UC IPM
Pest Management Guidelines:
CELERY

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General Information
Relative Toxicities of Insecticides Used in Celery to Natural Enemies and Honey Bees (6/08) ................................................................. 1

Insects (section reviewed 11/05)
Beet Armyworm (6/08) ......................................................................................................................................................................................... 3
Black Bean Aphid (6/08) ..................................................................................................................................................................................... 5
Foxglove Aphid (6/08) ....................................................................................................................................................................................... 8
Leafminers (6/08) ............................................................................................................................................................................................. 10
Lygus Bug (6/08) ............................................................................................................................................................................................ 12
Other Aphids (6/08) .......................................................................................................................................................................................... 14

Diseases (section reviewed 11/05)
Apium Virus Y (6/09) ...................................................................................................................................................................................... 17
Aster Yellows (11/05) .................................................................................................................................................................................... 18
Bacterial Leafspot (11/05) ............................................................................................................................................................................... 19
Celery Mosaic Virus (6/08) .......................................................................................................................................................................... 20
Crater Rot (6/08) .......................................................................................................................................................................................... 21
Early Blight (6/08) ........................................................................................................................................................................................... 22
Fusarium Yellows (11/05) ............................................................................................................................................................................. 24
Late Blight (6/08) .......................................................................................................................................................................................... 25
Other Virus Diseases (6/08) ........................................................................................................................................................................ 27
Pink Rot (6/08) .............................................................................................................................................................................................. 28

Nematodes (6/08) (section reviewed 11/05) .................................................................................................................................................. 29

Weeds (section reviewed 11/05)
Integrated Weed Management (6/09) ............................................................................................................................................................ 31
Special Weed Problems (6/09) ....................................................................................................................................................................... 33
Common and Scientific Names of Weeds (5/99) ........................................................................................................................................ 34
Susceptibility of Weeds to Herbicide Control (6/09) .................................................................................................................................. 35
Herbicide Treatment Table (6/09) ............................................................................................................................................................ 36

Precautions for Using Pesticides ............................................................................................................................................................. 38

An illustrated version of this guideline is available online at http://www.ipm.ucdavis.edu/PMG/selectnewpest.celery.html

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

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

**RELATIVE TOXICITIES OF INSECTICIDES USED IN CELERY TO NATURAL ENEMIES AND HONEY BEES (6/08)**

<table>
<thead>
<tr>
<th>Common name (trade name)</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>abamectin (Agri-Mek)</td>
<td>6</td>
<td>moderate (mites, leafminers)</td>
<td>H</td>
<td>L</td>
<td>M/H</td>
<td>I</td>
<td>long to predatory mites and affected insects</td>
</tr>
<tr>
<td>acephate (Orthene)</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>M/H</td>
<td>I</td>
<td>intermediate</td>
</tr>
<tr>
<td>acetamiprid (Assail)</td>
<td>4A</td>
<td>broad (insects)</td>
<td>—</td>
<td>—</td>
<td>M</td>
<td>II</td>
<td>moderate</td>
</tr>
<tr>
<td>azadirachtin (AZA-Direct, Neemix)</td>
<td>un</td>
<td>broad (insects, mites)</td>
<td>M</td>
<td>L/M</td>
<td>L/M</td>
<td>II</td>
<td>short</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>cyromazine (Trigard)</td>
<td>17</td>
<td>narrow (leafminers)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>none</td>
</tr>
<tr>
<td>endosulfan (Thionex)</td>
<td>2A</td>
<td>broad (insects, mites)</td>
<td>L/M</td>
<td>M</td>
<td>M</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>imidacloprid (Admire)</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>insecticidal soap (M-Pede)</td>
<td>un</td>
<td>broad (exposed insects, mites)</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>III</td>
<td>short</td>
</tr>
<tr>
<td>malathion (EC)</td>
<td>1B</td>
<td>broad (insects, mites)</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>methomyl (Lannate)</td>
<td>1A</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>methoxyfenozide (Intrepid)</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>oxamyl (Vydate)</td>
<td>1A</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>I</td>
<td>moderate</td>
</tr>
<tr>
<td>permethrin (Ambush, Pounce)</td>
<td>3A</td>
<td>broad (insects, mites)</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>I</td>
<td>long</td>
</tr>
<tr>
<td>petroleum oil</td>
<td>un</td>
<td>broad (exposed insects, mites)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>pymetrozine (Fulfill)</td>
<td>9B</td>
<td>narrow (aphids, whiteflies)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>short</td>
</tr>
<tr>
<td>pyrethrin/rotenone (Pyrellin E.C.)</td>
<td>3A/21B</td>
<td>broad (insects)</td>
<td>—</td>
<td>—</td>
<td>H</td>
<td>I</td>
<td>short</td>
</tr>
<tr>
<td>spinetoram (Radiant)</td>
<td>5</td>
<td>narrow (caterpillars, thrips, whiteflies, aphids, scales, leafminers)</td>
<td>L</td>
<td>M&lt;sup&gt;10&lt;/sup&gt;</td>
<td>L/M</td>
<td>II</td>
<td>moderate&lt;sup&gt;11&lt;/sup&gt;</td>
</tr>
<tr>
<td>spinosad (Entrust, Success)</td>
<td>5</td>
<td>narrow (caterpillars, thrips, whiteflies, aphids, scales, leafminers)</td>
<td>L</td>
<td>M&lt;sup&gt;10&lt;/sup&gt;</td>
<td>L/M</td>
<td>II</td>
<td>short to moderate&lt;sup&gt;10&lt;/sup&gt;</td>
</tr>
<tr>
<td>tebufenozide (Confirm)</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>thiodicarb (Larvin)</td>
<td>1A</td>
<td>narrow (caterpillars)</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>II</td>
<td>—</td>
</tr>
<tr>
<td>zeta-cypermethrin (Mustang)</td>
<td>3A</td>
<td>broad (insects, mites)</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>I</td>
<td>moderate</td>
</tr>
</tbody>
</table>

H = high  
M = moderate  
L = low  
— = no information  
un = unknown or uncertain mode of action

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.

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 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.

*Continued on next page . . .*
Relative Toxicities of Pesticides Used in Celery to Natural Enemies and Honey Bee, continued

9  Rating depends on rate used.
10 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.
11 Residual is moderate if solution is between pH of 7 to 8.

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 (6/08)
Scientific Name: Spodoptera exigua

DESCRIPTION OF THE PEST
Beet armyworm adults are 0.5 to 0.75 inch, nondescript brown moths. They typically lay masses of 20 to 120 eggs and cover them with light-colored scales, which gives the egg masses a distinctive cottony appearance. Up to 400 or more eggs can be laid by each female. The early instar larvae are a pale green and often feed gregariously for the first few days. Larger larvae range from green to black, and often have a broad stripe along each side of the body. The larger larvae feed singly. The larval stages last from 2.5 to 3 weeks at 70° to 80°F. Large larvae generally hide in the center of the plant or underground during most daylight hours. After five to six instars, the larvae burrow into the soil to pupate. The pupal stage persists 7 to 10 days but may be much longer at cooler temperatures. Although newly emerged adults can be found throughout the year in central and southern California, major emergences and migration flights are usually recorded in spring through late summer.

DAMAGE
Young worms feed on celery leaves but rarely cause substantial damage. However, larger larvae feed on petioles and cause significant crop loss. Large larvae are quite mobile and have been observed to travel over 10 feet per night, feeding on several plants. If petioles near the outside of the plants are damaged, they can be removed. If damage occurs in a centrally located petiole the plant must often be discarded.

MANAGEMENT
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 also kill significant numbers.

Cultural Control
Disc fields immediately following harvest to remove the food source for any remaining larvae. Some pupae may be affected by discing as well.

Organically Acceptable Methods
Cultural and biological controls and sprays of Bacillus thuringiensis and the Entrust formulation of spinosad are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
Beet armyworm eggs and larvae are often easier to find on weeds in and near the field than in the celery plant. Weeds can be pulled and readily examined whereas celery is often brittle and easily damaged during the early morning and late evening hours when larvae are active. Chenopodium species (e.g., lambsquarters, goosefoot) appear to be particularly attractive to beet armyworm larvae. Populations can build rapidly, so check fields twice a week. Monitor adults with pheromone traps placed along the edges of fields. This is a particularly good technique for detecting large emergences or migrations occurring on weather fronts. Reliable treatment levels have not been established, but the presence of more than one large larva or five small larvae on 25 plants would be of concern. Make treatments when larvae are small; large larvae are more difficult to kill with compounds such as Bacillus thuringiensis. Because larvae become active at dusk, and sunlight degrades many pesticides, the best time for insecticide treatment is in the twilight evening hours.
<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><strong>When choosing a pesticide, consider information relating to water quality and impact on natural enemies and bees.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. SPINOSAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Entrust)#</td>
<td>1.25-2.5 oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>(Success)</td>
<td>4–8 fl 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: Apply as a foliar spray. Heavy infestations may require repeat applications but do not apply more than 3 times in any 21-day period or apply more than 6 treatments/crop. Provides some suppression of leafminer populations and has less of a negative impact on their natural enemies than other materials (except Bt) listed. Use allowed under a supplemental label.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. SPINETORAM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Radiant) SC</td>
<td>5–10 fl 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>C. METHOXYFENOZIDE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Intrepid) 2F</td>
<td>Label rates</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 18A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: An insect growth regulator. Do not apply more than 16 fl oz/acre/application or more than 64 oz/acre/season. See label for rotational crop restrictions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. METHOMYL*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Lannate LV)</td>
<td>0.75–1.5 pt</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Disruptive to parasites of lygus, leafminers, and aphids. If these pests are present, use of this material may result in outbreaks of these pests.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. BACILLUS THURINGIENSIS# ssp. AIZAWAI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(various products)</td>
<td>Label rates</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 11.B1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Apply when armyworms are small.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. THIODICARB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Larvin) 3.2</td>
<td>16–30 fl oz</td>
<td>48</td>
<td>14</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Use higher rates for heavier infestations of larger larvae. Do not exceed 60 fl oz/acre/season. Disruptive of natural enemies.</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.

