UC IPM
Pest Management Guidelines:
ALFALFA

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

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

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The UC IPM Pest Management Guidelines are available from:

- Online: http://www.ipm.ucdavis.edu
- UC Cooperative Extension County Offices
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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.

To be used with UC ANR Publication 3312, *Integrated Pest Management for Alfalfa Hay*

www.ipm.ucdavis.edu

Alfalfa Year-Round IPM Program *(Reviewed 8/07)*

ANNUAL CHECKLIST

Supplement to UC IPM Pest Management Guidelines: Alfalfa

These practices are recommended for a monitoring-based IPM program that reduces water quality problems related to pesticide use. Track your progress through the year using this form. Water quality becomes impaired when pesticides move off-site and into water. Each time a pesticide application is considered, review the Pesticide Application Checklist at the bottom of this form for information on how to minimize water quality problems.

This year-round IPM program applies to fall planted alfalfa hay in Sacramento or the San Joaquin Valley. Contact your farm advisor for IPM practices specific to alfalfa in your location or to seed alfalfa. Details on carrying out each practice, information on additional pests, and additional copies of this form are available from the UC IPM Pest Management Guidelines: Alfalfa at http://www.ipm.ucdavis.edu/PMG. Stand establishment is the most critical single factor affecting successful IPM strategies in alfalfa. Follow the practices below to establish and maintain healthy vigorous stand that resists pest problems.

PLANTING TO STAND ESTABLISHMENT

✓ Done	**Preplanting** **Special issues of concern related to water quality:** drift, runoff due to rain.
	Select your field, considering: • Pest history, especially weeds. • Current crops and pest problems. • Surrounding crops and vegetation. • *Sclerotinia* in neighboring mature fields. • Stem and crown rot (white mold). • Soil conditions.
	Prepare the field for planting by taking into account potential for drainage and run-off problems.
	Manage weeds with preplant herbicides if necessary.
	Consider crop rotation to minimize, weeds, diseases and nematodes.
	Select varieties that are tolerant or resistant to known problem pests.
	Select seeds, considering: • Use of weed free certified alfalfa seed. • Seed treatment for suspected field pathogens or if planting at suboptimal time. • *Rhizobium* treatment if alfalfa has not grown in the field for the last 5 to 10 (or more) years.

✓ Done	**Stand establishment** **Special issues of concern related to water quality:** drift, runoff due to rain, irrigation.
	Plant seed, following proper timing, depth, and seedling rates. • Plant in early fall for best results. • Plant 1/4" deep, depending on soil type. • Use a higher seed rate for organic production.
	Consider interplanting oats to: • Reduce weed competition. • Increase the first forage yield. • Reduce erosion.
	Survey weeds when the crop germinates. • Keep records on a weed survey form. • Treat** with postemergent herbicide, if needed according to PMG.
	Watch for seedling pests.

✓ Done	**Stand establishment** **Special issues of concern related to water quality:** drift, runoff due to rain, irrigation.
	• Damping off and other seedling diseases • Sclerotinia stem and crown rot (white mold) • Downy mildew • Aphids • Cutworms • Garden symphylans Keep records on a map of the field.

✓ Done	**Growth to first cutting** **Special issues of concern related to water quality:** drift, runoff due to rain, irrigation.
	Look for signs of weevils, such as chewed leaves. • Treat** if needed according to PMG.
	Monitor aphids and their natural enemies. • Keep records on an aphid monitoring form. • Manage if needed according to PMGs.
	Check soil moisture.
	Survey weeds to plan weed management strategy. • Keep records on a weed survey form. • Treat with postemergent herbicide, if needed according to PMG.
	Time first cutting carefully to maintain stand vigor. • Make sure rooting depth is at least 14 inches and the crown is formed. • Check soil moisture status considering compaction by heavy equipment.
	Identify other diseases you may see. • Sclerotinia • Downy mildew • Common leaf spot

ESTABLISHED STANDS

✓ Done	**Winter** **Special issues of concern related to water quality:** drift, runoff due to rain.
	Survey winter weeds in December through January. • Keep records on a winter weed survey form.
	Determine weed management strategy based on last year's weed population and consider: • Overseeding with grasses or legumes during the last year of the stand. • Grazing or cultivating with a spring-toothed harrow. • Applying herbicide**.
	Begin to monitor for cowpea aphid in late February.
	Monitor for weevils: • Look for damage such as chewed leaves or take sweep net samples. • Keep records on a weevil monitoring form. • Manage if needed according to PMG.
	Look for signs of vertebrates.

✓ Done	Spring

	Time harvests by evaluating:
	• Alfalfa growth, vigor and quality
	• Pest problems including:
	  ◦ Weevils
	  ◦ Aphids
	  ◦ Leaf and stem diseases
	• Irrigation and wheel traffic
	Consider border-strip harvesting to conserve natural enemies.

	Determine appropriate weed management strategies based on last summer's weed populations. Note any special problem weeds such as: • Grasses • Nutsedge • Dodder Manage if needed according to PMGs.
	Look for signs of vertebrates.
	Monitor weevils. Consider early harvest if Egyptian alfalfa weevil is a problem in your field. • Keep records on a weevil monitoring form. • Manage if needed according to PMG.
	Monitor aphids and their natural enemies. • Consider border or strip harvest to preserve natural enemies. • Keep records on an aphid monitoring form. Manage if needed according to PMG.
	Look for cutworms if damage is apparent. • Manage if needed according to PMG.
	If you see thrips, no treatment is needed.
	Watch for signs of diseases and nematodes.
	Consider field sanitation: • Harvest disease- and nematode-free fields before infested fields. • Avoid moving contaminated farm machinery or livestock from a field infested with nematodes or disease to a clean field.

✓ Done	Summer
	Time harvests by evaluating: • Alfalfa growth, vigor and quality • Pest problems • Irrigation and wheel traffic
	Survey weeds, especially weedy grasses. • Keep records on a weed survey form for next spring's weed management decisions.
	Monitor cowpea and spotted alfalfa aphids. • Consider border or strip harvest to preserve natural enemies. • Keep records on a monitoring form. Manage if needed according to PMG.
	Monitor caterpillars and armyworms. Consider early harvest to reduce losses. • Keep records on a caterpillar monitoring form. • Manage if needed according to PMGs.

✓ Done	Summer
	Monitor for leafhoppers at the first sign of damage. Consider early harvest to reduce losses. • Keep records on a monitoring form. • Manage if needed according to PMG.
	Look for cutworms if damage is apparent. Manage if needed according to PMG.
	Watch for signs of diseases and disorders.
	Keep records of other invertebrates.
	Consider field sanitation: • Harvest disease- and nematode-free fields before infested fields. • Avoid moving contaminated farm machinery or livestock from a field infested with nematodes or disease to a clean field.

✓ Done	Fall
	Time harvests by evaluating pest problems.
	Survey weeds in September just after the alfalfa is cut. • Keep records on a monitoring form.
	Monitor aphids and their natural enemies. • Keep records on a monitoring form. • Manage if needed according to PMG.
	Monitor caterpillars. Consider early harvest to reduce losses. • Keep records on a monitoring form. • Manage if needed according to PMG.
	Consider field sanitation: • Harvest disease- and nematode-free fields before infested fields. • Avoid moving contaminated farm machinery or livestock from a field infested with nematodes or disease to a clean field.

✓ Done	Pesticide application checklist When planning for possible pesticide applications in an IPM program, consult the Pest Management Guidelines, and review and complete this checklist to consider practices that minimize environmental and efficacy problems.
	✓ Choose a pesticide from the Pest Management Guidelines for the target pest, considering:
	• Impact on natural enemies and pollinators. For more information see Protecting Natural Enemies and Pollinators at http://www.ipm.ucdavis.edu/mitigation/protect_beneficials.html.
	• Potential for water quality problems using the UC IPM WaterTox database.See www.ipm.ucdavis.edu/TOX/simplewatertox.html.
	• Impact on aquatic invertebrates. For more information, see *Pesticide Choice*, UC ANR Publication 8161 (PDF), http://anrcatalog.ucdavis.edu/pdf/8161.pdf.
	• Chemical mode of action, if pesticide resistance is an issue. For more information, see *Herbicide Resistance: Definition and Management Strategies*, UC ANR Publication 8012 (PDF), http://anrcatalog.ucdavis.edu/pdf/8012.pdf.
	• Endangered species that may be near your site. Find out using the Department of Pesticide Regulation's PRESCRIBE program. (http://www.cdpr.ca.gov/docs/endspec/prescint.htm)

✓ Done	Pesticide application checklist
	✓ Before an application
	Ensure that spray equipment is properly calibrated to deliver the desired pesticide amount for optimal coverage. (See www.ipm.ucdavis.edu/training/incorporating-calibration.html)
	Use appropriate spray nozzles and pressure to minimize off-site movement of pesticides.
	Avoid spraying during these conditions to avoid off-site movement of pesticides. • Wind speed over 5 mph • Temperature inversions • Just prior to rain or irrigation (unless it is an appropriate amount, such as when incorporating a soil-applied pesticide) • At tractor speeds over 2 mph
	Identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding your application site.
	Review and follow labeling for pesticide handling, personal protection equipment (PPE) requirements, storage, and disposal guidelines.
	Check and follow restricted entry intervals (REI) and preharvest intervals (PHI).
	✓ After an application
	Record application date, product used, rate, and location of application.
	Follow up to confirm that treatment was effective.
	✓ Consider water management practices that reduce pesticide movement off-site.
	Consult relevant publications • *Reducing Runoff from Irrigated Lands: Orchard Floor Management Practices to Reduce Erosion and Protect Water Quality*, UC ANR Publication 8202 (PDF), http://anrcatalog.ucdavis.edu/pdf/8202.pdf. • *Reducing Runoff from Irrigated Lands: Causes and Management of Runoff from Surface Irrigation in Orchards,* UC ANR Publication 8214 (PDF), http://anrcatalog.ucdavis.edu/pdf/8214.pdf. • *Protecting Surface Water from Sediment-Associated Pesticides in Furrow-Irrigated Crops*, UC ANR Publication 8403 (PDF), http://anrcatalog.ucdavis.edu/pdf/8403.pdf.
	Consult the Department of Pesticide Regulation Groundwater Protection Program (GWPA) Web site for pesticide information and mitigation measures. (http://www.cdpr.ca.gov)
	Install an irrigation recirculation or storage and reuse system. Redesign inlets into tailwater ditches to reduce erosion.
	Use drip rather than sprinkler or flood irrigation.
	Limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET). (For more information, see *Reducing Runoff from Irrigated Lands: Understanding Your Orchard's Water Requirements*, UC ANR Publication 8212 (PDF), http://anrcatalog.ucdavis.edu/pdf/8212.pdf.)
	Consider using cover crops.
	Consider vegetative filter strips or ditches. (For more information, see *Vegetative Filter Strips,* UC ANR Publication 8195 (PDF), http://anrcatalog.ucdavis.edu/pdf/8195.pdf.)
	Apply polyacrylamides in furrow and sprinkler irrigation systems to prevent off-site movement of sediments.
	Redesign inlets and outlets into tailwater ditches to reduce erosion. (For more information, see *Reducing Runoff from Irrigated Lands: Tailwater Return Systems*, http://anrcatalog.ucdavis.edu/pdf/8225.pdf.)

✓ Done	Pesticide application checklist
	✓ Consider practices that reduce air quality problems.
	When possible, reduce volatile organic compound (VOC) emissions by decreasing the amount of pesticide applied, choosing low-emission management methods, and avoiding fumigants and emulsifiable concentrate (EC) formulations.
	Use the Department of Pesticide Regulation calculators to determine VOC emission rates from fumigant and nonfumigant pesticides. (http://www.cdpr.ca.gov)

More information about topics mentioned on this checklist is available at the UC IPM Web site: http://www.ipm.ucdavis.edu/PMG/selectnewpest.cherry.html.

For more about mitigating the effects of pesticides, see the Mitigation pages: www.ipm.ucdavis.edu/mitigation/.

General Information

(Section reviewed 11/06)

INTEGRATED PEST MANAGEMENT (11/06)

Integrated pest management uses a combination of compatible methods to prevent and manage pest outbreaks. In alfalfa hay production, common methods include biological control, modifications of cutting schedules, the use of strip or border cutting, resistant varieties, and pesticides when required. A list of alfalfa varieties and the pests to which they are resistant, including insects, diseases, and nematodes is available online from the National Alfalfa Alliance at http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf. Additionally, a yearly alfalfa variety report can be found at http://alfalfa.ucdavis.edu.

Proper identification of insect pests and natural enemy species is essential. Many insect species, particularly in the immature stages, are similar in appearance and may be easily confused with each other. For example, lygus nymphs may be confused with big-eyed bug nymphs, which are predators. Pea aphid and blue alfalfa aphid are similar in appearance and can easily be mistaken for each other. Because economic treatment thresholds are different for specific pest species, improper identification can lead to improper management decisions. Likewise, failure to properly identify natural enemy species may lead to unnecessary pesticide applications if predator or parasite populations are sufficient to maintain pest numbers below economic treatment levels.

When pesticide intervention becomes necessary, it is important that the proper chemical, rate, and application method be used. The selected chemical should be easy on natural enemy species and honey bees while maximizing control of the pest. Selection of an insecticide product for an application depends on several factors including proper registration status, activity on the pest to be controlled, preharvest interval, cost, length of residual control of the pest, and selectivity to natural enemies.

Use the online year-round IPM program for guidance in carrying out a comprehensive IPM program for alfalfa hay.

SELECTING THE FIELD (11/06)

Choose fields carefully for alfalfa planting. A field's cropping history is important; alfalfa planted in fields with poor nutrient balance or infested with alfalfa pests, especially weeds, will suffer yield loss.

Identify the crops and vegetation surrounding your alfalfa fields. For example, do they harbor pathogens such as *Sclerotinia*. Carefully planned cultural practices, including altering planting dates, can reduce losses to certain pests.

Use the information below when selecting fields for alfalfa planting.

SITE CROPPING HISTORY

- Identify previous crops that are known hosts to alfalfa pests.

CURRENT PESTS

Monitor and evaluate alfalfa pest infestations in the field or neighboring mature alfalfa fields.

- **Weeds**. For sites with high populations of weeds not controlled by herbicides labeled for alfalfa, consider rotating to another crop for easier management.
- **Sclerotinia**. Avoid by planting in February for infestations on site or in neighboring mature alfalfa fields.
- **Weevils**. Check for weevils in neighboring fall-planted alfalfa fields.
- **Stem nematode**.

ALFALFA VARIETIES

- Evaluate yield and quality of past alfalfa varieties grown on this site.
- Evaluate suitable varieties currently available.

LAND FEATURES

- **Topography.** Uneven fields may require extensive land leveling for proper drainage.
- **Drainage.** Check site for adequate irrigation and tail-water drainage.
- **Water.** Evaluate the quantity and quality of available irrigation water at the site.

CHECK SOIL RECORDS OR PERFORM SOIL ASSAYS

- **Nutrient balance.** Assay for phosphorous and potassium.
- **pH.** A pH of 6.2 to 7.5 is recommended. Lower pH does not support *Rhizobium* growth.
- **Salinity.** Electrical conductivity (EC_e) should be 2.0 mmhos/cm or less.
- **Toxic elements.** Check for excess of boron or sodium.
- **Soil type.** Alfalfa grows successfully on a wide range of soil textures, but sandy loam to clay-loam soils are preferred.
- **Soil depth.** A site should provide a minimum of 3 feet of unrestricted rooting depth.

TRANSGENIC HERBICIDE-TOLERANT ALFALFA (11/06)

Glyphosate-tolerant alfalfa (Roundup-ready alfalfa) is genetically engineered to tolerate over-the-top applications of glyphosate. Roundup-ready alfalfa allows growers a weed management timing option that allows effective control of many difficult-to-control weeds. Glyphosate controls most winter and summer annual weeds associated with alfalfa and suppresses or controls some problematic perennial weeds such as bermudagrass, quackgrass, and dandelion that are not currently well controlled with conventional herbicide systems.

Roundup-ready alfalfa varieties became commercially available in the fall of 2005. At the current time there are only a few Roundup-ready varieties available, especially for non-dormant varieties. However, the number of commercial alfalfa varieties with the glyphosate-resistant trait should increase in coming years.

While glyphosate controls a broader weed spectrum than the conventional herbicides used on alfalfa, it does not have residual control. Therefore, it is important to spray glyphosate after most of the weeds have emerged or the crop canopy is sufficient to out-compete later-emerging weeds. On the other hand, do not delay application so long that weeds become large and difficult-to-control. Generally, the best time to treat seedling alfalfa is when the alfalfa is between the three- and six-trifoliolate leaf stage. The soil is usually bare with earlier applications allowing subsequent weed emergence. With later applications, weeds may be too large for adequate control or with heavy weed infestations, alfalfa stand density or vigor may already be affected. Sometimes it may be necessary to make two applications of glyphosate during alfalfa stand establishment. Glyphosate treatments can be used between cuttings in established alfalfa to control summer annual grasses, such as yellow and green foxtail (*Setaria* spp.) and barnyardgrass (*Echinochloa crus-galli*). The number of applications depends on the geographic area and the infestation level.

WEED RESISTANCE AND WEED SHIFT CONCERNS

Potential for weeds to develop resistance to specific herbicides is always a concern with herbicide programs, but with Roundup-ready alfalfa, weed resistance is of greater concern because of the tendency to use a single herbicide repeatedly for several years.

Glyphosate is an herbicide that controls many weeds, including hard-to-control species. Because many growers may choose to use less expensive herbicides such as glyphosate, a real potential exists for the development of weeds that are resistant to it. Researchers in California have already identified and confirmed glyphosate-resistant ryegrass *(Lolium rigidum)* and horseweed (*Conyza* spp.) and other weeds are becoming more difficult to control.

A weed shift is another potential outcome of relying on a single herbicide or control strategy to manage weeds. A weed shift occurs when populations of tolerant weed species increase. While glyphosate controls most weeds, there are some tolerant species including cheeseweed (*Malva parviflora*), burning nettle (*Urtica urens*), filaree (*Erodium* spp.), and purslane (*Portulaca oleracea*). The prevalence of these weeds and others may increase if glyphosate alone is used repeatedly.

No matter which type of production system is used (standard or Roundup-ready varieties) a well-balanced, long-term weed management approach will incorporate resistance management strategies, including crop rotation, rotation of herbicides that have different mode of action group numbers, and control of escaped weeds by tillage or hand removal in order to delay or prevent development of resistant weeds or significant weed shifts.

Take the following factors into consideration when making a decision whether or not to use Roundup-ready varieties:

- What are the dominant weed species present (annual vs. perennial) and how are they controlled with conventional herbicides versus glyphosate?
- What is the density and extent of the perennial weed infestation?
- Is the price of the seed cost effective?
- Is the information regarding the agronomic suitability of the transgenic variety adequate for your area?
- Are your buyers willing to accept transgenic alfalfa?

BIOLOGICAL CONTROL (11/06)

Alfalfa is an important reservoir for natural enemies of insect pests. These natural enemy populations often develop in alfalfa fields and expand into other plantings such as cotton, melons, and beans.

Several species of **predaceous bugs** are found in alfalfa including assassin bugs, bigeyed bugs, damsel bugs and minute pirate bugs. Other predators found in alfalfa are lady beetles, collops beetles, lacewings, syrphid flies, and spiders. These predators feed on a variety of pests such as alfalfa weevil larvae, aphids, alfalfa caterpillars, beet armyworm, western yellowstriped armyworm, webworms, leafhoppers, and three-cornered alfalfa hopper.

Several species of **parasitic wasps** are found in alfalfa: *Hyposoter exigua* is a parasite of beet armyworm and western yellowstriped armyworm, *Cotesia (Apanteles) medicaginis* is a parasite of alfalfa caterpillars, and *Trichogramma* spp. are egg parasites of various caterpillar pests. Parasitic wasps that attack aphids in alfalfa include *Aphidius* spp., *Diaeretiella* spp., and *Lysiphlebus* spp. *Bathyplectes curculionis* is an important parasite of the alfalfa weevil. Do not treat alfalfa with insecticides until the economic treatment level for a specific pest has been reached and the predator and parasite populations have been assessed for their potential role in controlling the pest. Insecticides often destroy beneficial insects, leading to severe secondary pest outbreaks. See RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN ALFALFA TO NATURAL ENEMIES AND HONEY BEES to find out which pesticides are most compatible with natural enemies.

Birds are important predators of insect pests in desert alfalfa. Egrets, ibis, and gulls feed on crickets, cutworms, and other insects forced to move at the leading edge of flood irrigation water. Blackbirds eat alfalfa weevil larvae, aphids, cutworms, and other insect pests.

NATURAL ENEMIES AND THEIR COMMON PREY IN ALFALFA

Scientific Name	Common Name	Prey
PARASITIC WASPS		
Anaphes sp.		Lygus egg
Aphidius spp.		Aphids
Bathyplectes curculionis, *B. anurus*		Alfalfa weevil and Egyptian alfalfa weevil larvae
Cotesia (=Apanteles) medicaginis		Alfalfa caterpillar
Hyposoter exiguae		Beet armyworm and western yellowstriped armyworm
Trichogramma spp.		Caterpillar eggs
PREDATORS		
Chrysoperla sp., *Chrysopa* sp. and others	Lacewings	Aphids and small caterpillars
Coccinella septempunctata, *Coccinella* spp.	Sevenspotted lady beetle	Aphids and whitefly
Collops spp.	Collops beetles	Various small insects
Geocoris spp.	Bigeyed bugs	Aphids and small caterpillars
Hippodamia convergens	Convergent lady beetle	Aphids and whitefly
Nabis spp.	Damsel bugs	Caterpillars and other insects
Orius spp.	Minute pirate bugs	Aphids and small caterpillars
Scolothrips sexmaculatus	Sixspotted thrips	Various small insects, eggs, and mites
Various species	Spiders	Caterpillars and other insects
Zelus spp., *Sinea* spp.	Assassin bugs	Caterpillars and other insects

SAMPLING WITH A SWEEP NET (11/06)

Sampling with a sweep net is a common practice for many alfalfa pests when alfalfa plants are at least 6- to 10-inches tall. (For shorter regrowth, do not rely on sweep net sampling to determine population levels). Sweep net sampling is also used for estimating lady beetle populations. A 15-inch diameter sweep net is the standard sampling tool used in alfalfa. The manner in which this sweep net is used can greatly influence its effectiveness for collecting insects in alfalfa and, consequently, treatment decisions based on the number of insects caught. Therefore, standard methods have been developed for sampling so results from different individuals are comparable.

