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An illustrated version of this guideline is available online at http://ipm.ucanr.edu/PMG/selectnewpest.small-grains.html

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

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

To be used with UC ANR Publication 3333,
Integrated Pest Management for Small Grains
General Information

DEVELOPMENTAL GROWTH STAGES (2/07)

<table>
<thead>
<tr>
<th>Growth stages</th>
<th>Emergence</th>
<th>One-leaf</th>
<th>Two-leaf</th>
<th>Three-leaf</th>
<th>Tillering begins</th>
<th>Well-tillered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feekes</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growth stages</th>
<th>Jointing begins</th>
<th>Last leaf just visible</th>
<th>Early boot</th>
<th>Heading begins</th>
<th>Heading complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feekes</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>10.1</td>
<td>10.5</td>
</tr>
</tbody>
</table>
### Relative Toxicities of Insecticides and Miticides Used in Small Grains to Natural Enemies and Honey Bees

<table>
<thead>
<tr>
<th>Common name</th>
<th>Mode of action</th>
<th>Selectivity</th>
<th>Predatory mites</th>
<th>General predators</th>
<th>Parasites</th>
<th>Honey bees</th>
<th>Duration of impact to natural enemies</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>none</td>
</tr>
<tr>
<td>dimethoate (EC)</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate to long</td>
</tr>
<tr>
<td>malathion (EC)</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>short to moderate</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, toxicities 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 ratings](http://www.ipm.ucanr.edu/beeprecaution/).

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

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 Small Grains (2/09)

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Chemical class</th>
<th>Activity</th>
<th>Mode-of-action group no.</th>
<th>Resistance potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>azauxystrobin (Quadris)</td>
<td>QoI²</td>
<td>systemic</td>
<td>11 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>carboxin (Vitavax)</td>
<td>carboxamide</td>
<td>systemic (local)</td>
<td>7 (multi-site)</td>
<td>low</td>
</tr>
<tr>
<td>difenoconazole (Dividend)</td>
<td>DMI³-triazole</td>
<td>systemic (local)</td>
<td>3 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>mancozeb (Dithane)</td>
<td>carbamate (EBDC)⁴</td>
<td>contact</td>
<td>M2 (multi-site)</td>
<td>low</td>
</tr>
<tr>
<td>PCNB</td>
<td>aromatic hydrocarbon</td>
<td>systemic (slight)</td>
<td>14 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>propiconazole (Tilt)</td>
<td>DMI³-triazole</td>
<td>systemic (local)</td>
<td>3 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>pyraclostrobin (Headline)</td>
<td>QoI²</td>
<td>systemic</td>
<td>11 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>tebuconazole (Raxil)</td>
<td>DMI³-triazole</td>
<td>systemic (local)</td>
<td>3 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>thiram</td>
<td>dithiocarbamates</td>
<td>—</td>
<td>M2 (multi-site)</td>
<td>low</td>
</tr>
<tr>
<td>triadimenol (Baytan)</td>
<td>DMI³-triazole</td>
<td>systemic (local)</td>
<td>3 (single-site)</td>
<td>high</td>
</tr>
<tr>
<td>trifloxystrobin/propiconazole</td>
<td>QoI/DMI³-triazole</td>
<td>systemic</td>
<td>11/3 (multi/single-site)</td>
<td>high</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 a fungicide with a different mode-of-action group number.

² QoI = quinone outside inhibitor (strobilurin)

³ DMI = demethylation (sterol) inhibitor

⁴ EBDC = ethylene bisdithiocarbamate

— = unknown

Acknowledgment: This information was adapted from the Fungicide Resistance Action Committee website (http://frac.info).
## Cultivar Characteristics

CHARACTERISTICS OF BARLEY CULTIVARS GROWN IN CALIFORNIA  

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Type</th>
<th>Growth habit</th>
<th>Maturity</th>
<th>Plant height</th>
<th>Straw strength</th>
<th>Planting date: growing areas</th>
<th>Disease Susceptibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Metcalfe</td>
<td>2-row malt</td>
<td>Spring</td>
<td>Medium late</td>
<td>T</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>R, S, S, MR, S</td>
</tr>
<tr>
<td>Baronesse</td>
<td>2-row feed</td>
<td>Spring</td>
<td>Medium late</td>
<td>M</td>
<td>Poor</td>
<td>Spring: 5</td>
<td>S, S, MS, MS, S, MR</td>
</tr>
<tr>
<td>CDC Copeland</td>
<td>2-row malt</td>
<td>Spring</td>
<td>Medium late</td>
<td>T</td>
<td>Good</td>
<td>Spring: 5</td>
<td>MS, S, S, MR, —</td>
</tr>
<tr>
<td>Commander</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Medium late</td>
<td>M/S</td>
<td>Fair</td>
<td>Late Fall: 1, 2, 3, 4</td>
<td>S, S, S, S, S, MS</td>
</tr>
<tr>
<td>Eight-Twelve</td>
<td>6-row feed</td>
<td>Winter</td>
<td>Medium</td>
<td>M/S</td>
<td>Fair</td>
<td>Fall: 5</td>
<td>S, S, S, S, MS</td>
</tr>
<tr>
<td>Ishi</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Medium late</td>
<td>M/T</td>
<td>Fair</td>
<td>Late Fall: 1, 2, 3</td>
<td>MR, MS, R, MS, R, MR</td>
</tr>
<tr>
<td>Maja</td>
<td>6-row feed</td>
<td>Winter</td>
<td>Medium</td>
<td>M</td>
<td>Fair</td>
<td>Fall: 5</td>
<td>R, S, S, —</td>
</tr>
<tr>
<td>Melian</td>
<td>2-row feed</td>
<td>Spring</td>
<td>Late</td>
<td>M/S</td>
<td>Fair</td>
<td>Late Fall: 1, 2, 3</td>
<td>MS, R, S, S, R, S</td>
</tr>
<tr>
<td>Millennium</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Early</td>
<td>M</td>
<td>Good</td>
<td>Spring: 5</td>
<td>S, —, S, S, —, MS, S</td>
</tr>
<tr>
<td>Solar</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Early</td>
<td>T</td>
<td>Good</td>
<td>Late Fall: 2, 3</td>
<td>S, S, S, —, —, MS, S</td>
</tr>
<tr>
<td>Steptoe</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Early</td>
<td>M/T</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>S, MS, MS, S, S, MR</td>
</tr>
<tr>
<td>Strider</td>
<td>6-row feed</td>
<td>Winter</td>
<td>Medium early</td>
<td>M/S</td>
<td>Fair</td>
<td>Fall: 5</td>
<td>R, —, MS, MS, —, MS</td>
</tr>
<tr>
<td>Tamalpais</td>
<td>6-row feed/food (hulless)</td>
<td>Spring</td>
<td>Medium</td>
<td>M/S</td>
<td>Good</td>
<td>Late Fall: 1, 2, 3</td>
<td>MS, R, MR, MR, R, MR</td>
</tr>
<tr>
<td>UC 603</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Early</td>
<td>M/S</td>
<td>Excellent</td>
<td>Late Fall: 1, 2, 3</td>
<td>MS, MS, MR, S, MR, MR</td>
</tr>
<tr>
<td>UC 933</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Medium early</td>
<td>M</td>
<td>Fair</td>
<td>Late Fall: 1, 2, 3</td>
<td>R, S, R, R, MR, MR</td>
</tr>
<tr>
<td>UC 960</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Early</td>
<td>S</td>
<td>Excellent</td>
<td>Spring: 5</td>
<td>R, MR, MR, MR, —, MR</td>
</tr>
<tr>
<td>UC 969</td>
<td>6-row feed</td>
<td>Spring</td>
<td>Early</td>
<td>T</td>
<td>Good</td>
<td>Late Fall: 1, 2, 3</td>
<td>MS, MR, MR, MR, MR</td>
</tr>
<tr>
<td>WB-Champion</td>
<td>2-row feed</td>
<td>Spring</td>
<td>Medium</td>
<td>M</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>S, —, —, —, —, —</td>
</tr>
</tbody>
</table>

1 Plant Height: T = tall; M = medium; S = short

2 Growing Areas: 1 = Sacramento Valley and Delta; 2 = San Joaquin Valley; 3 = coastal; 4 = southern desert valleys; 5 = intermountain area

3 Disease Reactions: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; — = no information
CHARACTERISTICS OF OAT CULTIVARS GROWN IN CALIFORNIA  

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Maturity</th>
<th>Plant height</th>
<th>Stem fineness</th>
<th>Straw strength</th>
<th>Planting date: growing areas¹</th>
<th>Susceptibilities²</th>
</tr>
</thead>
</table>
| Bates 89     | Late     | Tall         | Fine          | Fair          | Fall: 1,2,3,4               | Stem rust  
Powdery mildew  
Barley root knot nematode  
Barley yellow dwarf  
Stem and bulb nematode |
| Everleaf 114 | Late     | Tall         | —             | Good          | Fall: 1,2,3,4               | —               |
| Kanota       | Early    | Tall         | Fine          | Poor          | Fall: 1,2,3,4               | S               |
| Montezuma    | Early    | Medium       | Fine          | Poor          | Fall: 1,2,3,4               | S               |
| Sierra       | Medium   | Tall         | Coarse        | Fair          | Fall: 1,2,3,4               | S               |
| UC 113       | Late     | Short        | Medium        | Excellent     | Fall: 1,2,3,4; Spring: 5    | R               |
| UC 125       | Late     | Short        | Medium        | Excellent     | Fall: 1,2,3,4; Spring: 5    | R               |
| UC 128       | Late     | Very tall    | Medium        | Excellent     | Fall: 1,2,3,4; Spring: 5    | MR              |
| UC 129 (“Mac”) | Late   | Very tall    | Medium        | Excellent     | Fall: 1,2,3,4; Spring: 5    | MR              |
| UC 130       | Late     | Short        | Medium        | Very good     | Fall: 1,2,3,4; Spring: 5    | MR              |
| UC 132       | Medium   | Very short   | Medium        | Excellent     | Fall: 1,2,3,4; Spring: 5    | S               |
| UC 142 (“Howard”) | Medium early | Short | Fine       | Good          | Fall: 1,2,3,4; Spring: 5    | R               |
| UC 148       | Medium   | Tall         | Medium        | Good          | Fall: 1,2,3,4; Spring: 5    | S               |

¹ Growing Region: 1 = Sacramento Valley and Delta; 2 = San Joaquin Valley; 3 = coastal; 4 = southern desert valleys; 5 = intermountain area

² Disease Reactions: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; — = no information
## CHARACTERISTICS OF WHEAT AND TRITICALE CULTIVARS GROWN IN CALIFORNIA

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Type</th>
<th>Maturity</th>
<th>Straw strength</th>
<th>Planting date: growing areas</th>
<th>DISEASE SUSCEPTIBILITIES&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Septoria tritici blotch</td>
</tr>
<tr>
<td>WHEAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alpowa</td>
<td>SWS</td>
<td>Medium late</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>MS</td>
</tr>
<tr>
<td>Alturas</td>
<td>SWS</td>
<td>Medium</td>
<td>Good</td>
<td>Spring: 5</td>
<td>---</td>
</tr>
<tr>
<td>Blanca Fuerte</td>
<td>HW</td>
<td>Medium</td>
<td>Good</td>
<td>Late Fall: 1,2,3,4</td>
<td>MS</td>
</tr>
<tr>
<td>Blanca Grande 515</td>
<td>HW</td>
<td>Medium early</td>
<td>Fair</td>
<td>Late Fall: 1,2,3,4</td>
<td>S</td>
</tr>
<tr>
<td>Blanca Royale</td>
<td>HW</td>
<td>Medium early</td>
<td>Good</td>
<td>Late Fall: 1,2,3</td>
<td>MR</td>
</tr>
<tr>
<td>Brundage 96</td>
<td>SWW</td>
<td>Medium early</td>
<td>Good</td>
<td>Fall: 5</td>
<td>S</td>
</tr>
<tr>
<td>Bruneau</td>
<td>SWW</td>
<td>Medium late</td>
<td>Fair</td>
<td>Fall: 5</td>
<td>---</td>
</tr>
<tr>
<td>Cal Rojo</td>
<td>HRS</td>
<td>Medium early</td>
<td>Excellent</td>
<td>Late Fall: 1,2,3,4</td>
<td>MR</td>
</tr>
<tr>
<td>Clear White</td>
<td>HW</td>
<td>Medium</td>
<td>Good</td>
<td>Late Fall: 1,2,3,4; Spring 5</td>
<td>S</td>
</tr>
<tr>
<td>Crown</td>
<td>D</td>
<td>Medium</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>MS</td>
</tr>
<tr>
<td>Desert King</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>R</td>
</tr>
<tr>
<td>Desert King HP</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 1,2,3,4</td>
<td>R</td>
</tr>
<tr>
<td>Duraking</td>
<td>D</td>
<td>Medium</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>MS</td>
</tr>
<tr>
<td>Expresso</td>
<td>HRS</td>
<td>Medium early</td>
<td>Fair</td>
<td>Late Fall: 1,2,3,4; Spring 5</td>
<td>MR</td>
</tr>
<tr>
<td>Fortissimo</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>R</td>
</tr>
<tr>
<td>Goetze</td>
<td>SWW</td>
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<td>Good</td>
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<td>MR</td>
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<tr>
<td>Hank</td>
<td>HRS</td>
<td>Medium early</td>
<td>Excellent</td>
<td>Spring: 5</td>
<td>---</td>
</tr>
<tr>
<td>Havasu</td>
<td>D</td>
<td>Medium early</td>
<td>Fair</td>
<td>Late Fall: 4</td>
<td>---</td>
</tr>
<tr>
<td>Joaquin</td>
<td>HRS</td>
<td>Medium early</td>
<td>Fair</td>
<td>Late Fall: 2,3,4</td>
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<tr>
<td>Kronos</td>
<td>D</td>
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<td>Poor</td>
<td>Late Fall: 2,4</td>
<td>S</td>
</tr>
<tr>
<td>Lariat</td>
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<tr>
<td>Lassik</td>
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<tr>
<td>Maestrale</td>
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<td>R</td>
</tr>
<tr>
<td>Malbec</td>
<td>HRS</td>
<td>Medium</td>
<td>---</td>
<td>Spring: 5</td>
<td>---</td>
</tr>
<tr>
<td>Mika</td>
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<td>Poor</td>
<td>Late Fall: 1,2,3,4</td>
<td>S</td>
</tr>
<tr>
<td>New Dirkwin</td>
<td>SWS</td>
<td>Late</td>
<td>Fair – Poor</td>
<td>Late Fall: 1,2,3,4</td>
<td>MS</td>
</tr>
<tr>
<td>Nick</td>
<td>SWS</td>
<td>Medium early</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>---</td>
</tr>
<tr>
<td>Normanno</td>
<td>D</td>
<td>Late</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>---</td>
</tr>
<tr>
<td>Orita</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 4</td>
<td>R</td>
</tr>
<tr>
<td>Patwin</td>
<td>HW</td>
<td>Medium late</td>
<td>Excellent</td>
<td>Late Fall: 1,2,3,4</td>
<td>MR</td>
</tr>
<tr>
<td>Patwin 515</td>
<td>HW</td>
<td>Medium late</td>
<td>Excellent</td>
<td>Late Fall: 1,2,3,4</td>
<td>MR</td>
</tr>
<tr>
<td>Platinum</td>
<td>D</td>
<td>Medium early</td>
<td>Fair</td>
<td>Late Fall: 2,4</td>
<td>R</td>
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<tr>
<td>Cultivar</td>
<td>Type1</td>
<td>Maturity</td>
<td>Straw strength</td>
<td>Planting date: growing areas2</td>
<td>Septoria tritici blotch</td>
</tr>
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<td>-------------</td>
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</tr>
<tr>
<td>PR 1404</td>
<td>HRS (forage)</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall; 1,2,3</td>
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<tr>
<td>Q-Max</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>R</td>
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<tr>
<td>Redwing</td>
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<td>Good</td>
<td>Late Fall: 1,2,3,4</td>
<td>MR</td>
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<tr>
<td>RSI 59</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 4</td>
<td>R</td>
</tr>
<tr>
<td>Saragolla</td>
<td>D</td>
<td>Medium late</td>
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<td>Late Fall: 2,4</td>
<td>R</td>
</tr>
<tr>
<td>Skiles</td>
<td>SWW</td>
<td>Medium</td>
<td>Good</td>
<td>Fall: 5</td>
<td>S</td>
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<tr>
<td>Stephens</td>
<td>SWW</td>
<td>Medium early</td>
<td>Fair</td>
<td>Fall: 5</td>
<td>S</td>
</tr>
<tr>
<td>Summit 515</td>
<td>HRS</td>
<td>Medium early</td>
<td>Good</td>
<td>Late Fall: 1,2,3,4</td>
<td>S</td>
</tr>
<tr>
<td>Tango</td>
<td>D</td>
<td>Medium early</td>
<td>Excellent</td>
<td>Late Fall: 2,4</td>
<td>—</td>
</tr>
<tr>
<td>Tipai</td>
<td>D</td>
<td>Medium late</td>
<td>Fair</td>
<td>Late Fall: 4</td>
<td>—</td>
</tr>
<tr>
<td>Topper</td>
<td>D</td>
<td>Medium late</td>
<td>Good</td>
<td>Late Fall: 2,4</td>
<td>R</td>
</tr>
<tr>
<td>Triple IV</td>
<td>HRS (forage)</td>
<td>Early</td>
<td>Poor</td>
<td>Late Fall: 1,2,3</td>
<td>MR</td>
</tr>
<tr>
<td>Tubbs</td>
<td>SWW</td>
<td>Medium</td>
<td>Good</td>
<td>Fall: 5</td>
<td>MS</td>
</tr>
<tr>
<td>Twin</td>
<td>SWS</td>
<td>Medium late</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>S</td>
</tr>
</tbody>
</table>