# 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.
BLACK BEAN APHID (6/08)

Scientific Name: *Aphis fabae*

DESCRIPTION OF THE PEST
A group of related species, or possibly biotypes, form the black bean aphid complex. These individuals are superficially identical. The black bean aphid is a dark green to black, soft-bodied insect with a dark-colored head, antennae, and cornicles. The legs are black at the base and tips.

Black bean aphids form dense colonies on the undersides of celery leaflets. Winged black bean aphids develop under specific conditions such as overcrowding and plant stress, and disperse to other plants or fields.

DAMAGE
Black bean aphid populations can build up in celery to densities of several thousand per plant. This pest can inflict three types of damage on the celery crop. First, it can stunt plant growth and reduce yields through removal of significant amounts of sap. Secondly, it can transmit virus diseases such as western celery mosaic, celery calico, cucumber mosaic, and celery yellow spot. And finally, it can contaminate celery produce, particularly fresh market celery, with aphid honeydew and debris; this contamination can lower the crop value. Feeding by black bean aphids may distort plant growth and development more than feeding by other aphid species.

MANAGEMENT

Biological Control
Several parasitic wasps provide natural control of aphids in celery, most notably species in the genera *Diaeretiella* and *Lysiphlebus*. In some cases, these parasites can eliminate high densities of aphids over a few weeks period. Predators such as lady beetles, syrphid flies and lacewing also attack aphids. Populations of aphid natural enemies should be preserved by avoiding unnecessary insecticide applications and by providing acceptable habitat for these beneficials.

Cultural Control
Destroy crop residue immediately after harvest. Avoid other aphid-favored crops, such as lettuce, in adjacent, upwind fields. Intensify field monitoring for aphids when adjacent fields with aphid-favored crops are harvested.

Organically Acceptable Methods
Biological controls, cultural controls, and insecticidal soaps are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
Economic thresholds for aphids on celery have not been established. Aphid survival and development are historically greatest during periods with temperatures that are less than 80°F. However, the black bean aphid is more tolerant of hot temperatures than other species, and therefore causes problems into summer. Generally, black bean aphids can be tolerated on young celery plants. On fresh market celery, infestations are more important when the petioles (stalks) start to form and when the rows begin to close. Infestations tend to be erratic in the field, so sample several locations. Sample intermediate-age stalks because this is where the highest population levels of aphids are found. Concentrate on field edges particularly where celery fields border harvested lettuce fields.
When choosing a pesticide, consider information relating to water quality and impact on natural enemies and bees.

**AT PLANTING**

A. **IMIDACLOPRID**  
   (Admire) 2F  
   10–24 fl oz  
   12  
   45  
   **MODE OF ACTION GROUP NUMBER**: 4A  
   **COMMENTS**: Soil application. Use at planting in fields that have a history of aphid infestations. The rate applied affects the length of control. Use higher rates where infestations occur later in crop development or where pest pressure is continuous. Do not apply more than 0.5 lb a.i./acre/year. Repeat applications of any neonicotinoid insecticide (acetamiprid-Assail or imidacloprid-Admire) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

**AFTER PLANTING**

A. **ACETAMIPRID**  
   (Assail) 70WP  
   0.8–1.2 oz  
   12  
   7  
   **MODE OF ACTION GROUP NUMBER**: 4A  
   **COMMENTS**: Thorough coverage is important. Do not make more than 5 applications/season. Repeat applications of any neonicotinoid insecticide (acetamiprid-Assail or imidacloprid-Admire) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

B. **ACEPHATE**  
   (Orthene) 75S  
   0.66–1.33 lb  
   24  
   21  
   **MODE OF ACTION GROUP NUMBER**: 1B  
   **COMMENTS**: Trim plants before shipment. Do not feed tops. Do not apply more than 2.66 lb/acre/season.

C. **PYMETROZINE**  
   (Fulfill)  
   2.75 oz  
   12  
   7  
   **MODE OF ACTION GROUP NUMBER**: 9B  
   **COMMENTS**: Thorough coverage is important. Do not exceed 5.5 oz/acre/season. Apply when aphids first appear before populations reach damaging levels.

D. **OXAMYL**  
   (Vydate L)  
   1–2 qt  
   48  
   21  
   **MODE OF ACTION GROUP NUMBER**: 1A  
   **COMMENTS**: Do not apply more than 3 gal/acre/season.

E. **ENDOSULFAN**  
   (Thionex) 3EC  
   1–1.33 qt  
   24  
   4  
   **MODE OF ACTION GROUP NUMBER**: 2A  
   **COMMENTS**: Do not make more than 1 application/season. Cannot be applied in any situation where runoff will occur. Do not exceed 1.33 qt/acre/year.

F. **NARROW RANGE OIL**  
   (JMS Stylet Oil)  
   3 qt/100 gal water  
   4  
   0  
   **MODE OF ACTION**: Contact including smothering and barrier effects.  
   **COMMENTS**: This material requires frequent applications and thorough coverage.
### Insecticidal Soap

<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>G. INSECTICIDAL SOAP#</td>
<td>2.5 oz/gal</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

**MODE OF ACTION:** A contact insecticide with smothering and barrier effects.

**COMMENTS:** Spray to wet all infested plant surfaces. Rotate sprays or rinse foliage to avoid more than 3 consecutive sprays. This material has no residual and requires frequent applications and thorough coverage.

+ **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 R.E.I exceeds the P.H.I. 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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**Notes:**

- Modes of action are important in preventing the development of resistance to pesticides. 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. 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 is 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/).
DESCRIPTION OF THE PEST
Foxglove aphid has several color forms, ranging from green to orange to pink. Most wingless aphids have dark green areas at the base of the cornicles (projections from the rear of the abdomen). Some of the wingless aphids have many black markings on the top of the abdomen as well. The winged adults are browner in color than the wingless forms, but also have various black markings.

Foxglove aphid is a pest of lettuce in California’s Central Coast, although it may also occur on other crops. Foxglove aphid is nearly indistinguishable in the field from another pest of lettuce, the lettuce aphid (*Nasonovia ribis-nigri*), and in fact in many parts of the world the two commonly infest the same fields. These two aphids, however, can be distinguished from green peach aphid by the lack of prominent, converging antennal tubercles.

Foxglove aphid has a very short life cycle and populations can build rapidly. It has a wide host range.

DAMAGE
Foxglove aphids feed deep inside the plant on younger leaves. It is known to vector several viral diseases.

MANAGEMENT

Monitoring and Treatment Decisions
Monitoring requires care in order not to miss early infestations that are hidden within the lettuce. This aphid has a tendency to disperse in the plant rather than forming colonies as green peach aphid does. Control of this aphid is difficult because of its rapid population growth combined with its preferred locations deep within the plant.

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

When choosing a pesticide, consider information relating to water quality and impact on natural enemies and bees.

**AT PLANTING**

A. IMIDACLOPRID
   (Admire) 2F
   MODE OF ACTION GROUP NUMBER: 4A
   COMMENTS: Soil application. Use at planting in fields that have a history of aphid infestations. The rate applied affects the length of control. Use higher rates where infestations occur later in crop development or where pest pressure is continuous. Do not apply more than 0.5 lb a.i./acre/year. Repeat applications of any neonicotinoid insecticide (acetamiprid-Assail or imidacloprid-Admire) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

   | 10–24 fl oz | 12 | 45 |

B. AFTER PLANTING

A. ACETAMIPRID
   (Assail) 70WP
   MODE OF ACTION GROUP NUMBER: 4A
   COMMENTS: Thorough coverage is important. Do not make more than 5 applications/season. Repeat applications of any neonicotinoid insecticide (acetamiprid-Assail or imidacloprid-Admire) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

   | 0.8–1.2 oz | 12 | 7 |

B. PYMETROZINE
   (Fulfill)
   MODE OF ACTION: A pyridine azomethine (Group 9B) insecticide.
   COMMENTS: Thorough coverage is important. Do not exceed 5.5 oz/acre/season. Apply when aphids first appear before populations reach damaging levels.

   | 2.75 oz | 12 | 7 |
C. **ENDOSULFAN**
   (Thionex) 3EC
   **Amount to Use:** 1–1.33 qt/acre
   **R.E.I.+ (hours):** 24
   **P.H.I.+ (days):** 4
   **MODE OF ACTION GROUP NUMBER:** 2A
   **COMMENTS:** Do not make more than 1 application/season. Do not exceed 1.33 qt/acre/year. Cannot be applied in any situation where runoff will occur.

D. **OXAMYL**
   (Vydate L)
   **Amount to Use:** 1–2 qt
   **R.E.I.+ (hours):** 48
   **P.H.I.+ (days):** 21
   **MODE OF ACTION GROUP NUMBER:** 1A
   **COMMENTS:** Do not apply more than 3 gal/acre/season.