To use a sweep net, swing it in a 180º arc such that the net rim strikes the top 6 to 8 inches of alfalfa growth. Hold the net slightly less than vertical so the bottom edge strikes the alfalfa before the top edge. This will facilitate getting the insects into the net. Each 180º arc counts as one sweep. A common practice is to take a sweep from right to left, walk a step, and take another sweep, left to right.

After taking the desired 5 sweeps, quickly pull the net through the air to force all insects into the bottom of the net bag and grasp the net bag with a hand at about the mid-point. Slowly invert the net bag while releasing your grasp on the bag allowing the insects to escape and count the numbers of key species. Many slow-moving insects, such as weevil larvae, aphids, and caterpillars can be counted by turning the net onto a white pan or even the hood of a vehicle. Divide totals by 5 to get the average number of insects per sweep. To get a good representation of insect numbers in the alfalfa field, take sweep net samples in four different areas of the field.

If the numbers are so large that counting in the field is difficult, the bag contents can be placed into a plastic or paper bag and the counting done after cooling the sample to slow down the insect movement. Pest management decisions, however, are generally made before such high numbers occur. Collect samples from all portions of the field but avoid unusual parts of the field, such as field edges. The exception to this is when sampling leafhoppers, which tend to be concentrated initially on the field margins. The table below details specific sweeping guidelines for each pest.

GUIDELINES FOR SWEEP NET SAMPLING

	Alfalfa caterpillars and armyworms	Egyptian alfalfa weevil and alfalfa weevil	Leafhoppers
When to start	In early summer (June) when plants reach adequate height.	In early January or later, depending on location. Sweep fields after weevil larvae appear (as evidenced by chewed leaves). (If plants are too short to sweep, monitor terminals for damage.)	In July to August at the first sign of injury (wedge-shaped leaf burn at the tip of leaves).
How often	Twice a week	Twice a week	Weekly until numbers approach the threshold.
Divide field	4 sections; 5 sweeps per section (20 sweeps total)	4 sections; 5 sweeps per section (20 sweeps total)	4 to 6 sections; 10 sweeps per section
Special instructions	Identify type of caterpillar. Count armyworms 0.5 inch or longer. Record the number of healthy and parasitized (pull apart caterpillars and look for a parasite larva) Keep records on monitoring form (*available online)*.	Continue to monitor weekly during spring or after a treatment: *Central Valley* through June *Southern deserts* until March *Intermountain areas* until mid-June. Keep records on monitoring form (*available online)*.	Count number of adults and nymphs. Be sure to include field edges when sampling. Keep records on monitoring form*(available online)*.

	Alfalfa caterpillars and armyworms	Egyptian alfalfa weevil and alfalfa weevil	Leafhoppers
Treatment thresholds	If cutting is not scheduled soon after monitoring, treat when there is an average of: 10 or more nonparasitized alfalfa caterpillars per sweep 15 or more nonparasitized armyworms per sweep or 10 or more per sweep of both species that are nonparasitized	For sweep net sampling, treat when weevil larval count reaches an average of 20 larvae per sweep.	If alfalfa is 2 or more weeks from harvest, apply treatments if counts reach 5 leafhoppers per sweep (adults and nymphs). For fields scheduled to be harvested in 10 days to 2 weeks, treat if counts reach 10 leafhoppers per sweep.

CROP ROTATION (11/06)

Avoid planting alfalfa directly into a field from which an alfalfa crop was recently removed. Rotation to a nonhost crop can significantly reduce pest populations in the field. The table below provides information on nonhost crops that suppress alfalfa-associated nematode and pathogen populations. Also included are a list of crops in which herbicides that are not registered for use in alfalfa can be used to manage weeds.

If your field is infested with stem nematode or pathogens listed in the key below, consider choosing a nonhost crop from the table. Although 3- to 4-year nonhost crop rotations are ideal, they are not commonly practiced. A rotation of lesser duration is still beneficial but to a lesser degree.

For winter weed control, choose a wheat or oat crop rotation and an herbicide treatment. Manage summer weeds by growing a corn rotation and using selective herbicides and cultivations. For fall plantings, rotate to another crop to manage established weeds such as nutsedge, bermudagrass, or burclover because they are not effectively controlled with herbicides used in conventional alfalfa.

Volunteer alfalfa around the field edges of a rotation crop may perpetuate nematode populations. If your field has a history of nematodes, be sure to remove all volunteer alfalfa.

	Rotation Information
Root knot nematode	1 year rotation with cotton.
Stem nematode	3-4 year rotation with small grains, beans, cotton, corn, sorghum, lettuce, carrots, tomatoes, or forage grasses[1].
Diseases: Bacterial wilt Anthracnose Spring blackstem Common leafspot Stagonospora	3-4 year rotation with small grains, beans, corn, sorghum, forage grasses[1].
	A minimum of 1 year (preferably longer) in crops such as small grains, wheat, oats, winter forage grasses that allow the use of selective herbicides that are not registered in alfalfa.
	A minimum of 1 year (preferably longer) in crops such as small grains, beans, cotton, corn, sorghum, summer forage grasses that allow the use of selective herbicides that are not registered in alfalfa.
SPECIAL WEEDS	
Dodder	At least 2 years with cotton or other nonhost crops such as small grains, beans, corn, sorghum, or forage grasses. Avoid rotations with crops such as tomatoes, onions, and carrots that also serve as a host for this weed.
Nutsedge	Two-year rotation with corn or sorghum rotation that includes application of herbicide to control nutsedge.

1 Three- to four-year rotations give satisfactory results. A rotation for fewer years will give some suppression.

APHID MONITORING (9/07)

Using the procedures below, take weekly stem samples for blue alfalfa aphids, pea aphids, cowpea aphids, and natural enemies during stand establishment and in spring- and fall-established stands. Sample for cowpea aphids, spotted alfalfa aphids and natural enemies in summer-established stands. Natural enemies can quickly reduce aphid infestations. As aphid threshold populations are approached, check every 2 to 3 days to determine if natural enemies and disease cause the population numbers to decrease.

See monitoring form with detailed treatment threshold information *(available online).*

HOW TO SAMPLE

(View photos online of aphids)

- Randomly choose 5 stems from each of 4 areas per field, noting if the average plant height is less than 10 inches, 10 to 20 inches, or more than 20 inches.
- Bend each stem sample over a white pan and tap; dislodged aphids will fall in. The stem can also be shaken into a sweep net if a pan is not available.
- Take sweep net samples, see SAMPLING WITH A SWEEP NET), for lady beetle adults and larvae, fungal-killed aphids, parasitized aphid mummies, and the presence of other predators such as syrphid flies and lacewing larvae. Natural enemies can quickly reduce the aphid population.
- Record results on a monitoring form. A treatment may be warranted if natural enemies fail to keep the aphid population in check.

PROCEDURE AND TREATMENT THRESHOLD

Treatment threshold	Stand establishment and established stands (spring and fall)	ESTABLISHED STANDS (SUMMER)
Aphid species	Blue alfalfa, Pea aphids, Cowpea aphid, and natural enemies	Cowpea aphid, spotted alfalfa aphid, and natural enemies
When to start	February during stand establishment	Early summer (June for spotted alfalfa aphid)
How often	Weekly	Weekly
Special instructions	If both blue alfalfa and pea aphid species are present, use the blue alfalfa aphid treatment thresholds. No thresholds are established for aphids on seedling alfalfa.	If only spotted alfalfa aphids are present and reach treatment thresholds, be sure to sweep and compare spotted alfalfa aphids and lady beetles according to the following "Treatment Thresholds" table.
If natural enemies are present	Check the field every 2 to 3 days to see if the aphid population declines. If it does, insecticides may not be necessary.	

TREATMENT THRESHOLDS (# aphids/stem)

Pest	Plants less than 10"	Plants 10-20"	Plants more than 20"	Summer	Spring	After last fall cutting
Pea aphid	40-50	70-80	100+	—	—	—
Blue alfalfa aphid	10-12	40-50	40-50	—	—	—
Cowpea aphid	10-12	40-50	40-50	—	—	—
Spotted alfalfa aphid	—	—	—	40*	20*	50-70

*Do not treat if there are 4 or more adult lady beetles or 3 or more lady beetle larvae per sweep for every 40 aphids counted per stem (on stubble this ratio is 1 larva per sweep to every 50 aphids per stem).

ALFALFA CATERPILLAR and ARMYWORM MONITORING (11/06)

Start sweeping for beet armyworm, western yellowstriped armyworm, and alfalfa caterpillars in the early summer (late May or June, as soon as you see caterpillars in the field) and continue through early fall. Large numbers of yellow and white butterflies during late spring or summer is a warning sign that alfalfa caterpillar populations may be increasing. See SAMPLING WITH A SWEEP NET for more details on sweeping.

Use a monitoring form with treatment thresholds to record observations *(available in the online version of this guideline).*

HOW TO MONITOR

(*View photos to identify caterpillars in the online version of this guideline*)
Take a weekly sweep net sample in fields that have adequate plant height to monitor for beet armyworm, western yellowstriped armyworm, and alfalfa caterpillars. Divide each field into 4 sections and take 5 sweeps per area with a 15-inch diameter sweep net, for a total of 20 sweeps.

Identify, count, and record the number of healthy and parasitized caterpillars caught in your sweep net and divide that total by the number of sweeps taken. Record the average number per sweep on a monitoring form. To determine if caterpillars are parasitized, pull young worms (at least 0.5 inch long) apart to see if white or green parasitic wasp larvae pop out. Base your population estimates on the average of all sweeps taken in that field, counting only those armyworms collected in sweeps that are at least 0.5 inches in length.

TREATMENT ACTION THRESHOLD

If cutting is not practical or not scheduled soon after monitoring, treat if there is an average of:

- 10 or more nonparasitized **alfalfa caterpillars** per sweep.
- 15 or more nonparastized **armyworms** per sweep.
- 10 or more combined nonparasitized **alfalfa caterpillars** and **armyworms** per sweep.

BORDER-STRIP HARVESTING (11/06)

Border-strip harvesting involves leaving uncut strips of alfalfa at various intervals across the field. These serve as a refuge for natural enemy species and to retain lygus bugs in the alfalfa where they do no harm, thus keeping them out of neighboring crops such as cotton or beans where they cause significant damage. Research has shown that this practice significantly increases populations of parasites and predators of aphids, caterpillars, and other alfalfa insect pests.

To carry out border-strip harvesting, leave 10 to 14 foot wide uncut strips adjacent to every other irrigation border (or levee). At the subsequent harvest, these strips are cut with half of the alfalfa strip going into one windrow and the other half going into a second windrow to give a 50:50 blend of new and old hay. These windrows are then each combined with a windrow of newly cut (100% new) alfalfa making a blend of 25% old hay and 75% new hay. This technique minimizes quality problems from the older hay. Specific blends of old and new hay have been found not to significantly impact forage quality compared to 100% new growth alfalfa in most cases. Crude protein was not affected in five of nine cuttings (over 2 years) and Acid Detergent Fiber, used to calculate several quality parameters, was not impacted by blends that included 25% or less of old alfalfa.

At the following cutting, uncut strips are left adjacent to the alternate irrigation borders. As an alternative, uncut strips of alfalfa may be left adjacent to the crop to be protected, such as cotton or dry beans.

HARVEST SCHEDULING (7/09)

Alfalfa is harvested more frequently in summer than in spring or fall when growth slows as a result of cooler weather. In California, many growers schedule 28-day harvesting schedules after the first cutting. However, there is considerable evidence that this might not be ideal. Decisions involving harvest timing, cutting height, windrow management, wheel compaction by harvesting equipment, and border harvesting can affect pest problems, as well as yield, quality, and profitability.

Usually, the choice of harvest time represents a compromise between the customer's demands for quality and the grower's desire to maintain high yields and a vigorous stand. The highest quality of alfalfa is low in fiber and high in digestible protein and total digestible nutrients. The best time to harvest alfalfa to maximize quality is from very young vegetative stages to early bud stage. However, cutting at these early growth stages produces low yields and can greatly weaken alfalfa stands; the plant does not have sufficient time to replenish carbohydrate and protein root reserves. Harvesting after the plant has had the opportunity to replenish root reserves increases yields and significantly improves health and competitive ability of the alfalfa stand. The benefits of long cutting schedules are often carried over from season to season.

Although there are clear economic incentives for growers to produce early harvested, high-quality forages, repeated early stage cutting schedules can be devastating to alfalfa persistence, growth, and yield and lead to severe weed infestations. Thus, it is important to allow several 'long' cutting intervals over the year to allow sufficient replenishment of root reserves, to maintain high yields, and for continued health of the stand. It is recommended that growers consider 'staggered' approaches to cutting schedules by alternating 'short' (e.g. 26-day) with 'long' (e.g. 35-day) intervals over the season. Some harvests could be cut early for quality, and a subsequent harvest would be cut late for high yields and stand health. Precise cutting schedules are difficult to recommend because the growth rate of alfalfa depends on location and time of year.

Early harvest may be a good strategy to avoid further damage when alfalfa crop has a high (late) infestation of alfalfa weevil in spring, or Lepidoptera (caterpillar) damage in summer and can help avoid an insect spray. After harvest however, growers need to monitor fields carefully to detect early damage the young shoots, which can be devastating to the following regrowth.

Ideally, the last harvest of the season should be early enough to allow plants enough time to build up reserves before the first frost, although this is not critical in more southern regions where frosts are later or nonexistent. Sufficient canopy coverage is important to suppress winter weeds. However, dense winter canopies can lead to high *Sclerotinia* infestations, and clipping (even late fall clipping) is an important management tool when conditions are right for *Sclerotinia.*

RELATIVE TOXICITIES OF INSECTICIDES and MITICIDES USED IN ALFALFA TO NATURAL ENEMIES and HONEY BEES (7/13)

Common name (example trade name)	Mode of Action[1]	Selectivity[2] (affected groups)	Predatory Mites[3]	General Predators[4]	Parasites[4]	Honey bees[5]	Duration of impact to natural enemies[6]
Bacillus thuringiensis spp. aizawai	11.B1	narrow (caterpillars)	L	L	L	IV	short
Bacillus thuringiensis spp. kurstaki	11.B2	narrow (caterpillars)	L	L	L	IV	short
carbaryl (Sevin)	1A	broad (insects, mites)	L/H	H	H	I	long
chlorantraniliprole (Coragen)	28	narrow (primarily caterpillars)	L	L	L/M	IV	short
chlorpyrifos (Lorsban)	1B	broad (insects, mites)	M	H	H	I	moderate
cyfluthrin (Baythroid, Renounce)	3	broad (insects, mites)	H	H	H	I	moderate
dimethoate	1B	broad (insects, mites)	H	H	H	I	long
flubendiamide (Belt)	28	—	L	L	L/M	I	short
indoxacarb (Steward)	22A	narrow (caterpillars, lygus)	—	L	L	I	moderate
lambda-cyhalothrin (Warrior)	3	broad (plant bugs, beetles, caterpillars)	H	H	H	I	moderate
malathion	1B	broad (insects, mites)	H	H	H	II	moderate
methomyl (Lannate)	1A	broad (insects, mites)	H	H	H	III	moderate
methoxyfenozide (Intrepid)	18	narrow (caterpillars)	L	L	L	IV	short
neem oil (Trilogy)	—	broad (soft-bodied insects)	L	L	L	III	short
permethrin (Pounce, Ambush)	3	broad (insects, mites)	L	H	H	I	long
phosmet (Imidan)	1B	broad (insects, mites)	H	H	H	I	moderate to long
zeta-cypermethrin (Mustang)	3	broad (insects, mites)	H	M	M	I	moderate

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

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent 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 or 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 to blooming plants; II = Apply only during late evening; III = Apply only during late evening, night, or early morning; and IV = Apply at any time withreasonable safety to bees. For more information, see *How to Reduce Bee Poisoning From Pesticides*, Pacific Northwest Extension Publication PNW591.

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

Insects and Mites

(Section reviewed 11/06)

ALFALFA CATERPILLAR (7/13)

DESCRIPTION OF THE PEST

The yellowish-orange or whitish butterflies of the alfalfa caterpillar lay eggs on the new growth of alfalfa that is less than 6 inches tall. Eggs hatch into green caterpillars in 3 to 7 days. Full-grown caterpillars are about 1.5 inches long and are distinguished from other common caterpillars on alfalfa by their velvety green bodies and white lines along their sides.

Caterpillar populations usually result from a flight of butterflies into the field when the alfalfa is less than 6 inches tall. Extremely large numbers of adults migrating between fields are often present from June to September in the Central Valley and from May to October in the Imperial Valley. Factors contributing to economic populations are slow and uneven growth of the crop, lack of parasites, and hot, dry weather. There are four to seven generations per year of alfalfa caterpillar, and each generation is closely synchronized with the hay-cutting cycle so that the caterpillar pupates before cutting occurs.

DAMAGE

Alfalfa caterpillars consume entire leaves. The larger larvae are most destructive. In contrast to armyworms, alfalfa caterpillars do not skeletonize leaves and will consume the midrib.

MANAGEMENT

The most important way to control the alfalfa caterpillar is to use nonselective insecticides against caterpillar pests in summer and preserve and encourage its natural enemies by avoiding unnecessary insecticide applications for aphids or weevils in late spring.

Biological Control

An important parasite of the alfalfa caterpillar is *Cotesia medicaginis*, a dark brown to black wasp about 0.25 inch long. This wasp stings very small alfalfa caterpillars and lays an egg inside. The egg hatches and the wasp larva consumes the body contents of the caterpillar. A parasitized caterpillar dies before it reaches 0.5 inch in length. It is recognized by being lighter in color than normal, somewhat shiny rather than velvety on the surface, and swollen toward the rear. Grasping the caterpillar at each end of the swelling and pulling it apart will expose the shiny, white parasite. It is important to determine the amount of parasitism because the economic threshold takes parasitism into account.

Cultural Control

Border-strip harvesting is a useful method for preserving the natural enemies of both the alfalfa caterpillar and aphids because it helps retain parasite larvae in the field. (For more details, see BORDER-STRIP HARVESTING.) Early harvesting of fields infested with economic levels of alfalfa caterpillars kills a large number of caterpillars, preserves crop yields, and avoids reducing the natural enemy population. Time this cutting to avoid serious damage, yet obtain satisfactory yield.

Organically Acceptable Methods

Biological and cultural controls, as well as sprays of *Bacillus thuringiensis,* are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

(View photos online of caterpillars) In early summer start sweeping fields with adequate plant height 2 to 3 times per week to monitor for caterpillars.

Combine monitoring of alfalfa caterpillars with armyworm monitoring as described in ALFALFA CATERPILLAR AND ARMYWORM MONITORING. Count and record the number of healthy and parasitized caterpillars caught in your sweep net on a monitoring form *(available online)*.

If cutting is not practical or not scheduled soon after monitoring, treat if there is an average of ten or more nonparasitized alfalfa caterpillars per sweep, fifteen or more nonparasitized armyworms per sweep, or 10 or more nonparasitized alfalfa caterpillars and armyworms combined per sweep.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)

The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. BACILLUS THURINGIENSIS ssp. KURSTAKI#
(various products) — Label rates — 4 — 0
MODE OF ACTION GROUP NUMBER[1]: 11
COMMENTS: Bacillus will give satisfactory control of the alfalfa caterpillar, does not affect beneficial species, and leaves no undesirable residue on the hay. Upon ingesting *Bacillus* the caterpillars cease feeding but may remain on plants 3-4 days before dying.

B. FLUBENDIAMIDE
(Belt SC) — 2–4 fl oz — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 28
COMMENTS: A newer material; impact on beneficials not yet determined. Highly toxic to honey bees.

C. INDOXACARB
(Steward EC) — 6.7–11.3 fl oz — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 22A
COMMENTS: Make no more than one application per cutting. Steward EC can be used for alfalfa grown for seed, but seeds cannot be used for sprouts intended for human consumption or livestock feed. All seed must be tagged, "Not for human or animal use.". Do not apply more than 45 fl oz/acre per crop season.

D. METHOXYFENOZIDE
(Intrepid 2F) — Label rates — 4 — 0^{F} $7^{FO/H}$
MODE OF ACTION GROUP NUMBER[1]: 18
COMMENTS: Make no more than one application per cutting. Not for use in alfalfa grown for seed or for sprouts for human consumption. Do not apply more than 32 fl oz/acre per crop season.

E. METHOMYL*
(Lannate 90SP) — 0.5 lb — 48 — 7
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Do not graze or feed livestock for 7 days after application. Do not apply more than 3.6 lb a.i./acre per crop. Do not apply when bees are present.

** See label for dilution rates.

‡ 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 an organically grown crop.

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

F Forage

FO Fodder

H Hay

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

BEET ARMYWORM (7/13)

DESCRIPTION OF THE PEST

The adult beet armyworm is a small, mottled gray- or dusky-winged moth. The moths fly mostly at night but may be seen flying up as you walk through the field.

Females deposit pale greenish or pinkish, striated eggs on the upper side of the alfalfa leaves in small or large masses covered with white cottony material. The eggs hatch in a few days, and the tiny caterpillars begin feeding on the plant. Heavy feeding on the tips of plant stalks can cause flagging as terminal leaves turn white. The smooth-skinned caterpillars become full grown in about 2 to 3 weeks and are about 1.25 inches long. They may be olive green to almost black in color down the middle of the back with a yellow stripe on each side of the body.

Armyworms are common pests in the Central Valley and desert valleys from June through September. There are at least 5 generations per year in the low desert and four in the Central Valley. The final generation may overwinter as large larvae or pupae.

DAMAGE

Armyworms skeletonize foliage, leaving veins largely intact. First and second instar larvae tend to feed in clusters around the egg mass from which they hatch. This frequently causes a tattered appearance to the terminals. This whitish appearance caused by the feeding is known as "whitecaps" and is very visible across a field. As the larvae mature and move to more stems, the areas of "whitecaps" tend to coalesce and the entire field takes on a tattered look.

MANAGEMENT

Populations of armyworms are frequently controlled by natural enemies and are more or less cyclic, occurring in large numbers only every few years. Early harvest, border cutting, and biological control are important components of a management program that will prevent damage from armyworms.

