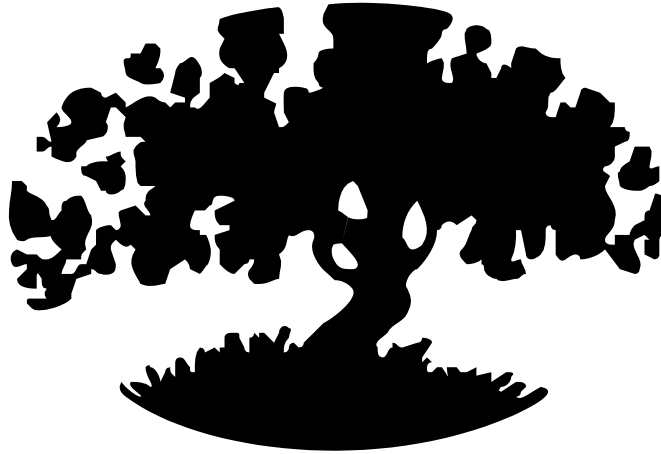


**EFFICACY AND TIMING OF FUNGICIDES,  
BACTERICIDES, AND BIOLOGICALS**  
*for*  
**DECIDUOUS TREE FRUIT, NUT,  
STRAWBERRY, AND VINE CROPS**  
**2010** (updated 5/1/10)



**ALMOND  
APPLE/PEAR  
APRICOT  
CHERRY  
GRAPE  
KIWIFRUIT**

**PEACH/NECTARINE  
PISTACHIO  
PLUM  
PRUNE  
STRAWBERRY  
WALNUT**

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

| Single active ingredient | Trade name                              | Class (FRAC number) <sup>1</sup>      | Systemic action | Mode of action            | Resistance potential   |
|--------------------------|---|---------------------------------------|-----------------|---------------------------|------------------------|
| copper                   | various                                 | Inorganic (M1)                        | No              | Multi-site                | Low                    |
| sulfur                   | various                                 | Inorganic (M2)                        | No              | Multi-site                | Low                    |
| mancozeb                 | Dithane/Manzate/<br>Penncozeb           | Carbamate (EBDC) <sup>2</sup> (M3)    | No              | Multi-site                | Low                    |
| maneb                    | Maneb/Manex**                           | Carbamate (EBDC) <sup>2</sup> (M3)    | No              | Multi-site                | Low                    |
| thiram                   | Thiram                                  | Carbamate (DMDC) <sup>3</sup> (M3)    | No              | Multi-site                | Low                    |
| ziram                    | Ziram                                   | Carbamate (DMDC) <sup>3</sup> (M3)    | No              | Multi-site                | Low                    |
| captan                   | Captan                                  | Phthalamide (M4)                      | No              | Multi-site                | Low                    |
| chlorothalonil           | Bravo/Chorothalonil<br>/Echo/Equus      | Chloronitrile (M5)                    | No              | Multi-site                | Low                    |
| dodine                   | Syllit                                  | Guanidine (M7)                        | Yes             | Few<br>(Multi-site)       | Medium                 |
| thiabendazole            | Mertect                                 | MBC (1)                               | Yes             | Single-site               | Very high <sup>4</sup> |
| thiophanate-methyl       | Topsin-M/T-Methyl<br>/Thiophanate-Methy | MBC (1)                               | Yes             | Single-site               | Very high <sup>4</sup> |
| iprodione                | Rovral/Iprodione/<br>Nevado             | Dicarboximide (2)                     | Yes             | Single-site?              | Medium                 |
| difenoconazole           | Inspire                                 | DMI <sup>5</sup> -triazole (3)        | Yes?            | Single-site               | High                   |
| fenarimol                | Rubigan                                 | DMI-pyrimidine (3)                    | Yes?            | Single-site               | High                   |
| fenbuconazole            | Indar (Enable*)                         | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| flutriafol               | Topguard*                               | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| metconazole              | Quash                                   | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| myclobutanil             | Rally/Laredo                            | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| propiconazole            | Bumper/Mentor/Tilt                      | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| tebuconazole             | Elite/Orius/Tebuzol                     | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| tetraconazole            | Mettle                                  | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| triadimefon              | Bayleton                                | DMI-triazole (3)                      | Yes?            | Single-site               | High                   |
| triforine                | Funginex**                              | DMI-piperazine (3)                    | Yes?            | Single-site               | High                   |
| triflumizole             | Procure                                 | DMI-imidazole (3)                     | Yes?            | Single-site               | High                   |
| mefenoxam                | Ridomil Gold                            | Phenylamide (4)                       | Yes             | Single-site               | High <sup>4</sup>      |
| boscalid                 | Endura                                  | SDHI <sup>6</sup> (7)                 | No              | Single-site               | High <sup>4</sup>      |
| fluopyram                | Luna Privilege*                         | SDHI (7)                              | No              | Single-site               | High <sup>4</sup>      |
| cyprodinil               | Vangard                                 | AP <sup>7</sup> (9)                   | Slight          | Single-site               | High <sup>4</sup>      |
| pyrimethanil             | Scala/Penbotec                          | AP (9)                                | Slight          | Single-site               | High <sup>4</sup>      |
| azoxystrobin             | Abound                                  | QoI <sup>8</sup> (11)                 | Yes?            | Single-site               | High <sup>4</sup>      |
| kresoxim-methyl          | Sovran                                  | QoI (11)                              | Yes?            | Single-site               | High <sup>4</sup>      |
| pyraclostrobin           | Cabrio                                  | QoI (11)                              | Yes?            | Single-site               | High <sup>4</sup>      |
| trifloxystrobin          | Flint/Gem                               | QoI (11)                              | Yes?            | Single-site               | High <sup>4</sup>      |
| fludioxonil              | Scholar                                 | Phenylpyrrole (12)                    | No              | Few<br>(Multi-site)       | Medium                 |
| quinoxifen               | Quintec                                 | Quinoline (13)                        | No              | Single-site               | Medium                 |
| dichloran                | Botran/Allisan                          | Aromatic hydrocarbon<br>(14)          | Slight          | Single-site               | Medium                 |
| fenhexamid               | Elevate/Judge                           | Hydroxyanilide (17)                   | No              | Single-site               | High <sup>4</sup>      |
| polyoxin-D               | Ph-D*/Endorse*                          | chitin synthesis inhibitor<br>(19)    | No?             | Single-site               | Medium                 |
| mandipropamid            | Revus                                   | cell wall synthesis<br>inhibitor (40) | Yes?            | Single-site               | High                   |
| fluopicolide             | Presidio                                | Benzamide (43)                        | Yes?            | Single-site               | High                   |
| metrafenone              | Vivando*                                | actin disrupter (U8)                  | No              | Unknown<br>(Single-site?) | High?                  |

General Properties of Registered and Experimental Fungicides, continued

| Multiple active ingredients (Premixtures) | Trade name       | Class (FRAC number) <sup>1</sup>         | Systemic action | Mode of action               | Resistance potential |
|---|------------------|--|-----------------|------------------------------|----------------------|
| captan/<br>fenhexamid                     | CaptEvate        | Phthalamide (M4)/<br>hydroxyanilide (17) | No              | Multi-<br>site/Single-site   | Low                  |
| tebuconazole/<br>trifloxystrobin          | Adament          | DMI-triazole (3)/QoI<br>(11)             | Yes?            | Single-site<br>Single-site   | Medium               |
| pyrimethanil/<br>trifloxystrobin          | Distinguish**    | AP (9)/QoI (11)                          | Yes?            | Single-site/<br>Single-site  | High                 |
| difenoconazole/<br>cyprodinil             | Inspire Super    | DMI-triazole (3)/<br>AP (9)              | Yes?            | Single-site/<br>Single-site  | Medium               |
| difenoconazole/<br>propiconazole          | Inspire XT*      | DMI-triazole (3)/<br>DMI-triazole (3)    | Yes?            | Single-site/<br>Single-site  | Medium               |
| tebuconazole/<br>fluopyram                | Luna Experience* | DMI-triazole (3)/ SDHI<br>(7)            | Yes?            | Single-site/<br>Single-site  | Medium               |
| fluopyram/<br>trifloxystrobin             | Luna Sensation*  | SDHI (7)/QoI (11)                        | Yes?            | Single-site/<br>Single-site  | High                 |
| pyraclostrobin /<br>boscalid              | Pristine         | SDHI (7)/QoI (11)                        | Yes?            | Single-site /<br>Single-site | High                 |
| difenoconazole/<br>azoxystrobin/          | Quadris Top*     | DMI-triazole (3)/QoI<br>(11)             | Yes?            | Single-site /<br>Single-site | Medium               |
| propiconazole/<br>azoxystrobin/           | Quilt Xcel       | DMI-triazole (3)/QoI<br>(11)             | Yes?            | Single-site /<br>Single-site | Medium               |
| fludioxonil /<br>cyprodinil               | Switch           | Phenylpyrrole (12)/ AP<br>(9)            | No/<br>Slight   | Single-site/<br>Single-site  | Medium               |

\* Registration pending in California

\*\* Not registered, label withdrawn or inactive

? = 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)

<sup>1</sup> 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 a fungicide with a different mode of action Group number.

<sup>2</sup> EBDC = ethylene bisdithiocarbamate.

<sup>3</sup> DMDC = dimethyl dithiocarbamate

<sup>4</sup> 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.

<sup>5</sup> DMI = demethylation (sterol) inhibitor

<sup>6</sup> SDHI = Succinate dehydrogenase inhibitor

<sup>7</sup> AP = Anilinopyrimidine

<sup>8</sup> QoI = quinone outside inhibitor (strobilurin).

## General Properties 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) <sup>1</sup> | Resistance potential |
|--|--|---------------------------|-----------------|---|----------------------|
| Actinovate                             | <i>Streptomyces lydicus</i> WYEC 108                   | biological                | No              | Various                                   | Low                  |
| AgriMycin/FireWall/<br>Ag Streptomycin | streptomycin   | antibiotic                | Yes             | Protein Synthesis(25)                     | High                 |
| Kasumin*                               | kasugamycin  | antibiotic                | Yes             | Protein Synthesis(24)                     | High                 |
| Mycoshield/FireLine/<br>(FlameOut**)   | oxytetracycline  | antibiotic                | Yes             | Protein Synthesis(41)                     | High                 |
| AQ-10**                                | <i>Ampelomyces quisqualis</i>                          | biological                | No              | Various                                   | Low                  |
| Arabesque*                             | <i>Muscodor albus</i>                                  | biological                | No              | Various                                   | Low                  |
| Auxigro**                              | GABA/L-glutamic acid                                   | SAR <sup>2</sup> -protein | Yes             | Host resistance                           | Unknown              |
| B-lock**                               | boric acid and latex paint                             | inorganic salt            | No              | Various                                   | Low                  |
| BlightBan                              | <i>Pseudomonas fluorescens</i> A506                    | biological                | No              | Various                                   | Low                  |
| BloomtimeBiological                    | <i>Pantoea agglomerans</i> E/325                       | biological                | No              | Various                                   | Low                  |
| Elexa**                                | glucosamine protein                                    | SAR <sup>2</sup> -protein | Yes             | Host resistance                           | Unknown              |
| KeyPlex 350 DP*                        | yeast extract  | SAR <sup>2</sup> -protein | Yes             | Host resistance                           | Unknown              |
| Plant Shield                           | <i>Trichoderma harzianum</i>                           | biological                | No              | Various                                   | Low                  |
| Serenade                               | <i>Bacillus subtilis</i>                               | microbial                 | No              | Various                                   | Low                  |
| Sonata                                 | <i>Bacillus pumilis</i>                                | microbial                 | No              | Various                                   | Low                  |
| Messenger                              | harpin   | SAR <sup>2</sup> -protein | Yes             | Host resistance                           | Unknown              |
| OxiDate/StorOx/<br>Perasan             | hydrogen dioxide in acetic acid<br>(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*                              | <i>Quillaja saponaria</i>                              | natural product           | No              | Various                                   | Low                  |
| Regalia                                | <i>Reynoutria sachalinensis</i>                        | natural product           | No              | Various                                   | Low                  |
| Sporan                                 | plant oils (clove, rosemary, thyme)                    | natural product           | No              | Various                                   | Low                  |
| Valero**                               | cinnamaldehyde   | natural product           | No              | Various                                   | Low                  |

\* Registration pending in California

\*\* Not registered, label withdrawn or inactive

<sup>1</sup> 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.

<sup>2</sup> SAR = Systemic acquired resistance induced in host

## MAXIMUM RESIDUE LIMITS (TOLERANCES) OF PESTICIDES ON AGRICULTURAL FOOD COMMODITIES

Residue tolerances are established for all pesticides registered on agricultural commodities. For synthetic pesticides, as well as materials that are produced by fermentation and are concentrated and/or reformulated, maximum residue limits (i.e., tolerances) have been established by national (country-based) and international regulatory agencies. In the United States, the Environmental Protection Agency (EPA), along with the Food and Drug Administration (FDA) are involved in establishing limits on agricultural food commodities for all registered products including those designated as “exempt” or “generally regarded as safe” or GRAS. Use limits are set for the latter materials, whereas all other materials must have analytical procedures available to measure chemical residues on the commodity. Internationally, the United Nations World Health Organization (WHO) and Food and Agricultural Organization (FAO) created the CODEX Alimentarius Commission to develop food standards, guidelines, and practice codes.

