UC IPM Almond

June 2019

PEST MANAGEMENT GUIDELINES FOR AGRICULTURE

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

Publication 3431 • Online with photos at ipm.ucanr.edu/agriculture/almond

University *of* California

Agriculture and Natural Resources • **UC Statewide Integrated Pest Management Program**

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UC PEER REVIEWED

This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Agricultural Pest Management.

The UC IPM Pest Management Guidelines are available from:

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- **UC Cooperative Extension County Offices**
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Updates: These guidelines are updated regularly. Check with your University of California Cooperative Extension Office or the UC IPM website for information on updates.

Note to readers: These guidelines represent the best information currently available by the authors and are intended to help you make the best choices for an IPM program. Not all formulations or registered materials are mentioned. Always read the label and check with local

authorities for the most up-to-date information regarding registration and restrictions on pesticide use. Check with your agricultural commissioner for latest restricted entry intervals.

This material is partially based on work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Crop Protection and Pest Management Competitive Grants Program.

To be used with *Integrated Pest Management for Almonds, 2nd edition,* UC ANR Publication 3308.

For information on almond production, see *Almond Production Manual*, UC ANR Publication 3364 (Available from http://anrcatalog.ucanr.edu)

Almond Year-Round IPM Program

ANNUAL CHECKLIST *(reviewed 8/17)*

Use these guidelines for a monitoring-based IPM program to effectively manage pests, while reducing the risks of pesticides on the environment and human health.

When a pesticide application is considered, review the Pesticide Application Checklist at the bottom of this page for information on how to minimize the risks of pesticide use to water and air quality. Water quality can be impaired when pesticides drift into waterways or when they move off-site. Air quality can be impaired when pesticide applications release volatile organic compounds (VOCs) into the atmosphere.

This year-round IPM program covers the major pests of almond in California. Details on carrying out each practice, example monitoring forms, and information on additional pests can be found in the Almond Pest Management Guidelines. Track your progress through the year with this annual checklist form. Color photo identification pages and examples of monitoring forms can be found on the forms and photo ID pages.

✓ Done	Dormancy to delayed-dormancy **Mitigate pesticide effects on air and water quality.**
	Count mummy nuts in orchard. • If more than two nuts per tree remain, knock off and destroy mummy nuts by the initiation of bloom to reduce navel orangeworm and brown rot.
	Manage orchard floor vegetation: • After harvest, assess weeds present and identify those that were not controlled by a fall preemergence herbicide application. • Keep records. In January, consider applying postemergence herbicides in tree row strips alone or in combination with preemergence herbicides.
	Take spur samples for scale and mite eggs mid-November to mid-January. • Record results. • Manage if needed according to the Pest Management Guidelines.
	Examine trees for peach twig borer hibernacula in the crotches of one-year-old wood. • Consult the Pest Management Guidelines to determine if treatments should be made during dormancy, bloom (*Bacillus thuringiensis* only), or in May.
	In orchards with varieties that retain leaves, monitor rust for possible spring fungicide application and take a first-year twig sample (green shoots) to monitor for scab infections. • If scab infections are high, consider dormant or delayed-dormant treatments.
	Other pests you may see: • Armillaria root rot (oak root fungus): mushrooms emerge during wet periods. • Pocket gophers (mound-building activity).

✓ Done	Bloom to postbloom **Mitigate pesticide effects on air and water quality.**

	Manage navel orangeworm:
	• Ensure that mummies on the ground are destroyed before navel orangeworm emergence.
	• Put out pheromone traps, egg traps, or both:
	  ○ Central and southern San Joaquin Valley by February 15 (pheromone) or March 15 (egg).
	  ○ Northern San Joaquin and Sacramento valleys no later than the first week of March (pheromone) or March 15 (egg).

	Monitor peach twig borer: • Put up pheromone traps by March 15 and check according to the Pest Management Guidelines.

✓ Done	Bloom to postbloom **Mitigate pesticide effects on air and water quality.**
	• Record results.
	When rainy conditions promote disease, time pesticide applications according to the Pest Management Guidelines for: • Anthracnose • Bacterial spot • Brown rot blossom blight • Green fruit rot (jacket rot) • Leaf blight • Rust (if overwintered lesions on retained leaves) • Scab • Shot hole
	Monitor for shot hole fruiting structures in leaf lesions as long as weather is wet. Apply fungicides if needed according to the Pest Management Guidelines.
	Monitor San Jose scale: • Put up pheromone traps by March 1 and check according to the Pest Management Guidelines. • Record results.
	Start to monitor for spider mites when mites are first seen in the lower center tree canopy. • Manage if needed according to the Pest Management Guidelines.
	Monitor for vertebrates and manage as necessary. • Gophers • Ground squirrels • Voles
	Other pests you may see: Insects: • Brown mite • European red mite • Forest tent caterpillar • Fruittree leafroller (possible nut drop) • Leaffooted plant bug (possible nut drop) • Obliquebanded leafroller Diseases: • Armillaria root rot (oak root fungus) • Bacterial canker • Phytophthora root and crown rot • Wood-decay fungi (fruiting bodies)
	Manage orchard floor vegetation: • Mow ground cover before bloom for frost protection and to remove competing bloom.

✓ Done	Fruit development (late April to start of shaking) **Mitigate pesticide effects on air and water quality.**
	Monitor shoot strikes for peach twig borer and Oriental fruit moth; examine strikes to properly identify species. • Manage if needed according to the Pest Management Guidelines.
	Monitor San Jose scale: • Pheromone traps are useful for detecting male scales and parasites.
	Monitor navel orangeworm egg, and pheromone, traps: • Keep records. • Manage if needed according to the Pest Management Guidelines.
	Monitor ant mounds (once during April or May) • Keep records. • Manage if needed according to the Pest Management Guidelines.
	Monitor spider mites weekly: • Keep records. • Manage if needed according to the Pest Management Guidelines.

✓ Done	Fruit development (late April to start of shaking) **Mitigate pesticide effects on air and water quality.**
	Take leaf samples in April or July to make sure that nitrogen levels do not favor hull rot.
	Monitor for and manage if needed according to the Pest Management Guidelines: • Alternaria leaf spot • Bacterial spot • Hull rot caused by *Monilinia* or *Rhizopus* spp. • Rust • Scab • Shot hole
	Assess weeds in late spring: • Identify uncontrolled weeds to plan future management strategies. • Keep records of monitoring. • Continue to maintain ground cover to facilitate cultural practices and pest management.
	Other pests you may see: Insects: • Brown mite • European red mite • Leaffooted bugs • Obliquebanded leafroller • Peach silver mite • Peachtree borer • Stink bugs • Tenlined June beetle (where soils are very sandy) Diseases: • Almond leaf scorch • Armillaria root rot (dying trees) • Band canker (2nd to 6th leaf trees) • Ceratocystis canker • Silver leaf • Wood-decay fungi (fruiting bodies) • Noninfectious bud failure
	Identify beginning of hullsplit; regulate irrigation during hullsplit to manage hull rot.

✓ Done	Harvest
	Harvest early to avoid third-generation navel orangeworm eggs and to minimize hull rot.
	Assess trunk damage to evaluate shaker or harvest operation for bark injury.
	Pick up nuts promptly to avoid ant damage.
	Take harvest sample to determine pest damage. • Store sample in freezer until nuts are cracked open for observation.

✓ Done	Postharvest **Mitigate pesticide effects on air and water quality.**
	Look for nuts or leaves stuck on trees well after harvest, indicating hull rot or San Jose scale.
	Monitor for rust lesions. Manage according to the Pest Management Guidelines.
	After fall rain begins, monitor for shot hole leaf lesions with fruiting structures. • Manage according to the Pest Management Guidelines.
	Survey weeds: • Record results. • If use of preemergence herbicide in rows is planned, time it properly for the weed spectrum.
	Consider planting a cover crop if resident vegetation is sparse and orchard floor cover is desired.

✓ Done	Pesticide application checklist
	When planning for possible pesticide applications in an IPM program, consult the Pest Management Guidelines, and review and complete this checklist to consider practices that minimize environmental and efficacy problems.
	✓ **Choose a pesticide from the Pest Management Guidelines for the target pest, considering:**
	• Impact on natural enemies and pollinators. For more information see Protecting Natural Enemies and Pollinators at http://ipm.ucanr.edu/mitigation/protect_beneficials.html.
	• Potential for water quality problems using the UC IPM WaterTox database. See http://ipm.ucanr.edu/TOX/simplewatertox.html.
	• Impact on aquatic invertebrates. For more information, see *Pesticide Choice*, UC ANR Publication 8161 (PDF), http://anrcatalog.ucanr.edu/pdf/8161.pdf.
	• Chemical mode of action, if pesticide resistance is an issue. For more information, see *Herbicide Resistance: Definition and Management Strategies*, UC ANR Publication 8012 (PDF), http://anrcatalog.ucanr.edu/pdf/8012.pdf.
	• Endangered species that may be near your site. Find out using the Department of Pesticide Regulation's PRESCRIBE program.
	✓ **Before an application**
	• Ensure that spray equipment is properly calibrated to deliver the desired pesticide amount for optimal coverage. (See http://ipm.ucanr.edu/training/incorporating-calibration.html)
	• Use appropriate spray nozzles and pressure to minimize off-site movement of pesticides.
	• Avoid spraying during these conditions to avoid off-site movement of pesticides. o Wind speed under 3 mph or over 10 mph o Temperature inversions o Just prior to rain or irrigation (unless it is an appropriate amount, such as when incorporating a soil-applied pesticide) o At tractor speeds over 2 mph
	• Identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding your application site.
	• Review and follow labeling for pesticide handling, personal protection equipment (PPE) requirements, storage, and disposal guidelines.
	• Check and follow restricted entry intervals (REI) and preharvest intervals (PHI).
	✓ **After an application**
	• Record application date, product used, rate, and location of application.
	• Follow up to confirm that treatment was effective.
	✓ **Consider water management practices that reduce pesticide movement off-site.**
	• Consult relevant publications: o *Reducing Runoff from Irrigated Lands: Orchard Floor Management Practices to Reduce Erosion and Protect Water Quality*, UC ANR Publication 8202 (PDF), http://anrcatalog.ucanr.edu/pdf/8202.pdf.

✓ Done	Pesticide application checklist
	○ *Reducing Runoff from Irrigated Lands: Causes and Management of Runoff from Surface Irrigation in Orchards,* UC ANR Publication 8214 (PDF), http://anrcatalog.ucanr.edu/pdf/8214.pdf. ○ *Protecting Surface Water from Sediment-Associated Pesticides in Furrow-Irrigated Crops*, UC ANR Publication 8403 (PDF), http://anrcatalog.ucanr.edu/pdf/8403.pdf.
	• Consult the Department of Pesticide Regulation Groundwater Protection Program (GWPA) website for pesticide information and mitigation measures. (http://cdpr.ca.gov)
	• Install an irrigation recirculation or storage and reuse system. Redesign inlets into tailwater ditches to reduce erosion. For more information, see these publications: ○ Reducing Runoff from Irrigated Lands: Tailwater Return Systems, UC ANR Publication 8225 (PDF), http://anrcatalog.ucanr.edu/pdf/8225.pdf. ○ Reducing Runoff from Irrigated Lands: Storing Runoff from Winter Rains, UC ANR Publication 8211 (PDF), http://anrcatalog.ucanr.edu/pdf/8211.pdf.
	• Use drip rather than sprinkler or flood irrigation.
	• Limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET). For more information, see ○ *Reducing Runoff from Irrigated Lands: Understanding Your Orchard's Water Requirements*, UC ANR Publication 8212 (PDF), http://anrcatalog.ucanr.edu/pdf/8212.pdf. ○ *Using the Pressure Chamber for Irrigation Management in Walnut, Almond, and Prune,* UC ANR Publication 8503.
	• Consider using cover crops.
	• Consider vegetative filter strips or ditches. For more information, see *Vegetative Filter Strips,* UC ANR Publication 8195 (PDF). (http://anrcatalog.ucanr.edu/pdf/8195.pdf.)
	• Apply polyacrylamides in furrow and sprinkler irrigation systems to prevent off-site movement of sediments.
	✓ **Consider practices that reduce air quality problems.**
	• When possible, reduce volatile organic compound (VOC) emissions by decreasing the amount of pesticide applied, choosing low-emission management methods, and avoiding fumigants and emulsifiable concentrate (EC) formulations.
For more about mitigating the effects of pesticides, see the Mitigation page: ipm.ucanr.edu/mitigation/.	

General Information

(Section reviewed 8/17)

DORMANT SPUR OR FIRST-YEAR TWIG SAMPLING AND TREATMENT GUIDELINES (8/17)

Dormant spur or twig sampling is used to determine the need for a dormant treatment to control San Jose scale, European red mite, brown mite, European fruit lecanium, and almond scab, caused by *Fusicladium carpophilum* (*Venturia carpophila*). Scale and mites are sampled on spurs; scab is sampled on twigs. Dormant spur and twig samples are taken once a year between mid-November and the end of January.

HOW TO SAMPLE

(View photo pages online for identification)

- Randomly select 35 to 50 trees from each orchard or plot to be sampled.
- Selecting major scaffolds randomly, clip 2 to 3 spurs (scale and mites) or twigs (scab) from the inside of each tree's canopy.
- Clip the spur or twig off at the base. For scales and mites, sample spurs that are at least two years or older. Make sure to include some old spur wood along with the last year's growth to detect parasite activities on scales.
- Using a hand lens or binocular microscope, examine 20 of the spurs for scales, European red mite or brown mite eggs, or one-year-old green twigs for scab lesions.
- Record observations in a sampling form. It is not necessary to count the number of individual insects or mite eggs present, just identify the pest or disease and record whether it is present or not.
- Note how many scales are parasitized. A parasitized scale can be distinguished from a live scale by a small hole in the top of the scale covering. Parasitized European fruit lecanium scales turn black. If a large number of scales have been parasitized, minimize the use of insecticides during the growing season and only use those that are not harmful to parasites so that naturally occurring populations will not be destroyed. See RELATIVE TOXICITIES OF PESTICIDES USED IN ALMONDS TO NATURAL ENEMIES AND HONEY BEES (http://ipm.ucanr.edu/PMG/r3900311.html) for a list of pesticides and their toxicity to parasites.

TREATMENT THRESHOLDS

Examine each of the 20 spurs or twigs for the presence or absence of scales, European red or brown mite eggs or scab lesions. **Do not combine totals for the two scale species**. For example, if 3 spurs out of a sample of 20 are infested with San Jose scale and 3 spurs contain European fruit lecanium, neither has exceeded the 20% treatment threshold and sampling should continue.

	NUMBER OF SPURS WITH SCALE OR MITES EGGS		
#Spurs sampled	Do not treat	Continue sampling	Treat
20 (scale)	0	1–3	4
20 (mite eggs)	Collect 40 spurs before making a treatment decision		
40	1	2–7	8
60	3	4–11	12
80	5	6–15	16
100	1–19	—	20

	NUMBER OF FIRST-YEAR GREEN TWIGS WITH SCAB		
#Twigs sampled	Do not treat	Continue sampling	Treat
20	Collect 40 twigs before making a treatment decision		
40	1	2–3	4
60	3	4–5	6
80	5	6–7	8
100	1–9	—	10

To determine treatment thresholds use the table below, with detailed treatment threshold information for dormant spur sampling. A dormant spur sampling form is available online.

Dormant Treatment Decision Table (% Infested or Infected Spurs or Twigs)

Pest	Threshold	Treatment
San Jose Scale	Below 20% 20%–60% Over 60%	No Spray Oil at 6–8 gals/acre Oil with insect growth regulator[2]
European Fruit Lecanium	Below 20% 20% and above	No spray Oil only
Overwintering Mite Eggs[1] (European red mite or (brown mite)	Below 20% 20% and above	No spray Oil only
Scab	Below 10% 10% and above	No spray Copper + oil or chlorothalonil + oil

1 Oil works best closer to delayed dormant timing or on warmer days when eggs are respiring. Using dormant oil alone does not provide adequate control for European red mites in Kern County.

2 See San Jose Scale section for specific insect growth regulators.

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

(8/17)

Common name (Example trade name)	Mode of Action[1]	Selectivity[2] (affected groups)	Predatory Mites[3]	General Predators[4]	Parasites[4]	Honey Bees[5]	Duration of impact to natural enemies[6]
abamectin (Agri-Mek)	6	moderate (mites, leafminers)	L	H	M/H	I	long to affected insects
abamectin (Clinch)	6	narrow (ants)	L	L	L	—	—
acequinocyl (Kanemite)	20B	narrow (mites)	L	—	—	III	—
Bacillus thuringiensis ssp. kurstaki	11A	narrow (caterpillars)	L	L	L	III	short
bifenazate (Acramite)	un	narrow (mites)	L	L	L	II	short
bifenthrin (Brigade)	3A	broad (insects, mites)	H	H	H	I	long
buprofezin (Centaur)	16	narrow (sucking insects, beetles)	L	H[7]	L	II	long
carbaryl (Sevin XLR Plus)	1A	broad (insects, mites)	L/H	H	H	I	long
chlorantraniliprole (Altacor)	28	narrow (primarily caterpillars)	L	L	L/M	III	short
clofentezine (Apollo)	10A	narrow (mites)	L	L	L	III	short
clothianidin	4A	—	—	M/H	M/H	I	—
cyfluthrin (Baythroid)	3A	broad (insects, mites)	H	H	H	I	moderate
diflubenzuron (Dimilin)	15	narrow (caterpillars)	L	H[8]	L	II	—
emamectin benzoate (Proclaim)	6	narrow (caterpillars)	—	—	—	I	—
esfenvalerate (Asana)	3A	broad (insects, mites)	H	M	H	I	moderate
etoxazole (Zeal)	10B	narrow (mites)	—[9]	—	—	II	very long to predatory mites
fenbutatin oxide (Vendex)	12B	narrow (pest mites)	L	L	L	III	short
fenpropathrin (Danitol)	3A	broad (insects, mites)	H	H	H	I	—
fenpyroximate (Fujimite)	21A	narrow (mites and some insects)	H	L	L	III	very long to predatory mites
hexythiazox (Onager)	10A	narrow (mites)	L	L	L	II	short to moderate
lambda-cyhalothrin (Warrior)	3A	broad (plant bugs, beetles, caterpillars)	H	H	H	I	moderate
metaflumizone (Altrevin)	22B	narrow (ants)	L	L	L	III	—
methoprene (Extinguish)	7A	narrow (ants)	L	L	L	III	—
methoxyfenozide (Intrepid)	18	narrow (caterpillars)	L	L	L	II	none
petroleum oils	—	broad (exposed insects, mites)	L	L	L	II	short to none
phosmet (Imidan)	1B	broad (insects, mites)	H	H	H	I	moderate to long
propargite (Omite)	12C	narrow (pest mites)	M[7]	L	L	III	short
pyriproxyfen (Seize)	7C	narrow (scale, beetles)	L	H[10]	L	II	long
pyriproxyfen (Esteem)	7C	narrow (ants)	L	L	L	III	—
spinetoram (Delegate)	5	narrow (caterpillars, aphids, scales)	L/H	M[11]	L/M	II	moderate[12]
spinosad (Entrust, Success)	5	narrow (caterpillars, aphids, scales)	L/H	M[11]	L/M	II	short to moderate
spirodiclofen (Envidor)	23	narrow (mites)	L	—	—	II	—
sulfur	—	narrow (mites and thrips)	L/H	M/L	H	III	short

H = high M = moderate L = low — = no information un = unknown or uncertain mode of action

Common name (Example trade name)	Mode of Action[1]	Selectivity[2] (affected groups)	Predatory Mites[3]	General Predators[4]	Parasites[4]	Honey Bees[5]	Duration of impact to natural enemies[6]

[1] Rotate pesticides with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; pesticides with a 1B group number should be alternated with pesticides that have a group number other than 1B. Mode-of-action group numbers (un=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

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

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

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

[5] Ratings are as follows: I–Do not apply or allow to drift to plants that are flowering; II–Do not apply or allow to drift to plants that are flowering, except when the application is made between sunset and midnight if allowed by the label and regulations; III–No bee precaution, except when required by the label or regulations. For more information about pesticide synergistic effects, see Bee Precaution Pesticide Ratings *(available online at http://ipm.ucanr.edu/beeprecaution/)*.

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

[7] Use lowest rates for best management of western predatory mite/spider mite ratio.

[8] High toxicity to juvenile stages of predators and reduces fertility of adult green lacewings.

[9] Acute toxicity low but reproductive capacity is impacted.

[10] Kills lady beetles.

[11] Toxic against some natural enemies (predatory thrips, syrphid fly larvae) when sprayed and shortly thereafter (8–24 hours).

[12] Residual is moderate if solution is between pH of 7 to 8.

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

GENERAL PROPERTIES OF FUNGICIDES USED IN ALMONDS (07/24)

Common name (Example trade name)	Chemical class[1]	Activity	Mode of action (FRAC[1] No.)	Resistance potential	Comments
azoxystrobin (Abound)	QoI[2]	contact, systemic	single-site (11)	high[10]	some populations of *Fusicladium* sp. (scab) and *Alternaria* sp. have been found to be resistant to QoI fungicides
azoxystrobin/difenoconazole (Quadris Top)	QoI[2]/DMI[3]-triazole	contact, systemic (local)	single-site/single-site (11/3)	medium	
azoxystrobin/propiconazole (Quilt Xcel)	QoI[2]/DMI[3]-triazole	contact, systemic (local)	single-site/single-site (11/3)	medium	
boscalid/pyraclostrobin (Pristine)	SDHI[4]/QoI[2]	contact, systemic	single-site/single-site (7/11)	medium	some populations of *Fusicladium* sp. (scab) and *Alternaria* sp. have been found resistant to QoI[2] and SDHI[4] fungicides
captan	phthalimide	contact	multi-site (M 04)	low	highly toxic to honey bee larvae
chlorothalonil (Bravo, Echo)	chloronitrile	contact	multi-site (M 05)	low	
copper[8]	inorganic	contact	multi-site (M 01)	low	
cyprodinil (Vangard)	anilinopyrimidine	contact, slightly systemic on some crops	single-site (9)	high[10]	more effective in spring than summer
difenoconazole (Inspire)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
difenoconazole/cyprodinil (Inspire Super)	DMI[3]/anilinopyrimidine	contact, systemic	single-site/single-site (3/9)	medium	
fenbuconazole (Indar)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
fenhexamid (Elevate)	hydroxyanilide	contact	single-site (17)	high[10]	
fluopyram/tebuconazole (Luna Experience)	SDHI[4]/DMI[3]-triazole	contact, systemic	single-site/single-site (7/3)	medium	some populations have been found resistant to SDHI[4] fungicides
fluopyram/trifloxystrobin (Luna Sensation)	SDHI[4]/QoI[2]	contact, systemic	single-site/single-site (7/11)	medium	some populations have been found resistant to QoI[2] and SDHI[4] fungicides
fosetyl-Al (Aliette)	ethyl phosphonates	systemic	unknown (P07, 33)	low–medium	
iprodione (Rovral, Nevado)	dicarboximide	systemic (local)	single-site? (2)	low	
mancozeb (Dithane, Manzate)	carbamate (EBDC[5])	contact	multi-site (M 03)	low	
mefenoxam (Ridomil Gold)	phenylamide	contact, systemic	single-site (4)	high[10]	
metconazole (Quash)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
myclobutanil (Laredo, Rally)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
penthiopyrad (Fontelis)	SDHI[4]	contact	single-site (7)	high[10]	use in mixtures when possible
polyoxin-D (Ph-D, Oso)	chitin synthesis inhibitor	contact	single-site (19)	medium	
potassium phosphite, phosphorous acid (ProPhyt, Fosphite)	Phosphorous acid or Mono- and dipotassium salts of phosphorus acid	systemic	unknown (multi-site?) (P07,33)	high	
propiconazole (Tilt, Bumper, Propicure, Propiconazole)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
pyraclostrobin/fluxapyroxad (Merivon)	QoI[2]/SDHI[4]	contact, systemic	single-site/single-site (11/7)	medium	some populations have been found resistant to QoI[2] and SDHI[4] fungicides
pyrimethanil (Scala)	anilinopyrimidine	contact, slightly systemic on some crops	single-site (9)	high[10]	more effective in spring than summer
sulfur	inorganic	contact	multi-site (M 02)	low	highly toxic to native strains of western predatory mite (*Galendromus occidentalis*) and to parasites

tebuconazole (Tebuzol, Tebucon, Toledo)	DMI[3]-triazole	systemic (local)	single-site (3)	high	
tebuconazole/phosphite (Viathon)	DMI-triazole /phosphonate	contact, systemic	single-site/multi-site? (3/P07,33)	medium	
thiophanate-methyl (Topsin-M, T-Methyl, Incognito)	MBC[6]	systemic (local)	single-site (1)	high[10]	resistant populations do not decline in absence of thiophanate-methyl use.
trifloxystrobin (Gem)	QoI[2]	contact, systemic	single-site (11)	high	
ziram	carbamate (DMDC[7])	contact	multi-site (M 03)	low	
BIOLOGICALS[9]					
Aureobasidium pullulans (Botector#)	biological-fungus	contact	(BM 02)	low	
Bacillus amyloliquefaciens D747 (Double Nickel 55#)	biological-bacteria	contact	(BM 02)	low	
Bacillus subtilis (Serenade#)	biological-bacteria	contact	(BM 02)	low	
Streptomyces lydicus (Actinovate AG#)	biological-bacteria	contact	(BM 02)	low	
Trichoderma harzianum (PlantShield)	biological-fungus	contact	(BM 02)	low	

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of action. Fungicides with different group numbers are suitable to alternate in a resistance management program. In California, make no more than one application of a fungicide with a mode-of-action group number associated with high resistance risk before rotating to a fungicide with a different mode-of-action group number; for other fungicides, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

2 QoI = quinone outside inhibitor (strobilurin)

3 DMI = demethylation (sterol) inhibitor

4 SDHI = succinate dehydrogenase inhibitor

5 EBDC = ethylene bisdithiocarbamate

6 MBC = methyl benzimidazole

7 DMDC = dimethyl dithiocarbamate

8 Fixed copper (M 01a) bactericides (e.g., Kocide, Badge, Nordox, and ChampION^{++}) may cause phytotoxicity (russetting) when applied after full bloom. Other copper products (M 01b) with lower metallic copper equivalent (i.e., MCE) such as copper complexes (e.g., Cueva, Copper Count-N, etc.) and copper sulfate pentahydrate (e.g., CS-2005, Phyton 27AG, etc.) have been reported to be less phytotoxic with applications following bloom because of lower MCE (*see* specific registrant label concerning product rates and number of times each material can be applied during the growing season).

9 For some biologicals growth is required for inhibition of pathogen by antagonism or mycoparasitism.

10 Resistance has been found in California for certain fungicides with a single-site mode of action. To reduce the risk of resistance development, take the mode of action into account when choosing a fungicide. At the beginning of a treatment program, use a fungicide with a multi-site mode of action; for subsequent applications rotate or mix fungicides with different mode of action FRAC numbers. Use labeled rates (preferably the upper range) of the single-site fungicides, and limit the total number of applications per season.

? Mode of action uncertain

Acceptable for use on organically grown produce.

Acknowledgment: Adaskaveg et al., 2025. *Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California.*

FUNGICIDE EFFICACY—CONVENTIONAL PRODUCTS (07/24)

Fungicide	Resistance risk (FRAC)[1]	Brown rot	Jacket rot	Anthrac-nose	Shot hole	Scab[3]	Rust[3]	Leaf blight	Alternaria leaf spot[3]	PM-like[5]	Hull rot[16]
Adament	medium (3/11)	5	4	4	5	4	5	ND	4	4	4
Aproach[3,4]	high (11)[7]	4	2	5	4	5	5	4	4	4	4
Axios	high (52)[7]	5	4	ND	4	3	ND	ND	3	ND	4
Bravo, Chlorothalonil, Equus, Echo[11,12,15]	low (M 05)	3	NL	4	4	4	5	NL	NL	0	0
Bumper**, Tilt, Propicure, Propiconazole[4]	high (3)	5	1	5	3	3	4	ND	3	4	3
Captan[4, 6, 12]	low (M 04)	3	3	4	4	3	0	4	2	0	0
CaptEvate**	low (M 04/17)	4	4	4	4	4	0	4	2	0	0
Cevya	high (3)	5	1	5	5	3/4	4	ND	4	ND	4
Copper + oil[14,15]	low (M 01)	ND	ND	0	2	4	0	0	ND	0	0
Copper[14,15]	low (M 01)	1	1	0	2	2	0	0	ND	0	0
Elevate[7]	high (17)	4	5	0	2	ND	ND	ND	ND	ND	0
Fervent	medium (3/7)	5	4	5	4	5	5	ND	5	4	4
Fontelis[3]	high (7)[7]	5	5	3	5	3	3	ND	4	ND	0
Gem[3,4]	high (11)[7]	4	0	5	4	5	5	4	4	4	4
Indar	high (3)	5	1	4	3	3	NL	ND	2	ND	0
Inspire	high (3)	5	3	5	3	4	5	ND	5	ND	4
Inspire Super[4]	medium (3/9)	5	5	ND	4	4	5	ND	5	ND	4
Kenja[4]	high (7)[7]	5	5	3	5	4	0	ND	4	ND	0
Laredo, Rally[13]	high (3)	4	0	3	3	0	2	4	0	4	0
Lime sulfur[12,15]	low (M 02)	1	NL	0	1	3	3	NL	NL	0	0
Luna Experience[3]	medium (3/7)	5	4	5	4	5	5	ND	5	4	4
Luna Privilege**	high (7)[7]	4	3	3	3	4	4	ND	4	3	3
Luna Sensation[3]	medium (7/11)	5	5	5	5	5	5	ND	5	4	4
Mancozeb	low (M 03)	3	3	4	4	3	4	4	2	0	0
Merivon[3]	medium (7/11)	5	5	5	5	5	4	ND	5	5	4
Miravis Duo	medium (3/7)	5	4	5	4	5	5	ND	5	4	4
Miravis Prime	medium (7/12)	5	4	5	5	5	5	ND	5	5	4
Parade*	high (7)[7]	5	5	ND	5	3	ND	ND	3	ND	1
Ph-D	medium (19)	3	4	0	3	4	4	ND	5	ND	4
Pristine[3]	medium (7/11)	5	5	5	5	5	4	ND	4	4	4
Protocol[2]	med.–high (1/3)	5	5	ND	4	4	5	ND	3	ND	2
Quadris Top[3]	medium (3/11)	5	5	5	4	5	5	ND	4	4	4
Quadris, (Abound discontinued)	high (11)[7]	4	2	5	4	5	5	4	4	4	4
Quash[4]	high (3)	5	3	5	4	4	5	ND	5	4	4
Quilt Xcel, Avaris 2XS[3]	medium (3/11)	5	4	5	4	5	5	ND	4	4	4
Regev	high (3/BM 01)	5	3	4	3	4	4	ND	4	ND	4
Rhyme	high (3)	4	1	ND	2	3	ND	ND	3	ND	ND
Rovral + oil[8, 9]	low (2)	5	5	0	4	1	3	ND	4	ND	0
Rovral[9], Meteor[9], Iprodione**, Nevado**	low (2)	4	4	0	4	0	0	ND	3	0	0
Scala[3,10]	high (9)[7]	5	5	ND	3	0	ND	ND	2	0	0
Sulfur[4,12]	low (M 02)	1	1	0	0	3	3	0	0	4	0
Syllit	medium (U 12)	2	0	ND	4	5	ND	ND	2	ND	0

Tebucon,Toledo, Teb, Tebuconazole**	high (3)	5	1	4	3	3	4	ND	2	ND	3
Topsin-M, T-Methyl, Incognito, Cercobin**[,2,6,8]	high (1)[7]	5	5	0	0	4	2	4	0	3	0
Vangard[3,7,9,10]	high (9)	5	5	ND	3	0	ND	ND	2	0	0
Viathon	medium (3, P 07/33)	5	1	4	3	3	4	ND	2	ND	3
Ziram	low (M 03)	3	2	4	4	4	0	3	2	0	0

FUNGICIDE EFFICACY—PHYTOPHTHORA ROOT AND CROWN ROT (PRCR) USING CONVENTIONAL TREATMENTS (07/24)

Fungicide	Resistance risk (FRAC group)1	PRCR
Aliette***, Fungi-Phite, K-Phite	low-medium (P07/33)	4
Elumin*	high (22)	4
Orondis	high (49)	5
Presidio	high (43)	4
Revus*	high (40)	5
Ridomil Gold, ProPhyt, Mefenoxam***	high (4)	4

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective, NL = not on label, and ND = no data

*** Registration pending in California.**
**** Not registered, label withdrawn or inactive in California**
***** 12-month preharvest interval (PHI)**

*** Registration pending in California.**
**** Not registered, label withdrawn or inactive in California**
**** 12-month preharvest interval (PHI)**
*****

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of action (for more information see www.frac.info). Fungicides with different group numbers are suitable to alternate in a resistance management program. In California, make no more than one application of a fungicide with a mode-of-action group number associated with high resistance risk before rotating to a fungicide with a different mode-of-action group number; for other fungicides, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

2 Strains of the brown rot fungi *Monilinia laxa* and *M. fructicola* resistant to Topsin-M and T-Methyl have been found in some California almond orchards. MBC-resistant strains of the jacket rot fungus, *Botrytis cinerea* and powdery mildew fungi, have been reported in California on crops other than almond and stone fruits and may have the potential to develop in almonds with overuse of fungicides with similar chemistry. MBC-resistant strains of the scab fungus, Venturia *carpophila* (syn. *Fusicladium Cladosporium*), have been found in California.

3 Field resistance of *Alternaria* sp. and *Fusicladium carpophilum* to QoI and SDHI fungicides has been detected in almond orchards. AP-resistant populations of *Monilinia* spp. have been found on other stone fruit crops in California.

4 Of the pesticides listed, only sulfur (FRAC group M 02), captan (M 04), Kenja (7), Approach, Gem, Quadris (11), and some of the DMI fungicides (3) are registered for use in late spring and early summer when treatment is recommended.

5 PM-like refers to a powdery mildew-like disease on almond fruit that is managed with fungicides. Information suggests an *Acremonium* species is involved.

6 Excellent control obtained when combinations of Topsin-M or T-Methyl and Captan are used.

7 To reduce the risk of resistance development, start treatments with a fungicide with a multi-site mode of action; rotate or mix fungicides with different mode of action FRAC numbers for subsequent applications, use labeled rates (preferably the upper range), and limit the total number of applications per season.

8 Oils recommended include "light" summer oil, 1 to 2% volume/volume.

9 Do not use later than 5 weeks after petal fall.

10 Efficacy reduced at high temperatures and relative humidity.

11 Bravo Ultrex, Bravo WeatherStik, Echo, and Chlorothalonil are currently registered.

12 Dormant applications with oil are highly effective against scab, Do not use in-season combinations with oil or shortly before or after oil treatment.

13 Efficacy is better in concentrate (80–100 gal/acre) than in dilute sprays.

14 The low rates necessary to avoid phytotoxicity in spring reduce the efficacy of copper.

[15] "Burns out" scab twig lesions when applied at delayed dormant. (Chlorothalonil can be applied with dormant oil during tree dormancy).

[16] Hull rot ratings are for the disease caused by *Rhizopus stolonifer*. Ratings for the disease caused by *Monilinia* or *Aspergillus* spp. will be provided in the future.

[17] PlantShield is best used for wood-exposing wounds to prevent silverleaf and wood decay.

Acknowledgment: Adaskaveg et al., 2025. *Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California*.

FUNGICIDE EFFICACY—BIOCONTROLS AND NATURAL PRODUCTS (07/24)

Fungicide	Biological or natural product (FRAC group)[1, 2, 3]	Brown rot	Jacket rot	Anthrac-nose	Shot hole	Scab	Rust	Alternaria leaf spot[4]	Hull rot[5]	PM-like[6]	Silver leaf	Bacterial spot
Botector	*Aureobasidium pullulans* (BM 02)	3	2	NL	NL	NL	NL	NL	NL	NL	NL	NL
Double Nickel 55	*Bacillus amyloliquefaciens* D747 (BM 02)	2	2	ND	2	NL	NL	NL	NL	NL	NL	2
Serifel	*B. amyloliquefaciens* MBI600 (BM 02)	2	2	NL	2	2	1	1	1	ND	ND	2
Sonata	*B. pumilis* QST2808 (BM 02)	2	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
Theia	*B. subtilis* AFS03232 (BM 02)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aviv	*B. subtilis* IAB/BS03 (BM 02)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Serenade	*B. subtilis* QST 713 (BM 02)	3	3	2	2	1	1	1	NL	ND	NL	3
Dart	capric and caprylic acids (BM 01)	3	2	ND	2	1	1	2	2	ND	0	3
Cinnacure, Seican, Cinnerate	Cinnamaldehyde/Cinnamon oil (BM 03)	1	1	NL	NL	NL	NL	NL	NL	NL	NL	2
Procidic	citric acid (NC)	ND	ND	ND	NL	NL	NL	ND	NL	NL	NL	NL
Vectorite	*Clonostachys rosea* CR-7 (BM 02)	4	2	ND	2	ND	ND	ND	ND	ND	ND	ND
EF400	clove, rosemary, peppermint oils (BM 01)	1	2	1	NL	ND	NL	NL	NL	NL	NL	NL
Employ	harpin (P unspecified)	NL	1	NL	NL	NL	NL	NL	NL	NL	NL	NL
Kasumin*	kasugamycin (24)[1]—Section 18	0	0	0	0	0	0	0	0	0	0	4
ProBLAD Verde	*Lupinus albus* (BM 01)	3	2	NL	NL	NL	NL	NL	NL	NL	NL	NL
Timorex (Act, Gold)	natural oil (BM 01)	1	1	2	1	2	2	1	ND	2	NL	NL
Trilogy, Rango	neem oil (BM 01)	1	1	1	1	1	2	1	ND	2	NL	NL
Oxidate 5.0	peroxyacetic acid (NC)	1	2	1	1	NL	NL	1	ND	ND	NL	2
Milstop	potassium bicarbonate (NC)	NL	NL	NL	NL	1	NL	NL	ND	3	NL	NL
All Phase	potassium sorbate (NC)	NL	NL	NL	NL	2	NL	NL	NL	NL	NL	NL
Howler	*Pseudomonas chlororaphis* strain AFS009 (BM 02)	2	1	NL	NL	NL	NL	NL	NL	NL	NL	3
BacStop-OPL,-XL	quaternary ammonia (NC-sanitizer)	1	1	1	NL	ND	NL	NL	NL	NL	NL	3
Regalia	*Reynoutria sachalinensis* (P 05)	2	2	1	1	1	1	1	ND	2	NL	3
Actinovate AG	*Streptomyces lydicus* (BM 02)	1	1	NL	NL	NL	NL	NL	NL	1	NL	2
EcoSwing	*Swinglea glutinosa* (BM 01)	3	2	NL	NL	1	NL	1	NL	ND	NL	ND
Vintec	*Trichoderma atroviride* (BM 02)[7]	NL	NL	NL	NL	NL	NL	NL	NL	NL	4	0
PlantShield**	*Trichoderma harzianum* (BM 02)	NL	NL	NL	NL	NL	NL	NL	NL	NL	4	0

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective, NL = not on label, and ND = no data.

*** Registration pending in California.**

**** Not registered, label withdrawn or inactive in California.**

*** Registration pending in California.**

**** Not registered, label withdrawn or inactive in California.**

1 Alphabetically arranged organic treatments. Note that kasugamycin is a fermentation (natural) product, but not an organic treatment.

3 Sodium lauryl sulfate is not organically approved for crop production (synthetic substance approved for noncrop areas); All Phase is not organic. Cinnacure, PlantShield and Vintec do not have OMRI/WSDA certification and do not claim to be compliant, but their active ingredients are allowed for organic production.

