Title

Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Decidous Tree Fruit, Nut, Strawberry, and Vine Crops

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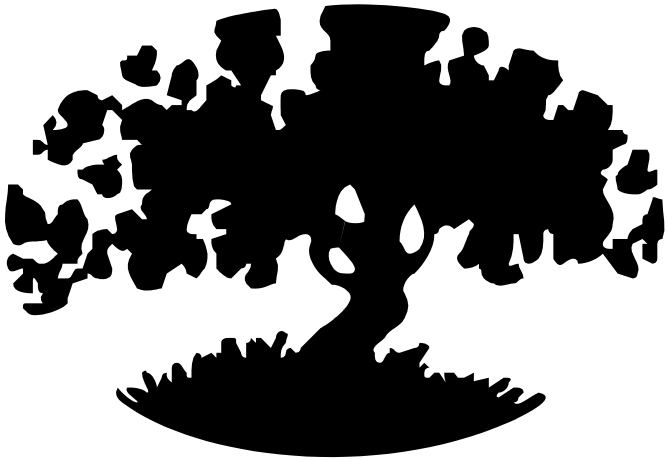
EFFICACY AND TIMING OF FUNGICIDES, BACTERICIDES, AND BIOLOGICALS *for* DECIDUOUS TREE FRUIT, NUT, STRAWBERRY, AND VINE CROPS 2008 (Updated 2/19/08)



ALMOND	*PEACH/NECTARINE*
APPLE/PEAR	*PISTACHIO*
APRICOT	*PLUM*
CHERRY	*PRUNE*
GRAPE	*STRAWBERRY*
KIWIFRUIT	*WALNUT*

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General Properties and Efficacy of Registered and Experimental Fungicides Used on Deciduous Tree Fruit, Nut, Strawberry, and Vine Crops in California

Trade name	Active ingredient	Class	Systemic action	Mode of action (FRAC number)[1]	Resistance potential
various	copper	inorganic	No	Multi-site (M1)	Low
various	sulfur	inorganic	No	Multi-site (M2)	Low
Aliette	fosetyl-aluminum	phosphonate	Yes	Multi-site (33)	Low
Dithane/Manzate	mancozeb	carbamate (EBDC)[2]	No	Multi-site (M3)	Low
Maneb/Manex	maneb	carbamate (EBDC)[2]	No	Multi-site (M3)	Low
Thiram	thiram	carbamate (DMDC)[3]	No	Multi-site (M3)	Low
Ziram	ziram	carbamate (DMDC)[3]	No	Multi-site (M3)	Low
Rovral/Iprodione	iprodione	dicarboximide	Yes	Multi-site (2)	Low
Scala/Penbotec[4]	pyrimethanil	anilinopyrimidine (AP)	Slight	Single-site (9)	High[5]
Vangard	cyprodinil	anilinopyrimidine (AP)	Slight	Single-site (9)	High[5]
Botran/ Allisan[4]	dichloran	aromatic hydrocarbon	Slight	Single-site (14)	Medium
Bravo/Chorothal-onil/Echo	chlorothalonil	chloronitrile	No	Multi-site (M5)	Low
Benlate**	benomyl	benzimidazole	Yes	Single-site (1)	Very high[5]
Mertect	thiabendazole	benzimidazole	Yes	Single-site (1)	Very high[5]
Topsin-M/ T-Methyl	thiophanate-methyl	benzimidazole	Yes	Single-site (1)	Very high[5]
Endura	boscalid	carboxamide	Yes?	Single-site (7)	High
Syllit***	dodine	guanidine	Yes	Few - multi-site (M7)	Medium/High
Elevate/Judge[4]	fenhexamid	hydroxyanilide	No	Single-site (17)	High[5]
Ridomil Gold	mefenoxam	phenylamide	Yes	Single-site (4)	High[5]
Captan	captan	phthalamide	No	Multi-site (M4)	Low
Captevate****	captan/ fenhexamid	phthalamide/ hydroxyanilde	No?	Multi-site (M4)/ Single-site (17)	Low
Quintec	quinoxyfen	quinoline	No	Single-site (13)	Medium
Scholar[4]	fludioxonil	phenylpyrrole	No	Few - multi-site (12)	Medium
Bayleton	triadimefon	DMI[6]-triazole	Yes?	Single-site (3)	High
Elite	tebuconazole	DMI-triazole	Yes?	Single-site (3)	High
Eminent*	tetraconazole	DMI-triazole	Yes?	Single-site (3)	High
Funginex**	triforine	DMI-piperazine	Yes?	Single-site (3)	High
Indar/Enable[7]	fenbuconazole	DMI-triazole	Yes?	Single-site (3)	High
Inspire*	difenoconazole	DMI-triazole	Yes?	Single-site (3)	High
Orbit/Bumper/ Mentor[4,8]	propiconazole	DMI-triazole	Yes?	Single-site (3)	High
Procure	triflumizole	DMI-imidazole	Yes?	Single-site (3)	High
Quash*	metconazole	DMI-triazole	Yes?	Single-site (3)	High
Rally/Laredo	myclobutanil	DMI-triazole	Yes?	Single-site (3)	High
Rubigan	fenarimol	DMI-pyrimidine	Yes?	Single-site (3)	High
Topguard	flutriafol	DMI-triazole	Yes?	Single-site (3)	High
Abound	azoxystrobin	QoI[9]	Yes?	Single-site (11)	High[5]
Cabrio	pyraclostrobin	QoI	Yes?	Single-site (11)	High[5]
Flint/Gem	trifloxystrobin	QoI	Yes?	Single-site (11)	High[5]
Sovran	kresoxim-methyl	QoI	Yes?	Single-site (11)	High[5]
Adament	tebuconazole/ trifloxystrobin	DMI-triazole[6]/QoI[9]	Yes?	Single-site (3)/ Single-site (11)	Medium
Distinguish	pyrimethanil/ trifloxystrobin	anilinopyrimidine/ QoI[9]	Yes?	Single-site (9)/ Single-site (11)	Medium
Inspire Super[8]	difenoconazole/ cyprodinil	DMI-triazole[6]/ anilinopyrimidine	Yes?	Single-site (3)/ Single-site (9)	Medium
Ph-D*	polyoxin-D	chitin synthesis inhibitor	No?	Single-site (19)	Medium

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General Properties Table, continued

Trade name	Active ingredient	Class	Systemic action	Mode of action (FRAC number)[1]	Resistance potential
Revus	mandipropamid	cell wall synthesis inhibitor	Yes?	Single-site (40)	High
Pristine	pyraclostrobin / boscalid	QoI[9]/carboxamide	Yes?/ Yes?	Single-site (11)/ Single-site (7)	High
Switch	fludioxonil / cyprodinil	phenylpyrrole/ anilinopyrimidine	No/ Slight	Single-site (12)/ Single-site (9)	Medium

* Experimental; registration pending
** Label withdrawn
*** Registered on pears and apples in California
**** Registered on almonds, blueberries, strawberries, and grapes in California
? = Fungicide is generally considered to have systemic action based on performance data but this characteristic has not been necessarily proven experimentally using more rigorous assays (e.g., radioactively labeled compounds)

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

[2] EBDC = ethylene bisdithiocarbamate.

[3] DMDC = dimethyl dithiocarbamate

[4] Postharvest use only

[5] 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/season.

[6] DMI = demethylation (sterol) inhibitor

[7] Indar registered; registration for Enable pending in California

[8] Check for Section 18 registration; registration pending

[9] QoI = quinone outside inhibitor (strobilurin).

General Properties and Efficacy of Registered and Experimental Antibiotics, Biologicals, Oils, and Natural Products Used on Deciduous Tree Fruit, Nut, Strawberry, and Vine Crops in California

Trade name	Active Ingredient	Class	Systemic action	Mode of action (FRAC number)[1]	Resistance potential
AgriMycin	streptomycin	antibiotic	Yes	Protein Synthesis(25)	High
Ag Streptomycin	streptomycin	antibiotic	Yes	Protein Synthesis(25)	High
Kasumin*[2]	kasugamycin	antibiotic	Yes	Protein Synthesis(24)	High
Mycoshield	oxytetracycline	antibiotic	Yes	Protein Synthesis(41)	High
AQ-10**	*Ampelomyces quisqualis*	biological	No	Various	Low
Arabesque*[3]	*Muscodor albus*	biological	No	Various	Low
Auxigro	GABA/L-glutamicacid	SAR-protein***	Yes	Host resistance	Unknown
B-lock	boric acid and latex paint	inorganic salt	No	Various	Low
BlightBan	*Pseudomonas fluorescens* A506	biological	No	Various	Low
BloomtimeBiologica*	*Pantoea agglomerans* E/325	biological	No	Various	Low
Elexa**	glucosamine protein	SAR-protein***	Yes	Host resistance	Unknown
KeyPlex 350 DP*	yeast extract	SAR-protein***	Yes	Host resistance	Unknown
Plant Shield	*Trichoderma harzianum*	biological	No	Various	Low
Serenade	*Bacillus subtilis*	ferm. product	No	Various	Low
Sonata	*Bacillus pumilis*	ferm. product	No	Various	Low
Messenger	harpin	SAR-protein***	Yes	Host resistance	Unknown
OxiDate/StorOx	hydrogen dioxide in acetic acid (peroxyacetic acid)	oxidizer	No	Oxidation	Very low
JMS Stylet oil	mineral oil	oil	No	Various	Low
Omni Supreme	low range oil	oil	No	Various	Low
Purespray	low range oil	oil	No	Various	Low
Saf-T-Side	petroleum oil	oil	No	Various	Low
Timorex*	natural oil	oil	No	Various	Low
Trilogy	neem oil	oil	No	Various	Low
Armicarb	potassium bicarbonate	inorganic salt	No	Various	Low
Kaligreen	potassium bicarbonate	inorganic salt	No	Various	Low
M-Pede	potassium salts	inorganic salt	No	Various	Low
Prev-am	sodium tetraborohydrate	inorganic salt	No	Various	Low
VigorCal*	calcium metalosate	inorganic salt	No	Various	Low
VigorK*	potassium metalosate	inorganic salt	No	Various	Low
Cinnacure	cinnamaldehyde	natural product	No	Various	Low
Quiponin*	*Quillaja saponaria*	natural product	No	Various	Low
Sporan	plant oils (clove, rosemary, thyme)	natural product	No	Various	Low
Valero	cinnamaldehyde	natural product	No	Various	Low

*Experimental; registration pending
**Label withdrawn
***SAR—Systemic acquired resistance induced in host
****Not registered in California

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

[2] Import tolerance established September, 2005.

