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## PRECAUTIONS FOR USING PESTICIDES
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- Online: http://ipm.ucanr.edu
- UC Cooperative Extension County Offices
- University of California
  ANR Communication Services
  Richmond, CA 94804
  510-665-2195; 800-994-8849

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

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

(Section reviewed 4/13)

**RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN KIWIFRUIT TO NATURAL ENEMIES AND HONEY BEES**

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Mode of action¹</th>
<th>Selectivity² (affected groups)</th>
<th>Predator y mites³</th>
<th>General predators⁴</th>
<th>Parasites⁴</th>
<th>Honey bees⁵</th>
<th>Duration of impact to natural enemies⁶</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus thuringiensis</em> ssp. <em>kurstaki</em></td>
<td>11A</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>cryolite (Kryocide)</td>
<td>8C</td>
<td>narrow (foliage chewing insects)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>esfenvalerate (Asana XL)</td>
<td>3A</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>petroleum oil</td>
<td>—</td>
<td>broad (exposed insects, mites)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>pyriproxyfen (Seize)</td>
<td>7C</td>
<td>narrow (scale, beetles)</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>II</td>
<td>long</td>
</tr>
</tbody>
</table>

H = high  
M = moderate  
L = low  
— = no information

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

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

³ Generally, toxicites are to western predatory mite, *Galendromus occidentalis*.

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

⁵ Ratings are as follows: I–Do not apply or allow to drift to plants that are flowering; II–Do not apply or allow to drift to plants that are flowering, except when the application is made between sunset and midnight if allowed by the label and regulations; III–No bee precaution, except when required by the label or regulations. For more information about pesticide synergistic effects, see *Bee precaution pesticide rating*.

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

⁷ Rating depends on rate used.

⁸ Kills lady beetles.

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

<table>
<thead>
<tr>
<th>Common name</th>
<th>Chemical class</th>
<th>Activity</th>
<th>Mode of action (FRAC number)</th>
<th>Resistance potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>cyprodinil (Vangard)</td>
<td>anilinopyrimidine</td>
<td>mostly contact,</td>
<td>single-site (9)</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td></td>
<td>slightly systemic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fludioxonil (Scholar)</td>
<td>phenylpyrrole</td>
<td>contact</td>
<td>few to multisite (12)</td>
<td>medium</td>
</tr>
</tbody>
</table>

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

2. Scholar is for postharvest use only.

FUNGICIDE EFFICACY  

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Resistance risk (FRAC number)</th>
<th>Botrytis Fruit Rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scholar***</td>
<td>high (12)</td>
<td>+++</td>
</tr>
<tr>
<td>Oso</td>
<td>medium (19)</td>
<td>+++</td>
</tr>
<tr>
<td>Vangard²</td>
<td>high (9)</td>
<td>+++</td>
</tr>
</tbody>
</table>

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

*** Scholar is for postharvest use only.

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

² Vangard preharvest registration for California is approved for the 2010 fall season as of Feb. 2010.

³ To reduce the risk of resistance development, start treatments with a fungicide with a multi-site mode of action; rotate or mix fungicides with different mode of action FRAC numbers for subsequent applications, use labeled rates (preferably the upper range), and limit the total number of applications/season.

MOST EFFECTIVE TREATMENT TIMINGS FOR KEY DISEASES IN KIWIFRUIT  

Not all indicated timings may be necessary for disease control.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Bud break</th>
<th>Full bloom</th>
<th>Preharvest Interval</th>
<th>Postharvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botrytis Fruit Rot</td>
<td>—</td>
<td>++ ²</td>
<td>++</td>
<td>+++</td>
</tr>
</tbody>
</table>

Rating: ++++ = most effective, +++ = highly effective, ++ = moderately effective, + = least effective, — = ineffective

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

² Apply only if rain is forecasted.

Insects  
(Section reviewed 4/13)

ARMORED SCALES (6/16)

Scientific Names:  
Greedy scale: *Hemiberlesia rapax*  
Latania scale: *Hemiberlesia lataniae*  
Oleander (Ivy) scale: *Aspidiotus nerii*

DESCRIPTION OF THE PESTS

Scale insects are found infesting the leaves, cordons, canes, and fruit of kiwifruit vines. Greedy scale and latania scale are armored scales and similar in size to adult oleander scale. However, the waxy shell covering of these two species is more conical with a small black spot or nipple to one side of the center. If the shell is removed, the female body is yellow. The male scale body is much smaller and elongated. It is difficult to distinguish between latania and greedy scales without a microscope, but identification is not necessary for management. There are usually several generations a year.

The adult female oleander scale is an armored scale that is about 0.1 inch (2.5 mm) long and oval. It has a waxy covering with a yellow or light brown spot near the center. The adult male scale is elongate. If the coverings are removed, the female body is yellow, while the male scale is brownish yellow. There are several generations a year.

DAMAGE

Scale insects feed on plant fluids and can be located on the bark or fruit of kiwi. Heavy infestations affect the vigor of the plant and result in the presence of scales on fruit, causing it to be offgraded.

MANAGEMENT

Although management for all three species is the same, biological control may play a significant role in the management of greedy and latania scales. If the previous year’s crop had an economic infestation of any of these scales, treatments are warranted.

Biological Control

Various predatory insects and parasitic wasps kill armored scales. Parasites include species of *Aphytis* wasps and predators include green lacewings, brown lacewings, minute pirate bugs, and small species of lady beetles.

Organically Acceptable Methods

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

Monitoring and Treatment Decisions

Evidence of scale on canes during dormant pruning or off-grade fruit at harvest caused by the presence of scales is justification for a treatment. Treatments are applied during the dormant period after pruning and tying to permit better spray coverage, but before budbreak to avoid phytotoxicity. Double-sided sticky tape wrapped around vine cordons is used to determine when crawlers are present. Monitoring scale crawler populations is beneficial in determining efficacy of the delayed-dormant treatment.

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

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Hemiberlesia rapax</em></td>
<td>Greedy scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hemiberlesia lataniae</em></td>
<td>Latania scale</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### A. PYRIPROXYFEN

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Days Before Harvest</th>
<th>Days After Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seize 35WP</td>
<td>4–5 oz</td>
<td>12</td>
<td>30</td>
</tr>
</tbody>
</table>

**MODE-OF-ACTION GROUP NUMBER**: 7C

**COMMENTS**: Use higher rates for high numbers of scales. Use allowed under a supplemental label that currently expires on December 31, 2016. Check for valid registration after this date.

**PLUS**: NARROW RANGE OIL# (PureSpray Green, Omni Supreme Spray, IAP 440 spray oil)

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Days Before Harvest</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAP 440 spray oil</td>
<td>1 gal</td>
<td>4</td>
<td>NA</td>
</tr>
</tbody>
</table>

### B. NARROW RANGE OIL# (PureSpray Green, Omni Supreme Spray, IAP 440 spray oil)

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Days Before Harvest</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAP 440 spray oil</td>
<td>4–6 gal/100 gal water</td>
<td>4</td>
<td>NA</td>
</tr>
</tbody>
</table>

**MODE OF ACTION**: Contact including smothering and barrier effects.

**COMMENTS**: For organically grown crops, check with your certifier to determine which products are organically acceptable. Use higher rates for high numbers of scales.

---

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

# **Acceptable for organically grown produce. Check with your certifier if permissible.**

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

NA **Not applicable**
**BOXELDER BUG** (6/16)

**Scientific Name:** Boisea trivittata

**DESCRIPTION OF THE PEST**
Adults have dark, oval bodies with many fine red lines on the back. Undersides of wings are red. Nymphs are small, bright red, crawling insects.

**DAMAGE**
Feeding before bloom is known to cause bud and fruit drop, as well as fruit malformation, which is apparent when the fruit is cut in half, but can also easily be seen when the fruit is left intact.

**MANAGEMENT**
Boxelder bugs are mainly found in vineyards near the coast. Treatment, if needed, should be aimed at adult bugs and applied in early spring as flower buds are developing. It has been observed that deformities of the fruit are lessened if a bloom time spray is applied.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESFENVALERATE</strong> (Asana XL)*</td>
<td>9.6 fl oz</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

**MODE-OF-ACTION GROUP NUMBER:** 3A

**COMMENTS:** Will provide suppression. Only effective when temperature is above 75°F. Damage occurs in spring when adults feed on developing flower buds and cool weather is common, so take note of daily temperature. Do not exceed seven applications per season or spray at less than 7-day intervals.

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

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

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.
LEAFROLLERS  (6/16)
Scientific Names:  Omnivorous leafroller: *Platynota stultana*
Fruittree leafroller: *Archips argyrospila*
Obliquebanded leafroller: *Choristoneura rosaceana*
Orange tortrix: *Argyrotaenia citrana*

DESCRIPTION OF THE PESTS
Omnivorous leafroller is the most common and damaging of the leafrolling caterpillars. Omnivorous leafroller caterpillars may differ in body color from cream to brown with light brown to black head capsules and resemble other tortricid species, except that they have white, slightly convex and oval tubercles at the base of each bristle on the upper side of the abdomen. Vineyards may be infested with omnivorous leafroller moths that develop on host plants outside the vineyard. Omnivorous leafroller has four to six generations per year depending on climatic conditions.

