress of the disease, but eradication is not likely.

#### Treatment Decisions

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

Common name (trade name)	Amount/Acre
-----------------------------	-------------

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

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

## Nematodes

**Scientific Names:** Pin nematode: *Paratylenchus hamatus*  
Root lesion nematode: *Pratylenchus neglectus*  
Dagger nematode: *Xiphinema americanum*  
Root knot nematode: *Meloidogyne* spp.

(Updated 12/97)

### DESCRIPTION OF THE PESTS

Nematodes are microscopic, unsegmented, roundworms that live in diverse habitats. Plant parasitic nematodes feed on plant roots by piercing and sucking the cell contents with a spearlike mouthpart called a stylet. They usually live in soil and plant tissues.

### DAMAGE

The nematodes listed above have been found in pistachio orchards in California but have not been associated with damage to this crop.

### SYMPTOMS

Tree symptoms may suggest but are never sufficient to diagnose a nematode problem. To adequately diagnose a nematode problem, soil and root samples must be examined by a diagnostic laboratory to determine if nematodes are present.

### FIELD EVALUATION

Although nematodes have not previously been found to cause problems on pistachios in California, if the cause for a problem cannot be found, soil samples could be taken to determine if nematodes are present in high numbers. Contact your farm advisor for more details about sampling, to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

### MANAGEMENT

No management practices are recommended because nematodes are not currently recognized as causing problems on pistachios in California. *Pistachia vera* rootstock is known to be susceptible to root knot nematode, whereas *P. atlantica*, *P. terrebinthus* and *P. integerrima* currently appear to be resistant or poor hosts for root knot and lesion nematodes.

## Weeds

### INTEGRATED WEED MANAGEMENT

(Updated 8/04)

Weeds compete with pistachio trees for water and nutrients. The competition for these resources is of greater concern when trees are young because weeds can delay growth and production. Weeds can also harbor pests and pathogens, interfere with irrigation uniformity and distribution, and reduce harvest efficiency. Integrated weed management involves the use of multiple strategies to manage weed populations in a manner that is economically and environmentally sound. Such strategies include cultural, mechanical, chemical, and biological methods.

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

Irrigation method, amount of water applied, and pattern of rainfall affect weed growth as well as the frequency and timing of cultivation and selection of herbicides and their residual properties. For example, soils that receive frequent, low-volume, drip or micro-sprinkler irrigation increase the degradation of herbicides in the soil. Herbicides are degraded faster in warm, moist soils as compared to cold, dry soils.

Although there are not many herbicides registered in California for use in pistachios, they are an important component of an integrated weed management program. Herbicide selection is an important process and is determined by the species of weeds present, stage of weed development, weed density, herbicide toxicity, herbicide persistence, soil type, soil moisture, irrigation method, environmental conditions, labor and equipment availability, and economics. Referring to the weed susceptibility charts and herbicide tables shown in this text can help in the process of herbicide selection and effectiveness.

Herbicides are either applied to the soil surface before weeds germinate and emerge (preemergent) or are applied directly to the foliage of small, actively growing weeds (postemergent).

**Preemergent herbicides** prevent weed germination and emergence; they do not control established plants. The effect of preemergent herbicides can last up to a year, depending on the solubility of the material, adsorption to the soil, weed species, and dosage applied. Soil type and irrigation methods are very important to the effectiveness of these herbicides. They tend to be more stable when used on heavier soil types than on lighter ones. These herbicides can also be lost as a result of leaching and runoff. Herbicide leaching is more extensive on sandy soils and runoff occurs more on clay soils. As a general rule, preemergent herbicides require rainfall or irrigation following treatment to activate them. Subsequent irrigations are less important on the movement of the herbicide. In most instances, combinations or sequential applications of herbicides will be needed to provide effective, economical control.

**Postemergent herbicides** are applied directly to weed foliage and they control weeds either by contact or through translocation. A **contact herbicide**, such as paraquat, kills young weeds by direct contact of the foliage. Therefore, it is essential to have good spray coverage and wetting for this type of herbicide to be effective. **Translocated herbicides**, like glyphosate, move within the plant to kill it. Complete coverage of weeds with translocated herbicides is not necessary. Furthermore, postemergent

herbicides can be selective or nonselective in their control. **Selective herbicides**, like sethoxydim and fluazifop-p, control only grassy weed species. **Nonselective herbicides**, like glyphosate and paraquat, control a broad spectrum of both grasses and broadleaf weeds. Regardless of the type of postemergent herbicides used, the best time to treat weeds is when they are in the seedling stage and actively growing.

## PREVENTION

A good weed management strategy in pistachio orchards begins with prevention. Keep irrigation canals, ditch banks, and irrigation systems free of weeds and weed seeds. Install filters in canals and irrigation systems to prevent weed seeds from entering the orchard. Prevent leaks in the irrigation system and the accumulation of water in furrows or low-lying areas, which encourage weed growth. Control weeds along field margins before they produce seed that can be dispersed readily into the orchard. Clean the undercarriage and tires of tractors and other equipment before entering new fields because weed seeds and reproductive parts of weeds can be transported along with them. This is especially important in preventing perennial weeds from entering a previously uninfected field.