Biological Control

Natural enemies can provide good control of armyworms in many fields. Predators include bigeyed bugs, spiders, minute pirate bugs, damsel bugs, and lacewings. The parasitic wasp, *Hyposoter exiguae,* is the most important of at least 10 parasites attacking this pest. Sample for parasitism by pulling the heads from older caterpillars and squeezing the body contents out toward the head end. *Hyposoter* larvae are a light, translucent green color. Viral diseases of armyworms are also important natural control agents. Diseased caterpillars first appear yellowish and limp. After death they hang from plants as shapeless, dark tubes oozing the disintegrated body contents.

Cultural Control

Border-strip harvesting is a useful method for preserving natural enemies because it helps retain parasite larvae in the field. For more details, see BORDER-STRIP HARVESTING. Early cutting will give satisfactory control if the infestation appears late in the cutting cycle.

Organically Acceptable Methods

Biological and cultural controls, as well as sprays of *Bacillus thuringiensis*, are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

In early summer start sweeping fields with adequate plant height 2 to 3 times per week to monitor for caterpillars and continue through fall. Divide each field into 4 sections and take 5 sweeps per section with a 15-inch diameter sweep net, for a total of 20 sweeps. For information on sampling, see SAMPLING WITH A SWEEP NET.

Combine monitoring of armyworms with monitoring for alfalfa caterpillar as described in ALFALFA CATERPILLAR AND ARMYWORM MONITORING. Count and record the number of healthy and parasitized caterpillars caught in your sweep net on a monitoring form *(available online)*.

If cutting is not practical or not scheduled soon after monitoring, treat if there is an average of ten or more nonparasitized alfalfa caterpillars per sweep, fifteen or more nonparasitized armyworms per sweep, or 10 or more nonparasitized alfalfa caterpillars and armyworms combined per sweep.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)

The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. FLUBENDIAMIDE
(Belt SC) — 2–4 fl oz — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 28
COMMENTS: A newer material; impact on beneficials not yet determined. Highly toxic to honey bees.

B. CHLORANTRANILIPROLE
(Coragen) — 3.5–5 fl oz — 4 — 0
MODE OF ACTION GROUP NUMBER[1]: 28
COMMENTS: Make no more than one application per cutting. Do not apply more than 0.2 lbs a.i./acre per crop of chlorotraniliprole products.

C. INDOXACARB
(Steward EC) — 6.7–11.3 fl oz — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 22A
COMMENTS: Make no more than one application per cutting. Steward EC can be used for alfalfa grown for seed, but seeds cannot be used for sprouts intended for human consumption or livestock feed. All seed must be tagged: "Not for human or animal use.". Do not apply more than 45 fl oz/acre per crop season.

D. METHOXYFENOZIDE
(Intrepid 2F) — Label rates — 4 — 0^{F} $7^{FO/H}$
MODE OF ACTION GROUP NUMBER[1]: 18
COMMENTS: Make no more than one application per cutting. Not for use in alfalfa grown for seed or for sprouts for human consumption. Do not apply more than 32 fl oz/acre per crop season.

E. METHOMYL*
(Lannate 90SP) — 0.5 lb — 48 — 7
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Do not graze or feed livestock for 7 days after application. Do not apply more than 3.6 lb a.i./acre per crop. Do not apply when bees are present.

F. BACILLUS THURINGIENSIS ssp. AIZAWAI#
(Xentari, Agree) — Label rates — 4 — 0
MODE OF ACTION GROUP NUMBER[1]: 11
COMMENTS: Apply when larvae are small (in first or second instar). Does not harm beneficial insects. Repeat treatment as necessary.

** See label for dilution rates.

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

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

\# Acceptable for use on an organically grown crop.

F Forage

FO Fodder

H Hay

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

BLISTER BEETLES (11/06)

Scientific Name: *Epicauta* spp., *Lytta* spp.

DESCRIPTION OF THE PESTS

Blister beetles are narrow and elongate and the covering over the wings is soft and flexible. They may be solid colored (black or gray) or striped (usually orange or yellow and black) and are among the largest beetles likely to be found in a sweep net sample in alfalfa.

DAMAGE

Blister beetles do not cause widespread feeding damage to alfalfa, however, they contain a chemical, cantharidin, that is toxic to livestock. Cantharidin is contained in the hemolymph (blood) of the beetles and may contaminate forage directly when beetles killed during harvest are incorporated into baled hay or indirectly by transfer of the hemolymph from crushed beetles onto forage. As the name implies, handling these insects may result in blisters, similar to a burn, on the hands or fingers. Blister beetles have been a serious problem in alfalfa in the northern United States, the Midwest, and the south for many years, but until recently have not been a problem in California.

Alfalfa contaminated with blister beetles in the southern Owens Valley has been linked to the death of several dairy cows. At this point, it is not known if blister beetles are widespread or confined to the Owens Valley. Likewise, it is not known if the problem is likely to spread and hence become a common occurrence in California alfalfa. In the meantime, growers and PCAs are advised to be on the lookout for blister beetles and to contact their farm advisor for advice if these insects are found.

MANAGEMENT

There are no known predators or parasites that effectively control blister beetles. Blister beetles are attracted to blooming alfalfa. Therefore, to reduce the incidence of blister beetles in alfalfa, cut hay before bloom. If beetles are found, remove the conditioner wheels from the swather in order to prevent crushing beetles. Also, these beetles are found on the edge of the field or congregated in groups within the field. Skip such areas when cutting or pick up the bales for these areas separately and isolate them from the rest of the field. No treatment thresholds have been established for blister beetles.

BLUE ALFALFA APHID and PEA APHID (4/08)

Scientific Names: Blue alfalfa aphid: *Acyrthosiphon kondoi*
Pea aphid: *Acyrthosiphon pisum*

DESCRIPTION OF THE PESTS

(View photos online to identify aphids)
The pea aphid and the blue alfalfa aphid are large green aphids with long legs, antennae, cornicles, and cauda. They are very similar in appearance but can be distinguished from each other by examining the antennae: the antennae of the pea aphid has narrow dark bands at the tip of each segment, whereas those of the blue alfalfa aphid are uniformly brown.

A pink biotype of the pea aphid has recently been found in the central valley of California, including Fresno, Kings, Tulare, Yolo and Sacramento counties. Except for its pink color, it is identical in appearance to the green biotype. The pink biotype causes similar damage to the green pea aphid and management practices are the same, but some studies have suggested it may be partially resistant to parasitization by *Aphidius ervi* and may also circumvent some of the pea aphid resistance bred into many alfalfa cultivars.

Both the blue alfalfa aphid and the two strains of the pea aphid prefer cool temperatures (optimal temperature for development of blue alfalfa aphid is 60°F) and reach damaging levels in spring, but blue alfalfa aphid is more tolerant than pea aphid of cool temperatures and appears earlier in spring. Pea aphid often reoccurs in fall as well. Both species may be present in alfalfa fields at the same time as the alfalfa weevils. The blue alfalfa aphid prefers the plant terminals while pea aphid is usually more generally distributed. Both species prefer the stems to the leaves.

DAMAGE

These aphids feed on alfalfa and inject a toxin that retards growth, reduces yield, and may even kill plants. Damage can also reduce the alfalfa's feed value. A black fungus, sooty mold, grows on the honeydew excreted by the aphid reduces palatability to livestock. Damage is more severe on short hay than on taller alfalfa for both species. The toxin injected by the blue alfalfa aphid is more potent than that of the pea aphid.

MANAGEMENT

Using resistant varieties of alfalfa and encouraging populations of natural enemies are very important in managing blue alfalfa aphid and pea aphid. It is important to distinguish these two species because blue alfalfa aphid causes more damage than pea aphid, and the two species have different treatment thresholds. Natural enemies, especially lady beetles, are monitored along with the aphids to determine the need for treatment. Aphids frequently become problems when their natural enemies are disrupted by weevil sprays. Border harvesting or strip cutting can be important for preserving natural enemies.

Resistant Varieties

Planting alfalfa varieties resistant to blue alfalfa aphid and pea aphid has been the most effective means of controlling aphids in alfalfa. Prolonged periods of below-normal temperatures, however, may lower resistance to blue alfalfa aphid injury and result in some crop injury. Studies in the eastern U.S. have shown that the pink biotype of the pea aphid easily overcame resistance in a number of cultivars with the exception of CUF 101. When selecting varieties, consult your farm advisor for information on resistant varieties suited to your area, or check the list provided by the National Alfalfa Alliance (http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf). Additionally, a yearly alfalfa variety report can be found at http://alfalfa.ucdavis.edu.

Biological Control

(View photos online of natural enemies)
The most significant aphid predators are several species of lady beetles, including *Hippodamia convergens* and *Coccinella septempunctata* that attack and consume both of these aphid species; treatment thresholds for pea aphid are based on the number of lady beetle adults and larvae present. Green lacewings can also be important in regulating aphids and many other predators including bigeyed bugs (*Geocoris* spp.), damsel bugs (*Nabis* spp.), and syrphid fly larvae also play a role. The major parasite of the pea aphid is *Aphidius smithi* while the parasite *A. ervi* attacks both species. However, several studies have suggested that the pink biotype of pea aphid shows signs of partial resistance to *A. ervi.* Large golden-brown aphid mummies on the upper surfaces of leaves indicate parasitization. When parasites are present, be careful when treating for aphids and other insects. Parasites

frequently provide adequate control. Aphids may also be controlled by a naturally occurring fungal disease, which is most prevalent during cool, rainy, or foggy weather.

Cultural Control

Use border-strip cutting during harvest to help maintain populations of parasites and predators within the field. For more details, see BORDER-STRIP HARVESTING.

Organically Acceptable Methods

The use of resistant varieties, biological control, and cultural control are acceptable to use on an organically certified crop. Organically certified insecticides such as azadirachtin (Neemix), neem oil (Trilogy), and pyrethrin (PyGanic) are registered for use on alfalfa to control aphids. Studies conducted in California, however, have shown that at best they provide some suppression of populations but do not control them.

Monitoring and Treatment Decisions

Start to monitor fields in February for blue alfalfa aphid and pea aphid and continue monitoring through spring. In fall resume monitoring pea and blue alfalfa aphids by combining with cowpea monitoring as described in APHID MONITORING.

If natural enemies fail to keep the aphid populations in check, an insecticide treatment may be necessary. Economic treatment thresholds for both aphids are as follows (if both species are present, use the blue alfalfa aphid treatment levels):

Plant height	Pea aphids	Blue alfalfa aphids
Under 10 inches	40 to 50 per stem	10 to 12 per stem
10 to 20 inches	70 to 80 per stem	40 to 50 per stem
Over 20 inches	100 + per stem	40 to 50 per stem

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A. CHLORPYRIFOS* (Lorsban) 4EC MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Do not make more than 4 applications per year or apply more than once per crop cutting. Do not apply when bees are present. Avoid drift and tailwater runoff into surface waters.	0.25–0.5 pt	24	7
B. DIMETHOATE 2.67EC MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Check label to see if product allows only one application per year or per cutting. Do not apply when bees are present.	Label rates	48	10

** See label for dilution rates.

‡ 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.

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

CLOVER ROOT CURCULIO (11/06)

Scientific Name: *Sitona hispidulus*

DESCRIPTION OF THE PEST

Adults of the clover root curculio are slightly smaller than alfalfa weevil adults and are a mottled gray-brown with no distinct patterns. The life cycle is similar to alfalfa weevil in that the adults leave the alfalfa fields and spend the summer in protected areas.

The clover root curculio is a recognized alfalfa pest in the eastern half of the US, but information on this pest in California is extremely limited. Clover root curculio is apparently more common in sandy soils than in the heavier soils.

DAMAGE

The white, grublike larvae of the clover root curculio feed on alfalfa roots and leave gouges in the tap root. They are most likely to be found in June. This damage has been shown to be detrimental to alfalfa yield and stand longevity in the eastern United States. The feeding also promotes root rot diseases by providing entry points for fungi.

MANAGEMENT

There are no thresholds or control measures for this pest.

COWPEA APHID (4/08)

Scientific Name: *Aphis craccivora*

DESCRIPTION OF THE PEST

(View photo online to identify aphids)
Cowpea aphid is readily distinguishable from other aphids inhabiting alfalfa because it is the only black aphid found infesting the crop. It is a relatively small aphid and the adult is usually shiny black while the nymph is slate gray. The appendages are usually whitish with blackish tips.

Cowpea aphid has been a long time resident of alfalfa in California as well as other states. In the Central Valley, populations are highest from February to April; numbers peak from October to January in the desert; and in the San Joaquin Valley, populations can reach treatable levels in August and September. Cowpea aphids are a sporadic pest in the Intermountain Region and require treatment in some years – mostly in spring, but damage can occur at other times during the growing season.

This aphid has an extensive host range. In addition to alfalfa, it infests many other legumes and cotton, as well as shepherd's-purse, lambsquarters, lettuce, pepperweed, *Polygonum* sp., and *Rumex* sp.

DAMAGE

Cowpea aphid injects a powerful toxin into the plant while feeding and, when populations are large, this can stunt or kill plants. While feeding, this aphid produces a considerable amount of honeydew upon which sooty mold grows. The black sooty mold reduces photosynthesis and may make leaves unpalatable to livestock. The honeydew also makes the alfalfa sticky, which causes problems with harvest.

MANAGEMENT

There are no known varieties of alfalfa that are resistant to cowpea aphid and economic thresholds have not been developed specifically for this pest. Treatments may be necessary if large populations are present. Border harvesting or strip cutting can be important for preserving natural enemies.

Biological Control

(View photos online of natural enemies)
Two common aphid parasites, *Lysiphlebus* sp. and *Diaraetiella* sp., have been identified from both the high and low desert. Although parasitism as high as 95% has been documented, aphid population levels can become so high that enough nonparasitized individuals remain to cause significant injury. This aphid is also susceptible to the usual complement of aphid predators including lady beetles, lacewings, bigeyed bugs, damsel bugs, and syrphid flies. Early in the season (February and early-March) many of these predators are generally not active, but in the low desert the sevenspotted lady beetle, *Coccinella septempunctata*, is abundant and feeding on the aphid.

Cultural Control

Use border-strip cutting during harvest to help maintain populations of parasites and predators within the field. For more details, see BORDER-STRIP HARVESTING.

Organically Acceptable Methods

The use of biological and cultural controls are acceptable on organically certified crops. Organically certified insecticides such as azadirachtin (Neemix), neem oil (Trilogy), and pyrethrin (PyGanic) are registered for use on alfalfa to control aphids. Studies conducted in California, however, have shown that at best they provide some suppression of populations but do not control them.

Monitoring and Treatment Decisions

Aphid infestations in a field are typically patchy, especially an early infestation. Stems on alfalfa plants in infested areas are often completely covered with aphids whereas plants in other areas of the field may appear aphid-free. Because of the spotty distribution of cowpea aphid infestations, spot treatments may be feasible, especially if the infestation is on the field border.

On dormant alfalfa, pay close attention to plants as they begin breaking dormancy. If shoots fail to grow normally and cowpea aphid is present, consider control measures.

Start to monitor fields in February for cowpea aphid and continue to monitor this aphid through fall at which time monitoring can be combined with that of blue alfalfa and pea aphid as described in APHID MONITORING. (During summer months, monitoring of cowpea aphid can be combined with that of spotted alfalfa aphids.)

Record counts on a monitoring form. (Example monitoring forms are available online.)

No guidelines or economic threshold levels have been established for cowpea aphid in alfalfa. Until economic thresholds are developed for the cowpea aphid, use the following thresholds, which were developed for the blue alfalfa aphid:

Plant height	Aphids
Under 10 inches	10 to 12 per stem
10 to 20 inches	40 to 50 per stem
Over 20 inches	40 to 50 per stem

Common Name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)

The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.

The following materials have not been tested under California conditions but have been found to be effective in other areas.

A. CHLORPYRIFOS*
(Lorsban) 4EC — Label rates — 24 — See comments
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Do not make more than 4 applications per year or apply more than once per crop cutting. Do not apply when bees are present. Avoid drift and tailwater runoff into surface waters. Preharvest interval is 7 days for cutting and grazing when 0.5 pt/acre used, 14 days for 1 pt/acre, and 21 days for rates above 1 pt/acre.

B. DIMETHOATE 2.67EC — Label rates — 48 — 10
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Check label to see if product allows only one application per year or per cutting. Do not apply when bees are present.

‡ 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.

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

GRASSHOPPERS (11/06)

Scientific Names: *Melanoplus* spp., *Trimerotropis* spp.

DESCRIPTION OF THE PESTS

Grasshoppers are readily distinguished from most other insects by hind legs, that have greatly enlarged femurs, are well adapted for jumping. Their bodies are robust and their antennae relatively short. In contrast, another alfalfa pest in the order Orthoptera, crickets, have long antennae. Most grasshoppers are winged and many are good flyers, although a few species are flightless.

Grasshoppers may be a pest in alfalfa production, but vary greatly in importance from area to area and season to season. They sometimes develop in uncultivated areas and move into cultivated fields. They should be controlled before they enter the alfalfa field.

DAMAGE

Grasshoppers feed on leaves and stems. When populations are high they can cause severe defoliation.

MANAGEMENT

Economically significant levels vary with the growth of the crop; in general, populations of 15 per square yard or higher are considered severe. Control measures will depend on the growth of the crop and the stage of development of grasshoppers present. Grasshoppers are best controlled before they enter alfalfa fields. Check with your County Agricultural Commissioner regarding the current registration of baits to control grasshoppers in alfalfa fields.

GROUND MEALYBUG (11/06)

Scientific Name: *Rhizoecus kondonis*

DESCRIPTION OF THE PEST

Ground mealybug is a small, whitish insect found on the roots of alfalfa and other crops. It is restricted to the heavier soils of the Sacramento Valley and is not found in the San Joaquin or Imperial Valleys.

The ground mealybug has slender, waxy filaments that form a sort of netting over some individuals. The ground mealybug also secretes a small amount of wax, which can give the soil a somewhat bluish appearance when the mealybugs are abundant. There are three generations per year with populations peaking in the early winter, spring and mid-summer periods. The eggs, nymphs and adults all occur in the soil.

DAMAGE

The ground mealybug feeds on alfalfa roots and can cause severe damage. Feeding interacts with stressful environmental conditions resulting in greatly reduced plant growth that is particularly evident during summer. Infestations in alfalfa fields generally occur in "circular" patches and spread slowly.

MANAGEMENT

There are no thresholds or control measures for this pest. Crop rotation may help, but this pest appears to survive on several crop plant and weed species. Because there is differential survival across species, rotation to a less preferred host may aid in management. In a greenhouse study, greatest survival was on potato, tomato, safflower, and alfalfa, followed by cotton, cantaloupe, dryland rice, sugarbeets, and wheat. There was only slight survival on field corn and kidney beans. However, there were no plant species without some level of survival.

LEAFHOPPERS (4/08)

Scientific Names: Garden leafhopper: *Empoasca solana*
Potato leafhopper: *E. fabae*
Mexican leafhopper: *E. mexara*

DESCRIPTION OF THE PESTS

Several species of *Empoasca* leafhoppers occur in alfalfa. They all have the same general overall appearance: small (0.125 inch long), bright green, wedge-shaped bodies. Nymphs (immatures) also have green wedge-shaped bodies and run rapidly when disturbed. They may run forward, backward, or from side to side. Their curious movement plus their shape serve to distinguish them from lygus bug nymphs and slower moving aphids. Other green leafhoppers may be present in alfalfa, but they are much larger in size. Other small leafhoppers found in alfalfa are brown or gray in color and do no apparent damage.

DAMAGE

The most common damage symptom is a yellow, wedge-shaped area at the tip of the leaf. Frequently, the leaf margin and tissue surrounding this area turns red. This symptom may occasionally be confused with boron deficiency but can easily be distinguished from it by the presence of the insect. Plants may become stunted and have very short internodes. Stunting and yellowing may persist into the next cutting cycle, even in the absence of leafhoppers.

Although *Empoasca* leafhoppers may be found throughout the year, damage in the Central Valley is generally found during July, August, and occasionally September. In the Imperial Valley, damage may occur from May through September; infestations are often adjacent to or upwind from sugarbeets.

MANAGEMENT

Scheduling an early cutting can effectively manage damaging leafhopper populations, otherwise insecticide treatment may be warranted.

Cultural Control

If alfalfa is within a few days of harvest, early cutting will control *Empoasca* leafhoppers.

Organically Acceptable Methods

Cultural controls are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

Check the field in July and August (and if necessary into September) to see if leafhoppers are present. At the first sign of injury, sample the field with a standard sweep net. Leafhopper infestations usually begin on the field margin so be sure to include field edges in your samples. For information on sweep sampling, see SAMPLING WITH A SWEEP NET.

Sample four areas over the entire field by taking 5 sweeps in each area and counting the number of adults and nymphs. Record observations on a monitoring form *(available online)*.

If alfalfa is 2 or more weeks away from harvest, apply treatments if counts reach five leafhoppers per sweep (adults and nymphs combined). Alfalfa scheduled to be harvested in 10 days to 2 weeks should be treated if counts reach 10 per sweep. Often, leafhopper infestations of treatable magnitude are confined to the first 50 to 100 feet of the field margin. If this is the case, treat only the field edges where high leafhopper counts are found.