1 Type: D = Durum; HRS = Hard Red Spring; HW = Hard White; HWS = Hard White Spring; SWS = Soft White Spring; SWW = Soft White Winter
2 Growing Region: 1 = Sacramento Valley and Delta; 2 = San Joaquin Valley; 3 = coastal; 4 = southern desert valleys; 5 = intermountain area
3 Disease Reactions: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; — = no information

Continued on next page . . .
<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Type1</th>
<th>Maturity</th>
<th>Straw strength</th>
<th>Planting date: growing areas2</th>
<th>Disease Susceptibilities3</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Septoria tritici blotch</td>
</tr>
<tr>
<td>Yamhill</td>
<td>SWW</td>
<td>Medium</td>
<td>Fair</td>
<td>Fall: 5</td>
<td>MR</td>
</tr>
<tr>
<td>Yecora Rojo</td>
<td>HRS</td>
<td>Medium</td>
<td>Fair</td>
<td>Late Fall: 2,3,4; Spring 5</td>
<td>S</td>
</tr>
<tr>
<td><strong>TRITICALE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camelot</td>
<td>Spring forage</td>
<td>Early</td>
<td>Good</td>
<td>Late Fall: 1,2,3,4</td>
<td>MR</td>
</tr>
<tr>
<td>Merlin</td>
<td>Winter forage</td>
<td>Late</td>
<td>Fair</td>
<td>Fall: 1,2,3; Spring 5</td>
<td>S</td>
</tr>
<tr>
<td>Pacheco</td>
<td>Spring forage</td>
<td>Medium</td>
<td>Very good</td>
<td>Fall: 2</td>
<td>MR</td>
</tr>
<tr>
<td>Trical Brand 102</td>
<td>Winter forage</td>
<td>Late</td>
<td>Fair</td>
<td>Late Summer/Fall: 5</td>
<td>R</td>
</tr>
<tr>
<td>Trical Brand 105</td>
<td>Spring forage</td>
<td>Medium</td>
<td>Good</td>
<td>Fall: 1,2,3,4</td>
<td>R</td>
</tr>
<tr>
<td>Trical Brand 118</td>
<td>Spring forage</td>
<td>Medium</td>
<td>Good</td>
<td>Fall: 1,2,3,4</td>
<td>MR</td>
</tr>
<tr>
<td>Trical Brand 2700</td>
<td>Spring forage</td>
<td>Medium late</td>
<td>Fair</td>
<td>Spring: 5</td>
<td>R</td>
</tr>
</tbody>
</table>

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Insects and Mites

APHID – GENERAL CONSIDERATIONS (2/07)

APHID SPECIES
In addition to aphids described in this guideline, there are several other species that may be found on cereals throughout the year. Many occur in extremely low numbers and cause no damage. If, however, you encounter large numbers of an aphid or aphids that do not fit any of the following descriptions, please contact your farm advisor or county agricultural commissioner immediately. New species occur frequently, and your assistance in finding these is greatly appreciated.

CHARACTERISTICS USED IN IDENTIFICATION
The antennae are appendages arising one each from the side of the head and function as sense organs. The cornicles are tubular structures that arise one each on the side of the body near the rear end. The cauda is a structure resembling a tail that arises from the tip of the abdomen. Depending on species, it may be elongated, knobbed, triangular, or other shapes.

MANAGEMENT
Biological Control
All aphids associated with small grains are attacked by the same group of natural enemies. Historically these natural enemies and the advent of warm temperatures during spring keep aphid populations from reaching damaging levels. Natural enemies include lady beetles, syrphid fly larvae, green lacewings, parasitic wasps that cause the aphids to develop into mummies; i.e., their bodies become dried and bloated and turn tan or black in color, and a fungus disease that attacks aphids, but not the plants, causing them to appear flattened and plastered to the leaf or stem.

Monitoring
Check fields periodically after seedling emergence. If aphids become numerous, increase frequency of sampling. Before tillering, sample whole plants. After tillering, sample individual tillers. Aphids are often concentrated in spots or near the field margin. Note the presence of such hot spots but avoid sampling only these areas. Also be sure to look for evidence of biological control, presence of predators, disease, and aphid mummies.
**ARMYWORMS** (7/16)

**Scientific Names:** Armyworm: *Pseudaletia unipuncta*
Western yellowstriped armyworm: *Spodoptera praefica*

**DESCRIPTION OF THE PESTS**
The armyworm is pale green when young; as they mature they become greenish brown to black with a yellowish stripe along each side. Young larvae move like loopers, arching their body into a loop as they crawl. Western yellowstriped armyworms are black with yellow or orange stripes along the side. Mature larvae of both species may reach 2 inches in length.

**DAMAGE**
Larvae of both species cause damage by eating leaves. Entire leaves may be consumed or damage may consist of notches chewed out of the leaves giving them a tattered look. Damage may occur when larvae hatch from eggs laid in the cereal crop or from larvae migrating into the cereal crop from an adjacent field.

**MANAGEMENT**

**Biological Control**
Armyworms are attacked by a parasitic wasp, *Hyposoter* sp. Parasitized worms can be identified by pulling the larvae apart and looking for the green parasite larvae that pop out. *Hyposoter* is usually not active in early spring when cereals may be attacked by armyworms but growers should check for its presence. Virus diseases of armyworms may also be important natural control agents. Diseased caterpillars first appear yellowish and limp, and after death hang from plants as shapeless, dark tubes from which the disintegrated body contents ooze.

**Organically Acceptable Methods**
Biological and cultural controls and sprays of *Bacillus thuringiensis*.

**Cultural Control**
If larvae are moving into the cereal crop from an adjacent crop, some control may be obtained by plowing a deep, wide ditch between the two fields and keeping it filled with water until the migration stops.

**Monitoring**
Examine fields periodically for the presence of armyworms. Larvae hatching from eggs laid in the field may be found throughout the field. Those migrating in from an adjacent crop will most likely be found at the edge of the field.

**Management Decisions**
No economic threshold levels have been established for armyworms. Fields should be treated if armyworm numbers are sufficient to cause defoliation. Small caterpillars, less than 0.5 inch long, are easier to kill than larvae over 0.5 inch in length.

---

**Common name**  
(Example trade name)  
Amount/Acre  
REI‡  
PHI‡

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>REI‡</th>
<th>PHI‡</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus thuringiensis</em> ssp. KURSTAKI# (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

**MODE-OF-ACTION GROUP NUMBER**: 11A

---

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

---

A.  
*Bacillus thuringiensis* ssp. KURSTAKI# (various products)

---

Illustrated version at http://ipm.ucanr.edu/PMG/selectnewpest.small-grains.html
COMMENTS: Effective only on larvae less than 0.5 inches long. This material can be applied at any time with reasonable safety to bees.

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

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

# Acceptable for use on organically grown produce.

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/.
BIRD CHERRY-OAT APHID  
Scientific Name: *Rhopalosiphum padi*

**DESCRIPTION OF THE PEST**
Bird cherry-oat aphid is the most common aphid found on cereals. Its color ranges from orange green to olive green to dark olive green, and sometimes greenish black. It has long antennae and long tube-shaped cornicles arising from the side of the abdomen near the rear end. Wingless forms frequently have a reddish orange patch around the base of the cornicles. Bird cherry-oat aphid may be found any time after seedling emergence but is most common in February and March. The bird cherry-oat aphid is most easily confused with the corn leaf aphid but the former has a rounded, bulblike body shape while the latter appears almost rectangular.

**DAMAGE**
Bird cherry-oat aphid attacks all small grains including wheat, barley, oats, rye, and triticale. It may also be found on sorghum and corn. Heavy populations may cause a golden yellow streaking on the leaves; do not confuse this with the white streaks caused by Russian wheat aphid. Occasionally heavy populations cause the flag to curl up in a tight corkscrew fashion that may trap the awns, resulting in a fish-hook appearance to the head. Leaf curl caused by the bird cherry-oat aphid resembles a corkscrew, while that by the Russian wheat aphid resembles an upright soda straw.

Bird cherry-oat aphid is a vector of BARLEY YELLOW DWARF virus.

**MANAGEMENT**

**Biological Control**
Bird cherry-oat aphid populations are usually kept under control by a combination of predators and parasites (see APHIDS – GENERAL CONSIDERATIONS). Before considering chemical controls, evaluate the activity and control potential of these natural enemies.

**Cultural Control**
Bird cherry-oat aphid can build up on volunteer cereals; destroy these plants before newly planted crops emerge to help reduce aphid numbers.

**Management Decisions**
Economic thresholds for bird cherry-oat aphid are not well established. Do not consider treatment until the number of aphids exceeds 50-60 per tiller. Chemical controls should then be applied only if there is no evidence of natural enemy activity or if the plants are several weeks from flowering.
Common name  | Amount/Acre  | REI‡  | PHI‡
--------------|-------------|-------|-------
(Example trade name) | (hours)    | (days) |

**UPDATED 7/16**

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

A. DIMETHOATE  
(Dimethoate 4EC)  

<table>
<thead>
<tr>
<th>Amount/Acre</th>
<th>REI‡</th>
<th>PHI‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5–0.75 pt</td>
<td>48</td>
<td>35</td>
</tr>
</tbody>
</table>

MODE-OF-ACTION GROUP NUMBER¹: 1B  
COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to honey bees if bees are present at treatment time or within a day after. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. MALATHION  
(Malathion 8)  

<table>
<thead>
<tr>
<th>Amount/Acre</th>
<th>REI‡</th>
<th>PHI‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pt</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

MODE-OF-ACTION GROUP NUMBER¹: 1B  
COMMENTS: May be used on wheat, barley, oats, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

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

*  
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/.
BLACK GRASS BUG  (2/07)

Scientific Name: *Irbisia* spp.

DESCRIPTION OF THE PEST
Black grass bugs are small (0.2 to 0.33 inch long), shiny or grayish black bugs with black or red legs and prominent eyes.

DAMAGE
Feeding damage appears as whitish or yellowish patches on the leaves. The association of the insect with these damage symptoms confirms black grass bug damage.

MANAGEMENT

Monitoring
Check field regularly throughout spring. If black grass bug is found, check the extent of the infestation by taking sweep net samples beginning at the field margin and progressing to the center of the field. Infestations are usually heaviest or entirely confined to the edge of the field.

Management Decisions
No economic thresholds have been established. No pesticides are registered for treatment of black grass bug on small grains.
CORN LEAF APHID  (7/16)

Scientific Name: *Rhopalosiphum maidis*

DESCRIPTION OF THE PEST
Corn leaf aphids are small aphids that are bluish green to dark olive in color, with a purplish patch around the base of the cornicles. Because of its small size and short antennae, it could be confused with the Russian wheat aphid. Corn leaf aphid, however, has prominent black cornicles and lacks a supracaudal process.

DAMAGE
Damage is usually minor. Corn leaf aphid is a vector of BARLEY YELLOW DWARF virus.

MANAGEMENT

Biological Control
Corn leaf aphid is attacked by the usual predators and parasites (see APHIDS – GENERAL CONSIDERATIONS).

Monitoring
Check for corn leaf aphid when evaluating the field for other aphid species.

Management Decisions
Corn leaf aphid seldom requires treatment.

### Common name | Amount/Acre | REI‡ | PHI‡
--- | --- | --- | ---
(Example trade name) | (hours) | (days)

**Updated 7/16**

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

**A. DIMETHOATE**
(Dimethoate 4EC)

| 0.5–0.75 pt | 48 | 35 |

MODE-OF-ACTION GROUP NUMBER: 1B

COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

**B. MALATHION**
(Malathion 8)

| 1 pt | 12 | 7 |

MODE-OF-ACTION GROUP NUMBER: 1B

COMMENTS: May be used on wheat, barley, oats, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

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ENGLISH GRAIN APHID  (7/16)

Scientific Name: *Sitobion avenae*

DESCRIPTION OF THE PEST
The English grain aphid is a yellow-green to reddish brown, medium sized aphid with black antennae, cornicles, and leg joints. It usually appears later in the season than the other cereal aphids.

DAMAGE
English grain aphid is found on the leaves and stem of barley and oats, but in wheat it frequently colonizes the heads. It causes little injury except in wheat when present in extremely high numbers, more than 80-100 per head. It is thought that large amounts of honeydew produced by this aphid, particularly when in the head, may clog harvesting equipment; however, this has not been confirmed.

English grain aphid is a vector of BARLEY YELLOW DWARF virus.

MANAGEMENT

Biological Control
English grain aphid is normally suppressed by the common aphid parasites and predators (see APHIDS–GENERAL CONSIDERATIONS).

Monitoring
Be sure to check for presence of this aphid in the heads when monitoring wheat.

Management Decisions
Economic thresholds have not been established.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount/Acre</th>
<th>REI‡</th>
<th>PHI‡</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UPDATED 7/16</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies—honey bees, and the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide’s properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. DIMETHOATE (Dimethoate 4EC)</td>
<td>0.5–0.75 pt</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. MALATHION (Malathion 8)</td>
<td>1 pt</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: May be used on wheat, barley, oats, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI; the longer of these two intervals is the minimum time that must elapse before harvest may take place.
* 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/.
GRASSHOPPERS (7/16)

Scientific Name: *Melanoplus* spp.

DESCRIPTION OF THE PEST

Grasshoppers may occasionally attack grain crops, particularly if planted adjacent to foothill rangeland. They normally migrate from the range into cultivated areas as vegetation on the rangeland dries up.

DAMAGE

Grasshoppers destroy leaf tissue and, if present in extremely large numbers, they will consume the entire plant.

MANAGEMENT

Management Decisions

Since most grasshopper problems begin outside the grain field, areas favorable to grasshopper development should be carefully monitored for build-up and control measures taken if necessary.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example trade name)</td>
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A. DIMETHOATE
   (Dimethoate 4EC)
   0.75 pt
   48
   35
   MODE-OF-ACTION GROUP NUMBER‡: 1B
   COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. MALATHION
   (Malathion 8)
   1 pt
   12
   7
   MODE-OF-ACTION GROUP NUMBER‡: 1B
   COMMENTS: May be used on barley, oats, wheat, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

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

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GREENBUG (7/16)

Scientific Name: Schizaphis graminum

DESCRIPTION OF THE PEST
The greenbug is a green to yellow-green aphid with a dark green stripe down the middle of its back. It can be distinguished from the Russian wheat aphid by its longer antennae, long tube-shaped cornicles, and the lack of a supracaudal process. Greenbug is most easily confused with the rose-grain aphid. However, the antennae of the greenbug are uniformly dark while those of the rose-grain aphid are darker only at each joint. Rose-grain aphid has eight or more hairs on the cauda while greenbug only has four; a microscope is needed to see these hairs.

DAMAGE
Like the Russian wheat aphid, greenbug injects a toxin into the plant while feeding. Injury appears as yellowish spots or patches on the leaves. In some cases, discolored areas show reddish or brown. The entire leaf or plant turns yellow as populations increase. Generally plants are damaged only if significant feeding occurs before tillering. Damage is more likely in the Imperial Valley but can occur in the San Joaquin Valley as well.

Greenbug is a vector of BARLEY YELLOW DWARF virus.

MANAGEMENT

Biological Control
Greenbug is attacked by several natural enemies (see APHIDS - GENERAL CONSIDERATIONS). Look for evidence of parasites (bloated mummies) and also for lady beetles, green lacewings, and syrphid fly larvae.

Monitoring
Fields should be checked regularly from seedling emergence to tillering. If discoloration is present be sure to check for the presence of the aphid. If you are not sure if the aphids are greenbug or rose-grain aphid, contact your farm advisor before applying any chemicals.

Management Decisions
If greenbug is present in large numbers and discoloration is evident before tillering, apply an insecticide.
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide’s properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

A. **DIMETHOATE**
   (Dimethoate 4EC)  
   **MODE-OF-ACTION GROUP NUMBER**: 1B  
   **COMMENTS**: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

   **Amount/Acre**: 0.5–0.75 pt  
   **REI‡**: 48  
   **PHI‡**: 35

B. **MALATHION**
   (Malathion 8)  
   **MODE-OF-ACTION GROUP NUMBER**: 1B  
   **COMMENTS**: May be used on wheat, barley, oats, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

   **Amount/Acre**: 1 pt  
   **REI‡**: 12  
   **PHI‡**: 7

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MITES (7/16)

Scientific Names: Brown wheat mite: *Petrobia latens*
Winter grain mite: *Penthaleus major*
Banks grass mite: *Oligonychus pratensis*

DESCRIPTION OF THE PESTS

Mites are tiny arthropods that feed on the sap of host plants. Because they are so small, use a hand lens to see them. They have 8 legs (6 in the first stage). The brown wheat mite is about 0.025 inch long (0.635 mm), oval shaped and dark red or brown in color. The winter grain mite is larger, 0.04 inch long (1 mm) and dark bluish black with red-orange legs and a reddish patch on the upper side. Banks grass mite is extremely small, 0.001 inch (0.025 mm), and yellow to cream colored. It is the only prominent wheat mite that webs the leaves.