4 Alternaria leaf spot caused by *Alternaria alternata* and *A. arborescens*.

5 Hull rot ratings are for the disease caused by *Rhizopus stolonifer*.

6 PM refers to a powdery mildew disease.

7 Labeled for *Eutypa* sp., *Botryosphaeria* sp., *Cytospora* sp., and other trunk diseases of almond.

Acknowledgment: Adaskaveg et al., 2025. *Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California*.

MOST EFFECTIVE TREATMENT TIMINGS FOR KEY DISEASES (07/24)

Note: Not all indicated timings may be necessary for disease control.

		Bloom			Spring[1]		Summer	
Disease	**Dormant**	**Pink bud**	**Full bloom**	**Petal fall**	**2 weeks**	**5 weeks**	**May**	**June/July**
alternaria	0	0	0	0	0	2	3	3
anthracnose[2]	0	2	3	3	3	3	3	2
bacterial spot	1	0	2	3	3	2	1	0
brown rot	0	2	3	1	0	0	0	0
green fruit rot	0	0	3	2	0	0	0	0
hull rot[7]	0	0	0	0	0	0	0	3
leaf blight	0	0	3	2	1	0	0	0
rust	0	0	0	0	0	3	3	1[6]
scab[3]	2	0	0	2	3	3	1	0
shot hole[4]	1[5]	1	2	3	3	2	0	0

Disease	**At planting**	**Spring root flush**	**Summer**	**Fall root flush**
phytophthora root and crown rot	3	3	2	3

Rating: 3 = most effective, 2 = moderately effective, 1 = least effective, and 0 = ineffective

1 Two and five weeks after petal fall are general timings to represent early postbloom and the latest time that most fungicides can be applied. The exact timing is not critical but depends on the occurrence of rainfall.

2 If anthracnose was damaging in previous years and temperatures are moderate (63°F or higher) during bloom, make the first application at pink bud. Otherwise, treatment can begin at or shortly after petal fall. In all cases, application should be repeated at 7- to 10-day intervals when rains occur during periods of moderate temperatures. Treatment should, if possible, precede any late spring and early summer rains. Rotate fungicides, using different fungicide classes, as a resistance management strategy.

3 Early treatments (during bloom) have minimal effect on scab; the 5-week treatment usually is most effective. Treatments after 5 weeks are useful in northern areas where late spring and early summer rains occur. Dormant treatment with liquid lime sulfur improves efficacy of spring control programs.

4 If pathogen spores were found during fall leaf monitoring, apply a shot hole fungicide during bloom, preferably at petal fall or when young leaves first appear. Reapply when spores are found on new leaves or if heavy, persistent spring rains occur. If pathogen spores were not present the previous fall, shot hole control may be delayed until spores are seen on new leaves in spring.

5 Dormant copper treatment seldom reduces shot hole infection but may be useful in severely affected orchards and must be followed by a good spring program.

6 Treatment in June is important only if late spring and early summer rains occur.

7 Make application at 1 to 5% hull split to manage hull rot caused by *Rhizopus stolonifer*; use earlier June timings for hull rot caused by *M. fructicola*. Apply a second application, mid-way through hull split especially if hull split is progressing slowly.

Acknowledgment: Adaskaveg et al., 2025.*Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California.*

FUNGICIDE RESISTANCE MANAGEMENT—CONVENTIONAL GROWERS (07/24)

SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FRAC[1] GROUP NUMBERS—CONVENTIONAL GROWERS

Note: Not all indicated timings may be necessary for disease control (see Effective Treatment Timings for Key Diseases). If treatments are needed based on host phenology, weather monitoring, inoculum models, or environmental-disease forecasting models, suggested fungicide groups are listed for each timing.

How to use this table:

1. Identify the disease(s) that need(s) to be managed. Know the disease history of the orchard, especially from the last season.
2. Select one of the suggested fungicide group numbers. **Numbers separated by slashes are pre-mixtures, whereas numbers separated by pluses are tank mixtures**. If several diseases need to be managed, select a group number that is effective against all diseases. Refer to the fungicide efficacy table for fungicides belonging to each FRAC group number. Group numbers are listed in numerical order within the suggested disease management program.
3. Rotate group numbers for each application within a season and, if possible, use each group number only once per season, except for multi-site mode-of-action materials (e.g., M 02).

		Bloom			Spring		Summer	
Disease	**Dormant**	**Pink bud**	**Full bloom**	**Petal fall**	**2 weeks**	**5 weeks**	**May**	**June/July**
alternaria	—	—	—	—	—	2	3, 7, 11, 19, 3/7, 3/9, 3/11, 3+P 07/33, 7/11, 52, 3/BM 01	3, 3/7, 7, 3/9, 3/11, 3+P 07/33, 7/11, 11, 19, 52, 3/BM 01
anthracnose	—	3, 3/7, 3/9, 3/11, 3+P 07/33, 7, 3/BM 01	3, 3/7, 3/9, 3/11, 3+P 07/33, 7, 7/11, 11, 3/BM 01	3, 3/9, 3/7, 3/11, 3+P 07/33, 11, 3/BM 01, M 03, M 04, M 05	3, 3/9, 3/11, 3/7, 7, 7/11, 3+P 07/33, 11, 3/BM 01, M 03, M 04, M 05	3, 3/7, 3/9, 3/11, 3+P 07/33,7, 7/11, 11, 3/BM 01,M 03, M 04, M 05	3, 3/7, 3/9, 3/11, 3+P 07/33, 7, 7/11, 11, 3/BM 01, M 04	3, 3/7, 3/9, 3/11, 3+P 07/33, 7, 7/11, 11, 3/BM 01, M 04
bacterial spot	M 01, M 01+M 03	—	M 01, M 01+M 03	M 01, M 01+M 03	M 01, M 01+M 03	M 01, M 01+M 03	M 01	—
brown rot	—	1[2], 2+oil, 3, 3/7, 3/9, 3/11, 3+P 07/33, 9, 52, 3/BM 01	1[2], 2+oil, 3, 3/7, 3/9, 3/11, 3+P 07/33, 7, 7/11, 9, 11, 19, 52, 3/BM 01	1[2], 2+oil, 3/11, 3+P 07/33, 7, 7/11, 9, 19, 52, 3/BM 01	—	—	—	—
hull rot[5]	—	—	—	—	—	—	3, 3/7, 3/9, 3/11, 7/11, 11, 19, 52, 3/BM 01	3, 3/7, 3/9, 3/11, 7/11,11, 19, 52, 3/BM 01
jacket rot	—	—	1[2], 2 +oil, 3/7, 3/9, 3/11, 7, 7/11, 9, 19, 52, 3/BM 01	1[2], 2+oil, 3/7, 3/9, 3/11, 7, 7/11, 9, 19, 52, 3/BM 01	—	—	—	—
leaf blight	—	—	1[2], 2, 3, 3/7, 3/9, 3/11, 3+P 07/33, 11, 3/BM 01	1[2], 2, 3, 3/7, 3/9, 3/11, 3+P 07/33, 11, 3/BM 01, M 03, M 04, M 05	3, 3/7, 3/9, 3/11, 3+P 07/33, 11, 3/BM 01, M 03, M 04, M 05	—	—	—

rust	—	—	—	—	—	3, 3/7,3/11, 3+P 07/33[1], 7, 7/11, 11, 19, 3/BM 01,M 03	3, 3/7, 3/11, 3+P 07/33, 7, 7/11,11, 19, 3/BM 01	3, 3/7, 3/11, 3+P 07/33, 7, 7/11,11, 19, 3/BM 01
scab[4]	M 01+oil, M 02[3], M 05+oil	—	—	1[2], 3/7, 3/9, 3+P 07/33, 3/11, 7, 7/11[2], 3/BM 01, 11[2] M 03, M 04, M 05	1[2], 3/7, 3/9, 3+P 07/33, 3/11,7, 7/11[2], 3/BM 01, 11[2], M 03, M 04, M 05	3, 3/7, 3/9, 3/11, 3+P 07/33, 7, 7/11[2], 3/BM 01, 11[2],M 02[3], M 03, M 04	M 02[3], M 04	—
shot hole	M 01	2, 3, 3/7, 3/9, 3/11, 7, 9, 11, 52, 3/BM 01	2, 3, 3/7, 3/9, 3/11,7, 7/11, 9, 11, 19, 52, 3/BM 01	2, 3, 3/7, 3/9, 3/11, 7, 7/11, 9, 11, 19, 52, 3/BM 01	7, 7/11, 11, 19, 52, 3/BM 01, M 03, M 04, M 05	7, 7/11,11, 19, 52, 3/BM 01, M 03, M 04, M 05	—	—

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (For more information, see www.frac.info). Group numbers are listed in numerical order within the suggested disease management program. Fungicides with a different group number are suitable to alternate in a resistance management program. Refer to the fungicide efficacy table for fungicides belonging to each FRAC group. Note: FC 33 is currently P 07 but is indicated as P 07/33.

2 Strains of Monilinia fructicola and M. laxa resistant to Topsin-M, and T-Methyl are present in some California almond orchards. Resistant strains of the jacket rot fungus, Botrytis cinerea, and powdery mildew fungi have been reported in California on crops other than almond and stone fruits and may have the potential to develop in almond with overuse of fungicides with similar chemistry.

3 Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.

4 Apply petal-fall treatments based on twig-infection sporulation model.

5 Effective hull rot management is dependent on integrated strategies including dust control, reduced irrigation, and limiting nitrogen fertilization prior to and during hull split, as well as ensuring adequate air circulation (appropriate pruning or hedging practices) in the orchard.

Acknowledgment: Adaskaveg et al., 2025.*Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California*.

FUNGICIDE RESISTANCE MANAGEMENT—ORGANIC GROWERS (07/24)

SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FRAC[1] GROUP NUMBERS—ORGANIC GROWERS

Note: Not all indicated timings may be necessary for disease control (see Effective Treatment Timings for Key Diseases). If treatments are needed based on host phenology, weather monitoring, inoculum models, or environmental-disease forecasting models, suggested fungicide group numbers are listed for each timing.

How to use this table:

1. Identify the disease(s) that need(s) to be managed. Know the disease history of the orchard, especially from the last season.
2. Select one of the suggested fungicide group numbers. If several diseases need to be managed, select a group number that is effective against all diseases. Refer to the fungicide efficacy table for fungicides belonging to each FRAC group number. Group numbers are listed in numerical order within the suggested disease management program.
3. Rotate group numbers for each application within a season and, if possible, use each group minimally per season.

		Bloom			Spring		Summer	
Disease	**Dormant**	**Pink bud**	**Full bloom**	**Petal fall**	**2 weeks**	**5 weeks**	**May**	**June/July**
alternaria	—	—	—	—	—	BM 01, BM 02, BM 03, oxidizer	BM 01, BM 02, BM 03, oxidizer	BM 01, BM 02, BM 03, oxidizer
anthracnose	—	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer
bacterial spot	M 01 + BM 01 (oil)	—	BM 01, BM 02, BM 03, M 01, oxidizer	BM 01, BM 02, BM 03, M 01, oxidizer	BM 01, BM 02, BM 03, M 01, oxidizer	BM 01, BM 02, BM 03, M 01, oxidizer	BM 01, BM 02, BM 03, M 01, oxidizer	—
brown rot	—	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	—	—	—	—
hull rot[2]	—	—	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	—	—	—	—
jacket rot	—	—	—	—	—	—	—	BM 01, BM 02, BM 03,
leaf blight	—	—	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	—	—	—
rust	—	—	—	—	—	BM 01, BM 02, BM 03, P 05, M 02	BM 01, BM 02, BM 03, P 05, M 02	BM 01, BM 02, BM 03, P 05, M 02
scab[3,4]	M 01 + BM 01 (oil), M 02	—	—	BM 01, BM 02, BM 03, P 05, NC	BM 01, BM 02, BM 03, P 05, NC	BM 01, BM 02, BM 03, P 05, NC	BM 01, BM 02, BM 03, P 05, NC	—
shot hole	M 01 + BM 01 (oil)	M 01+BM 01 (oil)	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	BM 01, BM 02, BM 03, P 05, oxidizer	—	—

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see www.frac.info). Group numbers are listed in numerical order within the suggested disease management program. Fungicides with a different group number are suitable to alternate in a resistance management program. Refer to the fungicide efficacy table for fungicides belonging to each FRAC group. NC = not coded in FRAC.

2 Effective hull rot management is dependent on integrated strategies including dust control, reduced irrigation, and limiting nitrogen fertilization prior to and during hull split, as well as ensuring adequate air circulation (appropriate pruning or hedging practices) in the orchard.

3 Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.

4 Apply petal-fall treatments based on twig-infection sporulation model.

Acknowledgment: Adaskaveg et al., 2025. *Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California*.

Insects and Mites

(Section reviewed 8/17)

ANTS (8/17)

Scientific Names: Pavement ant: *Tetramorium caespitum*
Southern fire ant: *Solenopsis xyloni*

DESCRIPTION OF THE PESTS

The pavement ant is 0.13 inch long, dark brown and covered with coarse hairs. It has ridges on its head, which can be viewed with a hand lens. It prefers to nest in sandy or loam soils. The ant hills often appear as small mounds or patches of loose soil. It is found throughout the Central Valley but is more common in the northern San Joaquin and Sacramento valleys.

The southern fire ant is 0.07 to 0.25 inch long, has an amber head and thorax with a black abdomen. It has a painful sting that causes visible swelling. Fire ants vigorously swarm from the nest entrance when disturbed. Nests in orchards with low-volume irrigation tend to be located around the edges of the wetted areas. In flood-irrigated orchards with heavy soils, nests tend to be concentrated on the berms. Where lighter soils are present, nests are located both on the berms and in the middles. Frequently, southern fire ant nests are associated with clumps of weeds, such as nutsedge or spotted spurge. Activity of these ant pests peaks in the morning and again just before sunset. In the San Joaquin Valley, it is a more important pest than the pavement ant.

Do not confuse southern fire ant with the pyramid ant, which is a beneficial species that is similar in size but active during mid-day and found in sandy, weed-free areas. The pyramid ant does not swarm.

DAMAGE

The southern fire ant generally causes more damage than the pavement ant. Ants are more prevalent in drip- or sprinkler-irrigated orchards than flood-irrigated orchards. Ants feed on other hosts and are principally a problem after almonds are on the ground; nut damage increases in relation to the length of time they are on the ground. The ants can completely hollow out nutmeats leaving only the pellicle. Damage potential of ants appears to be less in weed-free orchards and those without cover crops. Damage is also lower on varieties that have nuts with tight shell seal or with shell splits less than 0.03 inch wide. Shell seal can vary greatly from year to year depending on variety, crop size, and horticultural practices. Heavy crops that result in small nuts will likely have less open shells and thus less potential for ant damage.

MANAGEMENT

Survey your orchard for ant colonies in April or May to determine need for treatment. Apply baits before harvest; this is the best way to manage potentially damaging populations. Remove nuts from the orchard floor as soon after shaking as possible to limit losses caused by ants. A harvest sample for damage will help assess the effectiveness of your management program.

Cultural Control

Remove nuts from the orchard floor as rapidly as possible following shaking to prevent ants from infesting them. The table under MONITORING AND TREATMENT DECISIONS shows how increasing the days between shaking and pickup can increase damage done by ants.

Organically Acceptable Methods

Rapid removal of harvested nuts is the best way to reduce ant damage in organic orchards.

Monitoring and Treatment Decisions

Survey the orchard floor for ant colonies 2 to 3 days after irrigation in April or May in the southern San Joaquin Valley or June in the northern San Joaquin and Sacramento valleys.

1. Choose five survey areas per block of the orchard, each about 1000 square feet, including the soil area from mid-alley to mid-alley beneath trees.
2. Count the number of active pest-ant colonies in each area, sampling five different areas of the orchard.
3. Total the ant colonies to get the number in a 5000 square foot area and compare it to the table below which gives an indication of the amount of damage you can expect at harvest.
4. Record your results (*example form available online*).

Use baits if treatment is necessary. Foraging ants collect the bait and take it back to the colony. The bait eventually kills or sterilizes the queen and developing larvae fail to mature. Appy traditional bait products (e.g., Clinch, Esteem, Extinguish) 4 to 10 weeks prior to the initiation of harvest to allow time for their full effects to be seen. A newer bait, Altrevin, works much quicker (within days) than traditional baits, but does not have as long of a residual effect. Apply Altrevin approximately 2 weeks before shaking begins.

Maintain bait quality and maximize bait pickup by ants:

- Do not use baits within 24 hours after an irrigation or 48 hours before an irrigation with sprinklers or microsprinklers. The soil surface should be dry so that moisture is not absorbed by the bait, or its attractiveness to the ants will be reduced.
- Use bait products soon after opening, and do not store bait for more than a few weeks. Bags of bait product that have been stored for a few weeks or more should be turned over so that the soybean oil attractant remains evenly dispersed throughout the corn meal carrier. Product in open bags must be used within a week or two so that the soybean oil does not turn rancid. Rancid oil is not attractive to ants.
- Purchase only as much bait as can be used in the current season.
- Use good weed management practices, which minimize weed seeds that may be a more attractive food source for ants than baits.

Percent Damage by Southern Fire Ants to Almonds on the Ground in an Almond Orchard

Number of colony entrances per 5,000 sq. ft. in April to May	Days nuts are on the ground				
	4	7	10	14	21
15	0.9%	1.6%	2.1%	3.1%	4.9%
45	1.4%	2.3%	3.2%	4.7%	7.0%
185	2.0%	3.6%	5.0%	7.0%	11.1%

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

BAITS

A. PYRIPROXYFEN
(Esteem) 2 lb 12 42
MODE-OF-ACTION GROUP NUMBER[1]: 7C
COMMENTS: An insect growth regulator that does not immediately harm foraging worker ants. Existing foraging workers must die off naturally before a noticeable decrease in ant numbers is evident. Apply 6 to 8 weeks before harvest to allow sufficient time for workers to die off and prevent nut damage. Baits may be less effective where weedy cover crops exist. Weed seeds, particularly spurge, may attract the ants away from the bait, reducing the amount of bait consumed.

B. ABAMECTIN
(Clinch Ant Bait) 1 lb 12 0
MODE-OF-ACTION GROUP NUMBER[1]: 6
COMMENTS: Has insect growth regulator effects on the colony and some direct toxic effects on foraging workers. Existing foraging workers must die off naturally before a noticeable decrease in ant numbers is evident. Apply 4 weeks before harvest to allow sufficient time for workers to die off and prevent nut damage. Baits may be less effective where weedy cover crops exist. Weed seeds, particularly spurge, may attract the ants away from the bait, reducing the amount of bait consumed. This is particularly important with Clinch since the active ingredient degrades rapidly after application and is no longer effective after 24 to 36 hours.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
C. METHOPRENE (Extinguish)	1–1.5 lb	4	0
MODE-OF-ACTION GROUP NUMBER[1]: 7A COMMENTS: Has insect growth regulator effects on the colony and some direct toxic effects on foraging worker ants. Existing foraging workers must die off naturally before a noticeable decrease in ant numbers is evident. Apply 4 weeks before harvest to allow sufficient time for workers to die off and prevent nut damage. Baits may be less effective where weedy cover crops exist. Weed seeds, particularly spurge, may attract the ants away from the bait, reducing the amount of bait consumed.			
D. METAFLUMIZONE (Altrevin)	See label	12	5
MODE-OF-ACTION GROUP NUMBER[1]: 22B COMMENTS: This insecticide works much faster than other ant baits, but does not last as long. For that reason it should be applied as close to the initiation of harvest as possible.			

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

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

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

BROWN MITE (8/17)

Scientific Name: *Bryobia rubrioculus*

DESCRIPTION OF THE PEST

The brown mite is the largest in size of all almond pest mites and emerges first in the spring. Brown mite eggs are red, without a stalk, and overwinter in masses on twigs, especially at the junction of wood growth from the two previous seasons. Eggs hatch at the same time leaf and flower buds open. Newly hatched mites are red with six legs; after the first molt they are brown with eight legs, resembling the adult. Adults are flattened with long front legs.

Eggs of the in-season generations are laid on the undersides of leaves near prominent leaf veins. The mites feed only during the cool parts of the day and migrate off the leaves during midday. They are not active during hotter periods of the summer. There are two to three generations per year between February and June.

DAMAGE

Generally these mites are not considered major pests and low to moderate numbers can be beneficial in spring by providing mite predators with a food supply. Feeding by these mites can cause chlorosis, but leaves rarely drop. Infestations are generally confined to a few trees.

MANAGEMENT

Monitor for brown mite as part of the dormant spur sample and spray with dormant oil if required.

Biological Control

The western predatory mite and brown lacewing are both effective predators, but alone may not control brown mites. It is important to avoid using insecticides that kill these natural enemies; residues of certain pesticides, such as pyrethroids used during the dormant season, can harm predator mites.

Organically Acceptable Methods

Biological control and certain oil sprays are acceptable for use on organically grown crops.

Monitoring and Treatment Decisions

Brown mites are best controlled by the delayed-dormant spray. Sample for mites as part of the dormant spur sample. If more than 20% of spurs are infested, an application of oil is suggested. Occasionally there is an infestation during a cool spring when dormant treatments containing oil were not applied, when they were applied too early in dormancy, or were applied with a rate of oil that was too low. In this case, a spring oil spray can be applied if there is evidence of feeding damage (bronzing or stipling of the leaves) at this time of year.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
DELAYED-DORMANCY			
A. NARROW RANGE OIL# (Superior, Supreme)	4–6 gal	See label	0
MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Cover all parts of the tree. Oil alone will control low to moderate infestations. Do not apply oils to water-stressed trees. Check with certifier to determine which products are organically acceptable.			
SPRING			
A. NARROW RANGE OIL# (Omni Supreme)	2–4%	See label	0

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Be sure that trees are well-watered to avoid phytotoxicity. Works by contact activity only, so good coverage is essential. Check with certifier to determine which products are organically acceptable.			

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

\# Acceptable for use on organically grown produce.

EUROPEAN FRUIT LECANIUM (8/17)

Scientific Name: *Parthenolecanium corni*

DESCRIPTION OF THE PEST

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

DAMAGE

The chief injury is the production of honeydew that, in large amounts, can damage leaves and fruit. Sooty mold growing on the honeydew can cause blackened areas on leaves and fruit. For many years it was rare to see this pest due to the standard practice of applying oil during the dormant season. In recent years a reduction in the use of dormant sprays has caused this pest to be seen more often, though damaging levels are still not common.

MANAGEMENT

Natural enemies frequently keep lecanium scale below damaging numbers. If treatment is needed, oil during dormancy or delayed dormancy is the best treatment. Use dormant spur sampling to determine need for treatment.

Biological Control

Many natural enemies and summer temperatures consistently over 100°F help to control European fruit lecanium. Common predators include lady beetles (*Chilocorus orbus*, *Hyperaspis* spp., *Rhyzobius lophanthae*), lacewings, the predaceous sap beetle (*Cybocephalus californicus*), and predatory seed bugs (*Phytocoris* spp.). Parasites include, *Coccophagus* spp., *Encarsia* spp., and *Metaphycus* spp. Frequently, scales found during the growing season are heavily parasitized.

Organically Acceptable Methods

Naturally occurring biological control and certain oil sprays are organically acceptable.

Monitoring and Treatment Decisions

To determine if a dormant treatment is warranted, follow the sampling and treatment threshold guidelines in the section DORMANT SPUR SAMPLING. Examine scales during summer for parasitism before deciding to spray; if parasites are not present and treatment is necessary, a summer oil spray can be applied. When treatment is necessary, however, it is best to spray when leaves are off during the dormant or delayed dormant period. Oil alone is usually all that is required to manage this pest in the dormant season within an IPM program; the addition of another insecticide is necessary only when infestations are severe.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

DORMANCY OR DELAYED-DORMANCY

A.	DORMANT OIL such as:			
	DORMANT FLOWABLE EMULSION	6 gal	12	0
	NARROW RANGE OIL#	4 gal	See label	0

MODE OF ACTION: Contact including smothering and barrier effects.

COMMENTS: Oil alone can control moderate levels of scale and is often compatible with insecticides applied for other target pests. Check for compatibility with other insecticides or fungicides when used in a tank mix. Check with certifier to determine which products are organically acceptable.

SPRING OR SUMMER

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
A. NARROW RANGE OIL# (Omni Supreme)	Label rates	See label	0

MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Monitor before treating to determine if parasites are present. If scales are parasitized, a spray may not be necessary. Be sure that trees are well watered to avoid phytotoxicity. Works by contact activity only so good coverage is essential. Check with certifier to determine which products are organically acceptable.

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

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

\# Acceptable for use on organically grown produce.

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

EUROPEAN RED MITE (8/17)

Scientific Name: *Panonychus ulmi*

DESCRIPTION OF THE PEST

These mites overwinter as eggs located at the base of buds and spurs on small branches, in wounds, or bark cracks. Eggs are red with a slender stalk on top. Newly hatched mites are green, but with feeding, turn red. They have white spots at the base of the large hairs on the back. European red mite has 5 to 10 generations per year and is more common in the Sacramento and northern San Joaquin valleys than in other almond growing areas.

DAMAGE

European red mites cause leaf stippling. Prolonged feeding causes leaves to pale and appear bronzed and burned at the tips and margins. Almond trees that are not stressed for water or by any other factor can tolerate high infestation levels (in excess of 50 mites per leaf) for extended periods without experiencing leaf drop. If the trees are stressed, however, these levels can cause defoliation. At low numbers, this mite can be beneficial as it serves as an alternative food for mite predators. European red mites do not commonly reach damaging levels in almonds. Mite numbers often decline when temperatures turn hot. Occasionally, red mite numbers increase between late summer and fall on the west side of the Sacramento Valley.

MANAGEMENT

European red mite is often kept below damaging levels by natural enemies and is an important food source for building up natural enemies of spider mites early in the season. Monitor this mite as part of your regular monitoring program throughout the season. The best time for treatment in an IPM program is an oil spray during the dormant season as determined by a dormant spur sample.

Biological Control

The western predatory mite feeds on the immature and adult stages but is unable to break through the egg shell so it is not as effective in controlling European red mites as other mite pests. Several generalist predators also feed on European red mite.

Organically Acceptable Methods

Biological control and certain oil sprays are organically acceptable.

Monitoring and Treatment Decisions

Monitor the European red mite eggs as part of the dormant spur samples during the dormant season as described in the DORMANT SPUR SAMPLING SECTION. A delayed dormant oil spray is the preferred treatment to control mite eggs and is suggested when 20% of spurs have eggs. During the growing season, monitor orchards once a week along with other pests. No treatment thresholds have been established, but almond trees are able to tolerate greater numbers of European red mites than webspinning spider mites.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
DELAYED DORMANCY			
A. NARROW RANGE OIL# (Superior, Supreme)	6–8 gal	See label	0
MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Delayed dormant applications are more effective because eggs are closer to hatch. Cover all parts of the tree. Oil alone will control low to moderate infestations. Do not use oil sprays on water-stressed trees. Check with certifier to determine which products are organically acceptable.			
SPRING			

	Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
A.	SPIRODICLOFEN			
	(Envidor 2SC)	16–34 fl oz	12	7
	MODE-OF-ACTION GROUP NUMBER[1]: 23			
	COMMENTS: Most effective when applied with oil at 0.5 to 1% concentration.			
B.	NARROW RANGE OIL#			
	(Omni Supreme)	4–6 gal	See label	0
	MODE OF ACTION: Contact including smothering and barrier effects.			
	COMMENTS: Be sure that trees are watered well to avoid phytotoxicity. Works by contact activity only, so good coverage is essential. Check with certifier to determine which products are organically acceptable.			
C	CYFLUMETOFEN			
	(Nealta)	13.7 fl oz.	12	7
	MODE-OF-ACTION GROUP NUMBER[1]: 25A			
	COMMENTS: Works primarily on contact. Do not apply more one Nealta application before using an effective miticide with a different mode of action.			
D.	HEXYTHIAZOX			
	(Onager)	12–24 oz	12	7
	MODE-OF-ACTION GROUP NUMBER[1]: 10A			
	COMMENTS: Do not apply more than once a year.			
E.	BIFENAZATE			
	(Acramite 50WS)	0.75–1 lb	12	7
	(Vigilant 4SC)	16–24 floz	12	7
	MODE-OF-ACTION GROUP NUMBER[1]: un			
	COMMENTS: Relatively safe for beneficial predaceous mites. Apply with ground equipment; requires complete coverage of both leaf surfaces for effective control.			
F.	ACEQUINOCYL			
	(Kanemite 15SC)	21–31 fl oz	12	7
	MODE-OF-ACTION GROUP NUMBER[1]: 20B			
	COMMENTS: Do not apply more than twice a year.			
G.	ABAMECTIN*			
	(Agri-Mek SC, others)	Label rates	See label	See label
	MODE-OF-ACTION GROUP NUMBER[1]: 6			
	COMMENTS: May be combined with oil. Do not make more than two applications per growing season and allow at least 21 days between treatments. Do not exceed 20 fl oz/acre per application. Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. **Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019**. Review the Department of Pesticide Regulation's updated fact sheet.			
H.	ETOXAZOLE			
	(Zeal)	2–3 oz	12	28
	MODE-OF-ACTION GROUP NUMBER[1]: 10B			
	COMMENTS: Acts as a contact toxin to eggs, inhibits molting of juveniles, and causes adult female mites (both pest and beneficial) to produce sterile eggs. Do not apply more than once/season. Use for bearing trees allowed under a Supplemental Label.			
I.	FENPYROXIMATE			
	(Fujimite 5EC)	2–4 pt	12	14
	MODE-OF-ACTION GROUP NUMBER[1]: 21A			
	COMMENTS: Effective, but long residual toxicity to predatory mites is a concern.			

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

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

\# Acceptable for use on organically grown produce.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

FOREST TENT CATERPILLAR (8/17)

Scientific Name: *Malacosoma disstria*

DESCRIPTION OF THE PEST

The forest tent caterpillar overwinters in the egg stage, and eggs give rise to destructive caterpillars in spring and early summer. The caterpillars are grayish with yellow stripes along the side, separated by a broad blue stripe. There is a row of white, keyhole-shaped spots on the back. There is one generation each year.

DAMAGE

Defoliation caused by tent caterpillars may be serious on individual trees and along orchard edges but is usually randomly scattered throughout the orchard. Young orchards are usually the most severely affected. From April to June, caterpillars feed on leaves; young caterpillars skeletonize the leaves, whereas older caterpillars consume the leaf, leaving only the midvein.

MANAGEMENT

On small trees, infested twigs may be cut out and destroyed. Spray programs for other insects generally reduce forest tent caterpillar numbers. If insecticide treatments are required, localized treatments on individual trees and branches are generally all that is necessary. Spray when small caterpillars are first observed. Cateripllar numbers usually decline naturally due to disease.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. *BACILLUS THURINGIENSIS* ssp. *KURSTAKI*# (various products) MODE-OF-ACTION GROUP NUMBER[1]: 11A COMMENTS: Best when applied to small larvae.	Label rates	4	0

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

Acceptable for use on organically grown produce.

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

LEAFFOOTED BUG (8/17)

Scientific Name: *Leptoglossus zonatus, Leptoglossus clypealis* and *Leptoglossus occidentalis*

DESCRIPTION OF THE PEST

The leaffooted bug is a sporadic pest in almonds. It gets its name from the small, leaflike enlargements found on the hind legs of the large nymphs and adults. Adult bugs are about 1 inch long and have a narrow brown body with a yellow or white zigzag line across its flattened back. The leaffooted bug overwinters as an adult in large groups on host plants near orchards. Overwintering bugs migrate from these sites into orchards in March or early April in search of food.

Adult females lay eggs in strands of usually 10 to 15 eggs that are often found on the sides of nuts in almonds. Eggs hatch into small nymphs that resemble newly hatched assassin bugs.

There are three species of leaffooted bugs that can be found in almonds. The most common is *Leptoglossus zonatus*. All three species are similar in appearance, except that *L. zonatus* has two yellow spots just behind the head (on the pronotum), *L. clypealis* has a thorn-like projection called a clypeus that extends forward from the tip of the head, and *L. occidentalis* has neither of these features. All three species have a white zigzag pattern across the wings: this patten is prominent in *L. zonatus* and *L. clypealis* and is relatively faint in *L. occidentalis*.

DAMAGE

Although it is a sporadic pest in almonds, in years when weather and other conditions are right, significant damage can occur. Feeding by adult leaffooted bugs on young nuts before the shell hardens causes the embryo to wither and abort, or may cause the nut to gum internally, resulting in a bump or gumming on the shell. It can also cause nut drop. After the shell hardens, adult leaffooted bug feeding can still cause black spots on the kernel or wrinkled, misshapen nutmeats. Varieties with softer shells such as Fritz, Sonora, Aldrich, Livingston, Monterey, and Peerless are more susceptible to bug damage for a longer period during the season.

Be careful not to confuse leaffooted bug damage with damage by stink bugs. Both pests damage nuts by probing them with their needle-like mouthparts, and both result in gumming on the hull. In most cases, leaffooted bug damage occurs in March and April while stink bug damage is more common in May and June. Another way to distinguish damage, considering that symptoms are so similar, is to find the actual bugs or their egg masses; stink bug eggs are barrel-shaped and laid in clusters in contrast to leaffooted bug eggs, which are laid end-to-end in strands.

MANAGEMENT

Biological Control

Egg parasites, *Gryon* spp., often keep numbers of leaffooted bug below economically damaging levels. However, as egg parasites, they have no ability to control the overwintering adult leaffooted bugs that migrate into orchards in spring.

Monitoring and Treatment Decisions

Walk the orchard during the months of March and April to look for dropped nutlets (particularly on susceptible varieties), nuts with gummosis, and leaffooted bugs. Finding adult bugs is the best indication that a problem may arise, but the cryptic nature of these pests and their behavior of staying in the tops of trees make this difficult to do. A more practical approach is to look for nuts with gummosis or egg masses on the sides of nuts. If gummosis exists, cut a cross-section across the damaged site to look for a puncture mark from the bug's mouthparts to confirm that the gummosis is not due to physiological reasons. The easiest monitoring method is to look for aborted nuts on the ground. However, basing treatments on gummosis and nut drop also means that there can be a 7- to 10-day lag time between when feeding takes place and when gummosis and nut drop occur, so the dispersing insects may have already moved.

Treatment thresholds have not been developed for this pest in almonds, but low numbers of bugs can cause substantial damage. If bugs and their damage are evident, consider an insecticide application; apply insecticides from March through May to target the overwintering adults that have migrated into the orchard. Unfortunately, the broad-spectrum products that are most effective against leaffooted bugs are also very disruptive to biological control agents of spider mites and other almond pests. Later applications are not needed when numbers of

overwintering adults have declined or nymphs are the only life stage present, as their mouthparts are too small to feed on the kernel.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

A. BIFENTHRIN
(Brigade WSB)* — 8–32 oz — 12 — 7
MODE-OF-ACTION GROUP NUMBER[1]: 3A
COMMENTS: Do not repeat an application in less than 15 days. Spring applications may suppress or control peach twig borer and navel orangeworm. Can cause secondary pest outbreaks, especially spider mites.

B. LAMBDA-CYHALOTHRIN
(Warrior II with Zeon)* — 1.28–2.58 fl oz — 24 — 14
MODE-OF-ACTION GROUP NUMBER[1]: 3A
COMMENTS: Spring applications may suppress or control peach twig borer and navel orangeworm. Can cause secondary pest outbreaks, especially spider mites.

C. ABAMECTIN
(Agri-Mek SC*, others) — Label rates — See label — See label
MODE-OF-ACTION GROUP NUMBER[1]: 6
COMMENTS: Provides control of adult bugs on contact but does not have any residual control once residues have dried. Also provides control of spider mites. May disrupt biological control of spider mites, particularly sixspotted thrips. Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. **Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019**. Review the Department of Pesticide Regulation's updated fact sheet.

D. ESFENVALERATE
(Asana XL)* — 9.6–19.2 fl oz — 12 — 21
MODE-OF-ACTION GROUP NUMBER[1]: 3A
COMMENTS: Spring applications commonly cause secondary outbreaks of spider mites.

E. CLOTHIANIDIN
(Belay) — 6 fl oz — 12 — 21
MODE-OF-ACTION GROUP NUMBER[1]: 4A
COMMENTS: Provides partial control of adult bugs on contact but does not have any residual control once residues have dried.

Review and follow the California neonicotinoid regulations effective January 1, 2024. Permissible application rates of this insecticide may be lower than label rates if applying more than one neonicotinoid active ingredient or using more than one application method in the same season.

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

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

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

— Not recommended or not on label.

LEAFROLLERS (8/17)

Scientific Names: Fruittree leafroller: *Archips argyrospila*
Obliquebanded leafroller: *Choristoneura rosaceana*

DESCRIPTION OF THE PESTS

Fruittree leafrollers overwinter in the egg stage on limbs. Eggs hatch in early spring. Larvae are dark green with black heads and are about 1 inch long when fully grown; they are difficult to distinguish from obliquebanded leafroller. Adult moths emerge in June or July and deposit overwintering eggs. Adults appear bell-shaped when at rest and have dark brown bands running at oblique angles across their wings. The wings are mottled with gold and white flecks. There is one generation a year.

Obliquebanded leafrollers occur on a wide range of plants. These leafrollers overwinter as either a second- or third-stage larva within a silken case or hibernaculum. These hibernacula can be found in protected areas of the scaffold limbs, such as pruning scars. The overwintered larvae become active as the buds begin to open. They begin to feed by tying together a number of leaves with silk. They first feed on water sprouts and then move throughout the tree. Those feeding on developing flower buds do so before bloom and continue to consume floral parts throughout the blossom period. This is when they cause the most damage to the almond crop. After petal fall, these larvae continue to feed on developing fruit. Pupation occurs within these sheltered areas and the adult moths generally appear during late May and early June. Eggs are laid in flattened, overlapping masses of up to 300 on the upper surface of leaves. Emerging larvae are greenish yellow caterpillars, usually with black heads but sometimes with lighter-colored heads. Adults are reddish brown moths with alternating light and dark brown bands on the wings; the bands are oblique or chevron-shaped. There are two or three generations a year in the Central Valley.

DAMAGE

Leafrollers are occasional pests of almonds. The primary damage occurs early in the season when larvae of the overwintered generation feed on developing nuts and hollow them out. Many of the damaged nuts are lost in the June drop, presumably reducing yield. The summer generation of the obliquebanded leafroller ties leaves and nuts together and feeds on the hulls. Leafroller feeding on the hulls increases later nut infestation by navel orangeworm.

MANAGEMENT

Treatment is not normally needed unless leafrollers numbers are high. If treatment is required, *Bacillus thuringiensis*, spinosad (Entrust, Success) and methoxyfenozide (Intrepid) are environmentally sound insecticides that control leafrollers with less harm to natural enemies.

Degree-days

For assistance in calculating degree-days, see the obliquebanded leafroller model on the UC IPM website at http://ipm.ucanr.edu/WEATHER/.

Biological Control

The parasitic wasp, *Macrocentrus iridescens*, attacks obliquebanded leafroller larvae in the Central Valley, often with multiple cocoons on one host caterpillar.

Organically Acceptable Methods

Bacillus thuringiensis and the Entrust formulation of spinosad are organically acceptable insecticides.

Monitoring and Treatment Decisions

In orchards with a history of obliquebanded leafroller problems, monitor after bloom by putting out pheromone traps and sampling developing fruit.

- Put out pheromone traps by mid-April. (The lower-load-rate pheromone lures are the best indicators of leafroller numbers.)
- Begin accumulating degree-days once moths have been caught in pheromone traps on two or more consecutive observation dates (the biofix). Use a lower threshold of 43°F and an upper threshold of 85°F (vertical cutoff).
- Begin sampling for larval feeding or for leaves that are tied together at 930 degree-days from the biofix.

- Apply a treatment when larval activity is first detected; larvae are difficult to control once they are sheltered in leaves that are webbed together.