As an alternative to treating the entire field, border cutting works well to "herd" the leafhoppers into the uncut strip. The strip can then be sprayed a few days after cutting, thus reducing the need to spray the entire field.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)

The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
A. PERMETHRIN*			
(Pounce) 3.2EC	4–8 oz	12	See comments
(Ambush) 25WP	3.2–12.8 oz	12	See comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply when bees are present. Do not apply more than 8 oz/acre per cutting of Pounce or 12.8 oz/acre per cutting of Ambush. For Pounce the preharvest interval is 0 days for 4 oz/acre and 14 days for more than 4 oz/acre; for Ambush it is 0 days for less than 6.4 oz/acre and 14 days for more than 6.4 oz/acre.			
B. CARBARYL*			
(Sevin) XLR	1 qt	12	7
(Sevin) 4F	1 qt	12	7
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not use any carbaryl formulation when bees are present. For forage crops, do not apply more than once per cutting or exceed 1 qt/acre per cutting. For hay crops, do not exceed 3 pt/acre per cutting.			
C. DIMETHOATE			
(Dimethoate 400)	0.5–1 pt	48	10
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Check label to see if product allows only one application per year or per cutting. Do not apply when bees are present.			
D. CHLORPYRIFOS*			
(Lorsban) 4EC	0.5–1 pt	24	7 (0.5 pt); 14 (1 pt)
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Do not make more than 4 applications per year or apply more than once per crop cutting. Do not apply when bees are present. Avoid drift and tailwater runoff into surface waters.			
E. ZETA-CYPERMETHRIN*			
(Mustang) 1.5EW	2.4–4.3 fl oz	24	See comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply more than 4.3 oz/acre per cutting or more than 12.9 oz/acre per season. Preharvest interval is 3 days for cutting and grazing and 7 days for seed.			
F. METHOMYL*			
(Lannate) LV	Label rates	48	7
(Lannate) SP	Label rates	48	7
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not apply when bees are present.			
G. LAMBDA-CYHALOTHRIN*			
(Warrior)	1.92–3.2 fl oz	24	See comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply when bees are actively foraging. Do not apply more than 0.24 pt/acre per cutting or 0.96 pt/acre per season. Preharvest interval is 1 day for forage and 7 days for hay.			
H. CYFLUTHRIN*			
(Baythroid) 2E	0.8–1.6 fl oz	12	7
(Renounce) 20WP	1–2 fl oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply to alfalfa grown for seed because of potential for injury to bees. Baythroid: do not apply more than 2.8 fl oz/acre per cutting or more than 11.2 fl oz/acre per season. Renounce: do not apply more than 4 oz/acre per cutting or more than 16 oz/acre per season.			

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)

** See label for dilution rates.

‡ 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.

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

MORMON CRICKET (11/06)

Scientific Name: *Anabrus simplex*

DESCRIPTION OF THE PEST

Mormon crickets are not true crickets but more closely related to katydids and longhorned grasshoppers. They pass the winter as eggs in the soil, preferring barren, sandy soil in sunny locations. Eggs hatch in the first warm days of spring and the crickets pass through seven nymphal stages in about 75 to 100 days. Mature adult female crickets lay eggs throughout the summer, but the eggs don't hatch until the following spring.

Adults are about 1 inch long, heavy-bodied, and tan colored. The wings are small and useless; these insects do not fly. The antennae are as long as the body, and the female has a sword-shaped ovipositor also as long as the body. Mormon crickets are active only during the warm, sunny part of the day and seek shelter at night or in cloudy or rainy weather. When they are half grown, they begin migrating from their rangeland breeding grounds. The migrations occur at air temperatures of 65° to 95°F and when winds are less than 25 mile per hour.

DAMAGE

Mormon crickets become pests very sporadically (about once or twice in a decade) when populations build to high levels and they migrate over large areas. If an alfalfa field is in the path of a migration, Mormon crickets can cause severe damage by devouring the plants.

MANAGEMENT

Management of Mormon crickets centers on preventing invasions of fields with barriers or insecticide baits.

Cultural Control

Because these insects cannot fly, linear barriers of 10-inch strips of 28- to 30-gauge galvanized iron, held on edge with stakes driven into the ground may stop swarms. Soil pits or water traps may be made at intervals to catch crickets halted by the barrier.

Organically Acceptable Methods

Cultural controls are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

Treatments on the border of the field may be effective at limiting invasion of migrating populations of this pest; baits work well for this purpose. Check with your County Agricultural Commissioner regarding the current registration of baits to control Mormon crickets in alfalfa fields.

SHARPSHOOTERS (4/08)

Scientific Names: Green sharpshooter: *Draeculacephala minerva*
Red-headed sharpshooter: *Xyphon* (=*Carneocephala*) *fulgida*
Glassy-winged sharpshooter: *Homalodisca vitripennis (=H. coagulata)*
Blue-green sharpshooter: *Graphocephala atropunctata*

DESCRIPTION OF THE PESTS

Sharpshooters are members of the leafhopper family Cicadellidae. They have increased in importance over the last decade as a result of the introduction of the glassy-winged sharpshooter, which has been associated with increases in plant diseases caused by the bacterium *Xylella fastidiosa* that these sharpshooters vector. One such disease is alfalfa dwarf.

Historically, the green sharpshooter has been one of the two most important vectors of alfalfa dwarf in California. It is about 0.25 to 0.36 inch (6-9 mm) long and usually bright green (spring and summer) in color. Nymphs are brownish. In the eastern San Joaquin Valley, adults of the fall generation that overwinter are usually a dull brown color. The green sharpshooter usually has three generations per year in the Central Valley and requires grasses for breeding, favoring watergrass, bermudagrass, and fescues. It also feeds and reproduces on sedges. Like all sharpshooters, it prefers succulent plants. For this reason, it is most frequently found on perennial grasses in areas that are regularly irrigated.

The red-headed sharpshooter is the other sharpshooter of historical importance as a vector of alfalfa dwarf. It is about 0.25 inch (6 mm) long and similar in appearance to the green sharpshooter except that it has reddish coloration on the front tip of its head. The red-headed sharpshooter usually has four generations per year in the Central Valley and strongly prefers to breed on bermudagrass. It tolerates slightly drier conditions than the green sharpshooter.

The glassy-winged sharpshooter is a large leafhopper, about 0.5 inch (13 mm) long, that appears dark brown to black when viewed from the top or side. The abdomen is whitish or yellow, and the head is brown to black and covered with numerous ivory to yellowish spots. The glassy-winged sharpshooter has two generations per year, with peak adult populations in July and August. It feeds on over 150 genera of plants, but prefers feeding on crops such as citrus, grapes, and ornamentals. Eradication or area wide management programs are currently underway for this pest wherever it is found in California. There is currently no evidence that the glassy-winged sharpshooter breeds in alfalfa or spreads alfalfa dwarf.

The blue-green sharpshooter is about 0.25 inch (6 mm) long with blue wings. It is primarily found in riparian vegetation in cooler coastal regions and the foothills of the Sierra, where it spreads Pierce's disease of grapes but has not been documented as a significant vector of alfalfa dwarf disease.

DAMAGE

Sharpshooters feed on a wide range of host plants by inserting their proboscis into the xylem tissue and extracting xylem sap. They are vectors of the bacterium *Xylella fastidiosa*, which causes alfalfa dwarf disease, but only the green and red-headed sharpshooters are known to spread this disease in alfalfa. Other diseases in California caused by this bacterium include Pierce's disease of grapes and almond leaf scorch. Sharpshooters acquire the bacterium while feeding on an infected host plant and spread it to noninfested host plants through subsequent feeding. Sharpshooters continue to be able to transmit the bacterium to plants until they molt. Feeding by the leafhoppers themselves causes little or no damage.

The primary symptom of alfalfa dwarf disease is stunted regrowth after cutting. The stunting may not be apparent for many months after initial infection. Leaflets on affected plants are smaller, often a slightly darker (bluish) color but not distorted, mottled, or yellow. The taproot is normal sized, but slicing it diagonally or horizontally down the root reveals abnormally yellowish colored wood with fine dark streaks of dead tissue. In recently infected plants, the yellowing is mostly in a ring beginning under the bark, with a normal white-colored cylinder of tissue in the center. The inner bark is not discolored, and there are no large brown or yellow patches as is the case with bacterial wilt caused by *Clavibacter insodiosum*. Dwarf disease progressively worsens over 1 to 2 years after first symptoms and eventually kills the plant.

Alfalfa dwarf has rarely been reported since the 1950s and is primarily distributed only in southern California and from Madera County south in the San Joaquin Valley. It is currently unknown what effect the introduction of the glassy-winged sharpshooter will have on disease incidence in the San Joaquin Valley.

MANAGEMENT

Sharpshooter management in alfalfa depends on the species of pest that is present, and the potential for developing alfalfa dwarf. In the absence of the bacterium *Xylella fastidiosa*, there is no need to manage sharpshooters. If the bacterium is present, green and red-headed sharpshooters can be reduced by removing weed hosts they require for breeding. The best approach is to prevent grass weeds from establishing when alfalfa fields are planted. Grasses along field margins that receive irrigation water also need to be controlled.

If glassy-winged sharpshooters are found in areas of the state not previously known to be infested, notify the county agricultural commissioner or cooperative extension personnel. In many areas, especially major grape-growing regions, where glassy-winged sharpshooters are known to occur, area-wide management programs are in place, and this pest is being controlled with biological control or insecticide use in neighboring crops where its populations tend to build up.

Biological Control

Biological control is important for management of the glassy-winged sharpshooter. Egg parasitic wasps (family Mymaridae) in the genus *Gonatocerus* are commonly found wherever glassy-winged sharpshooter occurs in California and are most effective during summer. Parasitized glassy-winged sharpshooter eggs can be recognized by a small, round hole chewed through one end of the egg by the emerging adult wasp. Information is currently being developed on the role of biological control in the natural regulation of green, blue-green, and red-headed sharpshooters.

Cultural Control

Control green and red-headed sharpshooters by removing grass weeds from within the field and along ditches, ponds or roads. Green and red-headed sharpshooters require grasses such as bermudagrass, watergrass, cultivated fescues and perennial ryegrass to breed. Annual grass weeds or cover in orchards and vineyards do not seem to develop significant populations of sharpshooters if weeds are removed at least annually. Cultural controls for the glassy-winged sharpshooter have not been developed.

Organically Acceptable Methods

Biological and cultural controls (i.e., weed removal) are acceptable for use in an organically certified crop.

Monitoring and Treatment Decisions

Treatments of insecticides to alfalfa for sharpshooters are not recommended.

SILVERLEAF WHITEFLY (11/06)

Scientific Names: *Bemisia argentifolii*

DESCRIPTION OF THE PEST

Silverleaf whitefly adults are tiny (0.06 inch, 1.5 mm long), yellowish insects with white wings. Their wings are held somewhat vertically tilted, or rooflike, over the body and generally do not meet over the back but have a small space separating them. Another species that may be present, bandedwinged whiteflies (*Trialeurodes abutiloneus*), have brownish bands across their wings.

Whiteflies are found mostly on the undersides of leaves. They fly readily when plants are disturbed. The tiny, oval eggs hatch into a first nymphal stage that has legs and antennae and is mobile. The legs and antennae are lost after the first molt and subsequent stages remain fixed to the leaf surface. The last nymphal stage, often called the pupa or the red-eye nymph, is the stage that is easiest to identify.

Last instar silverleaf whitefly nymphs are oval and yellowish with red eye spots. The edge of the pupae tapers down to the leaf surface and has few to no long waxy filaments around the edge. In contrast, bandedwinged whitefly nymphs have many long waxy filaments around the edge, and the edge is somewhat vertical where it contacts the leaf surface.

DAMAGE

Whiteflies are sucking insects and their feeding removes nutrients from the plant. As they feed, whiteflies produce large quantities of honeydew that reduce alfalfa hay quality because sooty molds (fungi that produce black spores) often grow on honeydew. Sooty molds are not known to harm cattle or horses, but resemble mold from water damaged hay that produce toxins. Hay buyers are not likely to buy moldy looking hay or will discount the price of the hay. Silverleaf whitefly can cause economic damage to alfalfa in the low desert regions of Southern California and Arizona from July through September.

MANAGEMENT

A silverleaf whitefly-resistant alfalfa cultivar (UC-Impalo-WF) is available for use. Research continues to develop cultivars with higher levels of resistance to silverleaf whitefly as well as to bandedwinged whitefly. If insecticides were registered whitefly control in alfalfa, they would not be cost effective. The use of insecticides for whitefly control in alfalfa is not cost effective.

SPIDER MITES (11/06)

Scientific Names: *Tetranychus urticae*, *Tetranychus* spp.

DESCRIPTION OF THE PESTS

Spider mites are small pests, with adults about the size of a small pinhead, variable in color (green or yellow) with dark pigmented spots. Adult spider mites have eight legs and are oblong to spherical in shape. The eggs of spider mites species found in alfalfa are very small, whitish, and spherical in shape. You will need a hand lens to see them.

Spider mites are usually found on the undersides of leaves, with colonies beginning on the lower (older) leaves and moving upward on the plant.

DAMAGE

Spider mite feeding first appears as stippling (small yellow areas) on leaves. Severe damage desiccates leaves, and they may fall from the plants. Heavily infested plants may be stunted and have a yellowish appearance. Tonnage reduction of almost 0.2 tons of hay per acre has been documented in the low desert from severe spider mite infestations. Reductions are thought to be greatest when alfalfa is growing slower and when infestations occur early in the cutting cycle.

MANAGEMENT

Spider mite infestations may occur in any alfalfa growing area, but damage and yield losses are most common in the low desert production areas of Imperial and Riverside counties. Spider mite infestations in the Central Valley are rare and can usually be managed by a timely irrigation. Infestations and losses are most closely associated with bedded alfalfa production.

In the low desert, populations have been most damaging from March through May. More than one cutting may be affected. On bedded alfalfa, spider mites build up on weeds during the early spring and as the weeds dry-up move onto the alfalfa. (This is generally not a problem on solid planted alfalfa grown in the Central Valley or the Intermountain counties.) Control options for spider mites in alfalfa include weed management, proper irrigation and fertilization to minimize plant stress, timely harvest, and chemical control.

Biological Control

Western flower thrips are often an effective predator of spider mites, migrating into alfalfa from surrounding crops as their host plants desiccate or as they are attracted by alfalfa foliage following an irrigation. Spider mites are also fed on by minute pirate bugs, big-eyed bugs, and lacewing larvae.

Cultural Control

In the low desert, an important component of mite management is to control weeds along field edges during the winter to eliminate potential host plants that can serve as overwintering sites and initial locations of spider mite infestations. Since water stressed alfalfa is more prone to infestation that not stressed alfalfa a timely irrigation will most often alleviate the problem. Minimizing plant stress through improved irrigation, fertilization, and cultural practices such as timely harvests is also beneficial.

Organically Acceptable Methods

Clarified extract of neem oil (Trilogy) can effectively control spider mites. Activity is slower than that of other miticides because of the insect growth regulator properties of this product, which cause it to take several days to control a population. Best results are noted when the alfalfa plant is short, allowing for more thorough spray coverage.

Monitoring and Treatment Decisions

Look for spider mites on the undersides of leaves. Treatment thresholds have not been established, but treatments may be economically justified in alfalfa grown for hay when:

- Spider mites are present, and cutting cycles are longer than 30 days (more defoliation of lower leaves and quality reduction)
- Treatments are applied early in the cycle (right after bales removed), and spider mites have been a problem before cutting

- Regrowth is being hindered, and the field has been monitored to determine the cause of the slow growth is spider mites

Low desert areas

There are primarily two treatment timings for mites on alfalfa: a) treating the stubble at cutting, or b) treating the foliage between cuttings. Treating the stubble at harvest is a two-step process in which the alfalfa is cut while the stubble is sprayed, and then the foliage is laid on top of the stubble. Initial tests of alfalfa stubble treatment as foliage is harvested has shown positive economic results, but the new alfalfa growth is unprotected after cutting and can be reinfested with spider mites from cut alfalfa as it dries. These reinfestations generally occur across the entire field and not just under the windrows.

Reinfestations are usually not severe when temperatures are 108ºF (or higher) or when alfalfa is green chopped and moved immediately from the field. If fields of susceptible crops (such as cotton, melons) are adjacent to spider mite-infested alfalfa, they may become infested when the alfalfa is harvested if spider mites migrate from the drying plants. In these situations it may be necessary to treat the adjacent crop to protect it from migrating mites; a treatment to the field's border may be adequate.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
When choosing a pesticide, consider impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A. CLARIFIED EXTRACT OF NEEM OIL# (Trilogy)	32 oz	4	0
MODE OF ACTION: Unknown. A botanical insecticide. COMMENTS: Can be applied at cutting. Thorough coverage is essential for good control.			

** See label for dilution rates.

‡ 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 an organically grown crop.

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

SPOTTED ALFALFA APHID (4/08)

Scientific Name: *Therioaphis maculata*

DESCRIPTION OF THE PEST

View photos online to identify aphids)
The spotted alfalfa aphid is a small, pale yellow or grayish aphid with four to six rows of spined black spots on its back. Mature females may either be wingless or have wings with smoky areas along the veins. This aphid prefers warm weather and is generally found during summer months. In the Imperial Valley, high populations may continue into fall and winter.

DAMAGE

Spotted alfalfa aphids inject a toxin into the plant as they feed. Severe aphid infestations stunt plants, reduce yield, and may even kill plants. These aphids also secrete large quantities of honeydew. Plants become very sticky at relatively low aphid densities, and a black fungus that grows on the honeydew excreted by the aphid reduces palatability to livestock and lowers the alfalfa's feed value.

MANAGEMENT

The use of resistant varieties and encouragement of natural enemy populations help to control spotted alfalfa aphids. Border harvesting or strip cutting can be important for preserving natural enemies. In the event that host plant resistance fails or natural enemies do not hold aphid numbers below economic threshold levels, insecticide treatments may be necessary.

Resistant Varieties

Planting alfalfa varieties resistant to spotted alfalfa aphid has been the most effective means of controlling aphids in alfalfa. However, biotypes of spotted alfalfa aphid that are capable of infesting previously resistant varieties are constantly evolving, and even fields planted to resistant varieties should be checked frequently. When selecting varieties, consult your farm advisor for information on varieties suited to your area, or check a list of alfalfa varieties provided by the National Alfalfa Alliance, available online at http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf. Additionally, a yearly alfalfa variety report can be found *(online)* at http://alfalfa.ucdavis.edu.

Biological Control

View photos online of natural enemies
Common reddish lady beetles, including the convergent lady beetle, attack and consume this aphid. Green lacewings can also be important in regulating aphids and many other predators including bigeyed bugs (*Geocoris* spp.), damsel bugs (*Nabis* spp.), and syrphid flies also play a role. An introduced parasite, *Trioxys complanatus*, has become established on the spotted alfalfa aphid. Brown aphid mummies attached to leaves and stems of alfalfa plants indicate the presence of this parasite. Caution should be exercised in treating for aphids when the parasite is present.

Cultural Control

Use border-strip cutting during harvest to help maintain populations of parasites and predators within the field. For more details, see BORDER-STRIP HARVESTING.

Organically Acceptable Methods

The use of resistant varieties and biological and cultural controls are acceptable to use on an organically certified crop. Organically certified insecticides such as azadirachtin (Neemix), neem oil (Trilogy), and pyrethrin (PyGanic) are registered for use on alfalfa to control aphids but studies have not been conducted in California to determine their effectiveness.

Monitoring and Treatment Decisions

It is important to sample all fields, even those with resistant varieties, frequently during periods of maximum aphid activity. Start sampling for spotted alfalfa aphid in June and continue until fall. To combine monitoring with cowpea aphid, see APHID MONITORING.

In addition to monitoring aphid populations, also take sweep net samples for lady beetles and record all counts on a monitoring form *(available online)*.

Time of occurrence	No. of aphids per stem
Spring months	40 aphids per stem*
Summer months	20 aphids per stem*
After last cutting in the fall	50 to 70 aphids per stem
Newly seeded alfalfa in lower desert	20 aphids per stem
***Do not treat if the ratio of lady beetles to aphids is equal to or exceeds the following:**	
No. of lady beetles per sweep	**No. of aphids per stem**
ON STANDING ALFALFA	
1 or more adults	5 to 10 aphids
3 or more larvae	40 aphids
ON STUBBLE	
1 or more larvae	50 aphids

Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)

The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.

The following materials have not been tested under California conditions but have been found to be effective in other areas.

A. CHLORPYRIFOS*
(Lorsban) 4EC — Label rates — 24 — See comments
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Do not make more than 4 applications per year or apply more than once per crop cutting. Do not apply when bees are present. Avoid drift and tailwater runoff into surface waters. Preharvest interval is 7 days for cutting and grazing when 0.5 pt/acre used, 14 days for 1pt/acre, and 21 days for rates above 1 pt/acre.

B. DIMETHOATE 2.67EC — Label rates — 48 — 10
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Check label to see if product allows only one application per year or per cutting. Do not apply when bees are present.

‡ 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.

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

THREECORNERED ALFALFA HOPPER (11/06)

Scientific Name: *Spissistilus festinus*

DESCRIPTION OF THE PEST

The threecornered alfalfa hopper is a green, wedge-shaped insect with clear wings. The body, which is about 0.25 inch long, is higher and wider at the head end than and tapers towards the posterior. This insect gets its name from the hardened triangular (three cornered) area over the thoracic area as seen from above. It has piercing-sucking mouthparts. Nymphs are grayish white and soft bodied, with a line of saw-toothed spines on their backs.

Adults feed on numerous plants, including alfalfa. In alfalfa, nymphs are confined to the lower portions of the plant. Threecornered alfalfa hoppers can be found year-round. In the low desert, there are two population peaks for adults: one in late July/early August and a larger second peak in September/early October. In the San Joaquin Valley, threecornered alfalfa hoppers numbers usually peak in late September and October.

DAMAGE

Adults and nymphs of the alfalfa hopper feed by inserting their mouthparts into stems and sucking out juices. Injury is also caused when adult female hoppers insert their eggs into stems. Feeding and egg laying can girdle stems, causing the portion of the plant above the girdle to turn red, purple or yellow.

MANAGEMENT

Monitoring and treatment guidelines have not been developed, and there are no known parasites or predators effecting populations of this insect in California. Monitoring guidelines for sweep net sampling are difficult to develop because of the different alfalfa production systems and because the nymphs are concentrated on the plant at or near the soil line and not readily picked up by sweep nets.

This pest is not likely to cause severe damage in the San Joaquin Valley because it appears so late in the season, and treatment is rarely necessary.

In the Imperial Valley, damage is occasionally severe enough to justify control measures.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A. CYFLUTHRIN*			
(Baythroid 2)	1.6-2.8 fl oz	12	7
(Renounce 20WP)	2-3.5 oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply to alfalfa grown for seed because of the potential for injury to bees. Baythroid: Do not apply more than 0.044 lb a.i./acre per cutting or more than 0.175 lb a.i./acre per season. Do not make more than 4 applications per year. Renounce: Do not apply more than 0.05 lb a.i./acre per cutting or more than 0.2 lb a.i./acre per season.			
B. LAMBDA-CYHALOTHRIN*			
(Warrior)	1.92-3.2 fl oz	24	1-forage; 7-hay
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Apply only to fields planted to pure stands of alfalfa. Do not apply when bees are actively foraging. Do not apply more than 0.24 pt (0.03 lb a.i.)/acre per cutting or exceed 0.96 pt/acre per year.			
C. METHOMYL*			
(Lannate LV)	1.5 pt	48	7
(Lannate SP)	0.5 lb	48	7
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not graze or feed livestock for 7 days after application. Do not apply when bees are present.			