The main goal of national and international agencies is to protect the health of consumers, ensure fair trade practices in food trade, and promote coordination of food standards. The process of registering a pesticide on a food commodity is rigorous and requires numerous evaluations ranging from toxicity to environmental persistence and chemical fate studies. The limits of a pesticide residue are established as a maximum residue limit (MRL) that can occur on each commodity that is still considered an absolute minimal risk to the consumer. Generally, the MRL level is two times higher than what is expected for a residue under labeled pesticide usage. In the United States, the Foreign Agricultural Service or FAS has a website for viewing MRLs of registered pesticides for many markets around the world. The *International Maximum Residue Limit Database* provides users with a list of MRL tolerances by active ingredient to desired export destinations. Users may query by crop, pesticide active ingredient, and pesticide type. The web address is <http://www.mrldatabase.com/>.

Three rules of the International MRL Database should be noted:

1. Only those chemicals that have a permanently established EPA tolerance are included.
2. Foreign market MRLs are included only when an EPA tolerance is in place for the same commodity.
3. Sometimes the EPA sets tolerances for crop groups rather than for individual commodities (e.g. for stone fruit but not for peaches). These crop group MRLs will be shown for the individual commodities that are members of the crop group. A pop-up note will indicate that the commodity is part of a crop group and that the MRL is set for the group and not the individual commodity.

The MRL Database exclusively reflects maximum residue levels that have been established on a permanent basis under domestic US legislation according to the US Code of Federal Regulation (CFR). The following types of MRLs are **not** included in the database:

- Tolerances with regional registrations
- Time-limited and temporary tolerances
- US Section 18 tolerances
- US import tolerances explicitly noted in the CFR
- Tolerances for indirect residues
- Tolerances explicitly noted in the CFR as lacking a current US registration

## OVERALL EFFICACIES FOR TREE CROPS

For information regarding registration status on a particular crop, see the individual crop tables.

| Fungicide                       | Brown rot | Jacket rot (Botrytis) | Shot hole | Powdery mildew | Rust | Scab              |                   | Anthracnose | Alternaria       |
|---------------------------------|-----------|-----------------------|-----------|----------------|------|-------------------|-------------------|-------------|------------------|
|                                 |           |                       |           |                |      | Almond            | Apple/pear        |             |                  |
| <b>CONVENTIONAL FUNGICIDES</b>  |           |                       |           |                |      |                   |                   |             |                  |
| Abound                          | ++        | ---                   | +++       | ++             | +++  | ++++ <sup>1</sup> | NL                | ++++        | +++ <sup>1</sup> |
| Adament                         | ++++      | ++                    | ++        | +++            | ---  | +++               | ND                | ++++        | +++              |
| Botran                          | ++        | +++                   | ND        | NL             | NL   | NL                | NL                | NL          | NL               |
| Bravo/Chlorothalonil/Echo/Equus | ++        | ++                    | +++       | ---            | ++   | +++               | NL                | ++++        | +                |
| Bumper/Mentor/Tilt              | +++       | +/-                   | +/-       | +++            | +++  | NL                | NL                | +++         | ---              |
| Cabrio                          | ++        | ---                   | NL        | ++             | NL   | NL                | NL                | NL          | NL               |
| Captan                          | ++        | ++                    | +++       | ---            | +    | +++               | NL                | ++          | +                |
| Distinguish**                   | ++++      | +++                   | ++        | +++            | ---  | ND                | ND                | ++++        | ++               |
| Dithane/Manzate/Penncozeb       | NL        | NL                    | NL        | ---            | NL   | NL                | ++                | NL          | NL               |
| Elevate/Judge                   | +++       | ++++                  | +         | +              | ND   | ND                | ND                | ND          | ND               |
| Elite/Orius                     | ++++      | ++                    | +/-       | +++            | +++  | NL                | NL                | +++         | ++               |
| Flint/Gem                       | ++        | ---                   | ---       | ++             | +++  | ---               | ++++ <sup>1</sup> | ++++        | +++ <sup>1</sup> |
| Funginex**                      | +++       | ---                   | ---       | ++             | +    | ---               | +++               | ND          | ND               |
| Indar (Enable*)                 | +++       | +/-                   | +         | +++            | ND   | NL                | ---               | ++          | ---              |
| Inspire                         | ++++      | ++                    | ++        | +++            | ND   | ++++              | ND                | ND          | +++              |
| Inspire Super                   | ++++      | ++++                  | ++        | +++            | +++  | ++++              | ++++              | ND          | +++              |
| Laredo                          | +++       | ---                   | ++        | ++++           | ++   | ---               | NL                | ++          | ---              |
| Luna Privilege*                 | ++++      | +++                   | ++        | +++            | ---  | +++ <sup>1</sup>  | ++++              | ND          | +++ <sup>1</sup> |
| Luna Sensation*                 | ++++      | +++                   | ++        | +++            | +++  | ++++ <sup>1</sup> | ++++              | +++         | +++ <sup>1</sup> |
| Luna Experience*                | ++++      | +++                   | ++        | +++            | +++  | ++++ <sup>1</sup> | ++++              | +++         | +++ <sup>1</sup> |
| Maneb**                         | +         | +                     | ++        | ---            | +++  | ++                | ++                | ++          | +                |
| Manex**                         | +         | +                     | ++        | ---            | +++  | ++                | ++                | ++          | +                |
| Mettle                          | ++        | ---                   | ND        | ND             | ND   | ND                | ND                | +           | ND               |
| Penbotec                        | +++       | ++++                  | NL        | ND             | ND   | ND                | NL                | ND          | NL               |
| Ph-D/Endorse*                   | ++        | ++                    | ++        | ND             | ND   | ---               | ND                | ND          | +++              |
| Pristine                        | ++++      | +++                   | ++++      | +++            | ND   | ++++ <sup>1</sup> | ++++              | +++         | +++ <sup>1</sup> |
| Procure                         | ++        | ---                   | +/-       | +++            | ND   | ND                | ++++              | ND          | ND               |
| Quadris Top*                    | ++++      | +/-                   | +++       | +++            | +++  | ++++              | ND                | ND          | +++              |
| Quash                           | ++++      | ++                    | ---       | +++            | ---  | ND                | ND                | ++++        | +++              |
| Quilt Xcel                      | ++++      | ++                    | +++       | +++            | +++  | ND                | NL                | +++         | ++               |
| Quintec                         | ---       | ---                   | ---       | ++++           | ---  | ---               | ---               | ---         | ---              |
| Rally                           | ++        | ---                   | +/-       | ++++           | ++   | ---               | ++++              | ++          | ---              |
| Rovral/Iprodione/Nevado         | +++       | +++                   | +++       | ---            | ---  | ---               | NL                | ---         | ++               |
| Rovral + oil                    | ++++      | ++++                  | +++       | +              | ++   | ---               | NL                | ---         | ++               |
| Rubigan                         | +++       | ---                   | ---       | ++++           | ++   | NL                | ++++              | ND          | ND               |
| Sovran                          | ND        | ND                    | ND        | +++            | ++   | ND                | +++ <sup>1</sup>  | ND          | ND               |
| Scala                           | ++++      | ++++ <sup>1</sup>     | ++        | ND             | ND   | ND                | +++               | ND          | ++               |
| Scholar                         | ++++      | ++++                  | ---       | ---            | ---  | ---               | ---               | ---         | ---              |

Overall Efficacies for Tree Crops, continued

For information regarding registration status on a particular crop, see the individual crop tables.

| Fungicide                                     | Brown rot        | Jacket rot (Botrytis) | Shot hole | Powdery mildew | Rust | Scab             |            | Anthrac nose | Alternaria |
|---|------------------|-----------------------|-----------|----------------|------|------------------|------------|--------------|------------|
|   |                  |                       |           |                |      | Almond           | Apple/pear |              |            |
| <b>CONVENTIONAL FUNGICIDES (continued)</b>    |                  |                       |           |                |      |                  |            |              |            |
| Switch  | ND               | +++                   | ND        | ND             | ND   | NL               | NL         | ND           | +++        |
| Syllit  | +                | ----                  | ----      | ----           | ---- | NL               | +++        | ND           | ND         |
| Thiram  | +                | +                     | ND        | ----           | ---- | NL               | ++         | ND           | ND         |
| Topsin-M/<br>T-Methyl/Thio-<br>phanate-Methyl | +++ <sup>1</sup> | +++                   | ----      | +++            | ++   | +++ <sup>1</sup> | +++        | ----         | ----       |
| Vanguard                                      | ++++             | ++++                  | ++        | ND             | ND   | ----             | +++        | ND           | ++         |
| Ziram   | +                | +                     | +++       | ----           | ---- | +++              | ++         | +++          | +          |
| <b>BIOLOGICALS, NATURAL COMPOUNDS, SARs</b>   |                  |                       |           |                |      |                  |            |              |            |
| Copper  | +                | +                     | ++        | ----           | ---- | ++               | ----       | ----         | +/--       |
| Cinnacure                                     | ----             | ----                  | ----      | ++             | ---- | ----             | ----       | ----         | ----       |
| JMS Stylet Oil                                | +/--             | ----                  | +/--      | ++             | ---- | ----             | ----       | ----         | ----       |
| Kaligreen                                     | ----             | ----                  | ----      | ++             | ---- | ----             | ----       | ----         | ----       |
| Messenger                                     | ----             | ----                  | ----      | ++             | ---- | ----             | ----       | ----         | ----       |
| OxiDate                                       | ----             | ----                  | +/--      | ND             | ND   | ----             | ----       | ----         | ----       |
| Perasan                                       | ----             | ----                  | +/--      | ND             | ND   | ----             | ----       | ----         | ----       |
| Prev-am                                       | ND               | ND                    | ND        | ++             | ND   | ----             | ----       | ----         | ----       |
| Quiponin*                                     | ND               | ND                    | ND        | ++             | ND   | ND               | ND         | ND           | ND         |
| Regalia                                       | +                | ----                  | 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; NL = not on label; ND = no data

\* Registration pending in California

\*\* Not registered, label withdrawn or inactive

<sup>1</sup> Resistant populations of target organisms occur in California.



## DISEASE AND PATHOGEN NAMES

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

<sup>1</sup> 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.

Continued on next page . . .

Disease and Pathogen Names, continued

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

## FUNGICIDES LISTED BY CHEMICAL CLASS: MISCELLANEOUS FUNGICIDES/BACTERICIDES

### ANTIBIOTICS

| Trade name      | Common name     | Company                    | Activity |
|-----------------|-----------------|----------------------------|----------|
| Ag Streptomycin | Streptomycin    | Makhteshim Agan            | systemic |
| AgriMycin       | Streptomycin    | NuFarm                     | systemic |
| FireWall        | Streptomycin    | AgroSource, Inc./Advan LLC | systemic |
| Kasumin*        | Kasugamycin     | Arysta LifeScience         | systemic |
| Mycoshield      | Oxytetracycline | NuFarm                     | systemic |
| FireLine        | Terramycin      | AgroSource, Inc./Advan LLC | systemic |
| FlameOut**      | Terramycin      | UPI                        | systemic |

\*Registration pending in California

\*\*Label withdrawn

**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 |
|-----------------------|-------------------------------------|---------------------------------|----------|
| Actinovate AG         | <i>Streptomyces lydicus</i>         | Natural Industries, Inc.        | contact  |
| AQ10**                | <i>Ampelomyces quisqualis</i>       | Ecogen Inc.                     | contact  |
| Arabesque*            | <i>Muscodor albus</i>               | AgraQuest Inc.                  | contact  |
| BlightBan             | <i>Pseudomonas fluorescens</i> A506 | J.R. Simplot/Plant Health Tech. | contact  |
| BloomtimeBiologicalFD | <i>Pantoea agglomerans</i> E/325    | Northwest Ag Prod.              | contact  |
| Plant Shield          | <i>Trichoderma harzianum</i>        | CircleOne Organics              | contact  |
| Serenade              | <i>Bacillus subtilis</i>            | AgraQuest Inc.                  | contact  |
| Sonata                | <i>Bacillus pumilis</i>             | AgraQuest Inc.                  | contact  |

\*Registration pending in California

\*\*Label withdrawn

**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              |                             | contact  |
| B-Lock**                 | boric acid and latex paint      | Nutrient Technologies       | contact  |
| Cinnacure                | cinnamaldehyde                  |                             | contact  |
| JMS Stylet Oil           | mineral oil                     | JMS Flower Farms            | contact  |
| Milstop                  | potassium bicarbonate           | BioWorks                    | contact  |
| M-Pede Insecticidal Soap | potassium salts                 | Dow AgroSciences            | contact  |
| Kaligreen                | sodium bicarbonate              | Toagosei/ArystaLifeSciences | contact  |
| Omni Supreme             | low range oil                   | Helena Chemical             | contact  |
| Prev-am                  | sodium tetraborohydrate         | ORO Agri. Inc.              | contact  |
| Purespray                | low range oil                   | PetroCanada                 | contact  |
| Quiponin*                | <i>Quillaja saponaria</i>       | Nor-Natur                   | contact  |
| Regalia                  | <i>Reynoutria sachalinensis</i> | Marrone Bio Innovations     | contact  |
| Timorex*                 | natural oil                     | Biomor                      | contact  |
| Trilogy                  | neem oil                        | Certis USA                  | contact  |
| VigorCal*                | calcium metalosate              | Agro-K                      | contact  |
| VigorK*                  | potassium metalosate            | Agro-K                      | contact  |

\*Registration pending in California

\*\* Not registered, label withdrawn or inactive 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<sup>1</sup> Group M1; sulfur = FRAC<sup>1</sup> 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