DAMAGE

Leaves injured by brown wheat mite first appear silvery and later take on a scorched appearance. Injury caused by the winter grain mite results in yellowish leaves and stunted plants. The damage caused by this mite is similar to winter-kill. Banks grass mite turns leaves silvery and the tips and margins later turn brown. Webbing is an additional sign that injury is caused by the Banks grass mite. In California, mites seldom cause sufficient damage to be of concern.

MANAGEMENT

Cultural Control

Both brown wheat mite and Banks grass mite cause the greatest injury to water-stressed grain. A timely irrigation will usually alleviate the problem. Crop rotation is detrimental to the winter grain mite.

Management Decisions

Chemical controls are not generally recommended as cultural techniques generally suffice. Application of chemicals for aphid control may lead to a build-up of mites, however, leading to the occasional need for an acaricide.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>REI‡</th>
<th>PHI‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example trade name)</td>
<td>(hours)</td>
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<td></td>
</tr>
</tbody>
</table>

UPDATED 7/16

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

A. DIMETHOATE
   (Dimethoate 4EC) 0.33–0.5 pt 48 35
   MODE-OF-ACTION GROUP NUMBER1: 1B
   COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

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RANGE CRANE FLY  (2/07)
Scientific Name: Tipula spp.

DESCRIPTION OF THE PEST
Range crane fly larvae are pale brown, legless maggots that are often called leather jackets because of their leathery appearance. Mature larvae may reach 1 inch in length.

DAMAGE
Damage is caused by the larval stage and is primarily confined to rangeland and grasses, but occasionally dryland grains planted in the foothills may be injured. Damage generally occurs from late December through February and is first apparent as areas of dead or dying plants throughout the field. Larvae feed on plant roots and may emerge from the soil at night to feed on the plant crowns.

MANAGEMENT
No pesticides are registered for use on range crane fly on small grains.
ROSE-GRAIN APHID  (7/16)

Scientific Name: Metopolophium dirhodum

DESCRIPTION OF THE PEST
Rose-grain aphid is a large green aphid that may have a dark green stripe down the middle of the back. It looks similar to greenbug but is larger, the joints in the antennae are darker than the middle portion of the antennae, and the antennae usually reach beyond the base of the cornicles.

DAMAGE
Rose-grain aphids do not inject a toxin as they feed and generally cause very little injury. Since they are easily confused with the more damaging greenbug, care should be taken in identification. If you are not sure of the species, contact your farm advisor before any sprays are applied.

Rose-grain aphid is a vector of BARLEY YELLOW DWARF virus.

MANAGEMENT

Biological Control
Rose-grain aphid is attacked by the natural enemy species discussed under APHIDS–GENERAL CONSIDERATIONS.

Monitoring
Be sure of the species identification before spraying.

Management Decisions
Economic thresholds have not been established for rose-grain aphid.

<table>
<thead>
<tr>
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<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIMETHOATE</td>
<td>0.50–0.75 pt</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>(Dimethoate 4EC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MALATHION</td>
<td>1 pt</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(Malathion 8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A. DIMETHOATE (Dimethoate 4EC)

MODE-OF-ACTION GROUP NUMBER: 1B

COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. MALATHION (Malathion 8)

MODE-OF-ACTION GROUP NUMBER: 1B

COMMENTS: May be used on wheat, barley, oats, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

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RUSSIAN WHEAT APHID (7/16)

Scientific Name: *Diuraphis noxia*

DESCRIPTION OF THE PEST

The Russian wheat aphid is a small pale green insect with an elongated, spindle-shaped body that may be covered with a powdery coating of wax. It can be distinguished from all other cereal aphids by a second tail-like process (supracaudal process) located directly above the cauda, giving it a twin-tailed appearance when viewed with a hand lens. While easily seen in wingless aphids, in very small or winged forms the supracaudal process may be difficult to see. Russian wheat aphid survives the summer on a variety of grasses and migrates to cereals in late fall as summer hosts die. It is tolerant of cold weather and can survive sub-freezing temperatures.

Following its introduction into California, Russian wheat aphid spread rapidly throughout the entire state, causing serious injury and crop loss. In recent years, however, Russian wheat aphid populations have declined significantly throughout the Central Valley and the Intermountain region. The situation in the low desert (primarily Imperial County) is similar with spotty infestations appearing periodically, generally causing little or no damage. A few fields within each of these areas continue to have problems. Russian wheat aphid appears in the high desert (Antelope Valley), however, it is rarely a damaging pest because wheat heads are usually past the boot stage before damaging numbers can develop.

In most areas of California, it appears that Russian wheat aphid builds to damaging levels sporadically, much like the population cycles of bird cherry-oat aphid. The reasons probably involve natural enemies, pathogens, environmental conditions, and crop management techniques.

DAMAGE

Damage is restricted to specific members of the grass family. Wheat and barley are the most susceptible; rye and triticale, while susceptible, are usually less damaged; and oats appear to sustain little or no injury. Russian wheat aphid does not attack corn, sorghum, or rice. While feeding, Russian wheat aphid injects a toxin into the plant. This toxin is responsible for many of the damage symptoms, the most characteristic of which are white, longitudinal streaks on the leaves and sometimes the stem. Heavily infested plants are stunted, and sometimes exhibit a flattened appearance with tillers lying almost parallel to the ground. Occasionally, particularly during cold weather, plants show a purple color. Infested leaves curl up like a soda straw and remain in a rigid upright position rather than assuming the typical drooping posture. The tightly curled, upright leaves resemble onion leaves. If the awns are trapped in the curled flag leaf, the head is usually distorted and assumes a fish hook appearance. Improperly timed applications of phenoxy herbicides may cause similar injury.

Russian wheat aphid is not a vector of barley yellow dwarf virus.
MANAGEMENT

Biological Control
The effectiveness of biological control agents has not been fully evaluated. Russian wheat aphid is attacked by several predators and parasites commonly associated with other aphid pests of small grains. Efforts should be made to conserve these natural enemies as they are of great importance in controlling other cereal aphids and may reduce Russian wheat aphid populations as well.

Cultural Control
Destroy and remove volunteer cereals to help reduce or delay the buildup of Russian wheat aphid populations. Plants stressed for water or nutrients are more susceptible to and suffer greater damage from Russian wheat aphid, so maintain adequate soil moisture and fertilization.

Monitoring and Management Decisions
The best management strategy in areas where Russian wheat aphid is a problem is early planting, avoiding water stress, and isolation from riparian or permanent pasture. The major problems generally occur in late-planted grains. In the high desert, most growers no longer plant highly susceptible barley. Instead, they plant oats or an oat/wheat/barley mix. Russian wheat aphid is frequently found on the barley and wheat plants in such mixes, but good forage yields can be obtained.

Check fields regularly following seedling emergence. Russian wheat aphids are often difficult to find, particularly when present in low numbers. Look for the characteristic white stripes on the leaves and stem. The earliest infestations are often found on the edge of the field, particularly the upwind side. Aphids rapidly spread across the entire field after their initial establishment. Treatment thresholds have been developed for irrigated wheat; while thresholds for irrigated barley may be similar, they are probably not the same. Thresholds for dryland wheat or barley have not been developed.

When determining aphid densities in order to apply these thresholds, take a random sample across the field. Sample a minimum of four locations (quadrants) in each field. Take the sample in such a way as to avoid sampling only plants showing symptoms (streaking) of a Russian wheat aphid infestation. One way to do this is to use a metal rod that has a ribbon attached for easy location. Toss the rod backwards over your shoulder and select the plant it lands closest to as your sample plant. Or if you prefer, with your eyes closed, reach out to select a sample plant. It is very important that the sample be taken “blindly” or the sample will be bias toward treating.

Apply chemical control if aphid numbers reach the following on the indicated growth stages:

<table>
<thead>
<tr>
<th>Plant Growth Stage</th>
<th>Number of Aphids per Plant or Tiller</th>
</tr>
</thead>
<tbody>
<tr>
<td>two leaf</td>
<td>5 (per plant)</td>
</tr>
<tr>
<td>early tillering</td>
<td>5 (per tiller)</td>
</tr>
<tr>
<td>late tillering</td>
<td>10 (per tiller)</td>
</tr>
<tr>
<td>first node</td>
<td>10 (per tiller)</td>
</tr>
<tr>
<td>boot</td>
<td>20 (per tiller)</td>
</tr>
<tr>
<td>head exertion and later</td>
<td>30 (per tiller)</td>
</tr>
</tbody>
</table>
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   MODE-OF-ACTION GROUP NUMBER: 1B
   COMMENTS: For use on wheat and triticale only. Do not make more than two applications per year. Do not graze within 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. MALATHION
   (Malathion 8) 1 pt 12 7
   MODE-OF-ACTION GROUP NUMBER: 1B
   COMMENTS: May be used on wheat, barley, oats, and rye. If alfalfa is in bloom, apply during the night or early in the morning when bees are not foraging in the field. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

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STINK BUGS  (2/07)
Scientific Name: *Euschistus* spp.

DESCRIPTION OF THE PEST
Stink bugs are medium to large-sized bugs. Those that attack small grains are commonly grey brown to green in color and 0.38 to 0.5 inch long. Their bodies have a characteristic shield shape with a large triangle on the center back. They are most common where cereals are planted adjacent to rangeland near the foothills or desert.

DAMAGE
Damage usually occurs when stink bugs feed in the head during milk or soft dough stage.

MANAGEMENT
Monitoring
Observe fields frequently after heading, particularly those adjacent to desert or rangeland. If vegetation in areas surrounding the field is beginning to dry up, make more frequent observations. Using a sweep net, sample the margins, then move toward the center of the field; initially, stink bugs are generally confined to the edges of the field.

Management Decisions
No economic thresholds have been established for stink bug. No chemicals are currently registered for use against stink bug on barley, wheat, oats, or rye.
WHEAT STEM MAGGOT (2/07)

Scientific Name: *Meromyza americana*

DESCRIPTION OF THE PEST
The wheat stem maggot larva is as drab as the adult is colorful. Mature larvae are about 0.25 inch in length and are pale green or cream colored; they are a typical legless maggot and are generally found inside the stem. The adult is a small, yellowish white fly with bright green eyes and three black stripes across the thorax and abdomen.

DAMAGE
Injury caused by the wheat stem maggot is obvious but usually not serious. Eggs are laid in September and October and hatch later in fall. The young maggots overwinter. When development resumes in spring, damage is caused by maggots feeding in the upper portion of the stem, which cuts off nutrient flow and the heads turn a whitish color. These white heads may be distinguished from those caused by wireworms or root rot by pulling on them. Stems damaged by stem maggots easily pull free where it has been chewed and slides out of the leaf sheath. Infested plants also have fewer tillers than healthy ones.

MANAGEMENT
Injury in California is minimal and chemical controls are not recommended.
WIREWORMS  (2/09)


DESCRIPTION OF THE PESTS
Wireworms are found in the soil where they feed on the roots of various cereals. Damage is done by the larval stage, which is a yellowish brown, thin worm that has a shiny, tough skin.

DAMAGE
Wireworms feed on roots of emerging plants, killing the seedlings and reducing the stand. As plants mature, wireworms may girdle the stem, causing white heads. In appearance, this damage is similar to that caused by common root rot, take-all, or wheat stem maggot. Be sure to dig around the plant and look for wireworm larvae to confirm that they are the cause of injury.

MANAGEMENT

Cultural Control
In fields known to contain wireworm larvae, fallow during summer with frequent tillage (springtooth or disk). Damage from wireworm infestations to the crop when it is in the seedling stage can sometimes be reduced by replanting, if replanting occurs before existing plants begin to tiller. Rotate to nonhost crops if possible. Contact your county farm advisor for information regarding nonhosts. Do not plant a susceptible host crop following a cereal crop that has had a heavy infestation of wireworm without fallowing/tilling or applying a pesticide.

Monitoring
Wireworm infestations are difficult to detect prior to visible plant injury. They are most likely to be found following a long-term legume crop or natural or temporary pasture.

Management Decisions
Chemical controls are ineffective or impossible to apply to wireworms attacking a standing crop. If used, chemicals must be applied as preplant or seed treatments. If an insecticide is to be used before planting a cereal crop or rotational crop, check the label for plantback restrictions or possible residue problems.
Diseases

BACTERIAL BLIGHTS  (2/07)

Pathogens:  Bacterial leaf streak and black chaff:  *Xanthomonas campestris* pv. *translucens*
Bacterial leaf blight of wheat:  *Pseudomonas syringae* pv. *syringae*
Halo blight of oats:  *Pseudomonas syringae* pv. *coronafaciens*
Stripe blight:  *Pseudomonas syringae* pv. *striafaciens*

SYMPTOMS
Bacterial blights first appear as small, water-soaked spots. The lesions expand into spots, blotches, or streaks with a characteristic appearance. *Bacterial leaf streak* affects barley and wheat, occasionally oats. Lesions become brown streaks along leaf veins. Droplets or a shiny film forms on the streaks under damp conditions, leaving yellowish granules or scales upon drying. *Black chaff* is a blackening of glumes caused by the leaf streak pathogen when wet weather occurs during heading. *Bacterial leaf blight* affects wheat. Lesions develop into light tan spots, blotches, or streaks. *Halo blight* affects oats. Light tan spots characterized by a pale green margin (halo) may grow together to form blotches. Heavy infections kill leaves. *Stripe blight* affects oats. Light tan spots do not have a pale margin, and usually enlarge to form stripes. Heavy infections kill leaves.

COMMENTS ON THE DISEASES
Blights seldom cause significant damage in California because they develop only during wet weather. These bacteria survive on crop residue, volunteer grains and wild grasses, and grain seed.

MANAGEMENT
Use clean seed, practice crop rotation, avoid overhead irrigation if blight becomes a problem, and eliminate crop residue.
BARLEY STRIPE  (2/07)

Pathogen: Pyrenophora graminea

SYMPTOMS
Initially, long, pale or yellow stripes appear on 2nd, 3rd, and subsequent leaves. The stripes become a darker color as the fungus sporulates on the leaf surface. As the infected plant matures, the leaves tatter (split along stripes). Infected plants usually are stunted, and produce blank (sterile) spikes. Rarely, a few seed are produced by infected spikes, and late-forming tillers may produce normal (fertile) spikes.

COMMENTS ON THE DISEASE
Barley stripe is a problem only in barley (Hordeum spp.). The fungus is seedborne and survives in the outer layers of infected seed. Coleoptiles of seedlings are infected by the fungus under cool, moist conditions. The fungus grows systemically within the plant, produces toxins, and kills cells and discolors leaf tissue between veins, thus causing striped lesions. When conditions are wet or humid, spores are produced on the surface of leaves at about the time spikes of healthy plants in the field begin to flower. Spores are dispersed by wind to these developing spikes, germinate, and cause infections. After infection, the fungus becomes dormant in the hull or pericarp of the kernel until the seed germinates. Kernels are most susceptible to infection during early development. Moisture from rain or dew is necessary for spike infection, and plants with kernel infections are symptomless. Only one cycle of infection and spore production occurs each season.

MANAGEMENT
Use certified seed. (Fields are approved for certification only if they are found free of barley stripe.)
BARLEY YELLOW DWARF  (2/07)
Pathogen: Barley yellow dwarf virus

SYMPTOMS
Symptoms include uneven, blotchy leaf discoloration in various shades of yellow, red, or purple, progressing from leaf tip to base and margin to midrib. The most striking symptoms occur on older leaves; the youngest leaves usually are not affected. Wheat and barley leaves usually turn yellow, while oat leaves are more red. Stunting also occurs, especially if plants are infected at an early growth stage. Tillering is reduced and maturity is delayed. Severe early infections can kill young plants. An additional symptom of the disease that commonly is visible on oats is blasting (sterility) of florets in the panicle.

COMMENTS ON THE DISEASE
Barley yellow dwarf is an aphid-transmitted virus disease of wheat, barley, oat, and other small grains. The virus survives in most common grain aphids (including bird cherry-oat aphid, English grain aphid, rose-grain aphid, corn leaf aphid, and greenbug) and on numerous cereal and grass hosts. The Russian wheat aphid, however, is not a vector of the virus. Aphids acquire the virus by feeding on an infected host plant. Usually 12 to 30 hours of feeding are necessary for acquisition. After acquisition, a latent period of 1 to 4 days must pass before the aphid is able to transmit the virus to another host plant during feeding. Usually, at least 4 hours of feeding are required for transmission to occur. Plants can be infected throughout the season, and epidemics are most likely during cool, moist seasons that favor grass and cereal growth as well as aphid multiplication and migration. The virus interferes with the growth of infected plants, slowing the development of foliage and roots and sometimes preventing heading or killing the host. The virus multiplies within the phloem tissues of the plant; phloem cells are killed and downward movement of food produced by the leaves is impeded, thus leading to the expression of the symptoms described above.