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
D. PERMETHRIN* (Pounce 3.2 EC)	4–8 oz	12	See comments
MODE OF ACTION GROUP NUMBER[1]: 3 COMMENTS: Do not use more than 0.2 lb a.i./cutting. Do not apply to mixed stands with intentionally grown forage grasses and legumes. Preharvest interval is 0 days for 4 oz/acre and 14 days for more than 4oz/acre.			

** See label for dilution rates.

‡ 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.

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

THRIPS (11/06)

Scientific Names: Bean thrips: *Caliothrips fasciatus*
Onion thrips: *Thrips tabaci*
Western flower thrips: *Frankliniella occidentalis*

DESCRIPTION OF THE PESTS

Thrips are minute, slender-bodied insects usually possessing two pairs of long, narrow wings, the margins of which are fringed with long hairs. Some species cause injury by direct feeding, others by vectoring plant viruses, and still others are predatory on mites and small insects. Because of their high populations in alfalfa and their easily identifiable injury some have long considered thrips to be major alfalfa pests.

DAMAGE

Thrips mouthparts form a lacerating-sucking cone, and the insects feed by rasping and lacerating the food tissues and then sucking-up the resulting juices. The rasping leads to deformed and crinkled leaves resulting from uneven growth around the injury (feeding) site. Feeding, particularly near the leaf mid-rib, causes curling and distortion of the leaves, which often have a cuplike or puckered appearance.

MANAGEMENT

Western flower thrips have never been shown to cause economic damage in California. In fact, they often serve as alternate prey for a number of natural enemy species commonly found in alfalfa. Western flower thrips can be an effective natural enemy of spider mites. The cost of treatment (insecticide and application costs) is not justified for this species. In addition, disruption to natural enemy populations and the potential outbreak of other pests caused by insecticide treatment must be taken into account.

The exceptions to the "do not treat thrips" recommendation in alfalfa include the following:

- Very high populations of bean thrips and onion thrips. These species are relative newcomers to alfalfa and are considerably more destructive than flower thrips.
- Dryland alfalfa may be considerably more susceptible to thrips injury than irrigated alfalfa.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A. METHOMYL*			
(Lannate) LV	Label rates	48	7
(Lannate) SP	Label rates	48	7
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Do not graze or feed livestock for 7 days after application. Do not apply when bees are present or apply more than 3.6 lb a.i./acre per season.			
B. PERMETHRIN*			
(Pounce) 3.2 EC	Label rates	12	See comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not use more than 0.2 lb a.i./cutting. Do not apply to mixed stands with intentionally grown forage grasses and legumes. Preharvest interval is 0 days for 4 oz/acre and 14 days for more than 4oz/acre.			

** See label for dilution rates.

‡ 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.

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

VARIEGATED and OTHER CUTWORMS (11/06)

Scientific Names: Granulate cutworm: *Agrotis subterranea*
Variegated cutworm: *Peridroma saucia*

DESCRIPTION OF THE PESTS

Cutworms are only occasional pests of high desert and Central Valley alfalfa but are frequent pests in the low desert where alfalfa is planted on beds. The granulate and the variegated cutworms are the two species that most commonly attack low desert alfalfa.

Female moths lay white or greenish eggs in irregular masses on leaves or stems of plants, often near the base of the plant. Eggs darken as they approach hatching. Full grown caterpillars are about 1.5 to 2 inches long and appear as smooth-skinned caterpillars of various colors and patterns. Larvae frequently roll into a C-shape when disturbed. Cutworms feed at night and hide during the day in soil cracks and under debris and loose soil.

DAMAGE

In the Central Valley, variegated cutworm populations may develop in weedy areas and migrate into seedling stands or occasionally mature stands. Injurious populations usually occur from April to late June. Seedling alfalfa stands can be severely damaged by cutworms cutting the seedlings off at or just below the soil surface. Established fields are damaged when cutworms cut off new growth or feed on the alfalfa foliage.

Granulate cutworm is a devastating pest of bed-planted alfalfa and can also be a pest of alfalfa planted between borders. Low desert alfalfa fields are attacked from May through October, but the pest occurs year round in fields. Established alfalfa fields can be severely injured when cutworms cut off new shoots at or below ground level following harvest. The pest often goes undetected after cutting and hay removal but the problem becomes apparent when the field is irrigated and there is little or no regrowth.

MANAGEMENT

Tillage, flood irrigation, and weed control are important in cutworm management. When damage is severe in seedling fields, apply an insecticide bait.

Cultural Control

Tillage helps to limit cutworm populations; seedlings in well-tilled fields—especially when there is an interval between crops—are less likely to have cutworm problems. Keep the field and field edges weed-free. Flood irrigation can drown many cutworm larvae. Flood irrigation during the day will attract many birds that prey on the cutworms as the advancing water forces larvae from hiding.

Organically Acceptable Methods

Cultural controls are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

Cutworm infestations are sporadic, and treatment guidelines have not been established in California. Check for cutworms by looking under duff and carefully digging to a depth of 1 inch in loose soil near alfalfa crowns. When cutworm numbers exceed one or two per foot of row or severe damage is apparent, it may be necessary to treat. If treating with baits, apply baits in late evening or at night when cutworms are on plants.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A. PERMETHRIN*			
(Pounce) 25WP, 3.2EC, WSB	Label rates	12	14
(Ambush) 25WP	8.2–12.8 oz	12	14
MODE OF ACTION GROUP NUMBER[1]: 3			

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
B. CYFLUTHRIN*			
(Baythroid) 2E	0.8–1.6 fl oz	12	7
(Renounce) 20WP	1–2 oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 3			
C. LAMBDA-CYHALOTHRIN*			
(Warrior)	1.92–3.2 fl oz	24	7 – hay; 1 – forage
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply when bees are actively foraging. Do not apply more than 0.24 pt/acre per cutting or 0.96 pt/acre per season.			
D. INDOXACARB			
(Steward) 1.25 SC	6.7–11.3 fl oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 22A			
COMMENTS: Make no more than one application per cutting. Not for use in alfalfa grown for seed or for sprouts for human consumption. Do not apply more than 45 fl oz/acre per crop season.			

** See label for dilution rates.

‡ 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.

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

WEBWORM (11/06)

Scientific Name: *Loxostege* spp.

DESCRIPTION OF THE PEST

Webworms are dark green caterpillars with two white stripes and black spots on their backs. They are often found within webbed leaves. They vary in size up to almost 1.5 inches in length.

Webworms overwinter as larvae in the ground adjacent to their fall food host. Moths emerge in early spring and lay eggs on leaves of host plants. Larvae will feed for 3 to 5 weeks.

DAMAGE

The larval stage feeds inside of webbed leaves on the upper parts of the plant in summer and fall. If numbers are abundant, this webbing will be clearly visible and will cover extensive areas of foliage.

MANAGEMENT

Early cutting may give satisfactory control. Treatment is rarely justified in California.

WEEVILS (ALFALFA and EGYPTIAN ALFALFA) (9/10)

Scientific Names: Alfalfa weevil: *Hypera postica*
Egyptian alfalfa weevil: *Hypera brunneipennis*

DESCRIPTION OF THE PESTS

Two identical-looking weevils infest alfalfa in California. They are distinguished by their biology and distribution in the state. The alfalfa weevil is an annual pest in alfalfa districts east of the Sierra Nevada mountains and in the northernmost counties of California. In most other areas of California, it has been displaced by the Egyptian alfalfa weevil, which is a far more serious pest.

Adult weevils of both species are dark gray and about 0.20 inch long. The legless larva of the alfalfa weevil is about 0.25 inch long when fully grown. It is pale green with a thin white line down the center of the back and has a brown head. Larvae complete their growth in about 3 to 4 weeks. They will then spin a cocoon and pupate either in the leaves of the plant or on the ground.

Alfalfa weevil overwinters as an adult in field trash or other secluded hiding places and emerges in late winter or early spring. Soon after emergence and mating, the adult females begin inserting their eggs into the alfalfa stems, and hatching larvae make their way up the stem to feed on alfalfa terminals and drop to spin a cocoon and pupate by early summer. This species generally has only one generation a year.

Egyptian alfalfa weevils spend the summer as adults under the loose bark of trees, especially eucalyptus, or in any place they can wedge their bodies, such as in rough-barked trees (walnut) or under shake shingles on homes. In late fall or early winter, they emerge and migrate to alfalfa fields. Soon after entering the fields, adult females begin inserting their eggs into the stems of alfalfa, and hatching larvae make their way into the alfalfa terminals. Egyptian alfalfa weevil has one generation a year in most of its California range; a small area in the Central San Joaquin Valley is documented to have a second annual generation.

DAMAGE

Young larvae damage alfalfa by feeding on terminal buds; larger larvae feed on the leaflets. Feeding by older larvae is the most damaging and is characterized as skeletonization and bronzing of the leaves in spring. Under severe pressure, complete defoliation can occur. Damage from both weevils is most commonly seen before the first cutting. However, while alfalfa weevil may occasionally damage the second or third cutting, Egyptian alfalfa weevil is more likely to cause significant damage to the second cutting and occasionally the third cutting if a second generation occurs. Adult weevils feed on alfalfa but generally do not cause significant damage.

MANAGEMENT

Weevil management in alfalfa is focused on the period before the first cutting. Control options are insecticides and early harvest. Biological control is not effective at preventing economic damage in most areas because populations of natural enemies are not sufficient to provide control in the spring.

Biological Control

Two parasitic wasps, *Bathyplectes curculionis* and *Bathyplectes anurus*, have been introduced into California for control of the larval stage of the alfalfa weevil and the EAW. *Bathyplectes curculionis* is present throughout the range of both alfalfa weevil species in California. Before the Egyptian alfalfa weevil invaded California and spread into most of the areas occupied by the alfalfa weevil, *B. curculionis* effectively suppressed alfalfa weevil populations in the mid-coastal area.

Bathyplectes anurus has become established in Central Valley alfalfa as well as other locations; however, at the present time it is only found at very low levels. *Microctonus aethiopoides*, a parasite of the adult weevil, was established and had been recovered from some counties in California in the past, but recent studies indicate that the parasite is absent or present at very low levels throughout the state and does not provide adequate weevil control.

An alfalfa weevil-specific fungus occurs in many alfalfa growing regions in California that aids in biological control. In years experiencing heavy rainfall, this soil-dwelling fungus (*Zoophthora phytonomi*) sporulates and infects the larval stage, causing death of weevil larval within days of infection. In some regions in California, the fungus maintains weevil populations below the economic threshold of 20 per sweep and may help minimize the need to chemically treat for the weevil.

Cultural Control

After alfalfa weevil larvae begin to appear, check fields at 2- to 4-day intervals. Cutting the crop as soon as most of the plants are in the bud stage can sometimes prevent serious damage by the weevil. Also, most weevils are killed by the harvest and curing process. However, early cutting to control weevils concentrates the survivors in the windrows. Closely monitor alfalfa regrowth for the second cutting to detect feeding damage because both larvae and adults can cause injury.

Organically Acceptable Methods

The primary organically acceptable management method is cutting the crop early if damage seems imminent.

Monitoring and Treatment Decisions

Begin monitoring for weevils in early January in southern and central areas of the state and in April in the far northern intermountain area. If the alfalfa is too short to sweep, look for signs of feeding damage on the leaves.

Sweep fields with adequate plant height weekly after weevil larvae begin to appear in late winter or early spring. As thresholds are approached, monitor every 2 to 4 days to determine if populations decline or a treatment is required. (For details on sweep net sampling, see SAMPLING WITH A SWEEP NET.) Record your observations on a monitoring form *(available online)*. Research is underway to reevaluate threshold levels, but currently the recommendation is that a treatment is warranted when weevil larvae count reaches an average of 20 or more larvae per sweep.

Continue to monitor weekly during the spring through June or after a treatment through in the Central Valley, March in the southern deserts and mid-June in the northern intermountain areas.

In some situations early harvest can be used to manage larval populations when they reach damaging levels. This tactic minimizes the killing of predators and parasites of aphid pests by pesticides. However, before making a decision to harvest early, consider stand vigor and economic practicality.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.			
A. INDOXACARB			
(Steward) EC	6.7–11.3 fl oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 22A			
COMMENTS: Make no more than one application per cutting. Do not apply when bees are in the area. Not for use in alfalfa grown for seed or for sprouts for human consumption. Do not apply more than 45 fl oz/acre per crop season.			
B. PHOSMET			
(Imidan) 70W	1 lb	120	14
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Do not apply more than once per cutting or during bloom period.			
C. LAMBDA-CYHALOTHRIN*			
(Warrior)	2.56–3.84 fl oz	24	1–forage; 7–hay
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply when bees are actively foraging. Do not apply more than 0.24 pt/acre per cutting or 0.96 pt/acre per season			
D. CYFLUTHRIN*			
(Baythroid) 2E	1.6–2.8 fl oz	12	7
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Not for use in alfalfa grown for seed. Do not apply more than 2.8 fl oz/acre per cutting or more than 11.2 fl oz/acre per season.			
. . . or . . .			
(Renounce) 20WP	2–4 fl oz	12	7
COMMENTS: Do not apply to alfalfa grown for seed. Do not apply more than 4 oz/acre per cutting or more than 16 oz/acre per season.			

	Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)
E.	CHLORPYRIFOS* (Lorsban) 4EC	1–2 pt	24	See comments
	MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Will also kill aphids. Do not make more than 4 applications per year or apply more than once per cutting. Do not apply when bees are present. Avoid drift and tailwater runoff into surface waters. Preharvest interval is 14 days for 1 pt/acre and 21 days for more than 1 pt/acre.			
F.	MALATHION 8E	1–1.5 pt	12	0
	MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: *Use only when other products cannot be used.* Do not apply when bees are present. Where populations of 10 or 15 larvae per sweep are present at the time of cutting, malathion at 1.5 pt/acre can be applied as an under-the-windrow treatment. This treatment reduces the larval population as it filters down to the stubble from windrowed alfalfa. Thus, feeding damage to new regrowth is reduced and the alfalfa's vigor is preserved. Under-the-windrow treatment requires mounting a spray unit on the swathing machine.			

** See label for dilution rates.

‡ 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.

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

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

WESTERN YELLOWSTRIPED ARMYWORM (7/13)

DESCRIPTION OF THE PEST

This pest may be abundant in alfalfa fields in the Central Valley. The caterpillar is usually black, with two prominent stripes and many narrow bright ones on each side. At maturity it is approximately 1.5 to 2 inches long. Eggs are laid in clusters on the upper side of leaves and covered with a gray, cottony material. Eggs hatch in a few days and larvae reach full size in 2 to 3 weeks. Larvae pupate on or just under the soil surface. Adults are brown moths that primarily fly at night but may be encountered flying up as you walk through the field. There are at least five generations per year in the low desert and four generations in the Central Valley. This pest may be abundant at any time from June to early September.

DAMAGE

Armyworms skeletonize leaves, leaving veins largely intact.

MANAGEMENT

Populations of armyworms are frequently controlled by natural enemies and are more or less cyclic, occurring in large numbers only every few years. Early harvest, border cutting and biological control are important management methods that prevent damage from armyworms.

Biological Control

Natural enemies can provide good control of armyworms in many fields. Predators include bigeyed bugs, spiders, minute pirate bugs, damsel bugs, and lacewings. The parasitic wasp, *Hyposoter exiguae*, is believed to be the most important of at least 10 parasites attacking this pest. Sample for parasitism by pulling the heads from older caterpillars and squeezing the body contents out toward the head end. *Hyposoter* larvae are a light, translucent green color. Viral diseases can also be important.

Cultural Control

Fields may be cut to avoid damage.

Organically Acceptable Methods

Biological and cultural control methods, as well as sprays of *Bacillus thuringiensis* (e.g., Xentari, Agree), are acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

(View photos online for identification of caterpillars)

In early summer start sweeping fields with adequate plant height 2 to 3 times per week to monitor for caterpillars; monitoring can be discontinued after September. Divide each field into 4 sections and take 5 sweeps per section with a 15-inch diameter sweep net, for a total of 20 sweeps. For information on sampling, see SAMPLING WITH A SWEEP NET.

Combine monitoring of armyworms with monitoring for alfalfa caterpillars and leafhoppers as described in ALFALFA CATERPILLAR AND ARMYWORM MONITORING. Count and record the number of healthy and parasitized caterpillars caught in your sweep net on a monitoring form *(available online)*.

If cutting is not practical or not scheduled soon after monitoring, treat if there is an average of ten or more nonparasitized alfalfa caterpillars per sweep, fifteen or more nonparasitized armyworms per sweep, or 10 or more nonparasitized alfalfa caterpillars and armyworms combined per sweep.

Common name (example trade name)	Amount per acre**	R.E.I.‡ (hours)	P.H.I.‡ (days)

The following materials are listed in order of usefulness, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. FLUBENDIAMIDE
(Belt SC) — 2–4 fl oz — 12 — 0
MODE OF ACTION GROUP NUMBER[1]: 28
COMMENTS: A newer material; impact on beneficials not yet determined. Highly toxic to honey bees.

B. CHLORANTRANILIPROLE
(Coragen) — 3.5–5 fl oz — 4 — 0
MODE OF ACTION GROUP NUMBER[1]: 28
COMMENTS: Make no more than one application per cutting. Do not apply more than 0.2 lbs a.i./acre per crop of chlorotraniliprole products.

C. INDOXACARB
(Steward EC) — 6.7–11.3 fl oz — 12 — 7
MODE OF ACTION GROUP NUMBER[1]: 22A
COMMENTS: Make no more than one application per cutting. Steward EC can be used for alfalfa grown for seed, but seeds cannot be used for sprouts intended for human consumption or livestock feed. All seed must be tagged: "Not for human or animal use.". Do not apply more than 45 fl oz/acre per crop season.

D. METHOXYFENOZIDE
(Intrepid 2F) — Label rates — 4 — 0^{F} $0^{FO/H}$
MODE OF ACTION GROUP NUMBER[1]: 18
COMMENTS: Make no more than one application per cutting. Not for use in alfalfa grown for seed or for sprouts for human consumption. Do not apply more than 32 fl oz/acre per crop season.

E. METHOMYL*
(Lannate 90SP) — 0.5 lb — 48 — 7
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Do not graze or feed livestock for 7 days after application. Do not apply more than 3.6 lb a.i./acre per crop. Do not apply when bees are present.

F. BACILLUS THURINGIENSIS ssp. AIZAWAI#
(Xentari, Agree) — Label rates — 4 — 0
MODE OF ACTION GROUP NUMBER[1]: 11
COMMENTS: Apply when larvae are small (in first or second instar). Does not harm beneficial insects. Repeat treatment as necessary.

** See label for dilution rates.

‡ 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.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a1B 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/.

F Forage

FO Fodder

H Hay

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

\# Acceptable for use on an organically grown crop.

Diseases

(Section reviewed 11/06)

ALFALFA DWARF (11/06)

Pathogen: *Xylella fastidiosa*

SYMPTOMS

Plants infected with the bacterium *Xylella fastidiosa* are stunted. They often have small bluish-green leaflets and fine short stems. Taproots are normal in size but when cut open, roots appear abnormally yellowish in color with dark streaks of dead tissue scattered throughout. In newly infected plants the yellowing is mostly in a ring beginning under the bark. Unlike bacterial wilt, there are no gummy pockets underneath the bark. Plants become stunted and eventually die.

COMMENTS ON THE DISEASE

Dwarf is not recognized as an economic disease of alfalfa. However, the bacterium that causes alfalfa dwarf, *Xylella fastidiosa*, is the same pathogen that causes Pierce's disease of grapes, a very important grape disease in California. The role that alfalfa plays in the epidemiology of Pierce's disease is important. Leafhoppers, including the blue-green sharpshooter, spread the disease from alfalfa to grapes. Increased levels of Pierce's disease in grapes located adjacent to alfalfa has been documented in the San Joaquin Valley.

MANAGEMENT

To protect grapes, minimize the attractiveness of an alfalfa stand to sharpshooters by preventing the growth of grasses. This, in turn, will reduce the transfer of the bacterial pathogen between alfalfa and grape vineyards. When possible, avoid planting alfalfa adjacent to grape vineyards in areas where Pierce's disease is prevalent.

ALFALFA MOSAIC VIRUS and CUCUMBER MOSAIC VIRUS (11/06)

Pathogens: *Alfalfa mosaic virus* (AMV)
Cucumber mosaic virus (CMV)

SYMPTOMS

Alfalfa mosaic virus, may cause yellow mottling or streaking on leaves, but at other times the symptoms are masked and leaves appear normal.

Cucumber mosaic virus shows no symptoms in alfalfa.

COMMENTS ON THE DISEASES

These viruses have not been proven to be of economic importance in California alfalfa production. However, they may be transmitted by aphids that feed on alfalfa and then move to other crops. For example, alfalfa mosaic virus can cause economic losses in tomatoes and potatoes. Cucumber mosaic virus is one of several viruses that cause plant death in garbanzo beans grown in the San Joaquin Valley.

AIR POLLUTION (11/06)

Pathogen: none (abiotic disorder)

SYMPTOMS

High levels of ozone cause a bleached stippling on upper leaf surfaces. Symptoms usually appear on middle-aged and older leaves. Affected leaves may age rapidly and fall off. High concentrations of ozone are associated with low wind velocities and bright sunlight.

Symptoms of peroxyacetyl nitrate on alfalfa leaves resemble those described for ozone injuries but the lesions may be larger. A silver or copper sheen frequently apparent on affected leaves.

COMMENTS ON THE DISEASE

Crop injury from air pollutants results in reduced photosynthetic rates and early aging, which adversely affect crop yield and quality. Many air pollutants (e.g., ammonia, chlorine, hydrogen chloride, hydrogen fluoride, or sulfur dioxide) are capable of causing plant damage, but only the photochemical oxidants (ozone and peroxyacetyl nitrate) are of major concern. They are formed by the reactions of oxygen, nitrogen oxides, and organic molecules in the presence of sunlight. The primary source for these compounds is automobile exhaust, but industrial processes and other forms of combustion contribute to air pollution.

