UC IPM
Pest Management Guidelines: COLE CROPS

October 2018

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

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An illustrated version of this guideline is available online at http://www.ipm.ucanr.edu/PMG/selectnewpest.cole-crops.html
http://www.ipm.ucanr.edu/PMG/selectnewpest.cole-crops.html
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This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Agricultural Pest Management.

The UC IPM Pest Management Guidelines are available from:
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- UC Cooperative Extension: County Offices
- University of California
  ANR Communication Services
  2801 Second Street
  Davis, CA 95616-7779
  530-750-1213; 800-994-8849

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

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

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

To be used with UC ANR Publication 3307, Integrated Pest Management for Cole Crops and Lettuce
These practices are recommended for a monitoring-based IPM program that enhances pest control and reduces environmental quality problems related to pesticide use.

Each time a pesticide application is considered, review the Pesticide Application Checklist at the bottom of this page for information on how to minimize water and air quality problems. Water quality becomes impaired when pesticides and sediments move off-site and into water. Air quality becomes impaired when volatile organic compounds (VOCs) move into the atmosphere.

This year-round IPM program covers the major pests of cole crops in the Central Valley, Central and Southern Coast, and desert areas. Track your progress through the year with the annual checklist form. Links take you to information on how to monitor, forms to use, and management practices. Details on carrying out each practice and information on additional pests can be found in the Cole Crops Pest Management Guidelines.

<table>
<thead>
<tr>
<th>✓ Done</th>
<th>Preplant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Special issues of concern related to environmental quality: pesticide and fertilizer runoff and leaching. Mitigate pesticide effects on air and water quality.</td>
</tr>
<tr>
<td></td>
<td>If nematodes have not been previously identified, take soil samples preferably while the previous crop is still in the field.</td>
</tr>
<tr>
<td></td>
<td>Select the field:</td>
</tr>
<tr>
<td></td>
<td>• Consider soil type, plantback restrictions from previously applied pesticides, and rotational plan for the field.</td>
</tr>
<tr>
<td></td>
<td>• Consider crop, pest, and pest management history, especially:</td>
</tr>
<tr>
<td></td>
<td>º Clubroot: if lime was not applied in the previous crop, be sure to apply lime this season or choose another field if the field has a history of clubroot.</td>
</tr>
<tr>
<td></td>
<td>º Damping-off (wirestem): if the field has a history of severe damping-off, do not transplant cauliflower.</td>
</tr>
<tr>
<td></td>
<td>º Nutsedge and field bindweed: if infestation is moderate to severe, consider planting to a different field.</td>
</tr>
<tr>
<td></td>
<td>º Cyst nematodes: if present in soil samples, and damage noted in the previous crop, consider treatment or planting to another field.</td>
</tr>
<tr>
<td></td>
<td>º Fumigants used: previous crop fumigation may continue to provide control of soilborne diseases and nematodes in the current crop.</td>
</tr>
<tr>
<td></td>
<td>• Take a soil sample for nutrient, salinity, and pH analysis to determine field suitability and soil nutrient management.</td>
</tr>
<tr>
<td></td>
<td>• Manage residue from the previous crop to prevent the spread of diseases, root- and crown-feeding insects, symphylans, and centipedes.</td>
</tr>
</tbody>
</table>

Manage weeds according to the Cole Crops Pest Management Guidelines.

• Survey weeds and keep records, noting the presence of problem weeds, herbicide-resistant weeds, and volunteer crucifers.

• While surveying weeds around field edges, monitor for Bagrada bug (especially on cruciferous weeds), crickets and sowbugs (if crop is direct-seeded), cutworms (if crop is direct-seeded), and darkling beetles. If present, remove weeds before flowering.

• Control weeds now to help prevent damage from aphids (cabbage aphid and other aphids), beet armyworm, cutworms, and flea beetles. Weeds can also harbor pathogens that cause diseases such as black leg, black rot, and ringspot.

• Create a custom herbicide weed susceptibility chart for your field. Learn how online.

Clean equipment and tractors before they enter the field to prevent the spread of soilborne pathogens and weed seeds.
**Prepare the field:**
- Unless practicing reduced tillage or no-till, disc to incorporate crop residues and weeds.
- Prepare seed beds with good drainage.
- If the field has a history of clubroot, consider adding lime.

**Apply fertilizers, if necessary:**
- For broccoli and cauliflower, 20 to 30 lbs/acre nitrogen are applied preplant. In the southern desert and central valley, apply 150 to 300 lbs/acre P₂O₅. For other regions, apply phosphorus and potassium based on soil test results.
- For cabbage, apply 200 lbs/acre P₂O₅ is in the southern desert. Apply 500 lbs/acre complete fertilizer in coastal areas.

**Manage disease.**
- Choose less-susceptible cultivars.
- Select pathogen-free seeds or transplants that have been tested for seedborne pathogens such as bacterial leafspot, black rot, black leg, and Alternaria leafspot. If seedborne pathogens are detected, seed treatment is recommended.

**Planting to rosette**

**Special issues of concern related to environmental quality:** pesticide and fertilizer runoff and leaching. Mitigate pesticide effects on air and water quality.

- Monitor for Bagrada bug in nurseries where transplants are grown. Do not use damaged transplants, particularly for cabbage.
- At planting, select and apply herbicides if needed, based on the preplant weed survey.
  - Create a custom herbicide weed susceptibility chart for your field. Learn how online.
- Plant seeds or transplant seedlings into uniform beds to the proper depth with a precision planting system.
- Check for stand uniformity and wilted plants. Inspect plants for:
  - Aphids (cabbage aphid and other aphids)
  - Beet armyworm (eggs and newly hatched larvae)
  - Bagrada bug
  - Cabbage looper (eggs and newly hatched larvae)
  - Cabbage maggot
  - Crickets (if crop is direct-seeded)
  - Darkling beetles
  - Diamondback moth (coastal areas)
  - Flea beetles
  - Garden symphylans
  - Grasshoppers (if crop is direct-seeded)
  - Leafminers
  - Seedcorn maggot
  - Silverleaf whitefly
  - Sowbugs (if crop is direct-seeded)
  - Wireworms
- Manage as needed according to the Cole Crops Pest Management Guidelines.

Before cultivation, manage germinated weeds according to the Cole Crops Pest Management Guidelines.
- Survey the field to identify germinated weeds and keep records.
- Cultivate (as close to the seed line as possible), apply surface band fertilizer, or apply herbicides. If managing weeds with herbicides, create a custom herbicide weed susceptibility chart for your field. Learn how online.

If you observe severe symptoms of clubroot or Rhizoctonia diseases, note the location for future spot treatments if cole crops will be planted again, or to make management decisions for the next crop.

Sporadic or minor pests, diseases, or disorders you may see:
- Alternaria leafspot
- Cabbage looper
- Downy mildew
- Imported cabbageworm
- Vertebrates (mice, voles, or birds)
- Wind damage or wind whip: note for next year’s management

Install drip tape if sprinklers have been used to establish the crop.
<table>
<thead>
<tr>
<th>✓ Done</th>
<th>Rosette to heading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Special issues of concern related to environmental quality:</strong> pesticide and fertilizer runoff and leaching. Mitigate pesticide effects on air and water quality.</td>
</tr>
<tr>
<td></td>
<td>If you observe symptoms of Fusarium yellows or Verticillium wilt, note for future management.</td>
</tr>
<tr>
<td></td>
<td>Apply fertilizers, if necessary:</td>
</tr>
<tr>
<td></td>
<td>• For broccoli and cauliflower, estimate the sidedress nitrogen requirement with pre-sidedress soil nitrate testing (PSNT).</td>
</tr>
<tr>
<td></td>
<td>• For coastal area cabbage, direct-spray nitrogen at 130 lbs/acre when plants have 5 to 6 true leaves.</td>
</tr>
<tr>
<td></td>
<td>• Consider a surface band application of ammonium nitrate as a contact herbicide and as a nitrogen source.</td>
</tr>
<tr>
<td></td>
<td>Monitor for pests or their damage:</td>
</tr>
<tr>
<td></td>
<td>• Aphids (cabbage aphid and other aphids)</td>
</tr>
<tr>
<td></td>
<td>• Bagrada bug</td>
</tr>
<tr>
<td></td>
<td>• Beet armyworm</td>
</tr>
<tr>
<td></td>
<td>• Cabbage looper</td>
</tr>
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<td></td>
<td>• Diamondback moth</td>
</tr>
<tr>
<td></td>
<td>Manage according to the Cole Crops Pest Management Guidelines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>✓ Done</th>
<th>Heading to harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Special issues of concern related to environmental quality:</strong> pesticide and fertilizer runoff and leaching. Mitigate pesticide effects on air and water quality.</td>
</tr>
<tr>
<td></td>
<td>Monitor the presence and level of weeds. Keep records for next season’s management.</td>
</tr>
<tr>
<td></td>
<td>Monitor for pests or their damage:</td>
</tr>
<tr>
<td></td>
<td>• Aphids (cabbage aphid and other aphids)</td>
</tr>
<tr>
<td></td>
<td>• Bagrada bug</td>
</tr>
<tr>
<td></td>
<td>• Beet armyworm</td>
</tr>
<tr>
<td></td>
<td>• Cabbage looper</td>
</tr>
<tr>
<td></td>
<td>• Silverleaf whitefly</td>
</tr>
<tr>
<td></td>
<td>Manage according to the Cole Crops Pest Management Guidelines.</td>
</tr>
<tr>
<td></td>
<td>Monitor for and identify crop quality issues and note for next year’s management.</td>
</tr>
<tr>
<td></td>
<td>• Broccoli head rot</td>
</tr>
<tr>
<td></td>
<td>• Systemic downy mildew in broccoli and cauliflower</td>
</tr>
<tr>
<td></td>
<td>• White stem in broccoli</td>
</tr>
<tr>
<td></td>
<td>• Abiotic disorders:</td>
</tr>
<tr>
<td></td>
<td>◦ Broccoli brown bead</td>
</tr>
<tr>
<td></td>
<td>◦ Calcium deficiency in cauliflower</td>
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<tr>
<td></td>
<td>◦ Hollow stem in broccoli</td>
</tr>
<tr>
<td></td>
<td>◦ Cracked stem</td>
</tr>
<tr>
<td></td>
<td>Test soil for nitrogen and apply as needed based on test results. See</td>
</tr>
<tr>
<td></td>
<td>• <em>Cauliflower Production in California</em> (ANR free publication #7219)</td>
</tr>
<tr>
<td></td>
<td>• <em>Broccoli Production in California</em> (ANR free publication #7211)</td>
</tr>
<tr>
<td></td>
<td>• <em>Cabbage Production in California</em> (ANR free publication #7208)</td>
</tr>
<tr>
<td></td>
<td>Consider a surface band application of ammonium nitrate as a contact herbicide and as a nitrogen source.</td>
</tr>
<tr>
<td></td>
<td>Clean harvest equipment and tractors before they enter the field to prevent the spread of disease.</td>
</tr>
<tr>
<td></td>
<td>Note the presence and level of soilborne disease at harvest for next season’s management planning.</td>
</tr>
<tr>
<td></td>
<td>• Clubroot</td>
</tr>
<tr>
<td></td>
<td>• Fusarium yellows</td>
</tr>
<tr>
<td></td>
<td>• Rhizoctonia diseases</td>
</tr>
<tr>
<td></td>
<td>• Verticillium wilt</td>
</tr>
</tbody>
</table>
Examine roots of stunted plants for brown cysts of cyst nematodes.

** ✓ Done **

** Harvest and postharvest **

** Special issues of concern related to environmental quality: None. Mitigate pesticide effects on air and water quality. **

Immediately after harvest, shred and disc under crop remnants if the following pests were a problem:
- Aphids (cabbage aphid and other aphids)
- Beet armyworm
- Cabbage looper
- Cabbage maggot
- Cutworms
- Imported cabbageworm
- Silverleaf whitefly
- Wireworms

Remove drip tape.

Till soil.

If cover crops fit into the crop rotation, consider planting legume, rye, or sorghum to protect the soil if there will be a fallow period.

Plan next season’s crop rotation. Crops in the Brassicaceae (mustard family) are not recommended.

** ✓ Done **

** Pesticide application checklist **

When planning for possible pesticide applications in an IPM program, review and complete this checklist to consider practices that minimize environmental and efficacy problems.

ANR publications can be found in the ANR catalog, http://anrcatalog.ucdavis.edu/

✓ Choose a pesticide from the UC IPM Pest Management Guidelines for the target pest, considering:
  - Impact on natural enemies and honey bees
  - Potential for water quality problems and impact on aquatic invertebrates using the UC IPM WaterTox database (www.ipm.ucdavis.edu/TOX/simplewatertox.html, and see Pesticide Choice, UC ANR Publication 8161.)
  - Chemical mode of action if pesticide resistance is an issue (See Herbicide Resistance (PDF), UC ANR Publication 8012.)

✓ Before an application:
  - Choose sprayers and application procedures that keep pesticides on target.
  - Identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding your application site.
  - Review and follow labeling for pesticide handling, storage, and disposal guidelines.
  - Check and follow restricted entry intervals (REI) and preharvest intervals (PHI).

✓ After an application:
  - Record application date, product used, rate, and location of application.
  - Follow up to confirm that treatment was effective.
✔️ Consider water management practices that reduce pesticide movement off-site.
   - Consult relevant publications.
     - *Orchard Floor Management Practices to Reduce Erosion and Protect Water Quality* (PDF), UC ANR Publication 8202
     - *Reducing Runoff from Irrigated Lands: Causes and Management of Runoff from Surface Irrigation in Orchards* (PDF), UC ANR Publication 8214
     - *Protecting Surface Water from Sediment-Associated Pesticides in Furrow-Irrigated Crops* (PDF), UC ANR Publication 8403
   - Install an irrigation recirculation or storage and reuse system. For more information see:
     - *Tailwater Return Systems* (PDF), UC ANR Publication 8225
     - *Storing Runoff from Winter Rains* (PDF), UC ANR Publication 8211
   - Use drip rather than sprinkler or flood irrigation.
   - Limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET). (For more information see *Understanding Your Orchard's Water Requirements* (PDF), UC ANR Publication 8212.)
   - Consider using cover crops.
   - Consider vegetative filter strips or ditches. (See *Vegetative Filter Strips*, UC ANR Publication 8225.)
     - Install sediment traps.
     - Use polyacrylamide (PAM) tablets in furrows to prevent offsite movement of sediments.
     - Redesign inlets and outlets into tailwater ditches to reduce erosion.

✔️ Consider air quality management practices that reduce air quality problems.
   - When possible, reduce volatile organic compound (VOC) emissions by decreasing the amount of pesticide applied, choosing low-emission management methods, and avoiding fumigants and emulsifiable concentrates (EC) formulations.

For more information about mitigating the effects of pesticides, see the Mitigation Page.
# General Information

## Relative Toxicities of Insecticides and Miticides Used in Cole Crops to Natural Enemies and Honey Bees (10/10)

<table>
<thead>
<tr>
<th>Common name (trade name and formulation)</th>
<th>Mode of action</th>
<th>Selectivity (affected groups)</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>acephate (Orthene S)</td>
<td>1B</td>
<td>broad (insects)</td>
<td>H</td>
<td>H</td>
<td>M/H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>acetamiprid (Assail WP)</td>
<td>4A</td>
<td>moderate (sucking insects, larvae)</td>
<td>___⁷</td>
<td>___⁸</td>
<td></td>
<td></td>
<td>moderate</td>
</tr>
<tr>
<td>Bacillus thuringiensis ssp. aizawai</td>
<td>11A</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>Bacillus thuringiensis ssp. kurstaki</td>
<td>11A</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>bifenthrin (Brigade EC)</td>
<td>3A</td>
<td>broad (insects)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>long</td>
</tr>
<tr>
<td>carbaryl (Sevin bait)</td>
<td>1A</td>
<td>narrow (cutworms, armyworms)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>carbaryl (Sevin F, S)</td>
<td>1A</td>
<td>broad (insects)</td>
<td>M/H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>long</td>
</tr>
<tr>
<td>carbaryl (Sevin XLR Plus)</td>
<td>1A</td>
<td>broad (insects)</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>I</td>
<td>long</td>
</tr>
<tr>
<td>chlorantraniliprole (Coragen)</td>
<td>28</td>
<td>narrow (primarily caterpillars)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>III</td>
<td>—</td>
</tr>
<tr>
<td>chlorpyrifos (Lorsban Advanced)</td>
<td>1B</td>
<td>broad (insects)</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>cryolite (Kryocide W)</td>
<td>un</td>
<td>narrow (foliage chewing insects)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>III</td>
<td>—</td>
</tr>
<tr>
<td>cyromazine (Trigard WP)</td>
<td>17</td>
<td>narrow (leafminers)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>diazinon (EC, WP)</td>
<td>1B</td>
<td>broad (insects)</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate to long</td>
</tr>
<tr>
<td>diazinon (granular)</td>
<td>1B</td>
<td>narrow (soil insects)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>emamectin benzoate (Proclaim)</td>
<td>6</td>
<td>narrow (caterpillars)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>I</td>
<td>—</td>
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<tr>
<td>esfenvalerate (Asana)</td>
<td>3A</td>
<td>broad (insects)</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
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<tr>
<td>ethoprop (Mocap G)</td>
<td>1B</td>
<td>narrow (soil insects)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>—</td>
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<tr>
<td>ethoprop (Mocap EC)</td>
<td>1B</td>
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<td>—</td>
<td>—</td>
<td>II</td>
<td>—</td>
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<tr>
<td>flonicamid (Beleaf)</td>
<td>9C</td>
<td>narrow (plant bugs, aphids)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>imidacloprid (Admire Pro)</td>
<td>4A</td>
<td>narrow (sucking insects, beet armyworm, cutworms)</td>
<td>—</td>
<td>L</td>
<td>—</td>
<td>I</td>
<td>—</td>
</tr>
<tr>
<td>imidacloprid (Provado F)</td>
<td>4A</td>
<td>narrow (sucking insects)</td>
<td>—</td>
<td>—</td>
<td>H</td>
<td>I</td>
<td>short to moderate</td>
</tr>
<tr>
<td>indoxacarb (Avaunt)</td>
<td>22A</td>
<td>narrow (caterpillars)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>I</td>
<td>—</td>
</tr>
<tr>
<td>insecticidal soap (M-Pede)</td>
<td>un</td>
<td>broad (insects)</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>III</td>
<td>short to none</td>
</tr>
<tr>
<td>methomyl (Lannate SP, LV)</td>
<td>1A</td>
<td>broad (insects)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>Active Ingredient</td>
<td>Mode of Action</td>
<td>Toxicity</td>
<td>Selectivity</td>
<td>Resistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------</td>
<td>----------</td>
<td>-------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>methoxyfenozide (Intrepid F)</td>
<td>18</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>petroleum oil</td>
<td>un</td>
<td>broad (exposed insects)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short to none</td>
</tr>
<tr>
<td>pymetrozine (Fulfill)</td>
<td>9B</td>
<td>narrow (aphids, whiteflies)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>II</td>
<td>—</td>
</tr>
<tr>
<td>spinetoram (Radiant)</td>
<td>5</td>
<td>narrow (caterpillars, whiteflies, aphids, leafminers)</td>
<td>L/H</td>
<td>M⁹</td>
<td>L/M</td>
<td>II</td>
<td>moderate¹⁰</td>
</tr>
<tr>
<td>spinosad (Entrust, Success)</td>
<td>5</td>
<td>narrow (caterpillars, whiteflies, aphids, leafminers)</td>
<td>L</td>
<td>M⁹</td>
<td>L/M</td>
<td>II</td>
<td>short to moderate⁹</td>
</tr>
<tr>
<td>spiromesifen (Oberon SC)</td>
<td>23</td>
<td>narrow (whiteflies)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>II</td>
<td>—</td>
</tr>
<tr>
<td>spirotetramat (Movento)</td>
<td>23</td>
<td>narrow (aphids, whiteflies)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>II</td>
<td>—</td>
</tr>
<tr>
<td>thiamethoxam (Actara)</td>
<td>4A</td>
<td>narrow (sucking insects)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>M</td>
<td>I</td>
</tr>
</tbody>
</table>

**Notes:**
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 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 Web site at http://www.irac-online.org/.