MANAGEMENT
Control is through the use of resistant or tolerant barley cultivars (see BARLEY CULTIVAR TABLE), and wheat cultivars with tolerance (see WHEAT CULTIVAR TABLE). Also avoid very early (Sept. to Oct.) or very late (Feb. to Mar.) planting dates. Planting the crops during such times exposes the plants to active aphid populations at a time when plants are most vulnerable (early growth stage).
BLACK POINT OF WHEAT (2/07)

**Pathogens:** *Alternaria* spp., *Stemphylium* spp., *Nigrospora* spp., *Penicillium* spp., *Helminthosporium* spp., *Fusarium* spp., *Curvularia* spp., and others

**SYMPTOMS**
Kernels are discolored or blackened, usually at the embryo (germ) end. The entire kernel, or just a portion of it, can be discolored. Although usually not yield-reducing, black point can reduce grade and quality. In U.S. wheat standards, blackened kernels are considered damaged, and only 2% are permitted in wheat graded as US No.1, and 4% in US No.2. Black point is especially important on durum wheat because black specks can appear in the semolina, making it undesirable for further processing.

**COMMENTS ON THE DISEASE**
Black point is a disease that affects wheat and barley; it is most important on durum wheat. It is caused by several common fungi. These fungi are most troublesome when the relative humidity exceeds 90%. Expanding green kernels are most susceptible, while premature seed senescence also promotes black point. The fungi that cause black point often occur on kernels that do not show symptoms of black point. Some factor(s) related to moisture, temperature, and plant growth or senescence triggers the infection that results in symptom expression. High humidity or rainfall from anthesis to soft dough, high nitrogen fertility, excessive late season irrigation, and lodging usually are associated with high levels of the disease.

**MANAGEMENT**
Black point can be partially controlled by reducing irrigation frequency after heading and by reducing nitrogen rates, without sacrificing either yield or quality. Because black point can occur at damaging levels in some seasons despite modifications in cultural practices, the best option for control is to combine reduced input practices with black point resistant cultivars. Current cultivars differ in the level of resistance or tolerance to the disease, although there are no completely resistant cultivars available.
COMMON ROOT ROT AND SCAB  (2/07)

Pathogens: *Fusarium* spp., *Bipolaris sorokiniana*

**SYMPTOMS**
Symptoms of this disease include darkened and poorly developed roots and crown. Spikes turn white before healthy plants begin to mature. Heads and kernels do not fill normally. Plants are usually stunted and produce few tillers. Infected heads turn white; pink or orange fungal mycelium develops on the surface of bleached spikelets.

**COMMENTS ON THE DISEASE**
The fungi survive on host residue and in soil as mycelium and/or resting spores, and are favored by warm weather. Water stress following infection accentuates the disease. Root and crown tissues are infected if conditions are wet or warm enough to allow fungal growth. Scab is caused by strains of the same *Fusarium* spp. that cause root rot. Spores splash onto spikes and infect flower parts if they remain continually wet for several days.

**MANAGEMENT**
Follow good cultural practices: plant late in the fall to avoid excessively warm soil conditions; provide adequate nitrogen but avoid excessive fertilization; irrigate to avoid moisture stress; and rotate out of grain, or use oat, which is not affected. There are no recommended chemical treatments for this disease.
COVERED SMUT  (7/16)

Pathogens: Covered smut of wheat, also called common bunt and stinking smut: *Tilletia caries* and *Tilletia foetida*
Covered smut of barley and oats: different races of *Ustilago hordei*

SYMPTOMS
Plants are stunted and heads emerge later than normal. Kernels are replaced by dark gray spore masses that are enclosed in a gray membrane that persists until maturity and is partially covered by floral bracts. If the spore masses are crushed to release spores, they have a distinctive odor, similar to that of decaying fish.

COMMENTS ON THE DISEASE
Covered smut spore masses burst during harvest, spreading spores to healthy grain and to the soil. The fungi survive from one season to the next on the surface of infested seed or in the soil.

MANAGEMENT
Use certified smut-free seed. Hot water treatment can eliminate smut fungi from contaminated seed, but it must be used carefully to avoid reducing seed vitality. Treatment of seed with contact-type fungicides will control covered smut because the fungus is on the outside of the seed.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/cwt(^a)</th>
<th>REI(^\ddagger) (hours)</th>
<th>PHI (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example trade name)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A. CARBOXIN 34% F</td>
<td>2–3 oz</td>
<td>12</td>
<td>NA</td>
</tr>
<tr>
<td>(Vitavax 34)</td>
<td></td>
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<td></td>
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<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER(^1)): Carboxamide (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on barley, oats, triticale, wheat. Do not use treated seed for food, feed, or oil purposes.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>B. CARBOXIN 17%</td>
<td>3–4 fl oz</td>
<td>24</td>
<td>NA</td>
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<td>MODE-OF-ACTION GROUP NAME (NUMBER(^1)): Carboxamide (7)</td>
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<td>. . .PLUS. . .THIRAM 17% F</td>
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<tr>
<td>(Vitavax 200)</td>
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<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER(^1)): Multi-site contact (M3)</td>
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<tr>
<td>COMMENTS: Do not use treated seed for food, feed, or oil purposes.</td>
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</tr>
<tr>
<td>C. CARBOXIN 17%</td>
<td>3–4 fl oz</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER(^1)): Carboxamide (7)</td>
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<tr>
<td>. . .PLUS. . .PCNB 17% F</td>
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<tr>
<td>(Vitavax PCNB)</td>
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<td></td>
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<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER(^1)): Aromatic hydrocarbon (14)</td>
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</tr>
<tr>
<td>COMMENTS: This product is not labeled for use in California, but seed treated in and obtained from another state can be legally used in California even for a chemical not registered on small grains in California. Contact your retail seed dealer for information and availability. Do not use treated seed for feed or oil. All seed treated with this product must be colored with an EPA-approved dye (e.g., 40 CFR 180.1001) that imparts an unnatural color to the seed to help prevent the inadvertent use of treated seed as food for people or feed for animals. Follow label requirements for labeling treated seed.</td>
<td></td>
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</tr>
<tr>
<td>D. PCNB 24% EC</td>
<td>Label rates</td>
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<td>NA</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER(^1)): Aromatic hydrocarbon (14)</td>
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<td></td>
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</tr>
</tbody>
</table>

*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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Illustrated version at http://ipm.ucanr.edu/PMG/selectnewpest.small-grains.html
COMMENTS: This product is not labeled for use in California, but seed treated in and obtained from another state can be legally used in California even for a chemical not registered on small grains in California. Contact your retail seed dealer for information and availability. For use on barley, oats, and wheat only. Do not use treated seed for food, feed, or oil purposes.

E. MANCOZEB 80% DF
   (Dithane M45)
   Barley: 2.7–4.2 oz  24  NA
   Wheat: 2.2–3.3 oz  NA
   Oats: 4–6.3 oz  NA
   MODE-OF-ACTION GROUP NAME (NUMBER1): Multi-site contact (M3)
   COMMENTS: Do not use treated seed for feed or oil. All seed treated with this product must be colored with an EPA-approved dye (e.g., 40 CFR 180.1001) that imparts an unnatural color to the seed to help prevent the inadvertent use of treated seed as food for people or feed for animals. Follow label requirements for labeling treated seed.

F. TRIADIMENOL
   (Baytan 30)
   0.75–1.5 fl oz  NA  NA
   MODE-OF-ACTION GROUP NAME (NUMBER1): Demethylation inhibitor (3)
   COMMENTS: For use on barley, oats, rye, and wheat. Do not use treated seed for feed or oil. All seed treated with this product must be colored with an EPA-approved dye (e.g., 40 CFR 180.1001) that imparts an unnatural color to the seed to help prevent the inadvertent use of treated seed as food for people or feed for animals. Follow label requirements for labeling treated seed. Green forage may be grazed 40 days after seeding.

G. DIFENOCONAZOLE/MEFENOXAM
   (Dividend XL RTA)
   1.0 fl oz  48  See comments
   MODE-OF-ACTION GROUP NAME (NUMBER1): Demethylation inhibitor (3) and Phenylamide (4)
   COMMENTS: For use on barley and wheat only. Do not use treated seed for feed or oil. Do not graze green forage for 55 days after planting. Do not plant any crop other than wheat within 30 days to fields in which treated seed was planted.

H. TEBUCONAZOLE/THIRAM
   (Raxil-Thiram)
   3.5–4.6 fl oz  24  NA
   MODE-OF-ACTION GROUP NAME (NUMBER1): Demethylation inhibitor (3) and Multi-site contact (M3)
   COMMENTS: For use on barley, oats, triticale, and wheat. Do not use treated seed for feed, food, or oil purposes. Barley, oat, triticale, and wheat green forage may be grazed or harvested for hay 31 days after seeding.

∆ Centum weight (cwt) is 100 pounds.
‡ 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.
ERGOT  (2/07)

Pathogen: *Claviceps purpurea*

**SYMPTOMS**
The presence of bluish black, elongated sclerotia that replace one or more kernels of a grain spike signals an ergot infection.

**COMMENTS ON THE DISEASE**
Ergot affects rye and triticale more frequently than wheat, barley, or oats. Grasses are often the main reservoir of the disease. The fungus survives as sclerotia in or on the soil, producing airborne spores in spring. The spores infect floral tissue, eventually forming sclerotia in place of grain kernels. Sclerotia are toxic to both humans and livestock.

**MANAGEMENT**
Clean seed, crop rotation, and deep tillage help to control this disease. Sclerotia do not survive more than one year, and do not produce spores if they are buried more than 4 inches deep. There are no recommended chemical treatments for this disease.
KARNAL BUNT OF WHEAT  (7/16)
Pathogen: Tilletia indica (=Neovossia indica)

SYMPTOMS
Karnal bunt is first visible at the soft-dough stage in the form of blackened areas surrounding the base
of the grain; however, the disease is not usually noticed until the grain is threshed and partially
smutted kernels are exposed. Unless the disease is severe, only a few florets per spike are affected and
diseased spikes are not conspicuous because the glumes are not noticeably distorted. In severely
infected spikes, however, the glumes may spread apart near maturity, exposing the infected seed.
While diseased seeds usually retain a partial seed coat, the embryo and part of the endosperm have
been converted to masses of small black spores, which emit a fishy odor (due to the presence of
trimethylamine).

COMMENTS ON THE DISEASE
Karnal bunt only minimally affects grain yield, but many countries have a zero tolerance for the
presence of its spores in seed; consequently this disease has regulatory significance.

Karnal bunt is indigenous to the Punjab area of the Indian subcontinent, where it was first reported in
1930. It first appeared in Mexico in 1972. In March of 1996, its presence was confirmed in the U.S. in
Arizona on certified durum wheat seed, and later that year on seed that had been planted in New
Mexico, Texas, and California. Since that time, however, it has not been identified in California.

The disease spreads from spores that are present on infected seed and in soil contaminated from the
previous crop. The delicate outer layer that surrounds each sac of teliospores is easily broken during
harvest, dispersing the spores to contaminate the soil. The teliospores germinate in response to
moisture and produce numerous sporidia at the soil surface. These spores are forcibly ejected from
the sporidia and dispersed by either wind, splashing water, or insects. Sporidia have a short life span, even
at high relative humidity, and generally survive for only short periods when airborne.

Plants are most susceptible to infection when spikes emerge from the boot, but infection can occur
throughout the flowering period. Sporidia infect the ovaries, directly penetrating the glumes and ovary
wall. Diseased kernels may be partially or completely displaced by masses of teliospores. Teliospores
require a dormant period of up to 6 months before they can germinate and remain viable in the soil up
to 45 months.

MANAGEMENT
Use of disease-free seed is essential. Resistant cultivars are being developed, but at present, no cultivars
are immune. Durum wheat and triticale, however, are less susceptible than bread wheat. In areas
where the soil has become infested, rotate to crops other than wheat, durum wheat, and triticale for up
to 5 years. Mulching with polyethylene can be used to raise soil temperature and reduce teliospore
germination. Planting dates can also be adjusted so that heading does not occur under weather
conditions conducive to infection.

Although no seed treatment is 100% effective, several treatments that inhibit teliospore germination are
available.
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, bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.

### SEED TREATMENT

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount/cwt∆</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. CARBOXIN/THIRAM</strong>&lt;br&gt;(RTU-Vitavax-Thiram)</td>
<td>5–6.8 oz</td>
<td>24</td>
<td>See comments</td>
</tr>
<tr>
<td><strong>MODE-OF-ACTION GROUP NAME (NUMBER‡):</strong> Carboxamide (7) and Multi-site contact (M3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> This product is not labeled for use in California, but seed treated in and obtained from another state can be legally used in California even for a chemical not registered on small grains in California. Contact your retail seed dealer for information and availability. Do not use treated seed for feed, food, or oil purposes. Do not graze or feed livestock on treated areas for 6 weeks after planting.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. PCNB 24% EC</strong>&lt;br&gt;Label rates</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td><strong>MODE-OF-ACTION GROUP NAME (NUMBER‡):</strong> Aromatic hydrocarbon (14)</td>
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<td><strong>COMMENTS:</strong> This product is not labeled for use in California, but seed treated in and obtained from another state can be legally used in California even for a chemical not registered on small grains in California. Contact your retail seed dealer for information and availability. Do not use treated seed for food, feed, or oil purposes.</td>
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</tr>
<tr>
<td><strong>C. DIFENOCONAZOLE/MEFENOXAM</strong>&lt;br&gt;(Dividend XL RTA)</td>
<td>1.0 fl oz</td>
<td>48</td>
<td>See comments</td>
</tr>
<tr>
<td><strong>MODE-OF-ACTION GROUP NAME (NUMBER‡):</strong> Demethylation inhibitor (3) and Phenylamide (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> For use on barley and wheat only. Do not use treated seed for feed, food, or oil purposes. Do not graze green forage for 55 days after planting. Do not plant any crop other than wheat within 30 days to fields in which treated seed was planted.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. TEBUCONAZOLE/THIRAM</strong>&lt;br&gt;(Raxil-Thiram)</td>
<td>3.5–4.6 fl oz</td>
<td>24</td>
<td>See comments</td>
</tr>
<tr>
<td><strong>MODE-OF-ACTION GROUP NAME (NUMBER‡):</strong> Demethylation inhibitor (3) and Multi-site contact (M3)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>COMMENTS:</strong> For use on barley, oats, triticale, and wheat. Do not use treated seed for feed, food, or oil purposes. Barley, oat, triticale, and wheat green forage may be grazed 31 days after seeding.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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**∆** Centum weight (cwt) is 100 pounds.

**‡** 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.
LEAF BLOTCH OF OATS  (2/07)

Pathogen: *Pyrenophora avenae*

**SYMPTOMS**
This disease appears as reddish tan leaf blotches that are somewhat linear with irregular margins. Heavily infected leaves die. Seedling blight may occur if coleoptiles are infected.

**COMMENTS ON THE DISEASE**
The fungus survives on infected, undecayed plant debris in soil or less commonly inside the hull of infected seed. The disease is favored by cool and rainy weather.

**MANAGEMENT**
No specific control is necessary in California. Practices that control other diseases, such as the use of clean seed, crop rotation, and elimination of crop residue, help control leaf blotch as well.
LEAF RUSTS OF WHEAT AND BARLEY, CROWN RUST OF OATS (7/16)

Pathogens: *Puccinia recondita* (wheat); *Puccinia hordei* (barley); *Puccinia coronata* (oats)

SYMPTOMS
Symptoms on the foliage are similar for wheat, barley, and oats, although the species of *Puccinia* are different for each host. Pustules on barley are small, round, and yellowish brown. Pustules on wheat are reddish orange and scattered or clustered on upper leaf surfaces. Pustules on oat are oblong and orange colored. The shape of the spore and its ornamentation are the reasons that oat leaf rust is termed crown rust. The lack of ragged edges on pustules of leaf rusts distinguishes them from stem rusts. As the plants mature, the pustules turn dark and shiny as teliospores are formed. These spores do not play a role in disease development or survival in California.

COMMENTS ON THE DISEASES
Leaf rusts are late season diseases that cause losses in years of lower than normal late spring temperatures and high humidity conditions. The leaf rust fungi grow only on living host plants and are specialized to narrow host ranges (wheat leaf rust does not affect barley; barley leaf rust does not affect wheat). Sources of primary inoculum (urediospores) for crops include volunteer cereal plants and, because urediospores can be dispersed over great distances by air currents, distant fields of the respective cereal crops (wheat, barley, and oat). Spores from pustules of initial infections are windblown to initiate secondary cycles (7- to 10-day intervals) when temperatures are 60° to 72°F (16° to 22°C) and moisture is not limiting. The spores infect the plant through stomata; a film of moisture is required for infection. The fungi then grow between host cells just under the plant epidermis. Tiny structures, called haustoria, penetrate host cells to obtain nutrients. Fungus tissue proliferates beneath the epidermis and as masses of spores are formed, the epidermis bursts and characteristic rust pustules appear. Infections increase water loss and decrease the amount of photosynthate available for grain filling, resulting in reductions in the number and weight of kernels.