* Permit required from county agricultural commissioner for purchase or use.
+ 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.
· 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/.
LEAFMINERS  (6/08)
Scientific Names:  Serpentine leafminer: *Liriomyza trifolii*
Pea leafminer: *Liriomyza langei*
Vegetable leafminer: *Liriomyza sativae*

DESCRIPTION OF THE PESTS
Adults are small black to gray flies with yellow markings. Females puncture leaves to feed on plant sap and lay eggs within the leaf tissues. After 2 to 4 days eggs hatch and larvae feed between the upper and lower surface of the leaves, making distinctive winding, whitish tunnels or mines that are often the first clue that leafminers are present. Larvae emerge from the mines and pupate on the leaf surface or, more commonly, in cracks in the soil. Many generations occur each year and the entire life cycle can be completed in less than 3 weeks when the weather is warm.

The species can be separated on the basis of the adult's appearance or by the appearance of the mines. The serpentine leafminer is most common in the warmer, celery-growing areas of southern California and the Central Valley; it does not occur in Central Coast growing areas. The pea leafminer occurs in the Salinas Valley as well as in the central coast growing areas where it occurs with the serpentine leafminer. It also appears to be extending its distribution into the southern growing regions of the state. The vegetable leafminer may be present in the coastal areas in low populations.

The serpentine leafminer is the smallest and most yellow of the three and produces characteristically wandering mines. The pea leafminer is the largest and most black or gray and, following the first two instars, produces straight mines. The pea leafminer is more likely to mine the petioles and stalks of celery than the other species.

DAMAGE
Leafminers can reduce the plant’s photosynthetic capacity, render edible portions of the plant unmarketable, and provide an entrance for disease organisms. In addition, many countries and some states regulate the importation of produce grown in areas where pea leafminer exists to prevent its introduction.

MANAGEMENT

Biological Control
Natural enemies, especially parasitic wasps in the genus *Diglyphus*, commonly reduce populations of leafminers, unless killed off by insecticides applied to control other pests. Several other parasites also attack leafminers. Predators are not important biological control agents because leafminer eggs and larvae are protected within leaf tissue. Choose selective pesticides for treating other pests, if possible, to avoid killing parasites and inducing leafminer outbreaks.

Cultural Control
*Liriomyza* leafminers attack a wide variety of vegetable crops often grown in proximity to celery. Where possible, avoid planting next to infested fields, especially lettuce fields near harvest.

Organically Acceptable Methods
Biological and cultural controls and sprays of azadirachtin (Neemix) are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
Treatment thresholds must be based on the species involved. To measure infestation levels of the serpentine leafminer, place trays between the rows of celery to catch dropping pupae. Trays about 4 inches by 9 inches fit well between the rows. Catches of 15 pupae or more per day per tray may be indicative of populations that require treatment.

Populations of pea leafminer or vegetable leafminer are not as easily monitored, and the treatment threshold is probably considerably lower than for the serpentine leafminer because of the tendency of this species to mine the stalks.
When choosing a pesticide, consider information relating to water quality and impact on natural enemies and bees.

<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. ABAMECTIN* (Agri-Mek) 0.15EC</td>
<td>8 to 16 oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 6</td>
<td>COMMENTS: A larvacide. Best control is obtained when 2 applications are applied 7–10 days apart.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. CYROMAZINE (Trigard) WP</td>
<td>0.166 lb (one packet)</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 17</td>
<td>COMMENTS: Do not make more than 2 sequential applications or 6 applications to one crop of celery.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. OXAMYL* (Vydate L)</td>
<td>1–2 qt</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 1A</td>
<td>COMMENTS: Larvacide. May not effectively control serpentine leafminer. Do not apply more than 3 gal/acre/season.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. SPINOSAD (Entrust)#</td>
<td>2–3 oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>(Success)</td>
<td>6–10 fl oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 5</td>
<td>COMMENTS: Is less effective on pea leafminer (L. langei) larvae than on other leafminers. Effective as a wet spray against all leafminer adults. Do not apply more than 9 oz of Entrust or 29 fl oz of Success/acre/crop.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. SPINETORAM (Radiant) SC</td>
<td>6–10 fl oz</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 5</td>
<td>COMMENTS: Effective on L. sativae and L. trifolii, but may not be effective for L. langei.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. AZADIRACHTIN# (Aza-Direct)</td>
<td>1–2 pt</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>(Neemix) 4.5%</td>
<td>4–7 oz</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 18B</td>
<td>COMMENTS: Kills leafminer after pupation. Although OMRI approved, check with certifier for any restrictions that apply.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. PYRETHRIN/ROtenONE (Pyrellin E.C.)</td>
<td>1–2 pt</td>
<td>12</td>
<td>12 hours</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NUMBER: 3 and 21</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.

* Modes of action are important in preventing the development of resistance to pesticides. 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. 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 is assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

# Acceptable for use on organically grown produce.
LYGUS BUG  (6/08)
Scientific Name: Lygus hesperus

DESCRIPTION OF THE PEST
Adults are small (about 0.25 inch), variably colored yellowish to green to bronze true bugs with a distinctive triangular marking on the back and wings composed of both membranous and hardened sections that are carried folded over the back. The mouthparts are needlelike and long in relation to the body size.

Eggs are laid in plant tissue. Immature lygus bugs are light green and resemble adults in shape but lack wings. The wings gradually appear with each molt. First- and second- instar nymphs are often confused with aphids on casual observation but lack cornicles and move much more quickly.

DAMAGE
Lygus feed by piercing cell membranes. This activity affects the subsequent cell division in the area of feeding. The result is sunken, callused, elongated lesions, frequently just below the first node of the celery stalk. Inner petioles may show black spots, twisting, or other distortion, especially if immature lygus are present.

MANAGEMENT
Biological Control
Natural enemies, especially parasitic wasps that attack eggs or nymphs, help control lygus populations. However, in native vegetation where populations of lygus build, natural enemies are not effective at preventing large numbers of adults from migrating into crops such as celery. The most important predators of lygus bugs are bigeyed bugs, which feed on eggs and young nymphs. Lygus adults are more difficult for predators to capture than nymphs because of their quick movements.

Cultural Control
Encouraging natural populations of lygus parasites and managing populations of lygus in nearby weeds may contribute to the suppression of a lygus population.

Organically Acceptable Methods
Biological and cultural controls are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
Lygus bugs frequently move into crop fields in spring when weeds and native vegetation dry down. Consequently, large numbers of lygus can move into celery fields in a short period of time. Determining the level of lygus infestation is difficult because the insects are cryptic and their activity cycle during any day varies greatly. Lygus become inactive and secretive during temperature extremes and windy conditions.

Because of the severity of the damage to celery, the threshold, while not specifically established, is very low. Sweep nets and keeping a careful eye out for adults flying in front of your movement through the field are the only ways to check for lygus. Sticky traps are not useful for monitoring these pests.
When choosing a pesticide, consider information relating to water quality and impact on natural enemies and bees.

A. **ZETA-CYPERMETHRIN***
   (Mustang) 1.5EW
   Mode of action group number: 3
   Comments: Make applications at least 7 days apart. Do not apply more than 0.3 lb a.i./acre/season.
   
<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>ZETA-CYPERMETHRIN*</td>
<td>3.4–4.3 oz</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>

B. **PERMETHRIN***
   (Ambush, Pounce) 25WP
   Mode of action group number: 3
   Comments: Do not apply more than 2 lb a.i./acre/season. Do not use if leafminers are present.
   
<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>PERMETHRIN*</td>
<td>0.1–0.2 lb a.i.</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>

C. **OXAMYL***
   (Vydate L)
   Mode of action group number: 1A
   Comments: Do not apply more than 3 gal/acre/season.
   
<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>OXAMYL*</td>
<td>1–2 qt</td>
<td>48</td>
<td>27</td>
</tr>
</tbody>
</table>

D. **MALATHION**
   Mode of action group number: 1B
   Comments: Apply on fresh market celery only; do not use on celery grown for seed or oil.
   
<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>MALATHION</td>
<td>1.5 pt</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

E. **METHOMYL***
   (Lannate LV)
   Mode of action group number: 1A
   Comments: This material is very disruptive to parasites and predators. If worms must also be controlled, it can be used to control lygus; otherwise its use is not recommended. Do not apply more than 7.2 lb a.i./acre/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>
<tbody>
<tr>
<td>METHOMYL*</td>
<td>1.5–3 pt</td>
<td>48</td>
<td>7</td>
</tr>
</tbody>
</table>

F. **PYRETHRIN/ROTenONE**
   (Pyrellin E.C.)
   Mode of action group number: 3 and 21
   Comments: Provides moderate 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>PYRETHRIN/ROTenONE</td>
<td>1–2 pt</td>
<td>12</td>
<td>12 hours</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.

Modes of action are important in preventing the development of resistance to pesticides. 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. 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 is assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.
OTHER APHIDS  (6/08)

Scientific Names:  Green peach aphid: *Myzus persicae*
Hawthorn/parsley aphid: *Dysaphis apiifolia*
Cotton/melon aphid: *Aphis gossypii*

DESCRIPTION OF THE PESTS
In addition to the black bean aphid and foxglove aphid, which are discussed separately, about ten other species of aphids are found on celery. Of these, green peach aphid and hawthorn/parsley aphid (also known as the rusty banded aphid) are the most common. These aphid species vary in color (from light green to black), size, and shape. All are soft-bodied insects. They form dense colonies on the undersides of celery leaflets and in some cases on the celery petioles. Winged aphids form under specific conditions of overcrowding or plant stress and disperse to other plants or fields.

Cotton/melon aphid is a small to medium-sized aphid. It is highly variable in color, ranging from lemon yellow to blackish green in different individuals, often within the same colony. The aphid is commonly lighter in color during the hotter times of the year and darker during cooler periods, but both color forms may be found throughout the year. In some years this aphid may be quite common in celery.