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

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

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

*Continued on next page . . .*
Relative Toxicities of Insecticides and Miticides Used in Cole Crops to Natural Enemies and Honey Bees, continued

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 pesticide label and regulations; III—No bee precaution, except when required by the pesticide label or regulations. For more information about pesticide synergistic effects, see Bee Precaution Pesticide Ratings (available online at http://ipm.ucanr.edu/beeprecaution/).

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

7 May cause flare-ups of spider mite populations.

8 Acute toxicity low but reproductive capacity is impacted.

9 Toxic against some natural enemies (predatory thrips, syrphid fly and lacewing larvae, beetles) when sprayed and up to 5-7 days after, especially for syrphid fly larvae.

10 Residual is moderate if solution is between pH of 7 to 8.

11 May cause increase in spider mite populations.

Acknowledgements: 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.
Insects

BEET ARMYWORM (10/10)
Scientific Name: Spodoptera exigua

DESCRIPTION OF THE PEST
Beet armyworms vary in color but are usually a shade of olive green with many fine, wavy, light colored stripes down the back and sides. Often there is a dark spot on the side of the body just above the second true leg. The body surface is smooth and almost hairless. Mature larvae may be up to 1.5 inches long. Adult moths lay their eggs in scale-covered cottony masses on leaf surfaces. When eggs first hatch, the tiny larvae feed in groups near the egg mass, skeletonizing or completely consuming leaves. As they grow older, larvae disperse and move toward the center of the plant. Beet armyworms build up as weather warms and are most common on late summer and fall crops.

DAMAGE
Beet armyworms can destroy seedlings, consume large portions of leaves, or stunt growth by feeding on buds. However, serious economic damage to cole crops is uncommon.

MANAGEMENT
Cultural and biological controls help suppress armyworm populations. Disc fields immediately following harvest to kill larvae and pupae. Destroy weeds along field borders; armyworms often migrate from these areas into newly planted fields. Seedlings are very susceptible to armyworm damage. Fields should be monitored frequently for beet armyworm from planting until heading.

Biological Control
Many natural enemies attack beet armyworms. Among the most common parasites are the wasps Hyposoter exiguae and Chelonus insularis, and the tachinid fly Lespesia archippivora. Viral diseases may also be important.

Organically Acceptable Methods
Biological control and sprays of Bacillus thuringiensis and the Entrust formulation of spinosad are organically acceptable management tools.

Monitoring and Treatment Decisions
Start monitoring for beet armyworm even before seedlings emerge. Check for egg masses and young larvae in pigweeds, lambsquarters, nettleleaf goosefoot, and other weeds surrounding the field. If populations are high on weeds, watch especially carefully for infestations on crop seedlings. Pheromone traps are also available for monitoring adult flights in order to predict egg laying.

Once seedlings emerge, check them at least twice a week for armyworm egg masses and young larvae. Treat if you find one second or third instar larva for every 10 plants. Sample for armyworms at the same time you are sampling for loopers and cabbageworms and include them in your total counts for caterpillars. It is not usually necessary to treat older plants between thinning and heading. Treat just before heading if caterpillars are in the field. Beet armyworms are more difficult to control with insecticides than loopers and cabbageworms, so be sure to make note of their presence in your monitoring records. There are reports of insecticide resistance to certain materials in certain areas. The more broad-spectrum insecticides (endosulfan, methomyl) adversely affect natural enemies in most cases.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount / Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. BACILLUS THURINGIENSIS ssp. AIZAWAI# (various products)</td>
<td>Label rates 4</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, information related to natural enemies and honey bees and environmental impact.

A. BACILLUS THURINGIENSIS ssp. AIZAWAI# (various products) | Label rates 4 | 0 |

COMMENTS: This material is most effective against newly hatched larvae so proper treatment timing is essential.
B.  **EMAMECTIN BENZOATE***
    (Proclaim)  
    MODE OF ACTION GROUP NUMBER: 6
    3.2–4.8 oz  12  14

C.  **INDOXACARB**
    (Avaunt)  
    MODE OF ACTION GROUP NUMBER: 22
    2.5–3.5 oz  12  3
    COMMENTS: Do not apply more than 14 oz/acre/crop. Add a wetting agent to improve coverage. Minimum interval between sprays is 3 days.

D.  **SPINETORAM**
    (Radiant) SC  
    MODE OF ACTION GROUP NUMBER: 5
    5–10 fl oz  4  1
    COMMENTS: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after. Control improved with addition of an adjuvant.

E.  **SPINOSSAD**
    (Entrust)#  
    (Success)  
    MODE OF ACTION GROUP NUMBER: 5
    1.25–3 oz  4  1
    6 oz  4  1
    COMMENTS: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after.

F.  **CHLORANTRANILIPROLE**
    (Coragen)  
    MODE OF ACTION GROUP NUMBER: 28
    3.5–5 fl oz  4  3
    COMMENTS: Foliar application; use with an effective adjuvant for best performance.

G.  **METHOXYFENOZIDE**
    (Intrepid) 2F  
    MODE OF ACTION GROUP NUMBER: 18A
    8 fl oz  4  1
    COMMENTS: For early season applications only to young crop and small plants.

H.  **CRYOLITE**
    (Cryolite) 96W  
    MODE OF ACTION GROUP NUMBER: 9A
    8–16 lb  12  7
    COMMENTS: Use on broccoli, Brussels sprouts and cauliflower. Must be ingested by the insect. Apply when young caterpillars are present. Can be used in an insecticide resistance management program.

I.  **METHOMYL***
    (Lannate) LV  
    (Lannate) 90SP  
    MODE OF ACTION GROUP NUMBER: 1A
    0.75–3 pt  48  see comments
    0.25–1 lb  48  see comments
    COMMENTS: Preharvest interval is 3 days for broccoli, Brussels sprouts, and cauliflower and 1 day for cabbage. See label for other cole crops.

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

# Acceptable for use on organically grown produce.

* 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 Web site at http://www.irac-online.org/.

* Permit required from county agricultural commissioner for purchase or use.
CABBAGE APHID (9/09)

Scientific Name: *Brevicoryne brassicae*

DESCRIPTION OF THE PEST

Cabbage aphids are green gray with a white, waxy coating. They commonly occur in dense colonies, often covered with waxy droplets. They prefer to feed on the youngest leaves and flowering parts and are often found deep within the heads of cabbages or Brussels sprouts. The aphid has a simple life cycle with adult females giving birth to live offspring throughout the year in most parts of California. Both winged and wingless adults occur; the winged adults have a black thorax and lack the waxy coating. The aphid does not infest noncruciferous crops but can survive on related weed species when cole crops are not in the field.

DAMAGE

Cabbage aphids do not normally affect seedlings but build up after thinning or transplanting. Large colonies can stunt or kill small plants, but the most serious problem is contamination of the harvested crop. Dense populations cause leaves to curl around them, making them harder to reach with pesticide applications.

MANAGEMENT

Cultural practices and biological control agents can reduce aphid infestations and delay or prevent the need for pesticide use. Try to delay using insecticides for as long as possible while maintaining yields and quality. Most fields require at least one application against aphids at preheading; however, if you can delay applications until just before head formation, you will save the expense of additional applications and may also be able to maintain the natural enemies that will keep caterpillar pests, including loopers, imported cabbageworms, armyworms, and diamondback moths, below economically damaging levels.

Biological Control

Cabbage aphids have many natural enemies and these can sometimes control low populations; however, short crop life, use of pesticides for other pests, the tendency for the aphids to be deep within the head, and various other factors make it difficult for natural enemies to keep rapidly rising aphid populations from reaching economic levels. Important natural enemies include lady beetles, syrphid fly larvae, fungal diseases, and the parasitic wasp, *Diaeretiella rapae*. Protect habitat for natural enemies so that they can survive and increase their population levels.

Cultural Control

Destroy crop remnants immediately after harvest and remove or control alternate hosts, including mustards and related weeds, around field borders. Infestations on Brussels sprouts can start in seedling beds, so be sure transplants are clean before taking them to the field. Roguing (removal and destruction) of infested plants from the field can be effective early in the crop cycle.

Organically Acceptable Methods

Biological and cultural control are organically acceptable, as well as sprays of insecticidal soap, which can give partial control. Soap sprays, however, may be phytotoxic under some conditions, especially in Brussels sprouts and cabbage. For most effective control, apply during foggy conditions.

Monitoring and Treatment Decisions

Check each field at least twice a week. A sequential sampling program is available for Brussels sprouts. Sample upwind field borders and edges next to other crucifers first; this is where aphids tend to appear first. If no aphids are found, you may not need to take field samples. Take field samples in a zigzag pattern. Remember to check all quadrants of the field because aphid populations are often clumped.

Cabbage, broccoli, and cauliflower. Check for cabbage aphid in the youngest, highest, and innermost leaves of young plants. After heading, check the flowering parts of broccoli and cauliflower and pull back wrapper leaves of cabbage. Also check for natural enemies. Broccoli and cauliflower crops can tolerate up to 100 aphids per plant up to heading. Once heads begin to form, cabbage aphids must be controlled even if only a few are present. Because of the overlapping growth of their leaves, cabbage crops require more careful management and have less tolerance for aphids even during the early vegetative stages; treat as soon as 1 to 2% of plants are infested with one or more aphids. After treating, recheck fields frequently and treat if populations reappear.
Brussels sprouts. A presence-absence sequential sampling program is available for making treatment decisions in Brussels sprouts. In this program you do not need to count actual numbers of aphids on a leaf but need only to determine if aphids are present. The program also reduces the number of samples required when aphid populations are low. Start by sampling 13 randomly selected plants for each block that can be sprayed separately; take 5 samples along the field border and the rest scattered throughout the field. For each plant, simply record if the aphid is present or not. Use the table below to determine need for treatment or continued sampling. If you take 50 samples and still don’t reach a decision, wait until the next sampling date to make a decision.

<table>
<thead>
<tr>
<th>Plants sampled</th>
<th>Don’t treat</th>
<th>Continue sampling</th>
<th>Treat</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>0</td>
<td>1–4</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>2–4</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>2–5</td>
<td>6</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>2–6</td>
<td>7</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>3–6</td>
<td>7</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>3–7</td>
<td>8</td>
</tr>
<tr>
<td>33</td>
<td>2</td>
<td>3–8</td>
<td>9</td>
</tr>
<tr>
<td>34</td>
<td>3</td>
<td>4–8</td>
<td>9</td>
</tr>
<tr>
<td>38</td>
<td>3</td>
<td>4–9</td>
<td>10</td>
</tr>
<tr>
<td>43</td>
<td>4</td>
<td>5–9</td>
<td>10</td>
</tr>
<tr>
<td>44</td>
<td>4</td>
<td>5–10</td>
<td>11</td>
</tr>
<tr>
<td>49</td>
<td>4</td>
<td>5–11</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>5–11</td>
<td>12</td>
</tr>
</tbody>
</table>

Brussels sprouts can tolerate 40% infested plants from transplanting up until 2 weeks before harvest. This table advises treatment at 15% infested plants and is conservative. At topping, treatment is required if 1 or 2% of plants are infested with one or more aphids. Treatment is more effective after topping because coverage is greatly improved.

When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact.

Note: Resistance to some insecticides has been reported in some aphid populations. Rotating pesticide materials may effectively help slow the development of resistance. Several aphid control materials are quite toxic; use the least toxic material that is effective on your aphid populations.

A. ACETAMIPRID
   (Assail) 70WP
   MODE OF ACTION GROUP NUMBER: 4A
   COMMENTS: Do not apply more than once every 7 days or make more than 5 applications/season.

B. FLONICAMID
   (Beleaf) 50SG
   MODE OF ACTION GROUP NUMBER: 9C

C. SPIROTETRAMAT
   (Movento)
   MODE OF ACTION GROUP NUMBER: 23

D. CHLORPYRIFOS*
   (Lorsban Advanced)
   MODE OF ACTION GROUP NUMBER: 1B
   COMMENTS: Can only be applied in foliar applications to Brussels sprouts. Avoid drift and tailwater runoff into surface waters. Additional application restrictions may apply; for more information on current California permit restrictions, see the Department of Pesticide Regulation’s Chlorpyrifos Interim Recommended Permit Conditions.
<table>
<thead>
<tr>
<th>Product</th>
<th>Formulation</th>
<th>Rate</th>
<th>PHI</th>
<th>REI</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. DIAZINON*</td>
<td>(Diazinon) 50W</td>
<td>0.5–1 lb</td>
<td>4 days</td>
<td>0</td>
</tr>
<tr>
<td>F. IMIDACLOPRID</td>
<td>(Admire Pro)</td>
<td>7–10.5 fl oz (preplant injected)</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>(Provado) 1.6F</td>
<td>3.75 fl oz (foliar)</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>G. INSECTICIDAL SOAP#</td>
<td>(M-Pede)</td>
<td>1–2% solution</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>H. PYMETROZINE</td>
<td>(Fulfill)</td>
<td>2.75 oz</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NUMBER:**
- E: 1B
- F: 4A
- G: 9B

**COMMENTS:**
- Avoid drift and tailwater runoff into surface waters.
- MODE OF ACTION: A contact fungicide with smothering and barrier effects.
- Best used in a tank mix with another insecticide registered for aphids. Do not apply more than 2 applications/crop/season. Make applications at least 7 days apart.

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
- Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.

* 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 Web site at http://www.irac-online.org/.
CABBAGE LOOPER (10/10)

Scientific Name: *Trichoplusia ni*

**DESCRIPTION OF THE PEST**
Looper caterpillars can be distinguished from most other common caterpillars in cole crops by their distinctive looping movement in which they arch the middle portion of their body to bring the prolegs or hind legs forward to meet the front legs. Loopers are green, usually with a narrow white stripe along each side and several narrow lines down the back. Loopers are smooth-skinned with only a few long bristles down the back; they may grow up to 1.5 inches long. Mature larvae spin silken cocoons and pupate, usually attached to leaves. Adults are brownish moths with a distinctive silvery figure-8 on the front wings. Eggs are ridged and dome-shaped and usually laid singly on the undersurface of leaves. Loopers may have numerous generations and continue to develop all year long in cole crops growing areas of California with the highest populations usually occurring in fall.

**DAMAGE**
Although seedlings are occasionally damaged, most injury occurs after heading. Loopers eat ragged holes into leaves, bore through heads and contaminate heads and leaves with their bodies and frass. Young plants between seedling stage and heading can tolerate substantial leaf damage without loss of yield.

**MANAGEMENT**
Cabbage loopers have many natural enemies that frequently keep loopers below economic levels, at least until heading, if they are not killed by insecticide treatments for other pests. Monitor to determine population levels of loopers and natural enemies and to determine the need for treatment following heading. If treatment is needed, use a selective material such as *Bacillus thuringiensis*.

**Biological Control**
Important parasites include the egg parasite *Trichogramma pretiosum*, the larval parasites *Hyposoter exiguae*, *Copidosoma truncatellum*, and *Microplitis brassicae*, and the parasitic tachinid fly *Voria ruralis*. A nuclear polyhedrosis virus disease is also important under certain circumstances; the bodies of diseased caterpillars turn into shapeless sacks of dark liquid and can often be spotted hanging from leaves. Be sure to monitor for natural enemies; if looper populations are close to treatment thresholds but you find a significant percentage of parasitized or disease-killed individuals, delay treatment for a few days to see if these natural controls will bring populations down on their own. If treatment is necessary, use of *Bacillus thuringiensis* insecticide will minimize injury to natural enemies.

**Organically Acceptable Methods**
Biological control and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are organically acceptable management tools.

**Monitoring and Treatment Decisions**
Check 25 plants selected randomly throughout the field. Look for eggs and small larvae on the underside of lower leaves. If you find holes, search the general area for the caterpillar, opening damaged heads as necessary. Although damage can give you a general idea of where loopers may be and the seriousness of the infestation, do not base treatment on damage levels. Base treatment on numbers of healthy larvae present (include imported cabbageworms in counts, too, if they are also present). Treat seedlings or small plants if populations of medium-sized to large caterpillars are large enough to stunt growth. Before heading, well-established plants do not need to be treated unless you find more than 9 small- to medium-sized larvae per plant. Treat just before heading or at Brussels sprouts formation if counts show more than one looper or other caterpillar in 25 plants.

Where possible, use a selective insecticide to avoid adverse impacts on natural enemies. *Bacillus thuringiensis* and most other selective insecticides are very effective against cabbage loopers, especially when applied to early-instar caterpillars (i.e., very young). Cabbage loopers are also controlled with the more toxic materials recommended for use against other lepidopterous (caterpillar) pests. If significant numbers of other caterpillars (armyworms or diamondback moths) are present, the use of a carbamate or pyrethroid may be warranted.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>

Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.cole-crops.html
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, information related to natural enemies and honey bees and environmental impact:

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. METHOMYL*&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Lannate) 90 SP</td>
<td>0.5–1 lb</td>
<td>48</td>
<td>see comments</td>
</tr>
<tr>
<td>(Lannate) LV</td>
<td>1.5–3 pt</td>
<td>48</td>
<td>see comments</td>
</tr>
</tbody>
</table>

# Acceptable for use on organically grown produce.

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

Common name
(trade name)

- A. **BACILLUS THURINGIENSIS** ssp. **KURSTAKI**<sup>2</sup>
  (various products)
  MODE OF ACTION GROUP NUMBER: 11.B2
  Label rates

- B. **EMAMECTIN BENZOATE**<sup>3</sup>
  (Proclaim)
  MODE OF ACTION GROUP NUMBER: 1
  3.2–4.8 oz

- C. **INDOXACARB**
  (Avant)
  MODE OF ACTION GROUP NUMBER: 22
  2.5–3.5 oz

- D. **SPINETORAM**
  (Radiant) SC
  MODE OF ACTION GROUP NUMBER: 5
  5–10 fl oz

- E. **SPINOSAD**
  (Success)
  MODE OF ACTION GROUP NUMBER: 5
  6 oz

- F. **CHLORANTRANILIPROLE**
  (Coragen)
  MODE OF ACTION GROUP NUMBER: 28
  3.5–5 fl oz

- G. **METHOXYFENOZIDE**
  (Intrepid) 2F
  MODE OF ACTION GROUP NUMBER: 18A
  8 fl oz

- H. **CRYOLITE**
  (Cryolite) 96W
  MODE OF ACTION GROUP NUMBER: 9A
  8–16 lb

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

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Illustrated version at http://www.ipm.ucdavis.edu/PMG/selectnewpest.cole-crops.html
CABBAGE MAGGOT  (9/09)

**Scientific Name:** *Delia radicum*

**DESCRIPTION OF THE PEST**
Larvae are small, legless, white maggots usually less than 0.33 inch (8 mm) when full grown; their head end is pointed and the rear is blunt with a dozen short, pointed fleshy processes arranged in a circle around two brown, button-like spiracles. They are found feeding on feeder roots or boring into the taproot. Adults are dark gray flies about half the size of the common housefly; they lay their eggs in cracks in the soil near plant stems, and hatching larvae burrow beneath the soil surface to invade the roots. After feeding 3 to 5 weeks, larvae pupate in roots or surrounding soil. Adults may emerge from pupae within 2 to 3 weeks, or the pest may overwinter as pupae when conditions are unfavorable for development. There are at least two to three generations in cool, moist climates along the coast.