## MONITORING

Detecting new weeds and weeds that escaped previous control efforts is essential in preventing weed establishment or shifts in weed populations. Regular monitoring or scouting is a very important component of an integrated plan. For weed monitoring to be useful it is important correctly identify the weed species present in and around the orchard. Try to identify and control weeds when they are in the seedling stage. Most weeds are poor competitors for water and nutrients when they are small, but some can become very aggressive as they become large. Furthermore, it is easier to control annual weeds with chemical or mechanical tools when they are small and have not become established. Perennial weeds are more vulnerable to control at the early bud stage or during fall when the plants begin to go dormant. Herbicides applied at these stages can be translocated to the roots or rhizomes to better kill the weed. For assistance in identifying weeds in different stages of growth, consult the color photos in the online version of this guideline that are linked to the weeds listed in Common and Scientific Names of Weeds.

Monitor the orchard in a thorough and systematic manner. Include the entire orchard as well as field margins, ditch banks, and irrigation canals in your survey. Monitor at least four times a year (spring, summer, winter, and fall). Examine all areas that are susceptible to weed infestation, like areas of high moisture. Items of interest include weed species, location in the field, degree of control achieved with current program, and herbicides and other options used (including timing, rates, and dates treated). Record observations so the infested sites can be revisited for weed control. Maintain monitoring information for the life of the orchard. Over several years this information will help in determining changes in the weed species that are present. Comparing this information with the past and current weed management methods can help in evaluating the success of the techniques used and in deciding future strategies.

## WEED MANAGEMENT BEFORE PLANTING

Whenever possible, avoid fields known to be infested with perennial weeds such as johnsongrass, field bindweed, bermudagrass, and nutsedge. If perennial weeds infest a potential orchard site, control them before the final land preparation for planting because they can cause problems and increase management costs in the future. There are no preemergent herbicides that can be used before planting pistachio trees. It is important to note that young pistachio trees are very sensitive to soil residuals of certain preemergent herbicides such as diuron (Karmex), simazine (Princep), and bromoxynil (Buctril); carefully follow all label plantback restrictions in orchard sites where preemergent herbicides have been used. The only chemical option of controlling weed seeds in the orchard site is soil fumigation, which can be expensive.

Identify and control weeds that are growing on the orchard site either chemically with postemergent materials or mechanically before planting. Annual weeds are best controlled before they produce seeds.

Perennial weeds can be mechanically controlled by repeated diskings in summer or chemically treated with a postemergent herbicide in the early fall while the perennial weeds are still flowering. Re-treat with a postemergent herbicide the following spring to kill regrowth. Follow the re-treatment by disking the orchard site 2-3 weeks later to expose weed roots to drying.

Other herbicides, such as paraquat and sulfosate can also be used to control weeds before planting. It may be necessary to irrigate the field before treatment to encourage weed emergence and growth. This can also significantly reduce the amount of weed seed remaining in the soil and increase the degree of control of perennial weeds.

## WEED MANAGEMENT IN NEWLY PLANTED ORCHARDS

Weed control is especially important during the first few years of orchard establishment. Competition from weeds during this period can result in reduced tree vigor and productivity. Weedy orchards may require several more years to become economically productive than weed-free orchards. Regardless of the method to control weeds, be careful not to injure the young trees with herbicides or to mechanically damage the trunk or roots.

**Cultivation.** Weeds may be managed without the use of herbicides for the first few years after planting with cross disking or shallow cultivation in the tree row (less than 2" deep) and disking or mowing between tree rows along with some hand weeding in the area at the base of the trees. Cultivation is best done when weeds are in the seedling stage and easy to dislodge from the soil. Hand weeding is usually required up next to the trees to remove weeds missed during cultivation. Hand-held weed eaters can be used to kill small weeds around the trees, but take care not to injure the bark of young trees. Damage to either the bark or the roots can allow soil pathogens in, causing further damage to the trees.

**Herbicides.** Some weeds are best controlled in the early years of an orchard before the trees come into production because certain herbicides are registered only for use during the nonbearing period (normally four years). For example, the preemergent herbicide thiazopyr (Visor) can be used during the nonbearing years to help control nutsedge; however, once the orchard is in production, there are no preemergent herbicides to control nutsedge in pistachio.

*Preemergent herbicides.* If using preemergent herbicides to control weeds in a newly planted orchard, apply them to the soil only after the trees have completely settled in to reduce the likelihood of tree damage. The risk of damage is greater if the trees settle after treatment because the herbicide has a greater chance of coming into direct contact with tree roots.

Preemergent herbicides that may only be applied during the nonbearing years in pistachios are isoxaben (Gallery), pendimethalin (Prowl), and thiazopyr (Visor). Preemergent herbicides that are registered for both the nonbearing and bearing years in pistachio include napropamide (Devrinol), oryzalin (Surflan), and oxyfluorfen (Goal).

Preemergent herbicides can be applied to a small area immediately around the tree or in a 4- to 6-foot strip down the center of the tree rows. The soil surface should be free of leaves and other debris because some herbicides may adhere to the trash on the soil surface and not make adequate contact with the soil surface. Adequate rainfall is also required to activate the herbicides following application. Some herbicides, like napropamide, must be activated with rainfall or irrigation water within 4 to 5 days of treatment, while others, like oxyfluorfen and oryzalin can remain stable on the soil surface for 21 days or more.

*Postemergent herbicides.* Postemergent herbicides can also be used following planting once weeds have emerged. Herbicides registered for the nonbearing years only include clethodim (Prism), diquat (Reglone), fluazifop-p (Fusilade), sethoxydim (Poast), and sulfosate (Touchdown). Postemergent herbicides registered for both the nonbearing and the bearing years include glyphosate (Roundup

UltraMax, etc), halosulfuron (Sempra CA), paraquat (Gramoxone Extra), and 2,4-D amine (Orchard Master, etc). Postemergent herbicides usually require the addition of an adjuvant (either a nonionic surfactant or a nonphytotoxic oil) to be effective.