MANAGEMENT
Control is achieved through the use of resistant cultivars (see BARLEY, OAT, or WHEAT CULTIVAR TABLES). A statewide monitoring program exists for early detection of susceptible genotypes.

In the event that new races of the fungus render current sources of resistance obsolete, fungicides such as propiconazole (Tilt) can be applied at 4 oz per acre to control disease outbreaks. Applications should be made between tillering and heading to protect the flag leaf.
A. PROPICONAZOLE
   (Tilt)  4 fl oz  12  See label

   MODE-OF-ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)

   COMMENTS: For use on wheat, barley, triticale, oats, and rye. For wheat, apply until Feekes growth stage 10.5 (full head emergence). For other grains, apply until Feekes 9 growth stage (emergence of flag leaf ligule).

** See label for dilution rates.
‡ 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.
LEAF SCALD OF BARLEY  (2/07)

Pathogen: *Rhynchosporium secalis*

SYMPTOMS
Lesions first appear on foliage as dark, pale or bluish gray spots. These spots expand into oval lesions with bluish gray centers and dark brown margins. The lesions enlarge and coalesce, giving the appearance of rapid scalding. Entire leaves may be covered and killed if the disease is severe. Lesions normally occur only on leaves, but when conditions favor severe disease, they also develop on spikes.

COMMENTS ON THE DISEASE
Leaf scald of barley affects only domestic and wild barleys (*Hordeum* spp.). It is most severe in years of higher than normal rainfall. The fungus survives between seasons primarily on barley residue and volunteer barley plants, and to a lesser extent on some grasses and barley seed. Infection, development, and spread occur during cool, 40° to 77°F (4° to 25°C), rainy weather. Spores are formed in a thin layer of slime on the surface of lesions and are spread short distances by splashing or wind-driven rain. Spores that land on plant surfaces germinate and infect the leaf if the surfaces remain wet for at least 24 hours. If infected seeds are planted, coleoptiles can be infected after the seeds germinate. The optimum temperature for coleoptile infection is about 60°F (16°C).

MANAGEMENT
Control measures include crop rotation (to any crop other than barley), removal/disposal of barley residue from the surface of the soil, and destruction of volunteer barley and grass hosts. Also, avoid early plantings (Oct. to Nov.) because when conditions favor disease development late plantings (Dec. to Jan.) are less damaged. Use clean seed and resistant cultivars (see BARLEY CULTIVAR TABLE).
LOOSE SMUT  (7/16)

Pathogens: Loose smut of wheat, triticale, and rye: Ustilago tritici
Loose smut of barley: Ustilago nuda
Black loose smut of barley and oats: Ustilago nigra, but the strains that attack oats are different from those that attack barley.

SYMPTOMS
Symptoms are usually not apparent until heading. Smutted heads usually emerge earlier than healthy heads. Diseased heads consist of olive-black masses of teliospores in the place of kernels. The smut spores are enclosed in a fragile, gray membrane that soon ruptures to release the airborne spores. By the time the grain matures, the spores are dispersed, leaving only a bare rachis.

COMMENTS ON THE DISEASE
Most loose smut pathogens survive from one season to the next as dormant mycelium inside infected seed. The fungus that causes black loose smut survives as teliospores on the surface of contaminated seed.

MANAGEMENT
Use certified smut-free seed. Hot water treatment can eliminate smut fungi from contaminated seed, but it must be used carefully to avoid reducing seed vitality. For information on hot water treatments, see UC/ANR Publication 3333, Integrated Pest Management for Small Grains.

Seed treatment with systemic fungicides is necessary because loose smuts are borne internally in seed.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/cwt</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example trade name)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. CARBOXIN</td>
<td>2–3 oz</td>
<td>12</td>
<td>See comments</td>
</tr>
<tr>
<td>(Vitavax 34F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER):</td>
<td>Carboxamide (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on barley, oats, triticale, and wheat. Do not use treated seed for food, feed, or oil purposes. Do not graze or feed livestock on treated areas for six weeks after planting.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. TRIADIMENOL</td>
<td>0.75–1.5 fl oz</td>
<td>NA</td>
<td>See comments</td>
</tr>
<tr>
<td>(Baytan 30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER):</td>
<td>Demethylation inhibitor (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on barley, oats, rye, and wheat. Do not use treated seed for food, feed, or oil purposes. All seed treated with this product must be colored with an EPA-approved dye (e.g., 40 CFR 180.1001) that imparts an unnatural color to the seed to help prevent the inadvertent use of treated seed as food for people or feed for animals. Green forage may be grazed 40 days after seeding.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. DIFENOCONAZOLE/MEFENOXAM</td>
<td>1.0 fl oz</td>
<td>48</td>
<td>See comments</td>
</tr>
<tr>
<td>(Dividend XL RTA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER):</td>
<td>Demethylation inhibitor (3) and Phenylamide (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on barley and wheat only. Do not use treated seed for feed or oil. Do not graze green forage for 55 days after planting. Do not plant any crop other than wheat within 30 days to fields in which treated seed was planted.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. TEBUCONAZOLE/THIRAM</td>
<td>3.5–4.6 fl oz</td>
<td>24</td>
<td>See comments</td>
</tr>
<tr>
<td>(Raxil-Thiram)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER):</td>
<td>Demethylation inhibitor (3) and Multi-site contact (M3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on barley, oats, triticale, and wheat. Do not use treated seed for feed, food, or oil purposes. Barley, oats, triticale, and wheat green forage may be grazed or harvested for hay 31 days after seeding.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UPDATED 7/16

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.

SEED TREATMENT

Illustrated version at http://ipm.ucanr.edu/PMG/selectnewpest.small-grains.html
Δ  Centum weight (cwt) is 100 pounds.
‡ 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.
NET BLOTCH OF BARLEY  (2/07)

Pathogen: Pyrenophora teres

SYMPTOMS
Lesions first appear as tiny spots that may be dark green and water soaked initially, but turn to light brown as they mature. Later, symptoms appear as narrow brown blotches with a netted or cross-hatched appearance. Surrounding tissue becomes yellow. In advanced stages a series of stripes with irregular margins extend in a parallel direction, sometimes the length of the leaf. When disease is severe, the lesions spread over the entire leaf and kill it. Lesions may occur on the spikes as the crop matures.

COMMENTS ON THE DISEASE
Net blotch of barley affects only domestic and wild barleys (Hordeum spp.). The fungus survives between seasons on barley residue, volunteer barley plants, some grasses, and seed. Barley residue and volunteer barley plants are the main sources for new infections each season. After initial infections, spores are produced on lesions when humidity is near 100% and temperatures are mild, 60° to 80°F (16° to 27°C). Spores are windblown to other plants for secondary spread. If infected seeds are planted, coleoptiles can be infected after the seeds germinate. Free moisture and cool spring weather favor disease development.

MANAGEMENT
Cultural Control
Primary control measures include crop rotation (to any crop other than barley), removal/disposal of barley residue from the surface of the soil, and destruction of volunteer barley and grass hosts. Also, avoid early plantings (Oct. to Nov.) because when conditions favor disease development late plantings (Dec. to Jan.) are less damaged. Use clean seed and resistant cultivars (see BARLEY CULTIVAR TABLE).
POWDERY MILDEW (7/16)

Pathogens: Each type of small grain is attacked by a specific form of the fungus *Blumeria graminis* (*Erysiphe graminis*): *Erysiphe graminis* f. sp. *tritici* infects wheat; *Erysiphe graminis* f. sp. *hordetii* infects barley, and weeds in the genus *Hordeum*; *Erysiphe graminis* f. sp. *avenae* infects oats and wild oats

SYMPTOMS
The disease first appears on lower leaves: white, cottony patches of fungal growth on the upper leaf surface that are opposite chlorotic spots on the underside of the leaf. The patches of white growth turn a dull gray-brown as fruiting structures, called cleistothecia, develop. Plants are often low in vigor.

COMMENTS ON THE DISEASE
The fungus overwinters in tiny, dark, spore-forming structures called cleistothecia that release airborne spores (ascospores) in spring. It also can overwinter as mycelium on volunteer wheat, barley, or oat plants and produce spores (conidia) that can cause initial infections; conidia from resulting lesions are windblown for secondary disease cycles at 10-day intervals. Disease development is optimal at 59°F to 72°F (15°C to 22°C) and is retarded above 77°F (25°C). Disease is favored by dense stands, high nitrogen fertilization, high relative humidity, and cool temperatures.

MANAGEMENT
Resistant cultivars of barley and wheat are available (see BARLEY and WHEAT CULTIVAR TABLES). Crop rotation, elimination of crop residue, and control of volunteer grains and weed hosts reduce inoculum survival from one season to the next.

Although normally not economical, foliar fungicides can be used to control disease outbreaks and provide partial disease control. Applications should be made between tillering and heading with the objective being to protect the flag leaf. Depending on weather conditions from tillering to early dough stage, one or more applications may be needed.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount/Acre**</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UPDATED 7/16</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. PROPICONAZOLE (Tilt)</td>
<td>2–4 fl oz</td>
<td>12</td>
<td>See label</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on wheat, barley, triticale, oats, and rye. For wheat, apply until Feekes growth stage 10.5 (full head emergence). For other grains, apply until Feekes 9 growth stage (emergence of flag leaf ligule).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** See label for dilution rates.
‡ 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.

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.
SEPTORIA TRITICI BLOTCH OF WHEAT  

Pathogen: *Septoria tritici* (*Mycosphaerella graminicola*)

**SYMPTOMS**

Symptoms occur on foliage as small gray dead areas that expand to irregularly shaped blotches. The blotches (lesions) begin as light green areas that appear to be limited at first by the leaf veins. The light brown lesions change to yellow areas in a few days, then to reddish brown, ending as grayish tan necrotic areas with small, black specks inside the dead areas. The black specks (pycnidia) within the lesions are the asexual fruiting structures of *Septoria tritici* and exude pinkish brown, column-shaped, jellylike masses of spores (conidia) upon wetting by rain or dew. These asexual conidia thus function as a source of inoculum to spread the disease within an infected field.

**COMMENTS ON THE DISEASE**

*Septoria tritici* blotch affects only wheat and is an important foliar disease of wheat in the Sacramento and northern San Joaquin valleys. It is particularly severe in years of higher than average rainfall and is especially damaging when late spring rains persist after emergence of the flag leaf.

The spores (ascospores) of the sexual stage of the pathogen, *Mycosphaerella graminicola*, initiate the first infections in each growing season when they are discharged into the air from sexual fruiting bodies in wheat debris remaining from previous crops. The maturation and discharge of ascospores occurs following the first fall rains. The ascospores, which are forcibly discharged and become airborne under drying conditions, serve to uniformly inoculate new plantings over wide distances. Current data indicate that ascospores can be discharged from October through April with the subsequent appearance of *Septoria tritici* pycnidia in lesions on wheat plants 3 to 4 weeks later. With two potential sources of inoculum for infection throughout the growing season, the major factors affecting severity of *Septoria tritici* blotch are temperature and moisture during the growing season. Spore germination and disease development are optimal at 60° to 77°F (16° to 25°C) when free moisture is present on the foliage. About 6 hours of leaf wetness are required for infection. Under favorable conditions of moisture and temperature, secondary cycles of infection occur every 21 to 28 days. Conversely, dry periods and warm weather prevent infection and disease spread. The disease reduces grain number, grain filling, or both, depending on whether the disease is severe only before or after anthesis versus the entire growth period of the grain.

**MANAGEMENT**

The fungus survives between cropping seasons primarily as *M. graminicola* on wheat residue. The presence of the airborne ascospores, capable of long distance spread in the wheat growing regions, means that crop rotation will not afford escape from this source of inoculum. The impact of the disease is most severe in early planted wheat (October) because the plants are exposed to the pathogen over a longer period of time during a period when weather conditions are frequently favorable to disease development. Consequently, later plantings of wheat (Nov. to Dec.) are less likely to be severely affected.

**Cultural Control**

Use resistant cultivars (see WHEAT CULTIVAR TABLE). Avoid early planting (October).

**Chemical Control**

Although normally not economical, foliar fungicides can be used to control disease outbreaks and provide partial disease control. Applications should be made between tillering and heading with the objective being to protect the flag leaf. Depending on the weather conditions from tillering to early dough stage, one or more applications may be needed.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount/Acre**</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
</table>

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 factors.
impact. Not all registered pesticides are listed. Always read the label of the product being used.

A. MANCOZEB
   (Dithane M45) 2 lb 24 26
   MODE-OF-ACTION GROUP NAME (NUMBER1): Multi-site contact (M3)
   COMMENTS: Do not graze cattle in treated areas before harvest. Do not make more than three applications per season.

B. PROPICONAZOLE
   (Tilt) 2–4 fl oz 12 See label
   MODE-OF-ACTION GROUP NAME (NUMBER1): Demethylation inhibitor (3)
   COMMENTS: For use on wheat, barley, triticale, oats, and rye. For wheat, apply until Feekes growth stage 10.5 (full head emergence). For other grains, apply until Feekes 9 growth stage (emergence of flag leaf ligule).

‡ 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.

** See label for dilution rates.

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.
STEM RUSTS OF WHEAT, BARLEY, AND OATS (2/07)

Pathogens: *Puccinia graminis* f. sp. *tritici* (wheat); *Puccinia graminis* f. sp. *secalis* (barley);
*Puccinia graminis* f. sp. *avenae* (oat)

SYMPTOMS

Brick red spores are formed in elongated pustules that erupt through the surface of host tissues. The pustules mainly form on stems, but can also occur on leaves and leaf sheaths. The pustules are distinguished from those of the leaf rust fungi by their brick red color and conspicuously tattered edges. As the plants mature, the pustules turn dark and shiny as teliospores are formed.

COMMENTS ON THE DISEASE

Stem rusts of wheat and barley are not significant diseases in California because the commonly grown cultivars are resistant. Some cultivars of oats, however, can be severely affected by races (strains) of the form of fungus that is specialized to oats. The rust fungi grow only on living host plants and are specialized to narrow host ranges (wheat stem rust does not affect barley; barley [rye] stem rust does not affect wheat). Sources of primary inoculum (urediospores) for crops include volunteer cereal plants and, because urediospores can be dispersed over great distances by air currents, distant fields of the respective cereal crops (wheat, barley, and oat). Spores from pustules from initial infections are windblown to initiate secondary cycles (7- to 10-day intervals) when temperatures are above 60°F (16°C) and moisture is not limiting. Urediospores infect the plant through stomata; a film of moisture is required for infection. The fungi then grow between host cells just under the plant epidermis. Tiny structures, called haustoria, penetrate host cells to obtain nutrients. Fungal tissue proliferates beneath the epidermis and as masses of spores are formed, the epidermis bursts and characteristic rust pustules appear. Infections increase water loss and decrease the amount of photosynthate available for grain filling, resulting in reductions in the number and weight of kernels.

MANAGEMENT

Control is achieved through the use of resistant cultivars. Some cultivars of oat, specifically Montezuma and Swan, can be severely affected by races (strains) of the fungus that are specialized to oat and should not be grown in areas subject to significant disease pressure.
STRIPE RUSTS OF WHEAT AND BARLEY  (7/16)

Pathogen: *Puccinia striiformis*

SYMPTOMS
Symptoms include yellow orange pustules oriented linearly between vascular bundles of leaves. Glumes are often infected. Stripe rust symptoms usually appear earlier in the season than other rusts because the fungus develops at lower temperatures than the other rust fungi. As the plants mature, the pustules turn dark and shiny as teliospores are formed. These spores do not play a role in disease development or survival.

COMMENTS ON THE DISEASE
Different races (strains) of the stripe rust pathogen affect wheat and barley. The stripe rust fungus has been responsible for some of the most devastating epidemics on wheat in California.

Races that can cause significant damage to barley were confined to Europe until 1975, when they were introduced into South America. Barley stripe rust was first detected in the U.S. in Texas in 1991 and in California in 1993/94. Major epidemics on barley in California occurred in 1996, 1997, and 1998.

The fungus grows only on living host plants and survives between seasons on volunteer wheat, barley plants, and some wild grasses. Rust spores are spread by wind to initiate infections. Disease development is most rapid at temperatures of 50° to 60°F (10° to 16°C) with intermittent rain and dew, although disease can continue to develop at higher temperatures and drier conditions; secondary cycles occur at 7- to 10-day intervals. Races infecting barley can survive in warmer, drier climates. Infections increase water loss and decrease the amount of photosynthate available for grain filling, resulting in reductions in the number and weight of kernels.

MANAGEMENT
Control is achieved through the use of resistant cultivars (see BARLEY and WHEAT CULTIVAR TABLES). A statewide monitoring program exists for early detection of susceptible genotypes and identification of new resistant genotypes.