## SYSTEMIC ACQUIRED RESISTANCE (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 |

\*Registration pending in California

\*\*Not registered, label withdrawn or inactive

**Mode of action:** host resistance

**Resistance risk:** unknown

**Growth effects:** unknown

**Sporulation:** unknown

## FUNGICIDES LISTED BY CHEMICAL CLASS: SYNTHETIC FUNGICIDES

(Single Active Ingredients)

### ANILINOPYRIMIDINES (AP)

| Trade name  | Common name  | Company   | Activity               |
|-------------|--------------|---|------------------------|
| Penbotec*** | pyrimethanil | Janssen Pharmaceutica (Dist. by Cerexagri, Pace International, JBT, etc.) | slight (on most crops) |
| Scala       | pyrimethanil | Bayer CropScience   | slight (on most crops) |
| Vangard     | cyprodinil   | Syngenta Crop Protection  | slight (on most crops) |

\*\*\*Postharvest use only

**Mode of action:** FRAC<sup>I</sup> 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

### 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<sup>I</sup> Group 14; mechanism unclear.

**Resistance risk:** medium

**Growth effects:** interrupt mycelial growth

**Sporulation:** little effect

### METHYL BENZIMIDAZOLE CARBAMATE (MBC)

| Trade name         | Common name         | Company                               | Activity         |
|--------------------|---------------------|---------------------------------------|------------------|
| Mertect            | thiabendazole (TBZ) | Syngenta Crop Protection              | systemic (local) |
| T-Methyl           | thiophanate-methyl  | Arysta LifeScience                    | systemic (local) |
| Topsin-M           | thiophanate-methyl  | UPI                                   | systemic (local) |
| Thiophanate-Methyl | thiophanate-methyl  | Makteshim Agan of North America, Inc. | systemic (local) |

**Mode of action:** FRAC<sup>I</sup> 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:** inhibits

### BENZAMIDE

| Trade name | Common name  | Company | Activity |
|------------|--------------|---------|----------|
| Presidio   | fluopicolide | Valent  | systemic |

**Mode of action:** FRAC<sup>I</sup> Group 43; delocalization of a cellular spectrin-like proteins resulting in plasma membrane dysfunction.

**Resistance risk:** high; the fungicide should be used following FRAC guidelines and used in mixtures and rotations with other fungicides effective against target plant pathogens; to reduce the risk of resistance development start treatments with a fungicide with a multi-site mode of action; use labeled rates (preferably the upper range), and limit the total number of applications/season (less than 4).

**Growth effects:** inhibition of mycelial growth, and lysis of zoospores.

**Sporulation:** inhibits

## BENZOPHENONE

| Trade name        | Common name | Company | Activity             |
|-------------------|-------------|---------|----------------------|
| Vivando (BAS560)* | metrafenone | BASF    | contact and systemic |

### \*Registration pending in California

**Mode of action:** FRAC<sup>1</sup> Group U8 (unknown- proposed as an actin disrupter); single-site; proposed mechanism is actin disruption.

**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), follow protective application schedule, and limit the total number of applications/season.

**Growth effects:** abnormal spore germination, appressorium formation, and secondary hyphal growth (prevents plant infection).

**Sporulation:** inhibition of spore formation occurs if mycelium on leaf surfaces is treated.

## CARBAMATES

| Trade name                          | Common name | Company          | Activity |
|-------------------------------------|-------------|------------------|----------|
| Ethylene bisdithiocarbamates (EBDC) |             |                  |          |
| Dithane (coordinated product)       | mancozeb    | Dow AgroSciences | contact  |
| Maneb**                             | maneb       | UPI              | contact  |
| Manex**                             | maneb       | DuPont           | contact  |
| Manzate (coordinated product)       | mancozeb    | DuPont           | contact  |
| Penncozeb (coordinated product)     | mancozeb    | UPI              | contact  |
| Dimethyl dithiocarbamates (DMDC)**  |             |                  |          |
| Thiram                              | thiram      | Taminco          | contact  |
| Ziram                               | ziram       | UPI              | contact  |

### \*\*Not registered, label withdrawn or inactive

**Mode of action:** FRAC<sup>1</sup> Group M3; multi-site inhibitors that complex with enzymes probably inhibiting respiration.

**Resistance risk:** low

**Growth effects:** inhibit spore germination

**Sporulation:** no effect

## CARBOXYLIC ACID AMIDES

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

**Mode of action:** FRAC<sup>1</sup> 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

## CHLORONITRILES

| Trade name     | Common name    | Company                               | Activity |
|----------------|----------------|---------------------------------------|----------|
| Bravo          | chlorothalonil | Syngenta Crop Protection              | contact  |
| Chlorothalonil | chlorothalonil | Arysta LifeScience                    | contact  |
| Echo           | chlorothalonil | Sipcam Agro USA                       | contact  |
| Equus          | chlorothalonil | Makteshim Agan of North America, Inc. | contact  |

**Mode of action:** FRAC<sup>1</sup> 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/Tilt     | propiconazole  | Triazole   | Syngenta Crop Protection              | systemic (local) |
| Elite           | tebuconazole   | Triazole   | Bayer CropScience                     | systemic (local) |
| Indar (Enable*) | fenbuconazole  | Triazole   | Dow AgroSciences                      | systemic (local) |
| Inspire         | difenoconazole | Triazole   | Syngenta Crop Protection              | systemic (local) |
| Mentor***       | propiconazole  | Triazole   | Syngenta Crop Protection              | systemic (local) |
| Mettle          | tetraconazole  | Triazole   | Sipcam Agro USA                       | systemic (local) |
| Orius           | tebuconazole   | Triazole   | Makteshim Agan of North America, Inc. | systemic (local) |
| Procure         | triflumizole   | Imidazole  | Chemtura                              | systemic (local) |
| Quash           | metconazole    | Triazole   | Valent USA                            | systemic (local) |
| Rally (Laredo)  | myclobutanil   | Triazole   | Dow AgroSciences                      | systemic (local) |
| Rubigan         | fenarimol      | Pyrimidine | Dow AgroSciences                      | systemic (local) |
| Tebuzol         | tebuconazole   | Triazole   | UPI                                   | systemic (local) |
| Topguard*       | flutriafol     | Triazole   | Chemnova Inc.                         | systemic (local) |

\*Registration pending in California

\*\*\*Postharvest use only; check for Section 18 registration; registration pending in California

**Mode of action:** FRAC<sup>1</sup> 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

## DICARBOXIMIDES

| Trade name | Common name | Company                               | Activity         |
|------------|-------------|---------------------------------------|------------------|
| Iprodione  | iprodione   | Arysta LifeScience                    | systemic (local) |
| Rovral     | iprodione   | Bayer CropScience                     | systemic (local) |
| Nevado     | iprodione   | Makteshim Agan of North America, Inc. | systemic (local) |

**Mode of action:** FRAC<sup>1</sup> 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      | Aceto Ag. Chemicals Corp. | systemic (local) |

**Mode of action:** FRAC<sup>1</sup> 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<sup>1</sup> 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<br>Mefenoxam 2EC | mefenoxam   | Makhteshim Agan of North America, Inc. | contact, systemic |
| Ridomil Gold EC            | mefenoxam   | Syngenta Crop Protection               | contact, systemic |

**Mode of action:** FRAC<sup>1</sup> 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 Crop Protection | contact (except cherry-systemic) |

\*\*\*Postharvest use only

**Mode of action:** FRAC<sup>1</sup> 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 | Bayer CropScience                      | systemic |
| Legion     | fosetyl-aluminum | Makhteshim Agan of North America, Inc. | systemic |

**Mode of action:** FRAC<sup>1</sup> 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<sup>1</sup> 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 or Endorse* | polyoxin-D  | Arysta LifeScience | contact  |

\*Registration pending in California

**Mode of action:** FRAC<sup>1</sup> 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    | quinoxifen  | Dow AgroSciences | contact  |

**Mode of action:** FRAC<sup>1</sup> 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                 | azoxystrobin    | Syngenta Crop Protection | contact and systemic |
| Cabrio                 | pyraclostrobin  | BASF                     | contact and systemic |
| Flint/Gem <sup>2</sup> | trifloxystrobin | Bayer CropScience        | contact and systemic |
| Sovran                 | kresoxim methyl | BASF                     | contact and systemic |

\*Registration pending in California

<sup>2</sup>Gem registered on stone fruit and tree nuts; Flint registered on pome fruit and grape.

**Mode of action:** FRAC<sup>1</sup> 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

**SUCCINATE DEHYDROGENASE INHIBITORS (SDHIs)**

| Trade name                 | Common name  | Company           | Activity |
|----------------------------|--------------|-------------------|----------|
| Endura                     | boscalid     | BASF              | contact  |
| (DPX-LEM17)*               | penthiopyrad | DuPont            | contact  |
| Luna Privilege (USF-2015)* | fluopyram    | Bayer CropScience | contact  |

\*Registration pending in California

**Mode of action:** FRAC<sup>1</sup> 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

## MULTIPLE ACTIVE INGREDIENTS IN PRE-MIXTURES

### DMI/SDHI

| Trade name       | Common name            | Company           | Activity             |
|------------------|------------------------|-------------------|----------------------|
| Luna Experience* | tebuconazole/fluopyram | Bayer CropScience | contact and systemic |

#### \*Registration pending in California

**Mode of action:** FRAC<sup>1</sup> Groups 3 and 7; DMI single-site inhibitors (tebuconazole) target demethylation and other processes in sterol biosynthesis; whereas SDHI fungicides inhibit succinate dehydrogenase (fluopyram). Most DMI fungicides 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 post-infection or "kick-back" activity against brown rot, rust, perhaps scab, and apple and pear scab.

**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:** unknown for SDHI; DMI inhibits only growth

**Sporulation:** unknown for SDHI; DMI inhibits sporulation.

### DMI/STROBILURIN (QoI)

| Trade name   | Common name                  | Company                  | Activity             |
|--------------|------------------------------|--------------------------|----------------------|
| Adament      | tebuconazole/trifloxystrobin | Bayer CropScience        | contact and systemic |
| Quadris Top* | difenoconazole/azoxystrobin  | Syngenta Crop Protection | systemic (local)     |
| Quilt Xcel   | propiconazole/azoxystrobin   | Syngenta Crop Protection | systemic (local)     |

#### \*Registration pending in California

**Mode of action:** FRAC<sup>1</sup> Groups 3 and 11; both single-site inhibitors; DMIs (difenoconazole, propiconazole, tebuconazole) inhibit demethylation and other processes in sterol biosynthesis; strobilurins (azoxystrobin, 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.

### DMI/ANILINOPYRIMIDINE (AP)

| Trade name    | Common name               | Company                  | Activity             |
|---------------|---------------------------|--------------------------|----------------------|
| Inspire Super | difenoconazole/cyprodinil | Syngenta Crop Protection | contact and systemic |

**Mode of action:** FRAC<sup>1</sup> Groups 3 and 9; both single-site inhibitors; DMIs (e.g., tebuconazole) inhibit demethylation and other processes in sterol biosynthesis pathway; whereas AP fungicides are methionine inhibitors (e.g., cyprodinil).

**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.

### SDHI/STROBILURIN (QoI)

| Trade name      | Common name               | Company           | Activity             |
|-----------------|---------------------------|-------------------|----------------------|
| Luna Sensation* | fluopyram/trifloxystrobin | Bayer CropScience | contact and systemic |
| Pristine        | boscalid/pyraclostrobin   | BASF              | contact and systemic |

#### \*Registration pending in California

**Mode of action:** FRAC<sup>1</sup> Groups 7 and 11; Succinate dehydrogenase inhibitors possibly multi-site; whereas QoIs are single-site. The QoIs (pyraclostrobin, trifloxystrobin) block respiration by interfering with cytochrome b; SDHI fungicides inhibit succinate dehydrogenase (boscalid, fluopyram).

**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 SDHI

**Sporulation:** no effect for strobilurins; unknown for SDHI

### ANILINOPYRIMIDINE/STROBILURIN (QoI)

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

**\*\*Not registered, label withdrawn or inactive**

**Mode of action:** FRAC<sup>1</sup> Groups 9 and 11; both single-site, anilinopyrimidines (pyrimethanil) 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.

### ANILINOPYRIMIDINE/PHENYLPYRROLE

| Trade name | Common name            | Company                  | Activity                |
|------------|------------------------|--------------------------|-------------------------|
| Switch     | cyprodinil/fludioxonil | Syngenta Crop Protection | contact/slight systemic |

**Mode of action:** FRAC<sup>1</sup> 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:** reduction

<sup>1</sup> 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 a fungicide with a different mode of action Group number.