[3] Postharvest use

EFFICACY: TREE CROPS

Fungicide	Brown rot	Jacket rot (Botrytis)	Shot hole	Powdery mildew	Rust	Scab		Anthracnose	Alternaria
						Almond	Apple/pear		
CONVENTIONAL FUNGICIDES									
Abound[1]	++	----	+++	++	+++	++++[2]	NR	++++	+++[2]
Adament	++++	++	++	+++	----	+++	ND	++++	+++
Benlate[3]	+++[4]	+++	----	+++	++	+++	+++	----	----
Botran	++	+++	ND	NR	NR	NR	NR	NR	NR
Bravo/Echo	++	++	+++	----	++	+++	NR	++++	+
Cabrio[5]	++	----	NR	++	NR	NR	NR	NR	NR
Captan	++	++	+++	----	+	+++	NR	++	+
Distinguish	++++	+++	++	+++	----	ND	ND	++++	++
Dithane	NR	NR	NR	----	NR	NR	++	NR	NR
Elevate/Judge	+++	++++[3]	+	+	ND	ND	ND	ND	ND
Elite	++++	++	+/-	+++	+++	NR	NR	+++	++
Eminent[6]	++	----	ND	ND	ND	ND	ND	+	ND
Flint/Gem[5]	++	----	----	++	ND	----	++++[2,7]	++++	+++[2]
Funginex[4]	+++	----	----	++	+	----	+++	ND	ND
Indar/Enable[8]	+++	+/-	+	ND	ND	NR	----	++	----
Inspire[6]	++++	++	++	ND	ND	++++	ND	ND	+++
Laredo	+++	----	++	++++	++	----	NR	++	----
Maneb	+	+	++	----	+++	++	++[9]	++	+
Manex	+	+	++	----	+++	++	++[9]	++	+
Orbit/Bumper/ Mentor[10]	+++	+/-	+/-	+++	+++	NR	NR	+++	----
Penbotec[10]	+++[10,11]	++++	NR	ND	ND	ND	NR	ND	NR
Ph-D*	++	++	++	ND	ND	----	ND	ND	+++
Pristine[5]	++++	+++	++++	+++	ND[12]	++++[2]	++++	+++	+++[2]
Procure	++	----	+/-	+++	ND	ND	++++	ND	ND
Quash*	++++	++	----	+++	----	ND	ND	++++	+++
Quintec[6]	----	----	----	++++	----	----	----	----	----
Rally	++	----	+/-	++++	++	----	++++[9]	++	----
Rovral	+++	+++	+++	----	----	----	NR	----	++
Rovral + oil	++++	++++	+++	+	++	----	NR	----	++
Rubigan	+++	----	----	++++	++	NR	++++	ND	ND
Sovran[5]	ND	ND	ND	+++	++	ND	+++[2]	ND	ND
Scala[11,12]	++++[9,10]	++++[2]	++	ND	ND	ND	+++	ND	++
Scholar[10]	++++	++++	----	----	----	----	----	----	----
Switch[6]	ND	+++	ND	ND	ND	NR	NR	ND	+++
Syllit	NR	----	----	----	----	NR	+++	ND	ND
Thiram	+	+	ND	----	----	NR	++[9]	ND	ND
Topsin-M/ T-Methyl	+++[2]	+++	----	+++	++	+++[2]	+++[9]	----	----
Vangard[11,12]	++++[11]	++++	++	ND	ND	----	+++	ND	++
Ziram	+	+	+++	----	----	+++	++	+++	+

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Efficacy: Tree Crops, continued

Fungicide	Brown rot	Jacket rot (Botrytis)	Shot hole	Powdery mildew	Rust	Scab		Anthracnose	Alternaria
						Almond	Apple/pear		
BIOLOGICALS, NATURAL COMPOUNDS, SARs									
Copper	+	+	++	----	----	++[13]	----	----	+/-
Cinnacure	----	----	----	++	----	----	----	----	----
JMS Stylet Oil	+/-	----	+/-	++	----	----	----	----	----
Kaligreen	----	----	----	++	----	----	----	----	----
Messenger	----	----	----	++	----	----	----	----	----
Oxidate	----	----	+/-	ND	ND	----	----	----	----
Prev-am	ND	ND	ND	++	ND	----	----	----	----
Quiponin[4,6]	ND	ND	ND	++	ND	ND	ND	ND	ND
Serenade	+/-	+	+/-	++	ND	----	ND	ND	ND
Sonata	+/-	+	+/-	++	ND	----	ND	ND	ND
Sulfur	+	+	+/-	+++	+++	++	++	+	----
Trilogy	+/-	----	+	++	+/-	----	----	----	----
Sporan	+	----	+/-	++	+/-	----	----	----	----
Saf-T-Side	++	----	+/-	++	----	----	----	----	----
Valero	+/-	----	----	ND	ND	----	----	----	----

Rating: ++++ = excellent; +++ = very good; ++ = good; + = fair; +/- = minimal or often ineffective; - = ineffective; NR = not registered; ND = no data

***** Not registered in California
[1] Causes severe phytotoxicity on some apple cultivars
[2] Resistant populations of target organisms occur in California
[3] Label withdrawn
[4] No active label for tree or vine crops
[5] Strobilurin fungicides generally have very good to excellent efficacy against rust diseases.
[6] Registration pending (Eminent, Inspire, and Quiponin). Cabrio and Quintec are registered only on cherry, Switch is only registered on pistachio and strawberry, and Sovran only on pome fruit crops.
[7] Flint is registered on pome fruit and grape. Gem is registered on stone fruit and tree nuts in California.
[8] Indar registered but registration for Enable and Indar 2F (additional formulation) pending in California.
[9] Not registered for use on pear in California
[10] Postharvest use only
[11] High summer temperatures and relative humidity reduce efficacy
[12] Phytotoxicity to leaves reported on cherry; not registered for this crop
[13] Based on one trial with 4 applications of Cuprofix Ultra 40 Disperss. Other copper formulations may be phytotoxic as in-season treatments.

DISEASE AND PATHOGEN NAMES

Disease	Pathogen(s)	Host(s)
Alternaria late blight	*Alternaria alternata, A. arborescens, A. tenuissima*[1]	Pistachio
Alternaria leaf spot	*Alternaria alternata, A. arborescens, A. tenuissima*[1]	Almond
Angular leaf spot	*Xanthomonas fragariae* (bacterium)	Strawberry
Anthracnose	*Colletotrichum acutatum*	Almond, peach, strawberry
Black Foot	*Cylindrocarpon destructans/C. liriodendron*	Grapevine
Black Measles (Esca)	*Phaeoacremonium aleophilum*	Grapevine
Black root rot complex	*Cylindrocarpon destructans, Pythium ultimum, Rhizoctonia* spp.	Strawberry
Bot Canker	*Botryosphaeria* spp.	Grapevine
Botryosphaeria panicle and shoot blight	*Botryosphaeria dothidea* (*Fusicoccum* sp.)	Pistachio
Botrytis blossom and shoot blight	*Botrytis cinerea*	Pistachio
Botrytis fruit rot	*Botrytis cinerea*	Kiwifruit
Brown rot	*Monilinia fructicola*	Stone fruits
Brown rot	*Monilinia laxa*	Almond, apricot, prune
Bunch rot	*Botrytis cinerea*	Grapevine
Common leaf spot	*Ramularia tulasnii*	Strawberry
Crown rot	*Phytophthora* spp.	Strawberry
Downy mildew	*Plasmopora viticola*	Grapevine
Eutypa dieback	*Eutypa lata*	Apricot, grapevine
Fire blight	*Erwinia amylovora* (bacterium)	Pome fruit (apple, pear, quince, etc.)
Gray mold	*Botrytis cinerea*	Strawberry
Jacket rot	*Botrytis cinerea* *Monilinia laxa* *Monilinia fructicola* *Sclerotinia sclerotiorum*	All stone fruits
Leaf blight	*Seimatosporium lichenicola*	Almond
Leaf spot	*Blumeriella jaapii*	Cherry
Leaf curl	*Taphrina deformans*	Peach, nectarine
Leather rot	*Phytophthora cactorum*	Strawberry
Mucor rot	*Mucor piriformis* and other species	Pome and stone fruit; strawberry
Phomopsis blight	*Phomopsis* sp.	Pistachio

[1] These species are members of the *Alternaria alternata* complex and are the most prevalent in diseases of almond and pistachio. Other closely related species of *Alternaria*, however, may also be involved.

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Disease and Pathogen Names, continued

Phomopsis cane and leafspot	*Phomopsis viticola*	Grapevine
Phomopsis fruit rot and dieback	*Phomopsis amygdali*	Almond
Powdery mildew	*Erysiphe* (=*Uncinula*) *necator* *Podosphaera leucotricha* *Podosphae clandestina* *Podosphaera tridactyla* *Sphaerotheca macularis* *Sphaerotheca pannosa*	Grapevine Almond, Apple, peach, nectarine Cherry Apricot, plum, prune, peach Strawberry Apricot, peach, nectarine, plum
Red steele	*Phytophthora fragariae*	Strawberry
Rhizopus rot	*Rhizopus* spp.	Strawberry
Root rot	*Phytophthora* spp.	Pome and stone fruit crops including almond; pistachio, grapevine, strawberry, and walnut
Root rot	*Phytophthora spp.*	Stonefruit, pomefruit, grapevine, strawberry, walnut, almond, pistachio
Russet scab	Abiotic (rain during bloom)	Prune
Rust	*Tranzschelia discolor*	Almond, nectarine, peach, prune, plum
Scab	*Cladosporium carpophilum* (*Fusicladosporium carpophilum*)	Almond, nectarine, peach
Scab	*Venturia inaequalis*	Apple
Scab	*Venturia pirina*	Pear
Sclerotinia blight	*Sclerotinia sclerotiorum*	Almond, apricot, nectarine, peach, prune, pistachio
Shot hole	*Wilsonomyces carpophilus*	Almond, apricot, peach, nectarine
Silver leaf	*Chondrostereum purpureum*	Pone and stone fruit, including almond
Summer rot	*Aspergillus niger, Alternaria tenuis, Botrytis cinerea, Cladosporium herbarum, Rhizopus arrhizus, Penicillium* sp., and others	Grapevine
Walnut blight	*Xanthomonas juglandis* (bacterium)	Walnut

FUNGICIDES LISTED BY CHEMICAL CLASS: MISCELLANEOUS FUNGICIDES/BACTERICIDES

ANTIBIOTICS

Trade name	Common name	Company	Activity
Ag Streptomycin	Streptomycin	Makhteshim Agan	systemic
Agri-Mycin	Streptomycin	NuFarm	systemic
Kasumin*	Kasugamycin	Arysta	systemic
Mycoshield	Terramycin	NuFarm	systemic

***Registration planned or pending in California**
Mode of action: all are protein synthesis inhibitors but with specifically different modes of action.
Resistance risk: high
Growth effects: inhibit protein production and growth.