Regardless of the postemergent herbicide used, protect the foliage and bark of young trees from direct spray or spray drift in order to avoid tree injury. Young pistachio trees are very susceptible to damage from herbicides. Placing plastic or paper wraps around the tree trunks is helpful in preventing herbicide contact with young trees.

## WEED MANAGEMENT IN ESTABLISHED OR BEARING ORCHARDS

It takes about 6 years in most situations for pistachio trees to come into full production so they can be mechanically harvested. Trees less than 6 years old are generally harvested by knocking the nuts onto tarps on the ground. Generally, weeds are controlled between the tree rows by disking or mowing and herbicide strip applications directed down the tree row.

**Cultivation.** Cultivation can be used to manage annual and biennial weeds both between and within tree rows. Large weeds, perennials, or weeds with hearty roots and/or crowns (like cheeseweed and hairy fleabane) will not be controlled mechanically and may require postemergent herbicide treatments.

Generally, weeds growing between the rows of trees, in the alleys or middles, are disked 3 to 5 times a year. The size of the weeds is usually not a concern as long as the disk blades cut deep enough to destroy the weeds and seed has not yet been produced. Weeds within the tree row can be managed with a second pass of the cultivator. However, cross-disking must be carefully done to avoid damaging the trees and their roots. Injury to trees can lead to invasion by crown-rotting organisms. Leave a 1- to 2-foot strip next to the trees to prevent injury. Weeds in this undisturbed area can be removed by hand or spot treated with postemergent herbicides where appropriate (see section below). In-row mulching cultivators also can be used as long as the trees are not damaged. Shallow (less than 2 inches deep) mulching will destroy most annual and seedling biennial weeds.

Some problems that can develop with repeated disking are soil compaction, dust, reduced water infiltration, and soil erosion in hilly terrains and sloping lands. Disking may also bring some buried weed seeds to the surface or spread rhizomes, tubers, or stolons throughout the orchard. Therefore, some growers maintain a planted cover crop or resident vegetation that they mow. Where resident vegetation is maintained, a flail mower is used as needed to maintain the plants in a low-growing state. Mowing too close to the soil surface creates dust and should be avoided. If self-reseeding of a cover crop is desired, a final mowing should not be made until the plants have set seed. For more information on cover crops, consult UC/ANR Publication 21471, *Covercrops for California Agriculture*.

**Herbicides.** Established trees are generally more tolerant of many herbicides than newly planted ones. There are only three preemergent herbicides that are registered for use in a bearing pistachio orchard (napropamide-Devrinol, oryzalin-Surflan, and oxyfluorfen-Goal). When using a preemergent herbicide or combination of herbicides, apply a treatment in fall following harvest, in late winter before bloom, or split into two applications (fall and spring). Add a postemergent herbicide if weeds are emerged at the time of application. For the greatest safety, direct the spray to the base of the trees to avoid contact with young wood and foliage.

Apply preemergent herbicides as close to rainfall as possible to improve efficacy, and remove leaves or other debris that may be covering the tree row, preventing the herbicide from contacting the soil. Select the appropriate postemergent herbicide that best controls the weeds present in the field. Occasionally, a tank-mix of one or more herbicides may be required to control all the weeds. In situations where weeds are spotty, the amount of herbicide needed can be reduced by making spot applications or using a visual weed-seeking sprayer. With postemergent herbicides, it is important that weeds are small, not stressed

for moisture, or too large for control. Some weeds, like spotted spurge, set seed soon after emergence, so they must be sprayed often when they are small to provide adequate control.

*Herbicides and Irrigation.* In established pistachio orchards, chemical weed control has to be adjusted to the irrigation method used. In California, pistachios are irrigated by several methods, such as low-volume drip, micro-sprinklers, misters, solid-set sprinkler, furrow, or basin flood. Low-volume irrigation is common in California pistachio orchards because of better uniformity in irrigation application and efficiency than other methods. However, under certain conditions, low-volume irrigation water applied too frequently can increase the chance of leaching and herbicide degradation and the areas around the emitters often have vigorously growing weeds. It is important to monitor these areas closely monitored and spot treat, when necessary with postemergent sprays.

## SPECIAL WEED PROBLEMS

(Updated 8/04)

Many of these special weed problems can be minimized by managing them before planting pistachio orchards.

**HAIRY FLEABANE.** Hairy fleabane is a summer annual that reproduces from seed, although under certain environmental conditions it can grow like a biennial. It germinates from fall through spring and matures and produces seed from July through September. Hairy fleabane is a member of the sunflower family; its seed is readily disseminated by the wind. Of the preemergent herbicides registered, only isoxaben (Gallery) effectively controls it during the nonbearing period. Hairy fleabane can be difficult to control with a postemergent herbicide because its stems are multi-branched and often woody and it has a lack of significant leaf area. Hairy fleabane plants are most susceptible to control with postemergent herbicides or mechanical control when they are in the seedling stage.

**HORSEWEED (MARE'S TAIL).** Horseweed is a summer annual weed, closely related to hairy fleabane, with similar growth and reproductive characteristics. Unlike hairy fleabane, horseweed grows as a single stalk. Horseweed can become a prevalent weed where repeated uses of oryzalin (Surflan), napropamide (Devrinol), and oxyfluorfen (Goal) are used preemergence. Control emerged plants when they are in the seedling or rosette stage of growth. Delaying treatments beyond this can result in significant regrowth. Mowing is not recommended because cutting plants off above the soil line can result in the sprouting of lateral buds at the base of this weed.