**DAMAGE**
Cabbage maggots damage and destroy root systems of all cole crops, riddling roots with tunnels when infestations are heavy. Tunnels provide entryways for pathogens that cause blackleg and bacterial soft rot. Young plants between seedling emergence until about a month after thinning or transplanting are most vulnerable; healthy plants attacked after they are well established can usually tolerate moderate infestations. Cauliflower and Brussels sprouts may be more susceptible than hybrid cultivars of broccoli; crops planted in winter and spring suffer more damage than summer-planted crops.

**MANAGEMENT**
Cool, wet spring weather is favorable to the population development of these pests. Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic or organdy. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury when a set of drag chains is attached behind the planter to eliminate the moisture gradient in the seedrow. Adult flies are believed to be able to locate the seed row for egg laying by honing in on the higher moisture levels created when the soil is overturned for planting. Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disk under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops unless sufficient time has passed for the residue to dry or decompose completely.

**Monitoring and Treatment Decisions**
Every year, treat spring planted or transplanted crops in areas where cabbage maggot causes economic injury with a band of insecticide at the base of the plant at the time of planting or transplanting. Later sprays can not be relied upon to effectively control the pest. Seedbeds for transplanted crops should also be fumigated or treated with an insecticide. Once the crop emerges, watch for wilting, lighter green plants, or reduced growth that may indicate a maggot infestation; pull up affected plants and check roots and soil to confirm presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted; drenching with insecticide is also an option but such treatments are difficult, costly, and may not be adequate. If roots are tunneled but no maggots are present, maggots have left roots to pupate and insecticide treatments would be of little value.
When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. CHLORPYRIFOS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Lorsban Advanced)</td>
<td>1.6–2.75 fl oz/1000 ft row</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Soil application for broccoli, Brussels sprouts, cabbage. Do not apply more than 2.6 pt/acre in 40-inch rows or 4.5 pt/acre in 20-inch rows or apply more than once/season. Avoid drift and tailwater runoff into surface waters. Additional application restrictions may apply; for more information on current California permit restrictions, see the Department of Pesticide Regulation’s Chlorpyrifos Interim Recommended Permit Conditions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>. . . or . . . (Lorsban Advanced)</strong></td>
<td>1.6–2.4 fl oz/1000 ft row</td>
<td>3 days</td>
<td>30</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Soil application for cauliflower. Do not apply more than 2 pt/acre in 40-inch rows or apply more than once/season. Avoid drift and tailwater runoff into surface waters. Additional application restrictions may apply; for more information on current California permit restrictions, see the Department of Pesticide Regulation’s Chlorpyrifos Interim Recommended Permit Conditions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. DIAZINON</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Diazinon) 50W</td>
<td>0.5–1 lb</td>
<td>4 days</td>
<td>0</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Avoid drift and tailwater runoff into surface waters.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

 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 Web site at http://www.irac-online.org/.
**CUTWORMS** (9/09)

**Scientific Names:** Black cutworm: *Agrotis ipsilon*  
Glassy cutworm: *Crymodes devastator*  
Granulate cutworm: *Agrotis subterranea*  
Variegated cutworm: *Peridroma saucia*

**DESCRIPTION OF THE PESTS**
Cutworms include a number of species of dull gray to brown, medium-sized to large (up to 2 inches when full grown) caterpillars. Most cutworms curl up into a C-shape when disturbed. All normally feed close to the soil surface cutting off seedlings or damaging leaves resting on the ground. Most feeding occurs at night; during the day cutworms are usually found just below the soil surface or under dirt clods. First instar cutworms of some species may be found feeding on the leaf surface.

Adult cutworm moths have dark gray or brown front wings with irregular spots or bands and lighter hind wings. Females lay hundreds of white eggs, either singly or in clusters, depending on species, on leaves or stems close to the ground. After hatching, young larvae may feed on leaf surfaces for a while, but older larvae drop to the ground, tunnel into the soil, and emerge at night to feed.

**DAMAGE**
Seedlings or young plants are cut off at or just below ground level; often several plants in a row will wilt or cut off. Losses can be especially severe in fields seeded to a stand or recently thinned. Occasionally cutworms will bore into cabbage heads, but this is not common. Damage often recurs in the same fields and same parts of fields from year to year; damage is worst where large numbers of cutworms are present before planting.

**MANAGEMENT**
Cutworms migrate into newly planted crops from surrounding weeds or infested crops. Check for cutworms in weeds around the edges of the field before you plant. Remove weeds from field margins and plow fields at least 10 days before planting to destroy larvae, food sources, and egg-laying sites. Cutworms have numerous natural enemies, but none can be relied on to bring a damaging population down below economic levels.

**Organically Acceptable Methods**
Cultural practices such as removal of adjacent weeds are an essential part of an organic management program.

**Monitoring and Treatment Decisions**
After the crop is up, check for a row of four or more wilted plants with completely or partially severed stems. If you find damaged plants, look for cutworms by digging around the base of plants and sifting the soil for caterpillars. If you find substantial numbers of cutworms, you can use bait to control most species, except the glassy cutworm, which occurs in the southern San Joaquin Valley. Baits are more effective when food is limited, so get it out before the crop emerges. If unexpected damage occurs after crop emergence, treat as soon as you find several severed plants in the same row.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre**</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. CARBARYL (Sevin) 5% bait</td>
<td>20–40 lb</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 1A</td>
<td><strong>COMMENTS:</strong> For broccoli, Brussels sprouts, cabbage, cauliflower.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. DIAZINON* (Diazinon) 50W</td>
<td>4–8 lb</td>
<td>4 days</td>
<td>0</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 1B</td>
<td><strong>COMMENTS:</strong> Apply before planting. Avoid drift and tailwater runoff into surface waters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. ESFENVALERATE* (Asana XL)</td>
<td>2.4–5.8 fl oz</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER:</strong> 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.*
**Common Name (Trade Name)** | **Amount/Acre** | **R.E.I.** | **P.H.I.**
--- | --- | --- | ---
**D. INDOXACARB**<br>(Avaunt) | 2.5–3.5 oz | 12 | 3
*MODE OF ACTION GROUP NUMBER: 22*
COMMENTS: Do not apply more than 14 oz/acre/crop. Add a wetting agent to improve coverage. Minimum interval between sprays is 3 days.

**E. METHOMYL**<br>(Lannate) LV<br>(Lannate) 90SP | 1.5 pt<br>0.5 lb | 48 | 48
*MODE OF ACTION GROUP NUMBER: 1A*
COMMENTS: Add a wetting agent to improve coverage. Preharvest interval is 3 days for broccoli, Brussels sprouts, and cauliflower and 1 day for cabbage. See label for other cole crops.

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

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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 Web site at http://www.irac-online.org/.

**COMMENTS:** For broccoli, cabbage, cauliflower.
DARKLING BEETLES (11/08)

**Scientific Names:** Various species in the Tenebrionid Family

**DESCRIPTION OF THE PESTS**

Darkling beetles are dull bluish black or brown beetles that chew off seedlings or feed on foliage. They can be distinguished from the predaceous ground beetles by the enlargement of the segments at the tip of the antennae. Predaceous ground beetles are usually shiny and sometimes have colorful markings unlike the dull coloration of the pest species in the darkling beetle family.

**DAMAGE**

Damage is similar to that caused by cutworms: seedlings are chewed off at the base and foliage may also be chewed. Damage usually begins at field edges as beetles tend to come in from weedy areas, alfalfa, or cover crops. Feeding occurs primarily in the evening and at night.

**MANAGEMENT**

To prevent beetle invasions from an adjacent field, fill a ditch full of water to keep them out. If treatment is needed, a bait placed around the edges of the field will usually provide adequate control.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARBARYL (Sevin) 5%</td>
<td>20-40 lb</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For broccoli, Brussels sprouts, cabbage, cauliflower.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact.

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

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DIAMONDBACK MOTH (10/10)

Scientific Name: Plutella xylostella

DESCRIPTION OF THE PEST
Diamondback larvae are small (about 0.33 inch when full grown) compared to other caterpillars in cole crops. The larval body is wider in the middle and tapering at both ends with two prolegs on the last segment forming a distinctive V-shape at the rear end. When disturbed the larvae wiggle frantically or rapidly attach a silken line to a leaf and drop over the edge. They feed mostly on outer or older leaves of older plants chewing out small holes or at the growing points of young plants. They will also feed on floral stalks and flower buds. Larvae mature in 10 to 14 days and spin a loose cocoon on leaves or stems for pupation. Adult moths lay their tiny, roundish eggs singly on the undersides of leaves; eggs are difficult to find. Although they may occur all year round, especially in coastal areas, diamondback moths are often abundant in spring and early summer, and populations may rise again in fall.

DAMAGE
Diamondback moth infestations are most serious when they damage the crowns or growing points of young plants or Brussels sprouts. This injury can severely stunt growth. Sometimes diamondback moth caterpillars may also bore into heads of broccoli or cauliflower, or in the flower buds of stalks, causing economic injury and contamination. Injury to leaves is not usually serious, except when the wrapper or cap leaves of cabbage are injured.

MANAGEMENT
Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields in California, but keep records of diamondback moth as you monitor for other caterpillars.

Biological Control
Natural enemies often effectively control diamondback moth in California. In southern California, the ichneumonid wasp, Diadegma insularis, has been identified as the most common parasite. Trichogramma pretiosum may also attack diamondback eggs. Various predators such as ground beetles, true bugs, syrphid fly larvae, and spiders can be important factors in controlling populations. Microbial diseases are not known to be a significant mortality factor.

Organically Acceptable Methods
Biological control and sprays of Bacillus thuringiensis and the Entrust formulation of spinosad are organically acceptable management tools.

Monitoring and Treatment Decisions
Check fields during the seedling stage, at thinning, and just before heading. Also, record diamondback larvae numbers when you make your twice-weekly samples for other caterpillar pests. In cabbage fields, regularly monitor wrapper leaves for damage after heading. Adult moths frequently migrate from fields being harvested or disced under, so carefully check border rows if populations were high in adjacent fields. No treatment levels have been developed for diamondback moth in California; however, treatment may be required if significant injury to growing points is occurring.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount / Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 11.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. DIAZINON* (Diazinon) 50W</td>
<td>0.5–1 lb</td>
<td>4 days</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Avoid drift and tailwater runoff into surface waters.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, information related to natural enemies and honey bees and environmental impact.
C. EMAMECTIN BENZOATE*  
   (Proclaim) 3.2–4.8 oz 12 14  
   MODE OF ACTION GROUP NUMBER: 6

D. INDOXACARB  
   (Avaunt) 2.5–3.5 oz 12 3  
   COMMENT: Do not apply more than 14 oz/acre/crop. Add a wetting agent to improve coverage.  
   Minimum interval between sprays is 3 days.

E. SPINETORAM  
   (Radiant) SC 5–10 fl oz 4 1  
   MODE OF ACTION GROUP NUMBER: 5  
   COMMENT: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after. Control improved with addition of an adjuvant.

F. SPINOSAD  
   (Entrust)# 0.5–1.25 oz 4 1  
   (Success) 6 oz 4 1  
   MODE OF ACTION GROUP NUMBER: 5  
   COMMENT: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after.

G. CHLORANTRANILIPROLE  
   (Coragen) 3.5–5 fl oz 4 3  
   MODE OF ACTION GROUP NUMBER: 28  
   COMMENT: Foliar application; use with an effective adjuvant for best performance.

H. METHOXYFENOZIDE  
   (Intrepid) 2F 8 fl oz 4 1  
   MODE OF ACTION GROUP NUMBER: 18A  
   COMMENT: For early-season applications only to young crop and small plants.

I. METHOMYL*  
   (Lannate) LV 0.75–3 pt 48 see comments  
   (Lannate) SP 0.25–1 lb 48 see comments  
   MODE OF ACTION GROUP NUMBER: 1A  
   COMMENT: Preharvest interval is 3 days for broccoli, Brussels sprouts, and cauliflower and 1 day for cabbage. See label for other cole crops.

* Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest. 
# Acceptable for use on organically grown produce.  
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* Permit required from county agricultural commissioner for purchase or use.
FLEA BEETLES (9/09)

Scientific Names: Palestriped flea beetle: *Systena blanda*
Striped flea beetle: *Phyllotreta striolata*
Western black flea beetle: *Phyllotreta pusilla*
Western striped flea beetle: *Phyllotreta ramosa*

DESCRIPTION OF THE PESTS
Flea beetle adults are small (about 0.125 inch or 1 mm long), shiny, hard beetles with enlarged hind legs that allow them to jump like fleas. Different species vary in color and markings. Adults do most of the damage; flea beetle larvae may mine leaves or feed on roots, but this activity is not of economic concern.

DAMAGE
Flea beetles feed on the undersides of leaves, creating small pits or irregularly shaped holes. Large populations can kill or stunt seedlings. Older plants rarely suffer economic damage although their older, lower leaves may be damaged.

MANAGEMENT
Flea beetles occasionally infest cole crop seedlings. They are most common in spring but can occur any time, especially in fields that are weedy or surrounded by weeds. Remove weeds along field margins and deeply disk plant residue in infested fields after harvest. Regular monitoring of seedlings for these pests will help detect problems and treatment needs.

Organically Acceptable Methods
Cultural control is acceptable in an organically certified crop. Insecticidal soaps applied at cotyledon stage may provide partial control.

Monitoring and Treatment Decisions
Check newly emerged seedlings twice weekly for flea beetle damage until plants are well established. Relatively low populations can cause economic damage when plants are in the cotyledon or first-leaf stages. Treat if you find several damaged rows; spot treatment of outside rows or borders may be sufficient. Baits are not effective.

If populations are high, treat infested fields just before thinning to prevent post-thinning damage. Once plants have 5 leaves they can tolerate several beetles per plant without damage. Older plants are even more tolerant. One insecticide treatment should be all that is required.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARBARYL* (Sevin) 4F or XLR</td>
<td>1–2 pt</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>(Sevin) 80S</td>
<td>0.67–1.25 lb</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For broccoli, Brussels sprouts, cabbage, cauliflower.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact.

A. CARBARYL* (Sevin) 4F or XLR
   (Sevin) 80S
   MODE OF ACTION GROUP NUMBER: 1A
   COMMENTS: For broccoli, Brussels sprouts, cabbage, cauliflower.

B. DIAZINON* (Diazinon) 50W
   MODE OF ACTION GROUP NUMBER: 1B
   COMMENTS: Avoid drift and tailwater runoff into surface waters.

C. ESFENVALERATE* (Asana XL)
   MODE OF ACTION GROUP NUMBER: 3
   COMMENTS: For broccoli, cabbage, and cauliflower.
D. **INSECTICIDAL SOAP**
(M-Pede)  
**Mode of Action:** A contact fungicide with smothering and barrier effects.  
**Comments:** For broccoli, Brussels sprouts, cabbage, cauliflower. Provides partial control of flea beetles when plants are in the cotyledon stage.

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-Pede</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

E. **CRYOLITE**
(Cryolite) 96W  
**Mode of Action Group Number:** 9A  
**Comments:** For use on broccoli, Brussels sprouts, and cauliflower. Must be ingested by the insect. Apply when early insects are present. Can be used in an insecticide resistance management program.

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryolite 96W</td>
<td>8–16 lb</td>
<td>12</td>
</tr>
</tbody>
</table>

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* Permit required from county agricultural commissioner for purchase or use.  
# Acceptable for use on organically grown produce.

### Mode of Action Group Numbers

- 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 Web site at [http://www.irac-online.org/](http://www.irac-online.org/).
GARDEN SYMPHYLANS (9/09)

Scientific Name: *Scutigerella immaculata*

DESCRIPTION OF THE PEST
Garden symphylans (also called garden centipedes) are not insects; they are in their own arthropod class *Symphyla*. When full grown they are not more than 0.5 inch long and have 15 body segments and 11 to 12 pairs of legs. They are slender, elongated, and white with prominent antennae.

DAMAGE
Symphylans may damage sprouting seeds, seedlings before or after emergence, or older plants. They feed primarily on root hairs and rootlets and their ability to injure the crop decreases as plants get larger, however, their pitting of older roots may provide entryways for pathogens. Transplants may be stunted by their feeding as new roots attempt to grow out of the transplant plug.

MANAGEMENT
Symphylan damage is generally associated with soils that are high in organic matter content with good soil structure. Symphylans do not thrive in either compact soil or sandy soils because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury. Flooding has been used to control symphylans in some situations but has been unsuccessful in others. Flooding requires at least 2 to 3 weeks, is more likely to be effective in late spring or summer than in winter, and is probably most effective where there is a high water table. Symphylans may be found more than 3 feet below the soil surface and flooding to this level in many soils is difficult. Even in the best circumstances, flooding will only reduce populations; and they can be expected to increase when conditions are again favorable. Effectiveness of rotations with nonhost crops has not been studied. Soil fumigation can kill populations in the upper soil levels; eventually, however, the soil will be reinfested by populations deeper in the soil.

Biological Control
Numerous organisms prey on symphylans in the field including true centipedes, predatory mites, predaceous ground beetles, and various fungi; however, little is known about their effect on symphylan populations.

Organically Acceptable Methods
Cultural practices such as packing the soil surface after planting and flooding are suitable for organic crops.

Monitoring and Treatment Decisions
Sampling for symphylans is difficult and visible detection of any symphylans often indicates a population large enough to cause economic damage. A sampling plan modified from one developed by researchers at Oregon State has proven very efficient and relatively easy. Place thick slices of raw potato on the soil surface at the level at which moisture is clearly visible in the soil. Be careful when removing dry soil from the surface not to disturb the pores in the moist soil to prevent symphylans from reaching the bait. This can be done by raking the dry soil away with a lettuce knife, rather than slicing into the soil with a knife or spade. Then cover the bait with a solid plastic dome to protect the bait from drying out while it is allowed to attract symphylans. This plastic dome or cap must be large enough not to cause excessive heating of the area or to accumulate excess condensation. A 6 X 6 inch round white plastic pot with no drainage holes or a styrofoam cup is adequate. Leave the bait in place for 24 to 36 hours and then remove the cover to count the symphylans, both on the potato slice and on the soil surface underneath. Count the soil surface first as the symphylans there will quickly hide.

If symphylan counts approach 75 per potato slice, complete stand loss may occur. Significant stand loss will occur at lower symphylan populations.