If bloom time sprays for peach twig borer are applied, both leafroller species will be controlled.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

BLOOM

Note: *Additional insecticides are labeled for use during bloom. However, due to concerns over pollinator safety (adult, developing brood in the hive, or both), applications of other insecticides by themselves or in combination with fungicides should be delayed until bloom is complete and hives are removed.*

A.	*BACILLUS THURINGIENSIS* ssp. *KURSTAKI*#			
	(various products)	Label rates	4	0
	MODE-OF-ACTION GROUP NUMBER[1]: 11A			
	COMMENTS: Effective only under moderate pest pressure. Make 2 applications during bloom: the first between popcorn and the beginning of bloom and the second 7 to 10 days later, but no later than petal fall. Compatible with fungicide sprays and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80–100 gal water maximum) is preferred. If aerial applications must be made because conditions do not permit ground application, a concentrate rate (5 gal or less) is preferred. Apply aerially at a height of about 20 feet over the canopy using appropriate nozzles to allow better deposition on the treetops.			

POSTBLOOM

A.	SPINOSAD			
	(Entrust)#	1.25–3 oz	4	1
	(Success)	4–8 oz	4	1
	MODE-OF-ACTION GROUP NUMBER[1]: 5			
	COMMENTS: A fermentation-derived insect control product. May be disruptive of natural enemies except predaceous thrips and some parasitoids.			
B.	SPINETORAM			
	(Delegate WG)	3–7 oz	4	1
	MODE-OF-ACTION GROUP NUMBER[1]: 5			
	COMMENTS: Apply at night to target active adult moths and to avoid foraging bees when blooming groundcover is present. May be disruptive of natural enemies except predaceous thrips and some parasitoids.			
C.	METHOXYFENOZIDE			
	(Intrepid 2F)	24 fl oz	4	14
	MODE-OF-ACTION GROUP NUMBER[1]: 18			
D.	CHLORANTRANILIPROLE (RYNAXYPYR)			
	(Altacor)	3.0–4.5 oz	4	10
	MODE-OF-ACTION GROUP NUMBER[1]: 28			
E.	EMAMECTIN BENZOATE			
	(Proclaim)*	3.2–4.8 oz	See label	14
	MODE-OF-ACTION GROUP NUMBER[1]: 6			

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

\# Acceptable for use on organically grown produce.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

NAVEL ORANGEWORM (6/23)

Scientific Name: *Amyelois transitella*

DESCRIPTION OF THE PEST

Navel orangeworm is a primary pest of almonds in California and is found on several agricultural and nonagricultural hosts.

Moths have irregular, silver gray and black forewings and legs and a snoutlike projection at the front of the head. Females typically begin laying eggs the second night after emergence. Eggs are laid on mummy nuts remaining in the orchard or on new crop nuts after the initiation of hullsplit. Eggs hatch within 4 to 23 days, depending on temperature. When first laid, eggs are white, later turning orange just before hatching. Newly hatched larvae are reddish orange and later instars vary from milky white to pink. Larvae have reddish brown head capsules and a pair of crescent-shaped dark marks on the second segment behind the head. Pupae are light to dark brown, encased in a woven cocoon, and found inside nuts or between hulls and shells.

There are three to four adult flight periods per year depending on emergence from the overwintering stage and temperatures throughout the season. The larvae overwinter in mummy nuts either in trees or on the ground.

DAMAGE

First-instar larvae bore into the nutmeat, and later instars can consume most of the nut, producing large amounts of webbing and frass. Often, more than one larva can be found feeding in a nut. Navel orangeworm larval damage can also lead to fungal infections. Some cultivars are more susceptible to damage, especially later-maturing softshell almonds with a lengthy hullsplit period or a poor shell seal.

MANAGEMENT

Two cultural practices—effective removal with destruction of mummy nuts in fall or winter (sanitation) and early harvest with rapid removal of nuts from the orchard floor— are essential components of an effective navel orangeworm control program. Insecticide treatments are often needed if these practices are not carried out, in situations with high navel orangeworm numbers, or when navel orangeworm may immigrate in from neighboring orchards. When infested trees of alternate hosts are harvested, navel orangeworm moths may migrate into almond orchards. Treating border rows (at least 10 rows) may be adequate to prevent the moths from infesting the almond crop when navel orangeworm numbers are low to moderate in a given area. Sprays are timed using egg traps or pheromone traps in conjunction with degree-days, and monitoring hullsplit. Two parasitic wasps may be found in orchards, but they cannot be relied on to provide effective control alone without using other cultural or compatible chemical practices.

In contrast to the mid- and southern San Joaquin Valley, navel orangeworms are typically less abundant in the Sacramento and northern San Joaquin valleys, so nut damage tends to be less severe. However, environmental conditions, proximity to sources of infestation, and effectiveness of sanitation practices impact the potential for damage by this pest, regardless of growing region.

Biological Control

Parasitic wasps that are known to parasitize navel orangeworm include *Copidosoma (=Pentalitomastix) plethorica* and *Goniozus legneri*. *Goniozus legneri* is now available from commercial insectaries and can be purchased and released. Releases must be supplemented with cultural and other management practices.

Cultural Control

Remove Mummy Nuts (Sanitation)

Remove mummy nuts from trees before bud swell by mechanically shaking the tree or hand poling. Blow or sweep fallen mummy nuts to the row centers and destroy them by discing or flail mowing by March 1, especially where ground cover is not present or in years with dry winters. Moist orchard floor conditions provided by winter-resident vegetation and rain will enhance mortality of navel orangeworms in mummy nuts that have fallen from trees in years with adequate rainfall. Conversely, mummy removal is even more important during periods of drought because survival of the overwintering larvae in the mummies tends to be greater than in wet years. Nevertheless, mummies remaining in the orchard, even if not infested with overwintering populations, may provide a development site for first flight prior to hullsplit.

Early Harvest
Harvest nuts as soon as good removal can be achieved; this is when 100% of nuts are at hullsplit at the 6- to 8-foot level of tree canopy. Risk of navel orangeworm infestation in early-harvested varieties such as Nonpareil can be greatly reduced if nuts are harvested before third-generation eggs are laid.

Varietal Selection
Hard-shelled varieties and those with a tight shell seal are resistant to navel orangeworm.

Organically Acceptable Methods
Some mating disruption products are approved for use in organic orchards. Cultural and biological controls and sprays of Entrust formulation of spinosad or *Bacillus thuringiensis* are organically acceptable methods. Sprays are not a substitute for cultural practices, which are necessary for acceptable control. Hard-shelled varieties can also be used to avoid navel orangeworm damage.

Monitoring and Treatment Decisions
Management of navel orangeworm varies regionally within California.

- Central and southern San Joaquin Valleys: Provide excellent winter sanitation in combination with insecticide sprays when the new crop becomes susceptible. Base the number of applications and application timing on egg traps, pheromone traps, and crop phenology. When high numbers of navel orangeworm are present, a third spray may be needed, especially when late varieties are present that will be harvested after the start of the fourth flight.
- Northern San Joaquin and Sacramento valleys: Typically, natural winter mortality is higher, and fourth flights are less common. Provide good winter sanitation; and insecticides may or may not be needed depending on trap captures and environmental conditions.

Insecticides for navel orangeworm are primarily used at hullsplit and later when the new crop is susceptible. However, when high numbers of navel orangeworm are present in the San Joaquin Valley, an insecticide application might also be warranted in May. For information on spray programs, see the section on SPRING SPRAYS and HULLSPLIT SPRAYS below.

A harvest sample for nut damage will help assess the effectiveness of your management program.

Degree-days
Calculate degree-daysfor navel orangeworm in almond for your location using the navel orangeworm pest model. To learn more about using degree-days to time insecticide applications, watch the degree-days video.

Sample for Mummy Nuts
Sample your orchard for mummy nuts on or before January 15 to determine the density of mummy nuts in the orchard and assess sanitation needs. Examine and count the overwintering nuts on 20 trees per block to determine the average number of mummies. When sampling, be sure to evaluate trees from all varieties since mummy counts can be quite different from one variety to the next. In the southern and central San Joaquin valleys clean trees to no more than an average of 0.2 mummies per tree and eight per tree on the soil by February 1. In the northern San Joaquin and Sacramento valleys, clean trees to less than two mummies per tree. If possible, determine the percentage of infested mummies and the presence of live larvae or pupae to help estimate the carryover potential from one year to the next.

Navel Orangeworm Egg Traps
Place egg trapsin the orchard by March 15 at a rate of 1 trap per 10 acres, or a minimum of 4 traps per orchard. However, more egg traps (as many as 10 per orchard) enable a more precise estimation of biofix. Traps consist of a black plastic tube with a snap top and mesh sides that is half- to three-quarters full of almond presscake containing 3 to 10% almond oil. Some growers grind almond or pistachio mummies to use as an alternative to presscake.

- Monitor traps once or twice per week until a biofix is established.
- The biofix to start degree-day accumulation is established when egg numbers and number of traps with eggs increase for at least two consecutive sampling periods (the biofix point is the first of those two dates) or when 50% or more of the traps have eggs. Note: Be sure to remove eggs from the trap after it is examined.
- Egg hatch of the first brood is expected when 100 DD have accumulated after biofix.

Egg traps are most effective during the first flight in April and May. Though egg traps can be used during the second and third flight, they provide a less accurate estimate of biofix since they are competing with the new crop nuts during that period. To keep track of egg-trap counts, use the monitoring form.

Navel Orangeworm Pheromone Traps

Pheromone traps are used to monitor the flights of male moths. Place pheromone lures into delta or wing traps and hang in the tree canopies at approximately six to eight feet in early March. Hang one trap per 50 acres and at least two traps per orchard. Count the number of moths in the trap at least once per week and track the data to identify adult flight. Make sure not to confuse navel orangeworm with the meal moth (*Pyralis farinalis*) that is also attracted to the lure. Meal moths are light brown with dark brown bands on the wings.

Spring Sprays

Only consider spring sprays for navel orangeworm in orchards with a history of high navel orangeworm damage and high trap captures in the central and southern San Joaquin Valley. In the northern San Joaquin and Sacramento valleys, spring sprays for peach twig borer often have a secondary benefit to suppress navel orangeworm, but a dedicated spray targeting navel orangeworm is most effective at hull split. If an insecticide is used in the spring (late April to mid-May), make the application just after the first eggs of the spring brood hatch or at the appropriate timing for peach twig borer. Use a reduced-risk product (non-pyrethroid) to prevent secondary outbreaks of pests such as spider mites.

Hullsplit Sprays

The initiation of hullsplit is the most effective timing for a single insecticide application. Time the spray to the beginning of hullsplit (no later than 1% hullsplit) if eggs are being laid on egg traps or if pheromone traps indicate that the second flight has begun.

Hullsplit is determined to begin when sound fruit in the top southwestern quadrant of the trees just begin to split. Note that this is before the suture is wide open. At that time, the nuts at eye level will be less mature than those at the top and have only a deep furrow in the hulls. Blank nuts (usually 3 to 5% of the crop) will split 1 to 2 weeks ahead of sound nuts, and these should not be confused with hullsplit of the new crop. Use a long-extension pole pruner to cut small branches from this top southwestern portion of five or six trees in the orchard to check whether hullsplit nuts are blank or sound.

Orchards with moderate to high numbers of navel orangeworms require a second insecticide application approximately 2 to 3 weeks after the initiation of hullsplit. At this time, the primary variety (e.g., Nonpareil) is fully split and pollinizers are beginning to split. To determine if this treatment is needed, consider

- the varieties in the orchard,
- anticipated harvest dates,
- pest pressure noted from egg and pheromone traps,
- overwintering mummy load, and
- proximity to an external navel orangeworm source.

Mating Disruption

Mating disruption is a relatively new technique for managing navel orangeworm in almonds. As a supplemental management tool, use mating disruption in conjunction with strategically applied insecticides, most notably in orchards with high numbers of navel orangeworm or in the first years of a mating disruption program. Mating disruption dispensers should be hung from sturdy limbs midway up the tree in late March or early April according to manufacturer's guidance. In areas where the wind blows from one predominant direction, dispensers should be placed so there is a higher density of pheromone emitted on the windward edge (upwind) of the orchard.

In orchards with mating disruption, pheromone traps do not effectively monitor male flights.

- Use pheromone traps to assure that suppression of mating is achieved. Pheromone-only traps in mating disruption blocks should usually capture no adults, and no more than a few weekly.
- Use egg traps and monitoring of eggs on early-split nuts to determine the timing of insecticide treatments in orchards using mating disruption.

Postharvest Fumigation

If the crop was exposed to a significant third flight of navel orangeworm or peach twig borer before harvest, a postharvest fumigation of the crop may be warranted.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

MATING DISRUPTANTS (SEASON LONG)

A.	MATING DISRUPTION			
	(Checkmate Puffer NOW ACE)	1 dispenser	0	0
	(Checkmate Puffer NOW-O ACE)#	1 dispenser	0	0
	(Semios NOW Extra)	1 dispenser	0	0
	(Semios NOW Eco)#	1–2 dispensers	0	0
	(Isomate Mist NOW)	1 dispenser	0	0
	(CideTrak NOW MESO)#	15–28 dispensers	0	0
	COMMENTS: Apply in late March before egg laying begins and leave in the orchard until the last navel orangeworm flight is over and all pheromone has been released. For Semios NOW, release rates can be modified electronically from a remote location; other products release pheromone at a static rate throughout the season.			

SPRING SPRAYS

A.	METHOXYFENOZIDE			
	(Intrepid 2F)	12–24 fl oz	4	7
	MODE-OF-ACTION GROUP NUMBER[1]: 18			
	COMMENTS: An insect growth regulator.			
B.	CHLORANTRANILIPROLE (RYNAXYPYR)			
	(Altacor)	3.0–4.5 oz	4	10
	MODE-OF-ACTION GROUP NUMBER[1]: 28			
C.	METHOXYFENOZIDE/SPINETORAM			
	(Intrepid Edge)	10–18 fl oz	4	7
	MODE-OF-ACTION GROUP NUMBER[1]: 18/5			
	COMMENTS: May disruptof predatory thrips and some parasitoids. Includes an insect growth regulator.			
D.	SPINETORAM			
	(Delegate WG)	6–7 oz	4	1
	MODE-OF-ACTION GROUP NUMBER[1]: 5			
	COMMENTS: May be disruptive of predaceous thrips and some parasitoids.			
E.	EMAMECTIN BENZOATE			
	(Proclaim)	3.2–4.8 oz	See label	14
	MODE-OF-ACTION GROUP NUMBER[1]: 6			
F.	SPINOSAD			
	(Entrust)#	1.25–3 oz	4	1
	MODE-OF-ACTION GROUP NUMBER[1]: 5			
	COMMENTS: Apply in early morning or evening if bees are present in the orchard. May be disruptive of predaceous thrips and some parasitoids.			
G.	*BACILLUS THURINGIENSIS* ssp. *KURSTAKI*#			
	(various products)	Label rates	4	0
	MODE-OF-ACTION GROUP NUMBER[1]: 11A			
	COMMENTS: Effective only under moderate pest pressure. Make two applications, one at the beginning of egg hatch (100 degree-days) and the second 10 to 14 days later. Check with certifier to determine which products are organically acceptable.			

HULLSPLIT AND POSTHULLSPLIT SPRAYS

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
A. METHOXYFENOZIDE (Intrepid 2F) MODE-OF-ACTION GROUP NUMBER[1]: 18	12–24 fl oz	4	7
B. CHLORANTRANILIPROLE (RYNAXYPYR) (Altacor) MODE-OF-ACTION GROUP NUMBER[1]: 28	3.0–4.5 oz	4	10
C. METHOXYFENOZIDE/SPINETORAM (Intrepid Edge) MODE-OF-ACTION GROUP NUMBER[1]: 18/5 COMMENTS: May be disruptive of predaceous thrips and some parasitoids. Includes an insect growth regulator.	10–18 fl oz	4	7
D. SPINETORAM (Delegate WG) MODE-OF-ACTION GROUP NUMBER[1]: 5 COMMENTS: May disrupt of predatory thrips and some parasitoids.	6–7 oz	4	1
E. BIFENTHRIN (Brigade WSB, Bifenture 10DF) MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Pyrethroid residues are very toxic to beneficial predators and parasitoids long after application. Never use a pyrethroid insecticide as a May spray, and avoid use of pyrethroids in almond orchards if possible.	8–32 oz	12	7
F. LAMBDA-CYHALOTHRIN (Warrior II with Zeon) MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Pyrethroid residues are very toxic to beneficial predators and parasitoids long after application. Never use a pyrethroid insecticide as a May spray, and avoid use of pyrethroids in almond orchards if possible.	1.28–2.56 fl oz	24	14
G. FENPROPATHRIN (Danitol) MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Pyrethroid residues are very toxic to beneficial predators and parasitoids long after application. Never use a pyrethroid insecticide as a May spray, and avoid use of pyrethroids in almond orchards if possible.	10.66–21.33 fl oz	24	3
H. *BACILLUS THURINGIENSIS* ssp. *KURSTAKI*# (various products) MODE-OF-ACTION GROUP NUMBER[1]: 11A COMMENTS: Make two applications: (1) at hullsplit (or start of egg laying if after hullsplit) and (2) one week later. Check with certifier to determine which products are organically acceptable.	Label rates	4	0
I. ESFENVALERATE (Asana XL) MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Pyrethroid residues are very toxic to beneficial predators and parasitoids long after application. Never use a pyrethroid insecticide as a May spray, and avoid use of pyrethroids in almond orchards if possible.	9.6–19.2 fl oz	12	21
J. SPINOSAD (Entrust)# MODE-OF-ACTION GROUP NUMBER[1]: 5 COMMENTS: May disrupti predatory thrips and some parasitoids.	1.25–3 oz	4	1
K. PHOSMET (Imidan 70W) MODE-OF-ACTION GROUP NUMBER[1]: 1B COMMENTS: Can be used where label restrictions prevent use of other organophosphates. Late-season treatments must be applied before hullsplit reaches 10%.	4.33 lb	72 (3 days)	30

POSTHARVEST

A. ALUMINUM PHOSPHIDE*

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(various products)	Label rates	See label	0
MODE-OF-ACTION GROUP NUMBER[1]: 24A			
COMMENTS: Apply as fumigant to harvested almonds that have been exposed to navel orangeworm.			

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

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

\# Acceptable for use on organically grown produce.

1 Group numbers for insecticides and miticides are assigned by the Insecticide Resistance Action Committee (IRAC). Rotate pesticides with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; insecticides with a 1B group number should be alternated with insecticides that have a group number other than 1B. For more information, see irac-online.org

ORIENTAL FRUIT MOTH (8/17)

Scientific Name: *Grapholita molesta*

DESCRIPTION OF THE PEST

Oriental fruit moth is an occasional pest of almonds. It overwinters as a mature larva in bark cracks and in leaf litter. The small brown moths emerge in late February. Larvae are white to pink with a brown head capsule. There are five to six generations per year.

DAMAGE

First- and second-generation larvae mine young, tender shoots, causing them to wilt and die. Third- and fourth-generation larvae feed between the hull and shell; this damage is difficult to distinguish from that caused by peach twig borer. Damage is rarely significant. Occasionally, larvae have been found feeding on nut meats. They may feed in groups of several larvae within a nut. Larvae do not produce webbing but do produce a characteristic reddish brown frass in the hull.

MANAGEMENT

Oriental fruit moth rarely causes significant kernel damage to almonds. Sprays are usually only required if significant damage by this pest occurred the previous year or in orchards that are near to other sources of oriental fruit moth (e.g. infested peach and nectarine orchards, which are harvested before almonds). Monitor oriental fruit moth densities in late April to early May by opening shoot strikes and looking for larvae, as described in the monitoring section for peach twig borer. Oriental fruit moth larvae will look distinctly different from peach twig borer larvae (reddish-brown with white intersegmental banding) and strikes occur after peach twig borer strikes. A harvest sample will help evaluate the effectiveness of your management program.

Monitoring and Treatment Decisions

Adult oriental fruit moths can be monitored and a treatment timed (if necessary) with pheromone traps. These should be placed in orchards by February 15 in the northern or eastern quadrant of the tree, 6 to 7 feet high. Use three traps per orchard or varietal block less than 30 acres. Use one trap per 10 acres for 30- to 80-acre orchards and one trap per 20 acres for orchards larger than 80 acres. Monitor traps once a week. Replace pheromone lures according to manufacturer's directions, and replace trap liners when dirty, or after counting and removing an accumulated total of 150 moths. Oriental fruit moth traps usually catch many more moths than do peach twig borer traps, and like peach twig borer traps, trap catch numbers are generally not a good indicator of potential damage.

Degree-days

Calculate degree-days for oriental fruit moth in almond for your location using the oriental fruit moth pest model. To learn more about using degree-days to time insecticide applications, watch the degree-days video.

To determine optimum time to spray, accumulate degree-days beginning with the first male moth trapped from the second flight, which usually peaks in late May. Use a lower threshold of 45°F and an upper threshold of 90°F. The optimum time to spray for oriental fruit moth is 500 to 600 degree-days after the first trapped male in any flight.

	Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*				
A.	CHLORANTRANILIPROLE (RYNAXYPYR) (Altacor) MODE-OF-ACTION GROUP NUMBER[1]: 28	3.0–4.5 oz	4	10
B.	METHOXYFENOZIDE (Intrepid 2F) MODE-OF-ACTION GROUP NUMBER[1]: 18A	12 oz	4	14

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

COMMENTS: Apply in sufficient water to ensure good coverage. Apply with Latron or similar surfactant at 0.125% volume by volume.

C. SPINETORAM
(Delegate WG) 3–7 oz 4 1
MODE-OF-ACTION GROUP NUMBER[1]: 5
COMMENTS: Apply at night to target active adult moths and to avoid foraging bees when blooming groundcover is present. May be disruptive of predaceous thrips and some parasitoids.

D. PHOSMET
(Imidan 70W) 4.33 lb 72 (3 days) 30
MODE-OF-ACTION GROUP NUMBER[1]: 1B
COMMENTS: Do not apply more than 1 foliar spray per season. Breaks down rapidly in water. Can be used where label restrictions prevent use of other organophosphates.

E. SPINOSAD
(Entrust)# 1.25–3 oz 4 1
(Success) 4–10 oz 4 1
MODE-OF-ACTION GROUP NUMBER[1]: 5
COMMENTS: Apply in early morning or evening if bees are present in the orchard. May be disruptive of predaceous thrips and some parasitoids.

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

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

\# Acceptable for use on organically grown produce.

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

PEACH SILVER MITE (8/17)

Scientific Name: *Aculus cornutus*

DESCRIPTION OF THE PEST

Peach silver mite is white or cream-colored and extremely small. The body is teardrop-shaped with four short legs at the larger (anterior) end. Because it is much smaller than other mites on almonds, a high-power hand lens (15X or higher) is needed to see it clearly.

DAMAGE

Peach silver mite is not usually damaging in almonds, although it can cause symptoms if numbers increase to high levels on trees less than 6 years old. Feeding by peach silver mite causes tiny chlorotic spots that give the leaf a silvery appearance, especially along the midvein of the upper leaf surface. Symptoms resemble thrips or leafhopper damage. Once higher temperatures occur in late spring, brown necrotic spots develop along leaf margins following silver mite feeding early in the season that may superficially resemble rust symptoms.

MANAGEMENT

For the most part, peach silver mite is usually considered beneficial to have in the orchard because it serves as a food source for mite predators. Unless peach silver mite numbers are high enough (hundreds to thousands per leaf) that some defoliation is observed, no treatment is necessary.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. NARROW RANGE OIL# (Omni Supreme and others)	Label rates	See label	See label
MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Cover all parts of the tree. Will control low-to-moderate infestations. See DORMANT TREATMENT DECISION TABLE for rate to use based on the percent infested spurs. Check with certifier to determine which products are organically acceptable.			
B. WETTABLE SULFUR# (various products)	Label rates	24	0
MODE OF ACTION: Unknown. An inorganic insecticide. COMMENTS: Check with your certifier to determine which products are organically acceptable.			
C. ABAMECTIN* (Agri-Mek SC, others)	Label rates	See label	See label
MODE-OF-ACTION GROUP NUMBER[1]: 6 COMMENTS: Apply with 1 to 2% horticultural oil by volume according to label directions. Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. **Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019**. Review the Department of Pesticide Regulation's updated fact sheet.			

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

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

\# Acceptable for use on organically grown produce.

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

PEACH TWIG BORER (8/17)

Scientific Name: *Anarsia lineatella*

DESCRIPTION OF THE PEST

Peach twig borer is a major pest in several tree crops. Adult moths have steel gray mottled forewings. Females lay eggs on twigs, fruit, and leaves. Eggs hatch in 4 to 18 days. Larvae are small, brown caterpillars with white intersegmental bands and a black head capsule. They go through four to five instars. Overwintering larvae are sheltered in tiny cells (hibernacula) that they bore under the bark of limb crotches on 1- to 4-year-old wood, or in bark cracks on larger limbs and the trunk. Pupae are dark brown, without a cocoon, and are found in tree crevices, between hull and shell, in curled leaves, or in debris on the ground. There are four generations per year.

DAMAGE

Larvae damage both growing shoots and nuts, causing shallow channels and surface grooves on the nutmeat. Peach twig borer damage can be masked by navel orangeworm feeding, which often occurs on nuts previously damaged by peach twig borer.

MANAGEMENT

Some orchards will require a treatment for peach twig borer.

- Use past history, including harvest samples from the previous year, to determine if your orchard will require treatment.
- Preferred treatment timing is during the dormant period (combined with oil sprays if there is concern for San Jose scale, European red mite, or brown almond mites) or at full bloom and petal fall.
- Treatments during the dormant season with environmentally-sound insecticides are acceptable.
- Avoid applications of organophosphates during the dormant season, as these applications threaten water quality when they run off during winter rainfall.
- Be particularly cautious when using insecticides for peach twig borer during bloom, even if it is labeled for this spray timing. Insecticide residues may be picked up in the almond pollen and taken back to the hive by foraging bees where it is fed to bee larvae. The impact of these residues on bee larvae is not fully known. Therefore as a precaution, applications of insecticides during bloom should be avoided until more is known about the impacts on bee larvae. One exception is *Bacillus thuringiensis*, which can be used safely during bloom when pollinators are present. *Bacillus thuringiensis* may be combined with bloomtime fungicide sprays, but check restrictions on compatibility.
- Place pheromone traps out around March 15, and monitor for shoot strikes in mid-April to catch any in-season problems.

Biological Control

Peach twig borer has about 30 known species of natural enemies. Among those commonly found in California are the chalcid wasps *Copidosoma* (=*Paralitomastix*) *varicornis* and *Euderus* (= *Hyperteles*) *lividus*. Another commonly found parasite is *Macrocentrus ancylivorus,* which attacks both peach twig borer and Oriental fruit moth. In some years and orchards, these natural enemies destroy a significant portion of larvae, but they may not reduce twig borer numbers below economically damaging levels. Ants, *Formica* spp., also can be found preying on peach twig borer larvae.

Organically Acceptable Methods

Use *Bacillus thuringiensis* at bloom or spinosad (Entrust) as a delayed-dormant treatment or at the May spring timing in an organically certified crop.

Monitoring and Treatment Decisions

Peach twig borer can be successfully managed with environmentally sound insecticides such as spinosyns (Delegate, Entrust, and Success), *Bacillus thuringiensis,* and chlorantraniliprole (Altacor). Although dormant treatments with organophosphate insecticides are effective and easy to time, they should generally be avoided because of their potential harmful effects on water quality except in orchards where runoff is highly unlikely.

Degree-days

Calculate degree-days for peach twig borer in almond for your location using the peach twig borer pest model. To learn more about using degree-days to time insecticide applications, watch the degree-days video.

Bloom Sprays

To effectively time bloom sprays with *Bacillus thuringiensis*

- Monitor to determine when larvae are emerging from overwintering hibernacula on limb crotches or on tree trunks.
- Make the first application when 20 to 40% of larvae have emerged.
- Make the second application 7 to 10 days later or when 80 to 100% of larvae have emerged from overwintering hibernacula.
- If emergence is spread out, a third spray may be needed when emergence finally reaches 80 to 100%.

A less-precise method is to apply the first spray between popcorn and full bloom on Nonpareil and a second spray at Nonpareil petal fall, unless there is an extended bloom period, in which case a third application may be needed.

Peach twig borer can be very damaging to developing scaffolds in the second growing season, so a dormant spray is recommended in the first dormant season when monitoring indicates peach twig borer hibernacula.

Spring Sprays

Spring sprays are usually not needed if a dormant spray or the series of *Bacillus thuringiensis* bloom sprays have been successful, or there is no history of peach twig borer problems. If broad-spectrum insecticides are applied in May, they can cause outbreaks of mites and other secondary pests. Softer pesticides such as spinosad (Entrust, Success), spinetoram (Delegate), and chlorantraniliprole (Altacor) have recently become available that cause less harm to natural enemies.

Place peach twig borer pheromone traps in orchards, one per 20 acres (but never less than two traps in smaller orchards) by March 15. Hang traps 6 to 7 feet high in the northern quadrant of the tree, 1 to 3 feet from the outer canopy. Monitor twice a week; replace pheromone lures at the interval recommended by the manufacturer and replace trap bottoms after 100 moths have been counted and removed or if dust or other debris has accumulated.

If shoot strike monitoring (below) indicates treatment is necessary, use trap catches and degree-days to time a May spray. Optimum timing for first-generation larvae (the May spray) depends on the insecticides used.

- When using spinosyns (Entrust, Success, and Delegate), diamides (Altacor), or organophosphates, apply insecticides at 400 degree-days after the first male is trapped in pheromone traps and moths have been captured on at least two consecutive sampling periods.
- When using an insect growth regulator (Intrepid), make the application at 300 to 400 degree-days.

Accumulate degree-days for peach twig borer using a lower threshold of 50°F and an upper threshold of 88°F.

Monitor trees of any age for shoot strikes in mid-April. Shoot strikes are easiest to see on young trees and on water sprouts. If several strikes are seen in each tree by late April, a spring spray timed with pheromone traps and degree-days may be required. When examining shoot strikes, look for larvae to determine if peach twig borer or oriental fruit moth are the cause of the shoot strikes. Although oriental fruit moth larvae mine deeper into a shoot than peach twig borer larvae, distinguishing the damage can be difficult. Cut the shoot lengthwise to find the larva and identify it: oriental fruit moth larvae are white or pink with a brown head and peach twig borer larvae are dark brown with white portions between each body segment and a black head. Also, peach twig borer shoot strikes occur earlier in the season than do oriental fruit moth strikes.

If navel orangeworm is also a problem, it may be possible to time the May spray to control both pests if navel orangeworm egg hatch occurs at about the same time as the optimum time for the peach twig borer spray. If not, wait and spray the navel orangeworm at hullsplit and time the May spray for peach twig borer. Applying an insecticide during hullsplit for the control of peach twig borer is not as effective as the May spray timing.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

DORMANT

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
A. SPINOSAD			
(Entrust)#	1.25–3 oz	4	1
(Success)	4–10 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply with a dormant oil to suppress overwintering mite and scale populations. Use caution if there is bloom on orchard floor vegetation that is being visited by pollinators.			
B. SPINETORAM			
(Delegate WG)	1.5–3.5 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply with a dormant oil to suppress overwintering mite and scale populations. Apply at night to avoid foraging bees that may be present on blooming groundcover.			
C. DIFLUBENZURON			
(Dimilin 2L)*	12–16 oz	12	28
MODE-OF-ACTION GROUP NUMBER[1]: 15			
COMMENTS: Apply at a volume sufficient to ensure good coverage. Use with a narrow range oil at 1.5 to 4% by volume, but do not use oil on water-stressed trees or following periods of dry winds.			
D. CHLORANTRANILIPROLE (RYNAXYPYR)			
(Altacor)	3–4.5 oz	4	10
MODE-OF-ACTION GROUP NUMBER[1]: 28			
COMMENTS: Apply with a narrow range oil to suppress overwintering mite and scale populations.			
E. ACETAMPRID			
(Assail 30SG)	5.3–9.6 oz	12	14
MODE-OF-ACTION GROUP NUMBER[1]: 4A			
COMMENTS: Apply with a narrow range oil to suppress overwintering mite and scale populations. Use caution if there is bloom on orchard floor vegetation that is being visited by pollinators.			
F. ESFENVALERATE			
(Asana XL)*	9.6–19.2 oz	12	21
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Residue has been shown to harm predatory mites into the growing season. When widely used in a watershed, runoff following rainfall events may result in its presence in surface waters at levels that violate federal and state water quality standards.			
G. BIFENTHRIN			
(Brigade WSB)*	8.0–32.0 oz	12	7
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Pyrethroid insecticides have a broad spectrum of activity against nontarget organisms. When Brigade is widely used in a watershed, runoff following rainfall events may result in its presence in surface waters at levels that violate federal and state water quality standards.			
H. CYFLUTHRIN			
(Baythroid XL)*	2.4–2.8 oz	12	14
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Pyrethroid insecticides have a broad spectrum of activity against nontarget organisms. When Baythroid is widely used in a watershed, runoff following rainfall events may result in its presence in surface waters at levels that violate federal and state water quality standards.			
I. LAMBDA-CYHALOTHRIN			
(Warrior II with Zeon)*	1.28–2.56 fl oz	24	14
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Pyrethroid insecticides have a broad spectrum of activity against nontarget organisms. When Warrior is widely used in a watershed, runoff following rainfall events may result in its presence in surface waters at levels that violate federal and state water quality standards.			
DELAYED-DORMANCY OR PINK BUD			
A. METHOXYFENOZIDE			
(Intrepid 2F)	8–16 fl oz	4	14
MODE-OF-ACTION GROUP NUMBER[1]: 18			

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
COMMENTS: Apply in sufficient water to ensure good coverage. Apply with Latron or similar surfactant at 0.125% volume by volume.			
B. DIFLUBENZURON			
(Dimilin 2L)*	12–16 fl oz	12	28
MODE-OF-ACTION GROUP NUMBER[1]: 15			
COMMENTS: Apply in sufficient water to ensure good coverage. Apply with Latron or similar surfactant at 0.125% volume by volume. Avoid use when honey bees are already present in the orchard.			
C. CHLORANTRANILIPROLE (RYNAXYPYR)			
(Altacor)	3–4.5 oz	4	10
MODE-OF-ACTION GROUP NUMBER[1]: 28			
COMMENTS: Apply with a dormant oil to suppress overwintering mite and scale populations.			
BLOOM			
Note: *Additional insecticides are labeled for use during bloom. However, due to concerns over pollinator safety (adult, developing brood in the hive, or both), applications of other insecticides by themselves or in combination with fungicides should be delayed until bloom is complete and hives are removed.*			
A. *BACILLUS THURINGIENSIS* ssp. *KURSTAKI*#			
(various products)	Label rates	4	0
MODE-OF-ACTION GROUP NUMBER[1]: 11A			
COMMENTS: Best if applied by ground, because thorough coverage of the shoot tips is essential. If it must be applied by air because of wet ground or other factors that preclude ground spray, fly about 20 ft over the tree canopy to allow better spray deposition on treetops. Make two applications during bloom: the first between popcorn and full bloom on Nonpareil, and the second at Nonpareil petal fall. A third *Bacillus thuringiensis* spray may be needed in cool and wet years when peach twig borer emergence is extended. Compatible with fungicide sprays. Will not control San Jose scale, European red mite eggs or other pests normally controlled with oil sprays during the dormant or delayed-dormant periods.			
SPRING			
A. CHLORANTRANILIPROLE (RYNAXYPYR)			
(Altacor)	3.0–4.5 oz	4	10
MODE-OF-ACTION GROUP NUMBER[1]: 28			
B. SPINETORAM			
(Delegate WG)	3–7 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Apply at night to target active adult moths and to avoid foraging bees that might be present on foraging groundcover. May be disruptive of predaceous thrips and some parasitoids.			
C. EMAMECTIN BENZOATE			
(Proclaim)*	3.2–4.8 oz	See label	14
MODE-OF-ACTION GROUP NUMBER[1]: 6			
D. SPINOSAD			
(Entrust)#	1.25–3 oz	4	1
(Success)	4–10 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: A fermentation-derived insect control product. May be disruptive of predaceous thrips and some parasitoids.			
E. *BACILLUS THURINGIENSIS* ssp. *KURSTAKI*#			
(various products)	Label rates	4	0
MODE-OF-ACTION GROUP NUMBER[1]: 11A.			
COMMENTS: Make two applications: one at 300 to 350 DD from biofix and the other at 450 to 500 DD. Compatible with fungicide sprays and can be tank mixed with them. Good coverage is essential. Ground application using a concentrate rate (80–100 gal water maximum) is preferred.			
F. ACETAMPRID			
(Assail 30SG)	5.3–9.6 oz	12	14

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
MODE-OF-ACTION GROUP NUMBER[1]: 4A			

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

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

\# Acceptable for use on organically grown produce.

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

PEACHTREE BORER (8/17)

Scientific Name: *Synanthedon exitiosa*

DESCRIPTION OF THE PEST

Gum and frass exuding from around the base of the trunk is evidence of peachtree borer. Larvae of the peachtree borer, found mainly in coastal areas and in the northern San Joaquin and Sacramento valleys, are white with brown heads. Adults are clear-winged moths with blue-black bodies that have yellow or orange bands across the abdomen. The adult peachtree borer flies during the day and may be found from June to September, with larvae present in the tree the rest of the year. There is only one generation each year.

DAMAGE

This wood-boring insect can successfully attack healthy trees. The larval stage bores into the crown and trunk of the tree, and mines the cambial layer, often near the graft union. If this occurs for several years, the tree may eventually become girdled and die. It attacks only the peach rootstock and does not infest the almond scion.

MANAGEMENT

Treatment is rarely needed, but if a severe infestation exists, apply insecticides when adults emerge to help control peachtree borer adults and to kill newly hatching larvae. Pheromone traps are available to monitor adult emergence.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. ESFENVALERATE (Asana XL)*	9.6–19.2 fl oz	12	21
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Apply as a directed trunk and scaffold limb spray. Thorough coverage of trunk and scaffolds is required.			

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

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

1 Modes of action are important in preventing the development of resistance to pesticides. Rotate pesticides with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season. For example, the organophosphates have a group number of 1B; pesticides with a 1B group number should be alternated with pesticides that have a group number other than 1B. Mode of action is assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

RED IMPORTED FIRE ANT (8/17)

Scientific Name: *Solenopsis invicta*

DESCRIPTION OF THE PEST

Red imported fire ant is an invasive species that is not currently present in California almond orchards. However, growers should be aware of this pest and watch for it, particularly after bloom in orchards that rented bee hives from areas of the country that are known to be infested.

Fire ants are characterized by having a 2-segmented petiole (the narrow waist between the thorax and abdomen), 10-segmented antennae with a 2-segment club, and a stinger. There are two native fire ant species likely to be encountered in California that can be confused with the red imported fire ant. The more common one, the southern fire ant (*Solenopsis xyloni*) is 0.1 to 0.18 inches (2.5 to 4.5 mm) in length and found in coastal and inland regions. It is very similar in appearance to the red imported fire ant. The southern fire ant differs from the red imported fire ant in that it is bicolored, with a reddish head and thorax and a dark brown abdomen. By contrast, the red imported fire ant is an almost uniform dark reddish-brown and 0.12 to 0.24 inches (3 to 6 mm) long. Both species have workers of mixed sizes.

Red imported fire ant mounds are frequently built up into domes, while the southern fire ant mounds are irregular craters. Mounds produced by red imported fire ants can reach 10 to 12 inches in height: however the size of mounds will vary with soil types, and mounds may be absent. A characteristic difference between these species is the aggressiveness of the workers. Although they will both sting, the ferocity of the red imported fire ant is notable. Any object touching their mound is immediately attacked and stung, and the workers will quickly run up a stick that touches the mound. It is still uncertain whether the red imported fire ant colonies in California have one or multiple queens per colony. This could have a significant impact on the selection of treatment strategies.