**FIELD BINDWEED.** Field bindweed is a vigorous perennial weed that grows from seed, which can survive as long as 30 years in the soil, or more commonly, from reproductive stolons, rhizomes, or extensive roots. It is important to control this weed before it has the chance to produce seed. While cultivation can be used to control seedlings, cultivating mature plants can result in aiding the spread of the reproductive structures. Once field bindweed appears in an orchard, spot treat with high label rates of glyphosate (Roundup) or sulfosate (Touchdown) to prevent its establishment.

**NUTSEDGE.** Yellow and purple nutsedge are perennial weeds that reproduce mainly from underground tubers. Yellow nutsedge is the most common species found in pistachio orchards. Most tubers of yellow nutsedge will survive in the soil for less than 5 years and are found primarily in the top 8" of the soil profile. Yellow nutsedge grows and reproduces best under sandy, well-irrigated conditions. The tuber of each plant has several buds that can each give rise to additional plants. Under normal conditions, one or two buds sprout to form new plants; however, if killed by cultivation or an herbicide, then new buds are activated. Thiazopyr (Visor) is effective at controlling yellow nutsedge before it emerges in nonbearing orchards. Treat emerged plants with glyphosate (Roundup) or sulfosate (Touchdown) before they reach the 4- to 5-leaf stage. Repeat applications will be required when new growth occurs.

**LITTLE MALLOW (CHEESEWEED).** Little mallow is an annual or biennial weed that is sometimes not effectively controlled with preemergent herbicides. High rates of oxyfluorfen (Goal) or thiazopyr (Visor) can provide acceptable control. Once established, little mallow becomes woody and forms a thick crown and root, making it difficult to control mechanically or with postemergent herbicides. Plants that are less than 4 to 6 inches tall are easiest to control with a tank-mix application of oxyfluorfen plus glyphosate (Roundup) or sulfosate (Touchdown). Repeated mowing is not an effective means of control.

## COMMON AND SCIENTIFIC NAMES OF WEEDS

(Updated 8/04)

Common Name	Scientific Name
barley, hare	<i>Hordeum leporinum</i>
barnyardgrass	<i>Echinochloa crus-galli</i>
bermudagrass	<i>Cynodon dactylon</i>
bindweed, field	<i>Convolvulus arvensis</i>
bluegrass, annual	<i>Poa annua</i>
bromegrasses	<i>Bromus</i> spp.
canarygrass	<i>Phalaris canariensis</i>
chickweed, common	<i>Stellaria media</i>
clovers	<i>Trifolium</i> spp.
cocklebur	<i>Xanthium</i> spp.
crabgrasses	<i>Digitaria</i> spp.
cudweeds	<i>Gnaphalium</i> spp.
dallisgrass	<i>Paspalum dilatatum</i>
dock, curly	<i>Rumex crispus</i>
eveningprimrose, cutleaf	<i>Oenothera laciniata</i>
fescues	<i>Festuca</i> spp.
fiddlenecks	<i>Amsinckia</i> spp.
filarees	<i>Erodium</i> spp.
fleabane, hairy (fleabane, flaxleaved)	<i>Conyza bonariensis</i>
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>
horseweed	<i>Conyza canadensis</i>
johnsongrass	<i>Sorghum halepense</i>
junglerice	<i>Echinochloa colona</i>
knotweed, common	<i>Polygonum arenastrum</i>
lambquarters, common	<i>Chenopodium album</i>
lettuce, prickly	<i>Lactuca serriola</i>
lovegrasses	<i>Eragrostis</i> spp.
mallow, little (cheeseweed)	<i>Malva parviflora</i>
mullein, turkey	<i>Eremocarpus setigerus</i>
mustards	<i>Brassica</i> spp.
nettle, burning	<i>Urtica urens</i>
nightshades	<i>Solanum</i> spp.
nutsedge, yellow	<i>Cyperus esculentus</i>
nutsedge, purple	<i>Cyperus rotundus</i>
oat, wild	<i>Avena fatua</i>
pigweeds	<i>Amaranthus</i> spp.
pineapple-weed	<i>Chamomilla suaveolens</i>
puncturevine	<i>Tribulus terrestris</i>
purslane, common	<i>Portulaca oleracea</i>
radish, wild	<i>Raphanus raphanistrum</i>
rocket, London	<i>Sisymbrium irio</i>
ryegrass, Italian	<i>Lolium multiflorum</i>
shepherd's-purse	<i>Capsella bursa-pastoris</i>
sowthistles	<i>Sonchus</i> spp.
sprangletops	<i>Leptochloa</i> spp.
spurge, spotted	<i>Chamaesyce maculate</i>
thistle, Russian	<i>Salsola tragus</i>
willowherb, panicle-leaf	<i>Epilobium brachycarpum</i>
witchgrass	<i>Panicum capillare</i>

# SUSCEPTIBILITY OF SPRING/SUMMER WEEDS TO HERBICIDE CONTROL

(Updated 8/04)