Chemical Control
In the event that new races of the fungus render current sources of resistance obsolete, foliar fungicides can be applied to control disease outbreaks. Application timing will depend on when initial infections occur and on the specific label restrictions for each fungicide; the objective is to protect the flag leaf from infection and to protect the plant during the grain-fill period.

<table>
<thead>
<tr>
<th>Common name (Example trade name)</th>
<th>Amount/Acre**</th>
<th>REI‡ (hours)</th>
<th>PHI‡ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. PROPICONAZOLE</strong> (Tilt)</td>
<td>4 fl oz</td>
<td>12</td>
<td>See label</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td>COMMENTS: For use on wheat, barley, triticale, oats, and rye. For wheat, apply until Feekes growth stage 10.5 (full head emergence). For other grains, apply until Feekes 9 growth stage (emergence of flag leaf ligule).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. AZOXYSTROBIN</strong> (Quadris)</td>
<td>Barley, Oats, Rye: 9–12 fl oz</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11)</td>
<td>COMMENTS: For use on barley, oats, rye, and wheat. Do not apply after heading is completed (Feekes 10.5). Do not make more than two applications per season.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
C. PYRACLOSTROBIN

(Headline) 6–9 fl oz 12 See comments

MODE-OF-ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11)
COMMENTS: For use on barley, rye, triticale, and wheat. Do not apply to barley after 50% head emergence (Feekes 10.5) or to wheat after heading is completed (Feekes 10.5). Do not harvest wheat or barley hay or feed green-chopped wheat or barley within 14 days of last application. Do not make more than 2 applications per season.

D. TRIFLOXYSTROBIN/PROPICONAZOLE

(Stratego) See comments 12 See comments

MODE-OF-ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11) and Demethylation inhibitor (3)
COMMENTS: On wheat and triticale: rate is 10 fl oz/acre. Do not apply after Feekes growth stage 10.5 (full head emergence). Do not make more than 2 applications per season or apply within 35 days of harvest. If one application or a total of 10 fl oz of Stratego per season is applied, do not allow livestock to graze within the treated area within 30 days after application, and do not harvest the treated crop for forage within 30 days after application or use for hay within 45 days after application. If 2 applications or a total of 20 fl oz of Stratego per season is applied, do not allow livestock to graze within the treated area and do not harvest the treated crop for forage or hay. On barley and oats: rate is 7 fl oz/acre. Do not apply after Feekes growth stage 8 (emergence of flag leaf ligule). Do not make more than 2 applications per season or apply within 40 days of harvest. If 1 application or a total of 7 fl oz is applied per season, do not allow livestock to graze within the treated areas within 30 days after application, and do not harvest the treated crop for forage within 30 days after application or for hay within 45 days after application. If two applications or a total of 14 fl oz is applied in a season, do not allow livestock to graze within the treated area and do not harvest the treated crop for forage or hay.

‡ 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.

** See label for dilution rates.

† 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.
TAKE-ALL (2/07)

Pathogen: *Gaeumannomyces graminis* f. sp. *tritici*

SYMPTOMS
Symptoms first appear as stunting and reduced tillering early in the growing season. Later, infected plants prematurely form white heads that lack grain. Roots and crowns are darkened. The presence of a layer of dark brown or black fungal mycelium underneath the lowest leaf sheaths distinguishes take-all from common root rot.

COMMENTS ON THE DISEASE
The fungus survives on crop residue and on roots of certain grass weeds, including bentgrass, quackgrass, and some species of brome. Under conditions of high soil moisture, the fungus spreads to adjacent plants by root contact. Infection is favored by cool weather. Take-all is more severe in plants grown on alkaline soil or soil deficient in nutrients.

MANAGEMENT
Cultural Control
Crop rotation: oats and rye are acceptable rotation crops because they are not hosts for the pathogen. Improve field drainage. Provide optimum soil fertility. Avoid excessive nitrate fertilizer, which aggravates take-all.

Chemical Control
There are no recommended chemical treatments for this disease.
Scientific Names:
- Barley root knot nematode: *Meloidogyne naasi*
- Columbia root knot nematode: *Meloidogyne chitwoodi* (Race 1 & 2)
- Southern root knot nematode: *Meloidogyne incognita*
- Javanese root knot nematode: *Meloidogyne javanica*
- Peanut root knot nematode: *Meloidogyne arenaria*
- Lesion nematode: *Pratylenchus thornei* and *P. neglectus*
- Stem and bulb nematode: *Ditylenchus dipsaci*
- Cereal cyst nematode: *Heterodera avenae*

DESCRIPTION OF THE PESTS

Plant parasitic nematodes are microscopic roundworms that feed on plant roots. They survive in soil and plant tissues, and several species may occur in a field. They have a wide host range, vary in their environmental requirements, and in the symptoms they cause.

DAMAGE

Eight different species of nematodes are known to attack small grains in California, but each is important only in certain areas. *Meloidogyne chitwoodi* in northeastern California, and *M. incognita*, *M. javanica*, and *M. arenaria* in the central and southern portions of the state build up on grains, but their damage is mostly on subsequent rotation crops. *Meloidogyne naasi* in northeastern California is known to reduce yields of barley. In the Imperial Valley and some other warm areas, lesion nematode, *Pratylenchus thornei*, may damage small grains. Stem and bulb nematode has damaged susceptible oat cultivars in parts of the south central coast. If grain were to be planted in spring or summer in fields infested with *M. incognita*, *M. javanica* or *M. arenaria*, the crop could suffer damage.

SYMPTOMS

The symptoms described below are indicative of a nematode problem, but are not diagnostic as they could result from other causes as well. Infestations may occur without causing any aboveground symptoms.

Feeding by root knot nematodes cause cell enlargement and proliferation and may result in swellings, called galls, on roots. Galls are not always formed, and when present are very small and may be spindle shaped or in spirals. Sometimes there will be a proliferation of lateral root branches. Occasionally plants infested with Columbia root knot nematode will have egg masses, which appear as tiny bumps, on the root surface. Plants heavily infested with barley root knot nematode may be stunted, chlorotic, and often fail to develop heads. Plants infested by lesion nematode, *Pratylenchus thornei*, will be stunted and yellow in patches, have brown leaf tips, fewer tillers and smaller heads. Stem and bulb nematodes can curl newly emerging leaves into spirals, stunt plants, reduce tillering, inhibit head formation, and sometimes kill the plant. The cereal cyst nematode has been found on grasses in some parts of California, but not on small grains. It is potentially very damaging to grains; an infestation would produce aboveground symptoms similar to that of root knot and lesion nematodes. Infested roots are short, and abnormally branched. Adult females (cysts) can be seen on the root surface as tiny, pinhead size, white or brown, lemon-shaped structures.

FIELD EVALUATION

To make management decisions, it is important to know the nematode species present and their population estimates. If a previous crop had problems caused by nematodes that are also listed as pests of small grains, population levels may be high enough to cause damage to subsequent crops. If nematode species have not previously been identified, soil samples should be taken and sent to a diagnostic laboratory for identification.

Soon after harvest or preferably just before harvest take soil samples from within the root zone of the previous crop. Divide the field into sampling blocks of not more than twenty acres each that represent cropping history, crop injury, or soil texture. Take several subsamples randomly from a block, mix them thoroughly and make a composite sample of about 1 quart (1 liter) for each block. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address,
location, and the current/previous crop and the crop you intend to grow. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

**MANAGEMENT**

**Sanitation.** Use a high-pressure hose to wash soil from equipment before moving from infested to noninfested fields.

**Crop rotation.** Rotation with resistant cultivars of oats or to noncereal crops is recommended for fields with *Meloidogyne naasi*. A 1-year rotation with Cayuse oats is reported to reduce *M. naasi* populations to levels sufficient to grow a crop of barley. The cultivar Kanota is also known to be resistant. Weed hosts should be destroyed during crop rotations. Contact your farm advisor for information on susceptibility of newer oat varieties.

**Planting date.** For *Meloidogyne incognita* and *M. arenaria*, fall planting after soil temperature has dropped below 64°F, reduces damage by the nematodes and also nematode population development.

**Fallow.** Weed free fallow reduces most nematode populations. Fallow is more effective if soil is plowed and exposed to sun. Irrigation during the dry period stimulates egg hatch and so further reduces nematode populations if proper weed control is maintained.

**Resistant cultivars.** Genes for resistance to *Meloidogyne chitwoodi*, *M. incognita*, and *M. javanica* have been transferred to experimental lines of bread wheat. Consult your farm advisor for more information regarding availability of resistant cultivars for your area.

**Chemical.** Use of chemical control on small grains has not generally been found to be cost effective.
Weeds

INTEGRATED WEED MANAGEMENT  (2/09)

Weeds compete with small grains (barley, oats, wheat, rye, and triticale) for nutrients, water, and light, reducing crop yields and grain quality. An integrated weed management program in small grains combines cultural, mechanical, and chemical weed control practices. A vigorous, competitive crop produced through good cultural practices is the best defense against weed competition. Several herbicides are available for use in grain; however, one should rely on an integrated approach to weed management. An integrated approach is all inclusive, using good cultural practices and crop rotation along with the appropriate herbicides.

The variety of environments and production systems in California requires several different strategies for weed control. Grain is grown under irrigated and dryland conditions in California. These different cultural and climatic conditions have considerable impact on weed management.

Dryland grain yields less than irrigated grain, reducing the grower's incentive to invest in chemical weed control. The dryland grower's options for crop rotation are limited compared to those of the irrigated grower. Where annual rainfall is less than 18 inches, dryland management may include a rotation into summer fallow to conserve moisture and to reduce weed problems. In irrigated fields, the grower has more options to manage weed problems within a rotational system.

MONITORING

Weeds are controlled best in the seedling stage; therefore, it is important to be able to identify weed seedlings. A good pictorial reference, such as the online weed gallery photos on the UC IPM website (http://ipm.ucanr.edu/PMG/weeds_common.html) will help assist in identifying weeds. It is important to keep a log of summer and winter weeds by field for a comprehensive management system.

Examine the grain field when the crop is in the 2- to 3-leaf stage so weeds can be detected easily. The entire field should be examined to determine which species of weeds are present. Visualize a square yard area and count the number of weeds, identifying species and size. Make frequent counts as you walk through the field to get a realistic picture of the problem. Five or more competitive weeds (e.g., wild oats) per square yard or one or more large weeds (e.g., wild mustard) per square yard indicates that the weed population is at the threshold stage and should be removed by a herbicide application to avoid an economic yield loss.

WEED MANAGEMENT BEFORE PLANTING

Weed management before planting is primarily a matter of properly preparing the field as well as various other cultural practices and keeping fence lines, ditches, and wasteland areas free of weeds to reduce sources of infestation. Thoroughly cleaning combines and tillage equipment before entering or leaving a field is an important practice.

Certified seed. Seed certified by the California Crop Improvement Association is slightly more expensive than common seed, but is a good investment to ensure potential for higher yield, increased germination, and reduced risk of introducing a new weed species. A few weed seeds planted with grain seed can contaminate a sizable area within a few years. Wild oats, ripgut brome, and field bindweed are often spread as contaminants in common seed.

Crop rotation. Crop rotation helps manage weeds (johnsongrass, wild oats, ryegrass, etc.) in the following ways: different crops allow different types of tillage and cultivation, plus various herbicides can be used when crops are rotated. Crops other than grain may be more competitive with certain weeds. For example, corn or dry beans can cover and shade the rows during summer, helping to compete with annual weeds. Cotton, corn, alfalfa, potato, sugarbeet, dry beans, tomato, and safflower are among the crops grown in rotation with grains.
Crop/fallow rotation conserves moisture and has many additional benefits, such as controlling wild oats by curtailing its seed production and reducing the number of seeds in the soil. Fallow also encourages microbial activity, releasing essential elements from decomposing cereal stubble. Crop/fallow rotation may include crop-pasture-fallow or crop-hay-fallow rotations. A grower usually needs to till during fallow to control weeds. In conservation tillage farming or in fields severely infested with weeds, a grower will need to use herbicides during fallow, a practice called chemical fallow. Herbicides used for this use are listed in the HERBICIDE TREATMENT TABLE.

Preirrigation. In arid regions, such as the Imperial and San Joaquin Valleys, cereal growers often preirrigate or wait for the first rain to germinate weed seeds and remove them by tilling before planting or by applying postemergent herbicides such as glyphosate (Roundup) or paraquat (Gramoxone). In spring-planted areas, fall preirrigation is practiced to germinate wild oats and volunteer grains; however, in high rainfall areas or in heavy soils, preirrigated fields remain too wet for timely planting of the crop.

Land preparation. Adequate drainage is essential for fields planted to small grains. Excessive moisture in low areas creates and aggravates problems, such as stand loss, loss of soil nutrients, reduced oxygen supply, and root diseases. Chiseling the soil before seedbed preparation greatly enhances drainage and root development.

Growing grain on beds in the Sacramento and San Joaquin Valleys has a two-fold advantage: drainage in winter and furrow irrigation in spring. In the Delta where grain is grown on organic soils, spud ditches are used for this same purpose. In areas where flooding and high water tables occur, grow small grains on 30 to 60 inch raised beds.

Tillage. Tillage practices vary widely in California. Tillage is used to eliminate existing weeds, incorporate residues and fertilizer, reduce compaction, and prepare a seedbed. It includes chiseling, disk ing, plowing, and harrowing to firm the seedbed before planting. Plowing the soil 12 to 14 inches reduces the risk of herbicide carryover from the previous crop. Dilution of possible residuals of herbicides applied to previous crops is very important if grains are planted after cotton, sugarbeet, dry beans, tomato, alfalfa, corn, potato, lettuce (Imperial Valley), or oil seed crops.

Under dryland conditions, primary fall tillage with a disk, chisel plow, or moldboard plow, usually follows as soon after the first autumn rainfall to eliminate germinating winter weed seedlings.

Planting methods and seeding rates. Small grains are either planted with a grain drill or broadcast and incorporated to a depth not to exceed 2 inches. Drilled grain generally produces a more uniform stand than broadcast planting. Sowing date can influence weed competition. Grains planted late are shorter, produce fewer tillers, and are less competitive with weeds than grains planted at the recommended time. Plant late-planted wheat at higher seeding rates to improve yield and weed competitiveness. Broadcast applications require about 15% more seed than drilling. In many areas high seeding rates of wheat (175 lb per acre) are used as a form of weed control to compete with johnsongrass, smartweed, and wild oats. Excessive seed rates in barley and oats increase lodging and diseases.

Mulch planting. An effective means of weed control used in the southern desert is mulch planting. Mulch planting places the seed beneath a layer of dry mulch, which inhibits weed seed germination. Before planting, the field is shallowly cultivated to destroy weeds that have germinated following a rainfall or irrigation. The crop is then sown into moist soil below the mulch layer of dry soil that resulted from the cultivation. Because the crop seed is placed into moist soil, it germinated quickly, ahead of weeds. In some cases this method eliminates the need for herbicides.

Preplant fertilizer. Proper amounts of nitrogen and phosphorus are critical in managing crop yield and its ability to compete with weeds. Grain fields low in nitrogen and phosphate are not vigorous, giving weeds the advantage. Anytime a fertilizer is broadcast, weeds benefit more than the crop. Banding of fertilizers in or near the crop seed row will make fertilizer more available to the crop during the seedling stage than to weeds. This is particularly advantageous with phosphate applications.

Herbicides. Weeds that have germinated can be chemically removed with paraquat or glyphosate before planting or before crop emergence. Pyraflufen-ethyl (ET) is also labeled for control of emerged
broadleaves. These nonselective herbicides have no soil residual effects on germinating small grain plants as long as they are applied before the plants emerge through the soil. If the herbicide comes into contact with wheat and barley plants, severe injury will occur. Glyphosate also can be a tool at this time to suppress perennial weeds such as johnsongrass, nutsedge, bermudagrass and dandelion.

Preemergent herbicides are not commonly used in small grains in California but can be effective in certain situations. Trifluralin (Treflan) is a preemergent herbicide used for wild oat and canarygrass control in wheat and barley. It is applied before or after sowing and must be incorporated no deeper than 2 inches. A double incorporation is more effective than a single incorporation. Small grains must be planted below the 2-inch herbicide zone (for semi-dwarf wheat, this depth is near the limit for successful emergence). Results can be erratic if the zone of treatment does not have adequate moisture. Crop safety is marginal.

WEED MANAGEMENT AFTER PLANTING

After grain is planted, weeds typically emerge along with the crop. Cultivation is not possible and producers must rely on herbicides and good agronomic practices for effective control. Depending upon the amount of rainfall after planting, one to three nitrogen top dressings may be required for wheat.

Herbicides. Postemergent herbicides are applied to the crop, usually at the 2- to 3-leaf and tillered stages. Fall-planted grains are treated between December to mid-March, depending on time of planting and on growing conditions. Generally, spring-planted grains at higher elevations are treated from April to June. Depending on weeds present, one or two herbicide applications or combinations may be required. Application must be properly timed for maximum weed control and avoidance of crop injury. Grass and broadleaf weeds germinate with the beginning of the rainy season. Depending upon species, they can sometimes be controlled at the same time, permitting the use of tank-mixed herbicide combinations, but often grass and broadleaf control need separate applications. A tank mix can mean an important savings of time and cost. Refer to herbicide labels for mixing recommendations.