Fruittree leafroller, obliquebanded leafroller, and orange tortrix may also attack kiwifruit. Fruittree leafroller is a minor pest of kiwifruit that only has one generation per year. Overwintering eggs hatch in spring, and larvae can be found feeding on leaves until about June. The larvae are dark green caterpillars with black heads. Adult moths appear in June or July and lay the overwintering eggs. Obliquebanded leafroller may be the most common leafroller found in the Sacramento Valley. It has two generations per year in the Sacramento Valley. Larvae are green to tan-colored caterpillars. Orange tortrix is mostly found in the cool, coastal regions where it has two to four generations per year. The larvae vary in color but are generally yellowish tan to light brown.

DAMAGE
Omnivorous leafroller and the other leafrolling caterpillars directly damage fruit by scarring the surface when they feed.

MANAGEMENT
Closely examine blossoms and vegetative shoots in the vineyard during prebloom and bloom for the presence of caterpillars, webbed leaves, or feeding damage. If present, or if leafroller damage was evident in previous harvest, a postbloom treatment is justified. This postbloom treatment is often sufficient to keep leafrollers under control for the remainder of the season.

Decisions to treat summer generations of the omnivorous leafroller should be based on the presence of caterpillars observed from periodic visual inspection of the vines, not from moths caught in traps. No correlation exists between pheromone trap catches of adult moths and damage. However, the timing of treatment should be based on trap catches.

Biological Control
Various parasitic wasps and tachinid flies attack leafroller eggs, larvae, or pupae.

Organically Acceptable Methods
Applications of *Bacillus thuringiensis* are acceptable in an organically certified crop.

Monitoring and Treatment Decisions
Treat for omnivorous or obliquebanded leafroller at bloom if the vineyard has a history of this pest or if a serious infestation occurred in the previous season. Otherwise, monitor to determine the need for treatment. There is not enough research in kiwifruit regarding monitoring; therefore for omnivorous leafroller, refer to the monitoring information used in grapes. For the obliquebanded leafroller use managing information found in peaches.

Use pheromone traps, degree-days, and monitoring to assess omnivorous and obliquebanded leafroller treatment timing and populations.

Pheromone traps
Place pheromone traps in the vineyard just before budbreak, and check traps twice a week. Information obtained from trap catches is used to establish a biofix, which is an identifiable point in the life cycle of this pest. The biofix is the first night moths are consistently caught in traps. Continue to monitor with pheromone traps through fruit
set to track adult flights of subsequent generations. For information on placing and monitoring traps in a vineyard, see the PHEROMONE TRAPS section in the Grapes Pest Management Guidelines.

**Degree-days**

For omnivorous leafroller, please refer to the degree–day calculator for grapes. For obliquebanded leafroller, please refer to the degree–day calculator for peaches.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BACILLUS THURINGIENSIS ssp. KURSTAKI</strong> (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>MODE-OF-ACTION GROUP NUMBER</strong>: 11A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Apply at end of hatch. Most effective on small caterpillars at low rates. Repeat a low application rate in 5 to 10 days or a high rate will be required on large larvae. Does not disrupt natural enemies.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **CRYOLITE** (Kryocide)             | 6–8 lb          | 12           | 30          |
| **(Prokil Cryolite 96)**            | 6–8 lb          | 12           | 30          |
| **MODE-OF-ACTION GROUP NUMBER**: 8C |                  |              |             |
| **COMMENTS**: Ground application only in up to 200 gal spray/acre. No more than four applications per season at 15- to 30-day intervals. |

| **ESFENVALERATE** (Asana XL)*       | 9.6 fl oz       | 12           | 14          |
| **MODE-OF-ACTION GROUP NUMBER**: 3A |                  |              |             |
| **COMMENTS**: For use when severe damage is occurring. Only effective when temperature is above 75°F. Do not exceed seven applications per season or spray at less than a 7-day interval. |

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

¤ Acceptable for organically grown produce.

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

*(Section reviewed 4/13)*

**ARMILLARIA ROOT ROT** *(4/13)*

Pathogen: *Armillaria mellea*

**SYMPTOMS AND SIGNS**

Vines infected with Armillaria root rot usually completely collapse. Occasionally, white mycelial mats can be found under the bark at the soil line, but more commonly white mycelial strands are seen interwoven through darkened cortical tissue. Dark, rootlike structures called rhizomorphs grow from the root into the soil after symptoms develop on vines.

**COMMENTS ON THE DISEASE**

The fungal pathogen survives on diseased wood and roots below ground for many years. Healthy plant roots can become infected when they come in contact with inoculum from a preceding orchard crop, nearby oak trees, or remnants of *Armillaria*-infected roots when land is cleared and prepared for planting kiwi vines. Although kiwifruit plants are somewhat tolerant of this fungus, if the vine has already been weakened by *Phytophthora* infection, its death may be hastened by an invasion of *A. mellea*. Flood waters sometimes spread infected roots in a vineyard. The fungus is favored by soil that is continually damp. Although the pathogen may produce mushrooms around the base of the vine trunk, they are not considered significant in disease spread.

**MANAGEMENT**

When clearing land for planting or replanting vines, carefully remove and burn roots 1 inch or greater in diameter. Ensure that vines are properly irrigated and not overwatered.
BACTERIAL BLIGHT  (4/13)
Pathogen:  *Pseudomonas viridiflava* and *Pseudomonas syringae*

SYMPTOMS
Bacterial blight symptoms appear as brown, sunken lesions on the petals that enclose the floral buds. During bud expansion, the petals exhibit a yellow-orange discoloration that later becomes necrotic. The buds fail to mature and abscise. Small yellow leaf spots may occur after summer rains or when overhead irrigation is used. The leaf spot phase occurs along the leaf margins and begins as small, yellow halos 0.04 to 0.08 inch (1 to 2 mm), the center of which becomes necrotic. Later the spots enlarge and coalesce to form large irregular patches (lesions) of necrotic tissue.

COMMENTS ON THE DISEASE
*Pseudomonas viridiflava* and *Pseudomonas syringae* are widespread plant pathogens that exist on the leaf surfaces of many fruit and vegetable crops. They gain entry into a plant through injured tissues, or when the plant has been predisposed to disease by conditions such as chilling injury or rainfall that favor growth of the bacteria.

MANAGEMENT
Besides avoiding injury to plant tissues, there are currently no cultural practices or chemical controls that are recommended for the control of this disease.

BLEEDING CANKER  (4/13)
Pathogen:  *Pseudomonas syringae*

SYMPTOMS AND SIGNS
Symptoms of bleeding canker first appear in early spring, soon after leaf emergence. Young canes exhibit “hooking” at the terminal growing point, leaf wilt, blight, and canker formation. Externally, cane symptoms include dried, shriveled bark. Internally, affected tissue becomes discolored, appearing red-rusty brown. A pruning wound is often associated with the canker. Cankers may occur on canes, cordons, or trunks. Plants are often killed back past the bud union when trunks are attacked. Less severely affected plants generally resume growth in late spring. When regrowth occurs, profuse rusty red exudate (bleeding) occurs from the canker margins, often to the extent that bark tissue is discolored. Suckering is extensive from rootstocks of severely affected plants.

COMMENTS ON THE DISEASE
Bleeding canker has been observed in most areas of the state where kiwifruit are grown. *Pseudomonas syringae* has a wide host range and is believed to overwinter on kiwifruit vines as well as on weeds and grasses in vineyards. Although widespread, this disease is not a major problem in kiwifruit. Young vines that have been weakened by freezing or chilling injury are predisposed to infection.

MANAGEMENT
Control of bleeding canker is currently unresolved, although protecting vines from stresses caused by winter injury should alleviate disease severity. Prune infected vines when symptoms are observed. Make cuts one foot below the leading edge of the canker.
**BOTRYTIS FRUIT ROT**

*Pathogen:* *Botrytis cinerea*

**SYMPTOMS AND SIGNS**

Botrytis fruit rot, also known as gray mold decay, is a soft fruit rot that can result in significant crop losses during storage. Symptoms of decay and signs of the pathogen develop as shriveled fruit that may have gray fungal growth mostly at the stem end and occasionally around the sepals or over the entire surface of the fruit. Diseased internal fruit tissues appear water-soaked and dark green. In advanced stages of the disease black, irregular-shaped sclerotic areas of the fungus up to about 0.2 inch (5 mm) in diameter may form on the infected fruit.