ANTHRACNOSE (11/06)

Pathogen: *Colletotrichum trifolii*

SYMPTOMS

Anthracnose can affect leaves and stems, but crown rot is the most important phase of the disease. The most obvious symptom is the bluish-black, V-shaped rot in the crown. Dead stems associated with such crowns are sometimes bleached white. Because stems die suddenly, the dead leaves do not drop from the stem.

Anthracnose also causes small, irregularly shaped blackened areas on stems that become large, oval, or diamond-shaped straw-colored lesions with black borders. Black fruiting bodies (acervuli), which under a hand lens look like small dots, develop in the lesion. As lesions enlarge, they may coalesce, girdle, and kill affected stems. In summer and fall, dead shoots (white in color) are scattered throughout the field.

COMMENTS ON THE DISEASE

Anthracnose is a common problem in older alfalfa stands. The fungus persists in alfalfa debris and crowns. The disease reaches maximum severity during late summer and early fall coincident with warm and humid weather. During the growing season, spores on stem lesions are a source of inoculum. Splashing rain and irrigation water disperse spores onto growing stems and petioles. Spores may also be spread with seed contaminated during the threshing process.

MANAGEMENT

Control of anthracnose involves use of resistant cultivars or cultural practices. Start looking for signs of anthracnose in early summer. If an infestation is found, harvest alfalfa before losses become too severe.

Rotation with crops other than clover and alfalfa for at least two years will eliminate sources of inoculum in the field. For more information, see CROP ROTATION.

BACTERIAL WILT (11/06)

Pathogen: *Clavibacter michiganense subsp insidiosus* (formerly *Corynebacterium insidiosum*)

SYMPTOMS

Above ground symptoms of bacterial wilt include a yellow-green foliage and stunted growth. Leaflets may be mottled and slightly cupped or curled upward. Stems on affected plants may be thin and weak. Disease symptoms are most evident after clipping during regrowth. A cross section of an infected taproot reveals a yellowish tan color in the center. Brown pockets on the inside of bark tissue are sometimes evident. Once infected, plants do not usually recover. Within 5 to 8 months after showing symptoms, plants usually die. Infected plants are prone to winter kill in areas where soil freezes in winter.

COMMENTS ON THE DISEASE

Bacterial wilt is a warm-season disease that occurs in most areas of California but is rarely seen today because of the development and use of wilt-resistant cultivars in the Sacramento Valley.

The disease is not a serious problem in the southern San Joaquin and desert valleys because symptoms rarely appear before the second or third year of a stand. Stands in these areas are removed after 3 to 4 years.

The bacterium survives on plant residues in the soil and enters plants through wounds in the roots and crown or through the cut ends of freshly mowed stems. Disease severity and incidence increase when root knot nematodes are present. The bacterium can survive in dry plant tissue or seed for at least 10 years and can be disseminated over long distances in seed and dry hay. However, the population of the organism in soil declines quickly when infected plant residue decomposes. The bacterium also can be spread by surface water, tillage, mowing, and harvesting equipment. The greatest incidence of the disease occurs in poorly drained areas of fields, and large areas can be infected during periods of continuous wet weather.

MANAGEMENT

Use resistant cultivars to keep the disease under control in areas where the alfalfa crop remains in the field for more than four years. If bacterial wilt is discovered in a field, cut it last during harvest to prevent spread of inoculum by the mower to younger stands. Within a field, remove infested areas last and never mow when the foliage is wet.

Crop rotation can reduce inoculum in the field. For more information, see CROP ROTATION.

COMMON LEAFSPOT (11/06)

Pathogen: *Pseudopeziza medicaginis*

SYMPTOMS

Symptoms of common leaf spot include small (0.12 inch), circular, brown-to-black spots on leaves. Margins of spots are characteristically toothed or uneven. As the disease progresses, infected leaves turn yellow and drop. In cool, moist weather circular, raised, brown fruiting bodies, called apothecia, are visible within the spots with the use of a hand lens.

COMMENTS ON THE DISEASE

Common leaf spot is a cool-season foliar disease that requires moisture. The causal fungus overwinters in undecomposed leaves and leaf debris on the soil surface. In spring, spores are forcibly discharged into the air and some land on alfalfa leaves.

MANAGEMENT

Start looking for leafspot in spring. Harvest infected alfalfa early because the severity of this disease increases over time. Although the disease does not kill plants, defoliation reduces vigor, hay quality, and yield. In irrigated fields in California, common leaf spot can cause more leaf loss during drying and harvesting than before harvesting. Most growers just live with this disease but some cultivars may be less susceptible than others.

Crop rotation can reduce inoculum in the field. For more information, see CROP ROTATION.

DOWNY MILDEW (11/06)

Pathogen: *Peronospora trifoliorum*

SYMPTOMS

The upper surface of leaves infected with downy mildew becomes lighter in color, in some cases almost a mottled yellow. Bluish-gray areas of mycelial mats and spores can be seen with a hand lens on the underside of the affected area. Spores are more often found in the morning when humidity is high. Sometimes entire buds and leaves become infected, resulting in distortion of leaves and general yellowing. Infected leaves drop off the plant, reducing yield and quality.

COMMENTS ON THE DISEASE

Downy mildew is a cool season foliar disease. It occurs when temperatures are cool and humidity is high enough for the pathogen to infect alfalfa and produce spores. For this reason it is rarely seen in some years, and even in "wet" years it is usually a problem only for a few to several weeks in spring.

Spring-planted fields are impacted the most because plants are in the seedling stage when weather tends to be most favorable for the disease. Stand survival is usually not affected. Early harvests can be used to reduce losses.

FUSARIUM WILT (11/06)

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

SYMPTOMS

The first symptom of Fusarium wilt is wilting shoots. Bleaching of the leaf and stem color follows, and finally there may be a reddish tint to the foliage. In roots, dark reddish-brown streaks occur in the stele (the center part of the root that contains the vascular tissue). In advance stages, the entire stele may be discolored. The dark discoloration caused by Fusarium wilt is in contrast to the yellow-brown discoloration of bacterial wilt.

COMMENTS ON THE DISEASE

Fusarium wilt is favored by high soil temperatures and was significant in the past in California, but resistant cultivars have now made this disease an infrequent occurrence. For more information on resistant cultivars, see the National Alfalfa Alliance Web site, available on line at http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf.

PHYMATOTRICHUM ROOT ROT (11/06)

Pathogen: *Phymatotrichum omnivorum*

SYMPTOMS

The first symptom of Phymatotrichum root rot on alfalfa is a rot of the outer surfaces of the roots, followed by bronzing of leaves and sudden wilting. Plants die quickly when taproots are girdled. A sheath of soil clings to the roots, and white-to-tan mycelial strands are found on the root surface. The disease appears as somewhat circular spots (fairy rings) within the field, which increase in size following rain or irrigation. The disease develops in late spring as soil temperatures increase.

COMMENTS ON THE DISEASE

Phymatotrichum root rot, also called Phymatotrichopsis root rot, cotton root rot, and Texas root rot, is limited to certain areas in the deserts of southern California (Palo Verde and to a lesser extent the Imperial and Coachella Valleys) and to Texas and Arizona. The causal fungus has a host range of more than 1800 species of plants.

Extensive research in Arizona and Texas indicates that a *P. omnivorum* infestation is limited to certain soil types and that the infestation was most likely originally associated with native desert flora.

The fungus survives many years in soil as sclerotia, as deep as 6 feet or more. Sclerotia produce mycelial strands that grow through soil and eventually contact a root. The growth of the fungus is favored by moist soil conditions. The temperature range for growth is 59° to 95°F with an optimum of 82°F. The fungus is more prevalent in heavy alkaline soils than in acidic soils.

Because the causal fungus is almost impossible to eradicate and could affect the value of the land, have the diagnosis confirmed by an expert diagnostician.

MANAGEMENT

Crop rotation with resistant crops such as corn, sorghum, or onion can help prevent the infestation from spreading within a field and reduce the level of inoculum, but it will not eliminate the infestation. For more information, see CROP ROTATION. No resistant cultivars are available.

PHYTOPHTHORA ROOT and CROWN ROT (11/06)

Pathogen: *Phytophthora megasperma*

SYMPTOMS

Primary symptoms of Phytophthora root and crown rot include tan-to-brown lesions on taproots, especially where a lateral root emerges. Lesions eventually turn black while the center of the root becomes yellow. In the root interior, orange-to-reddish streaks spread up several inches from the rotted end of the roots. Lesions can appear at any depth where water drainage is impeded. Occasionally, the disease may spread to the crown from the taproot.

COMMENTS ON THE DISEASE

Phytophthora root rot is a cool season crown and root disease. It is important where soil water is excessive and can affect large areas of a field. Root and crown rot is common at the tail end of flood-irrigated fields where water collects.

The causal organism survives in soil as mycelia in infected plant tissue or as thick-walled oospores. The fungus also produces thin-walled sporangia, which release motile zoospores in the presence of free water.

If the crown becomes infected, the plant will likely die. If infection is limited, the plant may continue growing at a reduced rate, and it will be susceptible to other pests and diseases. Root and crown rot can be injurious to seedling stands but is more common in established fields.

MANAGEMENT

Use resistant cultivars to keep the disease under control in areas where the alfalfa crop remains in the soil and water management are the keys to controlling Phytophthora root rot. Take the following steps to decrease the amount of time that soil is saturated with water: till deeply to reduce compaction, reduce the length of flood irrigation runs, shorten irrigation time, level land before planting, install a tailwater ditch to remove excess water, and plant on beds to help alleviate disease severity.

Be careful when using return water because this and other pathogens (and nematodes) can be carried in recirculated irrigation water. Cultivars resistant to Phytophthora root rot are listed in the National Alfalfa Alliance Web site, available on line at http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf. Use resistant cultivars with sound cultural practices in fields known to have problems with Phytophthora.

RHIZOCTONIA ROOT CANKER (11/06)

Pathogen: *Rhizoctonia solani*

SYMPTOMS

Tan, elliptical lesions on the taproot in the areas where lateral roots emerge are distinctive symptoms of Rhizoctonia-related diseases. In winter when the fungus is inactive, these sunken lesions will turn black and appear to be inactive. If roots are girdled during summer, the plant will die. If infection is not severe, new roots will emerge when temperatures are too cool for the fungus.

COMMENTS ON THE DISEASE

Rhizoctonia root canker, also known as crown and stem rot, occurs during periods of high temperatures and high soil moisture. The fungus occurs worldwide and also causes serious seedling damping off; however in California, most new stands are planted when temperatures are less than ideal for disease development. The disease is mainly found in the low desert valleys of Palo Verde, Imperial, and Coachella. Only certain strains of the fungus can cause the root canker form of disease. No control measures are known for these diseases.

SCALD (FLOODING and HIGH TEMPERATURE INJURY) (11/06)

Pathogen: none (abiotic disorder)

SYMPTOMS

Symptoms of scald include an off-color of the foliage and wilting, even though the soil is wet. Roots may rot and have a putrid odor when removed from the soil. The water-conducting tissue of affected roots die and becomes brown.

Scald is often confused with Phytophthora root rot because both occur in saturated soil conditions, but if temperatures have not exceeded 100°F, it is probably not scald.

COMMENTS ON THE DISEASE

Scald is related to the combination of high soil temperatures and length of time soil is saturated with water. When air temperatures are in the range of 104° to 113°F, alfalfa is extremely susceptible to flooding injury. Scald is usually limited to hot desert valleys, such as the Imperial and Palo Verde Valleys, when soil is saturated for long periods after irrigation or rainfall. Affected plants may die within 3 or 4 days after irrigation.

Fields that have been recently mowed are much more susceptible to scald than fields closer to harvest.

MANAGEMENT

The primary control measure is proper water management. Irrigating for relatively short periods (e.g., 4 hours) when temperatures are high may reduce the likelihood of scald. Some soils, however, remain saturated long after irrigation because of heavy texture, slope of the land, and length of the irrigation run. Avoid irrigation when temperatures are over 109°F**.** Do not irrigate newly mowed plants until enough regrowth occurs to prevent submersion of entire plants.

SCLEROTINIA STEM and CROWN ROT (WHITE MOLD) (11/06)

Pathogen: *Sclerotinia sclerotiorum*

SYMPTOMS

When active, the fungus that causes Sclerotinia stem and crown rot is easily identified by white, cottony, mycelial growth on crowns or stems. In seedling fields infected plants wilt and die, often causing stand loss. For established fields, infected stems wilt and die. The disease can grow into crowns, but plants usually recover.

The disease starts as small, white patches on stems and then spreads to other parts of the plant. Diagnosis can be confirmed by the presence of black, hard resistant structures (called sclerotia) that look like peppercorns. They can be round or irregular in shape and, when broken open, have a white interior. Sclerotia are found at the base of stems, on soil near the crown, or inside infected stems. Dead stems are hollow and easily flattened between the thumb and fingers, making it easy to feel sclerotia, if present, inside. Sclerotia found in stems are elongated in shape.

COMMENTS ON THE DISEASE

Sclerotinia stem and crown rot is a cool-season disease. In wet or foggy winters, this disease can be serious on stands planted in September and October, especially when rapidly growing plants form a dense canopy in which high humidity is favorable for disease. Weeds, such as chickweed, further encourage disease by prolonging moist conditions in the canopy.

All the stems of a plant may be infected and die, which makes the plant appear to be dead. But crowns may still be alive and healthy regrowth may appear later in spring, especially in established plants. If plants are young, weakened by stress or other factors, or if favorable conditions for disease exist long enough, entire plants may be killed.

MANAGEMENT

The best strategy for established fields is to remove as much foliage before winter as possible by mowing or grazing. Deep plowing of fields will prevent germination of most sclerotia; however, neighboring fields of alfalfa or weeds hosts (pineappleweed, sowthistle, groundsel, mayweed, mustards, radish, legumes, etc.) can be the source of new infections. Good weed control reduces hosts and opens the canopy, allowing air movement and sunshine at the base of plants, thereby reducing humidity and moisture required by the fungus to start and maintain infections. In dry winters, this disease is not a problem. There is no effective genetic-based resistance incorporated into commercial varieties at this time.

Early February plantings usually escape disease, but growers who prefer to plant in September and October face potential damage from this disease in the first winter. Research has not shown conclusively that using herbicides to burn back seedling growth is effective in reducing disease. The disease may thin stands and, on rare occasions, replanting may be necessary.

SEEDLING or DAMPING-OFF DISEASES (11/06)

Pathogen: *Pythium ultimum*, *P. irregulare*, *P. violae*, *Phytophthora megasperma*, and *Rhizoctonia solani*

SYMPTOMS

Damping off is a name given to a condition where seeds are killed before germination or seedlings are stunted or collapse and die. Seeds destroyed before germination are discolored and soft. After seed germination, symptoms include brown necrotic lesions along any point of the seedling. Lesions that girdle the young root or stem lead to plant death. Partially girdled plants, as well as those subject to continued root tip necrosis, may be stunted and yellowish in color to varying degrees.

A discolored, constricted area near the soil surface may be seen in older seedlings. The magnitude of the dark discoloration is dependent upon the age of the seedling as well as the duration of environmental conditions favorable for disease development.

Pythium ultimum and *P. irregulare* cause both pre- and postemergent damping-off of alfalfa in California. *Pythium violae* causes root tip necrosis and inhibition of lateral root formation. *Rhizoctonia solani* may cause preemergent death of seedlings but usually causes postemergent necrosis of the stem at or near the soil surface, which is marked by a distinct margin between infected and healthy tissue.

Phytophthora megasperma, another common soilborne pathogen, can be particularly devastating in poorly drained soils see PHYTOPHTHORA ROOT ROT.

COMMENTS ON THE DISEASES

Pythium and *Rhizoctonia* are common in most soils where they persist indefinitely. Both fungi are transported by water, contaminated soil on equipment, and movement of infected plant materials. Both have wide host ranges. Damping-off is favored by poor growth of alfalfa seedlings resulting from such factors as unfavorable temperatures, excessive moisture, low light, or improper fertilization.

Damping-off caused by *Pythium* spp. usually occurs under cool soil temperatures in fields with poor drainage.

Damage by *R. solani* is often related to the amount of organic matter that remains in the soil from the previous crop, with damage increasing as the level of organic matter increases.

MANAGEMENT

Planting high quality seed under environmental conditions favoring rapid germination and seedling growth reduces the chance of infection. Therefore, avoid planting in November and December. Also avoid excessive irrigation and compaction or poorly drained soils. Purchase seed treated with an appropriate fungicide to protect seedlings from the damping-off pathogens. Although crop rotations do not eliminate these pathogens because of their wide host ranges, rotations with crops like small grains may help to reduce inoculum levels.

SPRING BLACK STEM (11/06)

Pathogen: *Phoma medicaginis*

SYMPTOMS

Spring black stem is a cool season foliar disease. Symptoms include small, black-to-dark brown spots on lower leaves, petioles, and stems. The lesions are irregularly to triangularly shaped. As they increase in size, lesions coalesce and become light brown. Affected leaves turn yellow and often wither before falling. Lesions on stems and petioles enlarge, causing large areas near the base of the plant to turn black. Young shoots are often girdled and killed. Most damage occurs before the first cutting.

COMMENTS ON THE DISEASE

The causal fungus produces brown-to-black fruiting bodies (pycnidia) on overwintered stem and leaf lesions. In early spring, spores released from pycnidia on dead stems during wet weather or overhead irrigation are splashed onto foliage and stems. In addition new shoots are infected as they grow through the crop residue or stubble. The fungus also may be seedborne.

MANAGEMENT

Control measures include early cutting to reduce leaf loss, planting resistant cultivars, and planting pathogen-free seed.

Crop rotation can reduce inoculum in the field. For more information, see CROP ROTATION.

STAGONOSPORA CROWN and ROOT ROT (11/06)

Pathogen: *Stagonospora meliloti*

SYMPTOMS

Symptoms of Stagonospora crown and root rot include rough and cracked bark tissue on infected roots and crowns. The presence of red flecks in diseased root tissue is a distinctive diagnostic symptom. Fine red streaks also occur in the xylem (water-conducting tissue) in the center of the root, below rotted portions of the crown. Affected crown tissue is generally firm and dry, unless secondary organisms invade the tissue. The pathogen also may infect leaves and stems, causing irregular, bleached lesions with diffuse margins. Infected leaves soon drop after lesions form.

COMMENTS ON THE DISEASE

Stagonospora crown and root rot is a cool season crown and root rot disease. Spores of the pathogen form in black pycnidia and are spread by water that splashes from infected leaves, stems, or plant debris. The fungus enters the crown through stems and grows slowly downward into the taproot. Although the infection can take 6 months to 2 years to kill a plant and above-ground symptoms may be indistinct, the disease reduces plant vigor and yield. Leaves and stems are generally infected during spring rains, but crown infections can occur anytime. The disease is most damaging when alfalfa is not actively growing.

MANAGEMENT

To minimize the affects of Stagonospora crown and root rot, provide optimum growing conditions for the alfalfa crop. Consider rotating out of alfalfa for 2 years to eliminate the sources of inoculum within a field. For more information, see CROP ROTATION. No resistant cultivars are available, but germplasm with moderate resistance has been released.

STEMPHYLLIUM LEAF SPOT (11/06)

Pathogen: *Stemphyllium botryosum*

SYMPTOMS

A tan center and a dark border around an irregularly shaped lesion distinguish Stemphyllium leaf spot from other leafspot diseases. Once the border is formed, the spot ceases to get larger in size. New spores will form in the center of the leaf spot.

COMMENTS ON THE DISEASE

Stemphyllium leaf spot is a cool season foliar disease. Cool temperatures (60-70ºF) and moist weather favor infection and spread. The disease is usually found in first and second cuttings. Because defoliation occurs only under heavy disease pressure, Stemphyllium leaf spot is not considered as serious as some other leaf spot diseases.

MANAGEMENT

No known control measures are used. Early harvest is an option with severe infestations. Some varieties may have more levels of resistance than others, but companies do not commonly report resistance to this disease.

SUMMER BLACK STEM and LEAF SPOT (11/06)

Pathogen: *Cercospora medicaginis*

SYMPTOMS

Symptoms of summer black stem and leaf spot usually appear after the alfalfa has grown a dense canopy. Defoliation from the base of the stem to the top is the most obvious symptom, but leaf spots usually appear first. Leaf spots begin as brown areas with a wavy margin. As spores on the surface of the spot are produced, the color of the spot appears gray or silvery. A diffuse yellow margin often surrounds the spot. Brown lesions also form on stems. High humidity (close to 100%) and temperatures ranging from 75° to 82°F favor disease development.

COMMENTS ON THE DISEASE

Summer black stem is a disease of limited importance and has been observed primarily in the Imperial Valley.

MANAGEMENT

Harvest early before extensive defoliation occurs to minimize losses.

VERTICILLIUM WILT (11/06)

Pathogen: *Verticillium albo-atrum*

SYMPTOMS

Verticillium wilt symptoms include yellowing of leaf tips, sometimes in a V-shaped pattern. The edges of some apical leaflets will roll upward. As symptoms progress, leaves become desiccated and sometimes reddish in color. They may defoliate, leaving behind a stiff petiole. The infected stem does not wilt and remains green until all the leaves are dead. Xylem tissue in roots becomes brown in color.

COMMENTS ON THE DISEASE

Verticillium wilt of alfalfa is a warm season disease and can be serious in susceptible varieties. Yields have been reduced by 50% in the second year of production. This disease has been found in alfalfa growing in the Mojave Desert and Riverside and San Bernardino counties. It has not yet been identified in the Central Valley or Imperial, Palo Verde, or Coachella valleys but has been found in a few coastal areas.

Verticillium albo-atrum can be carried internally and externally on alfalfa seed. The fungus also survives in alfalfa hay and in animal manure. The fungus penetrates alfalfa roots directly or through wounds. Spread within an alfalfa field can also occur through infection of cut stems when swathing. The fungus has been detected on sheep, which are trucked from one region to another to graze fields in winter months.

MANAGEMENT

The most practical control measure is to plant resistant varieties. Cultivars resistant to Verticillium are listed in the National Alfalfa Alliance Web site, http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf. In areas where the disease does not occur, care to prevent importation of infected seed or plant materials is recommended.