BIOLOGICALS

Trade name	Common name	Company	Activity
AQ10*	*Ampelomyces quisqualis*	Ecogen Inc.	contact
Arabesque	*Muscodor albus*	AgraQuest Inc.	contact
BlightBan	*Pseudomonas fluorescens*A506	J.R. Simplot/Plant Health Tech.	contact
BloomtimeBiologicalFD**	*Pantoea agglomerans* E/325	Northwest Ag Prod.	contact
Plant Shield	*Trichoderma harzianum*	CircleOne Organics	contact
Quiponin**	*Quillaja saponaria*	Nor-Natur	contact
Serenade	*Bacillus subtilis*	AgraQuest Inc.	contact
Sonata	*Bacillus pumilis*	AgraQuest Inc.	contact

***Label withdrawn**
****Registration planned or pending in California**
Mode of action: antagonism, mycoparasitism, and/or site exclusion (no antibiosis)
Resistance risk: low
Growth effects: growth inhibition of pathogen by antagonism or mycoparasitism

NATURAL COMPOUNDS/OILS/INORGANIC SALTS

Trade name	Common name	Company	Activity
Armicarb	sodium bicarbonate	Helena Chemical	contact
B-Lock	boric acid and latex paint	Nutrient Technologies	contact
Cinnacure	cinnamaldehyde	ProGuard Inc	contact
JMS Stylet Oil	low range oil	JMS Flower Farms	contact
Milstop	potassium bicarbonate	BioWorks	contact
M-Pede Insecticidal Soap	potassium salts	Dow AgroSciences	contact
Kaligreen	sodium bicarbonate	Toagosei	contact
Omni Supreme	low range oil	Helena Chemical	contact
Prev-am	sodium tetraborohydrate	ORO Agri. Inc.	contact
Purespray	low range oil	PetroCanada	contact
Timorex*	natural oil	Biomor	contact
Trilogy	neem oil	Certis USA	contact
VigorCal*	calcium metalosate	Agro-K	contact
VigorK*	potassium metalosate	Agro-K	contact

***** Not registered in California
Mode of action: various
Resistance risk: low
Growth effects: various

MINERALS

Trade name	Common name	Company	Activity
Copper and sulfur	various	various	contact

Mode of action: both are multi-site inhibitors: copper = FRAC[1] Group M1; sulfur = FRAC[1] Group M2
copper inactivates numerous enzyme systems; sulfur inhibits respiration
Resistance risk: low
Growth effects: inhibit spore germination: sulfur also inhibits mycelial growth of powdery mildews
Sporulation: no effect

SAR*

Trade name	Common name	Company	Activity
Auxigro	GABA/L-glutamic acid	Emerald Bio	systemic
Elexa**	glucosamine protein	SafeScience Prod.	systemic
KeyPlex 350 DP***	yeast extract	Morse Enterprises	systemic
Messenger	harpin	Eden Bioscience	systemic

*SAR—Systemic acquired resistance
**Registration pending
***Not registered in California
Mode of action: host resistance
Resistance risk: unknown
Growth effects: unknown
Sporulation: unknown

FUNGICIDES LISTED BY CHEMICAL CLASS: SYNTHETIC FUNGICIDES

ANILINOPYRIMIDINE (AP)

Trade name	Common name	Company	Activity
Penbotec*	pyrimethanil	Cerexagri	slight (on most crops)
Scala	pyrimethanil	Bayer CropScience	slight (on most crops)
Vangard (see also Switch)	cyprodinil	Syngenta CropProtection	slight (on most crops)

***Postharvest use only**
Mode of action: FRAC[1] Group 9; single-site, methionine inhibitor; has "kick-back" activity against apple and pear scab and stone fruit fungi.
Resistance risk: high; 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/season.
Growth effects: APs inhibit mycelial growth and suppresses spore germination. More effective in spring (lower temperatures) than summer (higher temperatures)
Sporulation: no effect

ANILINOPYRIMIDINE (AP)/DMI

Trade name	Common name	Company	Activity
Inspire Super*	cyprodinil/difenoconazole	Syngenta CropProtection	contact and systemic

***Registration pending**
Mode of action: FRAC[1] Groups 9 and 3; both single-site inhibitors; methionine inhibitor (cyprodinil); DMIs (tebuconazole) inhibit demethylation and other processes in sterol biosynthesis
Resistance risk: medium; rating is a result of only partial overlap in the spectrum of activity of the two active ingredients. 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/season.
Growth effects: APs inhibit mycelial growth and suppresses spore germination; DMIs inhibit mycelial growth.
Sporulation: APs have no effect; DMIs suppress sporulation.

ANILINOPYRIMIDINE/PHENYLPYRROLE

Trade name	Common name	Company	Activity
Switch	cyprodinil/fludioxonil	Syngenta CropProtection	contact/slight systemic

Mode of action: FRAC[1] Groups 9 and 12; both single-site, anilinopyrimidines (cyprodinil) inhibit methionine; phenylpyrroles (fludioxonil) interfere with regulatory enzymes of oxidation, osmoregulation, and possibly respiration.
Resistance risk: high
Growth effects: both inhibit mycelial growth and germination
Sporulation: reduces

ANILINOPYRIMIDINE/STROBILURIN

Trade name	Common name	Company	Activity
Distinguish	pyrimethanil/trifloxystrobin	Bayer CropScience	contact/systemic

Mode of action: FRAC[1] Groups 9 and 11; both single-site, anilinopyrimidines (pyrimethalnil) inhibit methionine; strobilurins (trifloxystrobin) block respiration by interfering with cytochrome b.
Resistance risk: medium to high; rating is a result of only partial overlap in the spectrum of activity of the two active ingredients. 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/season.
Growth effects: anilinopyrimidines inhibit mycelial growth and suppresses spore germination; strobilurins inhibit spore germination.
Sporulation: no effect.

AROMATIC HYDROCARBONS

Trade name	Common name	Company	Activity
Botran	dichloran	Gowan	systemic (local)
Allisan*	dichloran	Gowan	systemic (local)

***Postharvest use only**
Mode of action: FRAC[1] Group 14; mechanism unclear.
Resistance risk: medium
Growth effects: interrupt mycelial growth
Sporulation: little effect

BENZIMIDAZOLES

Trade name	Common name	Company	Activity
Benlate*	benomyl	DuPont	systemic (local)
Mertect	thiabendazole (TBZ)	Syngenta CropProtection	systemic (local)
T-Methyl	thiophanate-methyl	Arysta LifeScience	systemic (local)
Topsin-M	thiophanate-methyl	Cerexagri	systemic (local)

***Label withdrawn**
Mode of action: FRAC[1] Group 1; single-site inhibitors that interfere with nuclear division
Resistance risk: high; levels of resistant populations do not decline in absence of fungicide use; 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/season.
Growth effects: inhibit mycelial growth
Sporulation: inhibit

CARBAMATE

Trade name	Common name	Company	Activity
Ethylene bisdithiocarbamates (EBDC)			
Dithane	mancozeb	Dow Agrosciences	contact
Maneb	maneb	Cerexagri	contact
Manex	maneb	DuPont	contact
Dimethyl dithiocarbamates (DMDC)*			
Thiram	thiram	Taminco	contact
Ziram	ziram	Cerexagri	contact

Mode of action: FRAC[1] Group M3; multi-site inhibitors that complex with enzymes probably inhibiting respiration.
Resistance risk: low
Growth effects: inhibit spore germination
Sporulation: no effect
*Ferbam, a DMDC, is not registered in California

CARBOXAMIDE

Trade name	Common name	Company	Activity
Endura*	boscalid	BASF	unknown
(DPX-LEM17)*	penthiopyrad	DuPont	contact

***Registration pending in California**
Mode of action: FRAC[1] Group 7; unknown mechanism, probably multi-site; registrant indicates that in general the fungicide deprives the fungal cell of its energy source and eliminates the availability of chemical building blocks for synthesis of essential cellular components.
Resistance risk: high
Growth effects: reduced mycelial growth
Sporulation: unknown

CARBOXYLIC ACID AMIDES

Trade name	Common name	Company	Activity
Revus	mandipropamid	Syngenta Crop Protection	contact, systemic

Mode of action: FRAC[1] Group 40; interferes cell wall biosynthesis
Resistance risk: high; 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/season.
Growth effects: inhibits conidial germination and mycelial growth
Sporulation: reduces

CHLORONITRILE

Trade name	Common name	Company	Activity
Bravo	chlorothalonil	Syngenta CropProtection	contact
Chlororthalonil	chlorothalonil	Makteshim Agan of North America, Inc.	contact
Echo	chlorothalonil	Sipcam Agro USA	contact

Mode of action: FRAC[1] Group M5; multi-site inhibitor affecting various enzymes and other metabolic processes.
Resistance risk: low
Growth effects: inhibit spore germination
Sporulation: unknown

DEMETHYLATION (ERGOSTEROL OR STEROL BIOSYNTHESIS) INHIBITORS (DMI OR SBI)

Trade name	Common name	Sub-class	Company	Activity
Bayleton	triadimefon	Triazole	Taminco	systemic (local)
Bumper*	propiconazole	Triazole	Makhteshim-Agan	systemic (local)
Elite	tebuconazole	Triazole	Bayer CropScience	systemic (local)
Eminent*	tetraconazole	Triazole	Sipcam Agro USA	systemic (local)
Indar/Enable**	fenbuconazole	Triazole	Dow Agrosciences	systemic (local)
Inspire*	difenoconazole	Triazole	Syngenta CropProtection	systemic (local)
Mentor***	propiconazole	Triazole	Syngenta CropProtection	systemic (local)
Orbit	propiconazole	Triazole	Syngenta CropProtection	systemic (local)
Procure	triflumizole	Imidazole	Chemtura	systemic (local)
Quash	metconazole	Triazole	Valent North America	systemic (local)
Rally (Laredo)	myclobutanil	Triazole	Dow Agrosciences	systemic (local)
Rubigan	fenarimol	Pyrimidine	Dow Agrosciences	systemic (local)
Topguard*	flutriafol	Triazole	Cheminova Inc.	systemic (local)

***Registration pending**
****Indar registered; registration for Enable pending in California**
*****Postharvest use only; check for Section 18 registration; registration pending in California**
Mode of action: FRAC[1] Group 3; single-site inhibitors; inhibit demethylation and other processes in sterol biosynthesis; most are absorbed quickly and move up but not down in the plant; all have little effect on spore germination, but interfere with other early developmental processes; all inhibit mycelial growth and may stop lesions from sporulating; many have "kick-back" activity against brown rot, rust, perhaps scab, and apple and pear scab. Systemic action was determined in leaves of annual plants. The requisite tests using radioactive labeled compounds on flowers, fruit and leaves of tree crops have not been conducted.
Resistance risk: high
Growth effects: inhibit mycelial growth
Sporulation: suppresses

DMI/STROBILURIN

Trade name	Common name	Company	Activity
Adament	tebuconazole/trifloxystrobin	Bayer CropScience	contact and systemic

Mode of action: FRAC[1] Groups 3 and 11; both single-site inhibitors; DMIs (tebuconazole) inhibit demethylation and other processes in sterol biosynthesis; strobilurins (trifloxystrobin) block respiration by interfering with cytochrome b.
Resistance risk: medium to high; rating is a result of only partial overlap in the spectrum of activity of the two active ingredients. 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/season.
Growth effects: DMIs inhibit mycelial growth; strobilurins inhibit spore germination.
Sporulation: DMIs suppress sporulation; strobilurins have no effect.