**COMMENTS ON THE DISEASE**

Symptoms are uncommon on immature fruit. Infections may begin, however, at bloom and continue during fruit maturation and ripening in storage. Early infections generally do not cause immediate decay, but the pathogen can resume its growth as the fruit ripens, usually in cold storage, causing postharvest rot. Infections commonly develop from the stem end where the stem is snapped off during harvest or from surface wounds that occur during harvest and handling. Infections may also start on the fruit sepals and invade the fruit stem.

The pathogen *Botrytis cinerea* can tolerate low storage temperatures 30° to 34°F (-1° to 1°C) and grow over a wide range of temperatures commonly used to store and market kiwifruit. The pathogen can overwinter in the vineyard on fruit decaying on the ground and vines, on infected plant tissues including weeds, and leaves blown into the vineyard from neighboring orchards (e.g., citrus, almond, stone fruit). Fruits that have been partially consumed by rodents and birds and were left behind in the vineyard are even more likely to harbor the pathogen.

The pathogen requires wetness for spore germination and infection; thus, this disease is more severe when rainy weather occurs during bloom or especially at harvest. In addition, other pests or extreme microclimate conditions (e.g., hail) may cause fruit injury and allow infection by the gray mold pathogen and other decay fungi. Inoculum may be dispersed by the common brown snail (*Helix aspersa*) that feeds on the flowers and then on sepals of immature fruit. In addition, slime from the snail can induce *B. cinerea* conidia to germinate.

**MANAGEMENT**

Fungicide applications are required only when rainy weather or high humidity conditions from sprinkler irrigation occur during bloom and at harvest. Decisions on fungicide sprays can be based on a prediction technique (BOTMON) that assesses the potential for the development of gray mold in cold storage. The BOTMON technique assesses the colonization of the sepals and stem ends, as well as the blossom ends of fruits by *B. cinerea* about one month before harvest, which determines the need of a preharvest spray.

**BOTMON protocol for sepal and receptacle evaluation**

Randomly collect 60 pieces of fruit for every five acres four months after fruit set or one month before harvest. Sample only pair rows of female vines, following a zigzag pattern. Select vines and fruit with a normal growing pattern, avoid weak and stressed vines and fruit (sunburned fruit, snail damage). Collect fruit with their stems attached and place them in flats with individual cells. If sepals break off while in the flats, collect them for later processing. Collect fruit in sets of 20 fruits per flat, if possible.

**Fruit analysis:**

1. Slice part of the fruit bearing the sepals and stem end.
2. Remove sepals (by hand) and stem end (with a cork borer) from each fruit.
3. Surface disinfect sepals and stem ends in 0.5% chlorine household bleach plus 2 drops of Triton-X-100 surfactant (per L water) for 1 minute.
4. Rinse the sepals and stem ends in sterile water and dry them in a positive-flow hood for 10 to 15 minutes.
5. Place the sepals and stem ends onto acidified potato-dextrose agar (pH=3.2-3.5), and incubate at 7°C for 6 days.
6. Record *B. cinerea* colonies growing from the sepals and stem ends in each plate (first Botrytis recording).
7. Incubate at 23°C for 3 more days and record additional *B. cinerea* colonies in each plate (second Botrytis recording).
8. Combine data from the two recordings (=total *B. cinerea* colonies) and calculate incidence (%) of colonization of sepals or stem ends.
9. Use Table 1 for sepal or stem end colonization to predict Botrytis gray mold expected to develop after 3 or 5 months storage of fruit in controlled atmosphere and to make management decisions.
Table 1 – Management decisions based on predicting incidence of gray mold on fruit in storage

<table>
<thead>
<tr>
<th>Colonization level</th>
<th>Incidence of gray mold on fruit</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (&lt; 2 %)</td>
<td>Medium (2-6 %)</td>
</tr>
</tbody>
</table>
| Low 0–15 %          | x                  |          |          | • No preharvest fungicide spray  
|                     |                    |          |          | • Fruit stores well  
|                     |                    |          |          | • No re-sorting or packing required  |
| Medium 16—50 %      |                    | x                   |          | • Preharvest fungicide spray: 1 spray, 7–14 days before harvest  
|                     |                    |          |          | • Fruit stores for a shorter time  
|                     |                    |          |          | • Re-sorting or packing may be required  |
| High >50 %          |                    |                    | x                   | • Preharvest fungicide spray: 2 sprays, 14 and 7 days before harvest  
|                     |                    |          |          | • Monitor fruit closely in storage  
|                     |                    |          |          | • Re-sorting or packing required  |

The BOTMON protocol requires experience and skill in identifying fungi on decaying plant material. The technique also allows for the development of saprophytic fungi, which may lead to misdiagnosis of the plant health problem.

Regardless of bloom and preharvest microclimate conditions, the most effective method to manage gray mold of kiwifruit is with the use of postharvest fungicide treatments. This will require adoption of new postharvest handling procedures of kiwifruit that include sanitation washes and aqueous fungicide applications.

Organically Acceptable Methods

Because a large proportion of infections by B. cinerea occur at the wound where the stem is snapped off during harvest, “curing” the fruit by letting the stem end dry out before packing and cold storage can reduce the incidence of gray mold. This method can be used for organically certified fruit. Pruning the vines to open up the canopy and increase air circulation can also help in the management of this disease.

Treatment Decisions

Most fungicide products are only available in the form of a postharvest dip or spray. Cyprodinil (Vangard) however, is intended as a preharvest application for the prevention of Botrytis fruit rot. Apply 7 to 14 days before harvest in a 7 to 10 day interval. Read product labels carefully for full instructions on legal use of materials listed.

Common name (Example trade name) | Amount per acre | REI‡ (hours) | PHI‡ (days)
--- | --- | --- | ---
CYPRODINIL (Vangard WG) | 10 oz | 12 | 7

Updated 6/16

When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide’s properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.

PREHARVEST

A. CYPRODINIL (Vangard WG)  
MODE-OF-ACTION GROUP NUMBER*: Anilino-pyrimidines (9)  
COMMENTS: Application may be made by ground. Aerial application in California only. Make no more than one application by air. One to two applications beginning 14 days before harvest, on a seven to ten day interval prior to harvest.

POSTHARVEST
<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. FLUDIOXONIL (Scholar 50WP)</td>
<td>8–16 oz</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**MODE-OF-ACTION GROUP NAME (NUMBER):** Phenylpyrrole (12)

**COMMENTS:** Use as a postharvest dip or spray. Dilution rate depends on application method to ensure application of the fungicide to the stem end wound (see label). Do not make more than one application.

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

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

NA Not applicable.
CROWN GALL (4/13)
Pathogen: *Agrobacterium tumefaciens*

SYMPTOMS AND SIGNS
Foliar symptoms typical of a root and/or crown rot pathogen are lack of vigor, small leaves, poor terminal growth, open canopy, and yield reduction. Galls are the most obvious symptoms of crown gall; however, they are not always visible. Galls range in size from nearly microscopic to 12 inches or more in diameter.

COMMENTS ON THE DISEASE
*Agrobacterium tumefaciens* is primarily disseminated by infected plant material or in soil during cultivation. It enters the plant only through wounds, most commonly on roots or the crown. The roots of young vines may be injured during transplanting, while older vines can be injured by common cultural practices that use machinery. Additionally, vines may be wounded by frost, herbicide, pruning, removal of suckers, or they may develop growth cracks.

MANAGEMENT
Control of crown gall is best achieved by avoiding injury to vines. A minimum of handling during transplanting and care during cultural practices using machinery should greatly reduce the risk of wounding. Galltrol is registered as a preventative preplant dip. Its effectiveness will depend on whether there are susceptible or resistant *A. tumefaciens* strains at the planting site. Existing galls can be surgically removed.
PHYTOPHTHORA ROOT and CROWN ROT (6/16)

Pathogen: Phytophthora spp.

SYMPTOMS AND SIGNS
Symptoms of Phytophthora root and crown rot commonly occur in spring and include reduced terminal shoot growth, chlorotic and/or undersized leaves, and an open canopy. As temperatures increase in summer, vines may collapse suddenly, or alternatively, vines may decline slowly over a few seasons. Roots and crowns of infected vines exhibit a red-brown rot that is easily observed by cutting into the cortical tissue. Often a margin where healthy, white tissue meets diseased tissue may be found. Feeder roots are lacking and active lesions often progress above ground on one or more sides of the lower trunk resulting in sunken areas.

COMMENTS ON THE DISEASE
The pathogens survive in soil and can be carried in irrigation water obtained from surface sources. Prolonged periods of saturated soil are optimal for the pathogen to infect roots. Disease development is enhanced in poorly drained soils or where vineyards receive long durations of flood irrigation. Several species of Phytophthora are known to attack kiwifruit roots and crowns.

MANAGEMENT
This disease can be managed using strict planting practices, water management, and fungicide treatments. Plant on raised berms in well-drained soil to allow for rapid water drainage following irrigation or rains. Duration of irrigations should not exceed six hours in fields where disease occurs. Intervals between irrigations may be shortened as needed as long as the soil has drained adequately since the last irrigation.