	PREEMERGENT						POSTEMERGENT									
	ISO	NAP	ORY	OXY	PEN	THI	CLE	DIQ	FLU	GLY	HAL	OXY	PAR*	SET	SUL	2,4-I
<b>ANNUAL WEEDS</b>																
<b>Grasses</b>																
barnyardgrass	N	C	C	P	C	C	C	P	C	C	N	P	P	C	C	N
crabgrass, large	N	C	C	P	C	C	C	P	C	C	N	N	C	C	C	N
fescues	N	C	C	P	C	P	P	C	P	C	N	N	C	P	C	N
foxtails	N	C	C	N	C	C	C	P	C	C	N	N	C	C	C	N
lovegrasses	N	C	C	P	C	P	C	P	C	C	N	N	P	C	C	N
sprangletops	N	C	C	P	C	C	C	P	C	C	N	P	P	C	C	N
witchgrass	N	C	C	P	C	P	C	P	P	C	N	N	C	P	C	N
<b>Broadleaves</b>																
cocklebur	--	P	N	P	N	N	N	C	N	C	C	C	C	N	C	C
cutweeds	C	C	N	P	N	C	N	C	N	C	N	C	C	N	C	N
eveningprimrose, cutleaf	C	C	P	P	P	C	N	C	N	C	N	P	C	N	C	--
fleabane, hairy	C	N	N	P	N	P	N	P	N	C	N	P	P	N	C	P
goosefoot, nettleleaf	C	C	C	C	C	C	N	C	N	C	N	C	C	N	C	C
groundcherries	C	N	N	C	N	P	N	C	N	C	N	C	C	N	C	P
horseweed	C	N	N	P	N	P	N	C	N	C	N	P	C	N	C	P
knotweed, common	C	C	C	C	C	C	N	P	N	C	N	N	P	N	P	C
lambquarters, common	C	C	C	C	C	C	N	C	N	C	N	C	P	N	C	C
lettuce, prickly	C	C	N	C	N	C	N	C	N	C	N	P	P	N	C	C
mullein, turkey	C	C	N	P	P	C	N	P	N	C	N	N	C	N	C	P
nightshades	C	N	N	C	N	P	N	C	N	C	N	C	C	N	C	C
pigweeds	C	C	C	C	C	C	N	C	N	C	P	C	C	N	C	P
puncturevine	C	P	P	P	P	P	N	C	N	C	N	P	C	N	C	C
purslane, common	C	C	C	C	C	C	N	C	N	C	N	P	N	C	P	
sowthistles	C	C	P	C	N	C	N	C	N	C	N	C	C	N	C	C
spurge, spotted	C	C	P	P	P	P	N	C	N	C	N	N	C	N	C	N
thistle, Russian	C	P	P	P	P	P	N	P	N	C	N	N	C	N	P	P
willowherb, panicle-leaf	C	N	P	C	P	--	N	P	N	P	N	N	P	N	P	--
<b>PERENNIALS</b>																
<b>Seedling</b>																
bermudagrass	N	C	C	P	C	C	C	P	C	C	N	N	C	C	C	N
bindweed, field	P	N	P	C	P	P	N	C	N	C	N	N	C	N	C	C
clovers	N	P	N	P	N	--	N	P	N	C	N	N	P	N	C	N
dallisgrass	N	P	C	N	C	C	C	P	C	C	N	N	C	C	C	N
johnsongrass	N	C	C	P	C	C	C	P	C	C	N	N	C	C	C	N
<b>Established</b>																
bermudagrass	N	N	N	N	N	N	P	N	P	C	N	N	P	P	C	N
bindweed, field	N	N	P	N	P	N	N	P	N	P	N	N	P	N	P	P
clovers	N	N	N	N	N	--	N	N	N	P	N	N	N	N	P	N
dallisgrass	N	N	N	N	N	N	P	N	P	C	N	N	N	P	C	N
dock, curly	N	N	N	N	N	--	N	N	N	P	--	N	N	N	P	N
johnsongrass	N	N	N	N	P	N	P	N	P	C	N	N	N	P	C	N
nutsedge, purple	N	N	N	N	N	P	N	P	N	P	P	N	P	N	P	N
nutsedge, yellow	N	N	N	N	N	C	N	P	N	P	C	N	P	N	P	N

Continued on next page

Susceptibility of Spring/Summer Weeds to Herbicide Control, continued

ANNUAL WEEDS	TANK-MIX COMBINATIONS				
	ORY/OXY	NAP/OXY	GLY/OXY	SUL/OXY	PAR*/ORY
<b>Grasses</b>					
barnyardgrass	C	C	C	C	P
crabgrass, large	C	C	C	C	C
fescues	C	C	C	C	C
foxtails	C	C	C	C	C
lovegrasses	C	C	C	C	C
sprangletops	C	C	C	C	C
witchgrass	C	C	C	C	C
<b>Broadleaves</b>					
cocklebur	C	P	C	C	C
cudweeds	P	C	C	P	P
eveningprimrose, cutleaf	P	P	C	C	P
fleabane, hairy	P	P	C	C	C
goosefoot, nettleleaf	C	C	C	C	C
groundcherries	C	C	C	C	C
horseweed	P	P	C	C	P
knotweed, common	C	C	C	P	P
lambsquarters, common	C	C	C	C	C
lettuce, prickly	C	C	C	C	C
mullein, turkey	--	C	C	C	C
nightshades	C	C	C	C	C
pigweeds	C	C	C	C	C
puncturevine	P	P	C	C	C
purslane, common	C	C	C	C	C
sowthistles	C	C	C	C	C
spurge, spotted	P	C	C	C	C
thistle, Russian	P	P	C	P	C
willowherb, panicle-leaf	C	C	C	C	P
<b>PERENNIALS</b>					
<b>Seedling</b>					
bermudagrass	C	C	C	C	C
bindweed, field	C	C	C	C	C
dallisgrass	P	P	C	C	C
johnsongrass	C	C	C	C	C
<b>Established</b>					
bermudagrass	N	N	P	P	N
bindweed, field	P	N	P	P	N
clovers	N	N	P	P	P
dallisgrass	N	N	P	P	N
dock, curly	N	N	P	P	N
johnsongrass	N	N	P	P	N
nutsedge, purple	N	N	P	P	P
nutsedge, yellow	N	N	P	P	P