Infested soil can be treated with insecticides, but their effect is limited because of the symphylan’s ability to migrate deep into the soil. Insecticides may help in giving the plants a chance to establish in a protected zone. Treat for symphylans just before planting. Spot treatments may be adequate.
When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. DIAZINON*&lt;br&gt;(Diazinon) 50W</td>
<td>0.5–1 lb</td>
<td>4 days</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: Avoid drift and tailwater runoff into surface waters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. ETHOPROP*&lt;br&gt;(Mocap) EC</td>
<td>2.4 fl oz/1000 ft</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>MODÉE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: For cabbage. Apply 1 week before planting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>. . . or . . .&lt;br&gt;(Mocap) 15G</td>
<td>0.9 lb/1000 ft</td>
<td>see label</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: For cabbage. Apply at planting.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

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IMPORTED CABBAGEWORM (10/10)

Scientific Name: *Pieris rapae*

DESCRIPTION OF THE PEST

Larvae are green and very hairy, with an almost velvetlike appearance. Older larvae may be up to an inch long and often have one faint yellow-orange stripe down their backs and broken stripes along the sides. Compared to other caterpillars, cabbageworms move slowly and are sluggish but they feed voraciously on both the outer and inner leaves, often feeding along the midrib, at the base of the wrapper leaves, or boring into the heads of cabbage. After 2 to 3 weeks of feeding, larvae pupate attached by a few strands of silk to stems or other nearby objects; pupae are green with faint yellow lines down the back and sides; there is no spun cocoon. The adult cabbage butterfly is white with one to four black spots on the wings; they are often seen fluttering around the fields. The whitish, rocket-shaped eggs are laid singly on the undersides of leaves. The cabbageworm is active throughout the year in California.

DAMAGE

Cabbageworm larvae chew large, irregular holes in leaves, bore into heads, and drop greenish brown fecal pellets that may contaminate the marketed product. Seedlings may be damaged, but most losses are due to damage to marketed parts of the plant.

MANAGEMENT

Between thinning or transplanting and heading, cole crops can tolerate considerable damage from the imported cabbageworm and other caterpillars that eat leaves. During this period the strategy is to sample frequently enough to assess population development accurately and to avoid unnecessary insecticide treatments that may disrupt biological control. Once plants begin to head, imported cabbageworms can cause serious economic damage, even when they are present in low numbers, so insecticide applications are required at much lower population densities. If cabbageworm populations build up on seedlings, damage can occur quickly so these must be watched closely.

Biological Control

Natural enemies can assist significantly in the control of imported cabbageworms. Important parasites include the pupal parasite *Pteromalus puparum*; the larval parasites *Apanteles glomeratus*, *Microplitis plutella*, and several tachinid flies; and egg parasites in the *Trichogramma* genus. Viruses and bacterial diseases are also sometimes important control factors in the field.

Organically Acceptable Methods

Biological control and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are organically acceptable management tools.

Monitoring and Treatment Decisions

Check for cabbageworms at the same time as you are monitoring for loopers; your sample should include 25 plants selected randomly throughout the field. Treatment levels combine the two species; however, cabbageworms may be harder to find because of their smaller size and their inconspicuous coloring. Look for small larvae and eggs on the undersides of leaves. Larger worms feed toward the center of the plant often near the midribs of leaves. Good clues to cabbageworm presence include their greenish brown fecal pellets or many cabbage butterflies fluttering around the field (check for eggs in a few days). Base treatment on numbers of healthy larvae present (include loopers in counts, too, if they are also present). Treat seedlings or small plants if populations of medium-sized to large caterpillars are high enough to stunt growth. Prior to heading, well-established plants do not need to be treated unless you find more than 9 small to medium-sized larvae per plant. Treat just before heading or at Brussels sprouts formation if counts show more than one caterpillar in 25 plants.

Where possible, use *Bacillus thuringiensis* to avoid adverse impact on natural enemies. *Bacillus thuringiensis* is very effective against imported cabbageworms, especially when applied to early-instar caterpillars (i.e., very young). Imported cabbageworms are also controlled with the more toxic materials recommended for use against other lepidopterous pests. If significant numbers of armyworms or diamondback moths are also present, use materials recommended for these species.
The following materials are listed in order of usefulness in an IPM program, taking into account efficacy, information relating to natural enemies and honey bees as well as environmental impact.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. BACILLUS THURINGIENSIS ssp. KURSTAKI</strong># (various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 11.B2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. EMAMECTIN BENZOATE</strong>* (Proclaim)</td>
<td>3.2–4.8 oz</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. INDOXACARB</strong> (Avaunt)</td>
<td>2.5–3.5 oz</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Do not apply more than 14 oz/acre/crop. Add a wetting agent to improve coverage. Minimum interval between sprays is 3 days.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. SPINETORAM</strong> (Radiant) SC</td>
<td>5–10 fl oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after. Control improved with addition of an adjuvant.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E. SPINOSAD</strong> (Entrust)# (Success)</td>
<td>1–2 oz (6 oz)</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F. CHLORANTRANILIPROLE</strong> (Coragen)</td>
<td>3.5–5 fl oz</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: Foliar application; use with an effective adjuvant for best performance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G. METHOXYFENOZIDE</strong> (Intrepid) 2F</td>
<td>8 fl oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 18A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: For early-season applications only to young crop and small plants.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H. CRYOLITE</strong> (Cryolite) 96W</td>
<td>8–16 lb</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NUMBER</strong>: 9A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS</strong>: For use on broccoli, Brussels sprouts, and cauliflower. Must be ingested by the insect. Apply when early insects are present. Can be used in an insecticide resistance management program.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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LEAFMINERS (9/09)

Scientific Name: *Liriomyza* spp.

**DESCRIPTION OF THE PESTS**

Adults are tiny black flies with a bright yellow spot on their thorax. Females puncture leaves to feed on plant sap and lay eggs within the leaf tissues. After 2 to 4 days the eggs hatch and larvae feed between the upper and lower surface of leaves, making the distinctive winding, whitish tunnels or leafmines that may be the first clue to the leafminers’ presence. Larvae emerge from the leafmines and pupate on the leaf surface or, more commonly, in cracks in the soil. Many generations may occur each year, and the entire life cycle can be completed in less than 3 weeks when the weather is warm.

**DAMAGE**

Leafminers can reduce the plant’s photosynthetic capacity, render edible leaf portions unmarketable, and provide an entrance for pathogenic organisms.

**MANAGEMENT**

Leafminers are primarily seedling pests. Natural enemies, especially parasitic wasps in the *Diglyphus* genus, commonly control leafminers, unless killed off by insecticides applied to control other pests. Choose selective pesticides for treating other seedling pests to avoid this problem. Regular monitoring during the seedling start will help determine the need for treatment.

Liriomyzid leafminers attack a wide variety of vegetable crops often grown in proximity to cole crops. Where possible avoid planting next to infested fields, especially those near harvest.

**Organically Acceptable Methods**

The Entrust formulation of spinosad is acceptable for use on organically certified produce.

**Monitoring and Treatment Decisions**

Regularly check young seedlings for leafmines. Most mines occur on the cotyledons and first true leaves. If leafminer populations build to high levels when seedlings have only four or five leaves, chemical treatment may be necessary. Treat if you find an average of one or more mines per leaf in your overall field samples. Broccoli or cauliflower with six or more leaves are rarely damaged by leafminers, regardless of population numbers. However, for cabbage or lettuce, if edible leaves are mined, chemical control may be justified.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYROMAZINE (Trigard) WP</td>
<td>2.66 oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For Chinese cabbage and Chinese mustard. Do not apply more than 1 lb of product/acre/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPINETORAM (Radiant) SC</th>
<th>5–10 fl oz</th>
<th>4</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after. Control improved with addition of an adjuvant.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPINOSAD (Entrust)#</th>
<th>1.25–3 oz</th>
<th>4</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUCCESS (Success)</td>
<td>4–10 oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Toxic against some natural enemies (predatory thrips, syrphid fly larva, beetles) when sprayed and 5 to 7 days after. Use higher rate for heavy infestations.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When choosing a pesticide, consider information relating to natural enemies and honey bees as well as the environmental impact.
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>

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LEAFROLLERS (11/15)

Scientific Names: Garden tortrix: Ptycholoma (=Clepsis) peritana  
Light brown apple moth: Epiphyas postvittana  
Orange tortrix: Argyrotaenia franciscana (=A. citrana)

DESCRIPTION OF THE PESTS

Several leafrollers in the family Tortricidae are present in vegetable growing areas of the Central Coast. In particular, garden tortrix, light brown apple moth, and orange tortrix are pests of cole crops.

Adults of these leafrollers have:
- light brown bodies with brown markings
- wings that form a bell shape while at rest
- protruding mouthparts that resemble a snout

Adults and larvae range in size depending on the species:

<table>
<thead>
<tr>
<th></th>
<th>garden tortrix</th>
<th>light brown apple moth</th>
<th>orange tortrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>adult</td>
<td>1/4 inch (6 mm)</td>
<td>1/4 to 1/2 inch (6–13 mm)</td>
<td>1/2 inch (12 mm)</td>
</tr>
<tr>
<td>larva (full grown)</td>
<td>1/2 inch (12 mm)</td>
<td>1/2 to 3/4 inch (12–18 mm)</td>
<td>1/2 inch (12 mm)</td>
</tr>
</tbody>
</table>

Although not well studied on cole crops, most leafrollers have one to four generations a year, depending on species and location.

Females lay eggs masses of 20 to 170 eggs per batch on smooth surfaces, such as shoots or upper leaf surfaces. Egg masses are difficult to find and are composed of elliptical eggs that overlap each other like fish scales. Eggs vary in color, but are often light green initially and turn from green to greenish-brown as the embryos develop.

When disturbed, leafroller caterpillars wriggle vigorously, suspend themselves from a silken thread, and drop to the ground. Larvae and pupae overwinter in debris around the base of the plant.

Garden tortrix
Like the orange tortrix, adult garden tortrix forewings are marked with a dark brown diagonal stripe and a marginal spot that produces a chevron (V-shaped) pattern when at rest. However the chevron pattern on the adult garden tortrix is darker than that of the orange tortrix, making it more noticeable. Garden tortrix also has a light-colored margin on the edge of the chevron that orange tortrix lacks.

Garden tortrix larvae are slender, with light brown to green bodies and light brown heads. The head has a small, distinct, dark brown spot on each side, as well as a darkened prothoracic shield (the top of first segment behind the head).
Orange tortrix
The adult orange tortrix, is also called apple skinworm. The female moth generally has a faint V-shaped marking located midwing. The male is similar to the female except that it has darker markings. Compared to the garden tortix, the V-shaped pattern is less visible.

At hatching, larvae are 0.2 inch (2 mm) long. Older larvae have greenish to straw-colored bodies with a yellowish or straw-colored head capsule and prothoracic shield. Larvae usually feed singly on shoot tips or on succulent leaves in nests they web together with silk. Larvae make a dense silken cocoon in webbed foliage and pupate. Adults emerge in about 1 to 3 weeks depending on temperature. Orange tortrix has two to four generations per year with all stages present throughout the year.

Light brown apple moth (FIELD IDENTIFICATION GUIDE)
The size of the moth may vary during the season with larger individuals during cool wet months and smaller individuals during warm dry months. The length of a resting moth is about half its wingspan. Distinguish light brown apple moth from the other two leafrollers by the extension on the outer edge of the forewing (costal fold). Females do not have the costal fold. Also, in contrast with garden tortrix and orange tortrix, light brown apple moths display a variable dark brown pattern on the wings, especially males. The larva is pale to medium green and has a light brown head capsule.

Moths emerge after 1 to 3 weeks of pupation and mate soon after emergence. They stay sheltered in the foliage during the day, resting on leaf undersides. Females begin to lay eggs 2 to 3 days after emerging, depositing them at night on the upper side of leaves.

Overwintering larvae do not have a winter resting stage (diapause). They pass the winter as second- to fourth-stage larvae on vegetation surrounding the field or on weeds. Larvae may survive for up to 2 months in the winter without feeding.

A degree-day model indicates that there will most likely be two generations a year in the central and north coast areas of California and three or four generations a year in the Central Valley and Southern California. Completion of the entire life cycle requires 620 degree-days above 45°F.

Light brown apple moth, also known as LBAM, is an introduced species native to Australia that was first detected in the San Francisco and Monterey Bay areas in the spring of 2007. Subsequent detections have occurred in coastal California from Los Angeles to Sonoma counties. In its native range it does not survive well at high temperatures, but it does thrive in cooler areas with mild summers, moderate rainfall, and moderate-to-high humidity. Updated information on light brown apple moth can be found on the UC IPM website. Because it is a quarantined pest with special requirements regarding movement, inspection, and treatment of regulated plant materials, consult the California Department of Food and Agriculture (CDFA) website or the county agricultural commissioner’s office for compliance information.

DAMAGE
Leafrollers are polyphagous (feed on many kinds of plants). Cole crops near native vegetation, riparian, and urban areas may have an increased risk for leafroller infestations because adults developing on wild hosts or landscape plants occasionally migrate to cole crop fields and lay eggs.

Direct feeding damage of leafrollers is minor on cole crops because leafrollers rarely infest the economic portion of the crop, such as the florets. Typically, most leafroller larvae, including light brown apple moth, tie one or more leaves together with webbing to create shelters and may feed from these sheltered areas on the leaf surface.

The main economic cost of leafrollers is the detection of light brown apple moth in a field. Because it is a quarantined pest, detection may result in difficulties shipping produce out of quarantined areas.

MANAGEMENT
Light brown apple moth is a class A rated pest subject to quarantine, so there is zero tolerance for larvae in fields or on harvested crops. Fields within a light brown apple moth quarantine area are managed differently for leafrollers than fields outside quarantine areas.
Cultural Control
Early weed control can help to reduce leafroller numbers. However, moths can fly for several miles and cause new infestations.

Organically Acceptable Methods
Cultural controls, applications of *Bacillus thuringiensis* spp. *kurstaki*, and the Entrust formulation of spinosad are acceptable for use in organically grown vegetable fields. When using *B. thuringiensis*, apply multiple times and at close intervals to expose survivors of previous applications to another dose. When mixing, decrease the water volume to concentrate the dose ingested by the larvae, but make sure the volume applied still ensures thorough spray coverage. Targeting a specific larval stage is difficult because leafrollers have overlapping generations.

Monitoring and Treatment Decisions
Prevention is especially important in quarantine zones. It is difficult to distinguish light brown apple moth larvae from other leafrollers, so a preventive approach, consisting of sanitation, monitoring, and early chemical treatments targeting all species of leafrollers, is currently suggested for cole crops within the quarantine zones.

Base the frequency of monitoring on the relative proximity of cole crops to high-risk areas or a history of detection. Increase monitoring frequency where an infestation is found. During the growing season through harvest:
1. Examine plants for larvae. The presence of frass or webbing under the lower leaves indicates leafroller activity. Leafrolls made by larvae are not hard to find and consist of one or more (usually mid-canopy) leaves webbed together.
2. When webbing is first detected, search nearby for other infestations. Infestations typically have a clustered distribution.
3. Separate the infested produce from the marketable produce when larvae are detected on leaves close to florets during harvest.

Insecticide sprays for other lepidopteran pests such as armyworms, corn earworm or diamondback moth may control leafrollers. However, apply insecticides if leafrollers are detected while scouting to prevent infestations in harvested produce and possible quarantine issues.

<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>A. SPINOSAD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Entrust)#</td>
<td>1.25–1.5 oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>(Success)</td>
<td>6 fl oz</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>
| **MODE-OF-ACTION GROUP NUMBER:** 5
**COMMENTS:** Most effective against younger larvae. Rotate to an insecticide with a different mode of action after two successive applications. Maintaining proper pH of the spray tank water is critical for maximum efficacy. |
| **B. SPINETORAM**                |                 |             |             |
| (Radiant SC)                     | 6–10 fl oz      | 4           | 1           |
| **MODE-OF-ACTION GROUP NUMBER:** 5
**COMMENTS:** It is extremely important to rotate to an insecticide with a different mode of action after two successive applications. Resistance has developed where rotations between spinosad and spinetoram have been made because they have the same mode of action. Maintaining proper pH of the spray-tank water is critical for maximum efficacy. |
| **C. BACILLUS THURINGIENSIS ssp. KURSTAKI#** | | | |

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.
<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>(various products)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 11A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: To be effective must be applied no later than the second instar.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. CHLORANTRANILIPROLE (Coragen)</td>
<td>3.5–5 fl oz</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. METHOXYFENOZIDE (Intrepid 2F)</td>
<td>6–12 fl oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. EMAMECTIN BENZOATE* (Proclaim)</td>
<td>3.2–4.8 oz</td>
<td>12</td>
<td>See label</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. METHOMYL* (Lannate SP)</td>
<td>0.5–1 lb</td>
<td>48</td>
<td>See label</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 1A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. INDOXACARB (Avaunt)</td>
<td>2.5–3.5 oz</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. DIAZINON*</td>
<td>Label rates</td>
<td>96 (4 days)</td>
<td>7</td>
</tr>
<tr>
<td>MODE-OF-ACTION GROUP NUMBER: 1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not allow this insecticide to run off into surface waters.</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 two intervals is the minimum time that must elapse before harvest.

# Acceptable for use on organically grown produce.

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

| 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://www.irac-online.org/ |
OTHER APHIDS (9/09)

Scientific Names: Green peach aphid: *Myzus persicae*
Turnip aphid: *Lipaphis erysimi*

DESCRIPTION OF THE PESTS
Several other aphids may occur on cole crops. The most common is the green peach aphid, which is a yellow-green aphid with prominent tubercles at the base of the antennae. None of the other aphids occurring in cole crops have the waxy coating that characterizes the cabbage aphid. Green peach aphid and turnip aphid also tend to be more randomly dispersed around the plants than the dense colonies of the cabbage aphid. The turnip aphid, a species that is a worldwide foliar aphid pest, occasionally infests the roots of cole crops in coastal California. These aphids are dark to olive green and unlike other root aphids, have visible cornicles.

DAMAGE
When populations are heavy, green peach aphid can stunt seedlings; however, economic damage rarely occurs on older plants because green peach aphids tend to feed on older leaves and rarely enter heads of broccoli, cauliflower, cabbage, or Brussels sprouts. Turnip aphids on the roots of cole crops can seriously stunt and even kill plants.

MANAGEMENT
These aphids rarely require treatment in cole crops. Because they remain mostly on the older, nonmarketable leaves of cole crops, low-to-moderate populations can be tolerated on older plants. High numbers of green peach aphid can kill young seedlings or transplants, so treat infested young plants if they show stress from feeding by this aphid. The same general predators and parasites that attach cabbage aphids also attack these aphids.

Biological Control
Many predators and parasites attack aphids, especially in fields that are not sprayed or sprayed with less toxic materials. These natural enemies, including general aphid predators and the parasites *Lysiphlebus testaceipes*, *Aphidius matricariae*, *Aphelinus semiflavus*, and *Diaeretiella rapae*, may provide adequate control under certain circumstances.

Cultural Control
Remove infested culls and weedy species around fields that may harbor the aphid between crops. Turnip aphid problems tend to recur in the same fields. Long term rotation to other crops may be advised.

Organically Acceptable Methods
Biological and cultural controls as well as sprays of insecticidal soap, which can give partial control of aphids, are organically acceptable methods. Insecticidal soap sprays, however, may be phytotoxic under some conditions and rates, especially in Brussels sprouts and cabbage.