DICARBOXIMIDES

Trade name	Common name	Company	Activity
Iprodione	iprodione	Arysta LifeScience	systemic (local)
Rovral	iprodione	Bayer CropScience	systemic (local)

Mode of action: FRAC[1] Group 2; multi-site
Resistance risk: low with low frequency of application; none reported in California; where resistance occurs, no crop losses reported on stone fruits; resistant populations are less fit and decline in absence of fungicide use.
Growth effects: inhibits mycelial growth and to a lesser extent spore germination
Sporulation: inhibits

GUANIDINES

Trade name	Common name	Company	Activity
Syllit	dodine	Platte Chemical Co.	systemic (local)

Mode of action: FRAC[1] Group M7; disrupts membranes.
Resistance risk: high

HYDROXYANILIDES

Trade name	Common name	Company	Activity
Elevate	fenhexamid	Arysta LifeScience	contact
Judge	fenhexamid	Pace International	contact

Mode of action: FRAC[1] Group 17; unknown, probably single-site and related to sterol biosynthesis inhibition.
Resistance risk: high; 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/season.
Growth effects: inhibits spore germination and mycelial growth
Sporulation: no effect

PHENYLAMIDES

Trade name	Common name	Company	Activity
FarmSaver Mefenoxam 2EC	mefenoxam	Makhteshim Agan of North America, Inc.	contact, systemic
Ridomil Gold EC	mefenoxam	Syngenta CropProtection	contact, systemic

Mode of action: FRAC[1] Group 4; interferes with activity of a nuclear RNA polymerase template complex.
Resistance risk: high; 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/season.
Growth effects: inhibits mycelial growth, sporangial development, and zoospore viability
Sporulation: reduces

PHENYLPYRROLES

Trade name	Common name	Company	Activity
Scholar*	fludioxonil	Syngenta CropProtection	contact (except cherry-systemic)

***Postharvest use only**
Mode of action: FRAC[1] Group 12; single-site; interferes with regulatory enzymes of oxidation, osmoregulation, and possibly respiration.
Resistance risk: high
Growth effects: inhibits mycelial growth and germination
Sporulation: reduces

PHOSPHONATES

Trade name	Common name	Company	Activity
Aliette	fosetyl-aluminum	BASF	systemic

Mode of action: FRAC[1] Group 33; reports indicate variable effects on both plant and organism physiology.
Resistance risk: low
Growth effects: may inhibit phosphorus deficiency signaling in the plant.
Sporulation: suppresses sporulation of *Phytophthora* spp.

PHTHALIMIDES

Trade name	Common name	Company	Activity
Captan	captan	various	contact

Mode of action: FRAC[1] Group M4; multi-site inhibitor that complexes with enzymes probably inhibiting respiration.
Resistance risk: low
Growth effects: inhibits spore germination
Sporulation: no effect

POLYOXINS

Trade name	Common name	Company	Activity
Ph-D	polyoxin-D	Arysta LifeScience	contact

Mode of action: FRAC[1] Group 19; single-site inhibitor of chitin synthase.
Resistance risk: medium
Growth effects: inhibits spore germination and mycelial growth.
Sporulation: no effect

QUINOLINES

Trade name	Common name	Company	Activity
Quintec	quinoxyfen	Dow AgroSciences	contact

Mode of action: FRAC[1] Group 13; probably single-site inhibitor; disrupts early cell signaling events.
Resistance risk: medium
Growth effects: suppresses spore germination, early germ tube development and/or appressorium formation
Sporulation: no effect

STROBILURINS (QoIs)

Trade name	Common name	Company	Activity
Abound/Quadris	azoxystrobin	Syngenta CropProtection	contact and systemic
Cabrio	pyraclostrobin	BASF	contact and systemic
Flint/Gem**	trifloxystrobin	Bayer CropScience	contact and systemic
Sovran	kresoxim methyl	BASF	contact and systemic

***Registration pending**
****Gem registered on stone fruit and tree nuts; Flint registered on pome fruit and grape.**
Mode of action: FRAC[1] Group 11; single-site; blocks respiration by interfering with cytochrome b.
Resistance risk: high; 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/season.
Growth effects: inhibit spore germination
Sporulation: no effect

STROBILURIN/CARBOXYAMIDE

Trade name	Common name	Company	Activity
Pristine	pyraclostrobin/boscalid	BASF	contact and systemic

Mode of action: FRAC[1] Groups 11 and 7; strobilurins single-site, carboxyamides possibly multi-site; strobilurins (pyraclostrobin) block respiration by interfering with cytochrome b; unknown for carboxyamide (boscalid).
Resistance risk: medium to high; rating is a result of only partial overlap in the spectrum of activity of the two active ingredients. 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/season.
Growth effects: strobilurins inhibit spore germination; unknown for carboxyamide
Sporulation: no effect for strobilurins; unknown for carboxyamide

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

ALMOND—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC)[1]	Brown rot	Jacket rot	Anthrac -nose	Shot hole	Scab[2]	Rust[3]	Leaf blight	Alternaria leaf spot [2]	PM-like[4]	Silver leaf
Adament	high (3/11)	++++	++	++++	++	+++	+++	ND	++	ND	----
Benlate[5]	high (1)	++++	++++	----	----	+++	+	++++[6]	----	----	----
Distinguish	high (9/11)	++++	+++	++++	++	ND	ND	ND	ND	ND	----
Indar	high (3)	++++	+/-	+++	++	++	+++	ND	+	ND	----
Inspire*	high (3)	++++	+	ND	++	+++	ND	ND	+++	ND	----
Inspire Super[16]	high (3/9)	++++	++	ND	++	+++	ND	ND	+++	ND	----
Orbit	high (3)	++++	+/-	++++	++	++	+++	ND	++	ND	----
Pristine[3]	medium (7/11) [7]	++++	++++	++++	++++	++++	+++	ND	+++	+++	----
Quash	high (3)	++++	++	++++	+++	ND	ND	ND	++	ND	----
Rovral + oil[8]	low (2)	++++	++++	----	+++	+/-	++	ND	+++[9]	ND	----
Scala	high (9) [7]	++++	++++	ND	++	----	ND	ND	NR	----	----
Topsin-M/T-Methyl[5]	high (1) [7]	++++	++++	----	----	+++[8]	+	+++[6]	----	++	----
Vangard	high (9) [7]	++++	++++	ND	++	----	ND	ND	+[9]	----	----
Abound	high (11) [7]	+++	----	++++	+++	++++	+++	+++	+++[10]	+++	----
Elevate	high (17) [7]	+++	++++	----	+	ND	ND	ND	ND	ND	----
Gem	high (11) [7]	+++	----	++++	+++	++++	+++	+++	+++[10]	+++	----
Laredo	high (3)	+++	----	++	++	----	+	+++	----	+++	----
Rovral/Iprodione	low (2)	+++	+++	----	+++	----	----	ND	++[9]	----	----
Bravo/Chloro-thalonil/Echo[11,12]	low (M5)	++	NR	+++	+++	+++	NR	NR	NR	----	----
Captan[12]	low (M4)	++	++	+++	+++	++	----	+++	+	----	----
Captevate	low (M4/17)	+++	+++	+++	+++	+++	----	+++	+	----	----
Maneb	low (M3)	++	+	++	++	++	+++	++	----	----	----
Ph-D	medium (19)	++	++	----	++	----	ND	ND	+++	----	----
Rally[13]	high (3)	++	----	++	+/-	----	+	+++	----	+++	----
Ziram	low (M3)	++	+	+++	+++	+++	----	++	+	----	----
Copper[14]	low (M1)	+/-	+/-	----	+[6]	----	----	----	ND	----	ND
Lime sulfur[12]	low (M2)	+/-	NR	----	+/-	++[15]	NR	NR	NR	----	NR
Sulfur[12]	low (M2)	+/-	+/-	----	----	++	++	----	----	+++	----
PlantShield**	low	----	----	----	----	----	----	----	----	----	+++[16]

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, NR = not registered, and ND = no data

* Not registered in California

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

[2] Field resistance of *Alternaria* sp. and *Cladosporium carpophilum* to strobilurin and carboxamide fungicides has been detected in almond orchards.

[3] Of the materials listed, only sulfur, Abound, and Flint are registered for use in late spring and early summer when treatment is recommended.

[4] PM-like refers to a powdery mildew-like disease on almond fruit that is managed with fungicides with activity against powdery mildew fungi.

[5] Benlate label withdrawn. Strains of the brown rot fungi *Monilinia laxa* and *M. fructicola* resistant to Benlate, Topsin-M, and T-Methyl have been found 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 almonds with overuse of fungicides with similar chemistry. Resistant strains of the scab fungus, *Cladosporium carpophilum*, have been found in California.

[6] Excellent control obtained with combination of Benlate and Captan; activity of Topsin-M and T-Methyl should be similar to that of Benlate.