Nematodes

(Section reviewed 11/06)

Scientific Names: Alfalfa stem nematode: *Ditylenchus dipsaci*
Root knot nematode: *Meloidogyne hapla*, *M. incognita*, *M. javanica*, *M. thamesi*, *M. arenaria*, and *M. chitwoodi*
Stunt nematode: *Tylenchorhynchus clarus*
Lesion nematode: *Pratylenchus penetrans* and *P. neglectus*

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. The alfalfa stem nematode feeds in the stems and crowns of the alfalfa plant, while the other nematodes listed above feed on roots.

The nematode life cycle typically includes an egg stage, four larval stages, and an adult stage. The life cycle, from egg hatching to egg production, usually requires 3 to 6 weeks under optimal conditions to complete. Environmental factors, such as soil temperature, soil moisture, host status, and time of infection, can influence the number of nematode generations completed within a year. Nematodes move relatively short distances on their own (a few inches per year), but they are easily spread long distances by soil movement (wind, farm equipment, etc.), irrigation water, nursery stock, seed, and debris in seed and hay.

DAMAGE

Both stem nematode and root knot nematodes cause substantial damage and are of major concern in California. In general, the symptoms and damage described below are characteristic of nematode problems but not diagnostic because they could result from other causes as well. Nematode injury typically occurs in areas or pockets of the field and is not evenly distributed throughout the field.

Alfalfa Stem Nematode

Stem nematodes enter bud tissue and migrate into developing buds. Infected stems become enlarged and discolored, nodes swell, and internodes become shorter than those on healthy plants. Alfalfa plants infected with the alfalfa stem nematode have stunted growth, fewer shoots, and deformed buds. As nematode populations increase, lower stems on infected plants may turn black. Long periods of parasitism during moderate temperatures and high humidity may cause stem blackening for 1 foot or more above the ground. Another typical sign of a stem nematode infection is the presence of "white flags," which are branches devoid of chlorophyll. White flags are caused when nematodes start moving to leaf tissue and destroy chloroplasts, leaving pale leaf tissue. As plants die in the field, weeds often invade the open areas.

Root Knot Nematodes

Infection of alfalfa by *Meloidogyne* species may be confined to localized areas of a field or extend throughout an entire field. The extent of the damage in the field depends on several factors, including initial nematode population level, alfalfa variety, and soil temperature at planting time. High initial populations and relatively warm soil temperatures may cause serious injury to seedlings, resulting in stunting. The northern root knot nematode (*M. hapla*) infects and parasitizes roots of alfalfa plants and causes the plant cells to enlarge into small oval galls on the roots that can be seen with the naked eye. Galls caused by root knot nematodes are accompanied by lateral root growth, unlike galls caused by the beneficial nitrogen-fixing bacteria. In a heavily infested field, young seedlings may be killed by this nematode, even though roots may not display galls. The Columbia root knot nematode (*M. chitwoodi*) produces symptoms similar to the northern root knot nematode, but it is less pathogenic to alfalfa. This nematode causes tiny galls that can easily be missed if roots are not examined carefully. Root knot nematodes, like stem nematodes, may enhance the development of diseases such as bacterial wilt, Phytophthora root rot, and Fusarium wilt. In addition, damage by the alfalfa stem nematode may be more severe when the northern root knot nematode is also present.

Root Lesion Nematodes

Plants infected with root lesion nematodes exhibit aboveground symptoms such as stunting and nutrient deficiencies. Impact on the root system includes reduced root growth and black or brown lesions on the root surface. Lesions may fuse to cause the entire roots to appear brown. Secondary infections of roots by bacterial and fungal pathogens commonly occur with a root lesion nematode infestation; feeding by root lesion nematodes may overcome the resistance of the alfalfa varieties to these pathogens. Damage caused by lesion nematode depends

on the alfalfa variety and the species of lesion nematode present in the field. Under severe infestation, young plants often die, resulting in yield reductions.

FIELD EVALUATION

It is critical to know the nematode species present and the density of their populations to make management decisions. If a previous field or crop had problems caused by nematodes that are listed as pests of alfalfa, population levels 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.

If symptoms of stem nematode are evident, such as stunted growth and open patches in the field, cut several stems with symptoms from several different plants, place them in a plastic bag, and send them to a laboratory for positive identification. If root-feeding nematodes are suspected, take soil samples from within the root zone (6 to 18 inches deep). Divide the field into sampling blocks of not more than twenty acres each that represent cropping history, crop injury, or soil texture. Take several subsamples randomly from a block, mix them thoroughly and make a composite sample of about 1 quart (1 liter) for each block. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, the current and previous crop, and the crop you intend to grow. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor for more details about sampling, to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

MANAGEMENT OF ALFALFA STEM NEMATODE

Resistant Varieties

Identify the species of nematodes present in the field because resistant alfalfa varieties are resistant to specific species and not all pest nematodes of alfalfa. It has been suggested that without some level of alfalfa stem nematode resistance, alfalfa production would be seriously threatened in many areas. For more information on current nematode-resistant varieties, see the list of alfalfa varieties provided by the National Alfalfa Alliance, available on line at http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf).

Prevention (Sanitation and Exclusion)

Use clean, nematode-free seed. Avoid moving contaminated farm machinery or livestock from an infested field to a clean field. Avoid using contaminated wastewater or tail water. Keep manure from feedlots where cattle have been fed infected hay out of clean fields.

Cultural Practices

Fall burning (in alfalfa seed production systems) decreases nematode infection and mortality, but spring burning appears to enhance infection and increase plant mortality.

The alfalfa stem nematode is a biological "race" of stem nematodes, and its host range is very limited. Consequently, rotation with nonhost crops such as sorghum, small grains, beans, and corn on a 2- to 4-year basis should reduce alfalfa stem nematode populations. Be careful to avoid reinfesting the field with contaminated irrigation water or machinery. Eliminating old and volunteer alfalfa plants through a weed control program is also important to avoid reinfestation. Also, cutting alfalfa fields only when the top 2 to 3 inches of soil are dry should help reduce reinfestation. University of Idaho variety trials demonstrate that frugal applications of irrigation water to keep soil surfaces dry will minimize spread into later cuttings.

Chemical Control

No nematicides are registered for use against the alfalfa stem nematode. Fumigation before planting may be too costly relative to potential economic benefits.

MANAGEMENT OF ROOT KNOT NEMATODES

Resistant Varieties

The use of resistant alfalfa varieties is probably the most practical means of managing root knot nematodes. A number of resistant varieties such as Archer II and a new variety, Ameristand 444NT, are now commercially available for the Columbia root knot and northern root knot nematodes. Unlike other crops such as tomatoes, resistant varieties of alfalfa do not help reduce nematode populations.

Crop Rotation

Depending on the root knot nematode species present in the field, crop rotation can be a useful management strategy. It is important to have the species identified. For *Meloidogyne incognita,* the following are good rotation crops: barley, oats, wheat, cole crops, corn, cotton, hops, sudangrass, cowpea, and watermelon. For *M. napla,* cotton serves as a good rotation crop.

Chemical Control

Soil fumigation before planting can be effective against the northern root knot nematode, but fumigants are expensive and generally not economically feasible on alfalfa. No nonfumigant nematicides are currently registered on alfalfa.

MANAGEMENT OF ROOT LESION NEMATODES

Resistant Varieties

Alfalfa germplasm with resistance to lesion nematodes has been identified and developed. Archer II, Ameristand 403T and Ameristand 444NT are commercial varieties developed for the lesion nematode. These varieties have satisfactory resistance to *Pratylenchus* species and are the best means of controlling lesion nematodes because the cost of chemical control is prohibitive.

Crop Rotation

Lesion nematodes have a very wide host range and more than one species may occur in a field making crop rotation not effective for lesion nematode management. However, leaving a field fallow, followed by treatment with a nematicide, can reduce lesion nematode populations.

Weed Management in Seedling Alfalfa

(Section reviewed 11/06)

INTEGRATED WEED MANAGEMENT IN SEEDLING ALFALFA (11/09)

Uncontrolled weeds in seedling alfalfa can cause loss of the stand during crop establishment. Weed infestations can weaken young alfalfa plants, retard growth, and delay the first cutting.

Proper establishment and management of an alfalfa stand are essential for weed control. It is not cost-effective to control weeds in a thin or weak stand. Alfalfa that germinates and grows rapidly in response to warm temperatures, adequate soil moisture, and shallow planting will develop into a competitive and relatively weed-free stand. Adequate soil fertility, especially phosphorus, is also essential in establishing and maintaining a vigorous stand. Plant alfalfa varieties that are well adapted and grow vigorously in your climate and soil.

Planting alfalfa in rows on beds or on shallow corrugations is commonly practiced in areas where soils lack good drainage, such as heavy clay soils, or on those with a high salt content. Possible weed problems associated with this practice include increased weed populations in the furrows and decreased effectiveness of water-run herbicides caused by uneven water distribution across the bed. When planted on beds, alfalfa is not as competitive against weeds because the ground is not covered completely by the crop canopy.

MONITORING

Start looking for weeds when the crop germinates. Correctly identifying weeds is fundamental to planning a weed control program. It is important to know the kind and abundance of weeds present in an alfalfa field. Weeds are easiest to identify when full grown and flowering; seedling weeds can be difficult to identify. However, ordinarily weed control decisions must be made quickly, on the basis of identifying weed seedlings. For help in identifying weed seedlings, view photos of common winter annual, summer annual, and perennial weed seedlings available in the online version of this guideline.

Monitor for weeds when they are expected to emerge. In the Central Valley most winter annual weeds start to germinate in late September or October and continue to germinate until late January whenever soil moisture and temperature conditions permit. Summer annual weeds, especially grasses, start to germinate in late February and early March and can continue to germinate until midsummer with each irrigation. Record observations on a monitoring form *(available online)*.

The need for treatment depends on weed species, their competitiveness and toxicity to livestock, the potential market for the alfalfa, and time of year. Vigor of the alfalfa stand is a complicating factor; weakened stands will require treatment when denser ones don't.

WEED MANAGEMENT BEFORE PLANTING

Prepare fields so drainage is adequate to prevent ponding or uneven irrigation. Avoid planting in fields that have serious perennial weed infestations. Preirrigate and then cultivate the germinating weeds before planting. This procedure may be repeated several times when topsoil is heavily infested with weed seeds.

Time of Seeding

It is important to select planting time carefully; generally, fall (September-October) is the preferred time in the San Joaquin and Sacramento Valleys, whereas late August is the preferred time in the intermountain area for a fall planting and April for spring seeding. Fields planted in summer can be seriously infested by weeds that germinate in summer. Alfalfa planted too late (December) will germinate and grow slowly, allowing winter weeds to become well established before alfalfa can be safely treated with an herbicide.

In areas where soil type allows, choosing a late winter or early spring planting date (February-March) in the Central Valley can reduce problems with winter annual weeds because the weeds can be removed before the seedbed is established. Planting too late in spring, however, can allow summer grasses to become established in seedling alfalfa if preplant herbicides are not used.

If fields infested with field bindweed, perennial grasses, or nutsedge must be used, plant in early fall. This will ensure that alfalfa is established and vigorous when these perennials start growing in spring.

Depth of Planting
Depending on the soil type, plant seeds into a firm seedbed about 0.25 inch in depth to provide for both proper soil-seed contact and timely alfalfa seed germination. Seeds placed too shallowly may dry out and die, or they may develop poor roots. Seeds planted too deeply may be unable to reach the surface to emerge after germination.

Seeding Rate
One of the few tools for weed management in organic production is the use of higher rates of seeding for competitiveness against weeds.

Interplanting Oats in Seedling Alfalfa
Planting oats with alfalfa can suppress weeds without the use of herbicides and reduce erosion during stand establishment. The first cutting will have lower alfalfa content but, in combination with the harvested oats, will provide higher yields of forage than pure alfalfa stands. The next two cuttings are affected only slightly and there is no affect on later cuttings or stand life, providing the oat seeding rate is not too high (i.e. above 20 lb/acre).

Planting oats with alfalfa is often a two-step process because of the difference in seed sizes. Establish the stand at the normal alfalfa planting time. If possible, preirrigate and cultivate to eliminate weeds before planting. Oat seed is planted first. The ideal seeding rate for oat in California is 8 to 16 pounds per acre with the standard alfalfa seeding rate. Most standard grain drills cannot plant oats at this low rate, so broadcast and incorporate oats with a disc or springtooth harrow. Do not apply nitrogen; it may make the oats too competitive.

A short, midseason oat variety works best with an early fall planting because it matures with the alfalfa and is less likely to lodge and reduce alfalfa growth. In spring plantings, an early maturing variety such as Montezuma produces more growth by the time alfalfa is ready to cut.

The first cutting will be mostly oats with a small amount of alfalfa. Curing time for the first cutting may be several days longer than that for pure alfalfa. For additional information on interplanting oats in alfalfa, see *Overseeding and Companion Cropping in Alfalfa,* UC ANR Publication 21594.

Herbicides
If afield has a history of weed populations, consider making a treatment with a preemergent herbicide. Apply a preplant, incorporated herbicide such as benefin (Balan) or EPTC (Eptam) to the soil surface and mechanically mix into the soil before planting the alfalfa seed. If a disk or a ground-driven tiller is used to incorporate herbicides, work the soil to double the desired depth of incorporation; power tillers incorporate to the set depth. To be effective, preplant herbicides require soil moisture. To control most emerged annual and perennial weeds, a postemergent herbicide can be applied either before planting or before crop emergence, depending on the particular herbicide being used. If postemergent herbicides are to be used, preirrigate to germinate the weed seeds. *(View photos online of weeds not controlled by herbicides in conventional alfalfa)*

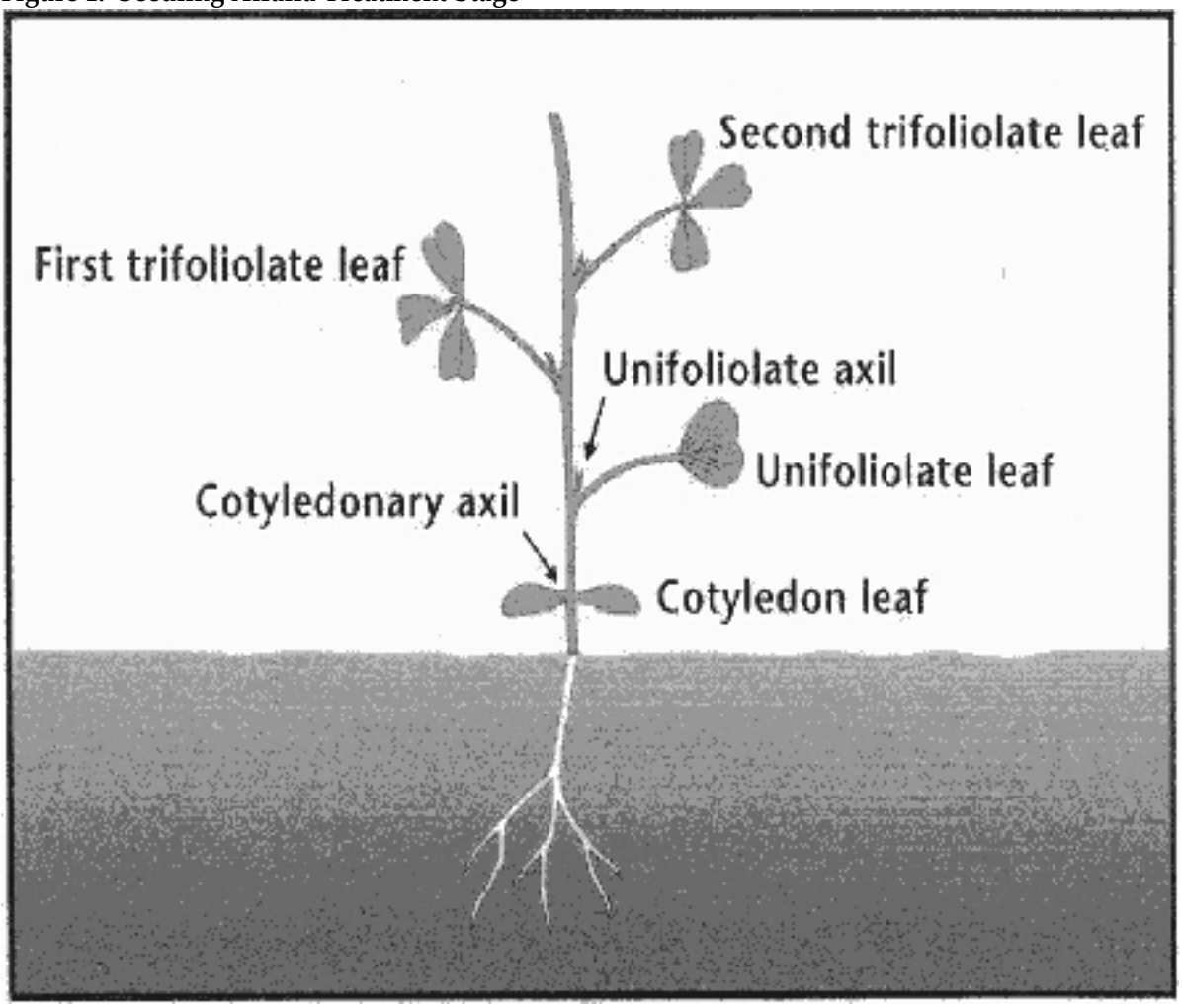
The use of transgenic alfalfa varieties such as Roundup-ready alfalfa allows glyphosate (Roundup) to be applied to emerged alfalfa at any growth stage without the risk of crop damage. By applying glyphosate according to the size of the weed, and not the crop, weeds can be controlled early in the life of the alfalfa stand before they compete with and damage the crop, a problem that exists with conventional alfalfa herbicide programs. For more information, see TRANSGENIC HERBICIDE-TOLERANT ALFALFA.

WEED MANAGEMENT AFTER PLANTING

Preemergent herbicides for use after alfalfa emergence must be water-incorporated by sprinklers or rainfall. Preemergent herbicides used postplant do not normally persist in the soil longer than 6 weeks under cropping conditions; cool soil in winter can prolong activity by a few weeks. Be sure to check labels for grazing and harvesting restrictions.

The most common means of controlling weeds in seedling alfalfa is to apply postemergent herbicides after the crop and weeds have emerged. The economic returns of an appropriate, well-timed postemergent herbicide application can often be realized in the first harvest alone and may continue with additional harvests. Timing application in relation to the crop size (Fig. 1) and weed size is very important; best results are obtained when weeds are small (cotyledon to 2nd leaf) and growing vigorously. The table below summarizes some of the characteristics of postemergent herbicides, application timing, and phytotoxicity symptoms.

Figure 1. Seedling Alfalfa Treatment Stage



From Canevari, W. M. et. al. 2002. *Postemergence Weed Control in Seedling Alfalfa and Phytotoxicity Symptoms,* UC ANR Publication 21615.

Herbicide Guide for Seedling Alfalfa.[1]

Herbicide (chemical name)	Activity	Soil-residual properties	Minimum alfalfa growth stage for treatment (see Fig. 1)	Recommended weed growth stage for treatment	Herbicide symptoms on alfalfa	Herbicide symptoms on weeds
Buctril (bromoxynil)	contact	no	second trifoliolate leaf	broadleaf weeds should be 2" tall or less	chlorosis and burn beginning on leaf margins across entire leaf; symptoms show within 1-2 days	browning and necrosis within 2-4 days
Butyrac (2,4-DB)	systemic (foliar)	no	second trifoliolate leaf	broadleaf weeds should be 3" tall or less	leaf narrowing and plant twisting; epinasty	twisting, epinasty, chlorosis in 1-10 days

Herbicide (chemical name)	Activity	Soil-residual properties	Minimum alfalfa growth stage for treatment (see Fig. 1)	Recommended weed growth stage for treatment	Herbicide symptoms on alfalfa	Herbicide symptoms on weeds
Gramoxone Inteon (paraquat)	contact	no	third trifoliolate leaf	small broadleaf weeds 1-3" tall and grasses to 6" tall	bleaching to browning of leaf; stand reduction on smaller seedling with less than three trifoliate leaves	leaf bleaching and necrosis; in 1-3 days
Kerb (pronamide)	some contact; mostly root uptake	yes	first trifoliolate leaf	best before weed germination, some postemergence control on seedling weeds	occasional white speckling of leaves; stubbed roots	leaf browning and necrosis; root inhibition in 2-4 weeks
Poast (sethoxydim)	systemic (foliar)	no	first trifoliolate leaf	grass weeds 2-6" tall, vigorously growing before tillers develop	none observed	chlorosis followed by necrosis at growing point in 6-10 days
Pursuit (imazethapyr)	systemic (foliar and root uptake)	yes	second trifoliolate leaf	broadleaf weeds and some grass weeds, less than 3" tall and vigorously growing	temporary growth reduction; mild chlorosis	chlorosis followed by necrosis in 2-4 weeks
Raptor (imazamox)	systemic (foliar and root uptake)	yes	second trifoliolate leaf	broadleaf and grass weeds, less than 3" tall and vigorously growing	temporary growth reduction; mild chlorosis	chlorosis followed by necrosis in 2-4 weeks
Roundup (glyphosate) (For Roundup-ready alfalfa only)	systemic (foliar)	no	any stage	broadleaf and grass weeds, less than 6" tall and vigorously growing	none	leaf chlorosis followed by necrosis in 1-2 weeks
Select Max (clethodim)	systemic (foliar)	no	first trifoliolate leaf	grass weeds 2-6" tall, vigorously growing before tillers develop	none observed	chlorosis followed by necrosis at growing point in 6-10 days
Velpar (hexazinone)	some contact; mostly root uptake	yes	sixth trifoliolate leaf, with multiple stems and root length greater than 6"	postemergent and preemergent activity on small broadleaf weeds less than 2" tall	leaf burn and chlorosis; small alfalfa seedlings may be killed	chlorosis and necrosis in 1-2 weeks

1 Adapted from Canevari, W. M. et. al. 2002. Postemergence Weed Control in Seedling Alfalfa and Phytotoxicity Symptoms, UC ANR Publication 21615.