Broadleaf weed control. Typically only postemergent herbicides are applied after the crop has emerged. Fall-sown small grains usually are treated between December and mid-March, depending on the sowing date and growing conditions. Spring-sown small grains in the intermountain area of northern California are treated between April and June. Several postemergent herbicides are registered for use.

Phenoxy herbicides, including 2,4-D and MCPA, commonly are used in small grains alone or in combinations. Dicamba, another hormonal-type herbicide, often is included in the phenoxy herbicide group because of its similar mode of action. These herbicides are most effective when applied to small and succulent weeds. Small grains vary in their sensitivity to these herbicides; for example, oat is more tolerant to MCPA than to 2,4-D. Ester and amine formulations of 2,4-D and MCPA control many broadleaf weed species encountered in small grains. The ester form usually is more effective than the amine form. However, ester use is not permitted in most counties or applications are limited to certain times of the year.

Apply phenoxy herbicides after the small grains are well tillered but before they reach the boot stage (see DEVELOPMENTAL GROWTH STAGES) in order to avoid yield reductions caused by phytotoxicity. Best control is obtained when weeds are small and before the crop has reached the jointing stage. Late applications are sometimes ineffective because the crop canopy shields the weeds, preventing herbicide contact. Dense weed populations require a more thorough application with a greater spray volume to ensure herbicide/weed contact. The use of aircraft often facilitates timely herbicide application, but care must be taken to make applications at the appropriate time to avoid injury to adjacent crops from drift or volatilization. MCPA does not control large weeds as well as 2,4-D amine and 2,4-D ester herbicides but has greater crop safety especially when applied to small grains in early growth stages.

Dicamba (Banvel, Clarity) is effective for broadleaf weed control; however, small grains generally are more sensitive to it than to 2,4-D. It is safer when applied at early growth stages (2- to 5-leaf stage). Dicamba cannot be used on fall-sown barley. It controls small chickweed and fiddleneck, which are not controlled by 2,4-D or MCPA. Dicamba usually is combined with bromoxynil and MCPA or carfentrazone (Shark). When applied early, this combination is very effective and increases the weed spectrum controlled compared to either of the herbicides used alone.
Bromoxynil (Buctril), a contact herbicide, is effective on young seedling weeds with no more than two to four leaves. It is less effective on older weeds and must be tank-mixed with other herbicides when larger mustards are present. Bromoxynil is not translocated, or moved, from the site of absorption like the phenoxy herbicides. Therefore, higher volume application and thorough coverage is more important with bromoxynil than with phenoxy herbicides. An advantage of bromoxynil is that it controls the toxic weed fiddleneck. Bromoxynil also is recommended in areas with phenoxy-sensitive crops (grapes, cotton, tree crops) and can be tank-mixed with grass herbicides.

Chlorsulfuron (Glean) is registered for use on wheat in a wheat/fallow rotation. It is a sulfonyl urea herbicide with a very low use rate. It is not widely used in California because it has a long soil life (at least 18 months) that prevents its use in areas where many different crops are grown. Most broadleaf weeds, including fiddleneck and chickweed, are controlled. Apply it to small weeds when the small grain crop is in the 2-3 leaf stage to boot stage (see DEVELOPMENTAL GROWTH STAGES) and should not be used on soils with pH above 7.5.

Clopyralid (Stinger), a picolinic acid, is registered for use on wheat, barley and oats. It translocates systemically through weeds, similar to phenoxy herbicides. It has a longer soil persistence than phenoxy herbicides, which limits planting of many broadleaf crops before 12 and 18 months. It is effective on a different spectrum of weeds than 2,4-D, MCPA or dicamba. Clopyralid is especially effective for control of legumes and composites (such as Canada and yellow starthistle). It does not control many common broadleaf weeds such as mustards, so must be tank-mixed for complete control of the wide range of broadleaf weeds found in small grains. The timing of application on wheat is from the 3-leaf stage to early boot stage (see DEVELOPMENTAL GROWTH STAGES), complimenting the timing of 2,4-D and MCPA.

Carfentrazone (Shark) is a contact herbicide that controls weeds by disrupting cell membranes. It is effective at very low use rates on fiddleneck, malva sp., burning nettle, and other weeds that are difficult to control with other herbicides. Adding surfactants to carfentrazone often causes temporary crop burn. Tank mixing with UN-32 may enhance weed control. Tank mixing with dicamba provides good control of chickweed. Combining carfentrazone with phenoxy herbicides broadens the weed spectrum controlled, lowers herbicide application rates, and can reduce the risk of weeds building up herbicide resistance. Avoid air applications during inversions (e.g., foggy conditions) to prevent off-target movement to sensitive crops (e.g., almonds). Several San Joaquin Valley counties have additional restrictions for carfentrazone, along with most of the other cereal herbicides.

Pyraflufen-ethyl (ET) is another contact herbicide that controls weeds by disrupting cell membranes. It is effective at very low use rates on Malva spp., burning nettle, and other weeds that are difficult to control with other herbicides. Tank mixing with dicamba provides good control of chickweed. Combining ET with phenoxy herbicides broadens the weed spectrum controlled, lowers herbicide application rates, and can reduce the risk of weeds building up herbicide resistance.

Grass weed control. Fenoxaprop (Puma) controls canarygrass, wild oat and several Setaria spp., including yellow and green foxtails. It also suppresses mustards. It has a wide window of application, providing effective control when applied between the 1-leaf and 6th leaf grass stage. For best control of wild oat, delay application until most wild oat plants have emerged, which often pushes this to the 5- to 6-leaf stage. A tank mixture with bromoxynil allows for a wide range of weed control at an early timing. Fenoxaprop cannot be tank-mixed with phenoxy herbicides because it often reduces grass control when tank mixed.

Mesosulfuron (Osprey) controls most grassy weeds and many broadleaf weeds in wheat. It is especially effective on Italian ryegrass, wild oat, little seed and hood canarygrass, and annual bluegrass. It controls ripgut brome and other brome species depending on weed size at application. Most California wheat cultivars have good tolerance to the herbicide. However, wheat plants will turn a lighter green color for a couple weeks following application. If soil nitrogen levels are low, this symptom will persist longer and require an application of supplemental nitrogen. When treated beyond the one-tiller stage, temporary growth suppression and shortening of the wheat plant will occur. The crop will recover more quickly from these symptoms under good growing conditions.
Mesosulfuron is effective on certain broadleaf weeds including chickweed, wild radish, and mustards. It also provides partial control of many other broadleaf weeds including common groundsel, common malva, fiddleneck, yellowstar thistle and milk thistle. Mesosulfuron can be tank mixed with bromoxynil and MCPA and may be applied from the 1-leaf to 1-tiller wheat stage and up to the 2-tiller stage of grass weed development (see DEVELOPMENTAL GROWTH STAGES). A methylated seed oil or a non-ionic surfactant is required; ammonium sulfate or low rates of UN-32 added will enhance weed control on difficult to control weeds. Restrictions on crop rotations are greater than with Fenoxaprop.

Pendimethalin (Prowl H20) is a selective herbicide applied after the wheat has emerged but before the weeds have emerged. Pendimethalin controls most annual grasses and certain broadleaf weeds as they germinate. Adequate rainfall or irrigation after application but before weed seedling emergence is needed to provide effective weed control.

**Harvesting.** Uncontrolled weeds delay maturing grains and create harvest problems. Field bindweed, prostrate knotweed, Russian thistle, fivehook bassia, lambsquarter, smartweed, and johnsongrass are examples. Heavy concentrations of green vines, stalks, or stems slow down combines and raise the moisture content of the harvested crop. Green debris and weed seeds mixed into grain causes heating in the grain bin; grain may be discolored and acquire off-flavors. Unclean storage also invites insect and mold damage. A mature grain field contaminated with immature weeds may be harvested in one of two ways: (1) the crop may be swathed (cut and left in windrows) or (2) where permitted, formulations of 2,4-D and glyphosate (Roundup) that are registered as preharvest aids can be applied to mature grain to kill and dry out weeds. In either case, grain is harvested after weeds have dried. Windrows are harvested with a combine equipped with a pickup attachment. Dry weeds and their seeds usually can be separated from grain during combining. In the San Joaquin Valley, use of 2,4-D is restricted between March 15 and October 15.

**Fallow.** For rainfed production systems, fields can be fallowed every other year to prevent weed seed build up and conserve moisture for maximum small grain growth. Do not allow weeds to grow and produce seed during the fallow season. Summer fallowing is practiced in dryland areas of the state that generally receive less than 18 inches of annual rainfall. The fallow season starts in fall after the crop is harvested. Depending on local rainfall patterns and availability of time and equipment, primary tillage is often performed in fall or winter when the following year’s crop is being planted. Tillage tools of choice for primary tillage vary from plows in the Sacramento Valley to chisel plows along the Central Coast. If primary tillage cannot be accomplished before heavy winter rains begin, it is often delayed until spring to reduce erosion hazards. One or more traditional tillage trips, with disks or field cultivators, are performed through the fallow season, depending on additional weed growth. Often, one of the final tillage trips in late summer or early fall is used to inject nitrogen fertilizer into the soil. In some areas, small grains are seeded in early fall to take advantage of the first rains and the ability to still move equipment across dry fields. The HERBICIDE TREATMENT TABLE lists herbicides used in small grain fallow.
SPECIAL WEED PROBLEMS  (2/09)

ANNUAL BROADLEAF WEEDS. The spectrum of broadleaf weeds in California grain fields differs considerably in fall- and spring-planted regions, and varies from the northern Sacramento Valley to the southern Imperial Valley. In fall-planted grain, the most troublesome broadleaf weeds are winter radish, fiddleneck, wild mustard, black mustard, London rocket, shepherd’s-purse, and spiny sowthistle. Many of the winter annual weeds, especially coast fiddleneck and the mustards and their allies, compete keenly with grain through the jointing stage. If such weeds are not controlled before the boot stage of the crop, they ultimately tower above it, creating severe competition for the grain plants.

Spring-germinating weeds become serious problems in fall-planted grain because they emerge after the cutoff date for applying phenoxy herbicides. In spring-planted grain, summer annuals such as redroot pigweed, common lambsquarter, kochia, Russian thistle, and common sunflower can be economically important because they can reduce yields and cause harvest problems. Smartweed (kelp) is a major problem in Delta areas with high water tables.

In cooler areas, where grain is only irrigated a few times during the growing season, weeds are primarily a problem in the summer and late season where they interfere with harvest unless controlled.

Wild beet is a problem in small grains only in the Imperial Valley; even a small amount of its purple seed can stain wheat flour and make it unusable. Dicamba or 2,4-D can control wild beet and prevent quality problems.

To determine the susceptibility of annual broadleaf weeds to various herbicides, check the SUSCEPTIBILITY TABLES. Recommended rates for individual herbicides are listed in the HERBICIDE TREATMENT TABLE.

ANNUAL GRASS WEEDS. Grassy weeds in California small grains are generally winter annuals. Wild oats, Italian ryegrass, ripgut brome, foxtail, wild barley, and hood canarygrass are the major grass weeds in small grains grown in California.

Wild oat is a major weed throughout the grain-growing areas in California because it emerges throughout the cool season from autumn through spring. It causes lodging, slows harvest, clogs harvester screens, and lowers yields dramatically. If wild oat populations are extreme, consider cutting small grains for hay or silage to greatly reduce the weed population in subsequent crops.

Ripgut brome, wild barley, and foxtail barley are mainly problems in new fields that were previously rangeland or pasture. The seeds of ripgut brome have a major impact on marketability of grain. Two to six ripgut brome seeds per quart of grain make it unsaleable for livestock feed.

Other problem grass weeds include littleseed canarygrass, rabbitfoot polypogon, and jointed goatgrass. Littleseed canarygrass is the major grass weed in southern deserts. Rabbitfoot polypogon can be a problem in areas of high water tables. These grasses are generally very competitive with grain, particularly during the seedling stage.

An annual grass weed found only in Siskiyou County, jointed goatgrass, is similar to wheat in all respects except for the head. There are no chemicals registered for its control in wheat; management of this weed is either when the field is fallow or planted to a rotation crop.

Crop rotation is of utmost importance for control of grassy weeds. Important rotational crops include cotton, corn, alfalfa, sugarbeet, and tomato. Consequently, grassy weeds are normally a greater problem in dryland production than on irrigated land, because grains are not grown in rotation with broadleaf crops in these areas. In irrigated systems, broadleaf crops provide an opportunity to control grasses because fields can be cultivated or mowed, and herbicides effective against grasses may be used. Some specific grassy weeds may be controlled in grains with difenzoquat (see the SUSCEPTIBILITY and HERBICIDE TREATMENT TABLES).
FIELD BINDWEED. Field bindweed is the most widespread and destructive perennial broadleaf weed in California, infesting grains and numerous other crops from the Oregon border to Baja California. Field bindweed can be suppressed with 2,4-D during the growing season, or with glyphosate (Roundup) or dicamba (Banvel) after harvest. Observe plantback restrictions for dicamba.

JOHNSONGRASS. Johnson grass creates problems in many areas, especially in the Sacramento/San Joaquin Delta and the Central and Imperial valleys. Johnson grass germinates in spring and may interfere with spring harvest. Growth just before and after harvest can be controlled by glyphosate (Roundup). Repeated summer tillage also helps reduce johnsongrass competition in the next crop. Increased seeding rates help control johnsongrass, especially in the Delta. Johnson grass can be more easily controlled in glyphosate-tolerant corn or cotton or using selective grass herbicides in corn, cotton, and alfalfa during crop rotation.
### COMMON AND SCIENTIFIC NAMES OF WEEDS

(2/07)

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>barley, hare</td>
<td><em>Hordeum leporinum</em></td>
</tr>
<tr>
<td>barnyardgrass</td>
<td><em>Echinochloa crus-galli</em></td>
</tr>
<tr>
<td>bassia, fivehook</td>
<td><em>Bassia hyssopifolia</em></td>
</tr>
<tr>
<td>bindweed, field</td>
<td><em>Convolvulus arvensis</em></td>
</tr>
<tr>
<td>bluegrass, annual</td>
<td><em>Poa annua</em></td>
</tr>
<tr>
<td>brome, ripgut</td>
<td><em>Bromus diandrus</em></td>
</tr>
<tr>
<td>burclover, California</td>
<td><em>Medicago polymorpha</em></td>
</tr>
<tr>
<td>buttercup, crowfoot</td>
<td><em>Ranunculus sceleratus</em></td>
</tr>
<tr>
<td>canarygrass, hood</td>
<td><em>Phalaris paradoxa</em></td>
</tr>
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<td>Canarygrass, littleseed</td>
<td><em>Phalaris minor</em></td>
</tr>
<tr>
<td>chamomile, mayweed</td>
<td><em>Anthemis cotula</em></td>
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<tr>
<td>chickweed, common</td>
<td><em>Stellaria media</em></td>
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<tr>
<td>fiddleneck, coast</td>
<td><em>Amsinckia menziesii var. intermedia</em></td>
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<tr>
<td>filarees</td>
<td><em>Erodium</em></td>
</tr>
<tr>
<td>foxtails (yellow and green)</td>
<td><em>Setaria spp.</em></td>
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<td>goatgrass, jointed</td>
<td><em>Aegilops cylindrica</em></td>
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<td>goosefoot, nettleleaf</td>
<td><em>Chenopodium murale</em></td>
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<td>groundsel, common</td>
<td><em>Senecio vulgaris</em></td>
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<tr>
<td>henbit</td>
<td><em>Lamium amplexicaule</em></td>
</tr>
<tr>
<td>johnsongrass</td>
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<td>knotweed, prostrate</td>
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<td>kochia</td>
<td><em>Kochia scoparia</em></td>
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<tr>
<td>ladythumb</td>
<td><em>Polygonum persicaria</em></td>
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<tr>
<td>lambsquarters, common</td>
<td><em>Chenopodium album</em></td>
</tr>
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<td>lettuce, prickly</td>
<td><em>Lactuca serriola</em></td>
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<tr>
<td>mallow, little (cheeseweed)</td>
<td><em>Malva parviflora</em></td>
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<tr>
<td>milkthistle</td>
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<tr>
<td>miner's lettuce</td>
<td><em>Claytonia perfoliata</em></td>
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<tr>
<td>mustards</td>
<td><em>Brassica</em></td>
</tr>
<tr>
<td>nettles</td>
<td><em>Urtica urens</em></td>
</tr>
<tr>
<td>nutsedge, yellow</td>
<td><em>Cyperus esculentus</em></td>
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<tr>
<td>oat, wild</td>
<td><em>Avena fatua</em></td>
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<tr>
<td>oxtongue, bristly (biennial)</td>
<td><em>Picris echioides</em></td>
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<tr>
<td>pigweed, redroot</td>
<td><em>Amaranthus retroflexus</em></td>
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<td>pimpernel, scarlet</td>
<td><em>Anagallis arvensis</em></td>
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<tr>
<td>pineapple-weed</td>
<td><em>Chamomilla suaveolens</em></td>
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<tr>
<td>polygogon, rabbitsfoot</td>
<td><em>Polypogon monspeliensis</em></td>
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<td>radish, wild</td>
<td><em>Raphanus raphanistrum</em></td>
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<tr>
<td>redmaids (desert rockpurslane)</td>
<td><em>Calandrinia ciliata</em></td>
</tr>
<tr>
<td>London rocket</td>
<td><em>Sisymbrium irio</em></td>
</tr>
<tr>
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<td>Scientific Name</td>
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## SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL