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[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/season.
[8] Oil is a "light" summer oil, 1-2% volume/volume.
[9] Not registered for use later than 5 weeks after petal fall.
[10] Efficacy reduced at high temperatures and relative humidity; experimental for Alternaria.
[11] Bravo Ultrex, Bravo WeatherStik, Echo, Echo Ultimate, and Chlorothalonil are currently registered.
[12] Do not use in combination with 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.
[16] Registration pending

ALMOND—TREATMENT TIMING

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
Alternaria	----	----	----	----	----	+++	+++	+++
Anthracnose[2]	----	++	+++	+++	+++	+++	+++	++
Brown rot	----	++	+++	+	----	----	----	----
Green fruit rot	----	----	+++	----	----	----	----	----
Leaf blight	----	----	+++	++	+	----	----	----
Scab[3]	+	---	---	++	+++	+++	++	---
Shot hole[4]	+[5]	+	++	+++	+++	++	----	----
Rust	----	----	----	----	----	+++	+++	+[6]

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = 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. Re-apply 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.

ALMOND: SUGGESTED DISEASE MANAGEMENT PROGRAMS WITH FUNGICIDE FRAC[1] GROUPS

Note: Not all indicated timings may be necessary for disease control (*see* Treatment Timing Table). 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 previous season.
2) Select one of the suggested fungicide groups. *Numbers separated by slashes are pre-mixtures, whereas numbers grouped by pluses are tank mixtures*. If several diseases need to be managed, select a group that is effective against all diseases. Refer to fungicide efficacy table for fungicides belonging to each FRAC group. Group numbers are listed in numerical order within the suggested disease management program.
3) Rotate groups for each application within a season and, if possible, use each group only once per season, except for multi-site mode of action materials or natural products/biological controls (e.g., M2, NP/BC).

Disease	Dormant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June
Alternaria	----	----	----	----	----	2	3 7/11 11 19	3 7/11 11 19
Anthracnose	----	3	3 7/11 11	3 11 M3 M4	3 7/11 11 M3 M	3 7/11 11 M3 M4	3 7/11 11 M3 M4	3 7/11 11 M3 M4
Brown rot	----	1[2] 2 (+oil) 3 9	1[2] 2 (+oil) 3 9 7/11 11	1[2] 2 (+oil) 9 7/11	----	----	----	----
Green fruit rot	----	----	1[2] 2 (+oil) 9 7/11	----	----	----	----	----
Leaf blight	----	----	1[2] 2 3 11	1[2] 2 3 11 M3 M4	3 11 M3 M4	----	----	----
Scab[4]	M2[3]	----	----	1[2] 7/11[2] 11[2] M3 M4 M5	1[2] 7/11[2] 11[2] M3 M4 M5	3 7/11[2] 11[2] M2[3] M3 M4	M2[3] M4	----
Shot hole	M1	2 3 9	2 3 7/11 9 11	2 3 7/11 9 11	7/11 11 M3 M4 M5	7/11 11 M3 M4 M5	----	----

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Almond: Suggested Disease Management Programs, continued

Disease	Dormant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June
Rust	----	----	----	----	----	3 7/11 11 M3	3 7/11 11 M3	3 7/11 11 M3

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Groups 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.

[2] Benlate label withdrawn. Strains of *Monilinia fructicola* and *M. laxa* resistant to Benlate, 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.

APPLE AND PEAR—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC#)[1]	Scab		Powdery mildew (apple only)
		Protectant	Eradicant	
Bayleton	high (3)	----	----	+++
Benlate[2]	high (1)	+++	+++	+++
Distinguish*	medium (9/11)	+++	+++	+++
Flint[3]	high (11)[4]	++++	++++	++++
Pristine	medium (11/7)	++++	----	ND
Procure[5]	high (3)	++++	++++	++++
Rally[6]	high (3)	++++	++	++++
Rubigan[5]	high (3)	++++	++++	+++
Scala	high (9)[4]	+++	+++	+
Sovran	high (11)[4]	+++	+++	+++
Syllit	medium (M7)	+++	+++	----
Topsin-M/ T-Methyl[4]	high (1)[4]	+++	+++	+++
Vangard	high (9)[4]	+++	+++	+++
Captan[7]	low (M4)	+++	----	----
Dithane[7]	low (M3)	+++	----	----
Maneb[6,7]	low (M3)	+++	----	----
Thiram[6]	low (M3)	++	----	----
Ziram[7]	low (M3)	++	----	----
Copper[7]	low (M1)	++[8]	----	----
Lime sulfur[7,9]	low (M2)	----	++++[9]	+++[10]
Sulfur[7]	low (M2)	++	----	++++

Bactericide/ Biological	Resistance risk	Fire blight[13]		Phytotoxicity
		Contact	Systemic	
Ag Streptomycin	high	++++	+++	+/-
Agri-Mycin	high	++++	+++	+/-
MycoShield[11]	high	+++	+++	+/-
Copper[8]	low	+++	----	+
Captan[7]	low (M4)	+++	----	----
Dithane[7]	low (M3)	+++	----	----
Blight Ban	low	++	----	+/-
Bloomtime Bio[12]	low	+++ (pending registration)	----	+/- (pending registration)

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective.

* Registration pending.

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

[2] Label withdrawn.

[3] Label withdrawn on pears because of resistance development.

[4] 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/season.

[5] On pear, use only **before** white bud and **after** full bloom.

[6] Labeled on apple; only the 40WSP formulation is registered on pear in California.

[7] These are important components of resistance management programs. Captan is registered on apples, whereas Dithane is registered on apples and pears.

Continued on next page . . .

[8] Copper, though effective for scab and blight control, causes fruit scarring.
[9] "Burns out" scab twig lesions when applied at delayed dormant and disrupts pseudothecial (or ascostroma) development when applied to leaves in fall. **CAUTION: LIME SULFUR IS INCOMPATIBLE WITH MOST OTHER PESTICIDES WHEN USED AFTER BUDBREAK. CHECK BEFORE USE.**
[10] In-season application eradicates powdery mildew.
[11] Labeled on pear but not on apple.
[12] Registration pending in California.
[13] Growth regulators such as prohexadione calcium (Apogee) can be used in an integrated approach to reduce host susceptibility but do not have antibiotic activity against fire blight. Thus, Apogee was not included in the fire blight activity ratings.

APPLE AND PEAR—TREATMENT TIMING

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

Disease	Fall	Delayed dormant	Green tip	Pink bud	Spring
Scab[1]	++[2]	++[2]	+++	+++	+++
Powdery mildew[3]	----	----	----	+++	+++
Fire blight	----	----	----	+++	+++[4]

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Protection of early tissue is important. Additional applications should be made according to infection periods as determined by the Mills table.
[2] Disruption of pseudothecial (or ascostroma) development (fall) and inactivation of overwintering twig lesions (delayed dormant) occurs; effects of these treatments on disease control uncertain.
[3] Early application is most effective; added treatments are made if mildew continues.
[4] Start management program at the beginning of bloom and continue through bloom including "rat-tail" bloom throughout spring. Several models are available for forecasting infection periods and treatment timing. Models include: Maryblyt, Cougar Blight, etc.

APRICOT—FUNGICIDE EFFICACY

Note: Do not use sulfur at any time on apricot trees or use captan preharvest on apricot fruit.

Fungicide	Resistance risk (FRAC#)[1]	Brown rot[2]		Jacket rot	Powdery mildew[2]	Shot hole	Eutypa
		Blossom	Fruit				
Benlate[3]	high (1)	++++	++++	++++	+++	----	----
Distinguish*	medium (9/11)	++++	+++	++++	+++	----	+++
Indar/Enable[4]	high (3)	++++	++++	----	ND	----	----
Orbit (Bumper)	high (3)	++++	++++	----	+++	----	+/-
Pristine	medium (7/11)[5]	++++	++++	+++	+++	----	++++
Rovral[6] + oil[7]	low (2)	++++	NR	++++	----	----	+++
Scala	high (9)[5]	++++	+++[8]	+++[9]	ND	----	++
Topsin-M/T-Methyl[3]	high (1)[5]	++++	++++	++++	+++	+++	----
Vangard	high (9)[5]	++++	+++[8]	+++[9]	ND	----	++
Rally	high (3)	+++	+++	----	+++	----	----
Rovral[6]	low (2)	+++	NR	+++	----	----	+++
Elevate	high (17)[5]	+++	++	+++	++	----	+
Abound	high (11)[5]	++	+	----	ND	----	+++
Botran	medium (14)	++	++	+++	ND	----	ND
Bravo/Chlorothalonil/Echo[10,11]	low (M5)	++	++	++	----	----	+++
Captan[11,12]	low (M4)	++	----[13]	++	----	----	+++
Gem	high (11)[5]	++	+	----	ND	----	+++
B-Lock	----	----	----	----	----	+++	----
Copper	low (M1)	+/-	----	----	----	----	++
Ziram	low (M3)	+/-	----	+	----	----	++++

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, ND = no data, and NR = not registered

* Registration pending.

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

[2] Do not use fungicides with the same FRAC number and high resistance risk more than twice in one year.

[3] Benlate label withdrawn. Strains of *Monilinia fructicola* and *M. laxa* resistant to Benlate, Topsin-M, and T-Methyl have been reported in some California apricot orchards. Resistant strains of the jacket rot fungus, *Botrytis cinerea*, have been reported in California on crops other than almond and stone fruits and may have the potential to develop in apricots with overuse of fungicides with similar chemistry.

[4] Indar registered; registration for Enable pending in California.

[5] 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/season.

[6] Blossom blight only; not registered for use after petal fall.

[7] The oil is a "light" summer oil, 1-2% volume/volume.

[8] High summer temperatures and relative humidity reduce efficacy.

[9] Has not been tested on apricot but is effective against the jacket rot pathogens.

[10] Do not use after jacket (shuck) split.

[11] Do not use in combination with or shortly before or after oil treatment.

[12] Causes fruit browning as a preharvest spray.

[13] May cause staining on fruit.

APRICOT—TREATMENT TIMING

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

Disease	Dormant	Red bud	Popcorn	Full bloom	Until pit hardening	Preharvest 1 to 3 weeks
Brown rot[1]	----	+++	+++	+++	----	+++
Jacket rot	----	----	----	+++	----	++
Powdery mildew	----	----	----	+++	+++[2]	----
Shot hole[3]	----	----	----	++	+++	----

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Begin at red bud, add one or two more sprays if weather favors disease.

[2] Repeated treatment at 7- to 14-day intervals may be necessary; earlier treatments are most effective.

[3] 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. Re-apply 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.