Fungicides with efficacy that are currently registered in California for the control of root and crown rot include mefenoxam and phosphonates. Hydrogen dioxide is also registered, but yields variable results.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. MEFENOXAM (various)</td>
<td>5.6–11.2 oz/40 gals of water</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION, GROUP NAME (NUMBER?): nucleic acids synthesis, Phenylamides (4) COMMENTS: REI may be shorter or not required if the product is soil-injected or soil-incorporated and workers will have no contact with anything that has been treated.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. PHOSPHONATES (Fungi-phite)</td>
<td>32–64 fl oz</td>
<td>4</td>
<td>NA</td>
</tr>
<tr>
<td>MODE OF ACTION, GROUP NAME (NUMBER?): unknown (33) COMMENTS: Foliar and chemigation applications are labeled.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. HYDROGEN DIOXIDE (TerraClean)</td>
<td>3–270 ppm</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>MODE OF ACTION: Oxidizer COMMENTS: Highly toxic to bees.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UPDATED 6/16
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide’s properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.

PREPLANT

When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide’s properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.

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

NA Not applicable.
WATER STAINING, JUICE BLOTCH, and SOOTY MOLD of FRUIT (4/13)

Pathogens: Cladosporium and Alternaria spp.

SYMPTOMS AND SIGNS
Staining includes three types of fruit skin discoloration: water staining, juice blotch, and sooty mold stains. All of these stains are only cosmetic blemishes that can be removed.

Water staining
Leaf and vine wetness from heavy dew, rainfall, or irrigation leaches tannins and minerals from dead organic material in the canopy and then drips onto the fruit, causing a brownish discoloration on the fruit surface. Stains can appear as teardrops, large darkened areas, or blotches that cover significant portions of the fruit surface. Water staining can also occur when harvested fruit gets wet during the handling and packing process.

Juice blotch
Lots can contain soft fruit that are crushed during handling and packaging operations, leaking juice that contaminates the surface of sound fruit. Juice on unblemished fruit placed in high humidity environments (room or inside box liner) may discolor the fruit.

Sooty mold stains
Juice on fruit may support the growth of molds. Often in storage, molds such as Cladosporium and Alternaria species may develop on the juice-blotch stained areas, causing additional discoloration such as dark spots or lines on the fruit surface. The darkened areas may appear sooty or moldy.

COMMENTS ON THE DISEASE
Staining can occur on kiwifruit wherever they are grown. Water staining more frequently occurs when fruit is harvested late and exposed to fall rainfall. Sooty mold stains commonly develop in cold storage.

MANAGEMENT
Management of staining in the field includes pruning dead tissue from the canopy and the application of citric acid or other agricultural acids prior to harvest. Use of soft water and high volume applications are needed to provide adequate coverage. Allow fruit to completely dry before harvesting. Citric acid sprays or postharvest dips remove field staining, but only for a short period of time. Under long cold storage conditions, sooty mold will grow on citric acid-treated fruit.

If fruit becomes wet during postharvest handling or after postharvest application of fungicides, be sure to remove excess water by brushing and allow time for air-drying before placing fruit into boxes with liners.
**Nematodes** (6/16)

**Scientific Name:** Root knot nematode: *Meloidogyne* spp.

**DESCRIPTION OF THE PEST**

Nematodes are microscopic, true roundworms. Root galling is associated with root knot nematodes only.

**DAMAGE**

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

**MANAGEMENT**

**Cultural Control**

Irrigate with greater frequency to avoid plant stress. Remove broadleaf weeds and do not plant cover crops susceptible to root knot nematode where root knot nematode is present.

**Treatment Decisions**

Nematodes are best controlled before planting because there are no kiwifruit rootstocks that are resistant to root knot nematode. Apply broadcast treatments in October or November the year before planting. The only alternative to fumigation is to not plant kiwifruit after kiwifruit and where root knot nematodes are present in the soil.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PREPLANT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. 1,3-DICHLOROPROPENE* (Telone II)</td>
<td>See comments</td>
<td>See label</td>
<td>NA</td>
</tr>
<tr>
<td>COMMENTS: The application rate for Telone II cannot exceed 35 gal/acre. In dry soils with slight surface moisture, the overall value of a Telone II application is equivalent to that of methyl bromide. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Become familiar with procedures that minimize off-gassing of fumigants.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. METAM SODIUM* (Vapam HL)</td>
<td>75 gal</td>
<td>See label</td>
<td>NA</td>
</tr>
<tr>
<td>COMMENTS: Metam sodium* (Vapam HL), applied at a rate of 75 gal/acre delivered uniformly in 6 inches water/acre, can be as effective as Telone II or methyl bromide if: there are no old root systems present containing viable root knot nematode; the orifices of the irrigation delivery system are large enough to avoid misting and thereby volatilization of the product; and the soil and irrigation system can infiltrate 6 acre inches water in 8 hours or less. For this latter requirement, sandy soils without a hardpan are usually suitable, whereas fine sandy loam soils may not be. Fumigants such as metam sodium are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Become familiar with procedures that minimize off-gassing of fumigants.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

NA Not applicable.
Weeds
(Section reviewed 4/13)

INTEGRATED WEED MANAGEMENT

Weeds may reduce kiwifruit vine growth and yields by competing for water, nutrients, and space. They interfere with low-volume irrigation emitters, reducing the uniformity of water output and efficiency of the system.

For optimum kiwifruit yield and vine health, weeds must especially be controlled in the area around the base of the vine. Generally the larger the area that remains weed-free, the greater the vine growth.

The first four years of a vineyard’s life are most critical. At or around the fourth year of growth the effect of weed competition is somewhat lessened as vines become established and shade from the canopy reduces weed growth.

Weeds in the 4- to 6-foot-wide vine rows and in the area between the vine rows (middles) are controlled mechanically, through tilling and mowing, or chemically. However, row middles are typically mowed and only rarely chemically treated. During the first four years, weeds in the row middles may need to be mowed multiple times. As vines become established and shade weeds, the number of mowings required will decrease.

A well-managed annual winter cover crop between the vine rows will reduce weed competition. However, if there is danger of frost in spring, the cover crop should be mowed to help moderate vineyard temperatures and reduce the potential for chill damage.

HERBICIDES

Very few herbicides are registered for use in kiwifruit vineyards. However, combinations and sequential applications of the available herbicides can provide effective and economical control. Before using any herbicide, always read the label, determine what weed species need to be controlled, and follow the directions carefully.

Most commonly, herbicides are used only in the vine row to control weeds. This will reduce the amount of herbicide used, and reduce the need for tillage operations close to the vine row, which may result in cut surface roots and injury to trunks. Frequently two or more herbicides must be combined to achieve adequate weed control. The weed species present will determine which herbicide combinations are needed. This may include more than one preemergence herbicide or, more frequently, a combination of preemergence and postemergence herbicides.

Preemergence herbicides
Preemergence herbicides are used to control weeds before they emerge, usually by affecting roots or shoots of very small seedlings. They can be applied in the fall after harvest, during the winter dormant period, or split into two applications: fall and either late-winter or early spring. Most preemergence herbicides must be incorporated into the soil and activated with water. The application should be made when rain is expected within 2–3 weeks of the application. Refer to the herbicide label for guidance on the length of time specific preemergence herbicides can remain on the soil surface before efficacy is reduced due to a lack of incorporation.

Postemergence herbicides
Postemergence herbicides control weeds already growing in the vineyard and should be applied whenever monitoring indicates a need. They may be combined with a fall or spring preemergence treatment or applied as spot treatments during the growing season. Control will be optimized when weeds are treated at a young age.

MONITORING

Several species of summer and winter annual, and perennial weeds can be found in California kiwifruit vineyards. The number and species of weeds vary from area to area, within a vineyard, and from year to year. Conduct weed surveys at least twice each year; once in late winter, again in late spring or summer, and/or following each weed management effort.

Use the Weed Gallery photos on the UC IPM website to help identifying weeds. Check the susceptibility charts to determine the herbicide(s) that give the best control.
Summer weed survey
A survey in summer will tell the spectrum of weeds present and help to determine the most effective control strategy by surveying the effectiveness of previous herbicide or cultivation practices.

Winter weed survey
By surveying weeds in late winter, it will be possible to identify any species that escaped control from earlier management. Surveying will help to determine if a change in herbicides or cultural methods is needed.

How to survey fields for summer and winter weeds:
- Survey the vineyard in late winter to identify winter annual weeds, and again in summer after perennial and summer annual weeds have germinated.
- If cultivation for weed control is used, monitor at least 2 weeks before planning to cultivate.
- Pay particular attention to perennial weeds. Sketch a diagram of the vineyard and mark areas where perennial weeds are found. A hand held GPS unit also works well for recording locations of perennial weeds. Check for re-growth of perennial weeds a few weeks after cultivation.
- Pay attention to low-lying areas or where water tends to accumulate. These are often problem areas for weed growth.
- Survey areas around the vineyards as potential sources for wind disseminated weed seeds such as horseweed, hairy fleabane etc.
- Keep records of survey results and control techniques (example form available online). By knowing what species are present, it will be possible to make appropriate decisions on cultural and chemical controls.