Monitoring and Treatment Decisions
No special monitoring is needed for green peach or turnip aphids in cole crops; keep notes on them as you monitor the cabbage aphid. Treat seedling plants if they appear to be stressed by aphid populations. Older plants can tolerate low to moderate populations. If applications are made for cabbage aphid just before heading, other foliar aphid species will be controlled as well.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. ACEPHATE (Orthene) 75S</td>
<td>0.66–1.33 lb</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1B</td>
<td>COMMENTS: For Brussels sprouts, cauliflower.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. ACETAMIPRID (Assail) 70WP</td>
<td>0.8–1.2 oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 4A</td>
<td>COMMENTS: Do not apply more than once every 7 days or make more than 5 applications/season.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. FLONICAMID  
(Beleaf) 50SG  
MODE OF ACTION GROUP NUMBER: 9C  
2-2.8 oz  
12  
0

D. SPIROTETRAMAT  
(Movento)  
MODE OF ACTION GROUP NUMBER: 23  
4-5 fl oz  
24  
1

E. DIAZINON*  
(Diazinon) 50W  
MODE OF ACTION GROUP NUMBER: 1B  
0.5-1 lb  
4 days  
0  
COMMENTS: Avoid drift and tailwater runoff into surface waters.

F. INSECTICIDAL SOAP#  
(M-Pede)  
1-2% solution  
12  
0  
MODE OF ACTION: A contact fungicide with smothering and barrier effects.  
COMMENTS: For broccoli, Brussels sprouts, cabbage, cauliflower. Only partial control. May be phytotoxic on Brussels sprouts and cabbage.

G. PYMETROZINE  
(Fulfill)  
MODE OF ACTION GROUP NUMBER: 9B  
2.75 oz  
12  
7  
COMMENTS: Best used in a tank mix with another insecticide registered for aphids. Do not apply more than 2 applications/crop/season. Make applications at least 7 days apart.

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

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

# Acceptable for use on organically grown produce.

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SEEDCORN MAGGOT (6/07)
Scientific Name: *Delia platura*

DESCRIPTION OF THE PEST
Seedcorn maggot larvae are legless, white maggots that cannot be distinguished from cabbage maggot larvae without microscopic examination by a trained taxonomist. However, unlike cabbage maggot larvae, they do not attack plants after seedling stages, so are rarely found tunneling in larger roots. The life cycle is similar to cabbage maggot with adult flies laying eggs singly or in clusters in the soil near plant stems. Larvae feed for 1 to 3 weeks on seeds and germinating seedlings and burrow into the soil to pupate. Numerous generations may occur, although maggots are most prevalent under cool spring conditions, especially after wet winters, and populations may decline in summer. This insect is attracted to soils that have a high organic matter content.

DAMAGE
Seedcorn maggots kill germinating seed and very small seedlings. Once the stand is established and seedlings have developed a few leaves, they are unlikely to cause economic damage.

MANAGEMENT
Prevention is the best management strategy. Seedcorn maggots prefer to lay their eggs in moist, organically rich soil. If you are using manure, let it age and incorporate it well before planting. Disk under cover crops at least 2 weeks before planting. Attach drag chains behind the planter during seeding to reduce egglaying in the seed row. Cool, wet spring weather is favorable to the development of seedcorn maggot populations.

Monitoring and Treatment Decisions
Treatment for seedcorn maggots is not generally necessary, especially in coastal areas. However, in the Central Valley, spring-planted fields with high organic matter may require treatment if not rotated to grains or other nonhosts. Preventive treatments applied for cabbage maggot prevent seedcorn maggot problems.
SILVERLEAF WHITEFLY (9/09)

Scientific Name: *Bemisia argentifolii* (=*Bemisia tabaci*, Biotype B)

**DESCRIPTION OF THE PEST**

Several species of whiteflies may infest cole crops. The most important one is the silverleaf whitefly, also known as the sweetpotato whitefly biotype B. Proper identification of silverleaf whitefly is important because other whitefly species do not cause economic damage in cole crops. Use a hand lens to examine both immatures and adults. Silverleaf whitefly adults are tiny (0.06 inch or 1.5 mm long), yellowish insects with white wings. Their wings are held somewhat vertically tilted, or rooflike, over the body and generally do not meet over the back but have a small space separating them. Greenhouse whitefly (*Trialeurodes vaporariorum*) adults, the species that is most similar in appearance, hold their wings flatter over the back, and there is no space between them where the wings meet in the center of the back.

Whiteflies are found mostly on the undersides of leaves. They fly readily when plants are disturbed. The tiny, oval eggs hatch into first instar (stage) larvae that have legs and antennae and are mobile. Both legs and antennae are lost after the first molt, and subsequent instars remain fixed to the leaf surface. The last nymphal instar, often called the pupa or the red-eye nymph, is the easiest nymphal instar to identify. Silverleaf whitefly pupae are oval, whitish, and soft. The edge of the pupae tapers down to the leaf surface and has few to no long waxy filaments around the edge. In contrast, the greenhouse whitefly pupae have many long waxy filaments around the edge and the edge is somewhat vertical where it contacts the leaf surface.

**DAMAGE**

Whiteflies damage cole crops by sucking enormous quantities of sap and covering plants with sticky honeydew. Black sooty mold grows over the honeydew, lowering the photosynthetic capacity of the plant. Feeding by silverleaf whitefly stunts plant growth and development; as a result harvest may be delayed. Silverleaf whitefly feeding on broccoli causes a bleaching or whitening in stems and leaf petioles.

**MANAGEMENT**

Silverleaf whitefly is a major problem in California's southern desert and an increasing problem in the southern San Joaquin Valley. Biological control can be helpful in controlling light populations of this pest, and cultural practices are important in helping to prevent severe infestation. Monitor for silverleaf whitefly and apply insecticides when necessary. If whiteflies are migrating into the field, treatments to field borders may be adequate.

**Biological Control**

Silverleaf whitefly is an introduced pest that has escaped its natural enemies. Some native parasites and predators do attack it, but do not keep it below damaging numbers. These include several wasps in the *Encarsia* and *Eretmocerus* genera and predatory bigeyed bugs, lacewing larvae, and lady beetles that feed on nymphs. Several exotic species of parasites in the *Encarsia* and *Eretmocerus* genera also have been introduced into southern California to assist in biological control.

**Cultural Control**

Populations peak in late summer and begin to decrease by November. Delaying planting or using host-free periods may decrease severity of attack. When possible, plant cole crops at least one-half mile upwind from other key whitefly hosts, such as melons and cotton. Maintain good sanitation in winter and spring host plants. Attempt to produce the crop in the shortest season possible; proper management of irrigation and nitrogen will assist in this. Remove/destroy all crop residue as soon as possible.

**Organically Acceptable Methods**

Biological and cultural control, and sprays of insecticidal soap and narrow range oils are organically acceptable management tools.

**Monitoring and Treatment Decisions**

Routinely check field margins for whiteflies; these areas are usually infested first. Be especially alert for rapid population buildup when nearby host crops are in decline. During these critical periods, check cole crop fields twice weekly. Sticky traps may be useful in detecting initial whitefly migrations into fields.
Allow beneficials an opportunity to control light whitefly infestations. If higher populations are present at the field margins than the field centers, then treat only the field margins. This approach will reduce treatment costs and help preserve beneficials in the field. Thresholds are not available for silverleaf whitefly in cole crops.

Effective treatments consist of combining a pyrethroid (bifenthrin-Capture) with a cyclodiene (endosulfan-Thiodan), carbamate (methomyl-Lannate), or organophosphate (acephate-Orthene, chlorpyrifos-Lorsban). Bifenthrin and endosulfan provide acceptable control of light populations when used alone, but use combinations of materials on moderate to heavy populations. An alternative to combining insecticides is to use one of the neonicotinoids (imidacloprid-Admire, or acetamiprid-Assail). Insecticidal soaps and oils are not as effective as other materials and require frequent applications and excellent coverage.

Rotate classes of insecticides to manage resistance. This includes all insecticides used in the field, including those used for other insect pests during the current season. Whitefly control with insecticides is maximized by thorough spray coverage. Ground application may give more complete coverage than air.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSECTICIDAL SOAP#</td>
<td>1% solution or less</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>(M-Pede)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION:</td>
<td>Contact with smothering and barrier effects.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>This material has no residual and requires frequent applications and thorough coverage.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NARROW RANGE OILS</td>
<td>1% solution or less</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>(Saf-T-Side)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>For all cole crops. This material requires frequent applications and thorough coverage.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

...or...

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Organic JMS Stylet Oil)#</td>
<td>3 qt/100 gal water or label rate</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>For cabbage and cauliflower only. This material requires frequent applications and thorough coverage.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**: For light populations the neonicotinoids (Actara, Admire, Assail) or bifenthrin (Brigade) may be used alone. For moderate to heavy populations use either a neonicotinoid or combine bifenthrin (Brigade) with spirotetramat (Movento) or spiromesifen (Oberon).
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. THIAMETHOXAM (Actara)</td>
<td>3–5.5 oz</td>
<td>12</td>
<td>see comments</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 4A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: PHI for head and stem <em>Brassica</em> is 0 days, whereas for leafy <em>Brassica</em> greens it is 7 days.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. IMIDACLOPRID (Admire Pro)</td>
<td>7–10.5 fl oz</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 4A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Effective against nymphs only.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. ACETAMIPRID (Assail) 70WP</td>
<td>1.1–1.7 oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 4A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Do not apply more than once every 7 days or make more than 5 applications/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. BIFENTHRIN* (Brigade) 2EC</td>
<td>3.8–6.4 fl oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Apply in a minimum of 5 gal water/acre by air or 20 gal/acre by ground. Do not apply more than 5 applications/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. SPIROTETRAMAT (Movento)</td>
<td>4–5 fl oz</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use following an adulticide or with an adulticide (such as bifenthrin) if adult numbers are high.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. SPIROMESIFEN (Oberon) 2SC</td>
<td>7–8.5 fl oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use following an adulticide or with an adulticide (such as bifenthrin) if adult numbers are high.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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WIREWORMS (6/07)
Scientific Names: Various species in the Elaterid Family

DESCRIPTION OF THE PESTS
Wireworms are the soil-dwelling larvae of click beetles. They are slender, cylindrical, usually yellowish and resemble mealworms.

DAMAGE
Wireworms injure seedlings by feeding on roots or boring into stems. Damage is more common in spring planted crops where the soil has a high organic content, such as fields that have recently been in or adjacent to alfalfa, pasture, or uncontrolled weeds. Wireworms do not significantly damage older plants.

MANAGEMENT
Soil fumigants and certain other pesticides kill wireworms, but special controls are seldom needed. Flooding a field for several weeks also reduces populations.
Diseases

ALTERNARIA LEAFSPOT (11/08)
Pathogens: Alternaria brassicae, A. brassicicola

SYMPTOMS
The two Alternaria species, A. brassicae and A. brassicicola, cause similar symptoms; small, dark specks first develop on leaves and later enlarge into circular, tan spots (0.25-0.5 inch in diameter). The spots caused by A. brassicicola tend to be darker than those caused by A. brassicae. If conditions are favorable, dark green spores of the pathogen will grow on the spots. Such growth causes the spots to have concentric rings in them. Old leafspots become papery in texture and may tear. When the dry tissue falls out, a shot hole effect results.

COMMENTS ON THE DISEASE
Alternaria leafspot is usually not an economic concern on cole crops. It occasionally is a problem on cabbage during cool, rainy months. The pathogen can also infect Brussels sprouts, broccoli, and cauliflower. Leafy crucifers that are harvested for their leaves (red mustard, Chinese cabbage, tat tsoi, and Mizuna mustard) are also susceptible to Alternaria brassicae and can be seriously damaged by this pathogen. Disease is favored by moist conditions. Spores are spread by winds and splashing water. The fungus does not survive in soil, but is carried over in crucifer seed, on weed or volunteer hosts, or on undecomposed crop residue.

MANAGEMENT
Use clean seed and practice crop rotation. Fungicides applied as foliar sprays will control this disease.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPRODIONE (Rovral)</td>
<td>2 pt</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Dicarboximide (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For broccoli only. Apply immediately after thinning (2- to 4-leaf stage) as a directed spray to the base of the plant and adjacent soil surface.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHLOROTHALONIL (various products)</td>
<td>Label rates</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use at 7- to 10-day intervals.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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.

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BACTERIAL BLIGHT (6/07)
Pathogen: *Pseudomonas syringae pv. alisalensis*

**SYMPTOMS**
Bacterial blight infections start as small, angular-shaped, water-soaked specks on leaves that are often surrounded by yellow borders. As the disease develops, specks enlarge and coalesce together into larger, irregularly shaped gray-to-tan spots. Leafspots are visible from both top and bottom sides of leaves. Symptoms may resemble those of the more familiar bacterial leafspot disease.

**COMMENTS ON THE DISEASE**
Recent research has identified this bacterial disease, which is caused by a pathogen related to, but distinct from, the bacterium that causes bacterial leafspot. For cole crops, bacterial blight has been found on broccoli, cauliflower, and Brussels sprouts. Other crucifer hosts include rappini, arugula, and rutabaga. The pathogen is seedborne and is splashed from plant to plant by rain and sprinkler irrigation. Bacterial inoculum may persist for short periods of time in soil.

**MANAGEMENT**
Plant clean and disease-free transplants. Rotation away from fields where the disease has recently occurred may reduce inoculum levels in soil or infected debris. A change from sprinkler to furrow or drip irrigation may limit its spread.

BACTERIAL LEAFSPOT (6/07)
Pathogen: *Pseudomonas syringae pv. maculicola*

**SYMPTOMS**
Bacterial leafspot infections start as small, dark specks on leaves. As disease develops, numerous water-soaked leafspots appear. Leafspots remain small (0.125 inch or 3 mm in diameter). Older leafspots turn tan and may or may not have a purple border around them. Leafspots are visible from both top and bottom sides of leaves. Symptoms on transplants may resemble downy mildew symptoms.

**COMMENTS ON THE DISEASE**
Bacterial leafspot is most often seen under greenhouse conditions. Occasionally it also occurs on cauliflower in coastal valleys, but its occurrence in production fields is sporadic. The pathogen is seedborne and is splashed from plant to plant by rain and sprinkler irrigation.

**MANAGEMENT**
Plant clean seed and disease-free transplants. Rotation away from fields where the disease has recently occurred may reduce inoculum levels in soil or infected debris. A change from sprinkler to furrow or drip irrigation may limit its spread. Cultivars vary in susceptibility.
BLACK LEG (11/08)

Pathogen: *Phoma lingam*

**SYMPTOMS**
The most serious symptoms occur on stems near the soil line where elongated, sunken, brown lesions form. These lesions may girdle the stem, resulting in stunting, wilting, and general poor growth of the plant. If the lesions enlarge, the stem may break, causing the plant to fall over. Lesions usually contain minute, spherical, dark structures that are the fruiting bodies of the pathogen. If conditions are right, pink masses of spores exude from these structures. If seedlings are infected early, they may die. Less important are the leafspots that may develop on foliage. Leafspots are circular, light tan, and contain the dark, spherical fruiting bodies of the pathogen. The disease damages the water-conducting tissue, and blackened streaks of xylem can be seen by cutting open the stem.

**COMMENTS ON THE DISEASE**
Of particular importance is the ability of this pathogen to be carried in and on seed. This is how the fungus is introduced into greenhouse and field plantings. The pathogen can live in crop debris if such material is not fully decomposed. Cool, moist conditions enhance disease development. Spores are spread with splashing water. A second spore type may occur that can be blown long distances on wind currents.

**MANAGEMENT**
Black leg can be managed by using disease-indexed seed, by cultural practices, and with foliar sprays. Remove cruciferous weeds and volunteer plants that may harbor the pathogen. Plow under debris in diseased fields to allow for more rapid and thorough decomposition. Practice crop rotation; rotate infested fields out of cruciferous crops for 1 or 2 years.

When choosing a pesticide, consider information relating to environmental impact.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. IPRODIONE (Rovral)</td>
<td>2 pt</td>
<td>24</td>
<td>0</td>
</tr>
</tbody>
</table>

**MODE OF ACTION GROUP NAME (NUMBER):** Dicarboximide (2)

**COMMENTS:** Registered for broccoli only. Use as a foliar treatment applied as a directed spray to the base of the plant. If conditions persist, a second application may be made. Do not make more than two applications/crop. Effective against the black leg pathogen in other Brassica crops outside of California, but no research has been done in California to test its effectiveness on broccoli.

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BLACK ROT  (6/07)
Pathogen: Xanthomonas campestris pv. campestris

SYMPTOMS
Black rot symptoms vary depending on the environmental conditions. Early in disease development, typical symptoms consist of angular or V-shaped chlorotic lesions along the leaf edges. With time these lesions will dry up and turn tan or brown. Black veins are often seen within these tan lesions, though they may not always develop. Severely infected leaves may wither and drop off the plant. If systemic infection has taken place, the vascular tissues in petioles and main stems can also turn black. If temperatures are cool, however, symptoms may not be expressed. Atypical symptoms, such as small, brown specks, may also occur and mimic other bacterial diseases.

COMMENTS ON THE DISEASE
The most severe losses from black rot have occurred in cabbage and cauliflower; crucifers grown for seed production crops can also be severely damaged. Black rot development is favored by warm, humid conditions. Splashing water from rain or sprinklers spreads the pathogen from plant to plant. Xanthomonas campestris pv. campestris is introduced into greenhouse or field situations primarily on seeds. The bacterium can also survive in soil if infected plant residues have not decomposed. Many cruciferous weeds are important reservoirs of the pathogen.

MANAGEMENT
Because the pathogen may survive in infected plant debris, do not plant a crucifer crop more often than every 2 years in any infested field. When possible, implement crop rotations using nonhosts. Some resistant cabbage cultivars are available.

Many cruciferous weeds host bacteria and must be controlled to prevent continued contamination. Remove weed and volunteer crucifers from production areas. Deep plowing can speed decomposition of infected plant debris, but care must be taken to bury all debris. Avoid sprinkler irrigation wherever possible, and do not plant infested fields during winter and spring when heavy rainfall occurs.

The bacterium can be carried on or in the seed. Plant seed that is free from the pathogen. Seed should be assayed to determine cleanliness, and it can be hot water treated to reduce infestation; however, hot water or other treatments are not 100% effective and may reduce germination. Transplants produced for field planting should likewise be disease-free. Clipping or mowing transplants before planting may result in widespread contamination of transplants.

Organically Acceptable Methods
Crop rotation, the use of resistant cultivars, weed management in the field and surrounding areas, and the use of pathogen-free seed and transplants are acceptable management strategies in an organically certified crop.
CLUBROOT  (6/07)
Pathogen: *Plasmodiophora brassicae*

**SYMPTOMS**
During initial stages of clubroot, aboveground symptoms may be absent. When present, foliar symptoms consist of stunting, yellowing, wilting, and other signs of a dysfunctional root system. Extensive galling, swelling, and distortion of the roots and hypocotyl are the main symptoms of the disease. Galled and clubbed roots are often invaded by secondary rot organisms such as soft rot bacteria; this results in the rapid decay of roots, further decline of infected plants, and release of additional inoculum into the soil.