CHERRY--FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC#)[1]	Brown rot [2]		Botrytis Blossom/Fruit	Powdery mildew [2]	Shot hole or Leaf spot[3]	Eutypa
		Blossom	Fruit				
Adament	medium (3/11)	++++	++++	++	+++	ND	----
Benlate[4]	high (1)	++++	++++	++++	+++	ND	----
Elite	high (3)	++++	++++	++	++	ND	----
Indar/Enable[5]	high (3)	++++	+++	----	+++	ND	----
Orbit (Bumper)	high (3)	++++	++++	----	+++	ND	----
Pristine	medium (7/11)[6]	++++	++++	+++	+++	ND	----
Rovral[7] + oil[8]	low (2)	++++	NR	++++	++	ND	----
Topsin-M/T-Methyl[4]	high (1)[6]	++++	NR	++++	+++	ND	+++
Abound	high (11)[6]	+++	+	----	++	ND	----
Cabrio	high (11)[6]	+++	++	----	++	ND	----
Elevate	high (17)[6]	+++	+++	++++	+	ND	----
Gem	high (11)[6]	+++	++	----	++	ND	----
Procure[9]	high (3)	+++	+++	----	++++	ND	----
Quintec	medium (13)	ND	ND	ND	++++	ND	----
Rally[9]	high (3)	+++	+++	----	++++	ND	----
Rovral[7]	low (2)	+++	NR	+++	----	ND	----
Rubigan	high (3)	+++	+++	----	++++	ND	----
Botran	medium (14)	++	++	+++	----	ND	----
Bravo/Chloro-thalonil/Echo[10,11]	low (M5)	++	NR	++	----	ND	----
Captan[11]	low (M4)	++	++	++	----	ND	----
B-Lock	----	----	----	----	----	----	+++
Copper	low (M1)	+/-	----	----	----	ND	----
Sulfur[11]	low (M2)	+/-	----	----	+++	ND	----
Ziram	low (M3)	+/-	NR	----	----	ND	----

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, ND = no data, NR = not registered, and ? = insufficient data or unknown

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

[2] Do not use the same fungicide or fungicides with similar chemistry more than twice in one year.

[3] Shot hole and leaf spot occur infrequently on cherry in California; control usually is not necessary.

[4] Benlate label withdrawn. Strains of *Monilinia fructicola* resistant to Benlate, Topsin-M, and T-Methyl are present in some California cherry 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 sweet cherry with overuse of fungicides with similar chemistry.

[5] Indar is registration; registration for Enable pending in California.

[6] 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/season.

[7] Blossom blight only; not registered for use after petal fall

[8] Oil is a "light" summer oil, 1-2% volume/volume.

[9] More effective when applied as a concentrate (80-100 gal/acre) than as a dilute spray.

[10] Do not use after jacket (shuck) split.

[11] Do not use in combination with or shortly before or after oil treatment.

CHERRY—TREATMENT TIMING

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

Disease	Late budbreak	Popcorn	Full bloom	Petal fall	2-3 weeks later	Preharvest 1-10 days[1]
Botrytis	----	+++	+++	++	----	+++
Brown rot[2]	----	+++	+++	++	----	+++
Powdery mildew	++[3]	++	+++	+++	+++	+

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Select broad-spectrum fungicides (or combinations) that have activity against both brown rot and Botrytis fruit rots.
[2] Begin at popcorn and repeat every 10 to 14 days through bloom if rains continue.
[3] Use sulfur at late budbreak, other fungicides for later treatment. Treat immediately if mildew is found on shoots or leaves on inner scaffolds.

CHERRY—SUGGESTED DISEASE MANAGEMENT PROGRAMS WITH FUNGICIDE FRAC[1] GROUPS

Note: Not all indicated timings may be necessary for disease control (*see* Treatment Timing Table). If treatments are needed based on weather monitoring or environmental monitoring 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 previous season.
2) Select one of the suggested fungicide groups. *Numbers separated by slashes are pre-mixtures, whereas numbers grouped by pluses are tank mixtures*. If several diseases need to be managed, select a group that is effective against all diseases. Refer to fungicide efficacy table for fungicides belonging to each FRAC group. Group numbers are listed in numerical order within the suggested disease management program.
3) Rotate groups for each application within a season and, if possible, use each group only once per season, except for multi-site mode of action materials or natural products/biological controls (i.e., M2, NP/BC).

Disease	Dormant	Prebloom	White Tip /Popcorn	Full bloom	Petal fall	2-3 weeks later	Preharvest 1-10 days
Botrytis blossom blight/Gray mold fruit decay	----	----	1[3] 2 (+oil) (3)[4]	1[3] 2 (+oil) (3)[4] 3/11 3+17 7/11 17	2 (+oil) 7/11 17	----	(3)[4] 3+17 7/11 17
Brown rot blossom blight/Fruit rot	----	----	1[3] 2 (+oil) 3 3/11	1[3] 3 3+17 3/11 7/11 17	----	----	3 3/11 7/11 17
Powdery mildew	M2[2]	M2[2]	2 (+oil), 3	1[3] 3 7/11	13 M2[2] NP/BC[5]	3 11 13 M2[2] NP/BC[5]	3 3/11 3+17 7/11 11

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Groups 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.

[2] Use liquid lime sulfur in dormant applications and wettable sulfur at and after prebloom.

[3] Benlate label withdrawn. Strains of *Monilinia fructicola* resistant to Benlate, Topsin-M, and T-Methyl are present in some California cherry 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 sweet cherry with overuse of fungicides with similar chemistry.

[4] Among the group 3 fungicides, only Elite has activity against *Botrytis cinerea*.

[5] Natural Products/Biological Controls (NP/BC) – see efficacy table above.

GRAPEVINE—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC#)[1]	Powdery mildew	Downy mildew	Bunch rot		Phomopsis	Eutypa
				Botrytis	Summer		
Abound	high (11)[2]	++++	++++	+	----	+++	----
Adament	medium (3/11)	++++	+	++	++	++	----
Distinguish*	medium (9/11)	+++	++	+++	++	++	----
Flint[3]	high (11)[2]	++++	+++	++	++	++	----
Elite	high (3)	++++	----	++	++	----	----
Eminent[6]	high (3)	++++	----	----	----	----	----
Inspire[6]	high (3)	++++	----	----	----	----	----
JMS Stylet oil[4]	low	++++	----	+++	++	----	----
Pristine	medium (7/11)[2]	++++	++++	++++	+++	+++	----
Procure	high (3)	++++	----	----	----	----	----
Quintec	high (13)	++++	----	----	----	----	----
Rally	high (3)	++++	----	----	----	----	----
Rubigan	high (3)	++++	----	----	----	----	----
Sovran	high (11)[2]	++++	++++	++	++	++++	----
Sulfur	low (M2)	++++	----	----	----	----	----
Topguard[6]	high (3)	++++	----	----	----	----	----
Topsin-M/T-Methyl	high (1)[2]	++++	----	++	++	+	++++
Armicarb	low	+++	----	----	----	----	----
Cinnacure	low	+++	----	----	----	----	----
Elexa[5]	low	++	----	----	----	----	----
Kaligreen	low	+++	----	----	----	----	----
Messenger	low	+++	----	----	----	----	----
Milstop	low	+++	----	----	----	----	----
Purespray	low	+++	----	----	----	----	----
Rovral + Oil[4]	low (2)	+++	----	++++	----	----	----
Serenade	low	+++	----	++	+	----	----
Sporan[6]	low	++	----	----	----	----	----
Sonata	low	+++	----	NR	NR	----	----
Copper	low (M1)	++	+++	++	+++	+	----
Bayleton	high (3)	++	----	----	----	----	----
Elevate	high (17[2]	++	----	++++	++	----	----
Scala	high (9)[2]	++	----	++++	++	----	----
Vangard	high (9)[2]	++	----	++++	++	----	----
VigorCal[6]	low	++	----	----	----	----	----
VigorK[6]	low	++	----	----	----	----	----
Timorex[4,6]	low	++	----	----	----	----	----
Prev-am[4,6]	low	++	----	----	----	----	++
B-Lock	low	----	----	----	----	----	++++
Captan	low (M4)	----	+	+++	+++	+++	----

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Fungicide	Resistance risk (FRAC#)[1]	Powdery mildew	Downy mildew	Bunch rot		Phomopsis	Eutypa
				Botrytis	Summer		
Captevate	low (M4/17)	----	+	+++	+++	+	----
Dithane/Maneb	low (M3)	----	----	++	----	+++	----
Revus	high (40)	----	++++	----	----	----	----
Ridomil Gold/Mefenoxan	high (4)	----	++++	----	----	----	----
Rovral	low (2)	----	----	+++	----	----	----

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective; and NR = not recommended

* Registration pending.

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

[2] 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/season.

[3] Causes severe phytotoxicity on Concord grape.

[4] Phytotoxic if used within 2 weeks of Captan or sulfur.

[5] Label withdrawn

[6] Not registered in California

GRAPEVINE—TREATMENT TIMING

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

Disease	Dormant	Bud break	Full bloom	Pre-close	Veraison	Preharvest/ Postharvest
Botryosphaeria canker	+++	----	----	----	----	----
Botrytis	+++[2]	----	+++[1]	+++[1]	+++[1]	+++[1]
Downy mildew	----	+++	+++	----	----	----
Esca	+++[2]	----	----	----	----	----
Eutypa	+++	----	----	----	----	----
Powdery mildew	+++[2]	+++[3]	+++[3]	+++[4]	+++[4]	+++
Summer rot	----	----	----	----	++++[1]	+++[1]

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Apply only if rain is forecasted.

[2] Use 10 gal lime sulfur per acre in at least 100 gal water.

[3] Apply bud break and full bloom treatments every year.

[4] Apply as needed (a disease risk assessment model is available to help determine need for spray).

GRAPEVINES: SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FUNGICIDE FRAC[1] GROUPS

Note: Not all indicated timings may be necessary for disease control (*see* Treatment Timing Table). If treatments are needed based on weather monitoring or environmental monitoring 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 previous season.
2) Select one of the suggested fungicide groups. *Numbers separated by slashes are pre-mixtures, whereas numbers grouped by pluses are tank mixtures*. If several diseases need to be managed, select a group that is effective against all diseases. Refer to fungicide efficacy table for fungicides belonging to each FRAC group. Group numbers are listed in numerical order within the suggested disease management program.
3) Rotate groups for each application within a season and, if possible, use each group only once per season, except for multi-site mode of action materials or natural products/biological controls (i.e., M2, NP/BC).

Disease	Dormant	Bud break	Full bloom	Pre-close	Veraison	Preharvest
Botryosphaeria canker	NP[7] (lime sulfur)[3]	----	----	----	----	----
Botrytis	----	----	7/11[2] 17 9 M4	7/11[2] 17 9	7/11[2] 17 9	7/11 17 9
Downy mildew		NP	4	----	----	----
Esca	NP[7] (lime sulfur)[3]	----	-----	-----	----	----
Eutypa	NP[7] (B-Lock) 1	----	----	----	----	----
Powdery mildew[4,5]	NP[7] (lime sulfur) Oil	M2 Oil	7/11 17+11 13 3+9	11 3 13 BC[7] NP[7] M4	3 11 13 M4	----
Phomopsis cane and leafspot	----	11 M4/M3 2[6]	----	----	----	----
Summer rot	----	----	----	**7**/11 Oil M1 9	7/11 M1 9	----

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Groups 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.