DAMAGE
Aphid populations can build up in celery to densities of several thousand per plant. These pests can inflict three types of damage to celery. First, they stunt plant growth and reduce yield through removal of significant amounts of sap. Next, they transmit virus diseases such as western celery mosaic, celery calico, and cucumber mosaic. Celery yellow spot may be found occasionally. And finally, they contaminate celery produce, particularly fresh market celery, with aphid honeydew and debris; this contamination can lower the crop value.

MANAGEMENT

Biological Control
Several parasitic wasps provide natural control of aphids in celery, most notably species in the genera *Diaeretiella* and *Lysiphlebus*. In some cases, these parasites can eliminate high densities of aphids over a few weeks. Predators such as lady beetles, syrphid flies, and lacewing also attack aphids. Populations of aphid parasites should be preserved by avoiding unnecessary insecticide applications and by providing acceptable habitat for these beneficials.

Cultural Control
Destroy crop residue immediately after harvest. Avoid other aphid-favored crops, such as lettuce, in adjacent, upwind fields. Intensify field monitoring for aphids when adjacent fields with aphid-favored crops are harvested.

Organically Acceptable Methods
Biological controls, cultural controls, and insecticidal soaps are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
Economic thresholds for aphids on celery have not been established. Aphid survival and development are historically greatest during periods with temperatures less than 80°F. On fresh market celery, infestations are more important when the petioles (stalks) start to form and when the rows begin to close. Infestations tend to be erratic in the field so sample several locations. Look at intermediate-age petioles to find the highest aphid populations. Concentrate on field edges particularly where celery fields border harvested lettuce fields.
When choosing a pesticide, consider information relating to water quality and impact on natural enemies and bees.

**AT PLANTING**

A. **IMIDACLOPRID**
   (Admire) 2F
   
   **Amount/Acre:** 10–24 fl oz
   **R.E.I.**+ (hours): 12
   **P.H.I.**+ (days): 45

   **MODE OF ACTION GROUP NUMBER:** 4A
   **COMMENTS:** Soil application. Use at planting in fields that have a history of aphid infestations. The rate applied affects the length of control. Use higher rates where infestations occur later in crop development or where pest pressure is continuous. Do not apply more than 0.5 lb a.i./acre/year. Repeat applications of any neonicotinoid insecticide (acetamiprid-Assail or imidacloprid-Admire) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

**AFTER PLANTING**

A. **ACETAMIPRID**
   (Assail) 70WP
   
   **Amount/Acre:** 0.8–1.2 oz
   **R.E.I.**+ (hours): 12
   **P.H.I.**+ (days): 7

   **MODE OF ACTION GROUP NUMBER:** 4A
   **COMMENTS:** Thorough coverage is important. Do not make more than 5 applications/season. Repeat applications of any neonicotinoid insecticide (acetamiprid-Assail or imidacloprid-Admire) can lead to resistance to all neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode of action to help delay the development of resistance.

B. **PYMETROZINE**
   (Fulfill)
   
   **Amount/Acre:** 2.75 oz
   **R.E.I.**+ (hours): 12
   **P.H.I.**+ (days): 7

   **MODE OF ACTION GROUP NUMBER:** 9B
   **COMMENTS:** Thorough coverage is important. Do not exceed 5.5 oz/acre/season. Apply when aphids first appear before populations reach damaging levels.

C. **ACEPHATE**
   (Orthene) 75S
   
   **Amount/Acre:** 0.66–1.33 lb
   **R.E.I.**+ (hours): 24
   **P.H.I.**+ (days): 21

   **MODE OF ACTION GROUP NUMBER:** 1B
   **COMMENTS:** Trim plants before shipment. Do not feed tops. Do not apply more than 2.66 lb/acre/season.

D. **OXAMYL**
   (Vydate L)
   
   **Amount/Acre:** 1–2 qt
   **R.E.I.**+ (hours): 48
   **P.H.I.**+ (days): 21

   **MODE OF ACTION GROUP NUMBER:** 1A
   **COMMENTS:** Do not apply more than 3 gal/acre/season.

E. **ENDOSULFAN**
   (Thionex) 3EC
   
   **Amount/Acre:** 1–1.33 qt
   **R.E.I.**+ (hours): 24
   **P.H.I.**+ (days): 4

   **MODE OF ACTION GROUP NUMBER:** 2A
   **COMMENTS:** Do not make more than 1 application/season. Cannot be applied in any situation where runoff will occur. Do not exceed 1.33 qt/acre/year.

F. **NARROW RANGE OIL**
   (JMS Stylet Oil)
   
   **Amount/Acre:** 3 qt/100 gal water
   **R.E.I.**+ (hours): 4
   **P.H.I.**+ (days): 0

   **MODE OF ACTION:** Contact including smothering and barrier effects.
   **COMMENTS:** This material requires frequent applications and thorough coverage.
<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>2.5 oz/gal</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

**MODE OF ACTION:** A contact insecticide with smothering and barrier effects.

**COMMENTS:** Spray to wet all infested plant surfaces. Rotate sprays or rinse foliage to avoid more than 3 consecutive sprays. This material has no residual and requires frequent applications and thorough coverage.

+ 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.

- 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.

# Acceptable for organically grown produce.
Diseases

APIUM VIRUS Y  (6/09)
Pathogen: Apium virus Y

SYMPTOMS
Disease symptoms caused by Apium virus Y are variable and depend on the celery cultivar. In general, older leaves show yellow or brown line patterns, yellow blotches, brown lesions, and in some cases have distorted and twisted leaflets. Younger leaves may show a faint mosaic or mottling. Celery petioles could exhibit dark brown, sunken, elongated lesions. However, for some cultivars, the celery plants having symptomatic foliage will not have any petiole symptoms. Overall plant growth does not appear to be affected.

COMMENTS ON THE DISEASE
Apium virus Y has only recently been reported in California and is thus far documented only in the Central Coast region. In addition to celery, this virus has been found in the field on cilantro, parsley, and the weed poison hemlock (Conium maculatum). This virus is vectored by aphids, and seed-borne transmission has not been reported.

MANAGEMENT
Cultural Control
Elimination of weed hosts like poison hemlock appears to be important, as most Apium virus Y cases occur where this weed is widely distributed.

Organically Acceptable Methods
Cultural controls are acceptable for use on organically grown produce.

Treatment Decisions
Chemicals are not effective against plant viruses. Insecticides for controlling the vector are not effective in preventing virus infections.
ASTER YELLOWS (11/05)

Pathogen: Aster yellows phytoplasma

SYMPTOMS
Aster yellows symptoms and severity can be highly variable depending on the strain of the pathogen, age of plant when infected, and other factors. Celery plants are usually severely stunted and yellowed. Inner petioles are characteristically short, yellow to white in color, and moderately to severely curved and twisted. On older plants, petioles become brittle in texture and the epidermis and underlying tissues can crack and peel. In later stages of the disease, the inner heart of the plant turns brown and can decay. Fusarium yellows can cause similar stunting and yellowing. However, Fusarium yellows causes distinct vascular browning in the roots and crowns and does not cause petiole deformities.

COMMENTS ON THE DISEASE
Aster yellows has viruslike symptoms but is actually caused by the aster yellows phytoplasma, a single-celled organism that, like bacteria, lacks a nucleus and is therefore classified as a prokaryote.

Aster yellows is transmitted to crops by leafhopper insect vectors. Overwintering leafhoppers can harbor the phytoplasma, or leafhoppers can obtain the pathogen while feeding on infected plants. Important weed hosts include dandelion, plantains, pineapple-weed, Russian thistle, sowthistle, wild lettuce, wild chicory, horseweed, and wild asters. When leafhoppers migrate from pasture or noncrop land to vegetable fields, or when drying vegetation drives leafhoppers from foothills and other areas, the insects encounter celery and other crops and transmit the phytoplasma during feeding. Therefore, significant aster yellows outbreaks almost always occur in fields near pastures, rivers, ditchbanks, foothills, and weedy noncrop land. Because of fluctuations in the populations and flight patterns of leafhoppers, and fluctuations in the populations of infected reservoir plants, aster yellows incidence varies greatly from year to year. Overall impact on celery is generally low.

MANAGEMENT

Cultural Control
Aster yellows is difficult to control, in part, because of the extensive host range of the phytoplasma. Over 300 species of food, forage, ornamental, and weed plants are susceptible. While weed management should be practiced, this will have little effect on aster yellows. For particularly valuable plantings, don’t plant celery on ranches that are near known phytoplasma and leafhopper reservoirs.

Organically Acceptable Methods
Cultural controls are acceptable for use on organically grown produce.

Treatment Decisions
There are no chemical controls for the aster yellows phytoplasma. Insecticides will have little effect on leafhopper transmission of the pathogen and are therefore not recommended.
BACTERIAL LEAFSPOT (11/05)
Pathogen: *Pseudomonas syringae pv. apii*

SYMPTOMS
Initial symptoms of bacterial leafspot are small, water-soaked spots that are visible from both sides of the leaf. The lesions usually are limited by leaf veins and thus have an angular, square, or rectangular appearance. These water-soaked lesions rapidly turn brown and with aging may dry out and become papery and tan. Lesions tend to be relatively small (less than 0.25 inch in diameter) and restricted to leaves. On greenhouse transplants, bacterial blight lesions may develop extensively on the foliage. However, in the field the disease usually is found only on the older leaves that are protected by the plant canopy, except where sprinkler irrigation is used. Under favorable conditions (free moisture), bacterial blight lesions may coalesce and cause considerable blighting of the foliage.