**COMMENTS ON THE DISEASE**
Clubroot infects all of the cole crops, as well as many weeds in the mustard family. The fungus persists in soil as thick-walled resting spores that can remain viable for 10 years or longer. Infection is favored by acid soils with adequate moisture, but infections do occur above pH 7.0. In the presence of host plant roots, these resting spores germinate by releasing swimming zoospores. Such zoospores infect and colonize root hairs. Later, a second type of zoospore appears that can infect the main roots. Infection and colonization by this second zoospore causes the galling and clubbing of roots. Additional resting spores are formed inside the galled roots and are released into the soil when roots decay. The fungus is dispersed from field to field by the use of diseased field-grown transplants and movement of infested soil on machinery and surface water.

**MANAGEMENT**
Once in the soil, clubroot fungus remains viable for many years. There is no economical way to eliminate it. Rotation with nonhost crops generally does not provide effective control; however, a 2-year rotation away from crucifer crops and into cereals may be helpful in some instances.

Minimize the spread of the pathogen by using pathogen-free transplants. It is preferable to use transplants that are produced in soil-less rooting mixes in trays. However, if field-grown transplants must be used, then grow transplants in fumigated plant beds; young plants can be infected for some time without indicating infection and cannot always be detected at transplanting.

Restrict the movement of contaminated soil (on farm implements) from infested to noninfested fields. Do not use tailwater from contaminated fields to irrigate noninfested fields because the fungus can be transported in water.

Where fields are already infested with the clubroot pathogen, applying lime to infested fields can help create soil conditions unfavorable for spore germination. In general, apply lime if soil pH is lower than 7.2. Annual applications are usually necessary. Not all soils respond favorably to this treatment.

**Organically Acceptable Methods**
Crop rotation, proper handling of transplants and irrigation water, and liming the field are acceptable management tools in an organically certified crop.
DOWNY MILDEW (11/08)

Pathogen: *Peronospora parasitica*

SYMPTOMS
Infections begin as irregular yellow patches on leaves; these chlorotic lesions later turn tan to light brown. If conditions are favorable, white fluffy growth of the fungus develops on the undersides of leaves. If disease development is extensive, leaves may take on a blighted effect as a result of numerous infection sites. Systemic infections can cause internal black streaks and patches to form in stems and floret branches of broccoli and cauliflower. Early symptoms on transplants may resemble bacterial leafspot symptoms. Severely diseased seedlings may be stunted or die.

COMMENTS ON THE DISEASE
*Peronospora parasitica* requires cool, moist weather for infection and disease development to take place. The pathogen survives between crops on weed hosts or as resilient oospores in crop residue. Spores are airborne. This disease is most serious on young seedlings; if cotyledons and the first true leaves are severely infected, the young plant may die.

MANAGEMENT
A few broccoli varieties are available that are resistant to downy mildew. Fungicide treatment of susceptible varieties is needed when the disease occurs on transplants or early in crop development in the field; repeated applications may be required, depending on weather. Treatment during early flowering is required on seed crops.

Organically Acceptable Methods
Resistant varieties and some copper sprays are suitable for organically grown crops.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. CHLOROTHALONIL</td>
<td>Label rates</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(various products)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use at 7- to 10-day intervals, if necessary.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. MEFENOXAM/CHLOROTHALONIL</td>
<td>1.5 lb</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>(Ridomil Gold/Bravo) 76.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M5) and phenylamide (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use at 14-day intervals, if necessary.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. FOSETYL-ALUMINUM</td>
<td>Label rates</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>(Aliette)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Phosphonate (33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use on a 7- to 21-day intervals as necessary. Do not tank mix with copper compounds.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. COPPER#</td>
<td>Label rates</td>
<td>see label</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Not all copper compounds are approved for use in organic production; be sure to check individual products.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The following materials are listed in order of usefulness in an IPM Program. Also, consider information relating to environmental impact.*
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
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<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>

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# Acceptable for organically grown produce.

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FUSARIAUM YELLOWS (11/08)

Pathogen: *Fusarium oxysporum* f. sp. *conglutinans*

SYMPTOMS
In California this pathogen affects primarily cabbage. Symptoms consist of yellowing of the lower leaves, often on one side of the plant. These leaves later turn brown and drop off. A brown discoloration of the water-conducting tissues (xylem) is characteristic of this disease. With time the entire plant may yellow, wilt, and collapse.

COMMENTS ON THE DISEASE
Once present, this fungus survives indefinitely in the soil. The pathogen may be introduced to uninfested locations by the movement of infected plant residues and infested soil adhering to farm equipment. This disease causes more severe symptoms on summer crops due to warmer soil temperatures; *Fusarium* develops most rapidly at temperatures ranging from 75° to 85°F (24° to 29°C); little development occurs below 60°F (16°C).

MANAGEMENT
Avoid introducing the pathogen to clean fields. In areas where the fungus is known to occur, plant cabbage in spring or winter. Some resistant cabbage cultivars are available. However, there are several races of the pathogen, some of which may render these cultivars susceptible and generally, resistance diminishes with increases in soil temperature. For *Fusarium* infested fields consider rotating cabbage with crops that use pre-plant fumigation, such as strawberry; risk of Fusarium yellows should be significantly reduced in such situations.
PHYTOPHTHORA ROOT ROT (11/08)

Pathogen: Phytophthora megasperma

SYMPTOMS
The external surfaces and internal tissues of infected roots are water-soaked and dark in color and are rotted. Leaves, especially older ones, first turn purple-red and later yellow and then wilt. The plant may be stunted, and with time, the entire plant wilts. The stem near the soil line may turn black and become soft.

COMMENTS ON THE DISEASE
Phytophthora root rot occurs on cauliflower, Brussels sprouts, and other crucifers in the coastal areas. It usually occurs only if cole crops are planted in poorly draining, fine-textured soils that are kept overly wet. Hence, root rot is most often found at low spots in the field or at the tail-end of irrigation runs. The fungus is a soil inhabitant that survives in the soil for long periods.

MANAGEMENT
Control is difficult, but soil management that improves drainage, such as planting high, well-drained beds, and carefully irrigating to avoid prolonged saturation of the soil, will reduce chances of infection. Because drought stress also makes plants susceptible to Phytophthora, ensure an even supply of moisture without major fluctuations to help suppress disease development. If a field has a history of Phytophthora disease problems, a treatment can be applied at planting.

When choosing a pesticide, consider information relating to environmental impact.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEFENOXAM</td>
<td>1–2 pt</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>(Ridomil Gold EC)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A. MEFENOXAM
(Ridomil Gold EC)

MODE OF ACTION GROUP NAME (NUMBER): Phenylamide (4)
COMMENTS: Apply as a soil application at planting; can be preplant incorporated or applied as a soil surface spray after planting.

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RHIZOCTONIA DISEASES (6/07)

Pathogen: *Rhizoctonia solani*

**SYMPTOMS**

On cole crops, *Rhizoctonia* causes two types of disease symptoms: damping off (or wirestem) and bottom rot.

Damping off or wirestem occurs on newly emerged or very young transplants when *Rhizoctonia* attacks the hypocotyl or lower stem tissue in contact with the soil. This results in browning and cracking of the epidermis and the formation of lesions. As infection progresses, the outer stem decays, leaving only the fibrous inner xylem intact (hence the name wirestem). Affected plants wilt, turn purple, and remain stunted. Seedlings may break off at the soil line. The pathogen can usually be identified by its coarse mycelia that often causes soil particles to adhere to and dangle from diseased stems.

Bottom rot is primarily a problem on cabbage, bok choy, and Chinese cabbage. Once head formation begins, lower leaves in contact with the soil may become infected with *Rhizoctonia*. Dark brown, oval lesions develop where soil touches the leaves. Secondary decay organisms may follow and make these lesions soft and watery. Infected leaves may wilt, exposing the head. Occasionally the pathogen may grow up into the inner tissues of the cabbage head.

**COMMENTS ON THE DISEASE**

*Rhizoctonia solani* is a common soil inhabitant that survives for long periods in soil on crop residue or as sclerotia. Wet, warm soils favor wirestem development. Seedling susceptibility decreases as plants mature.

**MANAGEMENT**

Prepare good quality seedbeds before planting. If possible, plant when soils are warm because seeds germinate faster and seedlings are more vigorous. Avoid excessively wet soils during early stages of seedling growth. If transplants are used, do not plant too deep if Rhizoctonia diseases are a problem in the field. No other control measures are recommended.
RINGSPOT (11/08)
Pathogen: *Mycosphaerella brassicicola*

**SYMPTOMS**
In California, this disease occurs primarily on Brussels sprouts. Symptoms consist of circular leafspots (0.5 inch in diameter) that range in color from light brown to black. With time these spots develop concentric rings much like a target pattern. Small spherical fruiting structures may also be observed within the leafspots. If disease is severe, some defoliation may take place. This pathogen may also infect the sprouts, causing dark lesions on outer leaves.

**COMMENTS ON THE DISEASE**
The infection and disease development are favored by cool, moist conditions. Spores produced by this pathogen are spread by wind. *Mycosphaerella brassicicola* will persist in soil on infected plant residues only. There is some evidence that this pathogen may be carried on seed.

**MANAGEMENT**
Incorporate plant residues so that infected material decomposes fully. Remove volunteer plants that may be infected. Plant disease-free transplants. If ringspot is a problem in the area, use a protectant fungicide before infection takes place.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount / Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. CHLOROTHALONIL (various products)</td>
<td>Label rates</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NAME (NUMBER):</strong> Multi-site contact (M5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Use at 7- to 10-day intervals; multiple applications are needed (up to 4 maximum).</td>
<td></td>
<td></td>
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</tbody>
</table>

When choosing a pesticide, consider information relating to environmental impact.

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SCLEROTINIA DISEASES (6/07)

Pathogens: *Sclerotinia sclerotiorum*, *S. minor*

SYMPTOMS
Two species of *Sclerotinia* cause disease on cole crops. *Sclerotinia minor* only infects stems or leaves in close contact with the soil. Once infection takes place, water-soaked, brown necrotic areas develop on these structures. The necrotic areas rapidly turn into soft, watery rots. Plants then wilt and collapse. Profuse amounts of white mycelial growth and numerous small (up to 0.125 inch or 3 mm), black, hard resting bodies called sclerotia, form on the outside and inside of the stems. *Sclerotinia sclerotiorum* can also infect lower leaves and stems, causing the same type of symptoms as *S. minor*. In addition, *S. sclerotiorum* forms tiny, brown, mushroomlike bodies (apothecia) that release aerial spores, which can infect any of the upper leaves and flowers. If conditions are right, these spores cause a watery, soft rot of these tissues as well. *Sclerotinia sclerotiorum* forms sclerotia that are larger (0.25–0.5 inch) on average than those of *S. minor*.

COMMENTS ON THE DISEASE
Sclerotia of both species enable the pathogens to survive in soil for a number of years without susceptible hosts. Wet soil conditions favor disease development. On crucifers, *S. sclerotiorum* tends to be the more important pathogen, while *S. minor* is only found infrequently. For *S. sclerotiorum*, cool and moist conditions are necessary for development of and infection by the spores. The aerial spores usually only infect injured or senescing leaves and flowers.

MANAGEMENT
Crop rotations and deep inversion plowing may be helpful in reducing severity of *S. minor* infections. Deep plowing or soil inversion reduces the number of sclerotia of *S. sclerotiorum* in the particular field, but has no effect on incoming aerial spores from surrounding fields and from long distances.

Chemical treatments are usually not required for Sclerotinia diseases in fresh market cole crops, but may be necessary in seed production fields. Currently only iprodione (Rovral) is registered for use on broccoli.

VERTICILLIUM WILT (6/07)

Pathogen: *Verticillium dahliae*

SYMPTOMS
The older, lower leaves of plants turn yellow and wilt. These leaves eventually turn brown and drop off the stem, usually when plants approach maturity. The water-conducting tissues (xylem) of the stems and roots become black. Overall growth of the plant may be stunted.

COMMENTS ON THE DISEASE
Verticillium wilt is usually a minor problem on cole crops. However, a more serious Verticillium problem occurs on cauliflower in coastal areas. Verticillium wilt symptoms are more prevalent on late summer and early autumn crops; cool soil temperatures favor infection and disease symptom development. The pathogen forms resistant structures (microsclerotia) that enable it to survive in soil for a decade or longer.

MANAGEMENT
Known infested fields should be planted to cauliflower only in winter or early spring. Some cauliflower cultivars may be more tolerant to Verticillium wilt than others. Avoid introducing the pathogen into clean fields. Planting broccoli, a nonhost of *V. dahliae*, may help reduce pathogen levels through a process called biofumigation: decaying broccoli residue, when disced into the soil, either gives off natural chemicals that can kill *V. dahliae* or alters the soil microflora so that *V. dahliae* survival is reduced.
WHITE RUST  (11/08)
Pathogen: *Albugo candida*

SYMPTOMS
The fungus infects leaves and floral parts, causing distinctive white, raised pustules to form underneath the plant epidermis. These blisterlike pustules sometimes result in twisted, deformed growth of the stem, leaves, or flowers. When mature, the epidermis covering the pustule will rupture, releasing powdery white sporangia (a type of spore) that can be carried by winds or splashing water onto neighboring host plants. Severely infected leaves can wither and die.

COMMENTS ON THE DISEASE
The white rust pathogen of crucifers infects only plants in this host group, including arugula, bok choy, broccoli raab (rappini), Brussels sprouts, cabbage, cauliflower, Chinese cabbage, collards, Japanese or Mizuna-type mustards, radish, tah tsai, and turnip. However, economic damage is only found on the crucifer crops in which the leaves are marketed. If free moisture and cool temperatures are present, the sporangia germinate by producing several smaller motile spores (zoospores) that swim and enter susceptible young tissues. Because *A. candida* is dependent on cool, wet conditions, the disease is consistently more severe during winter and early spring months. In addition to sporangia, *A. candida* also produces a second type of spore, the oospore, that can resist drying conditions and enable the fungus to survive in a dormant state in soil or crop residue. The white rust pathogen exists in the form of distinct races.

MANAGEMENT
White rust resistant cultivars do not appear to be available for the host plants grown in California. Reducing leaf moisture by avoiding sprinkler irrigation will not prevent white rust, but keeping leaves dry may reduce disease severity. For sensitive crops such as arugula and rappini, avoid planting in fields having a history of white rust problems; soilborne oospores may result in severe disease. Fungicides may be appropriate in some situations on leafy crucifer crops. The same fungicides that control downy mildews are also effective against white rust.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. MEFENOXAM (Ridomil Gold) EC</td>
<td>1–2 pt</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Phenylamide (4)</td>
<td>COMMENTS: Apply as a soil application at planting; can be preplant incorporated or applied as a soil surface spray after planting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. MEFENOXAM/CHLOROTHALONIL (Ridomil Gold/Bravo) 76.5</td>
<td>1.5 lb</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M5) and phenylamide (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. FOSETYL-ALUMINUM (Aliette)</td>
<td>Label rates</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Phosphonate (33)</td>
<td>COMMENTS: Do not tank mix with copper compounds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. COPPER#</td>
<td>Label rates</td>
<td>see label</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M1)</td>
<td>COMMENTS: Not all copper compounds are approved for use in organic production; be sure to check individual products.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The following materials are listed in order of usefulness in an IPM Program. Also, consider information relating to environmental impact.*
### White Rust

**Common name**

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Amount/Acre</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>

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

# Acceptable for organically grown produce.

Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. For fungicides with mode of action Group numbers 1, 4, 9, 11, or 17, make no more than one application 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.
WHITE SPOT (6/07)
Pathogen: *Pseudocercosporella capsellae*

**SYMPTOMS**
This fungus causes circular, light tan leafspots that are up to 0.5 inch in diameter. Sometimes dark streaks and sploitches develop in the spots. If conditions are favorable, the characteristic white growth of spores may be observed on the leafspots.

**COMMENTS ON THE DISEASE**
White spot is a relatively minor and infrequent disease on cole crops. Occurrence is often related to heavy winter rains. The pathogen does not persist in soil, but survives on weed hosts and volunteer crucifers. This pathogen also infects leafy crucifers such as red mustard and tat tsoi grown in coastal areas.

**MANAGEMENT**
No control measures are recommended.
Nematodes

Scientific Names:
Cabbage cyst nematode: *Heterodera cruciferae*
Root-knot nematodes: *Meloidogyne incognita*, *M. javanica*, *M. arenaria*, and *M. hapla*
Sugarbeet cyst nematode: *Heterodera schachtii*

DESCRIPTION OF THE PESTS
Plant-parasitic nematodes are microscopic roundworms that live in soil and plant tissues, and feed in or on roots. Several species may occur in the same field. Certain nematode species infest a wide variety of crops and other plants, while other nematodes are only able to feed on a few closely related plants.

Certain cyst nematodes and root-knot nematodes are pests of cole crops. The abundance and geographical distribution of each nematode species varies depending on cropping history, soil temperature, and soil type.

DAMAGE
Cyst nematodes occur in all cole crop-growing regions of California. They can severely damage any cole crop in any type of soil. Sugarbeet cyst nematode is more widespread in California than cabbage cyst nematode. High numbers of either species, particularly at seeding or transplanting, can stunt plants, reduce yields, and delay crop maturity.

When abundant, root-knot nematodes can cause significant yield reductions. They are most prevalent and damaging in moist, coarse-textured soils (sandy, loamy sand, and sandy loam), warm interior valleys, and warm-season crops. However, cyst nematodes cause the most damage to cole crops in California.

SYMPTOMS
Aboveground symptoms caused by nematodes are not diagnostic, because certain nutrient deficiencies, plant pathogens, and root-feeding insects cause similar symptoms. Symptoms of nematode infestation include yellowing of foliage and slowed or stunted growth. Infestations may also occur without causing any aboveground symptoms.

Cyst nematodes cause:
- patches of stunted or dying plants,
- yellowing of foliage, and
- reduction in head and curd size.

Cyst nematodes do not form root galls. With careful observation, the pinhead-size, lemon-shaped females are visible on root surfaces. Young females are white, then become brown and eventually turn into black cysts (egg-filled bodies).

Root-knot nematodes cause:
- Gnarled roots.
- Galls on roots:
  - *M. hapla* forms numerous spherical, small galls.
  - Other *Meloidogyne* species form galls that are irregular in shape and often coalesce.
- Slow or stunted growth beginning with the seedling stage.
- Patches of stunted plants apparent by midseason.
- Wilting occurs earlier in the day than noninfected plants during periods of moisture stress (e.g., warm and windy conditions).

FIELD EVALUATION
To make management decisions, it is critical to know which nematode species are present and how numerous they are in soil samples.
For root-knot nematodes, diagnostic laboratories usually report the number of second-stage juveniles (J2) per 100 cubic centimeters of soil, since only this stage can be identified in soil samples.
- Later stages (J3, J4, and adult females) are always embedded in roots.
- Eggs and first-stage juveniles (J1) may be present in soil, but their extraction is difficult.

For cyst nematodes, extraction techniques are targeted towards extracting the cysts themselves (which can be filled with eggs) from the soil. The extracted cysts may be squashed to release their eggs. Laboratories therefore report cyst nematode infestations as the number of cysts per 100 cubic centimeters of soil, or the number of cyst nematode eggs per gram of soil.

If a previous crop was damaged by nematodes, and soil testing reveals the presence of nematode species that are pests of cole crops, their numbers may be high enough to damage cole crops. Once nematodes have infested a field, continuous management is necessary.