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

ISO = isoxaben (Gallery T&V)

NAP = napropamide (Devrinol)

ORY = oryzalin (Surflan, Oryzalin)

OXY = oxyfluorfen (Goal)

PEN = pendimethalin (Prowl)

THI = thiazopyr (Visor)

CLE = clethodim (Prism)

DIQ = diquat (Reglone)

FLU = fluazifop-p (Fusilade DX)

GLY = glyphosate (Roundup UltraMax)

HAL = halosulfuron (Sempra CA)

PAR = paraquat (Gramoxone Max)

SET = sethoxydim (Poast)

SUL = sulfosate (Touchdown)

2,4- D = (Orchard Master, etc.)

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

## SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL

(Updated 8/04)

	PREEMERGENT						POSTEMERGENT									
	ISO	NAP	ORY	OXY	PEN	THI	CLE	DIQ	FLU	GLY	HAL	OXY	PAR*	SET	SUL	2,4-D
<b>ANNUAL WEEDS</b>																
<b>Grasses</b>																
barley, hare	N	C	C	P	C	C	C	P	C	C	N	N	C	C	C	N
bluegrass, annual	N	C	C	P	C	C	C	P	N	C	N	N	C	N	C	N
bromegrasses	N	C	C	P	C	C	P	P	P	C	N	N	C	P	C	N
oat, wild	N	C	P	P	P	P	C	P	C	C	N	N	C	C	C	N
ryegrass, Italian	N	C	C	P	C	C	C	P	C	C	N	N	C	C	C	N
<b>Broadleaves</b>																
chickweed, common	C	C	C	P	C	C	N	C	N	C	N	N	C	N	C	C
cudweeds	C	C	N	N	N	C	N	C	N	C	N	C	C	N	C	N
fiddlenecks	C	C	C	C	C	C	N	C	N	C	N	C	C	N	C	C
filarees	C	C	P	C	P	P	N	C	N	P	N	C	C	N	P	C
groundsel, common	C	P	P	C	N	C	N	C	N	C	N	C	C	N	C	P
henbit	C	P	P	C	C	P	N	C	N	C	N	C	C	N	C	C
mallow, little (cheeseweed)	C	P	P	C	P	C	N	C	N	P	N	C	P	N	P	C
mustards	C	P	N	C	P	P	N	C	N	C	N	P	C	N	C	C
nettle, burning	C	P	P	C	C	C	N	P	N	N	N	P	P	N	P	C
radish, wild	C	P	P	C	P	C	N	C	N	C	N	P	C	N	C	C
rocket, London	C	C	P	C	P	C	N	C	N	C	N	P	C	N	C	C
shepherd's-purse	C	P	N	C	P	C	N	C	N	C	N	C	C	N	C	C

	TANK-MIX COMBINATIONS				
	ORY/OXY	NAP/OXY	GLY/OXY	SUL/OXY	PAR*/ORY
<b>ANNUAL WEEDS</b>					
<b>Grasses</b>					
barley, hare	P	C	C	C	C
bluegrass, annual	C	C	C	C	C
bromegrasses	P	C	C	C	C
oat, wild	P	C	C	C	C
ryegrass, Italian	C	C	C	C	C
<b>Broadleaves</b>					
chickweed, common	C	C	C	C	C
cudweeds	C	C	C	C	P
fiddlenecks	C	C	C	C	C
filarees	C	C	C	C	P
groundsel, common	C	P	C	C	P
henbit	C	C	C	C	C
mallow, little (cheeseweed)	C	C	C	C	P
mustards	P	P	C	C	C
nettle, burning	P	P	C	C	P
radish, wild	P	C	C	C	P
rocket, London	P	C	C	C	P
shepherd's-purse	P	P	C	C	P

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

ISO = isoxaben (Gallery T&V)  
 NAP = napropamide (Devrinol)  
 ORY = oryzalin (Surflan, Oryzalin)  
 OXY = oxyfluorfen (Goal)  
 PEN = pendimethalin (Prowl)

THI = thiazopyr (Visor)  
 CLE = clethodim (Prism)  
 DIQ = diquat (Reglone)  
 FLU = fluazifop-p (Fusilade DX)  
 GLY = glyphosate (Roundup UltraMax)

HAL = halosulfuron (Semptra CA)  
 PAR = paraquat (Gramoxone Max)  
 SET = sethoxydim (Poast)  
 SUL = sulfosate (Touchdown)  
 2,4-D = (Orchard Master, etc.)