Information collected over a period of years can help to better understand ongoing weed control problems such as perennial weeds, herbicide resistance, shifts in the weed population, and the overall effectiveness of the selected weed management program.

WEED MANAGEMENT BEFORE PLANTING
An especially effective method of weed management before planting vines is to cultivate, irrigate to germinate new weeds, then cultivate again. This reduces the weed seed population in the soil, thus reducing weed emergence. At least two cycles of cultivating, irrigating, and cultivating again should be used to make marked reductions in weed seedlings. This method will effectively control annual weeds, but is not effective on perennial weeds if irrigation is used to keep soil moist.

To control perennial weeds such as dallisgrass, bermudagrass, and johnsongrass, cultivate dry soil to cut the rhizomes into small pieces and bring them to the surface to dry. Once desiccated, rework the soil to pull new rhizomes to the surface and dry them as well. If the soil is irrigated or rain occurs before complete control of the perennial plant is achieved, this practice will be only partially effective. Working wet soil can increase the population of these weeds, because plant fragments may re-root. After rhizomes, stolons, and other perennial weed parts have been destroyed, weed seedlings, emerging after irrigation or rainfall, should be destroyed immediately; otherwise these perennial weeds can quickly reestablish.

Herbicides
Currently, there are no preemergence herbicides registered for use in kiwifruit vineyards prior to planting. It is also safer for young vines to control perennial weeds with postemergence herbicides before planting, because preemergence herbicides can persist in the soil and negatively affect newly planted vines. Established perennial grass weeds can be controlled with glyphosate followed 2 to 3 weeks later with cultivation.

If the soil and plant material can be dried after treatment by withholding irrigation in summer, increased control is achieved. However, usually this is not feasible in winter due to rainfall. Field bindweed will be partially controlled with this method. Yellow nutsedge plants will be controlled, but new plants will emerge from underground tubers. In most cases, repeated treatments of perennial weeds may be required.

Alternatively, a fumigant, such as metam sodium (Vapam), can be used to control most annual and perennial weeds and many soilborne pests. Follow directions carefully in relation to soil moisture, timing, and method of application to achieve the best results.
WEED MANAGEMENT AFTER PLANTING

There are a number of ways that weeds growing at the base of the vines can be controlled, including mulching, various forms of cultivation, mowing, and herbicides.

Hoeing or using weed knives in the row and cultivating between the rows are cultural methods that must be performed frequently to reduce competition and to keep weeds from setting seed. If weeds are allowed to mature, not only do the plants often become a fire hazard, but more importantly, they produce enough seeds for many years of weeds.

When mulching, make sure the mulch does not harbor insects or disease organisms. Black polypropylene mulches are also available. These prevent germination and establishment of weed seedlings while allowing water to percolate through into the soil. Mulches work well in vineyards irrigated with low-volume emitters (drip and microsprinklers), but they are quite costly. To reduce costs, some growers install mulches only in a 2-x-2-foot or 3-x-3-foot area under the emitters.

Herbicides
Herbicides are commonly used to control weeds in a 4–6-foot-wide strip under the vine row. Removing weedy plants from around the base of the vine reduces weed competition and the potential for rodent damage.

Preemergence herbicides are the safest for use around established vines. Currently registered preemergence herbicides will control only seedlings of annual and some perennial weeds. Postemergence herbicides may be used either alone or combined with a preemergence herbicide to kill existing weeds and to provide residual control of new seedlings. Repeated spot applications of postemergence herbicides are often used to treat perennial weeds during the growing season. Be careful to prevent spraying the vines with postemergence herbicides, because injury can occur.
WEED MANAGEMENT IN ORGANIC KIWIFRUIT VINEYARDS (4/13)

It is especially important for organic vineyards to be as clean and weed-free as possible, since there are no organic herbicides with high efficacy available. Furthermore, weeds can serve as a host for pest and disease organisms and make an excellent habitat (especially grassy weeds) for destructive rodents. Perennial weeds cause the most problems, but some annual weeds, such as horseweed, which can grow among the vines to a height of six feet in one season, can be very troubling too.

Weed control in organically managed vineyards requires special attention to preventing weed problems before they start. Any method that reduces the amount of weed seed in the vineyard will diminish weed populations over time; therefore, one of the best ways to prevent weed problems is to control existing weeds before they go to seed. Cover crops or repeated mowing of weeds in row middles, coupled with mechanical control of weeds in the vine row, are key components of an organic weed management program.

Transitioning mature, full-canopied kiwifruit vines to organic production will require less intensive weed management than starting a new organic vineyard. Mature, shady vineyards often have limited weed growth when compared to newly planted vineyards, because the full vine canopy cover blocks sunlight for weed growth.

WEED MANAGEMENT BEFORE PLANTING

Weed management during the season before vines are planted is a critical practice for ensuring that young vines can become established with reduced competition from weeds. Two methods of managing weeds prior to planting are cultivation and soil solarization.

Cultivation
Repeated cycles of irrigation to germinate weeds, followed by cultivation to destroy young weeds, can reduce the amount of weed seed in vineyard soil. Do not work the soil when wet.

Cultivation works well with summer annuals but not as well with perennial weeds such as nutsedge, field bindweed, bermudagrass, and johnsongrass. If the site is not already certified organic, herbicides can be used until the transition time to organic begins, which can be very helpful in ridding the area of these hard-to-control perennial weeds as well as annual weeds.

Or, if most of the weed seeds on the site are located in the surface 4 inches of soil, a soil-inverting plow can be used to bury them so deeply that they cannot germinate. Use a soil-inverting plow such as a Kverneland plow, because a standard moldboard plow will not sufficiently invert the soil. Avoid additional deep tillage operations, because they may bring buried weed seeds back to the surface.

Soil solarization
Soil solarization can significantly reduce weed populations in the planned vine rows. Soil solarization traps the sun’s energy beneath a layer of clear plastic, increasing the temperature in the top 6 inches of soil to levels lethal to many weed seedlings as well as vegetative structures of perennial weeds. In areas like the Central Valley, soil solarization is used during summer months to heat the soil to more than 130°F at a 3-inch depth.

The effect of solarization diminishes at greater depths and it does not control perennials as well as annuals. Seedlings of perennial weeds such as bermudagrass, johnsongrass, and field bindweed are controlled, but not their belowground vegetative structures at deeper depths in the soil. Yellow nutsedge is partially controlled while purple nutsedge is usually not significantly affected by solarization.

Effective soil solarization begins with preparing a smooth seed bed so that the plastic can be placed in direct contact with the soil surface. Disc the field to break up clods, smooth the soil, and remove any material such as rocks and weeds that will puncture or raise the plastic sheets.

Irrigate the area to be solarized either before or after applying the plastic, because wet soil conducts heat better than dry soil. If irrigating before the plastic film is laid, first allow the soil to dry somewhat to avoid compaction by heavy equipment, then immediately cover the soil with plastic. Alternatively, a drip system or microsprinkler line (with only the spaghetti tubing) may be installed on the soil surface and covered with plastic sheets to allow irrigation after the plastic was placed. Furrow irrigation under the plastic is another option. (If the entire site is
irrigated, weed growth will occur in the unta rped centers and will be difficult to control without disturbing the plastic.)

Use clear plastic that is 1.5 to 2 mils thick and impregnated with UV inhibitors to prevent premature breakdown of the material. (Black plastic suppresses weed seed germination but will not heat the soil sufficiently for solarization. Black plastic can be used as a mulch to suppress nutsedge or common purslane after planting the vineyard.) Contact plastic suppliers well in advance so they can formulate plastic tailored to your needs.

Cover the planned vine row with plastic from 6 to 10 feet wide. The width depends on the management program planned for the row middles. Bury the sides of the plastic to create a seal on the soil; this also helps prevent the plastic from being blown away by wind. Machines that lay down the plastic are available to automate the process.

In the Central Valley, the plastic should be in place from June through August and can remain in place until planting begins. Solarization may not be as effective in cooler coastal areas. In these areas, apply plastic in August and September or May and June. Cultivate solarized soil less than 3 inches deep to avoid bringing viable weed seeds to the surface where they can germinate.

WEED MANAGEMENT AFTER PLANTING

Vine-Row Management
Manage weeds in the vine row with in-row cultivation, mowing, mulches, hand hoeing, or flaming. The choice of method depends in part on the type of irrigation system.

**Furrow-irrigated vineyards**
Furrow-irrigated vineyards are well suited for in-row cultivation. Cultivation is probably the most widely used method of weed control in organic systems. Other options include the use of organically approved herbicides, flaming, and the use of weeder geese.