If nematode presence or the species have not previously been identified, take soil samples and send them to a diagnostic laboratory for identification.
1. Divide the field into sampling blocks of not more than five acres. Each block should be as uniform as possible regarding cropping history, crop injury, or soil texture.
2. Take samples after harvest, or preferably just before harvest, within the root zone of the previous crop. Take several subsamples randomly from a block, mix them thoroughly, and make a composite sample of about 1 quart (1 liter) for each block.
3. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, and the current or previous crop and the crop you intend to grow. Any other relevant information (such as the type or date of last nematicide application, the type of crop injury observed, crop cultivar, soil type, etc.) should be included in your records, but is not needed by diagnostic laboratories.
4. If plants with symptoms are available, place the roots in the same bag with soil.
5. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory.
6. Contact your cooperative extension advisor to help you use the best sampling procedures for your situation, find a laboratory for extracting and identifying nematodes, and for help in interpreting the test results.

**MANAGEMENT**

**Sanitation**
Prevent nematodes from moving into noninfested fields by doing the following:
- Thoroughly clean all equipment with water to prevent the spread of the nematodes in plant residue and soil.
- Do not allow irrigation or rainwater to flow from an infested field to other fields; impound or properly divert runoff.
- Prevent animal grazing and movement from infested fields into noninfested fields.

**Cultural practices**
To increase crop tolerance to nematode feeding, reduce plant stress with proper fertilization and irrigation (see the production guides in the More Information section for more details). Plow under infested plants after harvest to prevent further reproduction of nematodes. Control weed hosts of these nematodes, including pigweeds (hosts of sugarbeet nematode) and weedy mustards.

**Crop rotation**
Cyst nematodes have a relatively narrow host range and can be managed by rotation with nonhost crops. Crucifers are the only hosts for cabbage cyst nematodes. Sugarbeet cyst nematodes are hosted by crucifers, beets, spinach, and weeds in those plant families.

The higher the nematode numbers at harvest, the longer the period of rotation required to reduce nematode numbers before planting a susceptible crop. In Southern California, several years between host crops may be necessary. Longer rotations may be necessary in Northern California. See <Sugarbeet Pest Management: Nematodes> for more details.
Crop rotation is not very effective against root-knot nematodes because of their wide host range. Strawberry may be a suitable rotation crop in fields with root-knot nematodes because they are nonhosts to *M. incognita* and most populations of *M. javanica*. The northern root-knot nematode, *M. hapla*, does reproduce on strawberry.

**Nematicide Application**

Economic thresholds have not been established for nematodes in cole crops. Decide whether to apply a nematicide by doing the following:

1. Examine roots for presence of cyst nematodes or root galls before harvest.
2. Consider applying a nematicide whenever the nematodes listed as pests of cole crops are present in the field.

Contact your local UC Cooperative Extension advisor for advice on a specific situation. Nematicide efficacy varies depending on the method of application and soil conditions at the time of application.

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

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

**PREPLANT**

A. **1, 3-DICHLOROPROPENE***/CHLOROPICRIN***
   (InLine)
   Label rates
   See label
   NA
   COMMENTS: Multi-purpose liquid fumigant for the preplant, drip-irrigation treatment of soil for garden symphylan, plant-parasitic nematodes, and certain soilborne pathogens. Use of a tarp seal is mandatory for all applications of this product. Fumigants such as 1, 3-dichloropropene are a prime source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.

B. **1, 3-DICHLOROPROPENE**
   (Telone EC)
   9–18 gal
   See label
   NA
   COMMENTS: Liquid fumigant for the preplant, drip-irrigation treatment of soil for plant-parasitic nematodes and certain other soil pests. Fumigants such as 1, 3-dichloropropene are a prime source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone.

C. **ETHOPROP**
   (Mocap 15% Granular)
   0.9 lb/1000 ft of row (15 inches wide) or 34 lb/acre broadcast
   See label
   NA
   COMMENTS: Only registered for cabbage. Mix into the top 2 to 4 inches of soil right after application. Do not allow granules to contact crop seed.

**PREPLANT, AT PLANTING, or POSTPLANT**

A. **MYROTHECIUM VERRUCARIA STRAIN AARC-0255 FERMENTATION SOLIDS AND SOLUBLES**
   (DiTera DF)
   Label rates
   4
   0
   COMMENTS: Maintains crop health, growth and nutrient uptake in the presence of nematode infestations. Apply through the irrigation system or banded at the base of the plant. Rates indicate the total amount of product that was applied regardless of band width. Can be combined with fertilizers. If applied through the irrigation system, inject after the filter. Best results are obtained if the product is applied after the soil is saturated, during the last 15 to 20 minutes of the irrigation. Then flush the system with just enough water to clear the solution out of the irrigation system.
### Nematodes

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

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

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

# Acceptable for organically grown produce.

§ Do not exceed the maximum rates allowed under the California Code of Regulations Restricted Use Materials Requirements, which may be lower than maximum label rates.
Weeds

INTEGRATED WEED MANAGEMENT (11/08)

Weeds compete with cole crops for sunlight, nutrients, and water. Weeds in and around the field before planting sometimes harbor pathogens, nematodes, insects, or vertebrates that can invade or spread to the crop soon after planting. Weed control is especially important in precision-planted crops where loss of seedlings to competition can substantially reduce the vigor and uniformity of the overall stand. Also, any weeds that go to seed contribute to weed problems in succeeding crops.

Cole crops are either direct seeded or transplanted in the field. Cauliflower and Brussels sprouts are primarily transplanted, which simplifies weed control in these crops. The use of transplants allows for earlier crop maturity, a more uniform stand, and increased weed management options. An integrated weed control program relies on several management methods, both cultural and chemical, to keep weed populations at tolerable levels. Management of insects, diseases, and nematodes can affect a program’s success because damage by pests may limit the crop’s overall ability to outgrow competing weeds.

In direct-seeded crops, the first 30 days after seeding are the most important for weed control. As the crop grows older, most cole crops shade and compete well with weeds.

Careful water management is also important in weed control. Poorly maintained furrows may cause water to collect in parts of the furrows, favoring the growth of water-loving weeds, as well as soilborne disease organisms.

Regional differences in weed problems can be marked. The winter-spring weeds, which are favored by cool, moist conditions, predominate most of the year along coastal areas. In the southern desert area, however, early-planted crops must compete with weeds that germinate under the warm-to-hot conditions of early fall in the desert. Later fall plantings compete with winter annual weeds. In the San Joaquin Valley, grass weeds and the early fall-winter weeds are the most common.

Choice of an herbicide depends largely on the weed species to be controlled, but it is also influenced by soil type, irrigation method, and crop rotation. Very few herbicides are available for use in cole crops and several important weeds are not controlled by registered materials. Herbicides also vary in their selectivity or potential for damaging the crop at certain stages of development. When trying a new material or if you suspect an herbicide may be causing crop damage, leave part of a row untreated to check for effectiveness on weeds or crop sensitivity. No herbicide registered for cole crops provides satisfactory control of all the weeds likely to be found in the crop. Sometimes combinations of herbicides or sequential applications will be required. Check with your farm advisor or agricultural commissioner to make sure that you have the latest information on available materials, their compatibility, and recommended rates.

Proper application is just as important as the right choice of herbicide for controlling weeds without injuring the crop. Usually, lower rates are recommended for sandy soils. Timing of applications relative to rain or irrigation is important, as some herbicides may lose effectiveness when leached from the soil surface by excess water. In other cases, water can serve to move the herbicide into the soil after surface application, although care must be taken not to apply too much; 0.5 to 1 inch is often enough. With the exception of oxyfluorfen (GoalTender) registered for use in broccoli and cauliflower, many of the herbicides used in cole crops do not kill emerged weeds, so cultivation is needed before application to remove emerged weeds. If there is a chance that residues will damage subsequent crops, use a band application to reduce the total amount of herbicide in the soil. Then dilute the herbicide residue after harvest with deep plowing and disking. Use application equipment suited to field conditions and calibrate sprayers before each use.

Herbicides may be applied before planting (preplant), after planting but before the crop emerges (postplant preemergence), or after planting with crop emergence (postplant postemergence). In some districts, fall-planted cole crops may receive a layby treatment before winter rains. The choice of timing depends on your schedule and the proper method for the materials you choose. For example, many materials are incorporated with a sprinkler irrigation, so the timing of the first irrigation may be the most important determinant of when materials are best applied.
MONITORING

To plan a weed management program, you must know which weeds are present and their relative abundance. Survey each field for weeds before the first cultivation and at harvest. If possible, conduct the first survey while the previous crop is still in the ground. Make a record of weeds that are mature and producing seed; these weeds will be the sources of weed problems in succeeding crops. Repeat the survey midway through the growing season to check on the effectiveness of weed control measures. Small weed seedlings may be difficult to identify but if you look around the area there may be a few plants that are a bit larger and easier to identify. Areas of the field with perennial weed infestations can be managed separately, especially if a GPS is used to mark their location. Most herbicides used in cole crops are effective only on germinating weeds, so it is essential to know what the target weeds are before they grow. Normally, this information comes from routine weed surveys carried out during the previous crop. In some cases, it may be necessary to take soil samples for seed germination tests to determine the weed spectrum before planting.

To conduct a weed survey, walk through the field in a regular grid pattern and rate the degree of infestation for each weed species. Use a numerical scale or rate infestations as light, medium, or heavy. Check the area surrounding the field as well as the field itself. Maintain a file on each field to track long-term trends in weed species and density.

WEED MANAGEMENT BEFORE PLANTING

Weed control is easier and cheaper in fields that are not infested with difficult-to-control weeds. Problem weeds include burning nettle, annual sowthistle, shepherd’s-purse, London rocket, purslane, hairy nightshade, chickweed, and nutsedges. If problem weeds are present in significant numbers, the best strategy is to rotate to a crop in which they can be successfully controlled. Certain hard-to-control weeds such as yellow nutsedge may be best controlled in coastal California by rotating to a crop that receives preplant fumigation (e.g., strawberry). Planting date can have an impact on weed problems in a given region. For instance, fields planted between October 1 and October 15 in the southern desert are usually fairly weed-free.

Fallow

Sanitation is critical in a weed management program. Some weeds can produce thousands of seeds in a single season. To reduce seed production, disc or mow harvested fields before weeds flower and produce seeds. If weedy species are present, cultivate areas around the field such as field edges, fence lines, roadsides, and irrigation ditches regularly to prevent weed seed production. Cultivation equipment and irrigation water must also be kept free of weed seeds and vegetative propagules to avoid spreading weed populations. High pressure washing with water is necessary.

Several foliar-active herbicides are available that can be used on fallow beds to control troublesome weeds before planting cole crops. Paraquat (Gramoxone) controls most emerged annual weeds and grasses and burns back perennials. Glyphosate (Roundup, etc.) will control most annuals and many perennial weeds. Neither, however, will completely control field bindweed, nutsedge, burning nettle, or cheeseweed. Make fallow bed treatments after weeds have germinated following rains or irrigation. A common practice in the desert is to sprinkler irrigate to germinate weeds and make an aerial herbicide application a few weeks later.

Cultivation and bed preparation

Preplant plowing, followed by irrigation and one or two discings before bed formation, will destroy many weeds. Deep plowing and inverting soil to a depth of 16 inches has significantly reduced sowthistle and groundsel infestations in the central coast region, and may also serve to reduce certain disease organisms. If done with moldboard plows, deep plowing can reduce the nutsedge population by 95 to 98%. Plowing must be followed by rain or irrigation and discing of emerging weeds before they flower. Using cultivation to bury seeds is not as effective against weeds, such as cheeseweed, that have hard-coated seeds. These seeds can survive for years at lower depths until they are brought to the surface by subsequent plowing where they will then germinate.

Proper bed preparation is important for successful weed cultivation after the crop is planted. Poorly leveled land will cause water to collect in low areas of the field, favoring growth of water-loving weeds.
Effective cultivation of bed tops requires precise row spacing and careful alignment of cultivating tools. GPS-assisted, auto-guidance systems have been shown to produce precision aligned beds, permitting accurate, close cultivation.

A stale seedbed method can also be used for cole crops. The concept depends on controlling the final flush of weeds before crop emergence, followed by minimal soil disturbance to reduce subsequent weed flushes. To do this, prepare a seedbed and preirrigate it to germinate weed seeds. Once bed surfaces are dry enough to allow equipment on the field, the crop can be direct seeded. In the case of direct-seeded broccoli, an additional step can be taken to treat the field with an herbicide or with a propane flamer to kill all emerged weeds just before the crop emerges.

**Herbicides**

The preplant, preemergent herbicides commonly used in cole crops in California are bensulide (Prefar), trifluralin (Treflan), napropamide (Devrinol), and DCPA (Dacthal).

DCPA can be applied at planting to control many broadleaf and grass weeds. It is not very effective at controlling weeds in the mustard family, however.

Bensulide is relatively insoluble, readily absorbed into organic materials, leaches very little in soil, and consequently has a long residual period. It is not effective on volunteer grain crops and only controls a select group of broadleaf weed species.

Trifluralin must be mechanically incorporated 2 to 3 inches (5–7.5 cm) deep; once incorporated, it remains stable. Crop safety with this material is marginal under the arid conditions of the southern desert areas and in wet, cold coastal winters; this material is not widely used in these situations. Trifluralin has a somewhat limited spectrum of weeds that it will control and has a long residue period. Residues harmful to acutely sensitive crops, spinach, sugarbeets, milo, and corn, may persist up to 12 months.

Napropamide can be applied preplant and incorporated with power-driven rotary tillers. It provides excellent control of all annual grasses, including volunteer cereals and a large number of broadleaf weeds. It has long residual properties and a narrow range of crop tolerances; do not plant certain crops, especially lettuce, sugarbeet, and cereals, following its use in cole crops.

**Transplants**

When cole crops are grown from transplants, preemergent herbicides such as trifluralin, oxyfluorfen (Goal XL, GoalTender), ammonium nitrate solution AN-20 (20-0-0), and napropamide (Devrinol), can be applied before transplanting. By treating the field before transplanting, the transplants can be irrigated immediately following the transplanting operation.

The GoalTender formulation can be applied for postemergent control in direct-seeded or transplanted broccoli and cauliflower. GoalTender provides good control of a broad spectrum of broadleaf annual weeds and is safe on transplanted cauliflower or broccoli. It is less effective in controlling large lambquarters and grassy weeds and does not control yellow nutsedge.

Rates are dependent upon soil type. Transplanting should be completed with minimal soil disturbance and treated soil surfaces should be left undisturbed for as long as possible, however timely cultivation after weed emergence may also be necessary. Transplants may temporarily show leaf cupping or crinkling symptoms but rapidly outgrow symptoms, providing transplants are hardy and not severely stressed before planting.

**WEED MANAGEMENT AFTER PLANTING**

Control of weeds after planting is most critical during the seedling stage. Once established (4–5 inches tall), most cole crops, with the exception of cabbage, can shade out weeds. Scout for flowering wind-dispersed weeds (such as annual sowthistle) and destroy them before they produce seed to prevent dispersal and establishment in fields.
Cultivation

Effective cultivation of bed tops requires precise row spacing and careful alignment of cultivating tools. When plants have two to three leaves, sweeps or knives can be set as close as 2 inches on each side of the seed rows as long as they cultivate shallowly; closer cultivation will cut feeder roots. When crop seedlings are tall enough that they will not be buried, usually when they have three to four leaves, arrange tools so they move a 1-inch layer of soil toward and into the seed row. This mulch of dry soil will prevent many weed seeds from germinating.

Fields may be cultivated up to four or more times between planting and harvesting. Cauliflower is nearly all transplanted, and because of its low planting density, which facilitates cultivation, it may or may not require hand hoeing. Broccoli is usually planted to a stand and not thinned, but it is typically hand hoed or cultivated at least once if economically feasible. Weed control in Brussels sprouts relies largely on cultivation. Fall-planted cole crops in the coastal valleys may require more cultivation than summer-planted crops because cooler temperatures slow their growth rate. It may take 45 to 60 days for them to grow large enough to shade out weeds and eliminate the need for further weed control activity.

Surface banding of fertilizer

Surface banding is an effective way to apply nitrogen and it gives the crop a competitive advantage over the weeds. The waxy cuticle that cole crops develop once they have at least three true leaves prevents damage to the crop, unless the plants are very wet. However, because weeds lack this cuticle, they will be burned by the fertilizer; this effect is most pronounced on warm days. Use a shielded spray to avoid spraying the growing point or emerging new leaves of the cole crop plant.

Table 1. Effect of Surface Banding of Ammonium Nitrate Fertilizer on Weed Species in Cole Crops.

<table>
<thead>
<tr>
<th>Controlled</th>
<th>Partially controlled</th>
<th>Not controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>black nightshade</td>
<td>purslane, common</td>
<td>annual grasses</td>
</tr>
<tr>
<td>burning nettle</td>
<td></td>
<td>field bindweed</td>
</tr>
<tr>
<td>chickweed*</td>
<td></td>
<td>lambsquarters</td>
</tr>
<tr>
<td>common groundsel</td>
<td></td>
<td>nettleleaf goosefoot</td>
</tr>
<tr>
<td>hairy nightshade</td>
<td></td>
<td>nutsedge</td>
</tr>
<tr>
<td>little mallow (cheeseweed)</td>
<td></td>
<td>sowthistle</td>
</tr>
<tr>
<td>London rocket</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mustards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pigweeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pineapple-weed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shepherd’s-purse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wild radish</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Must be in the cotyledon to 2-leaf stage

Herbicides

After planting, DCPA (Dacthal), bensulide (Prefar), and napropamide (Devrinol) can be applied and sprinkler incorporated before the crop emerges.

Clethodim (Select Max) can be used for controlling small seedling annual grasses and some perennial grasses; it also controls annual bluegrass but not sedges or broadleaf weeds. Later growth stages of annual grasses are more difficult to control. Effectiveness is reduced when grasses are under moisture stress.

Oxyfluorfen (GoalTender formulation) is registered for postemergent use in broccoli and cauliflower to control broadleaf weeds at the two to three true leaf stage of the crop. It controls emerged weeds such as cheeseweed and burning nettle, as well as common purslane, sowthistle, and nettleleaf goosefoot, which are not burned back by fertilizer applications.
Sethoxydim is a selective, postemergent herbicide for control of annual and perennial grass weeds. However it does not control *Poa annua* (annual bluegrass) nor does it have any effect on sedges or broadleaf weeds. All grass crops (such as cereal grains and turf) are susceptible. Application made to control volunteer cereals (barley, corn, oats, rye, and wheat) should be made before tillering.
WEED MANAGEMENT FOR ORGANIC BROCCOLI PRODUCTION (6/07)

The goal of organic weed management techniques is to reduce weed pressure and/or give the crop an advantage over the weeds in order to produce the crop as economically as possible. Weed control in organic broccoli (and other cole crops) is dependent upon an integration of good cultural practices, careful cultivation and hand labor. Preventing the production of weed seed in the field before planting will reduce subsequent weeding costs during crop production.

The first step in developing a weed management program is to survey the planting site and identify the weeds that are there. Become familiar with each weed's growth and reproductive habits in order to choose the most effective management options. For help in identifying common weeds, see the weed photo pages that are linked to the weed list in the section COMMON AND SCIENTIFIC NAMES OF WEEDS.

Broccoli is produced in three distinct production districts (coastal valleys, San Joaquin Valley, and the desert) during the cooler times of the year (San Joaquin Valley and desert) and from spring to fall along the coast. Broccoli is typically grown on double row, 40-inch wide beds. It is very important to plant this crop in fields with low-weed pressure or to employ methods that reduce weed pressure before planting. Some growers utilize transplants to give the broccoli crop a head start on the weeds. Transplants establish a crop canopy more quickly and have fewer days to harvest. They generally only need one weeding instead of two.