COMMENTS ON THE DISEASE
*Pseudomonas syringae pv. apii* is a seedborne bacterium. Once introduced into transplant greenhouses, the pathogen can rapidly spread via splashing water. Disease development is favored by warm, moist conditions. Infected transplants carry the pathogen into production fields. In the field, widespread or severe symptoms generally do not develop unless the crop is sprinkler irrigated or subjected to a light frost during the production cycle. The pathogen survives in undecomposed celery residue.

MANAGEMENT
Cultural Control
Use seed that has been indexed free of *Pseudomonas syringae pv. apii*. Hot water seed treatment (122°F for 25 minutes) will significantly reduce seedborne inoculum, but may reduce seed germination. Using seed that is at least 2 years old can significantly reduce the incidence of this disease.

Disinfect transplant trays because bacteria may survive on dirty trays. In the greenhouse, lower the water pressure from overhead sprinklers because high pressures favor entry of the pathogen into celery leaves. In the field avoid sprinkler irrigation. Excessive application of nitrogen fertilizers appears to favor disease development.

Organically Acceptable Methods
Cultural controls and copper sprays are acceptable for use on organically grown produce.

Treatment Decisions
Only copper compounds are registered for use against this pathogen; however, copper has not been very effective.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. COPPER#</td>
<td>Label rates</td>
<td>see label</td>
<td>see label</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M1)</td>
<td>COMMENTS: Not very effective. Not all copper compounds are approved for use in organic production; check individual products.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Acceptable for use on organically grown produce.

+ 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 Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode of action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to a fungicide with a different mode of action Group number.
CELERY MOSAIC VIRUS  (6/08)

SYMPTOMS
Disease symptoms caused by Celery mosaic virus include yellowing of foliage, mosaic and/or mottling patterns on leaves, vein clearing, and curled, crinkled, or otherwise distorted foliage. On older leaves necrotic leaf spots may develop. Plants are sometimes stunted. Outer petioles grow horizontally, giving the plant a flattened appearance. Certain strains of the virus may cause more severe symptoms than other strains.

COMMENTS ON THE DISEASE
Celery mosaic is the most common viral disease of celery. The virus is not reported to be seedborne; it is vectored by aphids. Celery is the primary host of this disease.

MANAGEMENT
Cultural Control
For celery mosaic, a host-free period of at least 2 to 3 months (in which celery is not being grown in the area) greatly reduces the incidence of celery mosaic. Eliminate weed hosts like wild celery and wild parsnip, especially during the celery-free period. Although resistance has been reported in other areas, it does not pertain to commercial varieties used in California.

Organically Acceptable Methods
Cultural controls are acceptable for use on organically grown produce.

Treatment Decisions
Chemicals are not effective against plant viruses. Insecticides for controlling the vector are not effective in preventing virus infections.
CRATER ROT  (6/08)

Pathogen: Rhizoctonia solani

SYMPTOMS
Crater rot symptoms are usually restricted to the lower portions of the celery petioles where soil is in contact with plant tissue. Early symptoms consist of small, irregular, reddish-brown lesions that develop on outer and inner sides of the lower petioles. Developing lesions expand and become brown, sunken spots or craters. These lesions remain firm and dry unless secondary decay organisms invade and cause soft rots. With a hand lens, the dark brown, mycelia of Rhizoctonia solani may sometimes be seen within and on the margins of the lesions.

COMMENTS ON THE DISEASE
Rhizoctonia solani is a soilborne fungus that can persist in the soil for long periods of time. It infects many plant hosts and can also survive on decaying organic matter in the soil. This pathogen can survive in soil by forming tight masses of mycelium (sclerotia) that resist desiccation. Warm and moist soil conditions are needed for crater spot development.

MANAGEMENT
Cultural Control
Place transplants at proper planting depth. Planting too deeply can increase disease severity and incidence. Manage irrigations to avoid overly wet soils. Do not plant into fields with large amounts of undecomposed plant residue. During soil cultivation, avoid throwing soil onto the crowns of plants.

Organically Acceptable Methods
Cultural controls are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
If monitoring indicates crater rot is developing on the plants, protectant fungicides are sometimes necessary. Direct these sprays to the base of the celery plants.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHLOROTHALONIL</td>
<td>Label rates</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(Bravo Ultrex)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Echo 720)</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>
</tbody>
</table>

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

A. CHLOROTHALONIL
   (Bravo Ultrex)
   (Echo 720)

   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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EARLY BLIGHT (6/08)

Pathogen: *Cercospora apii*

**SYMPTOMS**
Small yellow spots, visible on both sides of the leaf, are the first symptom of early blight. Later the spots grow into gray, circular lesions that may be 0.25 to 0.75 inch in diameter. As leaf spots dry out, the tissue becomes papery in texture and often splits and cracks. Elongated lesions may develop on petioles. Under favorable conditions (temperatures between 60° and 86°F), the lesions will coalesce and cause a blighting effect on the leaves. The gray, fuzzy growth of the fungus may be observed in the centers of leaf and petiole lesions, but distinct structures (such as those found for celery late blight) are not formed by this pathogen. Even though the fungus growth is similar, do not confuse this disease with the early blight disease that occurs on tomato and potato, which is caused by an *Alternaria* sp. that does not infect celery.

**COMMENTS ON THE DISEASE**
Early blight is not as common as late blight in California celery. *Cercospora apii* is a seedborne pathogen and may also survive in the field on celery debris. Spores are spread via wind and splashing water. Celeriac is also a host of this pathogen.

**MANAGEMENT**

**Cultural Control**
Use *Cercospora*-indexed seed. Do not plant transplants infected with *Cercospora apii*.

**Organically Acceptable Methods**
Cultural controls and some copper sprays are acceptable for use on organically grown produce.

**Treatment Decisions**
Chemical treatments are usually not needed, but if they are, the same fungicides that control late blight will also help suppress this disease.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. PROPICONAZOLE (Tilt)</td>
<td>4 fl oz</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Apply on a 7-day schedule but do not exceed 16 fl oz of product/crop. Ground or aerial application.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. AZOXYSTROBIN (Quadris)</td>
<td>9.2-15.4 fl oz</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMENTS: Alternate applications with a fungicide that has a different mode of action. Do not apply more than 2.88 qt/acre/season.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. TRIFLOXYSTROBIN (Flint)</td>
<td>2–3 oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Quinone outside inhibitor (11)</td>
<td></td>
<td></td>
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<tr>
<td>COMMENTS: Do not apply more than 12 oz/acre/season or more than 4 applications of strobilurin fungicides/season. Use allowed under a supplemental label.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. CHLOROTHALONIL (Bravo Ultrex) 82.5%</td>
<td>1.8–2.7 lb/acre</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(Echo 720) 54%</td>
<td>2–3 pt/acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M5)</td>
<td></td>
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<tr>
<td>COMMENTS: Do not apply more than 18 lb a.i./acre/season.</td>
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<tr>
<th>Common name (trade name)</th>
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</thead>
<tbody>
<tr>
<td>COPPER HYDROXIDE (Kocide 101)</td>
<td>2 lb</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Champ)</td>
<td>1.33 pt</td>
<td>24</td>
<td>0</td>
</tr>
</tbody>
</table>

+ MODE OF ACTION GROUP NAME (NUMBER): Multi-site contact (M1)

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FUSARIUM YELLOWS  (11/05)
Pathogen:  *Fusarium oxysporum* f. sp. *apii*

SYMPTOMS
Symptoms of Fusarium yellows usually begin to appear after plants are well established. Infected plants turn yellow and are stunted. Some of the large roots may have a dark brown, water-soaked appearance. The water-conducting tissue (xylem) in the stem, crown, and root show a characteristic orange-brown discoloration, resulting from infection by this soilborne, vascular pathogen. In the later stages of infection, plants remain severely stunted and yellowed and may collapse. Invasion by secondary rot organisms results in soft rots and hollowed cavities in the plant crowns. Aster yellows also causes similar yellowing and stunting. However, aster yellows usually causes severe petiole twisting and lacks the vascular discoloration caused by Fusarium yellows.

COMMENTS ON THE DISEASE
Once introduced into a field, this pathogen can survive for long periods in the soil. The fungus can be moved about in infected plant residues and in infested soil. Symptoms are most severe on the summer celery crops because of warmer soil and air temperatures.

MANAGEMENT
Cultural Control
Use resistant or tolerant celery cultivars, and avoid fields with known histories of the disease. If infested fields must be used, plant resistant/tolerant cultivars only in winter or early spring. Avoid contaminating uninfested fields by preventing introduction of soil/crop residue.

Organically Acceptable Methods
Cultural controls are acceptable for use on organically grown produce.
LATE BLIGHT (6/08)
Pathogen: *Septoria apiicola*

SYMPTOMS
Early symptoms of late blight consist of small, discrete, yellow spots on leaves and petioles. The spots often are circular in shape but may be angular when they are delineated by leaf veins. As the disease progresses, leaf lesions enlarge and usually grow together. Mature lesions turn tan and dry out, becoming papery. A characteristic feature of these lesions is the presence of small, dark, round structures that are the reproductive bodies (pycnidia) of the fungus. Under favorable conditions (rainy weather, heavy dew or fog, or sprinkler irrigation during temperatures above 70°F), lesion development may be extensive on both leaves and petioles, resulting in blighting of the plant. Do not confuse this disease with late blight of tomato and potato caused by *Phytophthora infestans*, which does not infect celery.