**Microsprinkler-irrigated vineyards**
Few options are available in organic vineyards with microsprinklers. In-row cultivators may damage irrigation lines and emitters present on top of the soil surface. However, irrigation lines can be attached to the trellis with the microsprinklers facing upside down to allow for in-row mowing, cultivation, or flaming underneath. Hand hoeing, possibly flaming, organically approved herbicides, and weeder geese could also be used for weed management.

Plastic-coated cartons or wraps can help protect trunks of young vines from flame or herbicide injury; also keep flamers away from the plastic irrigation tubing. Mulches can suppress weed growth, but weeds that emerge through the mulch must be removed by hand hoeing or with organic herbicides.

**Drip-irrigated vineyards**
Weed control options for surface drip-irrigated vineyards are similar to those available for micro-sprinklers. However, if drip lines are suspended or subsurface drip irrigation is used, cultivation, mowing, flaming, or mulches can all be used.

Middles Management
Similar to many conventionally managed vineyards, weeds in the row middles of organic kiwifruit vineyards are commonly managed with cover crops, tillage, and mowing.

Consider planting a cover crop in the area between vine rows, because resident vegetation does not usually grow uniformly enough to compete well with newly invading weeds. In addition, resident vegetation includes weed species that can colonize the vine row. An annual cover crop that reseeds itself will compete against weeds and reduce the potential for problems in the future. Do not plant cover crops under vines because excess competition may occur, possibly reducing kiwifruit yields.

If there is a potential for frost and the cover crop is tall, mow once before the cover crop blooms to minimize frost damage; the cover crop will regrow and flower later in the season. However, the cover crop will be most competitive if mowing can be avoided. After most species in the cover crop have produced seed, mow or roll it with a ringroller. The ringroller will allow more seed production and also create a surface mulch that will help to prevent emergence of weed seedlings.
Cultivation
Mechanical cultivation uproots or buries weeds. Weed burial works best on small weeds, while larger weeds are better controlled by destroying the root-shoot connection or by slicing, cutting, or turning the soil to separate the root system from the soil. Keep cultivation shallow to minimize damage to crop roots and to avoid bringing more weed seeds near the surface where they can germinate.

Perennial weeds with established root systems are difficult to kill with a single tillage operation, because only the top of the plant is removed and established plants can often generate a new top using underground energy reserves. However, repeated cycles of tilling 3 or 4 inches deep and subsequent regrowth can reduce the plant’s stored reserves, and eventually suppression of these weeds can be achieved.

In-row cultivation
In-row cultivators are equipped with a sensor or trigger mechanism that pivots the cutting arm around the vine to minimize injury. Several companies make cultivation equipment; those that have performed well include equipment from Bezzerides, Kimco, and L&H Manufacturing.

In-row cultivation is amenable in furrow-irrigated vineyards. Some precautions to take with other irrigation systems include:
- In sprinkler-irrigated vineyards, take extra precautions to ensure proper operation of the trigger mechanism on the cultivator so that it moves away from the sprinkler head in the same way as it does from the vine.
- Protect microsprinkler irrigation lines and emitters from damage by suspending the surface lines in the vines or on stakes with the microsprinklers positioned upside down.
- Bury drip lines to avoid damage. This may also help to inhibit weed seed germination, as the top few inches of the soil will stay dry. This effect, however, will depend upon the depth of burial. Shallow drip-line burial that provides water to the top 3 inches of soil may not reduce weed emergence.

Mulches
Mulches can help with weed management in the organic vineyard by blocking light and preventing weed germination or growth. Many materials can be used as mulches including municipal yard waste, wood chips, straw, hay, sawdust, newspaper, and others approved for use in organic agriculture.

To be effective, mulches need to block all light to the weeds; therefore different mulch materials vary in the depth necessary to accomplish this. Mulches, such as yard waste, wood chips, straw, or hay must be maintained in a layer four or more inches thick. Organic mulches break down with time and the original thickness typically is reduced by 60% after one year. Thus, regular additions are needed to maintain weed control.

Another option is to combine weed control in the row middles with management efforts in the vine-row. This is known as “mow-and-throw”: cover crops grown in the row middles are mowed during the spring and placed into the vine row to serve as a mulch around the base of the vines. Weeds that emerge through the mulch can be controlled using an organic contact herbicide or with hand hoeing.

Organic Herbicides
Several approved contact herbicides are available to use in organically certified vineyards, but these materials are costly and tend to be less effective than synthetic herbicides. Check with the organic licensing organization to determine current status and any use restrictions for organically acceptable herbicides.

These oil-based products (clove oil = Matratec; clove oil + cinnamon oil = WeedZap; lemongrass oil = GreenMatch EX) damage green vegetation, including the leaves and young stems of kiwifruit vines. Apply these products directly to weed foliage.

Because these herbicides only kill contacted tissue, good coverage is essential and most effective control will be obtained when weeds are small. Best results have occurred when spray volumes are 60 gallons per acre or more and applications are made during warm, sunny conditions. Adding an organically acceptable adjuvant is also recommended. Because these materials lack residual activity, repeated applications will be needed to control each new flush of weeds.
Flaming
Flamers can be used for weed control in the vine row, with propane-fueled models being most common. Heat causes the cell sap of plants to rapidly expand, rupturing the cell walls. This process occurs in most plant tissues at about 130°F.

It is not necessary to “burn” the leaf tissue. After flaming, weeds that have been killed change from a glossy to a matte finish. This occurs very rapidly in most cases. Foliage that retains a thumbprint when pressure is applied between your thumb and finger has been adequately flamed.

Typically, flaming can be done at 3 to 5 mph through fields, although this depends on the heat output of the unit being used. Weeds should have less than four true leaves for greatest efficiency with flaming. Grasses are harder to kill than broadleaf weeds, because the growing point of grasses is at or below the ground. When flaming is used repeatedly, grasses will eventually dominate the vineyard, while perennial weeds such as field bindweed are suppressed.

Protect the trunks of young vines from flamers to avoid injury to the cambium layer, and keep flamers away from plastic irrigation tubing. Do not flame in vineyards with a lot of dried vegetation, in order to avoid fires that can injure vines and irrigations systems and spread beyond the boundaries of the vineyard.

Weeding animals
Before using any animals, check federal, state, and local food safety regulations and comply with them. Consult the following websites for further information on grazing animals:
- http://www.cnr.uidaho.edu/rx-grazing/index.htm
- http://extension.missouri.edu/p/G8922

Weeder geese
Geese can often be used to manage grass weeds in vineyards. Geese prefer grass species and will only eat other weeds and crops after the grasses are gone and they become hungry. If confined, they will even dig up and eat johnsongrass and bermudagrass rhizomes, which they have a particular preference for. Both of these weeds can be especially troublesome in vineyards.

Generally, about four geese per acre are needed. They require water for drinking, and some form of protection from predators (dogs, coyotes, etc.). Young geese are preferred, as they eat larger quantities of food, although having at least one older goose, helps to protect the younger birds.

Other animals
Sheep and goats are sometimes used in organic vineyards as well. Sheep will effectively remove all weeds down to ground level. Goats are browsers and must be carefully managed to avoid damage to the vines. Both sheep and goats are generally used during the time when vines are dormant and the chance of grazing damage is minimal.
SPECIAL WEED PROBLEMS (4/13)

Primary species that are difficult to control are the perennial grasses *bermudagrass*, *johnsongrass*, and *dallisgrass*. Control of these weed species before planting has been discussed under the preplant section. While it is best to control (eradicate) them before planting, if after planting these weeds are still present, a program is needed for their management.

All three species are sensitive to glyphosate. To achieve the best control, cultivate the weeds where possible to chop the stems and rhizomes into small pieces. Then encourage regrowth by irrigating; this will produce a lot of new leaf area on the weeds. Before the weeds produce flowers or seeds, treat with glyphosate and spot-treat any regrowth that occurs.

It will be necessary to control seedlings of these grasses with preemergence materials or spot treatments of glyphosate or paraquat before they become established. Seeds of these species last at least 2 years in the soil, so frequent monitoring is necessary for continued control. Do not allow perennial plants to reestablish or set seed.

Two other species difficult to control are *field bindweed* and *yellow nutsedge*. Seedling bindweed or young nutsedge can be controlled by cultivating when the soil is dry. Established populations of field bindweed can be reduced by irrigating in summer to encourage vigorous growth, then treating with glyphosate at flowering. This is a nonselective treatment and will kill other weeds as well. Regrowth will also have to be treated.

Yellow nutsedge can be reduced in a similar manner by re-treating with glyphosate before the nutsedge reaches the five-leaf stage so new tubers do not have the opportunity to form. To be effective, this treatment usually requires multiple applications during the season at intervals of 21 to 28 days apart. It may take two or more seasons of repeated timely treatments to eradicate yellow nutsedge.