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**HERBICIDE TREATMENT TABLE**

(Updated 8/04)

Herbicide (trade name)	Amount/Acre	P.H.I. + (days)
<b>SITE PREPARATION</b>		
<b>Established weeds</b>		
A. GLYPHOSATE (Roundup UltraMax, etc.)	0.5-4 lb a.i.	
COMMENTS: Apply with a ground sprayer with low-pressure, flat fan nozzles or a controlled droplet applicator. Use 10-40 gal water/acre with 1 lb a.i./acre for annual weeds. Add ammonium sulfate at 5-10 lb/100 gal water to improve control. Apply to young, actively growing annual weeds or perennial weeds when flowering. Some perennials may require the higher label rate for control. Application can be made in strips where the trees will be planted into the line of dead weeds. Do not cultivate weeds for 7-14 days after treatment to maximize control.		
B. SULFOSATE (Touchdown 5)	1-4 lb a.i.	
COMMENTS: Use 1 lb a.i. when susceptible annual weeds are less than 12 inches tall. For perennial weeds, use 1.5-4 lb a.i. in 10-30 gal water/acre. Use flat fan nozzles at a low pressure, not flood jets. A nonionic surfactant can be added at 0.25% volume by volume.		
C. PARAQUAT* (Gramoxone Max)	0.3-0.9 lb a.i.	
COMMENTS: Use in 20-60 gal water/acre when weeds are in the seedling stage with good cover of the weed foliage. Add a non-ionic surfactant at 0.5% volume by volume. Repeated applications will be required as new growth occurs.		
<b>AFTER PLANTING</b>		
<b>Before weeds emerge</b>		
A. ISOXABEN (Gallery T&V)	0.5-1 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. It controls broadleaf weeds only. Wait until trees have completely settled into the soil before application. Rainfall or irrigation of at least 0.5 inches should occur within 21 days of treatment to activate herbicide. Apply in at least 10 gal water/acre. Do not use within 1 year of harvest.		
B. NAPROPAMIDE (Devrinol 50 DF)	4 lb a.i.	
COMMENTS: For use in bearing and nonbearing orchards. Apply to the soil surface in 20-60 gal water/acre. Must be incorporated by rainfall or sprinkler irrigation within 7 days of treatment. Should be combined with a postemergent herbicide if weeds are present at application. Residual period: 4-10 months.		
C. ORYZALIN (Surflan AS, Oryzalin)	2-6 lb a.i.	
COMMENTS: For use in bearing and nonbearing orchards. Apply to the soil in 20-60 gal water/acre to soil that is relatively clean of leaves and other debris. If rainfall does not occur within 21 days of treatment, sprinkle irrigate with 0.5-2 inches of water. Often mixed with oxyfluorfen (Goal). Mix with a postemergent herbicide if weeds are present. Usually used at 4 lb a.i. For longer residual control, apply at 6 lb a.i., especially in high rainfall years. Chemigation is allowed-see label for instructions. Residual period: 4-10 months.		
D. OXYFLUORFEN (Goal 2XL, etc.)	1.2-2 lb a.i.	
COMMENTS: For use in bearing and nonbearing orchards. Apply in 20-60 gal water/acre. At least 0.25 inches rainfall or irrigation must be received within 3-4 weeks after treatment. Do not disturb with mechanical equipment or poor weed control will result. Often mixed with oryzalin (Surflan). Refer to the label for use period, cut-off dates, and other restrictions. Residual period: 4-10 months.		
E. PENDIMETHALIN (Prowl 3.3, etc.)	2-4 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. Apply in 20-40 gal water/acre to soil surface. Incorporate within 4 days of treatment with rainfall, irrigation, or mechanical incorporation. Directed at base of trees during dormant period, avoiding contact with foliage, or injury may result. Do not use within 1 year of harvest.		

Herbicide (trade name)	Amount/ Acre	P.H.I. + (days)
F. THIAZOPYR (Visor)	0.5-1.0 lb a.i.	365
COMMENTS: Registered for use in nonbearing orchards only under a SLN registration. Applied in 20-40 gal water/acre. Used at lower rates for control of annual weeds. Applied at 0.5 lb a.i. in fall and again in late-winter for yellow nutsedge control. Requires rainfall or irrigation within 21 days following treatment. Can be mixed with oxyfluorfen (Goal) for broader weed control. Residual period: 5-8 months. Do not use within 1 year of harvest or apply more than 4 pt (1 lb a.i.)/acre/year.		
<i>Established weeds</i>		
A. CLETHODIM (Prism)	0.09-0.25 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. A crop oil concentrate (1% volume by volume) or nonionic surfactant (0.25% volume by volume) must be added. Used in 20-40 gallons water/acre. For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Repeated applications needed on perennial grasses when their growth meets label requirements. Do not use within 1 year of harvest.		
B. DIQUAT (Reglone)	0.375-0.5 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. Add a nonionic surfactant at 0.25% v/v. Applied in 20-60 gallons water/acre. Apply when weeds are less than 4 inches tall. Control is improved during warm, dry weather. Do not use within 1 year of harvest.		
C. FLUAZIFOP-P-BUTYL (Fusilade DX)	0.25-0.375 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. A crop oil concentrate (1% volume by volume) or nonionic surfactant (0.25% volume by volume) must be added. Used in 20-40 gallons water/acre. For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Repeated applications needed on perennial grasses when their growth meets label requirements. Do not use within 1 year of harvest.		
D. GLYPHOSATE (Roundup UltraMax, etc.)	0.5-4 lb a.i.	3
COMMENTS: For use in bearing and nonbearing orchards. Apply with a ground sprayer with low-pressure, flat fan nozzles or a controlled droplet applicator. For annual weed control, use 1 lb a.i. in 10-40 gallons water/acre. Adding sprayable ammonium sulfate at 5-10 lb/100 gallons water may improve control. Apply to young, actively growing annual weeds or perennial weeds when flowering. Some perennials may require the higher label rate for control. Avoid drift onto green bark or foliage or injury will result. To maximize control, do not cultivate weeds for 7-14 days after treatment. Can be mixed with low rates of oxyfluorfen (Goal) for broader weed control.		
E. HALOSULFURON (Sempra CA)	0.032-0.063 lb a.i.	1
COMMENTS: Use allowed under a supplemental label for bearing and nonbearing orchards that have been established for at least 1 year. Avoid contact with foliage and tree roots, especially in soils that crack, or injury could result. Used where nutsedge is the predominate weed and is at the 4- to 5-leaf stage. Add nonionic surfactant at 0.25% volume by volume. Apply with flat fan nozzles using low pressure. Do not apply with a controlled droplet applicator. Thoroughly clean the sprayer following treatment per label recommendations. Clean soil is used as fill dirt for replants when previously treated with halosulfuron.		
F. OXYFLUORFEN (Goal 2XL, etc.)	0.5-1.0 lb a.i.	
COMMENTS: Dormant application to young (4-leaf stage) weeds. May be combined with other postemergence herbicides for specific weeds. Can be applied in-season following bloom (refer to label for specific timing).		
G. PARAQUAT* (Gramoxone Max)	0.3-0.9 lb a.i.	7
COMMENTS: For use in bearing and nonbearing orchards. Apply in 20-60 gallons water/acre to young, actively growing weeds. Add a nonionic surfactant at 0.5% volume by volume. Repeat applications will be required as new growth occurs. Do not exceed 2 applications after shells split.		