COMMENTS ON THE DISEASE
The primary inoculum source for late blight is contaminated celery seed. When temperatures do not exceed 55°F, disease development ceases until temperatures increase and moisture is present. Rain, heavy dew or fog, and sprinkler irrigation when temperatures are above 70°F encourage disease development; splashing water disperses spores and aids in spore germination and infection. The pathogen can survive in undecomposed plant residue. *Septoria apiicola* may also be found on celeriac.

MANAGEMENT
Cultural Control
Because this pathogen is seedborne, use *Septoria*-indexed seed. Hot water seed treatments may effectively reduce infestation levels on seed but also may reduce seed germination. There is some indication that storing celery seed for at least 2 years can significantly reduce pathogen viability on seed. Plant only disease-free celery transplants. Production of disease-free transplants involves planting of *Septoria*-indexed or hot water treated seed, roguing of infected plants, and the use of fungicides when necessary. Plow under infected celery tissue after harvest and rotate out of celery for at least one year. Once plants are established in the field, avoid overhead sprinkler irrigation if possible. Reduce movement of equipment through fields when foliage is wet because such passage may spread spores from diseased to healthy plants.

Organically Acceptable Methods
Cultural controls and some copper sprays are acceptable for use on organically grown produce.

Monitoring and Treatment Decisions
Monitor celery fields for late blight symptoms. If symptoms are detected, protectant fungicides may be required for disease control, especially if sprinkler irrigation is used or rain has occurred. To obtain best results, apply materials at first appearance of disease symptoms. Chemical treatment is not necessary when field temperatures remain below 55°F.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. PROPICONAZOLE</strong></td>
<td></td>
<td></td>
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<tr>
<td>(Tilt)</td>
<td>4 fl oz</td>
<td>24</td>
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<tr>
<td>MODE OF ACTION GROUP NAME (NUMBER): Demethylation inhibitor (3)</td>
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<tr>
<td>COMMENTS: Apply on a 7-day schedule but do not exceed 16 fl oz of product/crop. Ground or aerial application.</td>
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<td><strong>B. AZOXYSTROBIN</strong></td>
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<tr>
<td>COMMENTS: Alternate applications with a fungicide that has a different mode of action. Do not apply more than 2.88 qt/acre/season.</td>
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<td>Common name</td>
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<tr>
<td>------------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td><strong>TRIFLOXYSTROBIN</strong></td>
<td>2–3 oz</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(Flint)</td>
<td></td>
<td></td>
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<td><strong>COMMENTS:</strong> Do not apply more than 12 oz/acre/season or more than 4 applications of strobilurin fungicides/season. Use allowed under a supplemental label.</td>
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<tr>
<td><strong>CHLOROTHALONIL</strong></td>
<td>1.8–2.7 lb/acre</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(Bravo Ultrex) 82.5%</td>
<td>2–3 pt/acre</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>(Echo 720) 54%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NAME (NUMBER):</strong> Multi-site contact (M5)</td>
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<td><strong>COMMENTS:</strong> Do not apply more than 18 lb a.i./acre/season.</td>
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<tr>
<td><strong>COPPER HYDROXIDE</strong></td>
<td>Label rates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Kocide 101)</td>
<td>2 lb</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>(Champ)</td>
<td>1.33 pt</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td><strong>MODE OF ACTION GROUP NAME (NUMBER):</strong> Multi-site contact (M1)</td>
<td></td>
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OTHER VIRUS DISEASES  (6/08)
Pathogens:  *Cucumber mosaic virus* (CMV), *Tomato spotted wilt virus* (TSWV)

SYMPTOMS
Cucumber mosaic symptoms are similar to those of celery mosaic but in addition cause areas of sunken brown spots on the stalk. Symptoms of tomato spotted wilt appear on older leaves as yellow spots that turn brown. Large sections of stalks turn brown and eventually die; plants may be severely stunted. Tomato spotted wilt disease is most commonly found in the coastal celery-growing areas. Precise identification of the various celery viruses requires laboratory or greenhouse tests.

COMMENTS ON THE DISEASES
These virus diseases occur sporadically and usually do not cause significant economic loss in California celery. Both viruses have extensive host ranges and are found in many agronomic, ornamental, and weed plants. *Cucumber mosaic virus* is vectored by aphids, and *Tomato spotted wilt virus* is vectored by thrips.

MANAGEMENT
Cultural Control
Avoid planting celery in areas having a history of virus problems. Young celery should not be planted near fields having crops infected with virus. Weed management should be practiced.

Organically Acceptable Methods
Cultural controls are acceptable for use on organically grown produce.

Treatment Decisions
There are no chemical controls for plant viruses. Insecticides will have little effect on vector transmission of the pathogens and are therefore not recommended.
PINK ROT  

Pathogen: *Sclerotinia sclerotiorum*

**SYMPTOMS**
Celery is susceptible to the pink rot fungus at all stages of plant growth (including as transplants in trays), but the disease is most often observed on mature plants when leaf canopies are well developed.

Initial symptoms appear as brown lesions on the petioles that develop at or near the soil line or up in the plant canopy. Lesions rapidly expand into soft, watery, decayed areas. The plant tissue surrounding the lesions may turn pink. In advanced stages of the disease, lesions may contain profuse white mycelia of the pathogen. Hard, black, irregularly shaped resting structures (sclerotia) ranging in size from 0.25 to 0.5 inch long, may develop on diseased tissue. Under favorable conditions, the entire petiole and plant base may collapse.

Leaf infections on newly forming leaves may also occur. Brown leaf lesions rapidly expand into the leaf petiole. As the leaf and petiole collapse, white mycelia and black sclerotia develop.

**COMMENTS ON THE DISEASE**
Sclerotia survive in the soil for prolonged periods without plant hosts. When cool, wet conditions occur, sclerotia germinate and infect nearby plants at or below the soil surface. Alternately, sclerotia may develop spore-producing structures that release windborne spores. These spores may land on susceptible celery tissue and cause a canopy infection. Conditions that promote disease development are periods of prolonged wetness, excess moisture in heavy canopy, and fog.

Because many crops and weeds are hosts of this pathogen, spore releases may occur within and outside celery fields. Pink rot that occurs on celery transplants is caused by spores that blow into transplant facilities.

**MANAGEMENT**

**Cultural Control**
Crop rotation does not prevent pink rot but can reduce soil populations of the fungus. Maintain adequate air movement within fields by proper plant and row spacing. Use drip instead of furrow irrigation; do not use sprinkler irrigation, especially late in the crop cycle. Deep plowing or soil inversion does not reduce disease caused by *Sclerotinia sclerotiorum*.

**Organically Acceptable Methods**
Cultural controls are acceptable for use on organically grown produce.

**Treatment Decisions**
Directed sprays to the base of the plants may provide some protection against pink rot.

<table>
<thead>
<tr>
<th>Common name (trade name)</th>
<th>Amount to use</th>
<th>R.E.I.+ (hours)</th>
<th>P.H.I.+ (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. DICLORAN (Botran) 75W</td>
<td>5.33 lb/acre</td>
<td>12</td>
<td>28</td>
</tr>
</tbody>
</table>

MODE OF ACTION GROUP NAME (NUMBER): Aromatic hydrocarbon (14)

COMMENTS: Apply 4–8 weeks before harvest. Apply 1 application only at this rate.

+ 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 R.E.I exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode of action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to a fungicide with a different mode of action Group number.
Nematodes (6/08)

Scientific Names: Root knot nematodes: Meloidogyne hapla, M. incognita, and M. javanica

DESCRIPTION OF THE PESTS
Plant parasitic nematodes are microscopic roundworms that live in soil and plant tissues and feed on plants by puncturing and sucking the cell contents with a needlelike mouthpart called a stylet. Root knot nematodes live within the roots; the second stage juveniles are motile, and the other stages are sedentary. Adult females are swollen and produce eggs in an egg mass, typically on or just under the root surface.

DAMAGE
Root knot nematodes can cause stunting of celery plants. They can also reduce a stand, but this is rare and usually occurs under high nematode population densities when the growing season extends into warm weather.

Reports of nematode problems in California celery crops have increased in recent years. This increase is attributed to the loss of fumigants that were typically used on crops grown in rotation with celery.

SYMPTOMS
The symptoms described below are characteristic of a nematode problem, but are not diagnostic because they could result from other causes as well. Root knot nematode infestations can cause stunting, uneven stand of plants, and characteristic galls on roots. Nematode-infested plants often tend to wilt earlier than healthy plants even when soil moisture is adequate.

FIELD EVALUATION
It is critical to know whether or not nematodes are present to make management decisions. If a previous field or crop had problems caused by root knot nematode, numbers may be high enough to cause damage to seedlings. If nematode species have not previously been identified, take soil samples and send them to a diagnostic laboratory for identification.

Take soil samples from within the root zone (6 to 18 inches deep). Divide the field into sampling blocks of not more than five acres each that represent cropping history, crop injury or soil texture. Take several subsamples randomly from a block, mix them thoroughly and make a composite sample of about 1 quart (1 liter) for each block. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, and the current/previous crop and the crop you intend to grow. Plants suspected of having root knot infestation should be placed in a plastic bag and also sent to the lab for analysis. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor for more details about sampling, to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

MANAGEMENT
Cultural Practices
Rotating with nonhost crops can reduce nematode population levels but is difficult in fields with root knot nematodes because of their wide host range. Avoid infesting new fields by cleaning machinery and equipment with water and preventing movement of infested soil. Currently there are no nematode resistant cultivars available.