[2] Apply only if rain is forecasted. When using one class do not follow with the same class.

[3] Use 10 gal lime sulfur per acre in at least 100 gal water. Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.

[4] Apply bud break and full bloom treatments every year.

[5] Apply as needed (a disease risk assessment model is available to help determine need for spray).

[6] Numbers separated by slashes are pre-mixtures, whereas numbers grouped by pluses are tank mixtures.

[7] Natural Products/Biological Controls (NP/BC) – see efficacy table above.

KIWIFRUIT—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC number)[1]	Botrytis Fruit Rot
Vangard[2]	high (9)[3]	+++
Elevate[2]/Judge[4]	high (17)[3]	+++
Scholar[4]	high (12)	+++

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective; and NR = not recommended

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

[2] Vangard registration is pending for the 2007 fall season. Elevate is in the IR-4 program.

[3] 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/season.

[4] Judge and Scholar are for postharvest use only.

KIWIFRUIT—TREATMENT TIMING

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

	Bud	Full	Preharvest Interval[1]			
Disease	break	bloom	14 day	7 day	1 day	Postharvest
Botrytis fruit rot	----	+[2]	++	+++	++++	++++

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Apply as needed. A predictive model BOTMON is available using ONFIT methods for disease detection.

[2] Apply only if rain is forecasted.

PEACH AND NECTARINE—FUNGICIDE EFFICACY

Fungicide	Resistance Risk (FRAC#)[1]	Brown rot[2] Blossom	Brown rot[2] Fruit	Powdery mildew[2]	Scab	Rust	Leaf curl	Shot hole
Adament	medium (3/11)							
Benlate[3]	high (1)	++++	++++	+++	+++	+	----	----
Distinguish*	medium (9/11)	++++	+++	++	+++	+++	----	++
Elite	high (3)	++++	++++	+++	++	+++	----	+/-
Indar/Enable[4]	high (3)	++++	++++	+++	+++	ND	----	+/-
Orbit (Bumper)	high (3)	++++	++++	+++	----	+++	----	+/-
Pristine	medium (7/11)[5]	++++	++++	+++	+++	ND	ND	++++
Rovral[6]+ oil[7]	low (2)	++++	NR	+	+	++	----	++
Scala[8]	high (9)[5]	++++	+++[8]	ND	ND	ND	----	+
Topsin-M/T-Methyl[3]	high (1)[5]	++++	++++	+++	+++	+	----	----
Vangard	high (9)[5]	++++	+++[8]	ND	ND	ND	----	+
Elevate	high (17)[5]	+++	+++	ND	ND	ND	ND	ND
Rally	high (3)	+++	+++	++++	----	----	----	----
Rovral[6]	low (2)	+++	NR	----	----	----	----	----
Abound	high (11)[5]	++	+	++	++++	+++	----	++
Botran	medium (14)	++	+	ND	ND	ND	ND	ND
Bravo/Echo[9,10]	low (M5)	++	----	----	+++	+	+++	+++
Captan[10]	low (M4)	++	++	----	+++	----	----	+++[11]
Gem	high (11)[5]	++	+	++	++++	+++	----	++
Copper	low (M1)	+/-	----	----	----	----	+++	+++
Sulfur[10]	low (M2)	+/-	+/-	+++	+++	+++	----	----
Ziram	low (M3)	+/-	----	----	+++	----	++++	+++

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, ND = no data, and NR = not registered

* Registration pending.

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

[2] Do not use fungicides with the same FRAC number and high resistance risk more than twice in one year.

[3] Benlate label withdrawn. Strains of *Monilinia fructicola* resistant to Benlate, Topsin-M, and T-Methyl are present in some peach and nectarine 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 peach and nectarine with overuse of fungicides with similar chemistry.

[4] Indar is registered; registration for Enable pending in California.

[5] 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/season.

[6] Blossom blight only; not registered for use after petal fall.

[7] Oil is a "light" summer oil, 1-2% volume/volume.

[8] High summer temperatures and relative humidity reduce efficacy.

[9] Do not use after jacket (shuck) split.

[10] Do not use in combination with or shortly before or after oil treatment.

[11] Not effective if used as a dormant treatment.

PEACH AND NECTARINE—TREATMENT TIMING

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

		Bloom		3-6 weeks	Preharvest[1]	
Disease	**Dormant**	**20-40%**	**80-100%**	**postbloom**	**3 weeks**	**1 week**
Brown rot	----	++	+++	+	++	+++
Powdery mildew	----/ND	++	+++	+++[2]	----	----
Leaf curl[3]	+++	+	----	----	----	----
Rust	+[4]	----	----	+++	++	----
Scab	----	+	++	+++	----	----
Shot hole[5]	+++	+	+	++	----	----

Rating: +++ = most effective, ++ = moderately effective, + = least effective, ---- = ineffective, and ND = no data but needs to be evaluated.

[1] Timing not exact; weather conditions determine need for treatment.
[2] Apply until pit hardening.
[3] Treatment should be made before bud break and preferably before bud swell.
[4] Dormant treatment with liquid lime sulfur.
[5] Fall application before winter rains begin is the most important; additional spring sprays are seldom required but may be needed to protect the fruit if heavy persistent spring rains occur.

PEACH AND NECTARINE—SUGGESTED DISEASE MANAGEMENT PROGRAMS WITH FUNGICIDE FRAC[1] GROUPS

Note: Not all indicated timings may be necessary for disease control (*see* Treatment Timing Table). If treatments are needed based on weather monitoring or environmental monitoring 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 previous season.
2) Select one of the suggested fungicide groups. *Numbers separated by slashes are pre-mixtures, whereas numbers grouped by pluses are tank mixtures*. If several diseases need to be managed, select a group that is effective against all diseases. Refer to fungicide efficacy table for fungicides belonging to each FRAC group. Group numbers are listed in numerical order within the suggested disease management program.
3) Rotate groups for each application within a season and, if possible, use each group only once per season, except for multi-site mode of action materials or natural products/biological controls (e.g., M2, NP/BC).

		Bloom		3-6 weeks	Preharvest	
Disease	**Dormant**	**20-40%**	**80-100%**	**postbloom**	**3 weeks**	**1 week**
Brown rot	----	1[3] 2 (+oil) 3 3/11 9 9/11	1[3] 2 (+oil) 3[4] 3/11 9 9/11 7/11 17	3 3/11 9/11 7/11 17	3 3/11 9/11 7/11 17	3[4] 3/11 9/11 7/11 17
Powdery mildew	----/M2[2]	1[3] 2+oil 3	1[3] 3 7/11	3 7/11 11 M2[2] NP/BC[5]	----	----
Leaf curl	M1 M3 M5	M3 M5	----	----	----	----
Rust	M2[2]	----	----	1[3] 3 7/11 11 M2[2]	3 7/11 11 M2[2]	----
Scab	----	1[3] 3 3/11 7/11 9/11 M3 M4	1[3] 3 3/11 7/11 9/11 M4 M5	1[3] 3 3/11 7/11 9/11 11 M2[2] M4	----	----
Shot hole	M1 M3 M5	2 M3 M4 M5	2 7/11 M3 M4 M5	7/11 11 M4	----	----

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Groups 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.

Continued on next page . . .

Peach and Nectarine—Disease Management Programs, continued

[2] Efficacy of liquid lime sulfur in dormant applications has not be determined for powdery mildew. Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.

[3] Benlate label withdrawn. Strains of *Monilinia fructicola* resistant to Benlate, Topsin-M, and T-Methyl are present in some California cherry 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 sweet cherry with overuse of fungicides with similar chemistry.

[4] Among the group 3 fungicides, only Elite has activity against *Botrytis cinerea*.

[5] Natural Products/Biological Controls (NP/BC) – see efficacy table above.

PISTACHIO—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC#)[1]	Alternaria	Botrytis	Botryosphaeria
Abound[2]	high (11)[3]	+++	----	+++
Benlate[4]	low (1)	----	+++	++
Bravo	low (M5)	++	----	++
Cabrio	high (11)[3]	+++	----	+++
Distinguish	medium (9/11)	++	++	----
Echo[5]	low (M5)	NR	----	NR
Elevate	high (17)[3]	ND	++++	ND
Gem	high (11)[3]	+++	----	+++
Pristine	high (7/11)[3]	++++[6]	++++	++++
Scala	high (9)[3]	++	++	+++[7]
Switch	high (9/12)[3]	+++	+++	++
Topsin-M[8]	high (1)	----	+++	++
Copper	low (M1)	+	----	----
Liquid lime sulfur[9]	low (M2)	----	----	+/-

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, and ND = no data

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

[2] Field resistance of *Alternaria* spp. to Abound and to other strobilurin fungicides (Flint and Cabrio) is widespread in pistachio orchards.

[3] 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/season.

[4] Benlate label withdrawn. Previously registered for bloom treatment only.

[5] Label was withdrawn for pistachio due to phytotoxicity.

[6] Resistance to boscalid has been detected in high levels (80-90%) in some orchards; Pristine should not be applied if resistance to this fungicide is detected in an orchard.

[7] Under low and moderate disease pressure.

[8] Registered for bloom treatment only.

[9] Dormant treatment only.

PISTACHIO—TREATMENT TIMING

Disease	Dormant	April	June[3]	July	August
Alternaria[1]	----	----	+++	+++[2]	++
Botryosphaeria[3]	+	++	+++	+++	++
Botrytis	----	+++	----	----	----

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Three applications during the season are recommended.

[2] If only one application is done, the best timing is late June to early July.

[3] Treat with Topsin-M once at bloom when the terminals on female trees are 1-2 inches long. Begin summer applications in late May or early June. Treat at 2-3 week intervals until mid-August. For resistance management, do not apply consecutive applications of any strobilurin (Abound, Flint/Gem or Cabrio) or strobilurin-containing fungicides (Pristine), and make no more than two applications of a strobilurin or strobilurin-containing fungicide per season.

PLUM—FUNGICIDE EFFICACY

Note: Disease control in spring and preharvest is not necessary for most plum cultivars in California.