DAMAGE

Red imported fire ants can chew on soft plant tissue and growing buds. Their stinging behavior can be hazardous to people and pets. Their sting is noxious and produces a pustule on the skin that can scar if it gets infected. They can clog irrigation lines and short-circuit electrical systems.

MANAGEMENT

Although red imported fire ants are not present in all areas of California, they are a serious pest and are subject to quarantine regulations. In Southern California, state and federal officials have placed Orange County and portions of Los Angeles County and Riverside County under quarantine that limits the movement of regulated items including plants and soil. The California Department of Food and Agriculture (CDFA) has established the Red Imported Fire Ant hotline (1-888-4FIREANT or 1-888-434-7326) to report any suspected occurrence of red imported fire ant in California. This hotline is available 24 hours a day, 7 days a week to provide current information on the red imported fire ant. An operator is available Monday through Friday, 8:00 a.m. to 8:00 p.m.; after hours, callers may leave a message. All calls reporting suspected red imported fire ant mounds will be answered and the information will be referred to the appropriate agency for response. Border programs exist to ensure that red imported fire ants do not hitchhike on beehives brought into California for almond pollination.

Biological Control

There are no commercial biological control agents presently available. The U.S. Department of Agriculture and the University of Texas have begun the first biological control program to control fire ants using a tiny South American fly, called a phorid, which is a natural parasite of fire ants. These flies are being mass-reared and released in Florida and Texas for evaluation. Researchers are also investigating other parasitic insects and even protozoa from South America.

Monitoring

If you suspect a colony is red imported fire ant, use four or five small plastic vials baited with Spam meat as monitoring stations placed at 50-foot intervals around the colony. The sample should then be sent to your nearest cooperative extension advisor for identification.

Treatment

In areas not known to have red imported fire ant, contact CDFA or your county agricultural commissioner's office for information on approved treatments. RIFA Hotline: 1-888-4FIREANT (1-888-434-7326). In areas with established red imported fire ant populations where there are no eradication programs in place, see treatment guidelines for ants.

SAN JOSE SCALE (8/17)

Scientific Name: *Diaspidiotus* (=*Quadraspidiotus*) *perniciosus*

DESCRIPTION OF THE PEST

Mobile crawlers emerge from beneath the adult female scale cover. Crawlers are bright yellow and tiny (about the size of the sharp end of a pin), with well developed eyes, antennae, and legs. After locating a feeding site, the crawlers settle, begin feeding, and lose their antennae, legs, and eyes, becoming immobile. They soon begin to secrete a waxy substance that covers the body. Initially the waxy covering is white (white cap), but turns darker later in the first instar (black cap). Male scales have a more elongated covering than the females; males molt four times, whereas females have a rounder cover and molt twice. The male emerges as a winged adult and the female remains wingless under the scale covering. There are three to four generations per season, taking about 7 to 8 weeks per generation.

DAMAGE

Scales suck plant juices from twigs and limbs, and inject a toxin, resulting in loss of tree vigor, growth and productivity, and death of limbs. A red halo is produced around a feeding site on 1-year-old green wood. Untreated infestations can kill fruit spurs and scaffold wood within 1 to 3 years.

MANAGEMENT

San Jose scale has many natural enemies that can frequently keep the pest under control if not disrupted by in-season applications of broad-spectrum insecticides. Many orchards that have not used broad-spectrum sprays for 2 or 3 years do not have San Jose scale problems. Low to moderate numbers of scale can be managed with oil sprays during the dormant season. The best time to spray is during the dormant season, and low to moderate numbers can be managed with oil sprays alone at this time. The scale is monitored as part of the spur sample during the dormant season and with pheromone traps in the spring.

Biological Control

Natural enemies that feed on San Jose scale include two predaceous beetles: the twicestabbed lady beetle, *Chilocorus orbus,* and another small beetle *Cybocephalus californicus*. Small chalcid and aphelinid wasps parasitize this scale, including some species of *Aphytis* and *Encarsia (=Prospaltella)*. These natural enemies are helpful in reducing scale numbers, but insecticides used during the growing season for other pests disrupt this natural control, and scale numbers can increase as a result. Low winter mortality due to mild temperatures will also permit a buildup of scale numbers.

Organically Acceptable Methods

Biological control and a properly applied oil spray during the delayed-dormant period are organically acceptable management practices for this pest.

Monitoring and Treatment Decisions

Monitor San Jose scale during the dormant season by collecting spurs and examining them for live scale as well as for tiny emergence holes, which indicate parasite activity. For details on dormant spur sampling and treatment thresholds, see the section DORMANT SPUR SAMPLING and the monitoring form available online.
For high numbers of scale, a properly applied dormant spray with good coverage is the most effective spray timing and will eliminate the spring flight and suppress the infestation throughout the growing season. Do not use oil sprays, however, on water-stressed trees. The following table gives a guideline for making treatment choices based on levels of infestation on dormant spur samples:

Dormant Treatment Decision Table (Percent of Infested Spurs)

Threshold	Treatment
Below 20%	No Spray
20–60%	Oil at 6–8 gals/acre
Over 60%	Oil with insect growth regulator

Oil alone can be effective in controlling low to moderate numbers. If numbers are high, include an insect growth regulator (pyriproxyfen, Seize or buprofezin, Applaud) with the oil. Organophosphates are effective and available but are associated with water runoff concerns and should generally be avoided. When the traditional dormant organophosphate and oil spray is skipped, San Jose scale numbers tend to increase the first year, but by the second and third year parasite numbers have increased to levels where they reduce San Jose scale numbers and maintain them at low levels.

- Use pheromone traps to detect male emergence in spring ifmonitoring indicates that scale densities may require treatment and dormant or delayed-dormant controls were not applied.
- Place traps 6 to 7 feet high in the north or east side of trees by February 25 in southern areas and by March 15 in the north.
- To time this treatment, accumulate degree-days using a lower threshold of 51°F and an upper threshold of 90°F. The optimum time for spring spraying with an organophosphate is 600 to 700 degree-days (DD) after the beginning of the male flight or 200 degree-days after crawler emergence begins.
- Apply pyriproxyfen (Seize) and buprofezin (Centaur) at the beginning of crawler emergence, which is 400 degree-days from the beginning of the male flight.
- Use ticky tape to monitor crawlers when they hatch.
- Late-fall or postharvest treatments are not effective.

Degree-days

Calculate degree-days for San Jose scale in almond for your location using the San Jose scale pest model. To learn more about using degree-days to time insecticide applications, watch the degree-days video.

Parasite numbers can also be monitored with San Jose scale pheromone traps in spring because the parasites are attracted to the traps. To distinguish the adult male San Jose scale from the parasite *Aphytis* spp., look for a dark band across the back of the male San Jose scale at the base of its wings.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

DORMANCY

A. NARROW RANGE OIL#
(Omni Supreme) — 6–8 gal — See label — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Cover all parts of the tree. Will control low-to-moderate infestations. See DORMANT TREATMENT DECISION TABLE for rate to use based on the percent infested spurs. Check with certifier to determine which products are organically acceptable.

B. NARROW RANGE OIL
(Omni Supreme) — 4–8 gal — See label — 0
MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Cover all parts of the tree. Oil alone will control low to moderate infestations. Use with organophosphate insecticide for high infestations. Do not use oil sprays on water-stressed trees.
. . . PLUS. . .
PYRIPROXYFEN
(Seize 35WP) — 4–5 oz — 12 — 21
MODE-OF-ACTION GROUP NUMBER[1]: 7C
COMMENTS: An insect growth regulator. Do not apply more than once per growing season. Good coverage is essential for good control.
. . . or. . .
BUPROFEZIN
(Centaur WDG) — 34.5–46 oz — 12 — 60
MODE-OF-ACTION GROUP NUMBER[1]: 16
. . . or. . .
CARBARYL*
(Sevin XLR PLUS) — 2–5 qt — 12 — 14
MODE-OF-ACTION GROUP NUMBER[1]: 1A

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
COMMENTS: Best time to apply this material is about 2 to 3 weeks before bloom. Because carbaryl is so toxic to pollinators, do not apply when there is any bloom in the orchard or in neighboring orchards.			
DELAYED DORMANCY			
A. NARROW RANGE OIL# (Omni Supreme)	6–8 gal	See label	0
MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: High rates of oil alone will control scales at this time. Check with certifier to determine which products are organically acceptable.			
SPRING			
A. PYRIPROXYFEN (Seize 35WP)	4–5 oz	12	21
MODE-OF-ACTION GROUP NUMBER[1]: 7C COMMENTS: Apply at beginning of crawler emergence, which is 400 DD from the beginning of the male flight. Do not apply more than once per growing season. Good coverage is essential for good control.			
B. BUPROFEZIN (Centaur WDG)	34.5–46 oz	12	60
MODE-OF-ACTION GROUP NUMBER[1]: 16 COMMENTS: An insect growth regulator that should be applied at beginning of crawler emergence, which is 400 DD from the beginning of the male flight. Good coverage is essential for good control. Make no more than one application per season.			

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

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

\# Acceptable for use on organically grown produce.

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

— Not recommended or not on label.

STINK BUGS (8/17)

Scientific Names: Green stink bug: *Chinavia* (=*Acrosternum*) *hilaris*
Uhler's stink bug: *Chlorochroa uhleri*
Redshouldered stink bug: *Thyanta pallidovirens*

DESCRIPTION OF THE PESTS

The most common stink bug in almonds is the green stink bug. Adult green stink bugs are bright green with the entire lateral margin lined in yellow or orange. Green stink bug nymphs are a mixture of green, black, and orange. The redshouldered stink bug and green plant bug are smaller in size and less common. 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 Uhler stink bug is dull to bright green and slightly larger (0.4–0.6 inch in length).

Stink bugs often develop in weeds or field crops and migrate into almonds during spring, as weed or crop hosts dry up. The exception is the green stink bug, which overwinters within the orchard. Eggs of these stink bugs are laid in clusters, are barrel-shaped, and have concentric dark rings at the top. In almonds, they are often found on the hulls of the nuts. Immature stages resemble the adults, but are smaller, rounder, and shinier because they lack wings. They exhibit a wide range of color markings that can be different from the adult.

Do not confuse pest stink bugs with the rough stink bug, *Brochymena quadripustulata*, a predator that is speckled white and gray and can also be found in almonds. Nymphs of *Brochymena* are colored red, white, and blue.

DAMAGE

Stink bug damage to almonds is usually caused by the green stink bug. For decades this bug never reached pest status because broad-spectrum dormant insecticide treatments prevented it from overwintering in almonds. More recently there have been increasing numbers of reports of stink bug damage, especially in the lower San Joaquin Valley, in orchards where organophosphate, carbamate, or pyrethroid insecticides have not been used for 3 to 4 years.

Damage by stink bugs usually occurs from May through July, when the bugs insert their strawlike mouthparts through the hull and into the kernel. This damage is almost identical to damage caused by leaffooted plant bugs but occurs later in the season and does not result in nut abortion. Instead, damaged nuts can be recognized by strands of ooze, called gummosis, that exude from the puncture site. Kernels of damaged nuts either become wrinkled and misshapen, or if already hardened before bug damage, will contain a black spot at the puncture site.

MANAGEMENT

Monitor from May through July for gummosis on the surface of almond hulls. If found, cut a cross section through the damaged area to distinguish bug damage from physiological problems by the presence of a puncture mark on the kernel. Because stink bugs are not highly mobile, it is common to find damage in clusters, often with the bug or an egg mass still present in the vicinity.

There are currently no treatment thresholds for stink bugs. Base the decision to spray on the amount of damage and orchard history. Generally speaking, one dormant (green stink bug) or in-season broad-spectrum insecticide (all species) for any pest about every 3 years is sufficient to prevent economic damage. Where only reduced-risk products have been used and damage levels for stink bug become unacceptable, consider making an in-season spray with one of the products listed below. If stink bug numbers are high, consider applying one of these products in a tank mix with a neonicotinoid insecticide such as acetamiprid (Assail).

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

A. BIFENTHRIN

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(Brigade WSB)*	8–32 oz	12	7
MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Do not repeat an application in less than 15 days. Will cause secondary pest outbreaks, especially spider mites, if used before hullsplit.			
B. LAMBDA-CYHALOTHRIN (Warrior II with Zeon)*	1.28–2.56 fl oz	24	14
MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Will cause secondary pest outbreaks, especially spider mites, if used before hullsplit.			
C. CLOTHIANIDIN (Belay)	6 fl oz	12	21
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Provides partial control of adult bugs on contact but does not have any residual control once residues have dried. Review and follow the California neonicotinoid regulations effective January 1, 2024. Permissible application rates of this insecticide may be lower than label rates if applying more than one neonicotinoid active ingredient or using more than one application method in the same season.			

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

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

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

TENLINED JUNE BEETLE (8/17)

Scientific Names: *Polyphylla decemlineata* and *Polyphylla sobrina*

DESCRIPTION OF THE PEST

Adult beetles are about 1 inch long and brown with longitudinal white lines on the back. Adult males are commonly seen flying during the evening hours in mid-summer and remain hidden within tree canopies and under organic debris during daylight hours. Adult females produce pheromones to attract males. *Polyphylla sobrina* females usually mate on emergence at the soil surface. However, *P. decemlineata* females are reported to mate in trees and then may disperse to other locations.

Larvae are cream-colored grubs with a brown head capsule. They live in the soil and are about 2 inches long when mature (sandy soils are preferred). Development from egg to adult requires 2 years, and adults emerge from the soil from late June through September. First-instar grubs overwinter in the first year of their development. They molt to the second instar around March, then to the third instar around June. The third instars overwinter and molt to the pupal stage in late spring.

DAMAGE

Larvae feed on roots, causing severe injury and death to mature trees. Initial damage to root systems may not be immediately evident in aboveground tree growth (e.g., production of new shoots and leaves). Adults notch the edges of leaves, but this damage is not important.

MANAGEMENT

Tenlined June beetle infestations are localized within orchards and are often first noticed when a clump of trees start to decline and die. Infestations usually spread slowly from the initial sites where they are first identified in orchards, killing neighboring trees. Control requires the removal of infested trees and soil fumigation before replanting. When removing dead trees, inspect roots for the presence of larvae or larval feeding. Remove all trees in the infested area plus one or two uninfested trees on all sides of the infested area to slow the spread within the orchard.

Male tenlined June beetles are attracted to light sources (e.g., tungsten lights, black lights) and generally first appear in early June. Although there are no proven methods for controlling tenlined June beetle grubs other than removing infested trees and neighboring trees (including roots) and fumigating the soil before replanting, it has been observed that soil drenches of an organophosphate insecticide as soon as first adults emerge can reduce beetle numbers. Because the insect has a 2-year life cycle in the soil, this approach must be repeated in consecutive years. Grub control is difficult because no effective methods exist to move insecticides downward in the soil to where the larger second- and third-instar grubs are common (more than 8 inches below the soil surface). Natural enemies that parasitize the grubs (i.e., Scoliid wasps, entomopathogenic nematodes) and adults (tachinid flies) do exist, but these biological control agents do not greatly increase beetle mortality. Impacts of predators (e.g., burrowing owls) are also limited.

TREE BORERS (8/17)

Scientific Names: Prune limb borer: *Bondia comonana*
American plum borer: *Euzophera semifuneralis*

DESCRIPTION OF THE PEST

Prune limb borer and American plum borer are sporadic pests in young almond orchards and in bark injuries on mature trees. They occur from Tehama to Merced counties on all major almond cultivars, but in young trees are found mostly on Carmel, Sonora, and Price. Adult moths have gray forewings with brown and black marks and have a wingspan of about 0.75 inch. They overwinter in a cocoon within the tree. Adult moths emerge in April and May. The mature larva is about 1 inch long with a dull white or pinkish body. Females lay eggs near pruning wounds, in scaffold crotches of young trees, in areas where bark has been damaged by trunk shakers on mature trees, or near graft unions or on crown galls.

DAMAGE

Larvae bore into trees, leaving reddish orange frass and gum pockets. The boring is most damaging to the scaffold crotches or graft unions of young trees. Vigorous trees will heal over, but with heavy, prolonged infestations, scaffolds may break with wind or a heavy crop. Boring in callus formed under trunk-shaker bark injuries can greatly enlarge the initial injury, and also introduces spores of the Ceratocystis canker fungus, leading to subsequent trunk cankers that can girdle scaffolds and may ultimately lead to tree death.

MANAGEMENT

- Monitor young orchards in spring and summer for frass and gum pockets.
- If larvae are present, spray trees with a hand-held sprayer from 1 foot above the scaffold crotch to 1 foot below, two to three times during the growing season.
- Make the first application in mid- to late April, and subsequent applications at 6-week intervals.

Efficacy is improved if the trunk is painted with a latex paint to protect against sunburn immediately following a trunk spray. The paint helps to preserve the insecticide and give protection over a longer period of time. On mature trees, loose bark can be removed from trunk shaker injuries and wounds treated as described above for young trees.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. CARBARYL* (Sevin XLR Plus) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Do not exceed 15 lb/acre per season.	2–5 qt	12	14

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

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

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WEBSPINNING SPIDER MITES (8/17)

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

DESCRIPTION OF THE PESTS

These three spider mites are difficult to distinguish as adults, have similar life histories, and are controlled in the same manner. However, Pacific mite is often the most difficult to control with miticides.

The overwintering female mites are red- or orange-colored and are found under rough almond bark, in ground litter, and on winter weeds. During the season the color ranges from yellow to green to black depending on age and host food. All have dark spots. Adult males do not overwinter and are smaller than females. Eggs are laid on the foliage. Immature mites molt three times. Early in the season, mites are found in lower to central areas of the tree. The mites reproduce rapidly during warm weather between June and September. During favorable conditions, mites develop within 7 days, with 8 to 10 generations per season.

DAMAGE

Mites damage foliage by sucking cell contents from leaves. The damage begins with leaf stippling. Leaves can turn yellow and drop off. High numbers of mites cover tree terminals with webbing. Crop reduction and reduced vegetative tree growth shows up the year after damage occurs.

MANAGEMENT

Spider mites are often a problem in water-stressed orchards. Mites can also become a problem when their natural enemies are disrupted by the application of broad-spectrum insecticides including pyrethroids, which kill many types of predatory insects and predator mites. Almond trees can tolerate moderate mite numbers without suffering economic damage. Predators are important in managing mites, so consider their presence and relative abundance before treatments are applied. Orchards with high predator-to-pest mite ratios will not require treatment.

Monitor orchards for both predators and spider mites at least once every 2 weeks from March to early May; monitor at least once a week after that. When treatments are required, choose selective miticides that cause the least harm to predators.

Biological Control

Several species play an important role in mite control, including western predatory mite (*Galendromus* [= *Metaseiulus*] *occidentalis),* sixspotted thrips, the spider mite destroyer (*Stethorus* sp.) and minute pirate bugs (*Orius* sp.). In recent years the sixspotted thrips has become the most common insect predator of spider mites. Sixspotted thrips is an extremely good mite predator. It is highly mobile and both nymphs and adults feed on spider mites. However, movement of sixspotted thrips into orchards can be unpredictable and sometimes does not occur until mites have already exceeded treatment thresholds. If sixspotted thrips is present in an orchard, avoid using pyrethroid or spynosyn insecticides or miticides containing abamectin to preserve their presence and maximize biological control.

The most widespread predatory mite is the western predatory mite. It is about the same size as spider mites, but the western predatory mite lacks spots and its color ranges from cream to amber red. It often can be observed moving quickly over the underside of leaf surfaces in search of spider mites. This predator maintains good control, unless the proportion of leaves with spider mites is higher than the proportion with predatory mites.

Predators will typically control webspinning mites if presence-absence sampling indicates equivalent numbers of leaves with predators and with webspinning mites. When predator mites are present, but are not controlling the spider mites, a lower-than-label rate of a selective miticide may be applied to create a more balanced ratio (i.e., a 1:1 ratio of one leaf with a predatory mite for every leaf with a webspinning mite). If predatory mites are present in an orchard, choose a miticide with reduced toxicity to predatory mites. See RELATIVE TOXICITIES OF PESTICIDES USED IN ALMONDS TO NATURAL ENEMIES AND POLLINATORS for a list of pesticides used on almonds and their toxicity to the western predatory mite.

Predatory mites can be purchased from insectaries and released to augment natural populations of predatory mites. Before releases, be sure that insecticide residues have sufficiently broken down to allow the survival of

predatory mites. For example, research has shown that some pyrethroid insecticides can be highly toxic to predatory mites for several months to more than a year after application. In some cases, predatory mites from insectaries have been reared from stocks with tolerance to one or more pesticides, such as organophosphates and carbaryl, enabling survival in orchards if residues are present. Keep purchased mites cool when they are received from the insectary and release them as soon as possible. Release predatory mites when spider mites are present (to allow predatory mites to feed) but well before treatment thresholds are reached. Predatory mite releases are not advised in areas where sixspotted thrips are present, since the predatory thrips are known to eat both spider mites and predatory mites. For more detailed information on predatory mite releases, see *Integrated Pest Management for Almonds*, UC ANR Publication 3308 and *Natural Enemy Releases for Biological Control of Crop Pests*.

Organically Acceptable Methods

Biological controls, including predator releases, cultural controls, and various types of oil sprays are organically acceptable ways of managing spider mites.

Cultural Control

Reduce dusty conditions in orchards by oiling or watering roadways and maintaining a ground cover. Prevent water stress, as this condition results in higher mite numbers and makes trees more susceptible to infestation and damage.

During the season, avoid using broad-spectrum pesticides such as pyrethroids, carbamates, and organophosphates (unless organophosphate-resistant predator mites are present in the orchard); the use of these insecticides will often result in spider mite outbreaks.

Monitoring and Treatment Decisions

- Monitor for mites at least weekly from May through August. Treatment is not necessary after August because mites begin to migrate off trees to prepare for overwintering.
- If the orchard has problem areas, such as trees along roads or water-stressed trees, monitor every few days.
- Before July 1, focus monitoring on hot spots—that is, the areas that develop mites first; these are often dusty or water-stressed areas of the orchard. Once the treatment threshold has been reached in these areas, sample the remainder of the orchard to determine if a spot treatment is sufficient or the entire orchard requires treatment.
- After July 1, monitor the whole orchard, dividing it into sampling areas that could be treated separately.

Within each sampling area, sample a minimum of five trees. Select 15 leaves from each tree, randomly picking leaves from both the inside and outside of the canopy as you walk around it. Examine both sides of each leaf under a hand lens looking for spider mites and eggs, western predatory mites or eggs, sixspotted thrips, and other predators.

To sample trees that have not yet been treated for mites during the current season, use the presence-absence sampling form on the online version of this guideline to note the number of leaves on each tree with pest mites or their eggs, and the number of leaves with predators. There is no need to count total numbers of mites. Once you have sampled 5 trees, compare your total to the numbers in the "Don't Treat" and "Treat " columns on the form. Be sure to take into account the presence or absence of predators as noted on the form.

If treatment is required determine which natural enemies are present and choose a product that is compatible according to the RELATIVE TOXICITIES OF PESTICIDES USED IN ALMONDS TO NATURAL ENEMIES AND POLLINATORS table.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

PREDATOR RELEASES

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

A. *GALENDROMUS OCCIDENTALIS#*
COMMENTS: Predatory mites can be released early in the season to establish or to augment resident populations. If an acaricide is needed and predators are present, be sure to use a selective miticide. Monitor to ensure that pest numbers remain in balance with predator numbers.

MITICIDES

A. BIFENAZATE
(Acramite 50WS) 0.75–1 lb 12 7
(Vigilant 4SC) 14–24 fl oz 12 7
MODE-OF-ACTION GROUP NUMBER[1]: un
COMMENTS: Contact toxin that targets all stages. Relatively safe for beneficial and predaceous mites. Apply with ground equipment; requires complete coverage of both leaf surfaces for effective control. A good choice for post-hullsplit control.

B. HEXYTHIAZOX
(Onager) Label rates 12 7
MODE-OF-ACTION GROUP NUMBER[1]: 10A
COMMENTS: Apply after sampling indicates pest mites are increasing, but before significant damage or webbing is present. A mite growth regulator: a contact toxin to eggs and young larval stages, so it is best suited for an early-season application if needed; causes adult females lay sterile eggs. Believed to have same effect on predator mite females as well. Do not make more than one application per year.

C. SPIRODICLOFEN
(Envidor 2SC) 16–34 fl oz 12 7
MODE-OF-ACTION GROUP NUMBER[1]: 23
COMMENTS: Contact toxin that targets all stages. Most effective when applied with oil at 0.5 to 1% concentration. More effective against twospotted spider mites than against Pacific mites. Low-to-moderate harm to natural enemies. A good choice for post-hullsplit control of twospotted spider mites.

D. CYFLUMETOFEN
(Nealta) 13.7 fl oz 12 7
MODE-OF-ACTION GROUP NUMBER[1]: 23
COMMENTS: Contact miticide that targets all stages. Most effective when applied with oil at 0.5 to 1% concentration. More effective against twospotted spider mites than against Pacific mites. Low-to-moderate harm to natural enemies. A good choice for posthullsplit control of twospotted spider mites.

E. ACEQUINOCYL
(Kanemite 15SC) 21–31 fl oz 12 7
MODE-OF-ACTION GROUP NUMBER[1]: 20B
COMMENTS: Contact toxin that targets all stages. Most effective at high rate. Do not use lower label rates for moderate to high numbers of spider mites. Safest of miticides to beneficials. A good choice for post-hullsplit timing.

F. ABAMECTIN
(Agri-Mek SC*, others) Label rates See label See label
MODE-OF-ACTION GROUP NUMBER[1]: 6
COMMENTS: Contact or ingestion toxin that paralyzes juveniles and adults. Applications are more effective with an oil (at least 1% v/v) or a penetrating adjuvant. Applications are most effective before hullsplit or until leaves harden off. Can be used effectively for treatment in May based on mite monitoring guidelines, but it is not recommended for preventive use at this time. Do not make more than two applications per growing season and allow at least 21 days between treatments. Do not exceed 20 fl oz/acre per application. Resistance has been found in the San Joaquin Valley where abamectin products have been applied for many years. Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. **Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019**. Review the Department of Pesticide Regulation's updated fact sheet.

G. ETOXAZOLE
(Zeal) 2–3 oz 12 28
MODE-OF-ACTION GROUP NUMBER[1]: 10B
COMMENTS: Inhibits molting of juveniles and causes adult females of both pest and predator mites to produce sterile eggs. Do not apply more than once a season. Long residual activity that can be used early- to mid-season in the absence of concern for predator mites.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
H. NARROW RANGE OIL#			
(Omni Supreme)	Label rates	See label	See label
MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Use as an in-season treatment; oils do not control webspinning mites during winter dormancy. Be sure that trees are well watered to avoid phytotoxicity. Works by contact activity only, so good coverage is essential. Will affect natural enemies that are contacted with the spray, but there is little residual effect on remaining beneficials. Repeat applications may be necessary to control rapidly increasing numbers. Check with certifier to determine which products are organically acceptable.			
I. FENPYROXIMATE			
(Fujimite 5EC)	2–4 pt	12	14
MODE-OF-ACTION GROUP NUMBER[1]: 21A COMMENTS: Contact toxin to juveniles and adults with long residual activity. Residues are toxic to both pest and predator mites for several weeks. A good choice under extreme mite pressure in the absence of natural enemies.			
J. FENBUTATIN-OXIDE			
(Vendex 50WP)*	1–2.5 lb	48	14
MODE-OF-ACTION GROUP NUMBER[1]: 12B COMMENTS: Contact toxin that targets juveniles and adults. Do not apply more than twice a season. Good coverage is essential. Toxic to predator mites at full label rates but becomes less toxic at 10 to 25% maximum label rate when western predatory mites are present and if the development of resistance to this material by webspinning mites is not a concern (see ANR Publication 3308 for additional information). Below-label rates are intended to balance predator and spider mite populations. Most effective with 1% oil combination.			
K. CLOFENTEZINE			
(Apollo SC)	4–8 oz	12	14
MODE-OF-ACTION GROUP NUMBER[1]: 10A COMMENTS: A growth regulator that targets eggs and some immature stages. Research is lacking in California as to its effectiveness and impact on predator mites.			
L. PROPARGITE			
(Omite 6E)*	32–64 fl oz	528 (22 days)	28
(Omite 30WS)*	5–10 lb	528 (22 days)	28
MODE-OF-ACTION GROUP NUMBER[1]: 12C COMMENTS: Contact toxin that targets juveniles and adults. Do not apply more than twice a season. Do not apply less than 40 days after, or 30 days before, an oil application. Toxic to predator mites at full label rates but becomes less toxic at rates that are 1/2 to 1/10 maximum label rate when western predatory mites are present. Below label rates are intended to balance predator and spider mite populations.			

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

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

\# Acceptable for use on organically grown produce.

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

Diseases

(Section reviewed 8/17)

ALMOND BROWNLINE AND DECLINE (8/17)

Pathogen: *Peach yellow leafroll phytoplasma*

SYMPTOMS AND SIGNS

Trees with almond brownline and decline are stunted. Leaves droop and appear wilted. Current-season shoot growth is abnormally shortened or absent. If bark is removed from the graft union, brown necrotic areas can be seen. The brown areas at the graft union may be scattered around the trunk or may form a continuous line. Check several places around the circumference of the trunk to determine whether this symptom is present. Over time, the surface of the wood at the graft union becomes mildly to severely pitted. Trees decline and become unproductive.

COMMENTS ON THE DISEASE

Almond brownline and decline is a disease that affects almond cultivars grown on Marianna 2624 rootstock. The disease is associated with *Peach yellow leafroll phytoplasma*, which is transmitted by pear psylla (*Psylla pyricola*). The phytoplasma is a microbe that multiplies and spreads within the phloem of the infected tree. When the phytoplasma reaches the graft union, cells of the Marianna rootstock die. This results in a layer of brown necrotic cells in the phloem at the graft union, which prevents spread of the phytoplasma into the rootstock but also interferes with movement of nutrients between scion and rootstock.

Brownline and decline is most commonly seen on young nonbearing trees. It has been observed on Carmel, Peerless, and Price scions.

MANAGEMENT

Remove and replace stunted trees with replants. Because propagation may produce diseased trees, obtain trees from nurseries that use budwood sources tested free of the pathogen.

ALMOND KERNEL SHRIVEL (8/17)

Pathogen: Peach yellow leafroll phytoplasma

SYMPTOMS AND SIGNS

Trees affected by almond kernel shrivel bloom later than healthy trees, new shoot growth is stunted, and leaves are pale and smaller than normal. Trees develop thin canopies and the kernels of all nuts are shriveled at harvest.

COMMENTS ON THE DISEASE

Almond kernel shrivel has occurred in certain locations of the northern San Joaquin Valley on almond trees planted on peach rootstock. It is caused by the Peach yellow leafroll phytoplasma and is known to affect almond scions grown on peach rootstock. Peach yellow leafroll phytoplasma can be transmitted by certain insect vectors, and it is presumed that diseased almond trees are infected in this manner. The phytoplasma can also be transmitted in infected budwood.

MANAGEMENT

At the present time, the only management recommendations for almond kernel shrivel are to remove diseased trees and use planting material produced using budwood sources known to be free of the pathogen.

ALMOND LEAF SCORCH (8/17)

Pathogen: *Xylella fastidiosa*

SYMPTOMS AND SIGNS

Almond leaf scorch appears as a marginal scorching of leaves that begins as early as June and continues to develop during summer. A golden yellow band develops between the brown necrotic edge and the inner green tissues of the leaf. Disease symptoms may appear first on one branch or a portion of one scaffold. As years go by, more and more of the tree is affected until the whole canopy is involved. Another name for this disease, golden death, describes the golden yellow color of the canopy of a severely infected tree. Infected trees bloom and leaf out later than healthy trees, are stunted, less productive, and have reduced terminal growth. Trees with almond leaf scorch usually survive for many years.

COMMENTS ON THE DISEASE

Almond leaf scorch symptoms somewhat resemble those of salt burn. However, salt burn usually (but not always) has an abrupt margin between the necrotic and healthy tissue, with little or no intermediate yellowing. Almond leaf scorch necrosis usually progresses from the leaf tip and margins back to the base of the leaf and is *not* uniform along the leaf margins, whereas salt burn is more evenly distributed along the margins as well as the tip. Also, the pattern of symptom development over the years, and distribution within the tree and within the orchard, along with leaf nutrient analysis, should help distinguish the two.

The bacterium (*Xylella fastidiosa*) that causes almond leaf scorch also causes Pierce's disease of grapevines and alfalfa dwarf disease. Many common weeds and riparian plant species including bermudagrass, rye, fescue grasses, watergrass, blackberry, elderberry, cocklebur, and nettle are hosts and serve as reservoirs of inoculum. Common annual orchard weeds such as annual bluegrass, burclover, cheeseweed, chickweed, filaree, London rocket, and shepherd's purse can also be infected. Weed-to-tree or tree-to-weed spread is also a possibility.

Xylem-feeding insects, such as leafhoppers and spittlebugs, vector the bacteria. The most probable vectors for almond are the redheaded and green sharpshooters. However, it is not believed that currently identified vectors can spread the disease from an infected tree to a healthy one. The disease has not become more important even after the introduction of the glassy-winged sharpshooter (*Homalodisca vitripennis [=H. coagulata]*), which may also be a vector of the pathogen.

MANAGEMENT

First-year symptoms may be confined to a few inches from the infection site and not be noticed for 2 or 3 years. Movement within a tree may be slow and require several years to infect the entire tree. In other cases, spread throughout the tree appears to have occurred within a year. If discovered early and only in one branch, the infection may be removed by pruning off a primary scaffold 5 to 10 feet below visible symptoms. If this is attempted, flag the pruned tree and observe it in subsequent years for indications of the disease.

If the orchard is young (5–10 years old), the best course of action may be to remove infected trees. In older orchards (16 –20 years old), it may be more cost-effective to keep infected trees, because the entire orchard is normally removed between 22 and 25 years of age and infections will probably not significantly impact yields before then. The most difficult decision is what to do when infected trees are found in orchards 11 to 15 years old. The answer may depend on whether there are other young orchards nearby, how long the orchard is expected to last before it is likely to be removed, and once mapped, whether the number of infected trees increases rapidly.

Sharpshooter numbers increase slowly and the insects disperse slowly. Grass-feeding sharpshooters require year-round access to plants on which they can feed and reproduce. Clean cultivation of almond orchards for a 6-week period at any time of the year (like during harvest) should prevent the establishment of in-orchard vector populations. Thus, cover crops in almond orchards should not pose a threat. The most common habitats for sharpshooters in the Central Valley are irrigated pastures, alfalfa fields with grass weeds, and permanent cover crops.

ALTERNARIA LEAF SPOT (8/17)

Pathogens: *Alternaria alternata, Alternaria arborescens, Alternaria tenuissima*

SYMPTOMS AND SIGNS

Alternaria leaf spot appears as fairly large brown spots on leaves, about 0.5 to 0.75 inches (12–18 mm) in diameter. The spots turn black as the fungus produces spores. Leaf spot develops most rapidly in June and July, and trees can be almost completely defoliated by early summer when the disease is severe. The disease appears to be most severe where dew forms, humidity is high, and air is stagnant.

COMMENTS ON THE DISEASE

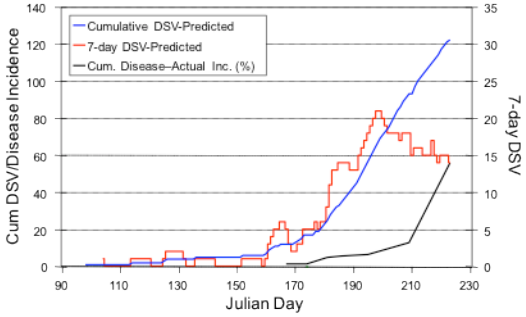
Alternaria leaf spot can occur on almond trees grown anywhere in the Central Valley, but rarely is it severe enough in the northern San Joaquin Valley to require treatment. It has been most serious on trees in the southern San Joaquin Valley and in the northern Sacramento Valley.

MANAGEMENT

- The disease occurs first and is most severe on exposed leaves.
- Trees trained to an open and spreading canopy usually have more severe Alternaria leaf spot.
- Trees planted with rows in an east-west direction also have more severe disease than do orchard with rows planted north-south.
- Varieties that are most susceptible include Carmel, Sonora, Monterey, Winters, and Butte.
- Monitor for signs of the disease in April through June. If monitoring indicates the presence of Alternaria, begin late-spring treatments about mid-April.
- In orchards with a history of the disease, treat in mid- to late April and again 2 to 3 weeks later.

A disease severity value or DSV model has been developed on tomato and modified for almond for forecasting Alternaria leaf spot. Index values are assigned for specific ranges of average temperatures during leaf wetness periods during a day. Apply fungicide if accumulated index values over a 7–day period reach a value of 10 or higher.

Mean temperature (C) during wetness	Leaf wetness duration (hours)				
15–17	0–6	7–15	16–20	21	-
17.1–20	0–3	4–8	9–15	16–22	23+
20.1–25	0–2	3–5	6–12	13–20	21+
25.1–29	0–3	4–8	9–15	16–20	23+
DSV	0	1	2	3	4



In some orchards, *Alternaria* sp. resistance to quinone outside inhibitor (QoI) fungicides (also known as strobilurins) and succinate dehydrogenase inhibitor (SDHI) fungicides have been documented; do not use FRAC mode-of-action group number 7 or 11 fungicides in these orchards.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table. *When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. METCONAZOLE
(Quash) 2.5-3.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than four applications per season and no more than two sequential applications before rotation to a different mode of action fungicide.

B. DIFENOCONAZOLE

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(Inspire)	7 fl oz	12	14

MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than four applications per season and no more than two sequential applications before rotation to a different mode of action fungicide.

C. POLYOXIN D ZINC SALT

(Ph-D)	6.2 oz	4	0

MODE-OF-ACTION GROUP NAME (NUMBER[1]): glucan synthesis (19)
COMMENTS: Do not make more than three applications per season and no more than two sequential applications before rotation to a different mode of action fungicide.

D. PYRACLOSTROBIN/BOSCALID

(Pristine)	10.5–14.5 oz	12	25

MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than four applications per season of (QoIs (strobilurins) or SDHIs and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance. Note that resistant populations have developed in selected almond-producing areas within California.

E. PYRACLOSTROBIN/FLUXAPYROXAD

(Merivon)	6.5 oz	12	14

MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than four applications per season of QoIs (strobilurins) or SDHIs to limit the potential for the development of resistance. Note that resistant populations have developed in selected almond-producing areas within California.

F. FLUOPYRAM/TRIFLOXYSTROBIN

(Luna Sensation)	5–7 fl oz	12	14

MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)
COMMENTS: Do not apply after hullsplit. Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 27.1 fl oz/acre per season.

G. DIFENOCONAZOLE/CYPRODINIL

(Inspire Super)	16–20 oz	12	60

MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3) and AP (9)
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 80 fl oz/acre per season.

H. AZOXYSTROBIN/DIFENOCONAZOLE

(Quadris Top)	14 oz	12	28

MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not use later than 5 weeks after petal fall. Not a good choice when disease pressure is severe because of label timing restrictions.

I. AZOXYSTROBIN

(Abound)	12.0–15.5 oz	4	28

MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11)
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season. For best results, mix with a DMI (FRAC Group 3), QoI (11), or other registered fungicide.

J. PENTHIOPYRAD

(Fontelis)	14–20 fl oz	12	14

MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7)
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than three applications of SDHI fungicides per year or apply more than 61 fl oz/acre per season. For best results, mix with a DMI (FRAC Group 3), QoI (11), or other registered fungicide.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
K. IPRODIONE			
(Rovral, Nevado)	1 pt	24	See comments
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboxamide (2)			
. . . PLUS . . .			
NARROW RANGE OIL			
(various)	Label rates	See label	See label
MODE-OF-ACTION: Contact			
COMMENTS: Do not apply later than 5 weeks after petal fall. Not a good choice when disease pressure is severe because of label timing restrictions.			