WEED MANAGEMENT BEFORE PLANTING

Crop rotations and field sanitation
The previous crop can significantly affect weed pressure in the broccoli crop. A previous crop that has had excellent weed control generates fewer weed seed to germinate in the broccoli crop. In addition, it is important to keep the areas surrounding the broccoli field free of weeds that have aerial dispersed seeds such as groundsel and sowthistle.

Pregeneration of weeds before bed shaping
Pregeneration involves the use of irrigation or rain to stimulate weed seed germination before planting broccoli. The emerged seedlings are then killed by shallow cultivation, flaming, an organic herbicide, or a combination of these treatments. Pregeneration as close as possible to the date of planting to assure that the weed spectrum does not change before planting the crop. (Changes in the weed spectrum may occur as a result of changes in the season or weather.) The time of year, irrigation system, and the interval between irrigation and weed control all affect the efficacy of this technique. Waiting 14 days from the preirrigation to control weeds with shallow tillage provides up to 50% weed control in the subsequent crop. If time permits, repeat the pregermination process to further reduce weed populations.

Pregeneration of weeds after bed shaping
Once beds are shaped and ready to plant, water can be applied to stimulate a flush of weeds, thereby depleting the quantity of weed seed in the top inch of soil. The flush of weeds can be killed by shallow cultivation, flaming, or applications of organic herbicides. Care must be taken to not till too deep or additional weed seed may be brought to the surface. The crop can then be planted immediately on these beds. This technique is called "stale" seedbed weed control and can provide substantial control.

Deep plowing
Deep plowing is a tillage technique that buries weed seed or propagules of perennial plants below the depth at which they can germinate. The viability of buried weed seed declines over time and longer intervals between deep plowing and subsequent deep plowing (i.e. 3-5 years) is preferred in order to avoid bringing up large numbers of viable weed seed back to the soil surface.
Cover crops
The use of cover crops is a key cultural practice in organic production. Cover crops provide a variety of benefits to crop production but can potentially both increase or decrease weed pressure in vegetable production systems.

Unfortunately, annual weeds frequently become established at the time of the cover crop, and depending upon the species of weed, can grow and set seed unnoticed in cover crops. Often weed plants decompose before the end of the cover crop cycle making their detection difficult. In such cases, the cover crops act as nurse crops to weeds, making substantial contribution to the seed bank.

Slow-growing winter cover crops (legumes and cereal/legume mixes) can be particularly problematic in this manner and may allow substantial weed growth that sets seeds early in the growth cycle of the cover crop. Fast-growing winter cover crops, such as cereals and mustards, provide complete ground cover in the first 30 days of the cover crop cycle and are better able to compete with weeds.

Competitive cereal and mustard cover crops varieties include Merced rye (Secale cereale), white mustard (Sinapis alba), and Indian mustard (Brassica juncea). An adequate seeding rate is also an important factor in providing for rapid ground cover. It is important to monitor your cover crops, particularly in the first 40 days following seeding, to make sure that they are not creating a weed problem for the subsequent broccoli plantings.

Soil sterilization
This technique is generally accomplished by heat generated by soil solarization. This technique is little used specifically for broccoli production given the high costs of these techniques and the relatively short crop cycle of broccoli.

Weed control before crop emerges
Flaming or organic herbicide treatments can be used to kill the flush of weeds anytime between seeding the crop and its emergence. This technique is particularly effective on crops that have slow seed germination. In addition, flaming and organic herbicides are effective on small (i.e. less than 2 true leaves) broadleaves but not effective on grass weeds.

WEED MANAGEMENT AFTER PLANTING
Cultivation
Cultivation is one of the most effective postplant cultural practices that can be carried out. On double row, 40-inch beds it is possible to cultivate 80% of the bed (assuming a 4-inch wide uncultivated strip is left for each seedline). Direct-seeded broccoli is frequently cultivated at about the two to three leaf stage and again 2 weeks later. The first cultivations remove early emerging weeds, and later cultivations cut out weeds that germinate later in the growth cycle.

The goal of cultivation is to cut weed seedlings as close to the seed row as possible without disturbing the crop. New precision guidance systems for cultivation (i.e. EcoDan and Robocrop) can help improve the accuracy of cultivation operations. More precise cultivation allows for reducing the width of the uncultivated band and thereby removing a higher percentage of the weeds. Uncontrolled weeds in the seedline are removed by hand or other mechanical means.

Removal of weeds from the seedline can be achieved by the use of specific weeding implements such as finger and torsion weeders. These devices are more suited to transplanted broccoli or later in the crop cycle of direct-seeded broccoli (i.e., at least 50 days following seeding) as their mode of action is more aggressive to the crop. They will not generally remove all of the weeds but rather remove an increased percentage of the weeds that will make subsequent hand-weeding operations more efficient.

Hand hoeing
Hand hoeing is generally necessary in organic broccoli. Broccoli is frequently planted or transplanted to a stand, and as such there is generally no need for a thinning operation. However, weeds are usually removed by hand in the first 30 to 40 days after seeding. Careful hand weeding is necessary at this early stage of the crop cycle because of the delicate stems of the crop. Depending on weed pressure, one or two
subsequent hand weedings may be undertaken. At present there are no successful techniques that can substitute for careful hand weeding of direct-seeded crops, but successful employment of the above mentioned techniques can help make hand-weeding operations less time consuming and effective.
SPECIAL WEED PROBLEMS (11/08)

COMMON GROUNDSEL
Common groundsel, a winter annual weed found throughout most of California except the southern desert area, may cause problems all year in the cooler coastal areas. Groundsel seeds cannot successfully germinate and grow unless they are in the top 0.5 inch of soil, so certain cultural practices can be helpful in weed management. Preplant irrigation to germinate seeds and a shallow cultivation just before planting will limit populations somewhat. This program can be augmented by throwing a dry, dust mulch along the seed row while carrying out the first cultivation. Deep plowing with a moldboard plow and inverting soil to 16 inches deep can bury many of the viable groundsel seeds. Rotate cole crops with other crops so that herbicides that effectively control this weed can be used.

PRICKLY LETTUCE
Prickly lettuce, a common winter weed in the Central Valley and southern desert area, germinates after fall irrigations or with the onset of winter rains. Napropamide and oxyfluorfen will control prickly lettuce.

COMMON PURSLANE
Be sure to remove uprooted purslane plants from the wet soil surface as they will reestablish and continue to grow if not removed.

ANNUAL SOWTHISTLE
Annual sowthistle, a widely distributed weed commonly germinating from late fall to early spring, can be controlled with napropamide or oxyfluorfen. Preplant cultivations, a dry soil mulch thrown over the seed, and deep plowing and inverting the soil to a depth of 16 inches (40 cm) will provide some control.

MUSTARDS
Mustard weeds, including London rocket and shepherd’s-purse, are in the same family as cole crops, and thus are very difficult to control with herbicides. If infestations of mustards are heavy, rotate to a crop in which mustards can be easily controlled with herbicides.

NUTSEDGES
Nutsedges are summer weeds favored by moist soil and warm, sunny conditions. The tubers are easily carried in soil on farm equipment. No herbicides are available to control nutsedge in cole crops. The best strategy is to plant cole crops in infested fields during cool weather when nutsedge is not a problem, and during summer plant other crops, such as tomatoes, beans, and potatoes, in which some control of nutsedge can be achieved with herbicides. Another possibility in coastal areas is to rotate to a crop, such as strawberry, that receives preplant fumigation.

Cultivation is the only method available for removing nutsedge during cole crop growth. Cultivate before the weed has four or more true leaves or tubers will be produced; these tubers can infest susceptible crops that follow. Deep plowing 10 to 12 inches with moldboard plows can reduce nutsedge populations by 95 to 98%; however, tubers must be left deeply buried for at least 2 years for this method to be effective.

CHEESEWEED
Cheeseweed, also known as little mallow, is a very competitive weed in cole crops. It is common in the coastal areas and the desert winter production regions. It germinates from 1 to 2 inches deep, which allows it to escape preemergent applications. Nitrogen surface applications are very effective when used postemergence on cheeseweed plants in the cotyledon to 2-leaf stage. A preplant treatment of oxyfluorfen (Goal) plus a surfactant is effective against this weed; a postemergent application of the GoalTender formulation of oxyfluorfen in broccoli or cauliflower can also be effective in controlling this weed.
BURNING NETTLE
Burning nettle is a prolific seed producer and can infest cole crops in all regions. Its offensive action on workers' skin make thinning or weeding quite difficult, increasing the cost of these operations. Preplant incorporated applications of trifluralin or oxyfluorfen will effectively control it.

CHICKWEED
Chickweed is a winter annual weed that is very competitive with seedling cole crops if not controlled. Preplant incorporated applications of napropamide are effective in its control.
## COMMON AND SCIENTIFIC NAMES OF WEEDS (6/07)

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
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<tbody>
<tr>
<td>barley, foxtail</td>
<td>Hordeum jubatum</td>
</tr>
<tr>
<td>barnyardgrass</td>
<td>Echinochloa crus-galli</td>
</tr>
<tr>
<td>bindweed, field</td>
<td>Convolvulus arvensis</td>
</tr>
<tr>
<td>bluegrass, annual</td>
<td>Poa annua</td>
</tr>
<tr>
<td>canarygrass, littleseed</td>
<td>Phalaris minor</td>
</tr>
<tr>
<td>chickweed, common</td>
<td>Stellaria media</td>
</tr>
<tr>
<td>goosefoot, nettleleaf</td>
<td>Chenopodium murale</td>
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<tr>
<td>groundcherries</td>
<td>Physalis spp.</td>
</tr>
<tr>
<td>groundsel, common</td>
<td>Senecio vulgaris</td>
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<tr>
<td>knotweed, prostrate</td>
<td>Polygonum arenastrum</td>
</tr>
<tr>
<td>lambsquarters, common</td>
<td>Chenopodium album</td>
</tr>
<tr>
<td>lettuce, prickly</td>
<td>Lactuca seminola</td>
</tr>
<tr>
<td>little mallow (cheeseweed)</td>
<td>Malva parviflora</td>
</tr>
<tr>
<td>mustards</td>
<td>Brassica spp.</td>
</tr>
<tr>
<td>nettle, burning</td>
<td>Urtica urens</td>
</tr>
<tr>
<td>nightshade, black</td>
<td>Solanum nigrum</td>
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<tr>
<td>nightshade, hairy</td>
<td>Solanum sarrachoides</td>
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<td>nutsedges</td>
<td>Cyperus spp.</td>
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<tr>
<td>oat, wild</td>
<td>Avena fatua</td>
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<td>pigweeds</td>
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<td>pineapple-weed</td>
<td>Chamomilla suaveolens</td>
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<td>Raphanus raphanistrum</td>
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<tr>
<td>rocket, London</td>
<td>Sisymbrium irio</td>
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<td>shepherd’s-purse</td>
<td>Capsella bursa-pastoris</td>
</tr>
<tr>
<td>sowthistles</td>
<td>Sonchus spp.</td>
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## SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL (6/07)

### ANNUAL WEEDS

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<th>NAP</th>
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### PERENNIAL WEEDS

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<th>Weed</th>
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<th>DCP</th>
<th>EPT</th>
<th>GLY</th>
<th>MET*</th>
<th>NAP</th>
<th>OXY</th>
<th>PAR*</th>
<th>PEL</th>
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<td>bindweed, field (seedlings only)</td>
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<td>nutsedge, yellow</td>
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* C = control   P = partial control   N = no control   — = no information

**BEN** = bensulide (Prefar)  **CAR** = carfentrazone (Shark)  **CLE** = clethodim (Select Max)  **DCP** = DCPA (Dachal)  **EPT** = EPTC (Eptam)  **GLY** = glyphosate (Roundup, etc.)  **MET** = metolosodium* (Vapam, Soil Prep)

* Permit required from county agricultural commissioner for purchase or use.
## HERBICIDE TREATMENT TABLE (11/08)

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I. (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FALLOW</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. PARAQUAT* (Gramoxone Inteon)</td>
<td>0.49–1 lb ai</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For use on broccoli, cabbage, Chinese cabbage, or cauliflower fields only. Apply to emerged weeds on winter beds; this contact herbicide will control many seedling weeds. Addition of a surfactant is essential for good control.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. GLYPHOSATE (Roundup)</td>
<td>1–3 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Rate depends on weed species. Apply to emerged weeds on winter beds. Seed into undisturbed soil for maximum effectiveness. Adding ammonium sulfate often enhances control in areas with hard water.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. EPTC (Eptam Selective) 7E</td>
<td>3.5–7 pt</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For fallow ground applications to suppress nutsedge. Apply at least 90 days before planting broccoli, cabbage, or cauliflower. Use allowed under a supplemental 24(c) label.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. PELARGONIC ACID (Scythe)</td>
<td>3–5% v/v in 75 to 200 gal water/acre</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: For nonselective burndown of weeds on winter beds. The smaller the weeds, the more effective the control.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PREPLANT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. TRIFLURALIN (Treflan) HFP</td>
<td>0.5–0.75 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Preplant incorporate for direct-seeded cole crops. Effective on summer broadleaf and grassy weeds. Avoid use in cold, wet soils or under arid desert conditions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. BENSULIDE (Prefar) 4E</td>
<td>5–6 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Apply preplant and mechanically incorporate 1–2 inches. May be followed by sprinkler or furrow irrigation. Effective on summer broadleaf and grassy weeds.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When choosing an herbicide, consider information relating to environmental impact.
### Herbicide Treatment Table

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I. (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C. NAPROPAMIDE</strong> (Devrinol) 50DF</td>
<td>0.5–1.0 lb a.i.</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMENTS:</strong> Best used on transplants. This herbicide has a narrow margin of direct-seeded cole crop tolerance. Do not use on cabbage in California. Use lower rate on coarse-textured soils.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRETRANSPLANT**
Before weeds emerge

| **A. TRIFLURALIN** (Treflan) 4L | 0.5–0.75 lb a.i. | 12 | 0 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 3 | | | |
| **COMMENTS:** Preplant incorporate with rotary-powered equipment for bed planting; if planting flat, shallow discing is acceptable. Transplanted cole crops have a higher level of selectivity than direct-seeded cole crops, but keep this material in the upper 2–4 inches of soil for optimum selectivity. |

| **B. OXYFLUORFEN** (Goal) 2XL | 0.25–0.5 lb a.i. | 1–2 pt | 24 | 0 |
| **(Goal Tender) 4F** | 0.5–1 pt | 24 | 0 | |
| **WSSA MODE OF ACTION GROUP NUMBER:** 14 | | | |
| **COMMENTS:** For use before transplanting broccoli, cauliflower, and cabbage. Apply to preshaped beds. If weeds are present, add a surfactant to enhance weed kill. The high rate is especially useful for hard-to-control weeds such as little mallow. Do not use on Brussels sprouts. Do not disturb the soil after treatment except for the transplanting operation. After application at least 0.25 inch rainfall or irrigation is needed to activate the herbicide. |

| **C. NAPROPAMIDE** (Devrinol) 50DF | 0.5–1.0 lb a.i. | 12 | 0 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 15 | | | |
| **COMMENTS:** Use only on broccoli, Brussels sprouts, and cauliflower. Best used on transplants. This herbicide has a narrow margin of direct-seeded cole crop tolerance. Do not use on cabbage in California. Use lower rate on coarse-textured soils. |

**AT PLANTING**
Before crop and weeds emerge

| **A. DCPA** (Dacthal) 75W | 4.5–10.5 lb a.i. | 12 | 0 |
| **WSSA MODE OF ACTION GROUP NUMBER:** 3 | | | |
| **COMMENTS:** Apply at planting as a banded spray to control annual grasses and some annual broadleaf weeds. Incorporate with sprinkler irrigation. DCPA can be sprayed directly over transplants without injury. In sandy loam soils, maximum preemergence rate of 10 lb/acre is recommended. |

<p>| <strong>B. BENSULIDE</strong> (Prefar) 4EC | 5–6 lb a.i. | 12 | 0 |
| <strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 8 | | | |
| <strong>COMMENTS:</strong> After planting apply as a surface application and follow immediately with sprinkler irrigation. |</p>
<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount/Acre</th>
<th>R.E.I. (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>
| **C. NAPROPAMIDE**
(Dervinol) 50DF | 0.5–1.0 lb a.i. 1–2 lb | 12 | 0 |
| **POSTPLANT**
After crop and weeds emerge |
| **A. SETHOXYDIM**
(Poast) | 0.09–0.28 lb a.i. 0.5–1.5 pt | 12 | 30 |
| **B. CLETHODIM**
(Select Max) | 0.091–0.12 lb a.i. 12–16 oz/acre | 24 | 30 |
| **C. CARFENTRAZONE**
(Shark) | 0.031 lb a.i. 2 fl oz | 12 | 0 |
| **D. OXYFLUORFEN**
(GoalTender) 4F | 0.125–0.25 lb a.i. 4–8 oz | 24 | 0 |
| **E. PELARGONIC ACID**
(Scythe) | 3–5% v/v in 75 to 200 gal water/acre | 12 | 0 |

**WSSA MODE OF ACTION GROUP NUMBER:** 15
**COMMENTS:** Use only on broccoli, Brussels sprouts, and cauliflower. May be applied post transplant or on established transplants followed by sprinkler irrigation. Do not use on cabbage in California.

**WSSA MODE OF ACTION GROUP NUMBER:** 1
**COMMENTS:** Maximum use per crop is 3 applications, not to exceed 3 pt/acre/season. Effective on grass seedlings except for annual bluegrass (*Poa annua*). Apply when grasses are small and actively growing. Do not cultivate within 5 days before or 7 days after application. An oil adjuvant is needed to achieve consistent weed control. Do not apply within 30 days of harvest.

**WSSA MODE OF ACTION GROUP NUMBER:** 1
**COMMENTS:** For control of annual and perennial grass weeds including annual bluegrass. Always apply with a crop oil concentrate. Use higher rates on perennial grasses. Use allowed under a supplemental label.

**WSSA MODE OF ACTION GROUP NUMBER:** 14
**COMMENTS:** May be applied to the row middles using a hooded sprayer. Take care to keep the spray material off the crop.

**WSSA MODE OF ACTION GROUP NUMBER:** 14
**COMMENTS:** For use on broccoli and cauliflower only as a broadcast application at 4-6 oz/acre or as a directed application at 4-8 oz/acre. Apply on direct-seeded crops when they have four true leaves. Do not mix with adjuvants, fertilizers, or other pesticides. Use allowed under a supplemental label.

**WSSA MODE OF ACTION GROUP NUMBER:** 27
**COMMENTS:** May be applied to the row middles using a hooded sprayer. Take care to keep the spray material off the crop.
<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount/Acre</th>
<th>R.E.I. (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
</table>

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+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) 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 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://www.hracglobal.com](http://www.hracglobal.com).
PRECAUTIONS FOR USING PESTICIDES

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

Legal Responsibility

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

Transportation

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

Storage

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

Container Disposal

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

Protection of Nonpest Animals and Plants

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

Posting Treated Fields

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

Preharvest Intervals

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

Permit Requirements

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

Processed Crops

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

Crop Injury

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

Personal Safety

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