## ALMOND: FUNGICIDE EFFICACY

| Fungicide  | Resistance risk (FRAC) <sup>1</sup> | Brown rot | Jacket rot | Anthracnose | Shot hole | Scab <sup>3</sup> | Rust <sup>3</sup> | Leaf blight      | Alternaria leaf spot <sup>3</sup> | PM-like <sup>5</sup> | Silver leaf |
|--|-------------------------------------|-----------|------------|-------------|-----------|-------------------|-------------------|------------------|-----------------------------------|----------------------|-------------|
| Adament  | high (3/11) <sup>3</sup>            | ++++      | ++         | ++++        | +++       | +++               | +++               | ND               | ++                                | +++                  | ----        |
| Bumper/Tilt <sup>4</sup>                           | high (3)                            | ++++      | +/-        | ++++        | ++        | ++                | +++               | ND               | ++                                | +++                  | ----        |
| Distinguish**                                      | high (9/11)                         | ++++      | ++++       | ++++        | ++        | ND                | ND                | ND               | ND                                | ND                   | ----        |
| Indar  | high (3)                            | ++++      | +/-        | +++         | ++        | ++                | NL                | ND               | +                                 | ND                   | ----        |
| Inspire <sup>4</sup>                               | high (3)                            | ++++      | +          | ND          | ++        | +++               | ND                | ND               | +++                               | +++                  | ----        |
| Inspire Super*                                     | high (3/9)                          | ++++      | ++         | ND          | ++        | +++               | ND                | ND               | +++                               | ND                   | ----        |
| Luna Sensation*                                    | medium (7/11) <sup>3,7</sup>        | ++++      | ++++       | ++++        | ++++      | ++++              | +++               | ND               | +++                               | +++                  | ----        |
| Pristine   | medium (7/11) <sup>3,7</sup>        | ++++      | ++++       | ++++        | ++++      | ++++              | +++               | ND               | +++                               | +++                  | ----        |
| Quash  | high (3)                            | ++++      | ++         | ++++        | ++        |                   | +++               | ND               | +++                               | +++                  | ----        |
| Quadris Top*                                       | medium (3/11) <sup>3</sup>          | ++++      | ++++       | ++++        | +++       | ++++              | +++               | ND               | +++                               | +++                  | ----        |
| Quilt Xcel   | medium (3/11) <sup>3</sup>          | ++++      | ++++       | ++++        | +++       | ++++              | +++               | ND               | +++                               | +++                  | ----        |
| Rovral + oil <sup>8</sup>                          | low (2)                             | ++++      | ++++       | ----        | +++       | +/-               | ++                | ND               | +++ <sup>9</sup>                  | ND                   | ----        |
| Scala <sup>3</sup>                                 | high (9) <sup>3,7</sup>             | ++++      | ++++       | ND          | ++        | ----              | ND                | ND               | +                                 | ----                 | ----        |
| Tebuzol (Elite*)                                   | high (3)                            | ++++      | +/-        | +++         | ++        | ++                | +++               | ND               | +                                 | ND                   | ----        |
| Topsin-M/T-Methyl/ Thiophanate-Methyl <sup>2</sup> | high (1) <sup>2,7</sup>             | ++++      | ++++       | ----        | ----      | +++ <sup>8</sup>  | +                 | +++ <sup>6</sup> | ----                              | ++                   | ----        |
| Vanguard   | high (9) <sup>3,7</sup>             | ++++      | ++++       | ND          | ++        | ----              | ND                | ND               | + <sup>9</sup>                    | ----                 | ----        |
| Abound <sup>4</sup>                                | high (11) <sup>3,7</sup>            | +++       | ----       | ++++        | +++       | ++++              | +++               | +++              | +++ <sup>10</sup>                 | +++                  | ----        |
| Elevate  | high (17) <sup>7</sup>              | +++       | ++++       | ----        | +         | ND                | ND                | ND               | ND                                | ND                   | ----        |
| Gem <sup>4</sup>                                   | high (11) <sup>3,7</sup>            | +++       | ----       | ++++        | +++       | ++++              | +++               | +++              | +++ <sup>10</sup>                 | +++                  | ----        |
| Laredo   | high (3)                            | +++       | ----       | ++          | ++        | ----              | +                 | +++              | ----                              | +++                  | ----        |
| Rovral/Iprodione/N evado                           | low (2)                             | +++       | +++        | ----        | +++       | ----              | ----              | ND               | +++ <sup>9</sup>                  | ----                 | ----        |
| Bravo/Chlorothalonil/Echo /Equus <sup>11,12</sup>  | low (M5)                            | ++        | NL         | +++         | +++       | +++               | NL                | NL               | NL                                | ----                 | ----        |
| Captan <sup>4,12</sup>                             | low (M4)                            | ++        | ++         | +++         | +++       | ++                | ----              | +++ <sup>6</sup> | +                                 | ----                 | ----        |
| CaptEvate*   | low (M4/17)                         | +++       | +++        | +++         | +++       | +++               | ----              | +++              | +                                 | ----                 | ----        |
| Maneb**  | low (M3)                            | ++        | +          | ++          | ++        | ++                | +++               | ++               | ----                              | ----                 | ----        |
| Ph-D/Endorse*                                      | medium (19)                         | ++        | ++         | ----        | ++        | ----              | ND                | ND               | +++                               | ----                 | ----        |
| Rally <sup>13</sup>                                | high (3)                            | ++        | ----       | ++          | +/-       | ----              | +                 | +++              | ----                              | +++                  | ----        |
| Ziram  | low (M3)                            | ++        | +          | +++         | +++       | +++               | ----              | ++               | +                                 | ----                 | ----        |
| Copper <sup>14</sup>                               | low (M1)                            | +/-       | +/-        | ----        | +         | + <sup>15</sup>   | ----              | ----             | ND                                | ----                 | ND          |
| Copper + oil <sup>14</sup>                         | low (M1)                            | ND        | ND         | ----        | +         | +++ <sup>15</sup> | ----              | ----             | ND                                | ----                 | ND          |
| Lime sulfur <sup>12</sup>                          | low (M2)                            | +/-       | NL         | ----        | +/-       | +++ <sup>15</sup> | ++                | NL               | NL                                | ----                 | NL          |
| Sulfur <sup>4,12</sup>                             | low (M2)                            | +/-       | +/-        | ----        | ----      | ++                | ++                | ----             | ----                              | +++                  | ----        |
| PlantShield  | low                                 | ----      | ----       | ----        | ----      | ----              | ----              | ----             | ----                              | ----                 | +++***      |

**Rating:** ++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; +/- = minimal and often ineffective; ---- = ineffective; NL = not on label; ND = no data

\* Registration pending in California

\*\* Not registered, label withdrawn or inactive

\*\*\* Section 24C (special local needs) registration approved in California.

<sup>1</sup> 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 fungicide with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode of action Group number.

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

*Almond: Fungicide Efficacy, continued*

- <sup>3</sup> Field resistance of *Alternaria* sp. and *Cladosporium carpophilum* to QoI and SDHI fungicides has been detected in almond orchards. AP-resistant populations of *Monilinia* spp. have been found on other stone fruit crops in California.
- <sup>4</sup> Of the materials listed, only sulfur, Abound, Gem, and some of the DMI fungicides (FRAC Group No. 3) are registered for use in late spring and early summer when treatment is recommended.
- <sup>5</sup> PM-like refers to a powdery mildew-like disease on almond fruit that is managed with fungicides with activity against powdery mildew fungi.
- <sup>6</sup> Excellent control obtained when combinations of Topsin-M or T-Methyl and Captan are used.
- <sup>7</sup> 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.
- <sup>8</sup> Oil recommended is a "light" summer oil, 1-2% volume/volume.
- <sup>9</sup> Not registered for use later than 5 weeks after petal fall.
- <sup>10</sup> Efficacy reduced at high temperatures and relative humidity; experimental for *Alternaria*.
- <sup>11</sup> Bravo Ultrex, Bravo WeatherStik, Echo, Echo Ultimate, and Chlorothalonil are currently registered.
- <sup>12</sup> Do not use in combination with or shortly before or after oil treatment.
- <sup>13</sup> Efficacy is better in concentrate (80-100 gal/acre) than in dilute sprays.
- <sup>14</sup> The low rates necessary to avoid phytotoxicity in spring reduce the efficacy of copper.
- <sup>15</sup> "Burns out" scab twig lesions when applied at delayed dormant.

## ALMOND: TREATMENT TIMING

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

| Disease                  | Dormant        | Bloom    |            |            | Spring <sup>1</sup> |         | Summer |                |
|--------------------------|----------------|----------|------------|------------|---------------------|---------|--------|----------------|
|                          |                | Pink bud | Full bloom | Petal fall | 2 weeks             | 5 weeks | May    | June           |
| Alternaria               | ----           | ----     | ----       | ----       | ----                | ++      | +++    | +++            |
| Anthracnose <sup>2</sup> | ----           | ++       | +++        | +++        | +++                 | +++     | +++    | ++             |
| Brown rot                | ----           | ++       | +++        | +          | ----                | ----    | ----   | ----           |
| Green fruit rot          | ----           | ----     | +++        | ----       | ----                | ----    | ----   | ----           |
| Leaf blight              | ----           | ----     | +++        | ++         | +                   | ----    | ----   | ----           |
| Scab <sup>3</sup>        | ++             | ---      | ---        | ++         | +++                 | +++     | +      | ---            |
| Shot hole <sup>4</sup>   | + <sup>5</sup> | +        | ++         | +++        | +++                 | ++      | ----   | ----           |
| Rust                     | ----           | ----     | ----       | ----       | ----                | +++     | +++    | + <sup>6</sup> |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> 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.

<sup>5</sup> 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.

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

## ALMOND: SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FUNGICIDE FRAC<sup>1</sup> 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 (e.g., M2) or natural products/biological controls (NP/BC).

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

*Continued on next page . . .*

*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, 3/11<br>7/11<br>11<br>M3 | 3, 3/11<br>7/11<br>11 | 3, 3/11<br>7/11<br>11 |

<sup>1</sup> 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/>). Group numbers are listed in numerical order within the suggested disease management program. Fungicides with a different group number are suitable to alternate in a resistance management program. Refer to the fungicide efficacy table for fungicides belonging to each FRAC group.

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

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

<sup>4</sup> Apply petal fall treatments based on twig-infection sporulation model.



## APPLE AND PEAR: FUNGICIDE EFFICACY

| Fungicide  | Resistance risk (FRAC#) <sup>1</sup> | Scab            |                   | Powdery mildew (apple only) |
|--|--------------------------------------|-----------------|-------------------|-----------------------------|
|  |                                      | Protectant      | Eradicant         |                             |
| Adament  | medium (3/11)                        | ++++            | ++++              | ++++                        |
| Bayleton   | high (3)                             | ----            | ----              | +++                         |
| Distinguish**                                      | medium (9/11)                        | +++             | +++               | +++                         |
| Inspire Super                                      | medium (3/9)                         | ++++            | ++++              | ++++                        |
| Flint <sup>2</sup>                                 | high (11) <sup>3</sup>               | ++++            | ++++              | ++++                        |
| Pristine   | medium (11/7)                        | ++++            | ----              | ND                          |
| Procure <sup>4</sup>                               | high (3)                             | ++++            | ++++              | ++++                        |
| Rally <sup>5</sup>                                 | high (3)                             | ++++            | ++                | ++++                        |
| Rubigan <sup>4</sup>                               | high (3)                             | ++++            | ++++              | +++                         |
| Scala  | high (9) <sup>3</sup>                | +++             | +++               | +                           |
| Sovran   | high (11) <sup>3</sup>               | +++             | +++               | +++                         |
| Syllit   | medium (M7)                          | +++             | +++               | ----                        |
| Tebuzol  | high (3)                             | +++             | +++               | +++                         |
| Topsin-M/T-Methyl /Thiophanate-Methyl <sup>3</sup> | high (1) <sup>3</sup>                | +++             | +++               | +++                         |
| Vanguard   | high (9) <sup>3</sup>                | +++             | +++               | +++                         |
| Ph-D*  | medium (19)                          | +               | +                 | +++                         |
| Captan <sup>6</sup>                                | low (M4)                             | +++             | ----              | ----                        |
| Dithane/Manzate/ Penncozeb <sup>6</sup>            | low (M3)                             | +++             | ----              | ----                        |
| Maneb**  | low (M3)                             | +++             | ----              | ----                        |
| Thiram <sup>5</sup>                                | low (M3)                             | ++              | ----              | ----                        |
| Ziram <sup>6</sup>                                 | low (M3)                             | ++              | ----              | ----                        |
| Copper <sup>6</sup>                                | low (M1)                             | ++ <sup>7</sup> | ----              | ----                        |
| Lime sulfur <sup>6,8</sup>                         | low (M2)                             | ----            | ++++ <sup>8</sup> | +++ <sup>9</sup>            |
| Sulfur <sup>7</sup>                                | low (M2)                             | ++              | ----              | ++++                        |

| Bactericide/<br>Biological                     | Resistance risk | Fire blight <sup>11</sup> |          | Phytotoxicity |
|--|-----------------|---------------------------|----------|---------------|
|  |                 | Contact                   | Systemic |               |
| Ag Streptomycin/Agri-Mycin /Firewall           | high            | ++++                      | +++      | +/--          |
| MycoShield/FireLine <sup>10</sup> / FlameOut** | high            | +++                       | +++      | +/--          |
| Copper <sup>7</sup>                            | low (M1)        | +++                       | ----     | +             |
| Captan <sup>6</sup>                            | low (M4)        | ++                        | ----     | ----          |
| Dithane/Manzate/ Penncozeb <sup>6</sup>        | low (M3)        | ++                        | ----     | ----          |
| Blight Ban                                     | low             | ++                        | ----     | +/--          |
| Bloomtime Bio                                  | low             | +++                       | ----     | +/--          |

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

\* Registration pending in California

\*\*Not registered, label withdrawn or inactive

<sup>1</sup> 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.

<sup>2</sup> Label withdrawn on pears because of resistance development.

<sup>3</sup> 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.

Continued on next page . . .

*Apple and Pear—Fungicide Efficacy, continued*

<sup>4</sup> On pear, use only **before** white bud and **after** full bloom.

<sup>5</sup> Labeled on apple only in California.

<sup>6</sup> These materials show some efficacy and should be used in mixtures with antibiotics as a component of resistance management programs. Captan is registered on apples, whereas Dithane is registered on apples and pears.