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

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

— No information

QoI = quinone outside inhibitor or strobilurin

DMI = demethylation (sterol) inhibitor

SDHI = succinate dehydrogenase inhibitor

ANTHRACNOSE (8/17)

Pathogen: *Colletotrichum acutatum*

SYMPTOMS AND SIGNS

Symptoms of anthracnose on almond include blossom blight and fruit infections often with spur and limb dieback. Infected flowers look similar to brown rot strikes. Leaves on infected spurs develop marginal necrosis, beginning with water-soaked areas that fade in color; leaves die but remain attached to branches.

Infected nuts show round, orangish, sunken lesions on the hull. These symptoms may appear about 3 weeks after petal fall; nuts remain susceptible and can be infected later in the season if conditions are favorable. Profuse gumming occurs as the infection progresses into the kernel. Diseased fruit die and turn into mummies that remain attached to the spur. The shoots or branches that bear infected nuts often die. Although the fungus may invade fruitwood, it is seldom cultured from affected branches. Death of the wood may result from a toxin rather than from direct colonization of the wood by the fungus.

COMMENTS ON THE DISEASE

All cultivars appear to be susceptible to anthracnose. The disease has been most damaging on Thompson, Merced, Price, Peerless, Winters, Monterey, Fritz, and Butte; moderate on Harvey, Carmel, NePlus Ultra, Padre, and Mission. Nonpareil is considered to be less susceptible. Ideal conditions for the development of this disease are warm, rainy weather.

MANAGEMENT

Fungicide treatment is the most important control strategy, but must be coupled with cultural practices to achieve the best control. In orchards that have a history of anthracnose, apply fungicide sprays beginning at 5-10% bloom or pink bud and repeat every 10 to 14 days if rains persist. Late spring rains may necessitate additional applications into May. Alternate materials as follows: make the first application at pink bud using either a demethylation (sterol) inhibitor (DMI; FRAC group 3) or quinone outside inhibitor (QoI; FRAC group 11) fungicide; follow this with a premixture (FRAC groups 3/11 or 7/11) fungicide application or a tank mix of captan or mancozeb mixed with iprodione or thiophanate-methyl applied at full bloom.

As long as conditions are conducive to disease development, alternate applications of demethylation (sterol) inhibitor (DMI), quinone outside inhibitor (QoI), captan, chlorothalonil, or mancozeb (FRAC Groups M3, M4, M5, 3, 11, respectively). Prune out dead, infected wood to reduce inoculum. If sprinkler irrigation is practiced, use low angle nozzles to prevent the tree canopy from being wetted by the sprinklers as a means of reducing disease spread.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table. *When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

PINK BUD

A. PYRACLOSTROBIN/FLUXAPYROXAD
(Merivon) 6.5 oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than two successive applications, and no more than 3 per season, to limit the development of resistance.

B. PROPICONAZOLE
(Bumper, Tilt) 8.0 oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

C. FLUOPYRAM/TRIFLOXYSTROBIN

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(Luna Sensation)	5.0-7.6 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
D. METCONAZOLE			
(Quash)	3.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
E. AZOXYSTROBIN			
(Abound)	12.0–15.5 oz	4	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Do not apply more than 2 sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season.			
F. AZOXYSTROBIN/DIFENOCONAZOLE			
(Quadris Top)	14 fl oz	12	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
G. TRIFLOXYSTROBIN			
(Gem 500SC)	2.9-3.8 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.			
H. CHLOROTHALONIL			
(various)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Chlorinated hydrocarbon (M5)			
COMMENTS: Use as a multi-site protective treatment with long residual. Do not apply one week before or after a treatment containing oil or an oil-based pesticide.			
BLOOM AND AFTER (AS LONG AS WEATHER CONDUCIVE)			
A. PROPICONAZOLE			
(Bumper, Tilt)	8.0 oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance			
B. FLUOPYRAM/TRIFLOXYSTROBIN			
(Luna Sensation)	5.0-7.6 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7), Quinone outside inhibitor (11)			
COMMENTS: Do not make more than two applications per season of QoIs or SDHIs to limit the potential for the development of resistance			
C. METCONAZOLE			
(Quash)	3.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance			
D. AZOXYSTROBIN/PROPICONAZOLE			
(Quilt Xcel)	17.5-26.0 fl oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)			

	Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
	COMMENTS: Do not make more than two applications per season of QoIs or SDHIs to limit the potential for the development of resistance.			
E.	TRIFLOXYSTROBIN			
	(Gem 500 SC)	2.9-3.8 fl oz	12	14
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
	COMMENTS: Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.			
F.	PYRACLOSTROBIN/BOSCALID			
	(Pristine)	10.5–14.5 oz	12	25
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)			
	COMMENTS: Do not make more than four applications per season of (QoIs (strobilurins) or SDHIs and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.			
G.	CAPTAN			
	(various)	Label rates	See label	See label
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
H.	ZIRAM			
	(Ziram 76DF)	6–8 lb	48	0
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
	COMMENTS: When Ziram 76F is not applied as a tank mix with other systemic fungicides, use the maximum rate. Do not apply more than 32 lb of product/acre per season.			
I.	THIOPHANATE-METHYL			
	(Topsin-M)	1.0-1.5 lb	See label	See label
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): methyl benzimidazole (1)			
	COMMENTS: Do not apply more than 3 lb product per year. Some populations of the pathogen are not sensitive to MBC fungicides on almond in California.			
J.	MANCOZEB			
	(Manzate Pro Stick)	4–6.4 lb	See label	See label
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): multi-site contact (M3)			

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

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

QoI = quinone outside inhibitor or strobilurin

SDHI = succinate dehydrogenase inhibitor

ARMILLARIA ROOT ROT (OAK ROOT FUNGUS) (8/17)

Pathogen: *Armillaria mellea*

SYMPTOMS AND SIGNS

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. Infected trees develop pale foliage with small leaves, a lack of new growth, and a thin canopy, usually followed by sudden death when the first hot weather of early summer arrives.

COMMENTS ON THE DISEASE

The fungus survives on dead roots. It spreads from one tree to another through close contact of diseased roots with healthy roots. All stone fruit rootstocks are susceptible to Armillaria root rot. The plum rootstock Marianna 2624 is the most resistant to the fungus, but it is not immune. Use of this rootstock is the only practical alternative if almonds are to be grown in soils where *Armillaria* has infected roots and killed trees on other rootstocks. Wet soil conditions resulting from heavy rainfall or excessive irrigations can exacerbate the disease.

MANAGEMENT

Management of the disease is based on prevention. There are no currently available postplant fungicides for this disease. Preplant fumigation can reduce, but not eliminate, the occurrence of the disease. Complete eradication is rarely achieved, and re-treatment may be necessary in localized areas.

- Before preplant fumigation, remove all infected trees, stumps, and as many roots greater than 0.5 to 1 inch in diameter as possible. Healthy-appearing trees adjacent to those showing symptoms are often infected also. Remove these adjacent trees and include that ground in the soil fumigation.
- Burn infected trees, stumps, and roots at the site or dispose of them in areas where flood waters cannot wash them to agricultural lands.

The greatest opportunity for eradication occurs on shallow soils less than 5 feet in depth. Treat for *Armillaria* root rot from late summer to early fall. 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.

Cultural practices such as deep plowing or subsurface ripping may move inoculum throughout the orchard and subsequently spread the disease when new trees are planted. Marianna 2624 is the most tolerant almond rootstock, although ongoing screening trials indicate that Krymsk 86 may also be tolerant. No rootstock is immune.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table*. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
PREPLANT			
A. 1,3 DICHLOROPROPENE/CHLOROPICRIN* (Telone C-35)	Label rates	See label	See label

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
COMMENTS: This restricted use product is applied only by professional fumigation companies and is a multi-purpose liquid fumigant for preplant treatment of soil to help manage certain soil-borne diseases and to control other pests (e.g., plant parasitic nematodes, symphylans) in croplands. It is effective at 39-46.7 gal/acre rate (labeled for shank applications) if applied to dried sandy soils or sandy loam soils with no more than 12% soil moisture content anywhere in the surface 5 feet of soil profile. In California, the applications must be applied to soils having a moist surface; this task is difficult to achieve without use of sprinklers unless there is a fortunate rainfall. Do not flood irrigate prepared lands to achieve this surface moisture requirement. Broadcast apply where nematode resistance is unavailable for prevailing nematodes. Strip applications are permitted at higher treatment rates and effective where resistant rootstocks are available, the clay loam soil profile contains no more than 19% soil moisture, the field has been pre-ripped to 4- or 5-foot depth, and the delivery shank is winged to limit off-gassing. Fumigants such as 1,3-dichloropropene and chloropicrin are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.			
B. CHLOROPICRIN			
(Pic-clor 60)	Label rates	See label	See label
COMMENTS: Fumigants such as chloropicrin are a source of volatile organic compounds (VOCs) but are not reactive with other air contaminants that form ozone.			
C. 1,3 DICHLOROPROPENE *			
(Telone II)	Label rates	See label	See label
COMMENTS: This restricted use product is applied only by professional fumigation companies and is a multi-purpose liquid fumigant for preplant treatment of soil to help manage certain soil-borne diseases and to control other pests (e.g., plant parasitic nematodes, symphylans) in croplands. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.			

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

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

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

BACTERIAL CANKER (8/17)

Pathogen: *Pseudomonas syringae*

SYMPTOMS AND SIGNS

Symptoms are most obvious in spring, and include limb dieback with rough cankers and amber-colored gum or total tree collapse. There may also be leaf spots and blast of young flowers, spurs, and shoots. The sour-sap phase of bacterial canker may not show gum and cankers, but the inner bark is brown, fermented, and sour smelling. Flecks and pockets of bacterial invasion in bark occur outside canker margins. Frequently, trees sucker from near ground level; cankers do not extend below ground.

COMMENTS ON THE DISEASE

Pseudomonas syringae survives on plant surfaces, is spread by splashing rain, and is favored by high moisture and low temperatures in spring. The disease occurs almost exclusively in orchards where almond or other *Prunus* spp. orchards previously existed. The disease is worse in low (cold) or sandy spots with high numbers of ring nematode. Nitrogen-deficient trees are most prone to bacterial canker, as are young trees that are 2 to 8 years old. The disease rarely occurs in the first year of planting and is uncommon in nurseries.

MANAGEMENT

The pathogen that causes bacterial canker is commonly present on the surfaces of many plants. Consequently, management of this disease should focus on preventing conditions that predispose trees to the disease.

- Before planting, rip or backhoe to break up hardpan areas. When replanting an orchard, fumigate the soil before planting to reduce ring nematode numbers. Consider using Viking, Lovell, or Guardian rootstocks, as they survive significantly better in the presence of this disease.
- Trees planted on Marianna 2624 and peach-almond hybrid (Hansen, Nickels, Cornerstone, Titan, and Bright's) rootstocks are very susceptible to bacterial canker.
- Maintaining proper nutrition, particularly nitrogen, is important.
- Recent studies have shown that when low-biuret urea is applied before leaf drop, canker size in infected trees is reduced.
- Annual nematicide treatments in October can help reduce disease severity.

Dormant use of copper has not been found to provide successful suppression of this disease in California. Most strains of the pathogen are resistant to copper.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table*. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
PREPLANT			
A. 1,3-DICHLOROPROPENE* (Telone II)	Label rates	See label	See label

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

COMMENTS: This restricted-use fumigant is applied only by professional fumigation companies. 1,3-dichloropropene is a multipurpose liquid fumigant for preplant treatment of soil to help manage certain soil borne diseases and to control other pests (e.g., plant parasitic nematodes and symphylans) in croplands. It is effective at 33.7 gal/acre rate (top label rate for broadcast applications) if applied to dried sandy soils or sandy loam soils with no more than 12% soil moisture content anywhere in the surface 5 feet of soil profile. In California the applications must be applied to soils having a moist surface; this task is difficult to achieve without use of sprinklers unless there is a fortunate rainfall. Do not flood irrigate prepared lands to achieve this surface moisture requirement. Broadcast apply where nematode resistance is unavailable for prevailing nematodes. Strip applications are permitted at higher treatment rates and effective where resistant rootstocks are available, the clay loam soil profile contains no more than 19% soil moisture, the field has been pre-ripped to 4- or 5-foot depth, and the delivery shank is winged to limit off-gassing. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only handlers may be in the application block from the start of the application until the entry restricted period ends, and in the buffer zone during the buffer zone period. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.

B. 1,3-DICHLOROPROPENE*/CHLOROPICRIN

(Telone C-35)	Label rates	See label	See label

COMMENTS: This restricted-use fumigant is applied only by professional fumigation companies and is a multipurpose liquid fumigant for preplant treatment of soil to help manage certain soil-borne diseases and to control other pests (e.g., plant parasitic nematodes and symphylans) in croplands. It is effective at 39 to 46.7 gal/acre rate (shank applications) if applied to dried sandy soils or sandy loam soils with no more than 12% soil moisture content anywhere in the surface 5 feet of soil profile. In California the applications must be applied to soils having a moist surface; this task is difficult to achieve without use of sprinklers unless there is a fortunate rainfall. Do not flood irrigate prepared lands to achieve this surface moisture requirement. Broadcast apply where nematode resistance is unavailable for prevailing nematodes. Strip applications are permitted at higher treatment rates and effective where resistant rootstocks are available, the clay loam soil profile contains no more than 19% soil moisture, the field has been pre-ripped to 4- or 5-foot depth, and the delivery shank is winged to limit off-gassing. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.

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

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

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

BACTERIAL SPOT (8/17)

Scientific Names: *Xanthomonas arboricola* pv. *pruni*

SYMPTOMS AND SIGNS

Fruit infections begin as small water-soaked, circular spots. Infections may enlarge slightly and become necrotic and continue to develop into the mesocarp, endocarp, and endosperm. Infection sites on the fruit often profusely exude amber-colored gum. Multiple lesions may develop on a fruit and cause the fruit to drop. Persistent lesions containing the pathogen are found on mummified fruit.

Leaf symptoms are less common than fruit symptoms. On leaves, small water-soaked circular lesions [0.02–0.08 inch (0.5–2 mm diameter)] develop mainly along the midrib and toward the tip and margin of the leaf. Lesions become chlorotic and then turn brown and necrotic. Some of them abscise, creating small holes with the appearance of shot holes. Lesions may coalesce to create larger, irregular lesions. Under severe disease severity, some defoliation of trees may occur.

COMMENTS ON THE DISEASE

Bacterial spot is caused by *Xanthomonas arboricola* pv. *pruni*. While the disease is a major problem on stone fruit crops (especially peach) in the eastern United States, it is a relatively new disease of almond and other *Prunus* spp. in California (first reported in 2013). The disease is found in the Sacramento and northern San Joaquin Valleys.

Fruit mummies are common bacterial spot overwintering sites in almond, but twig cankers are considered additional possible sites to harbor the pathogen during tree dormancy. In early spring as temperatures warm, the pathogen begins to multiply. However, under California conditions, infection of young green shoots in the spring, and subsequent development of small twig cankers, rarely occurs.

The bacteria are spread from mummified fruit by dripping dew and by water splashing or wind-driven rain to the newly emerging leaves and developing fruit. The pathogen infects through natural openings or wounds. High-moisture conditions and warm (greater than 68ºF) temperatures are very favorable for infection. Severe fruit infections are more common with frequent periods of rainfall or irrigation during fruit development.

Fritz is one of the most susceptible almond cultivars. Others, such as Nonpareil, Butte, Carmel, and Price are also affected although with generally lower disease severity. The disease is also occasionally found on other stone fruit crops at low incidence.

MANAGEMENT

Delayed dormant and in-season treatments with copper products and mancozeb to protect immature, developing fruit are highly effective. Low rates or reducing rates of copper with each application are effective strategies to prevent copper phytotoxicity to almond leaves. There are no reports of copper resistance in populations of this pathogen in California; however, resistance has been reported elsewhere. Rotate or mix copper applications with other modes of action when possible.

Cultural Control

- Use strategies to improve air movement to reduce relative humidity in the orchard.
- Design irrigation systems to reduce or prevent wetness of the tree canopy.
- Follow good sanitation practices, including
    - dormant fruit mummy removal from trees and mowing to grind up infected fruit.
    - cleaning harvesting equipment carefully to prevent the movement of infected fruit between orchards.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table. *When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
DORMANT			
A. COPPER#			
(various products)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1)			
. . . OR . . .			
COPPER#			
(various products)	Label rates	See label	See label
. . . PLUS . . .			
NARROW RANGE OIL#			
(various products)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1) + Contact			
COMMENTS: Not all copper and oil products are organically acceptable; check labels. Apply 1 to 2 lb metallic copper equivalent (MCE)/acre.			
B. MANCOZEB			
(Manzate Pro Stick)	4–6.4 lb	24	145
MODE-OF-ACTION GROUP NUMBER[1]:			
COMMENTS: Apply with copper (1–2 lb metallic copper equivalent (MCE)/acre) and 3 to 4.8 lb ai/acre mancozeb. Do not apply more than 19.2 lb of product (14.4 lb ai)/acre per season.			
BLOOM AND PETAL FALL			
A. COPPER			
(various products)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1)			
COMMENTS: Not all copper and oil products are organically acceptable; check with certifier. Apply with reducing rates of copper (1, 0.5, 0.25 lb metallic copper equivalent (MCE)/acre) from full bloom through 5 weeks after petal fall if environmental conditions favor disease.			
B. MANCOZEB			
(Manzate Pro Stick)	4–6.4 lb	24	145
MODE-OF-ACTION GROUP NUMBER[1]: Multi-site contact (M3)			
COMMENTS: Can be applied alone at 4 to 6.4 lb product/acre (3–4.8 lb ai/acre) or with reducing rates of copper (1, 0.5, 0.25 lb MCE/A) with each application from full bloom through 5 weeks after petal fall if environmental conditions favor disease. Do not apply more than 19.2 lb of product (14.4 lb ai)/acre per season. Full bloom and two petal fall applications (a minimum of 7 days apart) prior to rain events provide excellent control.			
C. *BACILLUS SUBTILIS* strain QST 713			
(Serenade Opti, Serenade Optimum)	14–20 oz	4	0
MODE OF ACTION: Biopesticide			
COMMENTS: The product is best used under low disease pressure and can be mixed and applied with copper. When using copper, use reducing rates (e.g., 1, 0.5, 0.25 lb metallic copper equivalent (MCE)/acre with each application) from full bloom through 5 weeks after petal fall if environmental conditions favor disease.			
D. *STREPTOMYCES LYDICUS* strain WYEC 108			
(Actinovate AG)	3–12 oz	1	0
MODE OF ACTION: Biopesticide			
COMMENTS: The product is best used under low disease pressure Applications should be made from full bloom through 5 weeks after petal fall if environmental conditions favor disease.			

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

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

\# Acceptable for use on organically grown produce.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

BAND CANKER (8/17)

Pathogens: *Botryosphaeria dothidea*, *Neofusicoccum parvum*, *Neofusicoccum mediterraneum*, *Neofusicoccum nonquaesitum*, and *Diplodia seriata*

SYMPTOMS AND SIGNS

Band canker is unusual because unlike other cankers it extends around the branch or trunk instead of longitudinally along the affected part. Cankers occur on the trunk or the lower portion of scaffold branches, with infection taking place through growth cracks in the bark on young trees. The fungus kills the bark and cambium layer, and the affected area becomes sunken and frequently girdles the limb. During the growing season copious amounts of amber-colored gum exude from the cankered area, forming a necklace or band of gumballs around the affected part of the tree. Although the disease is sporadic, it has started showing more frequently in the last decade. Band cankers are active only during warm spring and summer weather, and usually do not reactivate the following year. Some trees can develop up to three band cankers in the same trunk. Some cankers become chronic, and sometimes scaffolds or entire trees are killed.

COMMENTS ON THE DISEASE

Band canker occurs sporadically throughout the Central and Sacramento valleys. It primarily attacks trees in their third to fifth year, although recently even two-year-old trees showed severe band canker symptoms. The tree may fully recover and survive because cankers naturally heal over time. It has most commonly been reported on vigorous Nonpareil trees but can also be found on Padre, Mission, Ne Plus Ultra, Davey, Drake, Carmel, Aldrich, and Price.

Several species in the Botryosphaeriaceae are associated with the disease and the same pathogens can also cause cankers associated with pruning wounds. Other common hosts for these Botryosphaeriaceae include walnut, pistachio, grape, blackberry and numerous other tree species commonly found in riparian areas.

MANAGEMENT

Band canker can become of major importance in young almond orchards. Management practices include

- Remove of other woody hosts of the pathogens, such as abandoned walnut trees and grapevines adjacent to almond orchards (although the host range of these fungi is extensive).
- Avoid trunk injuries.
- Minimize trunk and scaffold wetness from irrigation systems.
- Remove infected branches or trees (without leaving the stumps in the orchard) and wood debris from almond orchards.

BROWN ROT BLOSSOM BLIGHT (8/17)

Pathogen: *Monilinia laxa*; rarely *Monilinia fructicola*

SYMPTOMS AND SIGNS

Young blossom spurs and associated leaves collapse to form shoot blight. Gum may exude at the base of infected flowers. Cankers on blighted twigs have tan centers with dark margins. At high humidity, gray to tan spore masses form on diseased flower parts and twig cankers.

Flowers may become infected from pink bud to petal fall and are most susceptible when fully open. In almonds, stigma, anthers, and petals are all very susceptible to infection.

COMMENTS ON THE DISEASE

The fungus survives in twig cankers and on remaining diseased flower parts and spurs. Spore pads (sporodochia) appear on these structures in late winter to provide inoculum for spring infection. Spores are airborne or rain splashed. Infection is favored by rainy weather with temperatures in the mid-70s during bloom. It can also occur in dry years with high humidity.

MANAGEMENT

Control is based upon protection of flower parts. Ideally, applications should be made for each cultivar according to its stage of bloom. Otherwise, determine timing by the bloom of the most seriously affected cultivar in the orchard.

Treat at pink bud (5–10% bloom) and full bloom. One application at full bloom is sufficient in most orchards in most years if there is low rainfall. If brown rot has been severe or in years of extended bloom accompanied by rainfall, a second or even third application near full bloom may be necessary.

Cultivars highly susceptible to brown rot include Drake, Winters, and Wood Colony; other cultivars such as Butte, Carmel, and Ne Plus Ultra are very susceptible.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table. *When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. PYRACLOSTROBIN/FLUXAPYROXAD
(Merivon) 5–6.5 oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than two successive applications, and no more than three applications per season or 19.5 fl oz/acre per season, to limit the development of resistance.

B. PROPICONAZOLE
(Bumper, Tilt) 8 oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

C. FENBUCONAZOLE
(Indar 2F) 4–6 fl oz 12 160
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)

D. DIFENOCONAZOLE/CYPRODINIL
(Inspire Super) 16–20 fl oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3) and anilinopyrimidine (9)

E. DIFENOCONAZOLE
(Inspire) 7 fl oz 12 14

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
F. FLUOPYRAM/TRIFLOXYSTROBIN (Luna Sensation)	5.0–7.6 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
G. METCONAZOLE (Quash)	3.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
H. FLUOPYRAM/TEBUCONAZOLE (Luna Experience)	6–17 fl oz	12	35
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications and no more than two per season to limit the development of resistance.			
I. AZOXYSTROBIN/PROPICONAZOLE (Quilt Xcel)	14–26 fl oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
J. AZOXYSTROBIN/DIFENOCONAZOLE (Quadris Top)	14 fl oz	12	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
K. PYRACLOSTROBIN/BOSCALID (Pristine)	10.5–14.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)			
COMMENTS: Do not make more than four applications per season of QoIs or SDHIs and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.			
L. IPRODIONE (Rovral, Nevado)	1 pt	24	See comments
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
. . . PLUS . . .			
NARROW RANGE OIL (various)	Label rates	See label	See label
MODE-OF-ACTION: Contact			
COMMENTS: Do not apply iprodione (Rovral, Nevado) later than 5 weeks after petal fall. Addition of a narrow range oil (superior, supreme) at 1 to 2% volume/volume increases the effectiveness of this material. Do not apply oil, however, within 3 weeks of a sulfur application or closely before or after an application of captan or chlorothalonil.			
M. PYRIMETHANIL (Scala SC)	9–18 fl oz	12	30
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Anilinopyrimidine (9)			
N. THIOPHANATE-METHYL (Topsin M WSB)	1.5 lb	72 (3 days)	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
COMMENTS: Strains of brown rot pathogen resistant to thiophanate-methyl have been found on almond, but resistance is not widespread. Do not apply more than 3 lb product/season per acre.			
O. CYPRODINIL (Vangard WG)	5 oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Anilinopyrimidine (9) COMMENTS: Do not apply more than 30 oz/acre per crop per year.			
P. AZOXYSTROBIN (Abound)	12.0–15.5 oz	4	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season.			
Q. FENHEXAMID (Elevate 50 WDG)	1–1.5 lb	12	See comments
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Hydroxyanilide (17) COMMENTS: Apply in sufficient water to obtain complete coverage of flowers and twigs. Do not make more than two consecutive applications or apply more than 6 lb/acre per season. Apply up to 28 days after petal fall.			
R. TRIFLOXYSTROBIN (Gem 500SC)	3.8 oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) COMMENTS: Do not apply within 14 days of harvest or after hullsplit. Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.			
S. MYCLOBUTANIL (Laredo EW, Rally 40WSP)	Label rates	24	90
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3) COMMENTS: Apply in 400 gallons water/acre. Do not make more than two successive applications and no more than three per season to limit the development of resistance. Use in rotation with different FRAC groups.			
T. CAPTAN (various 50WP)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4) COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.			
U. TEBUCONAZOLE (Toledo, Tebucon)	4–8 oz	12	35
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3). COMMENTS: Do not make more than two successive applications and no more than four applications per season to limit the development of resistance.			

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

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

QoI = quinone outside inhibitor or strobilurin

SDHI = succinate dehydrogenase inhibitor

CERATOCYSTIS CANKER (8/17)

Pathogen: *Ceratocystis fimbriata*

SYMPTOMS AND SIGNS

Ceratocystis cankers first develop as elongated water-soaked areas with amber-colored gum at the canker margins. Infected tissue turns dark brown, and eventually the affected area becomes sunken. Dark stains may permeate the heartwood and extend longitudinally 20 inches or more past the margin of the canker on the bark. Cankers can girdle and kill infected branches, scaffold limbs, or entire trees. A limb 4 to 6 inches in diameter can be girdled in 3 to 4 years. However, some cankers become inactive and heal after two or three growing seasons. Trees consistently damaged by tree shakers year after year are most severely affected by this canker.

Cankers caused by *Ceratocystis fimbriata* may be confused with branch cankers caused by *Phytophthora* spp.

Ceratocystis canker	**Phytophthora cankers**
Gumming: gum balls generally occur at the margins	Gumming: gum balls occur throughout the diseased area
Speed of canker growth: cankers grow slowly from year to year	Speed of canker growth: cankers advance rapidly but stop when the pathogen dies out in hot weather and do not resume.
Canker location: cankers are always associated with bark injuries.	Canker location: cankers can develop on uninjured portions of the tree or around pruning wounds,

COMMENTS ON THE DISEASE

Ceratocystis canker is a widespread disease of almond. Cankers often develop in areas of the trunk or branches that have been damaged by equipment, especially mechanical shakers during harvesting. Cultivars most susceptible to the disease are Mission, Ne Plus Ultra, and Nonpareil.

Obvious wounds, such as those caused by harvesting equipment or pruning, are the most common entry sites for *Ceratocystis*, but inconspicuous wounds on small twigs or branches are also susceptible. When pruned branches are pulled from the tree, small twigs are broken. If these or minor bark abrasions are infected by *Ceratocystis*, small cankers form. Once infection has occurred, there is no cure. Cankers will continue to expand each year until scaffolds are girdled and die.

Ceratocystis is spread by several species of sap-feeding beetles and a fruit fly. These insects feed on the fungi in diseased trees, including other stone fruit trees, and either ingest fungal spores and later excrete them or come into contact with the spores and transport them on their bodies to new locations. Insects that have fed on spores as larvae can retain the fungus through pupation and emerge with it as adults. The fungus can also contaminate adult insects in winter months if the adults inhabit old bark wounds.

Following a bark injury, most almond trees are susceptible to *Ceratocystis* infections for 8 to 14 days. Once it infects cambium, the fungus can invade healthy bark tissue and young xylem tissues. Dark stains permeate the sapwood and heartwood, but the fungus seldom penetrates further than the xylem of the previous year's growth. The fungus grows more rapidly in smaller branches, and these branches are killed sooner.

MANAGEMENT

The most effective way to prevent Ceratocystis canker is to avoid shaker injury to trunks and scaffolds. If the bark is injured, shave the rough portions to promote callus formation.

To control established cankers, you can perform tree surgery. Cankers are not easy to remove, however, and if you miss some of the infected tissue, the fungus can continue to grow and the canker will return. More often than not, tree surgery must be done year after year until you finally remove all infected tissue, and it may not be economically feasible.

The best time to carry out tree surgery is from December to February; both the pathogen and the insect vectors are less active at this time. However, surgery at this time of year may provide an opening for infection by aerial

Phytophthora species and wood-decay fungi. Also, surgery must be done when dry weather conditions are predicted, as rain may allow other pathogens of almond wood to produce infectious inoculum.

1. Remove infected bark and 0.25 to 0.5 inch of the woody tissue underneath the bark. Extend the cut at least 1 inch beyond the visible canker margin.
2. If surgery is done in the winter months when few insects are active, leave the wound undressed. The value of putting dressings on tree wounds following surgery has not been established, and it slows the healing process.
3. Recheck the area the following year. If the canker has returned, repeat the process.

Avoid clamping the shaker head on areas of the tree that have had surgery, as this can reopen wounds on a healing callus.

CROWN GALL (8/17)

Pathogen: *Agrobacterium tumefaciens*

SYMPTOMS AND SIGNS

Rough, abnormal galls on roots or trunk are the typical symptom of this disease. Galls are soft and spongy, and the centers of older galls decay. Young trees become stunted; older trees often develop secondary wood rots.

COMMENTS ON THE DISEASE

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

MANAGEMENT

To help prevent crown gall

- purchase trees from a reputable nursery and
- carefully handle trees to avoid injury as much as possible, both during planting and during the life of the tree in the orchard.

Preplant treatment is for prevention only. Galltrol is a preparation of the biological control agent *Agrobacterium tumefaciens* (formerly *A. radiobacter*) K-84, which produces an antibiotic that can reduce or eliminate infection. It is effective only as a preventive treatment and is used as a root dip or spray before heeling-in or planting. It does not eradicate existing galls. Chlorine bleach root dips or sprays are not effective as a crown gall protectant.

Strains of *A. tumefaciens* resistant to the K-84 strain have been reported. Their occurrence is not widespread, but failure to control crown gall with these materials should be reported to cooperative extension advisors and industry representatives.

Eradication involves removal of existing galls and topical application of Gallex. Carefully follow label instructions for exposing crown and roots and removing large galls.

Most peach-almond hybrid rootstocks are very susceptible to crown gall, and are more susceptible than Nemaguard rootstocks. Lovell peach is also very susceptible.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table. *When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
A. *AGROBACTERIUM TUMEFACIENS* (formerly *A. RADIOBACTER*) K-84# (Galltrol) MODE-OF-ACTION GROUP NAME (NUMBER[1]): A biological fungicide. COMMENTS: Preventive preplant treatment only.	Label rates	See label	See label
B. GALLEX COMMENTS: For removal of existing galls, apply winter through spring.	Label rates	See label	See label

Acceptable for use on organically grown produce.

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

FRUIT RUSSETING (POWDERY MILDEW-LIKE) (8/17)

Pathogens: Unknown

SYMPTOMS AND SIGNS

Russeting on almond hulls is reminiscent of rusty spot on peach fruit caused by *P. leucotricha,* but the typical powdery white growth is absent. No conidia (asexual spores) or chasmothecia (sexual fruiting structures) of powdery mildew fungi have been observed. Only thin hyphae, not characteristic of powdery mildew fungi, are present. An *Acremonium* species has consistently been observed sporulating on the fruit. Foliar and twig symptoms are absent.

COMMENTS ON THE DISEASE

The cause of fruit russeting of almond is unknown, but powdery mildew fungi (*Podosphaera pannosa*, *P. tridactyla*, and *P. leucotricha*) have been implicated. The absence of characteristic powdery mildew conidia and the presence of hyphae not typical for powdery mildew fungi provide evidence that different fungi are involved. More recently, an *Acremonium* species has been consistently observed growing and sporulating on, and has been isolated from, diseased fruit. Studies are currently being conducted to conclusively determine the pathogens involved.

Numerous fungicides with different modes of action are effective against the disease, including many that are effective against powdery mildew (e.g., demethylation inhibitor (DMI) and quinone outside inhibitor (QoI) fungicides) and others that are not (e.g., iprodione). The difficulty in working with powdery mildew fungi and *Acremonium* spp. has made absolute identification of the pathogen complicated.

The disease is only rarely reported in California and generally does not cause economic crop losses. Growth of the pathogen is favored by cool moist nights and warm days. Generally, fruit are susceptible only up to time of shell hardening, but later infections can occur on some varieties. Certain cultivars such as Mission, Padre, and Ruby are most susceptible.

MANAGEMENT

The disease is rarely an economic problem on almonds in California. If management is needed, control practices should focus on protecting fruit from infections. Jacket-split (late petal fall) and mid-spring applications of fungicides are highly effective in managing the disease.

Organically Acceptable Methods

Some sulfur sprays are acceptable for use in an organically certified crop.

Chemical Control

Generally, chemical control is not needed. If necessary, apply a fungicide from jacket split until mid-April.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table*. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. MYCLOBUTANIL
(Rally 40WSP, Laredo EW) — Label rates — 24 — 90
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications and no more than three per season to limit the development of resistance. Use in rotation with different FRAC groups.

B. TEBUCONAZOLE
(Toledo, Tebucon) — 4–8 oz — 12 — 35
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications and no more than four applications per season to limit the development of resistance.

C. PROPICONAZOLE

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(Bumper, Tilt)	8 oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
D. AZOXYSTROBIN/PROPICONAZOLE			
(Quilt Xcel)	14–26.0 fl oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four applications per season, to limit the development of resistance.			
E. PYRACLOSTROBIN/BOSCALID			
(Pristine)	10.5–14.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)			
COMMENTS: Do not make more than four applications per season of QoIs or SDHIs and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.			
F. PYRACLOSTROBIN/FLUXAPYROXAD			
(Merivon)	5–6.5 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)			
COMMENTS: Do not make more than four applications per season of QoIs (strobilurins) or SDHIs to limit the potential for the development of resistance.			
G. METCONAZOLE			
(Quash)	3.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
H. FLUOPYRAM/TEBUCONAZOLE			
(Luna Experience)	6–17 fl oz	12	35
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and demethylation (sterol) inhibitor (3)			
COMMENTS: Do not make more than two successive applications and no more than two per season to limit the development of resistance.			
I. SULFUR DUST#	Label rates	See label	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
COMMENTS: Do not apply within 3 weeks of an oil application. Check with your certifier to determine which products are organically acceptable.			
J. WETTABLE SULFUR#	Label rates	See label	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
COMMENTS: Do not apply within 3 weeks of an oil application. Check with your certifier to determine which products are organically acceptable.			
K. WETTABLE SULFUR#	Label rates	See label	0
. . . PLUS . . .			
LIQUID LIME SULFUR#	Label rates	See label	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
COMMENTS: Do not apply within 3 weeks of an oil application. Check with your certifier to determine which products are organically acceptable.			

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

\# Acceptable for use on organically grown produce.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

QoI = quinone outside inhibitor or strobilurin

SDHI = succinate dehydrogenase inhibitor

GREEN FRUIT ROT (JACKET ROT) (8/17)

Pathogens: *Botrytis cinerea*, *Sclerotinia sclerotiorum*, *Monilinia laxa*

SYMPTOMS AND SIGNS

Green fruit rot begins during the latter part of the bloom period when the fungus infects senescing petals and anthers. Infected petals develop water-soaked brown spots. Some infected petals may fall onto leaves causing secondary infections. Anther infections can spread to floral tubes or flower jackets causing them to wither and stick to developing fruit. As fruit sets and starts to grow, a brown spot develops where the jacket sticks to it. This is particularly a problem where nut clusters trap senescing flower parts. Frequently this leads to rot of entire nut clusters.

COMMENTS ON THE DISEASE

This disease is of little importance in many years, but when conditions are cool and wet during bloom, it can cause severe losses. One or more of several pathogens may be involved.

MANAGEMENT

When bloom is extended and moisture is abundant, apply a fungicide at full bloom to prevent green fruit rot. Continue treatment until rain stops. Be sure the fungicide you choose is effective against all three potential pathogens; demethylation (sterol) inhibitor fungicides such as myclobutanil (Laredo) and propiconazole (Orbit) are not effective against *Botrytis cinerea*.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table*. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. DIFENOCONAZOLE/CYPRODINIL
(Inspire Super) 10.0-12.0 fl oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3) and anilinopyrimidine (9)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

B. FLUOPYRAM/TRIFLOXYSTROBIN
(Luna Sensation) 5.0-7.6 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

C. PYRACLOSTROBIN/BOSCALID
(Pristine) 10.5–14.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than four applications per season of QoIs or SDHIs and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.

D. IPRODIONE
(Rovral, Nevado) 1 pt 24 See comments
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)
COMMENTS: Do not apply later than 5 weeks after petal fall. Addition of a narrow range oil (superior, supreme) at 1 to 2% volume/volume increases the effectiveness of this material. Do not apply oil, however, within 3 weeks of a sulfur application or closely before or after an application of captan or chlorothalonil.

E. PYRIMETHANIL
(Scala SC) 9–18 fl oz 12 30
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Anilinopyrimidine (9)

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
F. THIOPHANATE-METHYL (Topsin M 70WSB)	1.5 lb	72 (3 days)	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1) COMMENTS: Strains of brown rot pathogen resistant to thiophanate-methyl have been found on almond, but resistance is not widespread. Do not apply more than 3 lb/season per acre.			
G. CYPRODINIL (Vangard WG)	5 oz	12	60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Anilinopyrimidine (9) COMMENTS: Do not apply more than 30 oz/acre per crop per year.			
H. FENHEXAMID (Elevate)	1.5 lb	12	See comments
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Hydroxyanilide (17) COMMENTS: Apply up to 28 days after petal fall.			
I. CAPTAN (various 50WP)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4) COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.			
J. PYRACLOSTROBIN/FLUXAPYROXAD (Merivon)	6.5 oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7) COMMENTS: Do not make more than two successive applications, and no more than three applications per season or 19.5 fl oz/acre per season, to limit the development of resistance.			
K. POLYOXIN D ZINC SALT (Ph-D)	6.2 oz	4	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): glucan synthesis (19) COMMENTS: Do not make more than three applications per season and no more than two sequential applications before rotation to a different mode of action fungicide.			

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

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

QoI = quinone outside inhibitor or strobilurin

SDHI = succinate dehydrogenase inhibitor

HULL ROT (8/17)

Pathogens: *Rhizopus stolonifer* and *Monilinia* spp.

SYMPTOMS AND SIGNS

The first indication of hull rot usually comes several weeks before harvest, when leaves on a shoot wither and die. Closely examine fruit on this shoot for a brown area on the outside of the hull and either tan fungal growth in the brown area on the inside or outside of the hull (this indicates *Monilinia*) or black fungal growth on the inside of the hull (this indicates *Rhizopus*). Fungi invade hulls and produce a toxin that kills the spur and eventually the shoot attached to the fruit. Because the shoot is killed, nuts on affected shoots may be more difficult to remove during harvest. The disease causes dieback of shoots and fruiting wood (strikes) that reduces productivity in future years.

COMMENTS ON THE DISEASE

Almond hulls are susceptible to hull rot fungi from the beginning of hullsplit until the hulls dry—a period that can last from 10 days to 2 months depending on fertilization and irrigation.