Treatment Decisions
Damage thresholds for root knot nematode on celery have not been developed. If they are present, damage may occur and treatment is warranted.
PREPLANT

<table>
<thead>
<tr>
<th>Common name</th>
<th>Amount to use</th>
<th>R.E.I.+</th>
</tr>
</thead>
<tbody>
<tr>
<td>(trade name)</td>
<td>(hours)</td>
<td></td>
</tr>
</tbody>
</table>

A. METAM SODIUM* (50–80 gal/acre) 48
(Vapam, Sectagon 42)
COMMENTS: Contact your farm advisor for advice on the most effective application method for a particular situation. Fumigants such as metam sodium are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

B. 1,3-DICHLOROPROPENE* Label rates 7 days
(Telone II)
COMMENTS: Follow label directions for rates and application procedures. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

C. 1,3-DICHLOROPROPENE*/CHLOROPICRIN* Label rates 7 days
(InLine)
COMMENTS: Multipurpose liquid fumigant for the preplant treatment of soil to control plant-parasitic nematodes, symphylans, and certain soil-borne pathogens using drip irrigation systems only. Use of a tarp seal is mandatory for all applications of this product. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

D. 1,3-DICHLOROPROPENE* Label rates 7 days
(Telone EC)
COMMENTS: Liquid fumigant for the preplant treatment of soil against plant-parasitic nematodes and certain other soil pests in cropland using drip irrigation systems only. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.

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

INTEGRATED WEED MANAGEMENT (6/09)

Weeds reduce celery yields by competing for light, water, and nutrients, delaying maturity, and by reducing the efficiency of harvest. Weed control is especially critical in the early part of the season, to ensure a high quality crop at harvest.

The major counties where celery is grown include Monterey, Santa Barbara, and Ventura counties and to a lesser degree Santa Cruz, Orange, and San Benito counties. Within these counties, celery is in various stages of growth throughout the year; thus it encounters both winter and summer weeds. Weeds that commonly require control are little mallow, chickweed, nettleleaf goosefoot, lambsquarters, common groundsel, London rocket, burning nettle, redroot pigweed, tumble pigweed, purslane, shepherd’s-purse, and annual sowthistle. Perennials weeds are usually not a major problem in the intensively farmed land used for celery, with the exception of yellow nutsedge in certain locations.

Celery is almost entirely transplanted and only rarely direct-seeded. Although transplanted celery is planted to a high density (37,000 to 44,000 plants per acre), the early stages of growth do not provide much shading of weeds. This lack of shading together with the high moisture regime required following transplanting favor weed growth.

Direct-seeded celery is usually grown on double row, 40-inch beds. Weed control in field-sown celery or seedbeds is critical because of the long germination period (21 or more days) and subsequent slow growth of the seedlings. A high moisture regime during seed germination invariably favors weed growth. The slow-developing seedling provides little to no competition with weeds. By the time the celery seedling is in the 1- to 2-true leaf stage, weeds can completely obscure the celery plant. Mechanical cultivation typically removes weeds on 80% of the bed and the remaining weeds removed chemically or by hand.

In general, weed management in celery depends on good cultural practices such as field selection, crop rotation, preirrigation followed by cultivation, in-season cultivation, and hand hoeing. Herbicides can help provide control of broadleaf and grass weeds.

MONITORING
To plan a weed management program, it is essential to know which weed species are present and the relative abundance of each. Conduct weed surveys of each field at least twice a year: the first after planting but before weeding and the second just before harvest. Records from previous crops will indicate what weeds escaped control and will likely infest the celery crop. Also examine fencerows and ditch banks, as these are other sources for weed invasion. Pay special attention to where perennial weeds such as field bindweed occur so that follow-up control measures can be taken.

MANAGEMENT BEFORE PLANTING
An effective weed control program must take into account weed histories, soil types, celery culture, and subsequent rotational crops. Using a combination of weed management methods has the benefit of minimizing costs, while obtaining optimum weed control.

Crop Rotation. Celery is grown in rotation with either cool or warm season vegetable crops. The best crops to use in a rotational scheme are those that have effective weed management systems, such as strawberry, lettuce, or broccoli. Rotating to strawberries is especially useful in fields where yellow nutsedge is a problem; preplant fumigation helps to manage this weed. In using herbicides, always consider crop rotation schemes that allow for maximum flexibility in regards to plantback restrictions.

Field Selection and Preparation. Choose field sites that have a low weed population. If previous crops had heavy weed infestations, soil tillage practices such as plowing may reduce weed seed density. For summer-planted celery, preirrigation of preformed beds, followed by minimum tillage, will often reduce initial weed competition at seeding or transplanting. This procedure must be planned in advance to accommodate planting schedules.

Herbicides. Glyphosate (Roundup, Touchdown) and pelargonic acid (Scythe) can be used to control small weeds that have emerged before transplanting or field seeding, or to control weeds that have emerged...
between field seeding and emergence of the crop. Oxyfluorfen (Goal) can be applied to fallow beds up to 30 days before transplanting celery, but the beds must be thoroughly worked before planting.

**Transplanted.** For transplanted celery, prometryn and S-metolachlor (Dual Magnum) can be applied pretransplant.

**Direct-seeded celery.** Trifluralin (Treflan), which controls many grass weeds and some broadleaves (lambsquarters, pigweed) can be applied before planting direct-seeded.

### MANAGEMENT AT PLANTING

**Transplanted.** On transplanted celery prometryn, S-metolachlor, bensulide (Prefar), and trifluralin can be applied before transplanting. Trifluralin must be incorporated 2- to 3-inches deep, which may limit its use in winter-sown celery districts because of wet soils. S-metolachlor is effective on some broadleaf and grass weeds and is particularly useful for controlling yellow nutsedge.

**Direct-seeded celery.** Broadleaf weeds can be controlled in direct-seeded celery by prometryn, which will also make the thinning operation more efficient. For direct-seeded celery, prometryn can either be applied after seeding, or after crop emergence, and sprinkler irrigated within 48 hours. The treatment may be limited to a band application over the seed line or treating full coverage, depending upon weed history of the field and economics.

### MANAGEMENT AFTER PLANTING

For field-seeded celery, several irrigations are required to ensure germination and emergence. Following transplanting, the soil surface must also be kept moist for about 2 weeks by repeated sprinkler or furrow irrigation. The need for repeated applications of water during the period immediately following planting or transplanting limits access to the field. After celery plants are established, the irrigation interval is extended and the field becomes accessible for weeding and cultivation practices. Thinning and weeding of the celery is normally done at the three- to four-leaf stage. Hand-hoeing is essential to remove the weeds between the plants not controlled by herbicides or tillage. Depending on weed density, this practice may involve 10 to 15 person hours per acre.

Before making an herbicide treatment after planting, celery seedlings should have two to three leaves, while transplants should have new leaves developing from the crown, usually the third or fourth week after transplanting. At this time most weeds have emerged. Sprinkler irrigation should follow application after 24 to 48 hours for enhancement of weed control.

**Direct-seeded and Transplanted.** Herbicide applications after transplanting can provide preemergent and postemergent weed control. They are more selective in clay soils than sandy soils where they effectively control broadleaf weeds such as little mallow, redroot pigweed, lambsquarters, burning nettle, shepherd’s-purse, and hairy nightshade.

**Transplanted only.** Prometryn and linuron (Lorox) provide effective postemergent weed control of many broadleaf weed seedling in transplanted celery fields. Both can be applied after transplanting over the top of transplants. Prometryn is effective on many broadleaf weeds, including little mallow when applied postemergent. Linuron provides partial control of emerged yellow nutsedge. Both prometryn and linuron cause detectable plant injury, depending on weather conditions, but celery usually outgrows the injury without a significant reduction in yield or quality. S-metolachlor can be applied as a directed or broadcast application following transplanting celery.

**Both transplanted and direct-seeded.** Sethoxydim (Poast) or clethodim (Select Max) can be applied to control grass weeds. Carfentrazone (Shark) can be applied with a hooded sprayer to control the weeds in the furrows between the rows.
SPECIAL WEED PROBLEMS  (6/09)

Most celery-growing regions are only confronted with annual broadleaves and grasses, and most of these, except little mallow, are effectively controlled with current weed management tools.

LITTLE MALLOW. Little mallow can be controlled with postemergent applications of linuron and prometryn. However, it is difficult to control if allowed to get too large (five to six leaves). Larger plants will be burned back and not completely controlled.