<sup>7</sup> Copper, though effective for scab and blight control, causes fruit scarring.

<sup>8</sup> "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.**

<sup>9</sup> In-season application eradicates powdery mildew.

<sup>10</sup> Labeled on pear but not on apple.

<sup>11</sup> 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 <sup>1</sup>           | ++ <sup>2</sup> | ++ <sup>2</sup> | +++       | +++      | +++              |
| Powdery mildew <sup>3</sup> | ----            | ----            | ----      | +++      | +++              |
| Fire blight                 | ----            | ----            | ----      | +++      | +++ <sup>4</sup> |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> Protection of early tissue is important. Additional applications should be made according to infection periods as determined by the Mills table.

<sup>2</sup> Disruption of pseudothecial (or ascostroma) development (fall) and inactivation of overwintering twig lesions (delayed dormant) occurs; effects of these treatments on disease control uncertain.

<sup>3</sup> Early application is most effective; added treatments are made if mildew continues.

<sup>4</sup> 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#) <sup>1</sup> | Brown rot <sup>2</sup> |                    | Jacket rot       | Powdery mildew <sup>2</sup> | Shot hole | Eutypa |
|---|--------------------------------------|------------------------|--------------------|------------------|-----------------------------|-----------|--------|
|   |                                      | Blossom                | Fruit              |                  |                             |           |        |
| Adament   | medium (3/11)                        | ++++                   | ++++               | ++               | +++                         | +++       | ----   |
| Bumper/Tilt   | high (3)                             | ++++                   | ++++               | ----             | +++                         | +/----    | ----   |
| Distinguish**   | medium (9/11)                        | ++++                   | +++                | ++++             | +++                         | +++       | ----   |
| Elite/Tebuzol   | high (3)                             | ++++                   | ++++               | +                | +                           | +         | ----   |
| Indar (Enable*)                                       | high (3)                             | ++++                   | ++++               | ----             | ND                          | ----      | ----   |
| Quash   | high (3)                             | ++++                   | ++++               | +/-              | +++                         | ++        | ----   |
| Luna Sensation*                                       | medium (7/11) <sup>4</sup>           | ++++                   | ++++               | +++              | +++                         | ++++      | ----   |
| Pristine  | medium (7/11) <sup>4</sup>           | ++++                   | ++++               | +++              | +++                         | ++++      | ----   |
| Quadris Top*  | medium (3/11)                        | ++++                   | ++++               | +                | +++                         | +++       | ----   |
| Quilt Xcel*   | medium (3/11)                        | ++++                   | ++++               | ++               | +++                         | +++       | ----   |
| Rovral <sup>5</sup> + oil <sup>6</sup>                | low (2)                              | ++++                   | NL                 | ++++             | ----                        | +++       | ----   |
| Scala <sup>7</sup>                                    | high (9) <sup>3,4</sup>              | ++++                   | +++ <sup>7</sup>   | +++ <sup>8</sup> | ND                          | ++        | ----   |
| Topsin-M/T-Methyl/<br>Thiophanate-Methyl <sup>3</sup> | high (1) <sup>4</sup>                | ++++                   | ++++               | ++++             | +++                         | ----      | +++    |
| Vanguard <sup>7</sup>                                 | high (9) <sup>3,4</sup>              | ++++                   | +++ <sup>7</sup>   | +++ <sup>8</sup> | ND                          | ++        | ----   |
| Quintec   | high (13)                            | ----                   | ----               | ----             | ++++                        | ----      | ----   |
| Rally   | high (3)                             | +++                    | +++                | ----             | +++                         | ----      | ----   |
| Rovral/Iprodione/<br>Nevado <sup>5</sup>              | low (2)                              | +++                    | NL                 | +++              | ----                        | +++       | ----   |
| Elevate   | high (17) <sup>4</sup>               | +++                    | ++                 | +++              | ++                          | +         | ----   |
| Abound  | high (11) <sup>4</sup>               | ++                     | +                  | ----             | ND                          | +++       | ----   |
| Botran  | medium (14)                          | ++                     | ++                 | +++              | ND                          | ND        | ----   |
| Bravo/Chlorothalonil/Echo/Equus <sup>9,10</sup>       | low (M5)                             | ++                     | ++                 | ++               | ----                        | +++       | ----   |
| Captan <sup>10,11</sup>                               | low (M4)                             | ++                     | ---- <sup>11</sup> | ++               | ----                        | +++       | ----   |
| Gem   | high (11) <sup>4</sup>               | ++                     | +                  | ----             | ND                          | +++       | ----   |
| 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; NL = not on label

\* Registration pending in California

\*\*Not registered, label withdrawn or inactive

<sup>1</sup> 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.

<sup>2</sup> Do not use fungicides with the same FRAC number and high resistance risk more than twice in one year.

<sup>3</sup> Strains of *Monilinia fructicola* and *M. laxa* resistant to 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. Sub-populations of both *Monilinia* spp. have been shown to be resistant to AP (FRAC 9) fungicides on prune in CA.

<sup>4</sup> 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.

<sup>5</sup> Blossom blight only; not registered for use after petal fall.

<sup>6</sup> The oil is a "light" summer oil, 1-2% volume/volume.

<sup>7</sup> High summer temperatures and relative humidity reduce efficacy.

<sup>8</sup> Has not been tested on apricot but is effective against the jacket rot pathogens.

<sup>9</sup> Do not use after jacket (shuck) split.

<sup>10</sup> Do not use in combination with or shortly before or after oil treatment.

<sup>11</sup> Causes fruit browning or staining as a preharvest spray.

## 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 <sup>1</sup> | ----    | +++     | +++     | +++        | ----                | +++                     |
| Jacket rot             | ----    | ----    | ----    | +++        | ----                | ++                      |
| Powdery mildew         | ----    | ----    | ----    | +++        | +++ <sup>2</sup>    | ----                    |
| Shot hole <sup>3</sup> | ----    | ----    | ----    | ++         | +++                 | ----                    |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> Begin at red bud, add one or two more sprays if weather favors disease.

<sup>2</sup> Repeated treatment at 7- to 14-day intervals may be necessary; earlier treatments are most effective.

<sup>3</sup> 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#) <sup>1</sup> | Brown rot <sup>2</sup> |                    | Botrytis Blossom/Fruit | Powdery mildew <sup>2</sup> | Shot hole or Leaf spot <sup>3</sup> | Eutypa           |
|--|--------------------------------------|------------------------|--------------------|------------------------|-----------------------------|-------------------------------------|------------------|
|  |                                      | Blossom                | Fruit              |                        |                             |                                     |                  |
| Adament  | medium (3/11)                        | ++++                   | ++++               | ++                     | +++                         | ND                                  | ----             |
| Bumper/Tilt  | high (3)                             | ++++                   | ++++               | ----                   | +++                         | ND                                  | ----             |
| Elite/Orius/Tebuzol                                | high (3)                             | ++++                   | ++++ <sup>12</sup> | ++                     | ++                          | ND                                  | ----             |
| Indar (Enable*)                                    | high (3)                             | ++++                   | +++                | ----                   | +++                         | ND                                  | ----             |
| Luna Sensation*                                    | medium (7/11) <sup>5</sup>           | ++++                   | ++++               | +++                    | +++                         | ND                                  | ----             |
| Pristine   | medium (7/11) <sup>5</sup>           | ++++                   | ++++               | +++                    | +++                         | ND                                  | ----             |
| Quash  | high (3)                             | ++++                   | ++++               | ----                   | +++                         | ND                                  | ----             |
| Quadris Top*                                       | medium (3/11)                        | ++++                   | ++++               | ++                     | +++                         | ND                                  | ----             |
| Quilt Xcel*  | medium (3/11)                        | ++++                   | ++++               | ++                     | +++                         | ND                                  | ----             |
| Rovral <sup>6</sup> + oil <sup>7</sup>             | low (2)                              | ++++                   | NL                 | ++++                   | ++                          | ND                                  | ----             |
| Topsin-M/T-Methyl/ Thiophanate-Methyl <sup>4</sup> | high (1) <sup>5</sup>                | ++++                   | NL                 | ++++                   | +++                         | ND                                  | +++ <sup>4</sup> |
| Abound   | high (11) <sup>5</sup>               | +++                    | +                  | ----                   | ++                          | ND                                  | ----             |
| Cabrio   | high (11) <sup>5</sup>               | +++                    | ++                 | ----                   | ++                          | ND                                  | ----             |
| Elevate  | high (17) <sup>5</sup>               | +++                    | +++                | ++++                   | +                           | ND                                  | ----             |
| Gem  | high (11) <sup>5</sup>               | +++                    | ++                 | ----                   | ++                          | ND                                  | ----             |
| Procure <sup>8</sup>                               | high (3)                             | +++                    | +++                | ----                   | ++++                        | ND                                  | ----             |
| Quintec  | medium (13)                          | ND                     | ND                 | ND                     | ++++                        | ND                                  | ----             |
| Rally <sup>8</sup>                                 | high (3)                             | +++                    | +++                | ----                   | ++++                        | ND                                  | ----             |
| Rovral, Iprodione, Nevada <sup>6</sup>             | low (2)                              | +++                    | NL                 | +++                    | ----                        | ND                                  | ----             |
| Rubigan  | high (3)                             | +++                    | +++                | ----                   | ++++                        | ND                                  | ----             |
| Botran   | medium (14)                          | ++                     | ++                 | +++                    | ----                        | ND                                  | ----             |
| Bravo/Chlorothalonil /Echo /Equus <sup>9,10</sup>  | low (M5)                             | ++                     | NL                 | ++                     | ----                        | ND                                  | ----             |
| Captan <sup>10</sup>                               | low (M4)                             | ++                     | ++                 | ++                     | ----                        | ND                                  | ----             |
| Copper   | low (M1)                             | +/-                    | ----               | ----                   | ----                        | ND                                  | ----             |
| Sulfur <sup>10</sup>                               | low (M2)                             | +/-                    | ----               | ----                   | +++                         | ND                                  | ----             |
| Ziram  | low (M3)                             | +/-                    | NL                 | ----                   | ----                        | ND                                  | ----             |

**Rating:** ++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; +/- = minimal and often ineffective; ---- = ineffective; ND = no data, NL = not on label; ? = insufficient data or unknown

**\* Registration pending in California**

<sup>1</sup> 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.

<sup>2</sup> Do not use the same fungicide or fungicides with similar chemistry more than twice in one year.

<sup>3</sup> Shot hole and leaf spot occur infrequently on cherry in California; control usually is not necessary.

<sup>4</sup> Strains of *Monilinia fructicola* resistant to 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.

<sup>5</sup> 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.

<sup>6</sup> Blossom blight only; not registered for use after petal fall

<sup>7</sup> Oil to use is a "light" summer oil, 1-2% volume/volume.

<sup>8</sup> More effective when applied as a concentrate (80-100 gal/acre) than as a dilute spray.

<sup>9</sup> Do not use after jacket (shuck) split.

<sup>10</sup> 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<br>budbreak | Popcorn | Full bloom | Petal fall | 2-3 weeks<br>later | Preharvest<br>1-10 days <sup>1</sup> |
|------------------------|------------------|---------|------------|------------|--------------------|--------------------------------------|
| Botrytis               | ----             | +++     | +++        | ++         | ----               | +++                                  |
| Brown rot <sup>2</sup> | ----             | +++     | +++        | ++         | ----               | +++                                  |
| Powdery mildew         | ++ <sup>3</sup>  | ++      | +++        | +++        | +++                | +                                    |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup>Select broad-spectrum fungicides (or combinations) that have activity against both brown rot and Botrytis fruit rots.

<sup>2</sup>Begin at popcorn and repeat every 10 to 14 days through bloom if rains continue.

<sup>3</sup>Use sulfur at late bud break and other fungicides for later treatment. Treat immediately if mildew is found on shoots or leaves on inner scaffolds.

# CHERRY: SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FUNGICIDE FRAC<sup>1</sup> 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 <sup>3</sup><br>2 (+oil)<br>(3) <sup>4</sup> | 1 <sup>3</sup><br>2 (+oil)<br>(3) <sup>4</sup><br>3/11<br>3+17<br>7/11<br>17 | 2 (+oil)<br>7/11<br>17                      | ----   | (3) <sup>4</sup><br>3+17<br>7/11<br>17 |
| Brown rot blossom blight/Fruit rot            | ----            | ----            | 1 <sup>3</sup><br>2 (+oil)<br>3<br>3/11        | 1 <sup>3</sup><br>3<br>3+17<br>3/11<br>7/11<br>17                            | ----  | ----   | 3<br>3/11<br>7/11<br>17                |
| Powdery mildew                                | M2 <sup>2</sup> | M2 <sup>2</sup> | 2 (+oil), 3                                    | 1 <sup>3</sup><br>3<br>3/11<br>7/11<br>13                                    | 13<br>M2 <sup>2</sup><br>NP/BC <sup>5</sup> | 3, 3/11<br>11<br>13<br>M2 <sup>2</sup><br>NP/BC <sup>5</sup> | 3<br>3/11<br>3+17<br>7/11<br>11        |

<sup>1</sup> 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.

<sup>2</sup> Use liquid lime sulfur in dormant applications and wettable sulfur at and after prebloom.

<sup>3</sup> Strains of *Monilinia fructicola* resistant to 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.

<sup>4</sup> Among the group 3 fungicides, only Elite has activity against *Botrytis cinerea*.