Young kiwifruit vines can be injured by glyphosate. Protect green wood or the foliage of young vines by using:
- plastic-coated grow tubes or wrappers
- a shielded or hooded sprayer
- drift-reducing spray nozzles
### COMMON AND SCIENTIFIC NAMES OF WEEDS (4/13)

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley, hare</td>
<td>Hordeum murinum ssp. leporinum</td>
</tr>
<tr>
<td>Barnyardgrass</td>
<td>Echinochloa crus-galli</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>Cynodon dactylon</td>
</tr>
<tr>
<td>Bindweed, field</td>
<td>Convolvulus arvensis</td>
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<tr>
<td>Bluegrass, annual</td>
<td>Poa annua</td>
</tr>
<tr>
<td>Bromegrasses</td>
<td>Bromus spp.</td>
</tr>
<tr>
<td>Bermuda, California</td>
<td>Medicago polymorpha</td>
</tr>
<tr>
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<td>Phalaris canariensis</td>
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<tr>
<td>Chickweed, common</td>
<td>Stellaria media</td>
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<tr>
<td>Clover, white</td>
<td>Trifolium repens</td>
</tr>
<tr>
<td>Cockleburs</td>
<td>Xanthium spp.</td>
</tr>
<tr>
<td>Crabgrass, large</td>
<td>Digitaria sanguinalis</td>
</tr>
<tr>
<td>Cudweeds</td>
<td>Gnaphalium spp.</td>
</tr>
<tr>
<td>Dallisgrass</td>
<td>Paspalum dilatatum</td>
</tr>
<tr>
<td>Dandelion</td>
<td>Taraxacum officinale</td>
</tr>
<tr>
<td>Fescues</td>
<td>Festuca spp.</td>
</tr>
<tr>
<td>Fiddlenecks</td>
<td>Amsinckia spp.</td>
</tr>
<tr>
<td>Filarees</td>
<td>Erodium spp.</td>
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<tr>
<td>Fleabane, hairy</td>
<td>Conyza bonariensis</td>
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<tr>
<td>Foxtails</td>
<td>Setaria spp.</td>
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<tr>
<td>Goosefoot, nettleleaf</td>
<td>Chenopodium murale</td>
</tr>
<tr>
<td>Groundcherties</td>
<td>Physalis spp.</td>
</tr>
<tr>
<td>Groundsel, common</td>
<td>Senecio vulgaris</td>
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<tr>
<td>Henbit</td>
<td>Lamium amplexicaule</td>
</tr>
<tr>
<td>Horseweed</td>
<td>Conyza canadensis</td>
</tr>
<tr>
<td>Johnson grass</td>
<td>Sorghum halepense</td>
</tr>
<tr>
<td>Knotweed, common</td>
<td>Polygonum arenastrum</td>
</tr>
<tr>
<td>Lambsquarters, common</td>
<td>Chenopodium album</td>
</tr>
<tr>
<td>Lettuce, prickly</td>
<td>Lactuca serriola</td>
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<tr>
<td>Lovegrasses</td>
<td>Eragrostis spp.</td>
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<tr>
<td>Mallow, little (cheeseweed)</td>
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<td>Nettles</td>
<td>Urtica spp.</td>
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<tr>
<td>Nightshades</td>
<td>Solanum spp.</td>
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<tr>
<td>Nutsedge, yellow</td>
<td>Cyperus esculentus</td>
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<tr>
<td>Oat, wild</td>
<td>Avena fatua</td>
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<tr>
<td>Pigweeds</td>
<td>Amaranthus ssp.</td>
</tr>
<tr>
<td>Pineappleweed</td>
<td>Chamomilla suaveolens</td>
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<tr>
<td>Polypogon, rabbitfoot</td>
<td>Polypogon monspeliensis</td>
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<tr>
<td>Puncture vine</td>
<td>Tribulus terrestris</td>
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<tr>
<td>Purslane, common</td>
<td>Portulaca oleracea</td>
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<td>Raphanus raphanistrum</td>
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<tr>
<td>Redmaids (desert rockpurslane)</td>
<td>Calandrinia ciliata</td>
</tr>
<tr>
<td>Rocket, London</td>
<td>Sisymbrium irio</td>
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(continued next page)
<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
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<tbody>
<tr>
<td>Ryegrass, Italian</td>
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<td>Sonchus spp.</td>
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<td>Speedwells</td>
<td>Veronica spp.</td>
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<td>Spurges</td>
<td>Euphorbia spp.</td>
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<td>Thistle, Russian</td>
<td>Salsola tragus</td>
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<tr>
<td>Witchgrass</td>
<td>Panicum capillare</td>
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# SUSCEPTIBILITY OF WINTER WEEDS IN KIWIFRUIT TO HERBICIDE CONTROL

(4/13)

<table>
<thead>
<tr>
<th>ANNUAL WEEDS</th>
<th>PREEMERGENCE</th>
<th>POSTEMERGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISO¹</td>
<td>NAP</td>
</tr>
<tr>
<td>Barley, hare</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>Bluegrass, annual</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>Bromegrasses</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>Burclover, California</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Canarygrass</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>Chickweed, common</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Cudweeds</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Fiddlenecks</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Filarees</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Groundsel, common</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Henbit</td>
<td>C</td>
<td>P</td>
</tr>
<tr>
<td>Mallow, little (cheeseweed)</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Miner’s lettuce</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Mustards</td>
<td>C</td>
<td>P</td>
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<td>Nettles</td>
<td>C</td>
<td>P</td>
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<td>Oat, wild</td>
<td>N</td>
<td>C</td>
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<td>Pineapple-weed</td>
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<td>Polypogon, rabbitfoot</td>
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<td>Radish, wild</td>
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<td>Redmaids (desert rockpurslane)</td>
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<td>Rocket, London</td>
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<td>Ryegrass, Italian</td>
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<td>Shepherd’s-purse</td>
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<td>N</td>
</tr>
<tr>
<td>Sowthistles</td>
<td>C</td>
<td>N</td>
</tr>
</tbody>
</table>

GLY = glyphosate (Roundup)
ORY = oryzalin (Surflan)
ISO = isoxaben1 (Trellis)
OXY = oxyfluorfen (Goal)
NAP = napropamide (Devrinol)
PAR* = paraquat* (Gramoxone SL 2.0)

C = control
P = partial control
N = no control

¹ = nonbearing only
*Permit required from county agricultural commissioner for purchase or use.
# Susceptibility of Spring & Summer Weeds in Kiwifruit to Herbicide Control

## Annual Weeds

<table>
<thead>
<tr>
<th></th>
<th>PREEMERGENCE</th>
<th>POSTEMERGENCE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ISO¹ NAP ORY OXY</td>
<td>GLY OXY PAR* OXY</td>
</tr>
<tr>
<td>Barnyardgrass</td>
<td>N C C P C</td>
<td>C N P C C C</td>
</tr>
<tr>
<td>Cockleburs</td>
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<td>C C C C C C</td>
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<tr>
<td>Crabgrass</td>
<td>N C C P C</td>
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<tr>
<td>Cudweeds</td>
<td>C C N N P P</td>
<td>P P N P P P</td>
</tr>
<tr>
<td>Dandelion</td>
<td>N C C P P P</td>
<td>C N C C C P</td>
</tr>
<tr>
<td>Foxtails</td>
<td>N C C N C</td>
<td>C N C C C C</td>
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<td>Goosefoot, nettleleaf</td>
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<td>C P C C C C</td>
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<tr>
<td>knotweed, common</td>
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<td>C P P P P C</td>
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<td>Lambquarters, common</td>
<td>C C C C C C</td>
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</tr>
<tr>
<td>Lettuce, prickly</td>
<td>C C N C C</td>
<td>C C C C C C</td>
</tr>
<tr>
<td>Lovegrasses</td>
<td>N C C P P P</td>
<td>C N C C C P</td>
</tr>
<tr>
<td>Mallow, little (cheeseweed)</td>
<td>C C N C C</td>
<td>P C N P C C</td>
</tr>
<tr>
<td>Nettles</td>
<td>C P P C P</td>
<td>C P C C C P</td>
</tr>
<tr>
<td>Nightshades</td>
<td>P N N C C</td>
<td>C C C C C C</td>
</tr>
<tr>
<td>Pigweeds</td>
<td>C C C C C</td>
<td>C C C C C C</td>
</tr>
<tr>
<td>Polypogon, rabbitfoot</td>
<td>N C C P P P</td>
<td>C N C C C P</td>
</tr>
<tr>
<td>Puncreavenine</td>
<td>P P P P P P</td>
<td>C P C C C P</td>
</tr>
<tr>
<td>Purslane, common</td>
<td>C C C C C C</td>
<td>C C C C C C</td>
</tr>
<tr>
<td>Sandburrs</td>
<td>N C C N C</td>
<td>C N P C C C</td>
</tr>
<tr>
<td>Sowthistles</td>
<td>C C N C C</td>
<td>C C C C C C</td>
</tr>
<tr>
<td>Speedwells</td>
<td>C C P C P P</td>
<td>C P C C C P</td>
</tr>
<tr>
<td>Spurges</td>
<td>C N P P P P</td>
<td>C P C C C P</td>
</tr>
<tr>
<td>Thistle, Russian</td>
<td>C P P P P P</td>
<td>C P P C C P</td>
</tr>
<tr>
<td>Witchgrass</td>
<td>N C C P P P</td>
<td>C N C C C P</td>
</tr>
</tbody>
</table>