MANAGEMENT

Look for nuts or leaves stuck on trees well after harvest as an indication of hull rot infections. Managing tree vigor through proper irrigation and nitrogen fertilization is the most effective control.

- Regulated deficit irrigating or reducing irrigation at the onset of hullsplit greatly reduces incidence of hull rot.
- Avoid standing water at hullsplit.
- Avoid excess nitrogen fertilizer and applications 45 to 60 days before hull split. Take leaf samples in July to be sure nitrogen levels, which should be below 2.6%, do not favor hull rot.

Almond varieties vary in their susceptibility. The most susceptible important varieties are Nonpareil, Monterey, Sonora, Fritz, and Winters. Hard-shelled varieties such as Mission, Davey, and Drake may exhibit rotted hulls but rarely shoot dieback.

Management of hull rot caused by *Rhizopus stolonifer* shows that demethylation (sterol) inhibitor (DMI; FRAC group 3) and quinone outside inhibitor (QoI; FRAC group 11) fungicides are highly effective against this pathogen. A single application at hullsplit, timed with the navel orangeworm insecticide treatment, may reduce hull rot incidence by 60 to 70%. Fungicide treatments should be integrated into deficit irrigation practices during hullsplit. Hull rot caused by *Monilinia* spp. is best managed with fungicide applications 3 to 4 weeks before hull split (early June).

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table*. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. DIFENOCONAZOLE/CYPRODINIL
(Inspire Super) 10–12 fl oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3) and anilinopyrimidine (9)
COMMENTS: The demethylation (sterol) inhibitor component is the only ingredient in this product that is active against *Rhizopus stolonifer*.

B. FLUOPYRAM/TRIFLOXYSTROBIN
(Luna Sensation) 5.0-7.6 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)
COMMENTS: The QoI component is the only ingredient in this product that is active against *Rhizopus stolonifer*. Do not make more than four applications per season of QoIs or SDHIs to limit the development of resistance.

C. METCONAZOLE
(Quash) 3.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
D. DIFENOCONAZOLE (Inspire)	7 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3) COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.			
E. AZOXYSTROBIN/DIFENOCONAZOLE (Quadris Top)	14 oz	12	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3) COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not make more than four applications per season of QoIs or SDHIs to limit the potential for the development of resistance.			
F. AZOXYSTROBIN (Abound)	12.0–15.5 fl oz	4	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of QoI or SDHI fungicides per year or apply more than 92.3 fl oz/acre per season to limit the potential for the development of resistance.			
G. TRIFLOXYSTROBIN (Gem 500 SC)	3 fl oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) COMMENTS: Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.			
H. PYRACLOSTROBIN/FLUXAPYROXAD (Merivon)	6.5 oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7) COMMENTS: Do not make more than three applications per season of QoIs (strobilurins) or SDHIs to limit the potential for the development of resistance. Note that resistant populations have developed in selected almond-producing areas within California.			
I. PYRACLOSTROBIN/BOSCALID (Pristine)	10.5–14.5 oz	12	25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7) COMMENTS: Do not make more than four applications per season of QoI or SDHI fungicides and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.			

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

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

QoI = quinone outside inhibitor or strobilurin

DMI = demethylation (sterol) inhibitor

SDHI = succinate dehydrogenase inhibitor

LEAF BLIGHT (8/17)

Pathogen: *Seimatosporium lichenicola*

SYMPTOMS AND SIGNS

Individual leaves on spurs or shoots wither and die in early summer. The fungus kills the petioles and the axillary buds. Leaf blades disintegrate, but diseased petioles stick on tree during winter. When the axillary bud is killed, spurs do not develop.

COMMENTS ON THE DISEASE

The fungus survives on dead petioles. Spores are spread by rain, and disease is favored by wet spring weather. Leaf blight is usually not very severe or widespread; it rarely destroys more than 20% of the leaves in one season. Repeated early death of leaves will weaken trees, however, and may contribute to loss in yield as a result of the loss of spur development.

MANAGEMENT

Apply a fungicide during the period from bloom through early spring. Make the first application during early leafing, which usually occurs at full bloom to petal fall. Pink bud is too early for control.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table. *When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
A. AZOXYSTROBIN			
(Abound)	12.0–15.5 oz	4	28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season.			
B. TRIFLOXYSTROBIN			
(Gem 500SC)	1.9–3.8 oz	12	14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Do not apply within 14 days of harvest or after hullsplit. Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.			
C. MYCLOBUTANIL			
(Laredo EW)	9.6–15.3 fl oz	24	90
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation (sterol) inhibitor (3)			
COMMENTS: Apply in 400 gallons water/acre. Do not make more than two successive applications and no more than three per season to limit the development of resistance. Use in rotation with different FRAC groups.			
D. CAPTAN			
(various 50WP)	8 lb	96 (4 days)	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.			
E. ZIRAM			
(Ziram 76DF)	8 lb	48	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Do not apply more than 32 lb/acre per season.			

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

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

LOWER LIMB DIEBACK (8/17)

Pathogen: Unknown

SYMPTOMS AND SIGNS

Beginning in late April or May, leaves on lower limbs of affected trees first turn yellow, then brown. The limb eventually dies, often right up to the point of attachment, but the large wood of the scaffolds remains apparently unaffected. If the bark on dying limbs is scraped away with a knife, brown spots are evident in the wood. The symptoms can be confused with normal shade-out of low limbs. However, as lower limb dieback progresses, limbs receiving adequate sunlight several feet high in the tree can eventually become affected.

COMMENTS ON THE DISEASE

Padre appears to be the most seriously affected variety, although Butte can also be substantially affected. Less affected are Nonpareil, Carmel, and Aldrich varieties.

The occurrence of lower-limb dieback on almonds is still being researched. Thus the etiology is unknown, but it may be a physiological disorder related to water potential and light levels. Affected trees may be first weakened by pre-existing root problems, such as overly wet soils in the spring, low light, or possibly other causes including herbicides, fertilizers, or anything that may damage tree roots. Hull rot may also contribute to lower limb dieback because infected branches may continue to die in the following growing season after initial infections. Toxins such as fumaric acid may accumulate in large branches when multiple spurs are infected. Predisposed trees and dieback from hull rot are susceptible to infection by secondary pathogens such as *Botryosphaeria dothidea* and *Phomopsis amygdali*, or other species that may colonize and eventually girdle the limbs, resulting in limb death.

MANAGEMENT

Good management strategies have not yet been determined. Keep trees strong by proper irrigation management and maintain good control of scale insects. Dormant copper sprays and in-season fungicide sprays have not been shown to be effective in University trials.

PHOMOPSIS FRUIT ROT AND BRANCH DIEBACK (8/17)

Pathogen: *Phomopsis amygdali*

SYMPTOMS AND SIGNS

Fruit symptoms of Phomopsis fruit rot include extensive grayish brown discolored and shriveled hulls that often have clear gum secretions and shriveled kernels. Affected fruit frequently abscise. Second-year symptoms include twig and branch dieback (see LOWER LIMB DIEBACK). Leaf lesions are round to irregular in shape with red-brown margins; in later stages they are dry and brown. Lesions are generally isolated but may occur on grouped leaves along a branch. Leaf lesions may abscise causing a shot hole symptom.

COMMENTS ON THE DISEASE

The disease is uncommon under California growing conditions and has only occasionally been reported in late spring and early summer when unusual high rainfall occurs in mid- to late spring. Sonora and Carmel are very susceptible; whereas Nonpareil and Mission are less susceptible to the disease.

MANAGEMENT

Cultural control practices are ineffective. Fungicide applications in mid-spring may be beneficial.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
A CAPTAN (various 50WP)	8 lb	24	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): multi-site contact (M4)			
COMMENTS: Make one to two applications of Captan before late spring rains to prevent fruit rot. Do not apply in combination with, immediately before, or closely following oil sprays.			

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

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

PHYTOPHTHORA ROOT AND CROWN ROT (8/17)

Pathogen: *Phytophthora* spp.

SYMPTOMS AND SIGNS

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

COMMENTS ON THE DISEASE

Periods of 24 hours or more of saturated soil favor *Phytophthora* infections. Conversely, good soil drainage and more frequent but shorter irrigations reduce the risk of root and crown rot. Surface water from irrigation districts is mostly contaminated with *Phytophthora* species. Rootstocks vary in susceptibility to the different *Phytophthora* species; none are resistant to all pathogenic species of the fungus. Thus, the success of a rootstock may depend in part upon the species of *Phytophthora* present in the orchard. In general, plum rootstocks are more resistant than are peach or peach-almond hybrids. Of the plum rootstocks, Marianna 2624 is the most tolerant to *Phytophthora*.

MANAGEMENT

Proper water management is the most important aspect in controlling root and crown rot.

- Do not allow water to accumulate or stand around crowns of trees.
- Provide adequate drainage to
    - low spots in the orchard,
    - areas that flood frequently, and
    - places where water penetration is extremely poor.
- Leave areas without adequate drainage unplanted.

If you are replanting an area where *Phytophthora* is present, either plant trees on small mounds, as shallowly as possible, or on broad ridges with the upper roots near the soil level. Establish berms before planting; the ridges should be 8 to 10 inches (20–25 cm) high. Planting depth after settling should be no deeper than in the nursery, and the graft union should be well above the soil line.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
A. FOSETYL-AL			
(Aliette WDG)	5 lb/100 gal	12	365
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phosphonate (33)			
COMMENTS: For use on nonbearing trees only. Foliar spray, 60-day interval.			
B. MEFENOXAM			
(Ridomil Gold SL)	Label rates	48	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylamide (4)			
COMMENTS: Rate varies with method of application and size of tree. Make applications in early spring and fall.			
C. PHOSPHOROUS ACID			
(Fosphite)	1–2 qt	4	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phosphonate (33)			
COMMENTS: For use as a foliar or soil treatment. Note: Maximum residue levels (MRLs) may restrict the use of these fungicides.			

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

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

RUST (8/17)

Pathogen: *Tranzschelia discolor*

SYMPTOMS AND SIGNS

Rust appears as small, yellow spots on the upper surface of leaves. On the lower surface of the leaf these spots take on a rusty red appearance when the rust-colored spores produced in the lesions erupt through the surface. These spores are spread by air movement and infect other leaves to continue the disease cycle. Young twigs may be infected, but twig lesions are seldom seen on almond.

COMMENTS ON THE DISEASE

Rust occurs sporadically throughout almond-growing areas in California. The development of rust is favored by humid conditions (e.g., orchards near rivers or streams), and the disease becomes worse when rain occurs in late spring and summer. Excessive levels of nitrogen are also known to increase the tree's susceptibility.

Trees can be defoliated quickly when rust becomes severe. The disease causes leaves to fall prematurely and will weaken trees, reducing the following year's bloom if not controlled. Rust is often observed in second- and third-leaf nonbearing orchards where fungicides have not been applied.

The rust fungus survives from one season to the next in infected leaves and possibly also in infected twigs.

MANAGEMENT

In orchards with a history of rust, apply sulfur 5 weeks after petal fall and follow 4 to 5 weeks later in late spring and summer with a quinone outside inhibitor fungicide (QoI; FRAC group number 11) or demethylation inhibitor (DMI; FRAC group number 3) to control leaf infections. Two or three applications may be needed in orchards that have had severe rust problems. To be effective, fungicide must be applied before rust symptoms are visible.

When zinc sulfate (20–40 lb/acre) is applied in late October to early November to hasten leaf fall, rust inoculum is prevented from increasing. Otherwise, the inoculum may build up, overwinter on the trees, and infect leaves the following spring. In southern growing regions, leaves of some cultivars such as Sonora may remain attached over the winter and provide inoculum for new infections as leaves emerge the following spring.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. METCONAZOLE
(Quash) 3.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

B. TEBUCONAZOLE
(Toledo, Tebucon) 4–8 oz 12 35
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3).
COMMENTS: Do not make more than two successive applications and no more than four applications per season to limit the development of resistance.

C. AZOXYSTROBIN/PROPICONAZOLE
(Quilt Xcel) 17.5–26.0 fl oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

D. PROPICONAZOLE

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(Tilt, Bumper)	8 fl oz	12	60

MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications and no more than four per season to limit the development of resistance.

E. PYRACLOSTROBIN/FLUXAPYROXAD
(Merivon) 6.5 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than three applications per season of QoIs (strobilurins) or SDHIs to limit the potential for the development of resistance.

F. PYRACLOSTROBIN/BOSCALID
(Pristine) 10.5–14.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Chemical class: carboxyanilide/strobilurin. Do not make more than four applications per season of QoIs or SDHIs and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.

G. AZOXYSTROBIN
(Abound) 12.0–15.5 oz 4 28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season.

H. AZOXYSTROBIN/DIFENOCONAZOLE
(Quadris Top) 14 oz 12 28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than four applications per season or more than two sequential sprays of QoIs or SDHIs to limit the potential for the development of resistance.

I. FLUOPYRAM/TRIFLOXYSTROBIN
(Luna Sensation) 5.0–7.6 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7), Quinone outside inhibitor (11)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

J. TRIFLOXYSTROBIN
(Gem 500SC) 3.8 oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Chemical class: strobilurin. Do not apply within 14 days of harvest or after hullsplit. Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.

K. WETTABLE SULFUR# Label rates See label 0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)
COMMENTS: To be effective, sulfur treatments must be applied before rust symptoms appear, which can be anytime from late spring through fall. Do not apply within 3 weeks of an oil application. Check with your certifier to determine which products are organically acceptable.

L SULFUR DUST# Label rates See label 0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)
COMMENTS: To be effective, sulfur treatments must be applied before rust symptoms appear, which can be anytime from late spring through fall. Do not apply within 3 weeks of an oil application. Check with your certifier to determine which products are organically acceptable.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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

Acceptable for use on organically grown produce.

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

SCAB (8/17)

Pathogen: *Fusicladium carpophilum*

SYMPTOMS AND SIGNS

Grayish black, soft looking spots form on leaves, fruit, and twigs. Young lesions are indistinct small yellow specks, best seen by holding a leaf up to the light. Lesions usually are not visible until late spring or early summer.

COMMENTS ON THE DISEASE

The fungus survives in twig lesions, and spores are spread by wind or rain. The disease is favored by prolonged wet spring weather, and is most prevalent in the Sacramento Valley. Severe scab infections cause early defoliation; if left uncontrolled for several years, infected trees will become weakened. The disease often occurs in sprinkler-irrigated orchards where water reaches foliage.

MANAGEMENT

To determine if a fungicide application is warranted, follow the sampling and treatment threshold guidelines in the section DORMANT SPUR SAMPLING. Record observations in a <a href="C003/sampling form.

Scab may be controlled by shot hole fungicide sprays. However, a scab treatment may be required if rain occurs into mid- to late spring. One application as late as 5 weeks after petal fall can protect against scab, but an earlier application (2 weeks after petal fall) may improve control.

In severe outbreaks, dormant or delayed dormant applications of copper with oil or liquid lime sulfur can be used effectively to reduce and delay sporulation of twig infections in spring. Copper and oil has been found to be the most effective delayed dormant treatment, and when used in combination with petal fall applications of protective fungicides, the disease can be effectively managed.

Scab resistance to quinone outside inhibitor fungicides (also known as strobilurins) has been documented; do not use FRAC mode-of-action group number 11 fungicides in these orchards.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

DORMANT

A. LIME SULFUR#
(various) Label rates See label See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)
COMMENTS: Can improve spring control of scab, especially if a wet spring delays treatment. Check with your certifier to determine which products are organically acceptable.

B. COPPER
(various) Label rates See label See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1)
. . . PLUS . . .
NARROW RANGE OIL#
(various) Label rates See label See label
MODE-OF-ACTION: Contact
COMMENTS: Not all copper and oil products are organically acceptable; check with your certifier.

C. CHLOROTHALONIL
(Bravo Weather Stik) Label rates See label See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M1)
. . . PLUS . . .

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
NARROW RANGE OIL# (various)	Label rates	See label	See label

MODE-OF-ACTION: Contact
COMMENTS: Apply as dormant or delayed dormant treatment. Do not apply within two weeks of bud swell.

PETAL FALL (BEGINNING OF SPORULATION OF TWIG INFECTIONS)

A. FLUOPYRAM/TRIFLOXYSTROBIN
(Luna Sensation) 5.0–7.6 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

B. AZOXYSTROBIN/PROPICONAZOLE
(Quilt Xcel) 17.5–26.0 fl oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

C. PYRACLOSTROBIN/FLUXAPYROXAD
(Merivon) 5–6.5 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than three applications per season of Merivon to limit the potential for the development of resistance.

D. PYRACLOSTROBIN/BOSCALID
(Pristine) 10.5–14.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than four applications per season of QoIs or succinate dehydrogenase inhibitor and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.

E. AZOXYSTROBIN
(Abound) 12.0–15.5 oz 4 28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season.

F. TRIFLOXYSTROBIN
(Gem 500SC) 3.8 oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Do not apply within 14 days of harvest or after hullsplit. Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.

G. METCONAZOLE
(Quash) 3.0 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications and no more than four per season to limit the development of resistance. Do not apply after hullsplit.

H. AZOXYSTROBIN/DIFENOCONAZOLE
(Quadris Top) 14 oz 12 28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
I. THIOPHANATE-METHYL (Topsin M 70WSB)	1.5 lb	72 (3 days)	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
COMMENTS: Strains of scab pathogen resistant to thiophanate-methyl may occur. Do not apply more than once a year.			
J. CHLOROTHALONIL (Bravo Weather Stik, Echo 720)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
COMMENTS: Do not apply one week before or after a treatment containing oil or an oil-based pesticide.			
K. ZIRAM (Ziram 76DF)	8 lb	48	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Do not apply more than 32 lb/acre per season. Do not apply later than 5 weeks after petal fall.			
L. CAPTAN (various 50WP)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.			

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

Acceptable for use on organically grown produce.

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

SHOT HOLE (8/17)

Pathogen: *Wilsonomyces carpophilus*

SYMPTOMS AND SIGNS

Spots occur on leaves, fruit, twigs, and flowers; however, flower and twig lesions are relatively scarce or difficult to find. Leaf lesions begin as tiny reddish specks that enlarge by several millimeters into spots having tan centers and purplish margins. When the fungus sporulates, the fruiting structure appears as a small dark speck (the sporodochium and spores) in the center of the spot; this is a diagnostic characteristic of shot hole disease. Spots on young leaves usually fall out, leaving a hole (the shot hole); older leaves retain their lesions. Fruit spots are small with purplish margins, slightly corky, and raised. Spots are found on the upper surface of fruit with respect to the way it hangs on trees. Heavy infection of young fruit may cause fruit drop or distortion and gumming of fruit.

COMMENTS ON THE DISEASE

The fungus survives on infected twigs and as spores in healthy buds. Spores are moved by water to new sites; prolonged periods of wetness, either due to rain or sprinkler irrigation, are required for the disease to develop. Shot hole can cause losses in yield, defoliation, and weakened trees.

MANAGEMENT

Monitor orchards in fall and spring for shot hole lesions and fruiting structures. Fruiting structures appear in the center of leaf lesions as small black spots and can be seen with a hand lens.

In the fall:

- If fruiting structures are present in leaf lesions, there is a high risk of shot hole development the following spring and a petal fall treatment should be applied.
- If fruiting structures are not present on leaf lesions, the petal fall treatment is not needed for shot hole. (It may be necessary for control of other diseases such as scab or leaf blight, however.)

In the spring:
Whether or not a petal fall treatment is applied, monitor leaves for lesions with fruiting structures.

- As soon as fruiting structures are evident, apply a treatment and continue treatments at the recommended label interval as long as weather conditions are conducive to disease development.
- If fruiting structures are not present, a treatment is not required, but continue monitoring until weather conditions are no longer wet and conducive to shot hole development.

Contact fungicides serve as protectants, not eradicants, and provide control only if they are applied so foliage and fruit are well covered before a wet period. The minimum number of applications may vary each year, depending upon the rain pattern and use of sprinkler irrigation.

When zinc sulfate (20–40 lb/acre) is applied in late October to early November to hasten leaf fall, shot hole inoculum is prevented from increasing. Otherwise, high levels of inoculum may develop and overwinter on the trees, infecting leaves the following spring.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

A. FLUOPYRAM/TRIFLOXYSTROBIN
(Luna Sensation) 5.0–7.6 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and Quinone outside inhibitor (11)
COMMENTS: Do not make more than two applications per season of QoIs or SDHIs to limit the potential for the development of resistance.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

B. PYRACLOSTROBIN/FLUXAPYROXAD
(Merivon) 5–6.5 fl oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than three applications per season of QoIs (strobilurins) or SDHIs to limit the potential for the development of resistance.

C. PYRACLOSTROBIN/BOSCALID
(Pristine) 10.5–14.5 oz 12 25
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and succinate dehydrogenase inhibitor (7)
COMMENTS: Do not make more than four applications per season of QoIs or SDHI and no more than two sequential applications before rotation to a different mode of action fungicide to limit the potential for the development of resistance.

D. IPRODIONE
(Rovral, Nevado) 1 pt 24 See comments
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)
COMMENTS: Do not apply later than 5 weeks after petal fall. Addition of a narrow range oil (Superior, Supreme) at 1 to 2% volume/volume increases the effectiveness of this material. Do not apply oil, however, within 3 weeks of a sulfur application or closely before or after an application of captan or chlorothalonil.

E. AZOXYSTROBIN/PROPICONAZOLE
(Quilt Xcel) 17.5–26.0 fl oz 12 60
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

F. AZOXYSTROBIN/DIFENOCONAZOLE
(Quadris Top) 14 oz 12 28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than four per season, to limit the development of resistance.

G. FLUOPYRAM/TEBUCONAZOLE
(Luna Experience) 6–8 fl oz 12 35
MODE-OF-ACTION GROUP NAME (NUMBER[1]): succinate dehydrogenase inhibitor (7) and demethylation (sterol) inhibitor (3)
COMMENTS: Do not make more than two successive applications, and no more than two per season, to limit the development of resistance.

H. AZOXYSTROBIN
(Abound) 12.0–15.5 oz 4 28
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Do not apply more than two sequential sprays before alternating with a fungicide that has a different mode of action. Do not apply more than four applications of strobilurin fungicides per year or apply more than 92.3 fl oz/acre per season.

I. TRIFLOXYSTROBIN
(Gem 500SC) 3.8 oz 12 14
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)
COMMENTS: Do not apply within 14 days of harvest or after hullsplit. Do not make more than four applications per season and no more than two sequential sprays of QoI or SDHI fungicides to limit the potential for the development of resistance.

J. CHLOROTHALONIL
(Bravo Weather Stik, Echo 720) Label rates See label See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)
COMMENTS: Do not apply one week before or after a treatment containing oil or an oil-based pesticide.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
K. CAPTAN			
(various 50WP)	Label rates	See label	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
COMMENTS: Do not apply in combination with, immediately before, or closely following oil sprays.			
L. ZIRAM			
(various 76DF)	6–8 lb	48	0
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: When Ziram 76F is not applied as a tank mix with other systemic fungicides, use the maximum rate. Do not apply more than 32 lb/acre per season or apply later than 5 weeks after petal fall.			
M. MANCOZEB			
(various)	Label rates	24	See label
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Do not apply more than 19.2 lb ai/acre per season or apply later than 5 weeks after petal fall.			

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

Acceptable for use on organically grown produce.

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SILVER LEAF (8/17)

Pathogen: *Chondrostereum purpureum*

SYMPTOMS AND SIGNS

Silver leaf is caused by a fungus that infects wood and the water-conducting xylem through fresh wounds. A toxin produced by the pathogen is carried through the xylem to leaves, causing them to turn a silvery gray. As the disease progresses over a few years, leaves curl upward at the edges and turn brown. Eventually limbs, scaffolds, and the whole tree will die.

Dark brown discoloration of the heartwood in dead or dying limbs is a characteristic symptom of the disease. Spore-forming basidiocarps develop on the surface of trunks and branches that have been killed by the fungus. These are small, leathery structures that are often shelflike in shape and frequently form on the north side of affected trees. Their upper surface is grayish white and indistinctly zoned, and their lower surface is smooth and purplish. They may appear at any time of the year, but most often they are formed in fall. Spores are ejected from the basidiocarps' lower surface during rainy or moist weather and spread by wind. A basidiocarp can produce spores for 2 years. Sapwood-exposing wounds that have not healed over are susceptible to infection. Spores infect exposed xylem, and the pathogen remains confined to the xylem tissue until the infected branch dies.

Leaf symptoms are most easily identified in spring before leaves "harden off." Symptoms are most commonly seen in trees 3 to 5 years old, but the disease can affect trees of any age. It generally takes 1 to 2 years after infection before leaf symptoms are obvious.

COMMENTS ON THE DISEASE

The pathogen attacks a wide range of woody plants, including many indigenous to riparian habitats such as willow, poplar, birch, and oak. Silver leaf is most commonly found in almond orchards of the northern San Joaquin Valley and occasionally in other stone fruit species such as peach. The most commonly affected variety is Padre, followed by Butte.

MANAGEMENT

Certain cultural practices help reduce the spread of silver leaf.

- Avoid excessive and improper pruning, including pruning of large branches that may require long periods for wound healing.
- Remove and burn any prunings, branches, or stumps of diseased trees, since basidiocarps may form on infected wood after it is dead.
- Prune young trees in late spring and bearing trees immediately after harvest to reduce the likelihood of infection during rainy weather.
- Integrate management of this disease with biological control treatments such as the application of *Trichoderma harzianum*, which is available in a commercial formulation, to pruning cuts and other wood-exposing wounds.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
A. *TRICHODERMA HARZIANUM#* (PlantShield HC)	16–32 oz	4	0
MODE OF ACTION: Biological competition COMMENTS: Apply as soon as possible after pruning or whenever wood-exposing injuries occur (within 2–3 days).			

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

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

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Acceptable for use on organically grown produce.

VERTICILLIUM WILT (8/17)

Pathogen: *Verticillium dahliae*

SYMPTOMS AND SIGNS

Leaves on one or more branches, often on only one side of the tree, will turn yellow or wilt early in the growing season. The symptoms progress until the affected shoots die and dry up later in the season. Affected young shoots often resemble a shepherd's hook. When shoot, branch, or trunk tissue of infected trees is cut in cross section, the vascular ring and often much of the heartwood will display dark discoloration. Foliar symptoms usually appear only on young trees (first to fifth or sixth leaf). Older trees do not normally exhibit symptoms of Verticillium wilt.

COMMENTS ON THE DISEASE

The causal fungus survives from season to season in soil, in debris of previous susceptible crops, and probably in roots and the lower trunk of infected trees. Often the fungus can be isolated from living portions of infected tissue year-round in the Central Valley. Research has shown that trees' yields can be reduced by Verticillium wilt, even when foliar symptoms are not readily apparent. Specific rootstock or scion varieties may vary in susceptibility. Second-to fourth-year trees are usually the most susceptible to Verticillium wilt.

MANAGEMENT

This disease can adversely affect orchards even when low pathogen numbers are present in the soil (two to three propagules per gram). Avoid interplanting young orchards with susceptible cover plants, such as cotton, tomatoes, melons, etc. When replanting in an area where susceptible perennials were previously grown, try to remove as many roots of the previous crop as possible.

Soil Solarization

To solarize the soil before planting, cover the moistened soil with clear, UV-inhibited plastic sheeting in late spring. Leave the plastic in place during summer months. To solarize the soil after trees have been planted, cover the soil around trees with black plastic sheeting. Leave in place for one to two growing seasons.

Rootstocks and Varieties

Lovell rootstock is very susceptible to Verticillium wilt. Hansen may be more susceptible than Nemaguard. Carmel is much more susceptible to wilt symptoms than most other cultivars. Atlas rootstock appears to be highly tolerant.

Fumigation

Orchards may also be fumigated with chloropicrin-containing fumigants before trees are planted.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***			
PREPLANT SOIL FUMIGATION			
A. CHLOROPICRIN* (Pic-clor 60)	Label rates	See label	See label
COMMENTS: This restricted use product is applied only by professional fumigation companies and is a multi-purpose liquid fumigant for preplant treatment of soil to help manage certain soil-borne diseases and to control other pests (e.g., plant parasitic nematodes, symphylans) in croplands. Fumigants such as chloropicrin are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.			
B. 1,3 DICHLOROPROPENE/CHLOROPICRIN* (Telone C-35)	Label rates	See label	See label

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

COMMENTS: It is effective at 39 to 46.7 gal/acre rate (labeled for shank applications) if applied to dried sandy soils or sandy loam soils with no more than 12% soil moisture content anywhere in the surface 5 feet of soil profile. In California the applications must be applied to soils having a moist surface; this task is difficult to achieve without use of sprinklers unless there is a fortunate rainfall. Do not flood irrigate prepared lands to achieve this surface moisture requirement. Broadcast apply where nematode resistance is unavailable for prevailing nematodes. Strip applications are permitted at higher treatment rates and effective where resistant rootstocks are available, the clay loam soil profile contains no more than 19% soil moisture, the field has been pre-ripped to 4- or 5-foot depth, and the delivery shank is winged to limit off-gassing. Fumigants such as 1,3-dichloropropene and chloropicrin are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.

C.	1,3 DICHLOROPROPENE *			
	(Telone II)	Label rates	See label	See label

COMMENTS: This restricted use product is applied only by professional fumigation companies and is a multi-purpose liquid fumigant for preplant treatment of soil to help manage certain soil-borne diseases and to control other pests (e.g., plant parasitic nematodes, symphylans) in croplands. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.

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

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

WOOD-DECAY FUNGI (8/17)

Pathogens: *Oxyporus latemarginatus* (formerly known as Poria ambigua), *Ganoderma* spp., *Phellinus* spp., *Trametes* spp., and others

SYMPTOMS AND SIGNS

Oxyporus wood rot appears first as a white fungal growth around the base of an affected tree in late summer. The growth, which is made up of fungal fruiting structures, extends for a short distance up the trunk and out into the soil. *Ganoderma, Phellinus,* and *Trametes* species produce fruiting structures that appear as conks or shelf-like brackets on the trunk or branches. By the time fruiting structures appear, the wood-rotting fungus is well established in the inner structural tissues of the tree. Although the tree is still productive and may appear perfectly healthy otherwise, it will probably fall over during a windstorm because the interior wood of the tree is weak, soft, and decayed.

COMMENTS ON THE DISEASE

Damage by wood-decay fungi may be the leading cause of premature orchard decline. *Oxyporus latemarginatus* is also found on cherry; species of *Ganoderma, Phellinus,* and *Trametes* are found on almond, cherry and peach. These fungi cause white-rot decay. Another fungus, *Laetiporus sulphureus*, causes a brown rot of wood. Both white and brown rots lead to limb breakage or uprooting of trees during windstorms or mechanical harvesting.

MANAGEMENT

Most wood rots are secondary diseases that invade only injured or dead tree tissue. The best way to protect a tree from wood-rot fungi is to

- follow recommended cultural practices to maintain vigorous trees,
- protect against crown gall,
- use careful soil and water management to avoid crown and root problems, and
- take steps to avoid mechanical injuries and sunburn.

The incidence of wood rots is higher in orchards irrigated with sprinklers; if you use sprinklers, avoid wetting tree trunks as much as possible. Do not apply pesticides for wood-rotting fungi. Destroying the conk or the white fungal growth at the base of the tree, is useless—the fruiting bodies are only an indication of extensive inner rot.

Remove and destroy diseased wood. When a tree falls over and is removed, no treatment is necessary for wood rots before planting another tree in the same spot; the fungi are not a threat to healthy young trees. However, if other disease organisms or nematodes are present in the soil, a preplant fumigation may be necessary. Crown-gall infections are implicated in increasing the incidence of wood rots because the dead portion of the gall is a natural infection site for wood rots. Take precautions to prevent crown-gall infections when new trees are planted.

YELLOW BUD MOSAIC (8/17)

Pathogen: *Tomato ringspot virus*

SYMPTOMS AND SIGNS

Mission trees with yellow bud mosaic appear open and stunted. Leaves may be crinkled and distorted. Occasionally, chlorotic spots may develop that eventually become necrotic and are abscised, leaving holes or resulting in a tattered appearance. Leaves may also be stunted and form small rosettes or short tufts. They stand out in sharp contrast to normal leaves on the same branch or in other parts of the tree. In severe cases, the leaves may develop a mottled appearance.

Leaves with symptoms develop sporadically throughout the tree canopy. Affected branches lack lateral growth and have little terminal growth from one year to the next. Frequently, one or more normal shoots are produced on a branch that is otherwise completely diseased. Fruit set on diseased trees is reduced. Hulls are wrinkled or rough, and fruit appear larger than healthy fruit because the hulls are abnormally thick. Trees with yellow bud mosaic will live for many years but do not produce well; yield reduction is directly proportional to the severity of the symptoms.

COMMENTS ON THE DISEASE

Yellow bud mosaic was first described in California in 1936 on peaches and almonds in Solano and Yolo counties. It can affect most stone fruits. On almond, yellow bud mosaic seriously damages the cultivar Mission. Many other plants provide natural reservoirs of *Tomato ringspot virus*, which is transmitted from plant to plant by the dagger nematode *Xiphinema americanum*.

The yellow bud mosaic strain of *Tomato ringspot virus* can infect most rootstocks, except Marianna 2624 plum. Besides Mission, symptoms occasionally may be seen on water sprouts in the lower scaffold limbs of cultivars Nonpareil and NePlus Ultra, and a form of the disease has occurred in the Patterson area of Stanislaus County that caused Nonpareil trees to grow in a spiral form, similar to the characteristic spiraling of the IXL cultivar.

Tomato ringspot virus is indigenous to California and is widely distributed in the coastal areas and the Sacramento Valley; it also occurs in a few scattered areas of the San Joaquin Valley. *Tomato ringspot virus* is spread by budding and grafting and by dagger nematodes, *Xiphinema* spp., in the orchard soil. The virus is seedborne in dandelion, and infects a number of other broadleaf weeds (e.g., bristly oxtongue, little mallow, chickweed, lambsquarters, mullein, plantain, spurge, white clover) as well as apricot, apples, caneberries, peach, and grapevines. The nematode vector acquires the virus by feeding on the roots of infected hosts. *Xiphinema* juveniles remain infective until they molt. Adults remain infective for 3 to 8 months.

Susceptible rootstocks become infected with *Tomato ringspot virus* when infected dagger nematodes feed on their roots. Gradually, over the course of several years, the virus spreads to the upper shoot terminals. If nematodes carrying the virus feed only on one root, the disease will initially develop only on one side of the tree and then spreads throughout the tree. If the nematodes are distributed throughout the soil and feed on all the roots, the disease will progress more rapidly and uniformly.

Tomato ringspot virus is spread to new locations when floods or cultural operations move infective nematodes. Trees in areas adjacent to east-west streams flowing from the coastal mountains or Sierra foothills have a higher incidence of this disease. The disease also can spread when wind-disseminated seeds of virus-infected plants such as dandelion germinate and grow in an orchard with dagger nematodes. Within an orchard, the disease spreads slowly to adjacent trees, gradually enlarging the original area of infection. Frequently, symptoms first develop in border trees and subsequently spread to adjacent trees. Although it is possible for infection to spread from tree to tree through root grafts, this is less common. The disease spreads mainly by dagger nematodes. Mission trees planted in infested soil will exhibit symptoms in 2 years and will never be productive. When older Mission trees become infected as a result of natural spread of nematodes in the soil, they generally become uneconomical producers 3 to 5 years after the symptoms first appear.

MANAGEMENT

Once yellow bud mosaic symptoms appear in an orchard, it is extremely difficult to eliminate the virus. Deep soil fumigation at rates high enough to kill the nematode is expensive and often not practical, especially if other factors may also be affecting the growth of the tree.

If you have an area that contains *Tomato ringspot virus*, try to limit its spread to other parts of the orchard. Do not perform any cultural operations, including cross cultivation and flood irrigation that may move soil from this area to other locations. If the affected area involves only a small part of the orchard, remove infected trees and trees in at least two rows beyond. If several areas of diseased trees are present, you may need to remove the entire block. Before removing the trees, treat them with an herbicide or girdle them to aid in killing the roots. Remove as many roots (potential virus reservoirs) as possible. For best results, fallow the ground for 2 years and then fumigate the soil to kill the nematodes.

Do not plant Mission trees on peach or almond rootstock in infested areas. Marianna 2624 plum rootstock is resistant to the virus. Replant with cultivars that are compatible with Marianna 2624, or with non-hosts of the virus, such as walnut, pear, and plum or prune on Marianna 2624 rootstock.

Nematodes

(Section reviewed 8/17)

Scientific Names: Root-knot nematode: *Meloidogyne* spp.
Root lesion nematode: *Pratylenchus vulnus*
Ring nematode: *Mesocriconema (=Criconemella, Criconemoides) xenoplax*
Dagger nematode: *Xiphinema americanum*

DESCRIPTION OF THE PESTS

There are three major species of nematodes affecting almonds: root knot, root lesion, and ring. The dagger nematode is also common and is capable of transmitting *Tomato ringspot virus,* causing yellow bud mosaic disease on almond trees.

RESISTANT ROOTSTOCKS

Rootstocks for almonds differ in response to various plant-parasitic nematodes.

- Nemaguard and Guardian peach rootstocks, almond-Nemaguard hybrids (including Hansen 536, Nickels, Cornerstone, Bright's and Titan), and Marianna 2624 are resistant or immune to most common and injurious root-knot nematodes. Other hybrid rootstocks, including Viking, Atlas, Empyrean 1, Cadaman (a.k.a. Avimag) and Rootpac R are also considered to be immune to root-knot nematode.
- Peach-almond hybrid and most plum or plum hybrid rootstocks, including Krymsk 86, are particularly susceptible to ring nematode and the bacterial canker complex.
- Lovell peach rootstock is susceptible to root knot and root lesion nematodes but is more tolerant to ring than Nemaguard.
- Viking and Guardian rootstocks have ring nematode tolerance similar to Lovell.
- Almond rootstock is rated susceptible to root knot, root lesion, and ring nematodes.

MONITORING AND WHEN TO TREAT

When planting or replanting an orchard, be sure to sample for nematodes, especially if the land was previously an orchard or a vineyard. When sampling the soil:

- Use a soil probe or auger for best results.
- Discard the top few inches of soil. The majority of your sample should be from 4 -24 inches deep because nematodes live where the roots are.
- Pool together samples from several areas of the field because nematode populations can be spotty.

If sampling indicates that any of the pest nematodes of almond are present, plan to preplant fumigate using the following time schedule:

- **Summer to Fall:** Remove trees or vines, destroy residues, and deep cultivate to remove residual roots and break up cultivation pans or soil layering.
- **Winter to Spring:** Fallow or plant grains.
- **Spring to Summer:** Level (if necessary), cultivate, and do other operations required for next year's planting. Dry the soil.
- **Late Summer to Early Fall:** Rip the soil. You will be required to have surface moisture if applying Telone II. Fumigate preferably in September or October but before November 15. Fumigants are most effective in warm, dry soils. Efficacy is reduced and danger of damage to newly planted trees is increased if chloropicrin or 1,3 dichloropropene (Telone II) is applied after mid-November.
- **Winter to Spring:** Observe waiting period on fumigant container label; plant young trees on resistant rootstock if root-knot nematode is present.

Make a solid or strip application of Telone II or Telone C-35 if the rootstock to be used has no resistance to ring nematode (*Mesocriconema xenoplax*) or root lesion nematode (*Pratylenchus vulnus*) and sampling indicates either of these species is present. A solid application, when done properly, can provide control for up to 6 years.

If sampling indicates that only root-knot nematode is present, or if the orchard has soils that are not conducive to the development of high numbers of ring nematode, or the rootstock being used is resistant to these nematodes, a strip or spot fumigation can be made. Strip or spot applications provide about 6 months of control.

Formulations with chloropicrin may be used where other diseases are present, or because chloropicrin's odor helps to indicate the presence of the gas.