YELLOW NUTSEDGE. This weed is not a problem during the winter months and can be managed with field selection, crop rotation, or mechanical methods. Linuron provides postemergent burn back of this weed, and S-metolachlor provides preemergent control.
# COMMON AND SCIENTIFIC NAMES OF WEEDS

(5/99)

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>barnyardgrass</td>
<td><em>Echinochloa crus-galli</em></td>
</tr>
<tr>
<td>bluegrass, annual</td>
<td><em>Poa annua</em></td>
</tr>
<tr>
<td>chickweed, common</td>
<td><em>Stellaria media</em></td>
</tr>
<tr>
<td>goosefoot, nettleleaf</td>
<td><em>Chenopodium murale</em></td>
</tr>
<tr>
<td>groundsel, common</td>
<td><em>Senecio vulgaris</em></td>
</tr>
<tr>
<td>henbit</td>
<td><em>Lamium amplexicaule</em></td>
</tr>
<tr>
<td>knotweed, common</td>
<td><em>Polygonum arenastrum</em></td>
</tr>
<tr>
<td>lambsquarters, common</td>
<td><em>Chenopodium album</em></td>
</tr>
<tr>
<td>mallow, little (cheeseweed)</td>
<td><em>Malva parviflora</em></td>
</tr>
<tr>
<td>mustard, black</td>
<td><em>Brassica nigra</em></td>
</tr>
<tr>
<td>nettle, burning</td>
<td><em>Urtica urens</em></td>
</tr>
<tr>
<td>nightshade, hairy</td>
<td><em>Solanum sarrachoides</em></td>
</tr>
<tr>
<td>nutsedge, yellow</td>
<td><em>Cyperus esculentus</em></td>
</tr>
<tr>
<td>nutsedges</td>
<td><em>Cyperus spp.</em></td>
</tr>
<tr>
<td>pigweed, redroot</td>
<td><em>Amaranthus retroflexus</em></td>
</tr>
<tr>
<td>pineapple-weed</td>
<td><em>Chamomilla suaveolens</em></td>
</tr>
<tr>
<td>purslane, common</td>
<td><em>Portulaca oleracea</em></td>
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<tr>
<td>rocket, London</td>
<td><em>Sisymbrium irio</em></td>
</tr>
<tr>
<td>shepherd's-purse</td>
<td><em>Capsella bursa-pastoris</em></td>
</tr>
<tr>
<td>sowthistles</td>
<td><em>Sonchus spp.</em></td>
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</tbody>
</table>
# SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL

## ANNUAL WEEDS

<table>
<thead>
<tr>
<th></th>
<th>BSL</th>
<th>CAR</th>
<th>CLE</th>
<th>GLY</th>
<th>LIN</th>
<th>MET</th>
<th>OXY</th>
<th>PEL</th>
<th>PRM</th>
<th>SET</th>
<th>TRI</th>
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<tr>
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<tr>
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<td>nettle, burning</td>
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<tr>
<td>rocket, London</td>
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<tr>
<td>sowthistles</td>
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## PERENNIAL WEEDS

<table>
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<tr>
<th></th>
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<th>GLY</th>
<th>LIN</th>
<th>MET</th>
<th>OXY</th>
<th>PEL</th>
<th>PRM</th>
<th>SET</th>
<th>TRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>nutsedge, yellow</td>
<td>N</td>
<td>C</td>
<td>N</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>N</td>
<td>—</td>
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</tr>
</tbody>
</table>

BSL = bensulide (Prefar)
CAR = carfentrazone (Shark)
CLE = clethodim (Select Max)
GLY = glyphosate (Roundup, Touchdown)
LIN = linuron (Lorox)
MET = s-melolachlor (Dual Magnum)
OXY = oxyfluorfen (Goal)
PEL = pelargonic acid (Scythe)
PRM = prometryn (Prometryn)
SET = sethoxydim (Poast)
TRI = trifluralin (Treflan)

C = control
P = partial control
N = no control
— = no information
## HERBICIDE TREATMENT TABLE (6/09)

<table>
<thead>
<tr>
<th>Herbicide (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>BEFORE PLANTING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. TRIFLURALIN (Treflan) HFP</td>
<td>0.5–1 lb a.i.</td>
<td>1–2 pt</td>
<td>12</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 3</td>
<td></td>
<td></td>
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<tr>
<td>COMMENTS: Preplant incorporate 2–3 inches deep. Use high rate on clay soils.</td>
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<tr>
<td>B. GLYPHOSATE (Roundup)</td>
<td>2 lb a.i.</td>
<td>1.45 qt</td>
<td>4</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td></td>
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</tr>
<tr>
<td>. . . or . . . (Touchdown)</td>
<td>0.9375 lb a.i.</td>
<td>1.25 qt</td>
<td>12</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 9</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>COMMENTS: Apply to seedling weeds before seeding or before celery emergence.</td>
<td></td>
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</tr>
<tr>
<td>C. OXYFLUORFEN (Goal) 2XL</td>
<td>0.25–0.5 lb a.i.</td>
<td>1–2 pt</td>
<td>24</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 14</td>
<td></td>
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<tr>
<td>COMMENTS: Apply to fallow beds at least 30 days before transplanting. After application, thoroughly work the fallow beds to a depth of at least 2.5 inches before planting.</td>
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<td></td>
</tr>
<tr>
<td>D. PELARGONIC ACID (Scythe)</td>
<td>Label rates</td>
<td>12</td>
<td>NA</td>
</tr>
<tr>
<td>MODE OF ACTION: Unknown.</td>
<td></td>
<td></td>
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<tr>
<td><strong>BEFORE TRANSPLANTING</strong></td>
<td></td>
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</tr>
<tr>
<td>A. PROMETRYN 4L</td>
<td>1–2 lb a.i.</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 5</td>
<td></td>
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<tr>
<td>COMMENTS: Apply only 1 application in a minimum of 20 gal water/acre during the 2- to 6-week period before transplanting. Application may be made over the celery. Apply before weeds are 2 inches tall. On coarse-textured soils and low organic matter soils, make one application of 2–4 pt/acre. On fine-textured soils, use 3.2–4 pt/acre. Make the application up to 21 days before transplanting. Note: A post-transplant application is not allowed if the pre-transplant application was made at the maximum allowable use rate of 4 pt/acre.</td>
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<tr>
<td>B. BENSULIDE (Prefar) 4-E</td>
<td>5–6 lb a.i.</td>
<td>5–6 qt</td>
<td>12</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 8</td>
<td></td>
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</tr>
<tr>
<td>C. S-METOLACHLOR (Dual Magnum 7.63)</td>
<td>0.64–1.27 lb a.i.</td>
<td>24</td>
<td>62</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 15</td>
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<tr>
<td>COMMENTS: Apply as a preplant surface applied or preplant incorporated application before transplanting. It can also be applied post-transplant as a directed spray or as a broadcast postemergent application. Rate applied depends on the texture of the soil with lower rates applied to coarse-textured soils and higher rates to finer-textured soils. Multiple applications are allowed but the season total cannot exceed 2 pt/acre.</td>
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<tr>
<td><strong>AT PLANTING (DIRECT-SEEDED)</strong></td>
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</tr>
<tr>
<td>A. PROMETRYN 4L</td>
<td>1.2–1.6 lb a.i.</td>
<td>24</td>
<td>NA</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 5</td>
<td></td>
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<tr>
<td>COMMENTS: Apply after seeding. Sprinkler irrigate within 48 hours. Apply at least 1 inch of water. Do not use on sand or loamy sand.</td>
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</tr>
<tr>
<td>B. BENSULIDE (Prefar) 4-E</td>
<td>5–6 lb a.i.</td>
<td>5–6 qt</td>
<td>12</td>
</tr>
<tr>
<td>WSSA MODE OF ACTION GROUP NUMBER: 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide (trade name)</td>
<td>Amount/Acre</td>
<td>R.E.I.+ (hours)</td>
<td>P.H.I.+ (days)</td>
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<tr>
<td>------------------------</td>
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</tr>
<tr>
<td><strong>AFTER PLANTING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. PROMETRYN 4L</td>
<td>1–2 lb a.i.</td>
<td>24</td>
<td>45</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 5</td>
<td></td>
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<tr>
<td><strong>COMMENTS:</strong> For transplanted celery; apply during the 2- to 6-week period after transplanting. Actual dosage will depend on soil texture; use lower rate on coarse-textured soils. DO NOT USE SURFACTANT. Apply before weeds are 2 inches tall. May cause detectable plant injury if warm weather follows application, but celery usually outgrows the injury without a significant reduction in yield or quality.</td>
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<tr>
<td>B. LINURON (Lorox) DF</td>
<td>0.75–1 lb a.i.</td>
<td>1.5–2 lb</td>
<td>24</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 7</td>
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<tr>
<td><strong>COMMENTS:</strong> Use only on transplants; do not use after celery is 8 inches high. Do not apply in less than 20 gal water/acre by ground. Rate is determined by the size of the weed and soil type. With younger weeds lower rate may be used. May cause detectable plant injury if warm weather follows application, but celery usually outgrows the injury without a significant reduction in yield or quality.</td>
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<tr>
<td>C. SETHOXYDIM (Poast)</td>
<td>0.1875–0.28 lb a.i.</td>
<td>1–1.5 pt</td>
<td>12</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 1</td>
<td></td>
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<tr>
<td><strong>COMMENTS:</strong> Apply when celery has at least 2 true leaves. Use an approved oil concentrate at 2 pt/acre.</td>
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<tr>
<td>D. CLETHODIM (Select Max)</td>
<td>0.09093–0.12125 lb a.i.</td>
<td>12–16 fl oz</td>
<td>24</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 1</td>
<td></td>
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<tr>
<td><strong>COMMENTS:</strong> Use an approved crop oil concentrate at 1% (volume by volume).</td>
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<tr>
<td>E. CARFENTRAZONE (Shark)</td>
<td>0.00742–0.031 lb a.i.</td>
<td>0.5–2 fl oz</td>
<td>12</td>
</tr>
<tr>
<td><strong>WSSA MODE OF ACTION GROUP NUMBER:</strong> 14</td>
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<tr>
<td><strong>COMMENTS:</strong> May be applied to the furrows between the rows using a hooded sprayer. Do not apply more than 6.1 oz/acre (0.096 lb a.i./acre) per crop season. Weed should be less than 4 inches tall and rosettes less than 3 inches across. Care must be taken to avoid contact with the crop. A spray adjuvant such as nonionic surfactant, methylated seed oil, or crop oil concentrate is required.</td>
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</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.

NA Not applicable.
PRECAUTIONS FOR USING PESTICIDES

Pesticides are poisonous and must be used with caution. READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER.

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

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

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

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

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

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

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

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

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

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

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

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

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