Herbicide (trade name)	Amount/ Acre	P.H.I.+ (days)
H. SETHOXYDIM (Poast)	0.28-0.47 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. A crop oil concentrate must be added at 1% volume by volume. Used in 20-40 gallons water/acre with thorough spray coverage of the weed foliage. For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Repeat applications needed on perennial grasses when their growth meets label requirements. Do not use within 1 year of harvest.		
I. SULFOSATE (Touchdown 5)	1-4 lb a.i.	365
COMMENTS: For use in nonbearing orchards only. Use 1 lb a.i. when susceptible annual weeds are less than 12 inches tall. For perennial weeds, use 1.5-4 lb a.i. in 10-30 gallons water/acre. Use flat fan nozzles at a low pressure, not flood jets. A nonionic surfactant can be added at to 0.25% volume by volume. Avoid drift onto green bark or foliage or injury will result. Do not use within 1 year of harvest.		
J. 2,4-D AMINE (Orchard Master, etc.)	1-1.4 lb a.i.	60
COMMENTS: For use in bearing and nonbearing orchards that have been established for at least 1 year. Selective on small, vigorously growing broadleaf weeds. Applications made to sandy soils, under windy conditions, when trees are in bloom, or under hot conditions can result in tree injury. Do not apply before an irrigation or rainfall or injury can result. The sprayer is thoroughly cleaned following treatment as per label recommendations.		
<b>HERBICIDE TANK-MIX COMBINATIONS</b>		
<i>Tank-mix combinations are most often used to broaden the spectrum of weeds controlled. Perennial weeds may not necessarily be controlled with these combinations. Other tank-mix combinations can be used depending on the species present in the orchard.</i>		
A. ORYZALIN (Surflan AS, Oryzalin)	4 lb a.i.	
...PLUS...		
OXYFLUORFEN (Goal 2XL, etc.)	1 lb a.i.	
COMMENTS: Combined to give broad-spectrum control. Applied preemergence or combined with glyphosate if weeds have emerged. Activate with rainfall or irrigation within 21 days of treatment.		
B. NAPROPAMIDE (Devrinol 50 DF)	4 lb a.i.	
...PLUS...		
OXYFLUORFEN (Goal 2XL, etc.)	1 lb a.i.	
COMMENTS: Combined to give broad-spectrum control. Rainfall occurs within 7 days. Glyphosate is added if weeds have already emerged.		
C. GLYPHOSATE (Roundup UltraMax, etc.)	0.5-1 lb a.i.	3
...PLUS...		
OXYFLUORFEN (Goal 2XL, etc.)	0.1-1 lb a.i.	
COMMENTS: Combined for broad-spectrum control of weeds in orchards. Helps increase the control of cheeseweed, filarees, hairy fleabane, horseweed, chickweed, and grasses. Avoid drift onto trees or injury can result. Follow label directions for application period of oxyfluorfen.		

Herbicide (trade name)	Amount/ Acre	P.H.I. + (days)
D. SULFOSATE (Touchdown 5) ....PLUS.... OXYFLUORFEN (Goal 2XL, etc.) COMMENTS: Combined for broad-spectrum control of weeds in orchards. Helps increase the control of cheeseweed, filarees, hairy fleabane, horseweed, chickweed, and grasses. Avoid drift onto trees or injury can result. Follow label directions for application period of oxyfluorfen. Do not use within 1 year of harvest when sulfosate is added.	1-4 lb a.i.   0.1-1 lb a.i.	365
E. PARAQUAT* (Gramoxone Extra) ....PLUS.... ORYZALIN (Surflan AS, Oryzalin) COMMENTS: Provides burndown of emerged weeds and preemergent control of annual weeds. Avoid drift onto trees to prevent injury. Emerged weeds must be small for effective control.	0.5 lb a.i.   4 lb a.i.	7

\* Permit required from county agricultural commissioner for purchase or use.  
 + P.H.I. (Preharvest Interval): do not apply within this many days of harvest.

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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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