- Use the highest rate recommended for the soil conditions within the profile. For example, if a soil has a loamy sand surface layer with 5% soil moisture and a subsurface loam layer with 10% moisture, use the higher rate given for the loam.
- Do not plant for one month after tarps have been removed. If soils become cold (below 50°F) soon after treatment, an additional 30- to 60-day waiting period before planting may be necessary.
- Observe the waiting period on the fumigant container label, then plant young trees on resistant rootstocks, when available.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's propertiesand application timing, honey bees, and environmental impact.* ***Always read the label of the product being used.***

PREPLANT

A.	1,3 DICHLOROPROPENE*/CHLOROPICRIN (Telone C-35)	Label rates	See label	See label
	COMMENTS: Must be applied by a regulated commercial applicator. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.			
B.	1,3 DICHLOROPROPENE* (Telone II)	Label rates	See label	NA
	COMMENTS: Must be applied by a regulated commercial applicator. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.			

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

NA Not applicable.

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

Weeds

(Section reviewed 8/17)

INTEGRATED WEED MANAGEMENT (8/17)

Weed management is an integral part of an overall orchard management system. A good weed management program should start before trees are planted. The more difficult-to-control weeds (particularly perennial species) are easier to manage before trees are planted. Weed control in orchards enhances the establishment of newly planted trees and can improve the growth and yield of established trees.

Competition is most severe during the first four years. Weeds can reduce tree growth and yield by competing for water, nutrients, and sunlight. They also interfere with irrigation uniformity and distribution and, once the trees reach bearing age, can reduce harvest efficiency by making it more difficult to recover nuts from the orchard floor. Maintain a weed-free strip at least 30 inches from the trunk on each side of the tree to prevent weeds from competing with the developing tree.

Plants growing on the orchard floor influence the presence of other pests such as vertebrates, insects, mites, nematodes, and diseases.

- Weeds growing around the trunk compete directly with young tree growth, and provide a good habitat for field mice or voles.
- Gophers are most often found in nontilled orchards and are common where broadleaf weeds, such as field bindweed and perennial clovers, predominate.
- Crown rot in trees can also be a problem when weeds are allowed to remain around the trunks. Weeds must be controlled around the trunks, preferably without disks or other mechanical control that may cut roots or hit the trunks or main roots and cause wounding. These wounds are often an entry point for crown or root pathogens, such as crown gall.

Weeds are usually controlled either chemically or mechanically in a 4- to 10-foot-wide strip (depending on crop and age) in the tree row. The area between the tree rows may be sprayed, mowed, or tilled. Mulches, subsurface irrigation, and flamers can also be used to control weeds in orchards. Growers have many weed management tools available to achieve this objective, but the method in which these tools are utilized varies from year to year and orchard to orchard.

Soil Type Considerations

Soil characteristics play an important role in weed management. Soil texture and organic matter influence the composition of weed species present, the number and timing of cultivations required, and the residual activity of herbicides.

- On light textured soils, annual species such as puncturevine, crabgrass, horseweed, and *Panicum* spp., and perennial weeds such as johnsongrass, nutsedge, and bermudagrass are more prevalent.
- On heavier-textured soils, perennial weeds such as curly dock, field bindweed, and dallisgrass are commonly found.
- Higher rates of preemergence herbicides may be needed in clay or clay loam soils to achieve the same level of weed control as a lower rate in light, sandy soils. Many herbicide labels recommend that lower rates of the product be used on soils considered high in sand or low in organic matter.
- Soil texture affects water-holding capacity, which influences irrigation frequency and amounts. Soil moisture and wet-dry cycles can influence weed germination and establishment as well as persistence of residual herbicides.

Irrigation System Considerations

Weed growth is affected by the method of irrigation, amount of water applied, amount and timing of rainfall received, frequency and timing of cultivation, the herbicides used and their residual soil activity.

- During dry winters or in orchards with limited irrigation capacity during certain times of the year, effective weed control can increase soil water that is available to the trees.

- Frequent wetting also promotes herbicide degradation in the soil and, thus, degradation is generally faster under drip emitters, or micro-sprinklers, than under furrow irrigation.

Areas around sprinklers and emitters may require additional weed control measures, such as a postemergence herbicide applications or removal by hand. However, in the dry area between the sprinklers, weeds are less of a problem than in orchards with other types of irrigation. The first irrigation following an herbicide application is the most critical in determining the depth the herbicide is moved into the soil; subsequent irrigation is less important to the movement of the herbicide.

Preemergence herbicides can be incorporated using tillage, rainfall, or sprinkler, but not drip or furrow, irrigation. Flood irrigation will provide uniform incorporation of herbicides ONLY when the water distribution is uniform. Even when distribution is uniform, more water is usually applied by flood irrigation than is needed for herbicide incorporation; in sandy soils, excess irrigation water may move the herbicide deeper in the soil than is desired for optimum weed control. In furrow and basin flood systems with berms, preemergence herbicides dissipate more slowly on the berms because the soil surface in this area remains drier.

Choosing an Herbicide

Herbicides are traditionally discussed as belonging to two groups: those that are active against germinating weed seeds and very small seedlings (preemergence herbicides) and those active on emerged, growing plants (postemergence herbicides). Some herbicides have both pre- and postemergence activity. Herbicides vary in their ability to control different weed species. Before using any herbicide, identify the weed species to be controlled, then check the Susceptibility of Weeds to Herbicide Control tables and carefully follow the product labels for specific weed control activity. In most situations, combinations or sequential applications of herbicides will be required to provide effective and economical year-round control of a broad spectrum of weeds.

MONITORING

Detecting new weeds and weeds that escaped previous control efforts is essential for preventing weed establishment or identifying 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 that it be done at the right time and to correctly identify the weed species present in and around the orchard. Annual weeds generally fall into those that germinate in the fall and early winter (November–January) and those that germinate in the spring and summer (March–August). Try to identify and control weeds when they are in the seedling stage. 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.

Many herbicides are effective only against certain weed species. Regular monitoring will help to properly choose and time treatments. Follow-up monitoring allows you to assess if treatments were successful. Weeds often grow in patches, so it may not be necessary to apply postemergence herbicides or use mechanical control in the whole orchard. A spot treatment may save time and money while still achieving good weed control. Use the susceptibility charts in this guideline to determine alternative herbicides to control the weeds that escaped previous herbicide treatments.

Weed species that are not controlled by herbicides listed as effective against these weeds should be a warning to the manager: if there is no obvious pattern that could be attributed to sprayer malfunction or a misapplication, then herbicide resistance could be developing. See *Herbicide Resistance: Definition and Management Strategies*, UC ANR Leaflet 8012 and *Preventing and Managing Glyphosate-Resistant Weeds in Orchards and Vineyards*, UC ANR Publication 8501, *(available online)* for suggestions on how to adjust management to avoid development of herbicide resistance.

How to Monitor

- Survey your orchard for weeds in late fall and again in late spring
- 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.

- Examine all areas that are susceptible to weed infestation, like areas of high moisture. Important information includes 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 on a survey form that includes a map so the infested sites can be revisited for weed control. Pay particular attention to perennial weeds and other problem weeds and note their location on the map.
- Record weeds found in rows and middles separately. Weeds in tree rows must be managed, but annual weeds in row middles may have some benefit as an orchard floor cover.

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 actions including timing, rates and dates of herbicide applications and cultivations can help in evaluating the success of the techniques used and in deciding future strategies.

Late fall weed survey

Survey your orchard after the first rains of the fall when winter annuals have germinated and started to emerge. Monitoring weeds in fall accomplishes several tasks. It will identify remaining summer species and perennial weeds that escaped the previous year's weed control program so that adjustments can be made to control these species in the next year. Fall monitoring will also identify winter species that are emerging. Keep records of your observations and use the map to show areas of problem weeds (*example weed survey form*

Late spring weed survey

Survey your orchard in late spring or early summer, after summer annuals have started emerging. By surveying weeds at this time, you can identify any species that escape control from earlier management and know what perennial weeds are present. If herbicides were used, monitoring can help identify any need for changing to another herbicide. Pay particular attention to perennial weeds and check for their regrowth a few weeks after a mechanical or chemical control operation. Keep records of your observations and use the map to show areas of problem weeds (*example weed survey form* .

WEED MANAGEMENT BEFORE PLANTING

- Grade the orchard site to ensure even drainage. Low spots within the orchard promote perennial weed growth that is difficult to control and causes continuing problems. Maintain proper drainage, which keeps puddles from forming within the tree row. Puddles accelerate the dissipation of herbicides; this leads to weed growth that competes with the young treesAvoid fields known to be infested with perennial weeds such as johnsongrass, field bindweed, bermudagrass, and nutsedge whenever possible.
- Control annual and perennial weeds before planting an orchard to reduce competition during orchard establishment.
- Control annual weeds before they produce seeds and established stands of perennial weeds before trees are planted. This will also reduce potential injury to young trees from herbicides that would otherwise be used after planting the trees.

Nonchemical controls

Cultivation, followed by irrigation to germinate new weeds, and then cultivation again to kill weed seedlings is an especially effective weed control method that can be used before planting trees. Several cycles of germination and unsuccessful establishment reduces the number of weed seeds in the upper layers of the soil, thus reducing weed numbers. At least two cycles of cultivation, then irrigation, followed by a shallow cultivation are needed to achieve a marked reduction in weed seedlings. This method is not effective for established perennial weeds.

Cultivation when the soil is very dry is an effective method to control perennial grasses such as bermudagrass and johnsongrass. Cultivation cuts the rhizomes into small pieces so they can dry out. Rework the soil frequently with a spring tooth harrow to pull new rhizomes to the surface to dry out. If the site is irrigated, or rain occurs before total control of the perennial plant is achieved, the rhizome pieces may begin to grow, which can greatly reduce the effectiveness of this practice. Tillage in moist or wet soil can increase the number of perennial weeds because each piece of cut rhizome can root and develop into a new plant.

Field bindweed growth can be reduced for up to two years by deep plowing or using a reclamation blade (a large V-shaped blade) to cut the roots at a depth of 16 to 18 inches in dry soil. Nutsedge infestations can be reduced by deep plowing with large moldboard plows that bury the nutlets to a depth of at least 12 inches, but, subsequent deep plowing may bring viable seeds and nutlets back to the surface. Seedlings of annual and many perennial weeds can be controlled with repeated, timely cultivation.

Chemical control

Annual weeds can be controlled with preemergence herbicides before planting an orchard. Any established annual weeds should first be controlled with postemergence herbicides. Preemergence herbicides should be used in conjunction with a rotation crop, making sure the residual period of the herbicide is not so long that it will interfere with planting the trees. Most annual weeds can be controlled in a strip down the proposed tree row by using a preemergence herbicide (e.g., Treflan) and incorporating it into the soil. However, many growers prefer to use preemergence herbicides only after the trees have been planted and soil has settled around the plants to avoid possible exposure to herbicides that may be in the backfill soil.

When planting trees, be careful not to mix preemergence herbicide-treated soil into the planting hole or severe injury can result. When planting the trees, place untreated soil (from the untreated middles) directly around the roots and then cover it with a surface layer of treated soil. Many growers use glyphosate before planting and then follow planting with an application of a preemergence herbicide after the soil has settled. Follow all label plantback restrictions in orchard sites where preemergence herbicides have been used.

Postemergence herbicides generally have a little or no soil residual activity and typically are safer to use before planting trees. A common practice to control perennial weeds such as dallisgrass, bermudagrass, and johnsongrass is to apply glyphosate (Roundup) in summer when the weeds are growing vigorously and then follow with cultivation 2 weeks later. If the soil and plant material can be dried after treatment, increased control is achieved. Field bindweed can be suppressed, but usually is not eradicated with this method.

Soil solarization

Soil solarization is a nonpesticidal method of controlling soil-borne pests by placing clear plastic sheets on moist soil during periods of long day length. Soil solarization can be used in the area planned for tree rows to significantly reduce weed numbers and species. The plastic sheets trap the sun's radiant energy in the soil, heating the upper levels to temperatures (108–131°F at a depth of about 3 inches) that kill many disease-causing organisms (pathogens), nematodes, and weed seeds and seedlings.

In areas where summer fog is not a concern, solarization should be done when day length is as long as possible (from mid-June to mid-August), or at the latest by the beginning of August to have sufficient time (4 to 6 weeks) to complete the process. In areas where summer fog is prevalent, solarization should be done during the warm fall months when there are fewer foggy days. The soil in the area designated for solarization must be moist and the treated area should be at least 6 feet wide. Use 1.5 to 2 mil thick clear plastic that is impregnated with a UV-inhibiting component to ensure that it will not break down before solarization is completed. Black plastic suppresses weed-seed germination but will not heat the soil to the same degree as clear plastic.

Effective soil solarization begins with preparing a smooth seed bed so the plastic can be placed as close as possible to the soil surface.

- Disc to break up clods and then smooth the soil (e.g. with a roller).
- Remove any material that will puncture or raise the plastic sheets such as rocks and weeds.
- Irrigate before or after applying the plastic because wet soil conducts heat better than dry soil.
- If irrigating before applying the plastic: cover the soil with plastic as soon as feasible after irrigating. After irrigation, allow the soil to dry somewhat to avoid compaction by heavy equipment.
- To irrigate after laying the plastic: install the drip system or microsprinkler line (with only the spaghetti tubing) before planting or use furrow irrigation under the plastic. (If the entire site is irrigated, weed growth will occur in the untarped centers and will be difficult to control without disturbing the plastic.) The plastic should be buried on all sides to create a seal on the soil and help prevent the plastic from being blown away by wind.

Implements are available that assist in laying down the plastic and automate this otherwise labor-intensive process.
- Remove plastic before planting.
- Cultivate solarized soil less than 3 inches deep to avoid bringing viable weed seeds to the surface where they can germinate and establish.

The effect of solarization diminishes at greater depths, and it does not control perennial species as well as annuals. Seeds and seedlings of bermudagrass, johnsongrass, and field bindweed are controlled, but established plants are more difficult to control. Yellow nutsedge is partially controlled, while purple nutsedge is not significantly affected. Solarization leaves no toxic residues and can be used on a small or large scale. Soil solarization may also improve soil structure and increases the availability of nitrogen (N) and other essential plant nutrients.

For additional information see *Soil Solarization*, U.C. Publications, 21377.

WEED MANAGEMENT IN TREE ROW

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 orchards with effective weed management. Regardless of the method to control weeds, care must be taken not to injure the young trees with herbicides or to mechanically damage the trunk or roots. As the orchard becomes established, competition from weeds is lessened as shade from the tree canopy, especially in densely-planted orchards or in orchards with large-stature trees, reduces weed growth.

Weeds growing directly around the bases of trees can be controlled using a number of methods. A selective preemergence herbicide can be applied in a strip down the tree row or around the tree as soon as the soil has settled following planting. Do not let the spray contact tree leaves or the bark of trees less than 3 years old. Cardboard cartons are often used to protect trees at this stage. Trees are most sensitive to herbicides when they are young.

The area around young trees may also be hand hoed until the trees are 3 to 4 years old, at which point a swing mower or disc can be used to control the weeds between the tree rows. Other in-row mechanical tools available include discs, weed knives, cultivators, and rotary tillers. It is best to hoe when the weeds are a few inches tall; hoeing becomes difficult when weeds are allowed to get larger. Another alternative is the use of synthetic mulches made of polyethylene, polypropylene, or polyester around the base of trees to discourage weed growth; the weeds between the tree rows can be mowed or disced. However use these mulches with caution, since they may harbor voles that may feed on tree trunks.

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. Cartons, sleeves, or wraps can help to protect trees from string trimmers. 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 during the nonbearing period (normally four–six years) before the trees are at full production. Certain herbicides are registered for use only during this nonbearing period.

Preemergence herbicides

If using preemergence herbicides to control weeds in a newly planted orchard, apply them to the soil only after the soil has completely settled around the trees 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. Refer to the HERBICIDE TREATMENT TABLE for herbicides registered, tree age restrictions, and general label recommendations.

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

Established Orchards
Depending on the species and variety, it usually takes about 3 to 7 years in most situations for nut trees to come into production. Once the orchard is established, the area around the base of the tree should continue to be kept weed-free. By removing weeds from around the base of the tree, weed competition and the potential for rodent damage are reduced. In conventional orchards weeds are generally controlled between the tree rows by discing or mowing (see middles management) and in the tree row with an herbicide strip or with cultivation.

Herbicides
Herbicides are traditionally discussed as belonging to two groups: those that are active against germinating weed seeds (preemergence herbicides) and those active on emerged plants (postemergence herbicides). Some herbicides have both pre- and postemergence activity. In most orchards, herbicides are only used on a 4- to 10-feet-wide strip (depending on crop) centered on the tree row.

Preemergence herbicides
Preemergence herbicides are active in the soil against germinating weed seedlings. These herbicides should be applied to bare soil and then moved into the soil with rain or irrigation, where they can affect germinating weed seeds. If herbicides remain on the soil surface without being activated by rain or irrigation, some will degrade rapidly from sunlight and the resulting weed control will be reduced. Large weed seeds, such as wild oat, may germinate in the soil below the herbicide zone and not be controlled by the treatment.

For best results, most preemergence herbicides should be applied to the soil just prior to an irrigation or rainfall (0.25-0.5 inches) to be moved into the soil where the weed seeds germinate. Do not make an application if a large amount of precipitation is expected in a short period, as runoff or leaching of the herbicide may occur. Preemergence herbicides can provide control for several months or up to a year, depending on the soil type, solubility of the material, adsorption of the material to soil, the weed species present, and the dosage applied. Leaching from the soil is more extensive on sandy than on clay soils. Leaves or other debris covering the tree row can prevent the herbicide from contacting the soil; performance can often be increased by blowing or sweeping the rows right before application of preemergence herbicides.

Proper incorporation is important for the effectiveness of preemergence herbicides. This may be achieved mechanically (power incorporation or discing) or through irrigation. Rainfall may also be used for herbicide incorporation; however, weeds may germinate before a consistent rainfall pattern is established. As a result, postemergence herbicides are often used in combination with preemergence herbicides to control weeds that have germinated and emerged before the preemergence herbicide is properly incorporated.

Postemergence herbicides
Postemergence herbicides are applied to control weeds that have germinated and emerged. They can be combined with preemergence herbicides early in the season, alone as a broadcast treatment, or as spot treatments during the growing season. The trunks and foliage of young trees need to be protected from contact with some postemergence herbicides. Be sure to check and follow individual label instructions. Select the appropriate postemergence herbicide that best controls the weeds present. A tank mix of one or more herbicides may be required to control all the weeds.

Apply postemergence herbicides when weeds are small and not under moisture stress. If the weed population is sparse or patchy, the amount of herbicide needed can be reduced by making spot applications or by using a visual weed-seeking sprayer. Some weeds, like spotted spurge, set seed soon after emergence, so they must be treated frequently to provide adequate control if a postemergence-only strategy is used.

Postemergence herbicides are used on established weeds. Contact herbicides, such as paraquat, kill those parts of the plant that are actually sprayed, making good coverage and wetting essential. A single treatment can kill susceptible annual weeds but re-treatment is necessary if perennial weeds regrow from roots or other underground structures or if new germination of annual weeds occurs after the initial application. Translocated herbicides, such as glyphosate, move into the plant and are moved to other above- and below-ground portions of the plant and kill them. (glyphosate, however, does not translocate into mature nutsedge tubers.) Complete coverage with translocated herbicides is not as essential as with contact herbicides but better coverage will often result in better weed control efficacy with both types of herbicides.

Postemergence herbicides usually require the addition of an adjuvant (either a nonionic surfactant or a nonphytotoxic oil) to be effective. Ammonium sulfate is often added to the spray water first, before adding herbicide(s), to condition the water and help improve herbicide uptake by weeds, particularly where water high in calcium, sodium, magnesium, and iron is used. Many factors affect the performance of postemergence herbicides including: dust, spray volume, and hard water. For more information on the effective use of postemergence herbicides, see *Glyphosate Stewardship: Maintaining the Effectiveness of a Widely Used Herbicide*, ANR Publication 8492.

Application equipment must be accurately calibrated to apply the proper amount of herbicide to the soil and young growing weeds. For safe application and to minimize drift, spray equipment should be equipped with a short boom that has nozzles designed to minimize the amount of very small spray particles generated. Nozzle technology has advanced significantly in recent years and many manufactures have developed nozzles, or attachments to decrease the proportion of very small droplets in the spray pattern.

Herbicides and irrigation
In established orchards, chemical weed control must be adjusted to the irrigation method used. In California, nut trees 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 orchards because it provides better uniformity in irrigation application and efficiency when compared to other methods. However, low-volume irrigation water applied too frequently can, under certain circumstances, increase the chance of leaching and herbicide degradation, often leaving the areas around the emitters with vigorously growing weeds. It is important to monitor these areas closely and spot treat, when necessary, with postemergence herbicides. Prolonged moist conditions during winter in furrow bottoms or around low-volume emitters during irrigation favor the breakdown and leaching of herbicides.

Cultivation
Cultivation can be used to manage annual and biennial weeds both between and within tree rows. Large weeds, perennial species, or weeds with hardy roots or crowns (like cheeseweed) may not be completely controlled mechanically and require postemergence herbicide treatments. Mechanical methods of weed control include hoeing or using weed knives in the row and cultivating between rows. Mechanical cultivators, such as a Weed Badger, will be effective if used on loose soil that does not contain large rocks. These practices need to be done frequently when weeds are small to reduce competition and seed production. If weeds are allowed to mature the plants often become a fire hazard, but more importantly, can produce enough seeds to ensure many years of weeds.

Weeds within the tree row can be managed with a second pass of the cultivator. However, cross discing 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 postemergence herbicides where appropriate (see section above). 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.

MIDDLES MANAGEMENT

Weed management in orchards is often separated into two categories: weed control in the tree row and weed control in the middles. Weed control in the middle is often combined with cover cropping and known as "middles management."

Some growers prefer to maintain a planted cover crop or resident vegetation because of problems that can develop with repeated discing including:

- soil compaction
- dust
- reduced water infiltration
- soil erosion in hilly terrains and sloping lands

Discing may also bring some buried weed seeds to the surface or spread rhizomes, tubers, or stolons throughout the orchard.

If resident vegetation does not grow uniformly enough to compete well with newly-invading weeds, consider planting a cover crop in the area between the tree rows. An annual cover crop, such as sub-clovers that reseed themselves, will compete against weeds; however, it may also require occasional reseeding to maintain a uniform cover crop stand. 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.

Cover Crops

Two primary reasons for planting a cover crop are: to enhance soil quality by adding organic matter and to increase soil nitrogen with legume cover crops. Other benefits cover crops can provide include:

- improved orchard access during the rainy season
- enhanced water infiltration
- suppression of winter weed species (and summer species if cover crop remains or regrows through late spring)
- reduction of:
    - soil compaction and crusting
    - irrigation and rain runoff
    - off-site movement of pesticides and nitrogen
    - erosion on slopes
    - dust (reduced dust minimizes spider mite infestations)

Plan for the additional water needs of the cover crop so that it does not compete with trees for available water, or, in the case of dryland orchards, disc under the cover crop in spring to maximize the amount of water available to the tree.

Newly established cover crops may be seriously damaged by fall and winter orchard traffic during operations such as pruning, brush removal, chipping and shredding, and spraying. In orchards where these operations are planned, cover crops may be seeded in alternate middles and these operations carried out in the nonseeded middles. Or, plant cover crops in years when these operations are not planned in the orchard.

Although cover crops will be most competitive if mowing is avoided, mowing once before bloom is recommended, especially in almonds, to reduce frost hazard and eliminate pollination competition during flowering. The cover crop will regrow and flower later in the season. However, cover crops that are not mowed or are mowed infrequently in order to reseed also provide excellent cover for gophers. Gopher populations can frequently build up in cover-cropped orchards, and during harvest they have nothing to feed on except tree roots. Thus, it is imperative that gopher control is maintained, regardless of the middles management system employed, but particularly if cover crops are utilized.

An alternative to mowing is to let a cover crop grow until it is nearly mature and then roll it with a ring-roller to press the vegetation down. This accelerates the senescence process but allows for some seeds to mature. In addition, the intact mulch shades the soil and may prevent some weed seeds from germinating. This mulch

usually degrades by harvest, but if it hasn't degraded at least 3 weeks before harvest, a close mowing with a flail mower will chop the cover crop into pieces that will degrade or not interfere with harvest operations.

A once common practice was 'chemical mowing' in which the vegetation middles, consisting of either resident plants or a planted cover crop were treated with low rates of postemergence herbicide to stunt the plants rather than killing them. This practice is no longer recommended due the potential selection for herbicide-resistant weeds.

For more information on choosing a cover crop, how and when to plant, and suggestions of cover crop mixes, consult UC ANR Publication 21471, *Covercrops for California Agriculture* (*available online)*

HERBICIDE RESISTANCE

Herbicide resistance is the inherited ability of weeds to survive and grow at herbicide dosages many times greater than what is usually needed for control of that species. The potential risk for the development of herbicide resistance is greatest when the same herbicide is used repeatedly, as is often done in orchards. To prevent the development of herbicide resistance, use a variety of weed-control strategies, including cultural practices and alternating herbicides with different modes of action. Failure to do this can result in the rapid loss of herbicides as an effective pest management tool, although cultivation remains an option.

If resistant populations are observed, avoid moving resistant weeds from one field to another by cleaning equipment before moving out of a field with known herbicide-resistant weeds. Consider scheduling fields with known resistance problems as the last ones for field operations. Some populations of annual bluegrass (*Poa annua*), horseweed *(Conyza canadensis)*, annual or Italian ryegrass *(Lolium multiflorum),* junglerice *(Echinochloa colona),* and hairy fleabane *(Conyza bonariensis)* have developed resistance to glyphosate in California.

Detection

The first step in preventing herbicide resistance is early detection. Be on the lookout when monitoring for patterns that indicate resistance including:

- patches of dense weeds, with less dense populations radiating out from the central patch.
- weeds that have escaped control scattered in no particular pattern throughout the field.

Prevention and Management

One of the most important control strategies in managing resistant populations of these weeds is to not let the plants produce seed. To help prevent the development of resistance to herbicides in orchards:

- Rotate herbicides that have different modes of action and WSSA group numbers.
- Monitor for weed survival after an herbicide application.
- Include nonchemical weed-control methods such as cultivation or hand weeding.
- Clean equipment after working in weed-contaminated orchards to prevent the spread of weed seeds.
- Control weeds suspected of herbicide resistance before they can produce seed.
- If weeds escape treatment, use shovels, hoes, and other hand tools to cut the plants below the soil surface to prevent flowering.
- Use a preemergence herbicide before weeds emerge. Where the weeds emerge in fall and spring, consider splitting applications to meet the multiple emergence windows.

If horseweed and hairy fleabane are already growing in the orchard, either treat them with a postemergence herbicide or use mechanical cultivation before they get larger than 18 to 21 leaves. In established orchards, use 2,4-D, glufosinate (Rely 280), or saflufenacil (Treevix) to control these weeds early. Glyphosate can also work well for the non-resistant horseweeds if rates are 1 to 2 lb a.i./acre but even on the susceptible populations, control is best when plants are small. Mixing 2,4-D or glufosinate with glyphosate will improve control if resistance is suspected. Similarly, glyphosate-resistant ryegrass can be controlled with alternative herbicides such as paraquat (Gramoxone SL) or glufosinate if used at the appropriate stage. Closely monitor the weeds following treatment to assess the treatment's effectiveness.

For more information on herbicide resistance, see *Selection Pressure, Shifting Populations, and Herbicide Resistance and Tolerance*, UC ANR Publication 8493 and *Preventing and Managing Glyphosate-Resistant Weeds in Orchards and Vineyards*, UC ANR Publication 8501.

WEED MANAGEMENT IN ORGANIC ORCHARDS (8/17)

Weed control in organically managed orchards requires special attention to prevent problems before they start. Any method that reduces the amount of weed seed in the orchard will diminish weed numbers over time. One of the best ways to prevent weed problems is to control existing weeds before they go to seed. It is usually best to use conventional tactics, including synthetic herbicides, for one or two years after planting; this helps reduce the weed seed bank and weed numbers, and makes weed control by organically-approved means less expensive later. However, this approach will require three more years of *not* using synthetic herbicides in the orchard for it to be certified as organic. If the site is not already certified organic, herbicides can be used until the transition time to organic begins, which can be very helpful in ridding the area of these hard-to-control perennial weeds.

It is essential to correctly identify the diversity of weeds infesting the orchard or planting site. Become familiar with each weed's growth and reproductive habits in order to choose the most effective management options. See the weed photos linked to the weeds in the list of COMMON AND SCIENTIFIC NAMES OF WEEDS.

Transitioning mature, full-canopied trees to organic production will require less intensive weed management than starting out as a new organic orchard. Mature, shady orchards often have limited weed growth, whereas weeds can more effectively compete with trees in newly planted orchards where there is more sunlight available to the weeds.

WEED MANAGEMENT BEFORE PLANTING

The season before trees are planted is a critical period for weed management, so young trees can become established with reduced competition from weeds. Two methods of managing weeds at this time are cultivation and soil solarization.

Cultivation

Repeating a cycle of irrigation followed by cultivation several times to germinate and destroy young weeds can reduce the amount of weed seed in the orchard soil. Cultivation works well with summer annuals but not as well with perennial weeds such as nutsedge, field bindweed, bermudagrass, and johnsongrass. If the site is not already certified organic, herbicides can be used until the transition time to organic begins. This can be very helpful in ridding the area of these hard-to-control perennial species. Or, if most of the weed seeds are located in the surface 4 inches of soil, a soil-inverting plow can be used to bury them deeply so that they cannot germinate or successfully emerge. Use a soil-inverting plow such as a Kverneland plow because a standard moldboard plow will not sufficiently invert the soil in most cases.

Soil solarization Soil solarization can significantly reduce weed numbers in the planned tree rows. For more information on solarization, see the Soil Solarization section above.

WEED MANAGEMENT AFTER PLANTING

Controlling weeds while they are small is important for the most effective organic weed control.

Tree-row management

During the non-bearing years, mulch may be used to control weeds in the orchards. Maintain the mulch layer throughout the year. In-row mulches of woven fabric or a 4-inch layer of organic materials including compost, newspaper, straw, hay, and wood chips control weeds by preventing light penetration necessary for weed growth. The weed fabrics typically last 4 to 5 years. Since organic mulches may reduce the soil temperature slightly, it is often better to apply these materials when the trees have been in the ground for at least one full year to avoid the possibility of reduced tree growth. Both organic and fabric mulches may need to be removed when production starts, as they can interfere with harvest operations. Be sure to monitor for voles and gophers, as mulches provide cover for them and these vertebrate pests can be severely damaging to young trees. Once the trees are established, weeds in the tree row may be managed with shallow in-row cultivation, cross discing, cross mowing, hand hoeing, flaming, organically acceptable herbicides, or mulches. The choice of method depends in part on costs, tree spacing, the use of berms, orchard floor management practices, and the type of irrigation system.

In-row cultivation

In-row cultivators are equipped with a sensor or trigger mechanism that pivots the cutting arm around the tree to avoid injury. Several companies make cultivation equipment; those that have performed well include equipment from Bezzerides, Kimco, and L & H Manufacturing. They are more effective on smaller weeds.

- Sprinkler-irrigated orchards require extra precautions to ensure proper operation of the trigger mechanism on the cultivator so that it moves away from the sprinkler head in the same way as it does for the tree.
- Microsprinkler irrigation lines and emitters can be protected from damage by suspending the surface lines, with the microsprinklers positioned upside down, in the trees or on stakes.
- Drip lines may be buried or suspended above the soil to avoid damage.
- Furrow-irrigated orchards are amenable to in-row cultivation.

Flaming

Flaming can effectively manage in-row weeds that are smaller than eight leaves.

- Protect the trunks of young trees from flamers to avoid injury to the cambium layer of the tree.
- Keep flamers away from the plastic irrigation tubing.
- Flamer should be used on green vegetation and not in orchards with dried vegetation in order to avoid fires that may injure trees and irrigations systems or spread out of control. The flamer is passed quickly over the green vegetation to damage cells, not to start the plant on fire.
- Suspend microsprinkler irrigation lines and emitters in the trees or on stakes with the emitters positioned upside down, and bury drip lines to prevent damage to irrigation equipment.

When flaming is used repeatedly, grasses will eventually become the dominant weeds because their growing points are at or below soil level and are not readily killed with flaming. Also, perennial weeds can be suppressed, but usually are not controlled with flaming.

Organically-Approved Herbicides

Check with the organic licensing organization to determine current status and any use restrictions for organically acceptable herbicides. As with any contact herbicides, good coverage is essential. In most cases, a spray volume of at least 60 gallons per acre will be required when using these products.

- Repeated applications are necessary to control newly emerged weeds.
- Efficacy is greatest on seedlings or small weeds.
- Add an organically-acceptable surfactant to improve efficacy.
- Avoid spraying tree foliage to prevent injury to green tissue.

Broadcast application of organic herbicides is usually not economical. However, organic herbicides are useful for spot treatments, particularly to control weeds in mulches, because this will help to preserve the mulch and increase its useful life span.

Weeding animals

Before using any animals, check federal, state, and local food safety regulations and comply with them. Consult the University of Idaho and University of Missouri websites for further information on grazing animals.

Weeder geese

Geese can be used to manage grass weeds in orchards. Geese prefer grass species and will only eat other weeds and crops after the grasses are gone. If confined, they will even dig up and eat johnsongrass and bermudagrass rhizomes, which they prefer. These grasses are otherwise difficult to manage in organic systems.

Young geese are best because they eat larger quantities of food, although having at least one older goose helps to protect the younger birds. Generally, about four geese per acre are needed. Provide geese with drinking water and shade. Protect them from dogs and other predators; portable fencing works well. Consult the Metzer Farms website for further information on geese.

Other animals

Sheep and goats are sometimes used in organic orchards as well. Sheep will effectively remove all weeds down to ground level. Goats are browsers and must be carefully managed to avoid damage, especially to young trees. Both sheep and goats are generally used during the time when trees are dormant and the chance of grazing damage is minimal. Because of the need to maintain animal health and condition, grazing animals generally suppress weeds rather than fully control them. Use of animals for weed control in tree nut orchards raises some concerns about food borne illness and should be considered and managed carefully if used.

SPECIAL WEED PROBLEMS (8/17)

Currently registered preemergence herbicides will control only seedlings of annual and some perennial weeds. Repeated postemergence treatments are required to control perennials. While they are best controlled (preferably eradicated) before planting, if these weeds are still present after planting, a program is needed for their control. With these treatments, there is always some concern of injury to trees from careless application.

HERBICIDE-RESISTANT WEEDS

Some populations of annual bluegrass (*Poa annua*), horseweed *(Conyza canadensis)*, annual or Italian ryegrass *(Lolium multiflorum)*, junglerice *(Echinochloa colona)*, and hairy fleabane *(Conyza bonariensis)* have developed resistance to glyphosate in California. For more information on treating herbicide-resistant weeds, see INTEGRATED WEED MANAGEMENT.

PERENNIALS

Primary species that are difficult to control are the perennial grasses and broadleaf weeds. In mature orchards with heavy shade, perennial weeds will be a minimal problem. It will be necessary to control seedlings of these weeds with preemergence materials or spot treatments of glyphosate (Roundup) or paraquat before they become established. Seed from the grass species can last at least 2 years in soil, while seeds of the broadleaf weeds may last 10 to 60 years in the soil, depending upon species. Therefore, frequent monitoring is necessary for continued control. Do not allow perennial plants to reestablish or to produce seed.

BERMUDAGRASS

Bermudagrass is a vigorous spring- and summer-growing perennial grass. It grows from seed but, because of its extensive system of rhizomes and stolons, can also be spread during cultivation. It frequently becomes a problem in mowed orchards because mowing increases the amount of light that the stolons receive, thus stimulating their growth. This grass is very competitive with the trees for moisture and nutrients. Seedlings can be controlled with preemergence herbicides. If bermudagrass develops in localized areas, immediately spot-treat it with postemergence herbicides such as glyphosate (Roundup).

CURLY DOCK, DANDELION, and JOHNSONGRASS

Johnsongrass, dandelion, and curly dock may be controlled with multiple applications of glyphosate (Roundup, Touchdown), but use carefully around newly planted trees.

To achieve the best control with postemergence contact herbicides, cultivate the weeds to chop the stems, crowns, and rhizomes into small pieces, then irrigate to encourage regrowth and a lot of leaf area on the weeds. Spray before the weeds flower or set seed. Good coverage is important and spot treatment of regrowth may be needed. In young trees, fluazifop or sethoxydim can be used to control grasses without risk of tree injury. Curly dock can also be suppressed with 2,4-D applications, while dandelion can be controlled with 2,4-D. A permit is required for this material. Use 2,4-D with caution in tree nut orchards to prevent tree damage.

DALLISGRASS

Dallisgrass is a common perennial weed and can be highly competitive in newly-planted orchards. Dallisgrass seedlings germinate in spring and summer; this species can also form new plants on short rhizomes that develop from the original root system. Seedlings can be controlled with cultivation or with preemergence herbicides. Dallisgrass has a clumpy growth habit that gives it a bunchgrass appearance. Like bermudagrass, it tends to become dominant in mowed areas because mowing stimulates seed set. It also grows in areas with standing water. The plants are heavy seed producers. Treatment with glyphosate has been successful in controlling dallisgrass infestations.

FIELD BINDWEED

Field bindweed is a vigorous perennial weed that either grows from seed (which can survive for up to 30 years in the soil) or from stolons, rhizomes, or extensive roots. Because of the seed's longevity in the soil, it is critical to destroy plants before they can produce seed. The plants may spread from stem or root sections that are cut during

cultivation: however, cultivation when the soil is dry controls seedlings. If field bindweed appears in or around the orchard, spot-treat with high label rates of glyphosate, especially when the bindweed is actively growing.

NUTSEDGE

Yellow nutsedge is a difficult-to-control perennial weed that reproduces from underground tubers, which survive for 2 to 5 years in the soil. The tubers are easily spread by cultivation equipment. Each tuber contains several buds that are capable of producing plants. One or two buds germinate to form new plants; however, if the plant is destroyed by cultivation or an herbicide, then a new bud in the tuber may be activated.

In established orchards, if nutsedge develops, spot-treat it with glyphosate (Roundup). Then re-treat it before the plant reaches the five-leaf stage. New nutlets do not form if the plants are re-treated at or before this stage. As with seedling bindweed, young nutsedge can be controlled by cultivating when the soil is dry.

Nutsedge is a particular problem in young orchards or around replacement trees because it does best in full sun conditions.

COMMON PURSLANE

Common purslane is a prostrate summer annual that reproduces from seed, which germinate in April to early May. Common purslane grows into a plant with fleshy stems, which can root and continue to grow after cultivation or mowing if sufficient moisture is present. Common purslane can cause problems with both nut drying and pick-up during harvest operations.

This weed predominates in sunny areas of the orchard, especially if low rates of translocated herbicides (e.g., glyphosate) are used as preharvest sprays. If problems develop with this weed, use higher rates of glyphosate to control it.

A low-rate preemergence herbicide program can also effectively manage this weed and reduce the need for preharvest treatments. Pendimethalin (Prowl H2O) at 1 quart/acre applied with glyphosate in April to the area between the tree rows in the orchard can provide season-long control. Monitor the rates used and adjust them so that populations of winter annual vegetation such as annual bluegrass are preserved.

HAIRY FLEABANE

Hairy fleabane is an annual plant that normally emerges in late fall and early spring but can also emerge during winter if temperatures are relatively warm. This plant can withstand several mowings and still produce seed. It is not a good plant to have in a ground cover because its hard stem does not degrade easily and can cause harvest problems. In addition, it can interfere with moving sprinkler and drip irrigation lines. Simazine is an effective preemergence herbicide for hairy fleabane. Paraquat and saflufenacil can control this species when it is small, but once plants bolt (when they send up flowering stalks), they may not be completely effective. Glyphosate at 1 lb a.e./acre will control susceptible plants up to 13 leaves; for plants with 14 to 19 leaves 2 lb a.e/acre is required. Plants larger than 19 leaves are not adequately controlled. Most populations of hairy fleabane in California are not well controlled with glyphosate; some are also resistant to paraquat.