### (7/16)

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<th>GLY</th>
<th>MCA*</th>
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C = control    P = partial control    N = no control    — = no information

BRO = bromoxynil (Buctril)    MCA = MCPA Amine*
CAR = carfentrazone (Shark)    MES = mesosulfuron (Osprey)

Susceptibility of Winter Weeds to Herbicide Control (7/16)  
Illustrated version at http://ipm.ucanr.edu/PMG/selectnewpest.small-grains.html
Susceptibility of Winter Weeds to Herbicide Control

**CHS** = chlorsulfuron (Glean)  
**PAR** = paraquat* (Gramoxone)

**CLO** = clopyralid (Stinger)  
**PEN** = pendimethalin (Prowl H20)

**DIA** = dicamba* (Banvel, Clarity)  
**PYR** = pyraflufen-ethyl (ET)

**FEN** = fenoxaprop (Puma)  
**TRI** = trifluralin (Treflan)

**GLY** = glyphosate (Roundup)  
**24D** = 2,4-D Amine*

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

+ Control varies depending on size of weed at application; the smaller the weed, the better the control.
### SUSCEPTIBILITY OF SPRING/SUMMER WEEDS TO HERBICIDE CONTROL (2/09)

#### ANNUAL WEEDS

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<th>Postplant (selective)</th>
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<th>PYR</th>
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</tbody>
</table>

**C = control**  **P = partial control**  **N = no control**  **— = no information**  **BRO = bromoxynil (Buctril)**  **MCA = MCPA Amine**  **CAR = carfentrazone (Shark)**  **MES = mesosulfuron (Osprey)**  **CHS = chlorsulfuron (Glean)**  **PAR = paraquat* (Gramoxone)**  **DIA = dicamba* (Banvel, Clarity)**  **PEN = pendimethalin (Prowl H20)**  **FEN = fenoxaprop (Puma)**  **PYR = pyraflufen-ethyl (ET)**  **GLY = glyphosate (Roundup)**  **24D* = 2,4-D Amine**

*Permit required from county agricultural commissioner for purchase or use.*
**HERBICIDE TREATMENT TABLE** (7/16)

<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 7/16</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** When choosing an herbicide, an important factor to consider is the developmental growth stage of the crop (see DEVELOPMENTAL GROWTH STAGES).

**FALLOW PERIOD**

A. DICAMBA*
   - (Banvel) 0.25–2.0 lb a.e (0.5–4.0 pt).
   - (Clarity) 1 lb a.e. (2 pt)
   - WSSA MODE-OF-ACTION GROUP NUMBER: 4
   - COMMENTS: Apply after harvest. Use high rates for perennial weeds, but do not exceed 2 lb during any fallow periods. See label for rotational restrictions. Banvel can be used before planting wheat, but Clarity can be used before planting barley, oats, triticale, and wheat.

B. GLYPHOSATE
   - (Roundup PowerMax, WeatherMax) 0.38–0.5 lb a.i.
   - WSSA MODE-OF-ACTION GROUP NUMBER: 9
   - COMMENTS: A nonselective, translocated, postemergence herbicide; apply with nonionic surfactant anytime. Use higher rates for larger weeds, perennials, etc. Can be mixed with 2,4-D or dicamba (see 2,4-D and dicamba labels for restrictions on tank mix combinations).

C. PARAQUAT*
   - (Gramoxone SL 2.0) 0.5 lb a.i.
   - WSSA MODE-OF-ACTION GROUP NUMBER: 22
   - COMMENTS: A nonselective, postemergence herbicide; for use before planting wheat. Apply with nonionic surfactant before weeds are 6 inches tall. No soil residual activity. Good coverage is essential.

D. PYRAFLUFEN-ETHYL
   - (ET) 0.5–2 oz/acre
   - WSSA MODE-OF-ACTION GROUP NUMBER: 14
   - COMMENTS: A contact herbicide effective at very low use rates on many broadleaves. Combining pyraflufen-ethyl with phenoxy herbicides or dicamba broadens the weed spectrum controlled.

**PREPLANT or PREEMERGENCE TO CROP**

A. GLYPHOSATE
   - (Roundup PowerMax, WeatherMax) 0.38–0.5 lb a.i.
   - WSSA MODE-OF-ACTION GROUP NUMBER: 9
   - COMMENTS: A nonselective, translocated, postemergence herbicide; apply with nonionic surfactant anytime. Use higher rates for larger weeds, perennials, etc. Can be mixed with 2,4-D or dicamba (see 2,4-D and dicamba labels for restrictions on tank mix combinations).

B. PARAQUAT* 0.49–1 lb a.i.
### POSTPLANT – WHEAT

#### Before Weeds Emerge

**A. PENDIMETHALIN**

- **Chemical Name:** Prowl H2O
- **Rate:** 1.5-3 pt/acre
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 3
- **Comments:** Emerged weeds will not be controlled.

#### POSTPLANT – WHEAT

#### After Weeds Emerge

**A. 2,4-D AMINE**

- **Rate:** 0.31-0.87 lb a.i. (10.44-29.30 oz)
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 4
- **Comments:** Apply to crop only at the well-tillered stage. Application before well-tillered and after jointing stage may cause yield reductions; barley more susceptible than wheat. Use restricted in some counties. Immature crops (forage) may be grazed or cut for hay 30 days after treatment. Mature straw and grain may be fed to livestock 45 days after treatment.

**B. BROMOXYNIL**

- **Rate:** 0.25 lb a.i.
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 6
- **Comments:** Apply to crop from 2-leaf stage until just before boot. For best results, apply when weeds are in early seedling stage. Does not effectively control wild mustard greater than 3 inches in diameter. Do not graze for 45 days. A minimum of 10 gal water/acre is essential for best control, especially when weeds are larger or if small grain has a dense canopy.

**C. CARFENTRAZONE**

- **Rate:** Label rates
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 14
- **Comments:** For selective postemergence control of broadleaf weeds in wheat, barley, and oats. For best control apply before weeds are greater than 4 inches in height. Can cause necrosis and temporary stunting.

**D. CHLORSULFURON**

- **Rate:** 0.008–0.015 lb a.i. (0.006-0.011 oz)
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 2
- **Comments:** Apply to crop from 2 to 3 leaves until boot and weeds are less than 2 inches tall or 2 inches across. Use with surfactant. Do not apply to soils above pH 7.5. Apply on land used only for small grains. Do not apply more than 0.015 lb/acre per 18-month period. Also has soil activity to control weeds as they germinate. Soil residual activity can injure crops other than wheat, barley, or oats for 2 to 3 years or more.

**E. CLOPYRALID**

- **Rate:** Label rates
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 4
- **Comments:** Do not permit lactating dairy animals or meat animals being finished for slaughter to forage or graze treated grain fields within 1 week after treatment. Do not harvest hay from treated grain fields. See other label restrictions regarding grazing and use of hay, straw, and manure from treated fields.

**F. DICAMBA**

- **Rate:** 0.062-0.125 lb a.i.
- **WSSA MODE-OF-ACTION GROUP NUMBER:** 4
- **Comments:** Apply when crop has 2 to 3 leaves (before well-tillered) and weeds have 2 to 3 leaves. Do not
apply by air if sensitive crops are nearby. Usually mixed with MCPA or carfentrazone. Injury increases when mixed with 2,4-D or bromoxynil herbicides. May cause grain to temporarily flatten. Use is restricted in some counties.

G. FENOXAPROP
(Puma 1EC)  
Label rates 24 70  
WSSA MODE-OF-ACTION GROUP NUMBER: 1  
COMMENTS: For use on wheat and barley; apply to the crop from second leaf up to 70 days before harvest. May be tank mixed with bromoxynil. Rainfall within 1 hour of application will reduce weed control.

H. MCPA AMINE*  
0.23–0.46 lb a.i.  
0.5–1 pt 48 0  
WSSA MODE-OF-ACTION GROUP NUMBER: 4  
COMMENTS: Apply to crop from 3- to 4-leaf stage until just before boot. Less injurious than 2,4-D at early crop stages. Restricted use between Feb 15 and Oct 15.

I. MESOSULFURON  
(Osprey)  
4.75 oz 4  
See comments  
WSSA MODE-OF-ACTION GROUP NUMBER: 2  
COMMENTS: For control of annual grass and broadleaf weeds in wheat grown over the winter. Can be applied from wheat emergence up to the jointing stage. Apply with either a methylated seed oil or a basic blend type adjuvant. Use ammonium nitrogen fertilizer if using methylated seed oil to improve control. Do not make more than 1 application per growing season. Often causes temporary yellowing that typically goes away in two weeks. Wheat injury can be severe if a freeze occurs following an application. Pre-harvest interval is 30 days for wheat or triticale forage, and 60 days for hay, grain, and straw. See label for plantback restrictions.

J. PINOXADEN  
(Axial XL)  
16.4 fl oz 48  
See comments  
WSSA MODE-OF-ACTION GROUP NUMBER: 1  
COMMENTS: Selective grass herbicide. Pre-harvest interval is 30 days for silage, and 60 days for grain and straw.

K. PYRAFLUFEN-ETHYL  
(ET)  
0.5–2 oz/acre 12  
See comments  
WSSA MODE-OF-ACTION GROUP NUMBER: 14  
COMMENTS: A contact herbicide effective at very low use rates on many broadleaves. Combining pyraflufen-ethyl with phenoxy herbicides or dicamba broadens the weed spectrum controlled. Do not harvest wheat hay within 21 days after treatment. Wheat may be harvested for grain 60 days after treatment.

L. TRIBENURON METHYL  
(Express)  
0.25–0.50 oz 12 45  
WSSA MODE-OF-ACTION GROUP NUMBER: 2  
COMMENTS: Can be used after weed emergence. Do not exceed more than two applications per season (combined maximum 0.50 oz/A). Should be applied as tank mixture with other fallow herbicide. Apply after 2-leaf stage, but before development of flag leaf.

**POSTPLANT – BARLEY**

*After Weeds Emerge*

A. 2,4-D AMINE*  
0.26–0.95 lb a.i. (8.75-32.0 oz) 48  
See comments  
WSSA MODE-OF-ACTION GROUP NUMBER: 4  
COMMENTS: Apply to crop only at the well-tillered stage. Application before well-tillered and after jointing stage may cause yield reductions. Barley more susceptible than wheat. Restricted use between Feb 15 and Oct 15.
Do not permit lactating dairy animals or meat animals being finished for slaughter to forage or graze treated grain fields within 1 week after treatment; PHI is 14 days. Do not feed treated straw to livestock.

B. CARFENTRAZONE-ETHYL
(Shark EW)  
Label rates 12 7 - forage  
WSSA MODE-OF-ACTION GROUP NUMBER: 14  
COMMENTS: For selective postemergence control of broadleaf weeds in wheat, barley, and oats. For best control apply before weeds are greater than 4 inches in height.

C. CHLORSULFURON  
(Glean)  
0.008–0.015 lb a.i. 4 45  
0.006-0.011 oz  
WSSA MODE-OF-ACTION GROUP NUMBER: 2  
COMMENTS: Apply to crop from 2 to 3 leaves until boot and weeds are less than 2 inches tall or 2 inches across. Use with surfactant. Do not apply on soils above pH 7.9. Use only on dry land conditions. Do not apply more than 0.015 lb/acre per 18-month period. Also has soil activity to control weeds as they germinate. Soil residual activity can injure crops other than wheat, barley, or oats for 2 to 3 years or more.

D. CLOPYRALID  
(Stinger)  
Label rates 12 See comments  
WSSA MODE-OF-ACTION GROUP NUMBER: 4  
COMMENTS: Do not permit lactating dairy animals or meat animals being finished for slaughter to forage or graze treated grain fields within 1 week after treatment. Do not harvest hay from treated grain fields. See other label restrictions regarding grazing and use of hay, straw, and manure from treated fields.

E. FENOXAPROP-P-ETHYL  
(Puma) 1EC  
Label rates 24 70  
WSSA MODE-OF-ACTION GROUP NUMBER: 1  
COMMENTS: For use on wheat and barley; apply to the crop from second leaf up to 70 days before harvest. May be tank mixed with bromoxynil. Rainfall within 1 hour of application will reduce weed control.

F. MCPA AMINE*  
Label rates 0.23–0.46 lb a.i. 0.5–1 pt 48 0  
WSSA MODE-OF-ACTION GROUP NUMBER: 4  
COMMENTS: Apply to crop from 3- to 5-leaf stage to early jointing. Restricted use between Feb 15 and Oct 15.

G. PINOXADEN  
(Axial XL)  
16.4 fl oz 48 See comments  
WSSA MODE-OF-ACTION GROUP NUMBER: 1  
COMMENTS: Selective grass herbicide. Pre-harvest interval is 30 days for silage, and 60 days for grain and straw.

H. TRIBENURON-METHYL  
(Express)  
0.25-0.50 oz 12 45  
WSSA MODE-OF-ACTION GROUP NUMBER: 2  
COMMENTS: Can be used after weed emergence. Do not exceed more than two applications per season (combined maximum 0.50 oz/A). Should be applied as tank mixture with other fallow herbicide. Apply after 2-leaf stage, but before development of flag leaf.

POSTPLANT – OATS
After Weeds Emerge

A. BROMOXYNIL  
(Buctril)  
0.25 lb a.i. 1 pt 24 0  
WSSA MODE-OF-ACTION GROUP NUMBER: 6  
COMMENTS: Apply to crop from emergence until just before boot stage. For best results, apply when weeds are
in early seedling stage. Does not effectively control wild mustard greater than 3 inches in diameter. May temporarily burn oats. Do not graze for 45 days. Rates over 0.5 pint/acre may increase oat injury. Injury is greater during moisture stress and freezing temperatures. Adding foliar nitrogen will increase injury.

B. CARFENTRAZONE
(Shark EW)
Label rates
12
7 - forage
WSSA MODE-OF-ACTION GROUP NUMBER: 14
COMMENTS: For selective postemergence control of broadleaf weeds in wheat, barley, and oats. For best control apply before weeds are greater than 4 inches in height.

C. CHLORSULFURON
(Glean)
0.008–0.015 lb a.i.
0.006–0.011 oz
4
45
WSSA MODE-OF-ACTION GROUP NUMBER: 2
COMMENTS: Apply to crop from 2 to 3 leaves until boot and weeds are less than 2 inches tall or 2 inches across. Use with surfactant. Do not apply on soils above pH 7.9. Use on land used only for small grains. Do not apply more than 0.021 lb a.i./acre per 18-month period. Must be tank mixed with dicamba or bromoxynil if weeds are present at application time.

D. CLOPYRALID
(Stinger)
Label rates
12
See comments
WSSA MODE-OF-ACTION GROUP NUMBER: 4
COMMENTS: Do not permit lactating dairy animals or meat animals being finished for slaughter to forage or graze treated grain fields within 1 week after treatment. Do not harvest hay from treated grain fields. See other label restrictions regarding grazing and use of hay, straw, and manure from treated fields.

E. DICAMBA*
(Banvel, Clarity)
0.062–0.125 lb a.i.
2–4 oz
24
7
WSSA MODE-OF-ACTION GROUP NUMBER: 4
COMMENTS: Apply to oats before 5-leaf stage and weeds have 2 to 3 leaves. Do not apply by air if sensitive crops are nearby. When mixed with MCPA and bromoxynil injury is more likely to occur.

F. MCPA AMINE*
0.23–0.46 lb a.i.
0.5–1 pt
48
0
WSSA MODE-OF-ACTION GROUP NUMBER: 4
COMMENTS: Apply to oats from 5-leaf stage to early jointing. Restricted use between Feb 15 and Oct 15.

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

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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://plantprotection.org/HRAC/.
Precautions for Using Pesticides

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

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

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

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

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

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

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

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

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

Maximum residue levels
Before applying pesticides to crops destined for export, check maximum residue levels (MRLs) of importing country at http://mrldatabase.com.

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

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

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

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effort to achieve prompt and full utilization of minorities and women in all segments of its workforce where deficiencies exist. These efforts conform to all current legal and regulatory requirements, and are consistent with University standards of quality and excellence.

In conformance with Federal regulations, written affirmative action plans shall be prepared and maintained by each campus of the University, including the Division of Agriculture and Natural Resources. Such plans shall be reviewed and approved by the Office of the President and the Office of the General Counsel before they are officially promulgated. Inquiries regarding the University’s equal employment opportunity policies may be directed to Linda Marie Manton, Affirmative Action Contact, University of California, Davis, Agriculture and Natural Resources, One Shields Avenue, Davis, CA 95616, (530) 752-0495.