<sup>5</sup> NP/BC = Natural Products/Biological Controls such as copper, sulfur, potassium bicarbonate (Kaligreen), *Streptomyces lydicus* (Actinovate AG), *Bacillus pumilus* (Sonata), and *Bacillus subtilis* (Serenade).

## GRAPEVINE: FUNGICIDE EFFICACY

| Fungicide                            | Resistance risk (FRAC#) <sup>1</sup> | Powdery mildew | Downy mildew | Bunch rot |        |           | Eutypa |
|--------------------------------------|--------------------------------------|----------------|--------------|-----------|--------|-----------|--------|
|                                      |                                      |                |              | Botrytis  | Summer | Phomopsis |        |
| Abound                               | high (11) <sup>2</sup>               | ++++           | ++++         | +         | ----   | +++       | NR     |
| Adament                              | medium (3/11)                        | ++++           | +            | ++        | ++     | ++        | NR     |
| Distinguish**                        | medium (9/11)                        | ++++           | ++           | ++++      | ++     | ++        | NR     |
| Flint <sup>3</sup>                   | high (11) <sup>2</sup>               | ++++           | +++          | ++        | ++     | ++        | NR     |
| Elite/Orius/Tebuzol                  | high (3)                             | ++++           | ----         | ++        | ++     | ----      | NR     |
| Inspire*                             | high (3)                             | ++++           | ----         | ----      | ----   | ----      | NR     |
| JMS Stylet oil <sup>4</sup>          | low                                  | +++            | ----         | +++       | ++     | ----      | NR     |
| Luna Experience*                     | medium (3/7)                         | ++++           | ----         | ++++      | ++     | ----      | NR     |
| Mettle                               | high (3)                             | ++++           | ----         | ----      | +      | ----      | NR     |
| Ph-D*                                | medium (19)                          | ++++           | ----         | +++       | +      | ND        | NR     |
| Pristine                             | medium (7/11) <sup>2</sup>           | ++++           | ++++         | ++++      | +++    | +++       | NR     |
| Procure                              | high (3)                             | ++++           | ----         | ----      | ----   | ----      | NR     |
| Quintec                              | high (13)                            | ++++           | ----         | ----      | ----   | ----      | NR     |
| Rally                                | high (3)                             | ++++           | ----         | ----      | ----   | ----      | +++    |
| Rubigan                              | high (3)                             | ++++           | ----         | ----      | ----   | ----      | NR     |
| Sovran                               | high (11) <sup>2</sup>               | ++++           | ++++         | ++        | ++     | ++++      | ----   |
| Sulfur                               | low (M2)                             | ++++           | ----         | ----      | ----   | ----      | NR     |
| Topguard*                            | high (3)                             | ++++           | ----         | ----      | ----   | ----      | NR     |
| Topsin-M/T-Methyl/Thiophanate-Methyl | high (1) <sup>2</sup>                | ++++           | ----         | ++        | ++     | +         | ++++   |
| Vivando*                             | high (U8)                            | ++++           | ----         | ----      | ----   | ----      | ----   |
| Actinovate                           | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| Armcarb                              | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Cinnacure                            | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Elexa**                              | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| Kaligreen                            | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Messenger                            | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Milstop                              | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Purespray                            | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Regalia                              | low                                  | +++            | ----         | ----      | ----   | ----      | ----   |
| Rovral + Oil <sup>4</sup>            | low (2)                              | +++            | ----         | ++++      | ----   | ----      | NR     |
| Serenade                             | low (44)                             | +++            | ----         | ++        | +      | ----      | ----   |
| Sonata                               | low                                  | +++            | ----         | NR        | NR     | ----      | ----   |
| Sporan                               | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| Bayleton                             | high (3)                             | ++             | ----         | ----      | ----   | ----      | NR     |
| Copper                               | low (M1)                             | ++             | +++          | ++        | +++    | +         | ----   |
| Elevate                              | high (17) <sup>2</sup>               | ++             | ----         | ++++      | ++     | ----      | NR     |
| HiPeak*                              | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| Prev-am <sup>4</sup>                 | low                                  | ++             | ----         | ----      | ----   | ----      | ++     |



Grapevine Fungicide Efficacy, continued

| Fungicide                               | Resistance risk (FRAC#) <sup>1</sup> | Powdery mildew | Downy mildew | Bunch rot |        | Phomopsis | Eutypa |
|---|--------------------------------------|----------------|--------------|-----------|--------|-----------|--------|
|   |                                      |                |              | Botrytis  | Summer |           |        |
| Scala                                   | high (9) <sup>2</sup>                | ++             | ----         | ++++      | ++     | ----      | NR     |
| Timorex* <sup>4</sup>                   | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| Vanguard                                | high (9) <sup>2</sup>                | ++             | ----         | ++++      | ++     | ----      | NR     |
| VigorCal*                               | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| VigorK*                                 | low                                  | ++             | ----         | ----      | ----   | ----      | ----   |
| Captan                                  | low (M4)                             | ----           | +            | +++       | +++    | +++       | NR     |
| CaptEvate*                              | low (M4/17)                          | ----           | +            | +++       | +++    | +         | ----   |
| Dithane/Manzate/<br>Penncozeb/(Maneb**) | low (M3)                             | ----           | ----         | ++        | ----   | +++       | ----   |
| Presidio                                | high (43)                            | ----           | ++++         | ----      | ----   | ----      | ----   |
| Revus                                   | high (40)                            | ----           | ++++         | ----      | ----   | ----      | ----   |
| Ridomil Gold/<br>(Mefenoxam**)          | high (4)                             | ----           | ++++         | ----      | ----   | ----      | ----   |
| Rovral/Iprodione/Nevado                 | low (2)                              | ----           | ----         | +++       | ----   | ----      | ----   |
| Ziram                                   | low (M3)                             | ----           | ++           | +         | +      | +++       | ----   |

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

\* Registration pending in California

\*\* Not registered, label withdrawn or inactive

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Causes severe phytotoxicity on Concord grape.

<sup>4</sup> Phytotoxic if used within 2 weeks of Captan or sulfur.

## GRAPEVINE: TREATMENT TIMING

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

| Disease               | Dormant          | Bud break        | Full bloom       | Pre-close        | Veraison         | Preharvest/<br>Postharvest |
|-----------------------|------------------|------------------|------------------|------------------|------------------|----------------------------|
| Botryosphaeria canker | +++              | ----             | ----             | ----             | ----             | ----                       |
| Botrytis              | +++ <sup>2</sup> | ----             | +++ <sup>1</sup> | +++ <sup>1</sup> | +++ <sup>1</sup> | +++ <sup>1</sup>           |
| Downy mildew          | ----             | +++              | +++              | ----             | ----             | ----                       |
| Esca                  | +++ <sup>2</sup> | ----             | ----             | ----             | ----             | ----                       |
| Eutypa                | +++              | ----             | ----             | ----             | ----             | ----                       |
| Powdery mildew        | +++ <sup>2</sup> | +++ <sup>3</sup> | +++ <sup>3</sup> | +++ <sup>4</sup> | ----             | ----                       |
| Phomopsis             | ----             | +++              | ----             | ----             | ----             | ----                       |
| Summer bunch rot      | ----             | ----             | ----             | ----             | +++ <sup>1</sup> | +++ <sup>1</sup>           |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; and ---- = ineffective

<sup>1</sup> Apply only if rain is forecasted.

<sup>2</sup> Use 10 gal lime sulfur per acre in at least 100 gal water.

<sup>3</sup> Apply bud break and full bloom treatments every year.

<sup>4</sup> Apply as needed (a disease risk assessment model is available to help determine need for spray).

## GRAPEVINES: SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FUNGICIDE FRAC<sup>1</sup> 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 premixtures, 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 <sup>6</sup> (lime sulfur) <sup>3</sup>   | ---              | ---   | ---  | ---                                     | ---  |
| Botrytis                      | ---  | ---              | 3/7 7/11 <sup>2</sup><br>9, 17<br>19<br>M4  | 3/7<br>7/11 <sup>2</sup><br>9, 17<br>19                            | 3/7<br>7/11 <sup>2</sup><br>9, 17<br>19 | 3/7<br>7/11<br>9, 17<br>19                             |
| Downy mildew                  | ---  | NP<br>43/4       | 43/4  | ---  | ---                                     | ---  |
| Esca                          | NP <sup>6</sup> (lime sulfur) <sup>3</sup>   | ---              | ---   | ---  | ---                                     | ---  |
| Eutypa                        | NP <sup>6</sup> (B-Lock <sup>**</sup> )<br>1 | ---              | ---   | ---  | ---                                     | ---  |
| Powdery mildew <sup>4,5</sup> | NP <sup>6</sup> (lime sulfur)<br>Oil         | M2<br>Oil        | 3/7, 3+9<br>7/11<br>13<br>17+11<br>19<br>U8 | 3, 3/7<br>11<br>13, U8<br>BC <sup>6</sup><br>NP <sup>6</sup><br>M4 | 3, 3/7,<br>11<br>13, 19<br>M4<br>U8     | ---  |
| Phomopsis cane and leafspot   | ---  | 2<br>11<br>M4/M3 | ---   | ---  | ---                                     | ---  |
| Summer bunch rot              | ---  | ---              | ---   | 7/11<br>9<br>oil<br>M1   | 7/11<br>9<br>M1                         | 7/11 <sup>7</sup><br>9 <sup>7</sup><br>M1 <sup>7</sup> |

**\*\*Not registered, label withdrawn or inactive**

<sup>1</sup> 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.

<sup>2</sup> Apply only if rain is forecasted. When using one class do not follow with the same class.

<sup>3</sup> 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 prebloom.

<sup>4</sup> Apply bud break and full bloom treatments every year.

<sup>5</sup> Apply as needed (a disease risk assessment model is available to help determine need for spray).

<sup>6</sup> NP/BC = Natural Products/Biological Controls such as B-Lock, Sonata, Serenade, Kaligreen, Cinnacure, etc.

<sup>7</sup> Apply when insect and bird damage present or when rainfall is forecast.

## KIWIFRUIT: FUNGICIDE EFFICACY

| Fungicide                      | Resistance risk (FRAC number) <sup>1</sup> | Botrytis Fruit Rot |
|--------------------------------|--|--------------------|
| Vanguard <sup>2</sup>          | high (9) <sup>3</sup>                      | +++                |
| Judge <sup>4</sup> /(Elevate*) | high (17) <sup>3</sup>                     | +++                |
| Scholar <sup>4</sup>           | high (12)                                  | +++                |

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

**\* Registration pending in California**

<sup>1</sup> 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.

<sup>2</sup> Vanguard preharvest registration for California is approved for the 2010 fall season as of Feb. 2010.

<sup>3</sup> 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.

<sup>4</sup> Judge and Scholar are for postharvest use only.

## KIWIFRUIT: TREATMENT TIMING

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

| Disease            | Bud break | Full bloom      | Preharvest Interval <sup>1</sup> |       |       | Postharvest |
|--------------------|-----------|-----------------|----------------------------------|-------|-------|-------------|
|                    |           |                 | 14 day                           | 7 day | 1 day |             |
| Botrytis fruit rot | ----      | ++ <sup>2</sup> | ++                               | +++   | ++++  | ++++        |

**Rating:** +++++ = most effective; +++ = highly effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> Apply as needed. A predictive model BOTMON is available using ONFIT methods for disease detection.

<sup>2</sup> Apply only if rain is forecasted.