LITTLE MALLOW (CHEESEWEED)

Little mallow is an annual or biennial weed that is sometimes not effectively controlled with many common preemergence herbicides. High rates of oxyfluorfen (Goal) 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 postemergence herbicides. Plants that are less than 4 to 6 inches tall are easiest to control with a tank mix of oxyfluorfen plus glyphosate. Smaller plants can also be controlled with carfentrazone (Shark) or saflufenacil (Treevix). Repeated mowing is usually not an effective means of control.

COMMON AND SCIENTIFIC NAMES OF WEEDS (8/17)

Common Names	Scientific Names
Asparagus	*Asparagus officinalis*
Barley, hare	*Hordeum leporinum*
Barnyardgrass	*Echinochloa crus-galli*
Bermudagrass	*Cynodon dactylon*
Bindweed, field	*Convolvulus arvensis*
Blackberries	*Rubus spp.*
Bluegrass, annual	*Poa annua*
Bromegrasses	*Bromus spp.*
Burclover, California	*Medicago polymorpha*
Canarygrass	*Phalaris canariensis*
Catsear, common	*Hypochaeris radicata*
Chickweed, common	*Stellaria media*
Clovers	*Trifolium spp.*
Cockleburs	*Xanthium* spp.
Crabgrasses	*Digitaria spp.*
Cudweeds	*Gnaphalium spp.*
Dallisgrass	*Paspalum dilatatum*
Dandelion	*Taraxacum officinale*
Dock, curly	*Rumex crispus*
Fiddlenecks	*Amsinckia* spp.
Filarees	*Erodium spp.*
Fleabane, hairy	*Conyza bonariensis*
Foxtails	*Setaria spp.*
Goosefoot, nettleleaf	*Chenopodium murale*
Groundcherries	*Physalis* spp.
Groundsel, common	*Senecio vulgaris*
Henbit	*Lamium amplexicaule*
Horseweed	*Conyza canadensis*
Johnsongrass	*Sorghum halepense*
Junglerice	*Echinochloa colona*
Knotweed, common	*Polygonum arenastrum*
Knotweed, prostate	*Polygonum aviculare*
Lambsquarters, common	*Chenopodium album*
Lettuce, miner's	*Claytonia perfoliata*
Lettuce, prickly	*Lactuca serriola*
Lovegrasses	*Eragrostis* spp.
Mallow, little (cheeseweed)	*Malva parviflora*
Mustards	*Brassica spp.*
Nettle, burning	*Urtica urens*
Nettles	*Urtica* spp.
Nightshades	*Solanum spp.*
Nutsedge, yellow	*Cyperus esculentus*
Oat, wild	*Avena fatua*
Onion, wild	*Allium canadense*
Pigweeds	*Amaranthus spp.*
Pineappleweed	*Chamomilla suaveolens*
Poison-oak, Pacific	*Toxicodendron diversilobum*

Common Names	Scientific Names
Polypogon, rabbitfoot	*Polypogon monspeliensis*
Puncturevine	*Tribulus terrestris*
Purslane, common	*Portulaca oleracea*
Radish, wild	*Raphanus raphanistrum*
Redmaids (desert rockpurslane)	*Calandrinia ciliate*
Rocket, London	*Sisymbrium irio*
Ryegrasses	*Lolium spp.*
Sandburs	*Cenchrus spp.*
Shepherd's-purse	*Capsella bursa-pastoris*
Sorrel, red	*Rumex acetosella*
Sowthistles	*Sonchus spp.*
Speedwells	*Veronica* spp.
Sprangletops	*Leptochloa spp.*
Spurges	*Euphorbia (=Chamaesyce)* spp.
Star of Bethlehem	*Ornithogalum umbellatum*
Thistle, Russian	*Salsola tragus*
Willowherb, panicle-leaf	*Epilobium brachycarpum*
Witchgrass	*Panicum capillare*

SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL (8/17)

; Corrected 12/18

	PREEMERGENCE								POSTEMERGENCE					
	FLM	ISO	ORY	OXY	PEN	RIM	SIM	TRI	GLU	GLY	OXY	PAR*	RIM	24D*
Mode of Action[1]	14	21	3	14	3	2	5	3	10	9	14	22	2	4
ANNUAL WEEDS														
barley, hare	—	N	C	P	C	—	C	C	—	C	P	C	—	N
bluegrass, annual	—	N	C	P	C	C	C	C	C	C	P	C	C	N
bromegrasses	—	N	C	P	C	C	C	C	C	C	N	C	C	N
clovers	C	P	N	C	P	C	C	N	C	C	P	P	C	P
cudweeds	–	C	N	N	N	C	C	N	C	C	P	N	C	P
filarees	C	C	N	C	C	C	C	P	C	P	C	P	C	C
groundsel, common	C	C	N	C	P	C	C	N	C	C	C	C	C	C
henbit	C	C	P	C	C	C	C	C	C	C	C	C	C	C
mallow, little	C	C	N	C	P	—	N	P	C	P	C	N	—	N
mustards	C	C	N	C	N	—	C	N	C	C	P	C	—	C
nettle, burning	C	C	P	C	N	N	C	N	C	C	P	C	N	C
oat, wild	C	N	C	P	P	P	C	P	C	C	N	C	P	N
radish, wild	—	C	N	C	N	C	C	N	C	C	P	P	C	P
redmaids (desert rockpurslane)	C	—	C	C	C	C	C	C	—	C	C	C	C	C
rocket, London	—	C	N	C	C	C	C	N	C	C	C	C	C	C
ryegrasses	—	N	C	P	C	C	C	C	—	C[2]	N	C	C	N
shepherd's–purse	C	C	N	C	N	C	C	N	C	C	P	C	C	C

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

FLM = flumioxazin (Chateau)
GLU = glufosinate (Rely)
GLY = glyphosate (Roundup)
ISO = isoxaben (Trellis)
ORY = oryzalin (Surflan)
OXY = oxyfluorfen (Goal)
PAR = paraquat* (Gramoxone)
PEN = pendimethalin (Prowl H20)
RIM = Rimsulfuron (Matrix)
SIM = simazine (Princep)
TRI = trifluralin (Treflan)
24D = 2,4-D* (Orchard Master)

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

1 At rates used for annual weeds, control of perennials is less than expected with high label rates.

2 Resistance to glyphosate is appearing.

SUSCEPTIBILITY OF SPRING AND SUMMER WEEDS TO HERBICIDE CONTROL (8/17)

	PREEMERGENCE								POSTEMERGENCE						
	FLM	ISO	ORY	OXY	PEN	RIM	SIM	TRI	GLU	GLY	OXY	PAR*	RIM	SET	24D*
Mode of Action[1]	14	21	3	14	3	2	5	3	10	9	14	22	2	1	4
ANNUAL WEEDS															
barnyardgrass	—	N	C	P	C	C	P	C	C	C	N	P	C	C	N
chickweed, common	C	C	C	P	C	C	C	C	C	C	P	C	C	N	P
crabgrasses	P	N	C	P	C	C	N	C	C	C	P	C	C	C	N
fleabane, hairy	C	C	N	P	N	C	C	N	C	C[1]	P	P	C	N	C
foxtails	—	N	C	N	C	C	C	C	C	C	N	C	C	C	N
goosefoot, nettleleaf	C	C	C	C	P	P	C	C	C	C	P	C	P	N	C
horseweed	C	C	N	P	N	C	C	N	C	C[1]	P	P	C	N	C
junglerice	—	C	C	P	C	—	P	C	—	C[1]	N	P	—	C	N
knotweed, common	C	C	C	C	C	P	C	C	P	P	P	P	P	N	N
lambsquarters, common	C	C	C	C	C	P	C	C	C	C	C	P	P	N	C
lettuce, prickly	C	C	N	C	N	C	C	N	C	C	C	P	C	N	C
mallow, little	C	C	N	C	P	C	N	P	C	P	C	N	C	N	N
nettle, burning	C	C	P	C	C	N	C	N	C	N	P	P	N	N	N
nightshades	C	C	N	C	P	C	C	N	C	C	C	C	C	N	N
pigweeds	C	C	C	C	C	C	C	C	C	C	C	C	C	N	N
puncturevine	—	C	P	P	P	P	P	P	C	C	P	C	P	N	N
purslane, common	C	C	C	C	C	C	C	C	C	C	C	C	C	N	N
sandburs	—	N	C	N	C	—	N	C	—	C	N	P	—	C	C
sowthistles	C	C	N	C	N	C	C	N	C	C	C	P	C	N	N
sprangletops	—	N	P	P	N	P	P	P	C	C	P	P	P	P	N
thistle, Russian	—	C	P	P	P	N	C	P	C	C	P	C	N	N	N
PERENNIAL SEEDLINGS															
bermudagrass	—	N	C	N	C	N	P	C	C	C	P	C	N	C	N
bindweed, field	—	C	C	C	P	P	N	C	C	C	C	C	P	N	C
dallisgrass	—	N	C	N	C	—	C	C	C	C	N	N	—	N	N
dandelion	—	C	N	C	N	C	C	N	C	C	C	N	C	N	C
dock, curly	—	C	P	C	C	P	C	C	C	C	C	C	P	N	C
johnsongrass	C	N	P	N	P	C	P	C	C	C	N	C	C	C	P
PERENNIAL PLANTS															
bermudagrass	—	N	N	N	N	N	N	N	P	C	N	P	N	P	N
bindweed, field	N	C	P	N	N	P	N	P	P	P	N	P	P	N	P
blackberries	—	—	N	N	N	-	N	N	—	C	N	N	-	N	P
dallisgrass	—	N	N	N	N	—	N	N	P	C	N	N	—	P	N
dandelion	—	C	N	N	N	P	N	N	—	P	N	N	P	N	C
dock, curly	—	N	N	N	N	N	N	N	—	P	N	N	N	N	C
johnsongrass	C	N	N	N	N	P	N	P	P	C	N	N	P	P	N
nutsedge, yellow	–	N	N	N	N	P	N	N	P	P	N	N	P	N	P

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

FLM = flumioxazin (Chateau) ORY = oryzalin (Surflan) RIM = rimsulfuron (Matrix) 24D = 2,4-D* (Orchard Master)

GLU = glufosinate (Rely) OXY = oxyfluorfen (Goal) SET = sethoxydim (Poast)

GLY = glyphosate (Roundup) PAR = paraquat* (Gramoxone) SIM = simazine (Princep)

	PREEMERGENCE								POSTEMERGENCE						
	FLM	ISO	ORY	OXY	PEN	RIM	SIM	TRI	GLU	GLY	OXY	PAR*	RIM	SET	24D*

ISO = isoxaben (Trellis) PEN = pendimethalin (Prowl H20) TRI = trifluralin (Treflan)

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

1 Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode of action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://wssa.net/wssa/weed/herbicides/.

2 Resistance to glyphosate is appearing.

HERBICIDE TREATMENT TABLE (8/17)

Herbicide (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are listed alphabetically.*** *When choosing a pesticide, consider information relating to environmental impact, resistance management, the pesticide's properties, and application timing. Tank mixes may be necessary to achieve desired control; see the Susceptibility of Weeds to Herbicide Control for information on specific weed control. Always read the label of the product being used.*

PREPLANT

Preemergence (before weeds germinate)

A. ORYZALIN — 2–6 lb a.i. — 24 — 0
(Surflan A.S.) — 2–6 qt
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: May be applied preplant incorporated or preplant surface before transplanting or after transplanting trees. If using prior to planting, plant tree roots below treated soil and do not place treated soil near roots during planting. Considered safe for young or newly planted trees and on sandy or sandy loam soils. Do not apply over the foliage or buds to avoid crop injury. If rainfall of 0.5 to 1 inch does not occur within 21 days of treatment, sprinkle irrigate with 0.5 to 2 inches of water. Will not control emerged weeds. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

B. PENDIMETHALIN — 1.9–5.985 lb a.i. — 24 — 60
(Prowl H2O) — 2–6.3 qt
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: May be applied preplant incorporated or preplant surface before transplanting or after transplanting trees. If using prior to planting, plant tree roots below treated soil and do not place treated soil near roots during planting. Do not apply to newly seeded nursery stock. Do not apply over the foliage or buds to avoid crop injury. Best control is achieved when irrigation or rainfall occurs within 7 days. Will not control emerged weeds. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

C. TRIFLURALIN — 0.5–1 lb a.i.
(Treflan HFP) — 1–2 pt — 12 — 0
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: Can be used preplant incorporated by power tillage or irrigation. Plant tree roots below treated soil. Do not place treated soil near roots during planting. Recommended rate depends on soil type. Can use spray blade applicator for suppression of field bindweed. Residual period: 2 to 12 months.

Postemergence (after weeds emerge)

A. AMMONIUM NONANOATE
(AXXE)# — 6–15% v/v — 24 — NA
WSSA MODE-OF-ACTION GROUP NUMBER[1]: —
COMMENTS: Do not apply to weeds wet from dew rain or irrigation or if rain or irrigation is expected within 2 hours.

B. CAPRIC ACID/CAPRYLIC ACID
(Suppress)# — 3–9% v/v — 24 — NA
WSSA MODE-OF-ACTION GROUP NUMBER[1]: —
COMMENTS: Apply as a directed spray; avoid green bark. Do not apply to weeds wet from dew rain or irrigation or if rain or irrigation is expected within 4 hours.

C. GLYPHOSATE — 0.387–3.713 lb a.e.
(Roundup PowerMax) — 11 fl oz–3.3 qt — 4 — 3

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9

COMMENTS: Can be applied prior to planting, within or between tree rows, with shielded or wiper equipment, or as directed spot sprays. Apply to young, actively growing annual weeds or perennial weeds when flowering. Some perennials may require the higher label rate for acceptable control. Add ammonium sulfate to spray solution at 5 to 10 lb per 100 gal water prior to adding glyphosate to improve control. Use 10 to 40 gal water/acre with 1 lb a.e./acre for annual weeds. Avoid applications to foliage or green bark, or mechanical wounds as injury can occur.

D. NONANOIC ACID
(Scythe)# 1–10% v/v 12 NA
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 26
COMMENTS: Apply as a directed spray; avoid green bark.

E. PARAQUAT* 0.3125–1 lb a.i.
(Gramoxone SL 2.0) 1.25–4 pt 24 —
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22
COMMENTS: Use in 20 to 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 weeds emerge or surviving plants regrow. Do not allow spray to contact foliage or green bark (except suckers); shields or wraps recommended for young trees.

NEWLY PLANTED ORCHARDS (3 YEARS OR LESS SINCE PLANTING)

Preemergence

A. FLUMIOXAZIN 0.1913–0.3825 lb a.i.
(Chateau) 6–12 oz 12 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: **Do not use in nut trees established less than one year, unless protected from spray contact by non-porous tree protectors**. Check supplemental label for additional restrictions in Merced, San Joaquin, and Stanislaus Counties. Residual period: approximately 1 month for each 2 oz/acre product used.

B. INDAZIFLAM 0.046–0.085 lb a.i.
(Alion) 3.5–6.5 fl oz 12 14
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 29

COMMENTS: Can be used in tree nuts established in the orchard at least one year. Recommended rate depends on soil organic matter content. Do not use on soils with greater than 20% gravel content. In southern San Joaquin Valley counties, applications limited to between harvest and pink bud stage. Requires rainfall or irrigation within 21 days following treatment. Residual period: 5 to 8 months.

C. ISOXABEN 0.52–1 lb a.i.
(Trellis SC) 16–31 fl oz 12 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 21

COMMENTS: Can be used in new plantings and established tree nut orchards. In new plantings, soil must be settled around transplants by packing and irrigation or rainfall and no cracks present. Do not apply over the top of young trees as bud injury can occur. When replanting ensure that planting holes are not refilled with treated soil. Isoxaben controls broadleaf weeds only. Rainfall or irrigation of at least 0.5 inch should occur within 21 days of treatment to activate herbicide. Residual period: 4 to 6 months.

D. NORFLURAZON 0.9825–3.93 lb a.i.
(Solicam DF) 1.25–5 lb 12 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 12
COMMENTS: The maximum rate is determined by soil texture. **Use only on trees planted at least 18 months.** Norflurazon is known to leach through soil into ground water under certain conditions. Loss of pigment of leaf veins may occur in almonds grown in course-textured soils when applied within 3 months after bud break.

E. ORYZALIN 2–6 lb a.i
(Surflan A.S.) 2–6 qt 24 0
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: May be applied preplant incorporated or preplant surface before transplanting or after transplanting trees. If using prior to planting, plant tree roots below treated soil and do not place treated soil near roots during

planting. Considered safe for young or newly planted trees and on sandy or sandy loam soils. Do not apply over the foliage or buds to avoid crop injury. If rainfall of 0.5 to 1 inch does not occur within 21 days of treatment, sprinkle irrigate with 0.5 to 2 inches of water. Will not control emerged weeds. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

F.	OXYFLUORFEN	0.5–2 lb ai		
	(Goal 2XL)	1–8 pts	24	15–30

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: Rate range differs for dormant and non-dormant orchards and for different methods of application; see label for use period, cut-off dates, and other restrictions. Oxyfluorfen can be used after transplanting nut trees or in established orchards. Has both preemergence and postemergence activity; lower rates typically used for postemergence control while higher rates provide longer residual control. At least 0.75 inch rainfall or irrigation must be received within 3 to 4 weeks after treatment. Do not disturb with mechanical equipment or poor weed control will result. **Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019.** Review the **Department of Pesticide Regulation's updated fact sheet**. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

G.	PENDIMETHALIN	1.9–5.985 lb a.i.		
	(Prowl H2O)	2–6.3 qt	24	60

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: May be applied preplant incorporated or preplant surface before transplanting or after transplanting trees. If using prior to planting, plant tree roots below treated soil and do not place treated soil near roots during planting. Do not apply to newly seeded nursery stock. Do not apply over the foliage or buds to avoid crop injury. Best control is achieved when irrigation or rainfall occurs within 7 days. Will not control emerged weeds. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

H.	PENOXSULAM/OXYFLUORFEN	0.016–0.031 lb a.i. (penoxsulam) /0.74–1.47 lb a.i. (oxyfluorfen)		
	(Pindar GT)	1.5–3 pt	24	60

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2/14

COMMENTS: Can be used in almonds established at least 15 months. Rainfall or irrigation of at least 0.5 inches needed within 21 days of application for most effective performance. Use lower rates on lighter soils and higher rates on heavier soils. When replacing trees, make sure clean soil is used around the roots of replants. Use tree protectors to avoid contact with foliage or green bark. Applications recommended between harvest and pink bud stage. Residual period: 5 to 8 months.

I.	RIMSULFURON	0.0625 lb a.i.		
	(Matrix SG)	4 oz	4	14

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2

COMMENTS: Preplant and postemergence control of certain grasses and broadleaf weeds in trees at least 12 months since transplanting. Apply as a broadcast or band treatment directed at the base of the trunk in 10 to 20 gal water/acre. Best results when applied to moist soil or about 0.5 inch rainfall or irrigation occurs within 2 weeks after application. Add nonionic surfactant to increase postemergence activity. Avoid contact with foliage or fruit. Spray solutions below pH 4 or above pH 8 may reduce performance. Chemigation is allowed: see label for instructions. Residual period: 2 to 4 months.

J.	TRIFLURALIN	0.5–1 lb a.i.		
	(Treflan HFP)	1–2 pt	12	0

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: Can be used preplant incorporated by power tillage or irrigation. Plant tree roots below treated soil. Do not place treated soil near roots during planting. Recommended rate depends on soil type. Rate range for new plantings is 1 to 2 pt/acre while established orchard rate range is 2 to 4 pt/acre. Can use spray blade applicator for suppression of field bindweed. Residual period: 2 to 12 months.

Postemergence

A. 2,4-D — 1–1.4 lb a.e.
(Orchard Master) — 2–3 pt — 48 — 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4

COMMENTS: For use in orchards established at least one year. Selective control of most annual broadleaf species and control or suppression of perennial broadleaf weeds. May be used as a broadcast treatment to middles or banded within the tree row. Use caution to avoid contact with tree fruit, foliage, stems, lower limbs, and exposed roots. Do not use on sandy or shallow soils and do not apply immediately before an irrigation.

B. AMMONIUM NONANOATE
(AXXE)# — 6–15% — 24 — See label
WSSA MODE-OF-ACTION GROUP NUMBER[1]: —
COMMENTS: Do not apply to weeds wet from dew rain or irrigation or if rain or irrigation is expected within 2 hours.

C. CAPRIC ACID/CAPRYLIC ACID
(Suppress)# — 3–9% v/v — 24 — See label
WSSA MODE-OF-ACTION GROUP NUMBER[1]: —
COMMENTS: Apply as a directed spray; avoid green bark. Do not apply to weeds wet from dew rain or irrigation or if rain or irrigation is expected within 4 hours.

D. CARFENTRAZONE — 0.03 lb a.i.
(Shark EW) — 2 fl oz — 12 — 3
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: Selective on small, vigorously growing broadleaf weeds. Do not allow spray droplets to contact desirable fruit, foliage, flowers, or green stem tissue as injury can occur. Thorough coverage is needed for best performance.

E. CLETHODIM — 0.068–0.121 lb a.i.
(SelectMax) — 9–16 fl oz — 24 — 365
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1

COMMENTS: For use only in nonbearing tree nut orchards (no harvest within one year). For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Repeated applications may be needed on perennial grasses. A crop oil concentrate (1% volume by volume) or nonionic surfactant (0.25% volume by volume) must be added. Use in 20 to 40 gallons water/acre.

F. DIQUAT — 0.375–0.5 lb a.i.
(Reglone) — 1.5–2 pt — 24 — 365
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22
COMMENTS: **For use only in nonbearing tree nut orchards (no harvest within one year).** Can be used prior to planting and up to one year before first harvest for non-selective burndown of grasses and broadleaf weeds. Do not allow spray droplets to contact desirable fruit, foliage, flowers, or green stem tissue as injury can occur. Thorough coverage is needed for best performance.

G. FLUAZIFOP-P-BUTYL — 0.25–0.375 lb a.i.
(Fusilade DX) — 16–24 oz — 12 — 365
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1

COMMENTS: For use only in nonbearing tree nut orchards (no harvest within one year). For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Repeated applications may be needed on perennial grasses. A crop oil concentrate (1% volume by volume) or nonionic surfactant (0.25% volume by volume) must be added.

H. GLUFOSINATE — 0.878–1.5 lb a.i.
(Rely 280) — 48–82 fl oz — 12 — 1
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 10

COMMENTS: Nonselective control of annual broadleaf and grass weeds and burndown of perennial weeds. Can be used as banded, broadcast, or spot treatments. Add ammonium sulfate to spray solution prior to adding glyphosate to improve control. Use higher rates and greater application volume for large weeds or dense vegetation. Use tree protectors until trunks have mature, calloused brown bark and avoid contact with green bark, stems, foliage or fruit as injury can occur.

I.	GLYPHOSATE	0.387–3.713 lb a.e.		
	(Roundup PowerMAX)	11 fl oz–3.3 qt	4	3

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9

COMMENTS: Can be applied prior to planting, within or between tree rows, with shielded or wiper equipment, or as directed spot sprays. Apply to young, actively growing annual weeds or perennial weeds when flowering. Some perennials may require the higher label rate for acceptable control. Add ammonium sulfate to spray solution at 5 to 10 lb per 100 gal water prior to adding glyphosate to improve control. Use 10 to 40 gal water/acre with 1 lb a.e./acre for annual weeds. Avoid applications to foliage or green bark, or mechanical wounds as injury can occur.

J.	MESOTRIONE			
	(Broadworks)	See comments	12	30

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 27

COMMENTS: Only for use on trees established at least 12 months. Do not apply more than 6 oz. (0.188 lb a.i.) in the first application or more than 12 oz (0.376 lb a.i.) per 12 months, with no more than three applications per year. Do not apply to trees under stress.

K.	NONANOIC ACID			
	(Scythe)#	1–10% v/v	12	See label

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 26

COMMENTS: Apply as a directed spray; avoid green bark.

L.	OXYFLUORFEN	0.5–2 lb ai		
	(Goal 2XL)	1–8 pts	24	15–30

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: Rate range differs for dormant and non-dormant orchards and for different methods of application; see label for use period, cut-off dates, and other restrictions. Oxyfluorfen can be used after transplanting nut trees or in established orchards. Has both preemergence and postemergence activity; lower rates typically used for postemergence control while higher rates provide longer residual control. At least 0.75 inch rainfall or irrigation must be received within 3 to 4 weeks after treatment. Do not disturb with mechanical equipment or poor weed control will result. **Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019.** Review the **Department of Pesticide Regulation's updated fact sheet**. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

M.	PARAQUAT*	0.3125–1 lb a.i.		
	(Gramoxone SL 2.0)	1.25–4 pt	24	—

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22

COMMENTS: Use in 20 to 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 weeds emerge or surviving plants regrow. Do not allow spray to contact foliage or green bark (except suckers); shields or wraps recommended for young trees.

N.	PYRAFLUFEN-ETHYL	0.0027–0.0053 lb a.i.		
	(Venue)	2–4 fl oz	12	0

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: Selective on small, vigorously growing broadleaf weeds. Add crop oil concentrate and ensure thorough coverage for best performance. Use higher rates for large weeds and for sucker control. Do not allow spray droplets to contact desirable fruit, foliage, flowers, or green stem tissue as injury can occur; shields or tree wraps recommended for young trees.

O.	RIMSULFURON	0.0625 lb a.i.

(Matrix SG) 4 oz 4 14
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2
COMMENTS: Preplant and postemergence control of certain grasses and broadleaf weeds in trees at least 12 months since transplanting. Apply as a broadcast or band treatment directed at the base of the trunk in 10 to 20 gal water/acre. Best results when applied to moist soil or about 0.5 inch rainfall or irrigation occurs within 2 weeks after application. Add nonionic surfactant to increase postemergence activity. Avoid contact with foliage or fruit. Spray solutions below pH 4 or above pH 8 may reduce performance. Chemigation is allowed: see label for instructions. Residual period: 2 to 4 months.

P. SAFLUFENACIL 0.04375 lb a.i.
(Treevix) 1 oz 12 7
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14
COMMENTS: Selective control of annual broadleaf weeds. Can be used as banded, broadcast, or spot treatments. Add methylated seed oil and ammonium sulfate or ammonium nitrate for best performance. Spray contact with tree foliage, flowers, buds or fruit can result in crop injury.

Q. SETHOXYDIM 0.281–0.375 lb a.i.
(Poast) 1.5–2 pt 12 15
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1

COMMENTS: For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Can be used as banded, broadcast, or spot treatments. Can be sprayed over the top of small nonbearing trees. Repeated applications may be needed on perennial grasses. Add crop oil concentrate or methylated seed oil for best performance; ammonium sulfate or ammonium nitrate will enhance activity on some grass weeds.

ESTABLISHED ORCHARDS

Preemergence

A. FLAZASULFURON 0.033 lb a.i.
(Mission) 2.14 oz 12 130
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2

COMMENTS: **Do not use on trees established less than three years.** Direct spray to soil beneath trees, but do not apply where roots are exposed. Apply during the dormant season, but no later than 6 weeks prior to bud break. See label for all soil and geographical restrictions.

B. FLUMIOXAZIN 0.1913–0.3825 lb a.i.
(Chateau) 6–12 oz 12 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: **Do not use in nut trees established less than one year, unless protected from spray contact by non-porous tree protectors.** Check supplemental label for additional restrictions in Merced, San Joaquin, and Stanislaus Counties. Residual period: approximately 1 month for each 2 oz/acre product used.

C. INDAZIFLAM 0.046–0.085 lb a.i.
(Alion) 3.5–6.5 fl oz 12 14
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 29

COMMENTS: **Can be used in tree nuts established in the orchard at least one year.** Recommended rate depends on soil organic matter content. Do not use on soils with greater than 20% gravel content. In southern San Joaquin Valley counties, applications limited to between harvest and pink bud stage. Requires rainfall or irrigation within 21 days following treatment. Residual period: 5 to 8 months.

D. ISOXABEN 0.52–1 lb a.i.
(Trellis SC) 16–31 fl oz 12 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 21

COMMENTS: Can be used in new plantings and established tree nut orchards. In new plantings, soil must be settled around transplants by packing and irrigation or rainfall and no cracks present. Do not apply over the top of young trees as bud injury can occur. When replanting, ensure that planting holes are not refilled with treated soil. Isoxaben controls broadleaf weeds only. Rainfall or irrigation of at least 0.5 inch should occur within 21 days of treatment to activate herbicide. Residual period: 4 to 6 months.

E. NAPROPAMIDE 4 lb a.i.
(Devrinol 50DF) 8 lb 24 35
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 15

COMMENTS: **Do not use on trees established less than three years.** Apply a maximum of one application per year. Do not apply to Mission almonds or trees on plum rootstock. Check label for information on soil restrictions and chemigation.

F.	ORYZALIN	2–6 lb a.i			
	(Surflan A.S.)	2–6 qt	24		0

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: May be applied preplant incorporated or preplant surface before transplanting or after transplanting trees. If using prior to planting, plant tree roots below treated soil and do not place treated soil near roots during planting. Considered safe for young or newly planted trees and on sandy or sandy loam soils. Do not apply over the foliage or buds to avoid crop injury. If rainfall of 0.5 to 1 inch does not occur within 21 days of treatment, sprinkle irrigate with 0.5 to 2 inches of water. Will not control emerged weeds. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

G.	OXYFLUORFEN	0.5–2 lb a.i		
	(Goal 2XL)	1–8 pts	24	15–30

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14

COMMENTS: Rate range differs for dormant and non-dormant orchards and for different methods of application; see label for use period, cut-off dates, and other restrictions. Oxyfluorfen can be used after transplanting nut trees or in established orchards. Has both preemergence and postemergence activity; lower rates typically used for postemergence control while higher rates provide longer residual control. At least 0.75 inch rainfall or irrigation must be received within 3 to 4 weeks after treatment. Do not disturb with mechanical equipment or poor weed control will result **Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019.** Review the **Department of Pesticide Regulation's updated fact sheet**. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

H.	PENDIMETHALIN	1.9–5.985 lb a.i.		
	(Prowl H2O)	2–6.3 qt	24	60

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: May be applied preplant incorporated or preplant surface before transplanting or after transplanting trees. If using prior to planting, plant tree roots below treated soil and do not place treated soil near roots during planting. Do not apply to newly seeded nursery stock. Do not apply over the foliage or buds to avoid crop injury. Best control is achieved when irrigation or rainfall occurs within 7 days. Will not control emerged weeds. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

I.	PENOXSULAM/OXYFLUORFEN	0.016–0.031 lb a.i. (penoxsulam) /0.74–1.47 lb a.i. (oxyfluorfen)		
	(Pindar GT)	1.5–3 pt	24	60

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2/14

COMMENTS: Can be used in almonds established at least 15 months. Rainfall or irrigation of at least 0.5 inches needed within 21 days of application for most effective performance. Use lower rates on lighter soils and higher rates on heavier soils. When replacing trees, make sure clean soil is used around the roots of replants. Use tree protectors to avoid contact with foliage or green bark. Applications recommended between harvest and pink bud stage. Residual period: 5 to 8 months.

J.	RIMSULFURON	0.0625 lb a.i.		
	(Matrix SG)	4 oz	4	14

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2

COMMENTS: Preplant and postemergence control of certain grasses and broadleaf weeds in trees at least 12 months since transplanting. Apply as a broadcast or band treatment directed at the base of the trunk in 10 to 20 gal water/acre. Best results when applied to moist soil or about 0.5 inch rainfall or irrigation occurs within 2 weeks after application. Add nonionic surfactant to increase postemergence activity. Avoid contact with foliage or fruit. Spray

solutions below pH 4 or above pH 8 may reduce performance. Chemigation is allowed: see label for instructions. Residual period: 2 to 4 months.

K. SIMAZINE — 1–2 lb a.i.
(Princep 4L) — 1–2 qt — 12 — 0
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 5

COMMENTS: Can be used in almonds established at least 3 years. On lighter soils, use lower rates. Do not use on gravel, sand, or loamy sand soils. If an irrigation is applied immediately after application, limit water to 0.5 inch. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Residual period: 8 to 12 months.

L. TRIFLURALIN — 0.5–1 lb a.i.
(Treflan HFP) — 1–2 pt — 12 — 0
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3

COMMENTS: Can be used preplant incorporated by power tillage or irrigation. Plant tree roots below treated soil. Do not place treated soil near roots during planting. Recommended rate depends on soil type. Rate range for new plantings is 1 to 2 pt/acre while established orchard rate range is 2 to 4 pt/acre. Can use spray blade applicator for suppression of field bindweed. Residual period: 2 to 12 months.

Postemergence

A. 2,4-D — 1–1.4 lb a.e.
(Orchard Master) — 2–3 pt — 48 — 60
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4

COMMENTS: For use in orchards established at least one year. Selective control of most annual broadleaf species and control or suppression of perennial broadleaf weeds. May be used as a broadcast treatment to middles or banded within the tree row. Use caution to avoid contact with tree fruit, foliage, stems, lower limbs, and exposed roots. Do not use on sandy or shallow soils and do not apply immediately before an irrigation.

B. AMMONIUM NONANOATE
(AXXE)# — 6–15% v/v — 24 — See label
WSSA MODE-OF-ACTION GROUP NUMBER[1]: —

COMMENTS: Do not apply to weeds wet from dew rain or irrigation or if rain or irrigation is expected within 2 hours.

C. CAPRIC ACID/CAPRYLIC ACID
(Suppress)# — 3–9% v/v — 24 — See label
WSSA MODE-OF-ACTION GROUP NUMBER[1]: —

COMMENTS: Apply as a directed spray; avoid green bark. Do not apply to weeds wet from dew rain or irrigation or if rain or irrigation is expected within 4 hours.

D. CARFENTRAZONE — 0.03 lb a.i. — 12 — 3
(Shark EW) — 2 fl oz
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14
COMMENTS: Selective on small, vigorously growing broadleaf weeds. Do not allow spray droplets to contact desirable fruit, foliage, flowers, or green stem tissue as injury can occur. Thorough coverage is needed for best performance.

E. FLAZASULFURON — 0.033 lb a.i.
(Mission) — 2.14 oz — 12 — 130
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2

COMMENTS: **Do not use on trees established less than three years.** Direct spray to soil beneath trees, but do not apply where roots are exposed. Apply during the dormant season, but no later than 6 weeks prior to bud break. See label for all soil and geographical restrictions.

F. GLUFOSINATE — 0.878–1.5 lb a.i.
(Rely 280) — 48–82 fl oz — 12 — 1
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 10

COMMENTS: Nonselective control of annual broadleaf and grass weeds and burndown of perennial weeds. Can be used as banded, broadcast, or spot treatments. Add ammonium sulfate to spray solution prior to adding glyphosate to improve control. Use higher rates and greater application volume for large weeds or dense vegetation. Use tree protectors until trunks have mature, calloused brown bark and avoid contact with green bark, stems, foliage or fruit as injury can occur.

G.	GLYPHOSATE	0.387–3.713 lb a.e.		
	(Roundup PowerMax)	11 fl oz–3.3 qt	4	3
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9			

COMMENTS: Can be applied prior to planting, within or between tree rows, with shielded or wiper equipment, or as directed spot sprays. Apply to young, actively growing annual weeds or perennial weeds when flowering. Some perennials may require the higher label rate for acceptable control. Add ammonium sulfate to spray solution at 5 to 10 lb per 100 gal water prior to adding glyphosate to improve control. Use 10 to 40 gal water/acre with 1 lb a.e./acre for annual weeds. Avoid applications to foliage or green bark, or mechanical wounds as injury can occur.

H.	MESOTRIONE			
	(Broadworks)	See comments	12	30
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 27			

COMMENTS: Only for use on trees established at least 12 months. Do not apply more than 6 oz. (0.188 lb a.i.) in the first application or more than 12 oz (0.376 lb a.i.) per 12 months, with no more than three applications per year. Do not apply to trees under stress.

I.	NONANOIC ACID			
	(Scythe)#	1–10% v/v	12	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 26			

COMMENTS: Apply as a directed spray; avoid green bark.

J.	OXYFLUORFEN	0.5–2 lb ai		
	(Goal 2XL)	1–8 pts	24	15–30
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			

COMMENTS: Rate range differs for dormant and non-dormant orchards and for different methods of application; see label for use period, cut-off dates, and other restrictions. Oxyfluorfen can be used after transplanting nut trees or in established orchards. Has both preemergence and postemergence activity; lower rates typically used for postemergence control while higher rates provide longer residual control. At least 0.75 inch rainfall or irrigation must be received within 3 to 4 weeks after treatment. Do not disturb with mechanical equipment or poor weed control will result. **Certain formulations emit high amounts of volatile organic compounds (VOCs); use low-VOC formulations. Regulations affect use for the San Joaquin Valley from May 1 to October 31, 2018 and 2019.** Review the **Department of Pesticide Regulation's updated fact sheet**. Chemigation is allowed: see label for instructions. Residual period: 4 to 10 months.

K.	PARAQUAT*	0.3125–1 lb a.i.		
	(Gramoxone SL 2.0)	1.25–4 pt	24	—
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22			

COMMENTS: Use in 20 to 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 weeds emerge or surviving plants regrow. Do not allow spray to contact foliage or green bark (except suckers); shields or wraps recommended for young trees.

L.	PYRAFLUFEN-ETHYL	0.0027–0.0053 lb a.i.		
	(Venue)	2–4 fl oz	12	0
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			

COMMENTS: Selective on small, vigorously growing broadleaf weeds. Add crop oil concentrate and ensure thorough coverage for best performance. Use higher rates for large weeds and for sucker control. Do not allow spray

droplets to contact desirable fruit, foliage, flowers, or green stem tissue as injury can occur; shields or tree wraps recommended for young trees.

M. RIMSULFURON 0.0625 lb a.i.

(Matrix SG) 4 oz 4 14
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2
COMMENTS: Preplant and postemergence control of certain grasses and broadleaf weeds in trees at least 12 months since transplanting. Apply as a broadcast or band treatment directed at the base of the trunk in 10 to 20 gal water/acre. Best results when applied to moist soil or about 0.5 inch rainfall or irrigation occurs within 2 weeks after application. Add nonionic surfactant to increase postemergence activity. Avoid contact with foliage or fruit. Spray solutions below pH 4 or above pH 8 may reduce performance. Chemigation is allowed: see label for instructions. Residual period: 2 to 4 months.

N. SAFLUFENACIL 0.04375 lb a.i.
(Treevix) 1 oz 12 7
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14
COMMENTS: Selective control of annual broadleaf weeds. Can be used as banded, broadcast, or spot treatments. Add methylated seed oil and ammonium sulfate or ammonium nitrate for best performance. Spray contact with tree foliage, flowers, buds or fruit can result in crop injury.

O. SETHOXYDIM 0.281–0. 375 lb a.i.
(Poast) 1.5–2 pt 12 15
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1
COMMENTS: For selective control of annual grasses that are actively growing, before tillering, and not stressed for moisture. Can be used as banded, broadcast, or spot treatments. Can be sprayed over the top of small nonbearing trees. Repeated applications may be needed on perennial grasses. Add crop oil concentrate or methylated seed oil for best performance; ammonium sulfate or ammonium nitrate will enhance activity on some grass weeds.

[1] Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode-of-action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://wssa.net/wssa/weed/herbicides/.

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

Acceptable for use on organically grown produce

NA Not applicable

— Information not available

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

Precautions for Using Pesticides

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

Legal Responsibility

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

Transportation

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

Storage

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

Container Disposal

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

Protection of Nonpest Animals and Plants

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

Posting Treated Fields

For some materials, *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.

Maximum residue levels

Before applying pesticides to crops destined for export, check maximum residue levels (MRLs) of importing country at https://globalmrl.com.

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.