Fungicide	Resistance risk (FRAC#)[1]	Brown rot		Powdery mildew[3]	Shot hole[4]
		Blossom[2]	Fruit		
Benlate[5]	high (1)	++++	++++	+++	ND
Distinguish*	medium (9/11)	++++	+++	++	++
Indar	high (3)	++++	++++	+++	ND
Orbit/Bumper	high (3)	++++	++++	+++	ND
Pristine	medium (7/11)[6]	++++	++++	+++	ND
Rovral[7] + oil[8]	low (2)	++++	NR	----	ND
Scala	high (9)[6]	++++	+++[9]	ND	ND
Topsin-M/T-Methyl[5]	high (1)[6]	++++	++++	+++	ND
Vangard	high (9)[6]	++++	+++[9]	ND	ND
Rally	high (3)	+++	+++	+++	ND
Rovral[7]	low (2)	+++	NR	----	ND
Abound	high (11)[6]	++	+	ND	ND
Botran	medium (14)	++	++	ND	ND
Bravo/Chlorothalonil/ Echo[10,11]	low (M5)	++	++	----	ND
Captan[11]	low (M4)	++	++	----	ND
Gem	high (11)[6]	++	++	ND	ND
Copper	low (M1)	+/-	----	----	ND
Sulfur[11]	low (M2)	+/-	+/-	+++	ND

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, and ND= no data

* Registration pending.

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

[2] Brown rot is seldom observed on most plum cultivars and usually does not require treatment during bloom.

[3] Powdery mildew seldom is observed on most plum cultivars and control usually is unnecessary.

[4] Shot hole disease rarely occurs on plums in California. The small holes often observed on leaves in spring are caused by either a genetic disorder or by other agents including environmental factors.

[5] Benlate label withdrawn. Strains of the brown rot fungus *Monilinia fructicola* resistant to Benlate, Topsin-M, and T-Methyl are found in other stone fruit orchards in California. Brown rot is so seldom found in plum orchards that the resistance levels in plum orchards have not been assessed.

[6] 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/season.

[7] Blossom blight only; not registered for use after petal fall.

[8] The oil is a "light" summer oil, 1-2% volume/volume.

[9] High summer temperatures and relative humidity reduce efficacy.

[10] Do not use after jacket (shuck) split.

[11] Do not use in combination with or shortly before or after oil treatment.

PLUM—TREATMENT TIMING

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

Disease	Dormant	Green bud	Popcorn	Full bloom	Until pit hardening	Preharvest
Brown rot[1]	----	+	++	+++	----	+
Powdery mildew	----	+	+	+++	+++	----
Shot hole[2]	----	----	----	----	----	----

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective.

[1] One early application should suffice; a second treatment should not be needed.
[2] No treatment is recommended for shot hole because the shot holes found on plum leaves only rarely are caused by the shot hole fungus.

PRUNE (OR DRIED PLUM)—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC#)[1]	Brown rot		Russet scab	Rust
		Blossom	Fruit		
Benlate[2] + oil[3]	high (1)	++++	++++	----	----
Distinguish*	medium (9/11)	++++	++	----	++
Indar	high (3)	++++	++++	----	+++
Orbit (Bumper)	high (3)	++++	++++	----	+++
Pristine	medium (7/11)[4]	++++	++++	ND	ND
Rovral[5] + oil[3]	low (2)	++++	NR	----	NR
Scala	high (9)[4]	++++	+++[6]	----	ND
Topsin-M[2]/T-Methyl + oil[3]	high (1)[4]	++++	++++	----	----
Vangard	high (9)[4]	++++	+++[6]	----	ND
Benlate[2]	high (1)	+++	+/-	----	----
Elevate	high (17)[4]	+++	+++	ND	----
Rovral[4]	low (2)	+++	NR	----	NR
Topsin-M/T-Methyl[2]	high (1)[4]	+++	+/-	----	----
Abound	high (11)[4]	++	+	----	+++
Botran	medium (14)	++	++	ND	ND
Bravo/Chlorothalonil/ Echo[7,8]	low (M5)	++	++	++	----[8]
Captan[7]	low (M4)	++	++	+++	----
Gem	high (11)[4]	++	+	----	+++
Rally	high (3)	++	++	----	----
Sulfur	low (M2)	+/-	+/-	----	++

Rating: ++++= excellent and consistent, +++= good and reliable, ++= moderate and variable, += limited and erratic, +/- = minimal and often ineffective, ---- = ineffective, ? = insufficient data or unknown, NR=not registered after bloom, and ND=no data

* Registration pending.

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

[2] Benlate label withdrawn. Strains of *Monilinia fructicola* and *M. laxa* resistant to Benlate, Topsin-M, and T-Methyl have been reported in some California prune orchards. No more than two applications of Benlate and Topsin should be made each year. 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 prune with overuse of fungicides with similar chemistry.

[3] The oil is "light" summer oil, 1-2% volume/volume. If applied in summer causes fruit to lose bloom and look red. They dry to normal color.

[4] 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/season.

[5] Blossom blight only; not registered for use after petal fall.

[6] High summer temperatures and relative humidity reduce efficacy.

[7] Do not use in combination with or shortly before or after oil treatment.

[8] Do not use after jacket (shuck) split.

PRUNE (OR DRIED PLUM)—TREATMENT TIMING

Note: Timings listed are effective but not all may be required for disease control. Timings used will depend upon orchard history of disease, length of bloom, and weather conditions each year.

Disease	Green bud	White bud	Full bloom	May	June	July
Brown rot[1]	+++	+++	+++	----	+	++
Russet scab[2]	----	----	+++	----	----	----
Rust[3]	----	----	----	+	++	+++

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Flowers are susceptible beginning with the emergence of the sepals (green bud) until the petals fall but are most susceptible when open.
[2] A physiological disorder; no pathogens involved.
[3] More severe when late spring rains occur.

STRAWBERRY—FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC)[1]	Powdery mildew	Gray mold	Anthrac-nose	Angular leaf spot	Common leaf spot	Mucor rot	Rhizopus rot	Leather rot	Crown rot	Red steele
Rally	high (3)	++++	++	++	----	+++	----	----	----	----	----
Procure	high (3)	++++	----	+	----	----	----	----	----	----	----
Topsin-M	very high (1)[2]	+++	+++	----	----	++	----	----	----	----	----
Eminent*	high (3)	NR	NR	ND	----	ND	ND	ND	----	----	----
Copper	low (M1)	----	----	----	++	----	----	----	----	----	----
Sulfur	low (M2)	+++	----	----	----	----	----	----	----	----	----
Quadris	medium (11)[2]	+++	++	++	----	----	ND	ND	ND	ND	ND
Pristine	medium (7/11)[2]	+++	++++	ND	----	----	ND	ND	ND	ND	ND
Cinnacure	low	+	----	----	----	----	----	----	----	----	----
Elevate	high (17)[2]	+/-	++++	+++	----	----	----	----	----	----	----
M-Pede	low	+	----	----	----	----	----	----	----	----	----
Rovral	low (2)	----	+++	----	----	----	++	----	----	----	----
Switch	high (7/12)	----	++++	+++	----	----	+	+++	----	----	----
Captan	very low (M4)	----	+++	+++	----	----	+	----	----	----	----
Thiram	low (M3)	----	++	++	----	----	----	----	----	----	----
Aliette[3]	low (33)	----	----	----	----	----	----	----	+++	++	++
Ridomil Gold SL[4]	high (4)[2]	----	----	----	----	----	----	----	+++[4]	++	++

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, NR = not registered, and ND = no data

***Registration pending**

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

[2] 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/season.

[3] Foliar applications provide systemic treatment.

[4] Ridomil Gold SL is the only formulation registered. If the GR formulation is applied to a previous crop that must be removed, it has a 0-day plantback interval.

STRAWBERRY—TREATMENT TIMING

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

			At Planting		Preharvest[1]	
Disease	**Pre-plant fumigation[2]**	**Clean nursery stock**	**Dips or water washing**	**Before overhead irrigations**	**Foliar**	**Fruit**
Anthracnose[3]	+++	+++	+++	+	+	+++
Botrytis fruit rot[3]	----	----	----	+	++	+++
Mucor fruit rot	----	----	----	+	+	+++
Rhizopus rot	----	----	----	----	----	+++
Angular leaf spot	+	+++	+	+++	+	----
Common leaf spot[3]	+	+++	++	+++	+++	+
Powdery mildew[3]	----	+++	----	----	+++	+
Leather rot[4]	+++	----	----	++	----	++
Phytophthora crown rot[4]	+++	+	----	++	+	----
Red steele[4]	++	++	----	+	++	----
Verticillium wilt	+++	++	----	----	----	----

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective.

[1] Preharvest treatments include applications of fungicides before heavy fog, dews, or rain.
[2] Preplant fumigation includes methyl bromide/chloropicrin, 1,3-dichloropropene/chloropicrin or chloropicrin followed by metam sodium or metam potassium or solitary applications of 1,3-dichloropropene/chloropicrin or chloropicrin.
[3] Integrated programs required for management including rotation of fungicides of different classes.
[4] In-season, foliar treatments include phosphite or fosetyl-aluminum products or soil applications

WALNUT—BACTERICIDE EFFICACY

Material	Resistance risk (FRAC#)[1]	Walnut blight[2]	Phytotoxicity
Bordeaux	low (M1)	+++	NP
Fixed coppers	medium (M1)	+++	++*
Copper-maneb[3]	low (M1/M3)	++++	NP
Copper-maneb-surfactant (single application)[4]	low (M1/M3)	+	NP
Zinc-Copper Bordeaux	low (M1)	+++	NP
Serenade	low	+	NP

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and erratic, and NP = not phytotoxic.

***** Phytotoxicity of fixed coppers can be reduced with the addition of lime or agricultural oils to the tank mixture.

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

[2] Copper resistance occurs within sub-populations of *Xanthomonas juglandis*.

[3] Maneb refers to Manex registered under a Section 18 Emergency registration for the last 14 years.

[4] A single application with a surfactant is not recommended because of build up of populations on buds that may increase disease in subsequent years.

WALNUT—TREATMENT TIMING

Note: Timings listed are effective but not all may be required for disease control. Timings used will depend upon orchard history of disease and weather conditions each year.

Disease	Catkin emergence	Terminal bud break	1 week after bud break	7-10 day intervals[1]	May[2]
Walnut blight (on fruit/nuts)[3]	++	+++	+++	++[1]	+

[1] A temperature-leaf wetness model (e.g., XanthoCast) is available for determining optimum timing of bactericide applications.

[2] Late spring rains are less conducive to disease provided bloom is not delayed by low chilling.

[3] Male and female flowers are susceptible beginning with their emergence, depending on wetness and temperatures conducive to disease development.