## PEACH AND NECTARINE: FUNGICIDE EFFICACY

| Fungicide                                      | Resistance Risk (FRAC#) <sup>1</sup> | Brown rot <sup>2</sup> |                  | Powdery mildew <sup>2</sup> | Scab | Rust | Leaf curl | Shot hole         |
|--|--------------------------------------|------------------------|------------------|-----------------------------|------|------|-----------|-------------------|
|  |                                      | Blossom                | Fruit            |                             |      |      |           |                   |
| Adament  | medium (3/11)                        | ++++                   | +++              | +++                         | ---- | +++  | ----      | +/-               |
| Bumper/Tilt                                    | high (3)                             | ++++                   | ++++             | +++                         | ++   | +++  | ----      | +/-               |
| Distinguish**                                  | medium (9/11)                        | ++++                   | +++              | ++                          | +++  | +++  | ----      | ++                |
| Elite/Orius/Tebuzol                            | high (3)                             | ++++                   | ++++             | +++                         | ++   | +++  | ----      | +                 |
| Indar (Enable*)                                | high (3)                             | ++++                   | ++++             | +++                         | ++   | ND   | ----      | +/----            |
| Inspire*                                       | high (3)                             | ++++                   | ++++             | +++                         | ++   | ND   | ----      | +/----            |
| Inspire Super*                                 | high (3/9)                           | ++++                   | ++++             | +++                         | ++   | ND   | ----      | +/----            |
| Quash  | high (3)                             | ++++                   | ++++             | +++                         | ND   | +++  | ----      | +                 |
| Pristine                                       | medium (7/11) <sup>4</sup>           | ++++                   | ++++             | +++                         | +++  | ND   | ND        | ++++              |
| Luna Sensation*                                | medium (7/11) <sup>4</sup>           | ++++                   | ++++             | +++                         | +++  | ---- | ND        | ++++              |
| Quadris Top*                                   | medium (3/11)                        | ++++                   | +++              | +++                         | ---- | +++  | ----      | +/----            |
| Quilt Xcel*                                    | medium (3/11)                        | ++++                   | +++              | +++                         | ---- | +++  | ----      | +/----            |
| Rovral <sup>5</sup> + oil <sup>6</sup>         | low (2)                              | ++++                   | NL               | +                           | +    | ++   | ----      | ++                |
| Scala <sup>7</sup>                             | high (9) <sup>3,4</sup>              | ++++                   | +++ <sup>7</sup> | ND                          | ND   | ND   | ----      | ++                |
| Topsin-M /T-Methyl                             | high (1) <sup>3,4</sup>              | ++++                   | ++++             | +++                         | +++  | +    | ----      | ----              |
| /Thiophanate-Methyl                            |                                      |                        |                  |                             |      |      |           |                   |
| Vanguard <sup>7</sup>                          | high (9) <sup>3,4</sup>              | ++++                   | +++ <sup>7</sup> | ND                          | ND   | ND   | ----      | +                 |
| Elevate  | high (17) <sup>4</sup>               | +++                    | +++              | ND                          | ND   | ND   | ND        | ND                |
| Rally  | high (3)                             | +++                    | +++              | ++++                        | ---- | ---- | ----      | ----              |
| Rovral/Iprodione                               | low (2)                              | +++                    | NL               | ----                        | ---- | ---- | ----      | ----              |
| /Nevado <sup>5</sup>                           |                                      |                        |                  |                             |      |      |           |                   |
| Abound   | high (11) <sup>4</sup>               | ++                     | +                | ++                          | ++++ | +++  | ----      | ++                |
| Botran   | medium (14)                          | ++                     | +                | ND                          | ND   | ND   | ND        | ND                |
| Bravo/Chlorothalonil/Echo/Equus <sup>8,9</sup> | low (M5)                             | ++                     | ----             | ----                        | +++  | +    | +++       | +++               |
| Captan <sup>9</sup>                            | low (M4)                             | ++                     | ++               | ----                        | +++  | ---- | ----      | +++ <sup>10</sup> |
| Gem  | high (11) <sup>4</sup>               | ++                     | +                | ++                          | ++++ | +++  | ----      | ++                |
| Quintec  | high (13)                            | ----                   | ----             | ++++                        | ---- | ---- | ----      | ----              |
| Syllit <sup>11</sup>                           | medium (M7)                          | ND                     | ----             | ----                        | ND   | ---- | +         | ----              |
| Copper   | low (M1)                             | +/----                 | ----             | ----                        | ---- | ---- | +++       | +++               |
| Sulfur <sup>9</sup>                            | 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; NL = not on label

\* **Registration pending in California.**

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<sup>1</sup> 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.

<sup>2</sup> Do not use fungicides with the same FRAC number and high resistance risk more than twice in one year.

<sup>3</sup> Strains of *Monilinia fructicola* resistant to 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. Sub-populations of both *Monilinia* spp. have been shown to be resistant to AP (FRAC 9) fungicides on prune in CA.

<sup>4</sup> 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.

<sup>5</sup> Blossom blight only; not registered for use after petal fall.

<sup>6</sup> Oil is a "light" summer oil, 1-2% volume/volume.

<sup>7</sup> High summer temperatures and relative humidity reduce efficacy.

<sup>8</sup> Do not use after jacket (shuck) split.

<sup>9</sup> Do not use in combination with or shortly before or after oil treatment.

<sup>10</sup> Not effective if used as a dormant treatment.

<sup>11</sup> For use on peach only; not registered on nectarine.

## PEACH AND NECTARINE: TREATMENT TIMING

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

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

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective;

ND = no data but needs to be evaluated

<sup>1</sup> Timing not exact; weather conditions determine need for treatment.

<sup>2</sup> Apply until pit hardening.

<sup>3</sup> Treatment should be made before bud break and preferably before bud swell.

<sup>4</sup> Dormant treatment with liquid lime sulfur.

<sup>5</sup> 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 BY FUNGICIDE FRAC<sup>1</sup> 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).

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

<sup>1</sup> 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/>). Group numbers are listed in numerical order within the suggested disease management program. Fungicides with a different group number are suitable to alternate in a resistance management program. Refer to the fungicide efficacy table for fungicides belonging to each FRAC group.

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<sup>2</sup> Efficacy of liquid lime sulfur in dormant applications has not been determined for powdery mildew. Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.

<sup>3</sup> Strains of *Monilinia fructicola* resistant to Benlate (label withdrawn), 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. Subpopulations of both *Monilinia* spp. have been shown to be resistant to AP (FRAC 9) fungicides on prune in CA.

<sup>4</sup> Among the group 3 fungicides, only Elite has activity against *Botrytis cinerea*.

<sup>5</sup> NP/BC = Natural Products/Biological Controls such as copper, sulfur, potassium bicarbonate (Kaligreen), *Streptomyces lydicus* (Actinovate AG), *Bacillus pumilus* (Sonata), and *Bacillus subtilis* (Serenade)

## PISTACHIO: FUNGICIDE EFFICACY

| Fungicide   | Resistance risk (FRAC#) <sup>1</sup> | Alternaria late blight | Botrytis blossom & shoot blight | Botryosphaeria panicle & shoot blight |
|---|--------------------------------------|------------------------|---------------------------------|---------------------------------------|
| Adament   | medium (3/11) <sup>3</sup>           | ++                     | +++                             | ++                                    |
| Abound  | high (11) <sup>2,3</sup>             | +++                    | ----                            | +++                                   |
| Bravo   | low (M5)                             | ++                     | ----                            | ++                                    |
| Bumper/Tilt   | high (3)                             | ++                     | +                               | ++ <sup>5</sup>                       |
| Cabrio  | high (11) <sup>2,3</sup>             | +++                    | ----                            | +++                                   |
| Distinguish**   | medium (9/11)                        | ++                     | ++                              | ----                                  |
| Chlorothalonil/(Echo**) )                             | low (M5)                             | NR                     | ----                            | NR                                    |
| Elevate   | high (17) <sup>3</sup>               | ND                     | ++++                            | ND                                    |
| Gem   | high (11) <sup>2,3</sup>             | +++                    | ----                            | +++                                   |
| Quash   | high (3)                             | ++                     | +++                             | +++ <sup>5</sup>                      |
| Luna Sensation*                                       | medium (7/11) <sup>3</sup>           | ++++ <sup>4</sup>      | ++++                            | ++++                                  |
| Pristine  | high (7/11) <sup>3</sup>             | ++++ <sup>4</sup>      | ++++                            | ++++                                  |
| Ph-D* (Polyoxin-D*)                                   | medium (19)                          | +++                    | ----                            | +++                                   |
| Quilt Xcel*   | medium (3/11) <sup>3</sup>           | +++                    | ----                            | +++                                   |
| Scala   | high (9) <sup>3</sup>                | ++                     | ++                              | +++ <sup>6</sup>                      |
| Switch  | high (9/12) <sup>3</sup>             | +++                    | +++                             | ++                                    |
| Tebuzol   | high (3)                             | +++                    | +                               | +++ <sup>5</sup>                      |
| Topsin-M/T-Methyl/<br>Thiophanate-Methyl <sup>7</sup> | high (1)                             | ----                   | ++                              | ++                                    |
| Copper  | low (M1)                             | +                      | ----                            | ----                                  |
| Liquid lime sulfur <sup>8</sup>                       | low (M2)                             | ----                   | ----                            | +/--                                  |

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

\* Registration pending in California.

\*\*Not registered, label withdrawn or inactive

<sup>1</sup> 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.

<sup>2</sup> Field resistance of *Alternaria* spp. to Abound and to other strobilurin fungicides (Gem and Cabrio) is widespread in pistachio orchards.

<sup>3</sup> 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.

<sup>4</sup> Resistance to the SDHI (succinate dehydrogenase inhibitor) 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. Cross-resistance of SDHI fungicides (FRAC Group 7) may occur.

<sup>5</sup> Do not apply Bumper/Tilt within 60 days of harvest, Quash within 25 days of harvest, or Tebuzol within 35 days before harvest.

<sup>6</sup> Under low and moderate disease pressure.

<sup>7</sup> Registered for bloom treatment only; other registered fungicides may also be used at bloom.

<sup>8</sup> Dormant treatment only.



## PISTACHIO: TREATMENT TIMING

| Disease                     | Dormant | April            | May              | June <sup>1</sup> | July             | August <sup>2</sup> |
|-----------------------------|---------|------------------|------------------|-------------------|------------------|---------------------|
| Alternaria <sup>3</sup>     | ----    | ----             | -----            | +++               | +++ <sup>1</sup> | ++                  |
| Botryosphaeria <sup>4</sup> | +       | +++ <sup>5</sup> | +++ <sup>5</sup> | +++               | +++              | ++                  |
| Botrytis                    | ----    | +++              | -----            | ----              | ----             | ----                |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> If only one application is done, the best timing is late June to early July.

<sup>2</sup> Sprays not later than the first week in August.

<sup>3</sup> Three applications during the season are recommended.

<sup>4</sup> Treat 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.

<sup>5</sup> Early season sprays timed before and/or after rains are effective timings in April and May.

## PLUM: FUNGICIDE EFFICACY

Note: Spring brown rot and shot hole control is not necessary for most plum cultivars in California.

| Fungicide  | Resistance risk (FRAC#) <sup>1</sup> | Brown rot            |                   | Powdery mildew <sup>3</sup> | Shot hole <sup>4</sup> |
|--|--------------------------------------|----------------------|-------------------|-----------------------------|------------------------|
|  |                                      | Blossom <sup>2</sup> | Fruit             |                             |                        |
| Adament  | medium (3/11) <sup>5</sup>           | ++++                 | ++++              | +++                         | ND                     |
| Bumper/Tilt  | high (3)                             | ++++                 | ++++              | +++                         | ND                     |
| Distinguish**  | medium (9/11)                        | ++++                 | +++               | ++                          | ND                     |
| Elite <sup>6</sup> /Tebuzol <sup>6</sup>                 | high (3)                             | ++++                 | ++++ <sup>6</sup> | +++                         | ND                     |
| Indar  | high (3)                             | ++++                 | ++++              | +++                         | ND                     |
| Inspire*   | high (3)                             | ++++                 | ++++              | +++                         | ND                     |
| Inspire Super*   | high (3/9)                           | ++++                 | ++++              | +++                         | ND                     |
| Luna Sensation*  | medium (7/11) <sup>5</sup>           | ++++                 | ++++              | +++                         | ND                     |
| Pristine   | medium (7/11) <sup>5</sup>           | ++++                 | ++++              | +++                         | ND                     |
| Quash  | high (3)                             | ++++                 | ++++              | +++                         | ND                     |
| Quilt Xcel*  | medium (3/11) <sup>5</sup>           | ++++                 | ++++              | +++                         | ND                     |
| Quadris Top*   | medium (3/11) <sup>5</sup>           | ++++                 | ++++              | +++                         | ND                     |
| Rovral <sup>7</sup> + oil <sup>8</sup>                   | low (2)                              | ++++                 | NL                | ---                         | ND                     |
| Scala <sup>9</sup>                                       | high (9) <sup>5,10</sup>             | ++++                 | +++ <sup>9</sup>  | ND                          | ND                     |
| Topsin-M/T-Methyl/<br>Thiophanate-Methyl <sup>5</sup>    | high (1) <sup>5</sup>                | ++++                 | ++++              | +++                         | ND                     |
| Vangard <sup>9</sup>                                     | high (9) <sup>5,10</sup>             | ++++                 | +++ <sup>9</sup>  | ND                          | ND                     |
| Quintec  | high (13)                            | ---                  | ---               | ++++                        | ---                    |
| Rally  | high (3)                             | +++                  | +++               | +++                         | ND                     |
| Rovral/Iprodione/<br>Nevado <sup>7</sup>                 | low (2)                              | +++                  | NL                | ---                         | ND                     |
| Abound   | high (11) <sup>5</sup>               | ++                   | +                 | ND                          | ND                     |
| Botran   | medium (14)                          | ++                   | ++                | ND                          | ND                     |
| Bravo/Chlorothaloni<br>l/<br>Echo/Equus <sup>11,12</sup> | low (M5)                             | ++                   | ++                | ---                         | ND                     |
| Captan <sup>12</sup>                                     | low (M4)                             | ++                   | ++                | ---                         | ND                     |
| Gem  | high (11) <sup>5</sup>               | ++                   | ++                | ND                          | ND                     |
| Copper   | low (M1)                             | +/-                  | ---               | ---                         | ND                     |
| Sulfur <sup>12</sup>                                     | low (M2)                             | +/-                  | +/-               | +++                         | ND                     |

**Rating:** ++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; +/- = minimal and often ineffective; --- = ineffective; NL = not on label; ND = no data

\* Registration pending in California.

\*\* Not registered, label withdrawn or inactive

<sup>1</sup> Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (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.

<sup>2</sup> Brown rot blossom blight is seldom observed on most plum cultivars and usually does not require treatment during bloom.

<sup>3</sup> Powdery mildew seldom is observed on most plum cultivars and control usually is unnecessary.

<sup>4</sup> 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.

<sup>5</sup> 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.

<sup>6</sup> Registered for pre- and postharvest applications on plum.

<sup>7</sup> Blossom blight only; not registered for use after petal fall.

<sup>8</sup> The oil is a "light" summer oil, 1-2% volume/volume.

<sup>9</sup> High summer temperatures and relative humidity reduce efficacy.

- <sup>10</sup> Strains of the brown rot fungus *Monilinia fructicola* resistant to 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. Subpopulations of both *Monilinia* spp. have been shown to be resistant to AP (FRAC 9) fungicides on prune in CA.
- <sup>11</sup> Do not use after jacket (shuck) split.
- <sup>12</sup> 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 <sup>1</sup> | ----    | +         | ++      | +++        | ----                | +          |
| Powdery mildew         | ----    | +         | +       | +++        | +++                 | ----       |
| Shot hole <sup>2</sup> | ----    | ----      | ----    | ----       | ----                | ----       |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective.