## Perennial Seedlings

<table>
<thead>
<tr>
<th></th>
<th>PREEMERGENCE</th>
<th>POSTEMERGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISO¹ NAP ORY OXY</td>
<td>GLY OXY PAR* OXY</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>N C C N C</td>
<td>C P C C C C</td>
</tr>
<tr>
<td>Bindweed, field</td>
<td>P N C C C C</td>
<td>C C C C C C</td>
</tr>
<tr>
<td>Dallisgrass</td>
<td>N P C N C</td>
<td>C N C C C C</td>
</tr>
<tr>
<td>Dandelion</td>
<td>C C N C —</td>
<td>C C N — C —</td>
</tr>
<tr>
<td>Jonsongrass</td>
<td>N P P N P P</td>
<td>C N C C C P</td>
</tr>
</tbody>
</table>

## Established Perennials

<table>
<thead>
<tr>
<th></th>
<th>PREEMERGENCE</th>
<th>POSTEMERGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISO¹ NAP ORY OXY</td>
<td>GLY OXY PAR* OXY</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>N N N N N N</td>
<td>N N P P P N</td>
</tr>
<tr>
<td>Bindweed, field</td>
<td>N N P N P P</td>
<td>P N P P P P</td>
</tr>
<tr>
<td>Clover, white</td>
<td>N N N N N N</td>
<td>P N N P P N</td>
</tr>
<tr>
<td>Dandelion</td>
<td>N N N N N N</td>
<td>P N N P P N</td>
</tr>
<tr>
<td>Jonsongrass</td>
<td>N N N N —</td>
<td>P N N — — —</td>
</tr>
<tr>
<td>Nutsedge, yellow</td>
<td>N N N N N N</td>
<td>P N N P P N</td>
</tr>
</tbody>
</table>

GLY = glyphosate (Roundup)  
ORY = oryzalin (Surflan)  
ISO = isoxaben (Trellis)  
OXY = oxyfluorfen (Goal)  
NAP = napropamide (Devrinol)  
PAR = paraquat (Gramoxone SL 2.0)
### Susceptibility of Spring & Summer Weeds to Herbicide Control

<table>
<thead>
<tr>
<th>PREEMERGENCE</th>
<th>POSTEMERGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO¹</td>
<td>NAP</td>
</tr>
</tbody>
</table>
| C = control | P = partial control | N = no control | — = no information | ¹ Nonbearing only | * Permit required from county agricultural commissioner for purchase or use.
**HERBICIDE TREATMENT TABLE** (6/16)

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount per acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UPDATED 6/16</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The following are listed alphabetically. When choosing a pesticide, consider information relating to environmental impact, resistance management, the pesticide’s properties, and application timing. Not all registered pesticides are listed. Always read the label of the product being used.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PREPLANT**

*Before weeds emerge*

A. **METAM SODIUM** *(Vapam HL)*  
   **COMMENTS:** For spot treatment of certain perennial weeds.
   
   **Label rates**  
   See label  
   **NA**

*After weeds emerge*

A. **GLYPHOSATE** *(Roundup WeatherMax)*  
   **WSSA MODE-OF-ACTION GROUP NUMBER‡: 9**  
   **COMMENTS:** Apply in controlled droplet application or with low-pressure flat fan nozzles. For annual weed control use 10 to 40 gal water/acre with 1 lb/acre. Apply to young annuals or vigorously growing perennials in the early flowering stage or to nutsedge when it has 5 to 6 leaves. Some perennial weeds require the 3.7 lb a.e./acre rate for control. Adding sprayable ammonium sulfate at 5 to 10 lb/100 gal of spray solution before the glyphosate is added can often improve control.
   
   **Amount per acre**  
   0.38–3.7 lb a.e.  
   **4**  
   **NA**

   *(Roundup PowerMax)*
   **Amount per acre**  
   0.675–6.57 pt  
   0.55–5.38 pt

**POSTPLANT**

*Before weeds emerge*

A. **ISOXABEN** *(Trellis)*  
   **WSSA MODE-OF-ACTION GROUP NUMBER‡: 21**  
   **COMMENTS:** For use in nonbearing vineyards only. Apply in 20 to 60 gal water/acre. Requires rainfall or irrigation within 21 days of herbicide application to activate. May be combined with postemergence herbicides if seedlings have emerged. Combine with oryzalin if annual grasses are expected.
   
   **Amount per acre**  
   0.5–1.0 lb a.i.  
   **12**  
   **365**

   *(Devrinol 50DF)*
   **Amount per acre**  
   4 lb a.i.  
   **24**  
   **35**

B. **NAPROPAMIDE** *(Devrinol 50DF)*  
   **WSSA MODE-OF-ACTION GROUP NUMBER‡: 15**  
   **COMMENTS:** Apply in 20 to 60 gal water/acre. Must be incorporated within 4 to 7 days of application or sprinkler irrigated. Can be combined with a postemergence herbicide if weeds have emerged.
   
   **Amount per acre**  
   8 lb  
   **WSSA MODE-OF-ACTION GROUP NUMBER‡: 15**  
   **COMMENTS:** Apply in 20 to 60 gal water/acre. Must be incorporated within 4 to 7 days of application or sprinkler irrigated. Can be combined with a postemergence herbicide if weeds have emerged. Most applications are with the 4 lb a.i./acre rate to give maximum residual.
   
   **Amount per acre**  
   4 lb a.i.  
   **24**  
   **0**

C. **ORYZALIN** *(Surflan A.S.)*  
   **WSSA MODE-OF-ACTION GROUP NUMBER‡: 3**  
   **COMMENTS:** Apply in 20 to 60 gal water/acre. If rain does not occur within 21 days, sprinkle irrigate with 0.5 to 2 inches water. May be combined with postemergence herbicide if weeds have emerged. Most applications are with the 4 lb a.i./acre rate to give maximum residual.
   
   **Amount per acre**  
   2–4 lb a.i.  
   **24**  
   **0**

D. **OXYFLUORFEN** *(Goal 2XL)*  
   **WSSA MODE-OF-ACTION GROUP NUMBER‡: 14**  
   **COMMENTS:** Apply in 20 to 60 gal water/acre on firm soil. Must not be mechanically disturbed or poor weed control will result. May be used preemergence or early postemergence. Often is combined with oryzalin or glyphosate. The 1 lb a.i./acre rate gives minimal residual control but is combined with glyphosate to increase spectrum of annual weeds controlled. For use during the dormant season only (before February 15). Do not apply to kiwifruit established less than three years unless vines are on a trellis wire a minimum of 3 ft above the soil surface.
   
   **Amount per acre**  
   1.25–2 lb a.i.  
   **24**  
   **0**

*After weeds emerge*

A. **GLYPHOSATE**  
   **Amount per acre**  
   0.38–3.7 lb a.e.  
   **4**  
   **14**
### Herbicide Treatment Table

#### A. Roundup WeatherMax
- **Concentration**: 0.675–6.57 pt
- **Concentration**: 0.55–5.38 pt

**WSSA MODE-OF-ACTION GROUP NUMBER**: 9

**COMMENTS**: Apply in controlled droplet application or with low-pressure flat fan nozzles. For annual weed control use 10 to 40 gal water/acre with 1 lb a.e./acre. Apply to young annuals or vigorously growing perennials in the early flowering stage or to nutsedge when it has 5 to 6 leaves. Some perennial weeds require the 3.7 lb a.e./acre rate for control.

#### B. PARAQUAT*
- **Concentration**: 0.64–1 lb a.i.
- **Concentration**: 2.5–4.0 pt

**WSSA MODE-OF-ACTION GROUP NUMBER**: 22

**COMMENTS**: Apply in 30 to 60 gal water/acre to young plants. Thorough wetting of the weed foliage is essential for control. Use a 0.5% nonionic surfactant. Repeat herbicide application as new growth occurs. Do not apply this herbicide more than three times per year. Note: 12 hour REI is for dormant applications only, all other uses require a 24 hour REI.

### Herbicide Combinations

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

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

1 Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode of action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://wssa.net.

NA Not applicable
PRECAUTIONS FOR USING PESTICIDES

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

Legal Responsibility

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

Transportation

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

Storage

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

Container Disposal

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

Protection of Nonpest Animals and Plants

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

Posting Treated Fields

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

Preharvest Intervals

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

Permit Requirements

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

Processed Crops

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

Crop Injury

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

Personal Safety

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