<sup>1</sup> One early application should suffice; a second treatment should not be needed.

<sup>2</sup> 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 (DRIED PLUM): FUNGICIDE EFFICACY

| Fungicide   | Resistance risk<br>(FRAC#) <sup>1</sup> | Brown rot |                    | Russet<br>scab | Rust              |
|---|---|-----------|--------------------|----------------|-------------------|
|   |   | Blossom   | Fruit <sup>2</sup> |                |                   |
| Adament <sup>2,7</sup>  | medium (3/11)                           | ++++      | ++++               | ----           | +++               |
| Bumper/Tilt <sup>2</sup>                                      | high (3)                                | ++++      | ++++               | ----           | +++               |
| Distinguish**   | medium (9/11)                           | ++++      | ++                 | ----           | ++                |
| Elite/Tebuzol <sup>2,7</sup>                                  | high (3)                                | ++++      | ++++               | ----           | +++               |
| Indar <sup>2</sup>  | high (3)                                | ++++      | ++++               | ----           | +++               |
| Inspire* <sup>2</sup>   | high (3)                                | ++++      | ++++               | ----           | +++               |
| Inspire Super*  | high (3/9)                              | ++++      | ++++               | ----           | +++               |
| Luna Sensation* <sup>2</sup>                                  | medium (7/11) <sup>4</sup>              | ++++      | ++++               | ND             | ND                |
| Pristine <sup>2</sup>   | medium (7/11) <sup>4</sup>              | ++++      | ++++               | ND             | ND                |
| Quash* <sup>2</sup>   | high (3)                                | ++++      | ++++               | ----           | +++               |
| Quadris Top* <sup>2</sup>                                     | medium (3/11) <sup>4</sup>              | ++++      | ++++               | ND             | ++++              |
| Quilt Xcel* <sup>2</sup>                                      | medium (3/11) <sup>4</sup>              | ++++      | ++++               | ND             | ++++              |
| Rovral + oil <sup>2,5</sup>                                   | low (2)                                 | ++++      | NR                 | ----           | NR                |
| Scala <sup>6</sup>  | high (9) <sup>3,4</sup>                 | ++++      | +++ <sup>6</sup>   | ----           | ND                |
| Topsin-M /T-Methyl/Thiophanate-Methyl +<br>oil <sup>2,4</sup> | high (1) <sup>4</sup>                   | ++++      | ++++               | ----           | ----              |
| Vanguard <sup>6</sup>   | high (9) <sup>3,4</sup>                 | ++++      | +++ <sup>6</sup>   | ----           | ND                |
| Elevate <sup>2,7</sup>  | high (17) <sup>4</sup>                  | +++       | +++                | ND             | ----              |
| Rovral/Iprodione /Nevado <sup>2</sup>                         | low (2)                                 | +++       | NR                 | ----           | NR                |
| Topsin-M/T-Methyl/Thiophanate-Methyl <sup>2,3</sup>           | high (1) <sup>4</sup>                   | +++       | +/-                | ----           | ----              |
| Abound  | high (11) <sup>4</sup>                  | ++        | +                  | ----           | +++               |
| Botran  | medium (14)                             | ++        | ++                 | ND             | ND                |
| Bravo/Chlorothalonil/Echo/Equus <sup>8,9,10</sup>             | low (M5)                                | ++        | ++                 | ++             | ---- <sup>9</sup> |
| Captan <sup>7,8,10</sup>                                      | low (M4)                                | ++        | ++                 | +++            | ----              |
| Gem <sup>7</sup>  | high (11) <sup>4</sup>                  | ++        | +                  | ----           | +++               |
| Rally <sup>2</sup>  | high (3)                                | ++        | ++                 | ----           | ----              |
| Sulfur <sup>10</sup>  | 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; ND=no data

\* **Registration pending in California.**

\*\***Not registered, label withdrawn or inactive**

<sup>1</sup> 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..

<sup>2</sup> Fruit brown rot treatments for fungicides in FRAC Groups 1,2, 3, 17, 7/11 are improved with the addition of 2% light summer oil. The oil is "light" summer oil (1-2% vol/vol). If applied in summer, fruit will lose their waxy bloom and look red. They will dry to normal color.

<sup>3</sup> Strains of *Monilinia fructicola* and *M. laxa* resistant to Topsin-M and T-Methyl have been reported in some California prune orchards. No more than two applications of Topsin-M or T-Methyl 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. Subpopulations of both *Monilinia* spp. have been shown to be resistant to AP (FRAC 9) fungicides on prune in CA.

<sup>4</sup> 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.

<sup>5</sup> Blossom blight only; not registered for use after petal fall.

<sup>6</sup> High summer temperatures and relative humidity reduce efficacy.

<sup>7</sup> Registered for use on fresh prunes only.

<sup>8</sup> Do not use in combination with or shortly before or after oil treatment.

<sup>9</sup> Do not use after jacket (shuck) split.

<sup>10</sup> Do not use sulfur, captan, or chlorothalonil in combination with or shortly before or after oil treatment.

## PRUNE (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 <sup>1</sup>   | +++       | +++       | +++        | ---- | +    | ++   |
| Russet scab <sup>2</sup> | ----      | ----      | +++        | ---- | ---- | ---- |
| Rust <sup>3</sup>        | ----      | ----      | ----       | +    | ++   | +++  |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> Flowers are susceptible beginning with the emergence of the sepals (green bud) until the petals fall but are most susceptible when open.

<sup>2</sup> A physiological disorder; no pathogens involved.

<sup>3</sup> More severe when late spring rains occur.

## STRAWBERRY: FUNGICIDE EFFICACY

| Fungicide                             | Resistance risk (FRAC) <sup>1</sup> | Powdery mildew | Gray mold         | Anthracnose | Angular leaf spot | Common leaf spot | Mucor rot | Rhizopus rot | Leather rot      | Crown rot | Red steele |
|---------------------------------------|-------------------------------------|----------------|-------------------|-------------|-------------------|------------------|-----------|--------------|------------------|-----------|------------|
| Bumper/Tilt                           | high (3)                            | ++++           | ---               | ++          | ---               | +++              | ---       | ---          | ---              | ---       | ---        |
| Mettle*                               | high (3)                            | NR             | NR                | ND          | ---               | ND               | ND        | ND           | ---              | ---       | ---        |
| Procure                               | high (3)                            | ++++           | ---               | +           | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| Quilt Xcel*                           | medium (3/11)                       | ++++           | ++                | +++         | ---               | ---              | ND        | +            | ND               | ND        | ND         |
| Rally                                 | high (3)                            | ++++           | ---               | ++          | ---               | +++              | ---       | ---          | ---              | ---       | ---        |
| Topsin-M/T-Methyl/Thio-phanate-Methyl | very high (1) <sup>2</sup>          | +++            | +++               | ---         | ---               | ++               | ---       | ---          | ---              | ---       | ---        |
| Copper                                | low (M1)                            | ---            | ---               | ---         | +++ <sup>5</sup>  | ---              | ---       | ---          | ---              | ---       | ---        |
| Sulfur                                | low (M2)                            | +++            | ---               | ---         | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| Quadris                               | medium (11) <sup>2</sup>            | +++            | ++                | ++          | ---               | ---              | ND        | ND           | ND               | ND        | ND         |
| Pristine                              | medium (7/11) <sup>2</sup>          | +++            | ++++              | ND          | ---               | ---              | ND        | ND           | ND               | ND        | ND         |
| Ph-D                                  | medium (19)                         | +++            | ++                | ++          | ND                | ND               | ---       | ---          | ---              | ---       | ---        |
| Cinnacure                             | low                                 | +              | ---               | ---         | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| Elevate                               | high (17) <sup>2,6</sup>            | +/-            | ++++ <sup>6</sup> | +++         | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| M-Pede                                | low                                 | +              | ---               | ---         | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| Quintec                               | high (13)                           | ++++           | ---               | ---         | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| Rovral/Iprodione/Nevado               | low (2)                             | ---            | +++               | ---         | ---               | ---              | ++        | ---          | ---              | ---       | ---        |
| Switch                                | high (7/12)                         | ---            | ++++              | +++         | ---               | ---              | +         | +++          | ---              | ---       | ---        |
| Captan                                | very low (M4)                       | ---            | +++               | +++         | ---               | ---              | +         | ---          | ---              | ---       | ---        |
| Thiram                                | low (M3)                            | ---            | ++                | ++          | ---               | ---              | ---       | ---          | ---              | ---       | ---        |
| Aliette/Legion <sup>3</sup>           | low (33)                            | ---            | ---               | ---         | ---               | ---              | ---       | ---          | +++              | ++        | ++         |
| Ridomil Gold SL <sup>4</sup>          | high (4) <sup>2</sup>               | ---            | ---               | ---         | ---               | ---              | ---       | ---          | +++ <sup>4</sup> | ++        | ++         |

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

### \*Registration pending in California

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Foliar applications provide systemic treatment.

<sup>4</sup> 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.

<sup>5</sup> Greater than 4 applications causes severe stunting.

<sup>6</sup> Nonpersistent resistant populations of *Botrytis cinerea* to fenhexamid occur with repeated use of FRAC Group 17 fungicides.

## STRAWBERRY: TREATMENT TIMING

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

| Disease                             | At Planting                      |                     |                       |                             | Preharvest <sup>1</sup> |       |
|-------------------------------------|----------------------------------|---------------------|-----------------------|-----------------------------|-------------------------|-------|
|                                     | Preplant fumigation <sup>2</sup> | Clean nursery stock | Dips or water washing | Before overhead irrigations | Foliar                  | Fruit |
| Anthracnose <sup>3</sup>            | +++                              | +++                 | +++                   | +                           | +                       | +++   |
| Botrytis fruit rot <sup>3</sup>     | ----                             | ----                | ----                  | +                           | ++                      | +++   |
| Mucor fruit rot                     | ----                             | ----                | ----                  | +                           | +                       | +++   |
| Rhizopus rot                        | ----                             | ----                | ----                  | ----                        | ----                    | +++   |
| Angular leaf spot                   | +                                | +++                 | +                     | +++                         | +                       | ----  |
| Common leaf spot <sup>3</sup>       | +                                | +++                 | ++                    | +++                         | +++                     | +     |
| Powdery mildew <sup>3</sup>         | ----                             | +++                 | ----                  | ----                        | +++                     | +     |
| Leather rot <sup>4</sup>            | +++                              | ----                | ----                  | ++                          | ----                    | ++    |
| Phytophthora crown rot <sup>4</sup> | +++                              | +                   | ----                  | ++                          | +                       | ----  |
| Red steale <sup>4</sup>             | ++                               | ++                  | ----                  | +                           | ++                      | ----  |
| Verticillium wilt                   | +++                              | ++                  | ----                  | ----                        | ----                    | ----  |

**Rating:** +++ = most effective; ++ = moderately effective; + = least effective; ---- = ineffective

<sup>1</sup> Preharvest treatments include applications of fungicides before heavy fog, dews, or rain.

<sup>2</sup> 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.

<sup>3</sup> Integrated programs required for management including rotation of fungicides of different classes.

<sup>4</sup> Inseason, foliar treatments include phosphite or fosetyl-aluminum products or soil applications

## WALNUT: BACTERICIDE EFFICACY

| Material                                       | Resistance risk (FRAC#) <sup>1</sup> | Walnut blight <sup>2</sup> | Phytotoxicity   |
|--|--------------------------------------|----------------------------|-----------------|
| Bordeaux <sup>2</sup>                          | low (M1)                             | +++                        | NP              |
| Fixed coppers <sup>2</sup>                     | medium (M1)                          | +++                        | ++ <sup>3</sup> |
| Copper-maneb**                                 | low (M1/M3)                          | ++++                       | NP              |
| Copper-mancozeb* <sup>4</sup>                  | low (M1/M3)                          | ++++                       | NP              |
| Copper-maneb-surfactant (single application)** | low (M1/M3)                          | +                          | NP              |
| Regalia  | low                                  | ++                         | NP              |
| Serenade                                       | low (44)                             | +                          | NP              |
| Zinc-Copper Bordeaux                           | low (M1)                             | +++                        | NP              |

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

\* **Registration pending in California**

\*\* **Not registered, label withdrawn or inactive**

<sup>1</sup> 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.

<sup>2</sup> Copper resistance occurs within sub-populations of *Xanthomonas axenopodis* pv. *juglandis*.

<sup>3</sup> Phytotoxicity of fixed coppers can be reduced with the addition of lime or agricultural oils to the tank mixture.

<sup>4</sup> Currently, in 2010, a Section 18 Emergency registration has been approved for mancozeb under the label Manzate Prostick 75DF or Manzate Flowable.

<sup>5</sup> 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 <sup>1</sup> | May <sup>2</sup> |
|----------------------------|------------------|--------------------|------------------------|---------------------------------|------------------|
| Walnut blight <sup>3</sup> | ++               | +++                | +++                    | ++ <sup>1</sup>                 | +                |

<sup>1</sup> A temperature-leaf wetness model (e.g., XanthoCast) is available for determining optimum timing of bactericide applications.

<sup>2</sup> Late spring rains are less conducive to disease provided bloom is not delayed by low chilling.

<sup>3</sup> Male and female flowers are susceptible beginning with their emergence, depending on wetness and temperatures conducive to disease development.