Cutting and Grazing

If weeds do become established, a young alfalfa stand can be cut close to the ground and the forage and weeds removed. Cutting inhibits growth of most weeds, especially broadleaves, allowing alfalfa regrowth to compete more successfully. Use caution when removing the forage early so that wheel traffic does not damage young plants and compact wet soil. Young alfalfa plants should have at least three to four stems per crown and be at least in early flower before the first cutting because younger plants have low root reserves. Early forage removal is not generally recommended unless weeds are dense enough to overtop the alfalfa and cause stand loss.

In the low desert, sheep grazing is used to remove winter annual weeds from new alfalfa plantings. Grazing can be worthwhile if these requirements are met:

- The alfalfa is large enough (three to four stems) to prevent sheep from pulling the crop from the ground
- The soil is dry and a corral is available in case of rain
- The sheep are left long enough to eat all the weeds.

COMMON and SCIENTIFIC NAMES OF WEEDS IN SEEDLING ALFALFA (11/06)

Common Name	Scientific Name
Barley, hare	*Hordeum murinum* subsp. *leporinum*
Barnyardgrass	*Echinochloa crus-galli*
Bluegrass, annual	*Poa annua*
Brome, ripgut	*Bromus rigidus*
Burclover	*Medicago polymorpha*
Buttercup	*Ranunculus californicus*
Canarygrass, littleseed	*Phalaris minor*
Celery, wild	*Ciclospermum leptophyllum*
Chickweed, common	*Stellaria media*
Cocklebur, common	*Xanthium strumarium*
Dock, curly (seedling)	*Rumex cripus*
Dovefoot	*Geranium molle*
Fescue, rattail	*Vulpia myuros*
Fiddleneck	*Amsinckia intermedia*
Filarees	*Erodium* spp.
Foxtail, yellow	*Setaria pumila*
Goosegrass	*Eleusine indica*
Groundsel, common	*Senecio vulgaris*
Henbit	*Lamium amplexicaule*
Jimsonweed	*Datura stramonium*
Knotweeds	*Polygonum* spp.
Lambsquarters, common	*Chenopodium album*
Lettuce, prickly	*Lactuca serriola*
Mallow, little (cheeseweed)	*Malva parviflora*
Milkthistle	*Silybum marianum*
Miner's lettuce	*Claytonia perfoliata*
Mustard, black	*Brassica nigra*
Nettle, burning	*Urtica urens*
Nightshade, hairy	*Solanum sarrachoides*
Oat, wild	*Avena fatua*
Oxtongue, bristly	*Picris echioides*
Pigweed, redroot	*Amaranthusretroflexus*
Pineapple-weed	*Chamomilla suaveolens*
Punagrass	*Achnatherum brachychaetum*
Radish, wild	*Raphanus raphanistrum*
Redmaids (desert rockpurslane)	*Calandrinia ciliata*
Rocket, London	*Sisymbrium irio*
Rush, toad	*Juncus bufonius*
Ryegrass, Italian	*Lolium multiflorum*
Shepherd's-purse	*Capsella bursa-pastoris*
Smartweed, water	*Polygonum amphibium* var. *emersum*
Sowthistle	*Sonchus oleraceus*
Speedwell, thymeleaf	*Veronica serpyllifolia*

(continued next page)

Common Name	Scientific Name
Spurge, petty	*Euphorbia peplus*
Spurry, corn	*Spergula arvensis*
Starthistle, yellow	*Centaurea solstitialis*
Sunflower, yellow	*Helianthus annuus*
Swinecress	*Coronopus* spp.
Wheat, volunteer	*Triticum aestivum*
Willowherb, tall annual (panicle-leaf)	*Epilobium brachycarpum*

SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL IN SEEDLING ALFALFA (7/09)

	POSTEMERGENT																	
	24DB*[1]	24DB*[3]	24DB*[4]	BRO[1]	BRO[2]	CLE[1]	CLE[2]	GLY (RR)+	HEX	IMA[1]	IMA[2]	IMZ[1]	IMZ[2]	PAR*[1]	PAR*[2]	PRO*	SET[1]	SET[2]
BROADLEAF WEEDS																		
Burclover	N	N	N	N	N	N	N	P	P	N	N	N	N	N	N	N	N	N
Buttercup	N	N	N	N	N	N	N	—	—	C	C	P	C	P	C	—	N	N
Celery, wild	N	N	N	N	N	N	N	C	P	N	N	N	N	N	P	—	N	N
Chickweed	N	N	N	N	N	N	N	C	P	C	C	C	C	P	C	N	N	N
Cocklebur	C	C	C	C	C	N	N	C	C	C	C	C	C	N	P	N	N	N
Dock, curly (seedling)	P	C	C	N	N	N	N	C	N	N	P	N	N	N	N	P	N	N
Dovefoot	N	N	P	N	N	N	N	C	—	C	C	C	C	P	C	N	N	N
Fiddleneck	N	N	N	C	C	N	N	P	P	N	P	N	P	N	P	N	N	N
Filarees	N	N	N	N	N	N	N	P	P	P	C	P	C	N	P	N	N	N
Groundsel, common	N	P	C	P	C	N	N	C	C	N	N	N	N	N	P	N	N	N
Henbit	N	N	N	N	N	N	N	C	N	N	P	P	C	N	N	C	N	N
Jimsonweed	P	C	C	C	C	N	N	C	—	C	C	C	C	C	C	—	N	N
Knotweed (seedling)	N	P	C	P	P	N	N	C	C	P	C	P	C	N	N	C	N	N
Lambsquarters	C	C	C	C	C	N	N	C	C	N	N	P	C	P	C	C	N	N
Lettuce, miners	N	N	N	N	N	N	N	C	P	C	C	P	C	P	C	N	N	N
Lettuce, prickly	P	C	C	P	C	N	N	C	N	N	N	N	N	P	C	N	N	N
Mallow, little (cheeseweed)	N	N	N	N	N	N	N	P	N	P	C	P	C	N	N	N	N	N
Milkthistle	N	N	P	N	P	N	N	C	—	N	N	N	N	P	P	N	N	N
Mustard, black	N	P	C	C	C	N	N	C	P	C	C	C	C	N	P	N	N	N
Nettle, burning	N	N	P	N	N	N	N	P	N	P	C	P	C	N	N	N	N	N
Nightshade, hairy	P	C	C	C	C	N	N	C	C	C	C	C	C	—	C	C	N	N
Oxtongue, bristly	—	P	P	P	C	N	N	—	—	N	P	—	—	—	—	—	N	N
Pineappleweed	N	N	N	N	P	N	N	C	P	N	N	N	N	P	C	N	N	N
Pigweed, redroot	C	C	C	N	P	N	N	C	C	C	C	C	C	N	N	C	N	N
Radish, wild	N	P	C	N	P	N	N	C	P	P	C	P	C	N	P	N	N	N
Rockpurslane, desert	N	N	N	N	N	N	N	C	N	C	C	N	N	P	C	P	N	N
Rocket, London	P	C	C	P	C	N	N	C	P	C	C	C	C	C	C	C	N	N
Rush, toad	N	N	N	—	—	N	N	C	C	C	C	—	—	N	N	C	N	N
Shepherd's-purse	N	P	P	C	C	N	N	C	P	P	C	C	C	N	P	N	N	N
Smartweed, swamp	P	C	C	P	C	N	N	C	C	C	C	—	C	N	P	N	N	N
Sowthistle	P	C	C	C	C	N	N	C	N	N	N	—	—	N	C	N	N	N
Speedwell, thymeleaf	N	N	N	N	N	N	N	C	N	N	N	N	N	N	N	P	N	N
Spurge, petty	N	N	N	N	—	N	N	—	—	C	C	—	—	C	C	—	N	N
Spurry, corn	N	N	N	N	N	N	N	C	C	N	N	—	—	—	C	C	N	N
Starthistle, yellow	N	N	N	P	C	N	N	—	C	N	N	—	—	—	C	N	N	N
Sunflower, wild	C	C	C	C	C	N	N	C	C	C	C	C	C	N	P	N	N	N
Swinecress	N	N	P	N	P	N	N	C	C	C	C	—	—	N	P	N	N	N
Willowherb, panicle	P	C	C	N	—	N	N	—	—	C	C	—	—	N	N	—	N	N

	POSTEMERGENT																		
	24DB*[1]	24DB*[3]	24DB*[4]	BRO[1]	BRO[2]	CLE[1]	CLE[2]	GLY (RR)+	HEX	IMA[1]	IMA[2]	IMZ[1]	IMZ[2]	PAR*[1]	PAR*[2]	PRO*	SET[1]	SET[2]

C = control (100-80%control) P = partial control (79-65% control) N = no control (less than 65% control) — = no information

Weed size and spray coverage impact weed control as will herbicide rate, adjuvant type, spray volume, and environmental conditions.

24DB*[1] = 2,4-DB* (Butyrac 0.5, etc.)
24DB*[3] = 2,4-DB* (Butyrac 1.0, etc.)
24DB*[4] = 2,4-DB* (Butyrac 1.5, etc.)
BRO[1] = bromoxynil (Buctril 0.25)
BRO[2] = bromoxynil (Buctril 0.375)
CLE[1] = clethodim (Select Max 0.1)
CLE[2] = clethodim (Select Max 0.25)
GLY+ = glyphosate (Roundup WeatherMax)
HEX = hexazinone (Velpar 0.25)
IMA[1] = imazethapyr (Pursuit 0.063)
IMA[2] = imazethapyr (Pursuit 0.094)
IMZ[1] = imazamox (Raptor 0.032)
IMZ[2] = imazamox (Raptor 0.047)
PAR*[1] = paraquat* (Gramoxone 0.125)
PAR*[2] = paraquat* (Gramoxone 0.25)
PRO* = pronamide (Kerb 1.0)
SET[1] = sethoxydim (Poast 0.375)
SET[2] = sethoxydim (Poast 0.5)

\+ For Roundup-ready alfalfa only

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

	POSTEMERGENT																		
	24DB*[1]	24DB*[2]	24DB*[3]	24DB*[4]	BRO[1]	BRO[2]	CLE[1]	CLE[2]	GLY (RR)+	HEX	IMA[1]	IMA[2]	IMZ[1]	IMZ[2]	PAR*[1]	PAR*[2]	PRO*	SET[1]	SET[2]
GRASS WEEDS																			
Barley, hare	N	N	N	N	N	N	C	C	C	N	N	N	C	C	P	P	C	C	C
Barnyardgrass	N	N	N	N	N	N	C	C	C	N	C	C	C	C	P	P	N	C	C
Bluegrass, annual	N	N	N	N	N	N	P	C	C	P	N	P	N	P	P	C	C	N	N
Brome, ripgut	N	N	N	N	N	N	C	C	C	N	N	N	C	C	P	P	C	P	—
Canarygrass, hood	N	N	N	N	N	N	C	C	C	N	N	P	C	C	N	P	N	C	C
Fescue, rattail	N	N	N	N	N	N	—	C	C	N	N	N	P	P	P	P	—	N	P
Foxtail, yellow	N	N	N	N	N	N	P	C	C	N	N	P	C	C	P	P	N	C	C
Goosegrass	N	N	N	N	N	N	P	P	C	N	N	N	N	N	N	N	N	P	P
Oat, wild	N	N	N	N	N	N	C	C	C	N	P	P	C	C	P	P	C	C	C
Punagrass	N	N	N	N	N	N	P	C	P	N	N	N	N	N	N	N	—	P	C
Ryegrass, Italian	N	N	N	N	N	N	C	C	C/P^	N	N	N	C	C	P	C	C	C	C
Wheat, volunteer	N	N	N	N	N	N	C	C	C	N	N	P	C	C	P	C	C	C	C

C = control (100-80% control) P = partial control (79-65% control) N = no control (less than 65% control) — = no information

^ = glyphosate (Roundup) resistance developing in many crops

Weed size and spray coverage impact weed control as will herbicide rate, adjuvant type, spray volume, and environmental conditions.

24DB*[1] = 2,4-DB* (Butyrac 0.5, etc.)
24DB*[2] = 2,4-DB* (Butyrac 0.75, etc.)
24DB*[3] = 2,4-DB* (Butyrac 1.0, etc.)
24DB*[4] = 2,4-DB* (Butyrac 1.5, etc.)
BRO[1] = bromoxynil (Buctril 0.25)
BRO[2] = bromoxynil (Buctril 0.375)
CLE[1] = clethodim (Select Max 0.1)
CLE[2] = clethodim (Select Max 0.25)
GLY+ = glyphosate (Roundup WeatherMax)
HEX = hexazinone (Velpar 0.25)
IMA[1] = imazethapyr (Pursuit 0.063)
IMA[2] = imazethapyr (Pursuit 0.094)
IMZ[1] = imazamox (Raptor 0.032)
IMZ[2] = imazamox (Raptor 0.047)
PAR*[1] = paraquat* (Gramoxone 0.125)
PAR*[2] = paraquat* (Gramoxone 0.25)
PRO* = pronamide (Kerb 1.0)
SET[1] = sethoxydim (Poast 0.375)
SET[2] = sethoxydim (Poast 0.5)

\+ For Roundup-ready alfalfa only

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

Susceptibility of Weeds to Herbicide Control in Seedling Alfalfa, continued

	POSTEMERGENT COMBINATIONS										
	BRO IMA[1]	BRO 24DB*[2]	BRO SET[3]	BRO CLE[4]	BRO HEX[5]	IMA 24DB*[6]	IMA CLE[7]	IMA SET[8]	SET 24DB*[9]	IMA PAR*[10]	IMA HEX[11]
BROADLEAF WEEDS											
Burclover	N	N	N	N	P	N	N	N	N	N	P
Buttercup	C	N	N	N	N	C	C	C	N	C	C
Celery, wild	N	N	N	N	N	N	N	N	N	P	P
Chickweed	C	N	N	N	C	C	C	C	N	C	C
Cocklebur	C	C	C	C	C	C	C	C	C	C	C
Dock, curly (seedling)	C	C	N	N	N	P	N	N	C	N	P
Dovefoot	C	P	N	N	N	C	C	C	P	C	C
Fiddleneck	C	C	C	C	C	N	N	N	N	P	P
Filarees	C	N	N	N	P	P	P	P	N	C	C
Groundsel, common	C	C	C	C	C	N	N	N	C	C	C
Henbit	P	N	N	N	P	N	N	N	N	N	N
Jimsonweed	C	C	C	C	C	C	C	C	C	C	C
Knotweed	P	P	P	P	P	C	P	P	P	P	C
Lambsquarters	C	C	C	C	C	C	N	N	C	C	C
Lettuce, miners	C	N	N	N	P	C	C	C	N	C	C
Lettuce, prickly	C	C	C	C	C	C	N	N	C	C	N
Mallow, little (cheeseweed)	C	N	N	N	N	C	P	P	N	C	C
Milkthistle	P	P	N	N	N	N	N	N	P	P	—
Mustard, black	C	C	C	C	C	C	C	C	P	C	C
Nettle, burning	C	N	N	N	N	C	P	P	N	P	C
Nightshade, hairy	C	C	C	C	C	C	C	C	C	C	C
Oxtongue, bristly	P	P	C	C	P	—	N	N	P	—	P
Pineapple-weed	P	C	C	C	—	P	N	N	C	C	—
Pigweed, redroot	C	C	P	P	C	C	C	C	C	C	C
Radish, wild	C	P	P	P	P	P	P	P	P	P	C
Rockpurslane, desert	C	N	N	N	N	C	C	C	N	C	C
Rocket, London	C	C	C	C	P	C	C	C	C	C	C
Rush, toad	C	—	—	—	C	C	C	C	N	C	C
Shepherd's-purse	C	C	C	C	C	P	P	P	P	P	C
Smartweed, swamp	C	C	C	C	C	C	C	C	C	C	C
Sowthistle	C	C	C	C	C	N	N	N	C	C	N
Speedwell, thymeleaf	N	N	N	N	N	N	N	N	N	N	N
Spurge, petty	C	N	N	N	N	C	C	C	N	C	C
Spurry, corn	N	N	N	N	C	N	N	N	N	C	C
Starthistle, yellow	C	C	C	C	C	N	N	N	N	C	—
Sunflower, wild	C	C	C	C	C	C	C	C	C	C	C
Swinecress	C	N	P	P	—	C	C	C	P	C	C
Willowherb, panicle	C	C	—	—	—	C	C	C	C	C	C

	POSTEMERGENT COMBINATIONS										
	BRO IMA[1]	BRO 24DB*[2]	BRO SET[3]	BRO CLE[4]	BRO HEX[5]	IMA 24DB*[6]	IMA CLE[7]	IMA SET[8]	SET 24DB*[9]	IMA PAR*[10]	IMA HEX[11]

Weed size and spray coverage impact weed control as will herbicide rate, adjuvant type, spray volume, and environmental conditions.

C = control (100-80% control) P= partial control (79-65% control) N = no control (less than 65% control) — = no information

1 = bromoxynil (Buctril 0.25) + imazethapyr (Pursuit 0.064)
2 = bromoxynil (Buctril 0.25) + 2,4-DB* (Butyrac 1.0, etc.)
3 = bromoxynil (Buctril 0.375) + sethoxydim (Poast 0.375)
4 = bromoxynil (Buctril 0.375) + clethodim (Select Max 0.25)
5 = bromoxynil (Buctril 0.25) + hexazinone (Velpar 0.125)
6 = imazethapyr (Pursuit 0.063) + 2,4-DB* (Butyrac 0.5, etc.)
7 = imazethapyr (Pursuit 0.063) + clethodim (Select Max 0.1)
8 = imazethapyr (Pursuit 0.063) + sethoxydim (Poast 0.375)
9 = sethoxydim (Poast 0.375) + 2,4-DB* (Butyrac 1.5, etc.)
10 = imazethapyr (Pursuit 0.063) + paraquat* (Gramoxone 0.25)
11 = imazethapyr (Pursuit 0.094) + hexazinone (Velpar 0.25)

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

Susceptibility of Weeds to Herbicide Control in Seedling Alfalfa, continued

	POSTEMERGENT COMBINATIONS										
	BRO IMA[1]	BRO 24DB*[2]	BRO SET[3]	BRO CLE[4]	BRO HEX[5]	IMA 24DB*[6]	IMA CLE[7]	IMA SET[8]	SET 24DB*[9]	IMA PAR[10]	IMA HEX[11]
GRASS WEEDS											
Barley, hare	N	N	C	C	N	N	C	P	C	P	N
Barnyardgrass	C	N	C	C	N	C	C	C	C	C	C
Bluegrass, annual	N	N	N	P	N	N	C	N	N	C	P
Brome, ripgut	N	N	P	C	N	N	C	P	P	P	N
Canarygrass, hood	P	N	C	C	N	P	C	C	C	P	P
Fescue, rattail	N	N	N	—	N	N	—	N	N	P	N
Foxtail, yellow	P	N	C	C	N	N	C	C	C	P	P
Goosegrass	N	N	P	N	N	N	P	P	P	N	N
Oat, wild	P	N	C	C	N	P	C	C	C	P	P
Punagrass	N	N	P	—	N	N	P	P	P	N	N
Ryegrass, Italian	N	N	C	C	N	N	C	C	C	C	N
Wheat, volunteer	P	N	C	C	N	N	C	C	C	P	P

Weed size and spray coverage impact weed control as will herbicide rate, adjuvant type, spray volume, and environmental conditions.

C = control (100-80% control) P = partial control (79-65% control) N = no control (less than 65% control)— = no information

1 = bromoxynil (Buctril 0.25) + imazethapyr (Pursuit 0.064)
2 = bromoxynil (Buctril 0.25) + 2,4-DB* (Butyrac 1.0, etc.)
3 = bromoxynil (Buctril 0.375) + sethoxydim (Poast 0.375)
4 = bromoxynil (Buctril 0.375) + clethodim (Select Max 0.25)
5 = bromoxynil (Buctril 0.25) + hexazinone (Velpar 0.125)
6 = imazethapyr (Pursuit 0.063) + 2,4-DB* (Butyrac 0.5, etc.)
7 = imazethapyr (Pursuit 0.063) + clethodim (Select Max 0.1)
8 = imazethapyr (Pursuit 0.063) + sethoxydim (Poast 0.375)
9 = sethoxydim (Poast 0.375) + 2,4-DB* (Butyrac 1.5, etc.)
10 = imazethapyr (Pursuit 0.063) + paraquat* (Gramoxone 0.25)
11 = imazethapyr (Pursuit 0.094) + hexazinone (Velpar 0.25)

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

HERBICIDE TREATMENT TABLE FOR SEEDLING ALFALFA (7/09)

Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)

When choosing an herbicide, consider the environmental impact. Not all registered pesticides are listed. Always read label of product being used.

PREPLANT

Before Weeds Emerge

A. BENEFIN (Balan) 60DF — 1.2–1.5 lb a.i. — 12 — —
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Incorporate shallow (2-inch depth) once within 4-8 hours after application and again before planting. Do not use on high organic soils. See label for rotational restrictions.

B. EPTC (Eptam) 7EC — 2–4 lb a.i. — 12 — —
WSSA MODE OF ACTION GROUP NUMBER[1]: 8
COMMENTS: Incorporate immediately 3–4 inches. Use low rate on sandy soil, high rate on heavy soil. Can be water-run or through sprinklers. To avoid crop injury, water-run only on flat ground; i.e., flood irrigation, not in furrows or on corrugations. Also, if applied through sprinklers on hot days, a significant amount of the material may be lost through evaporation.

After Weeds Emerge

A. GLYPHOSATE
(Roundup) — Annuals: 0.25–1.375 lb a.i. Perennials: 2–4.5375 lb a.i. — 4 — —
. . . or . . .
(Touchdown) — Annuals: 0.24–1 lb a.i. Perennials: 0.75–3.75 lb a.i. — 12 — —
WSSA MODE OF ACTION GROUP NUMBER[1]: 9
COMMENTS: In conventional alfalfa, apply anytime before planting to kill existing weeds. No soil residue. Do not mow or till before application. Do not apply just before rain or irrigation. High rate for annuals is only suggested for filaree control.

B. PARAQUAT* (Gramoxone Inteon) — 0.638–1 lb a.i. — 24 — —
WSSA MODE OF ACTION GROUP NUMBER[1]: 22
COMMENTS: Apply to emerged weeds. Do not use in soils that lack clay minerals, i.e., peat, muck, pure sand. For use in certain northern counties only (see label). Always use a nonionic surfactant with paraquat.

C. 2,4-DB* (Butyrac) — 0.5–1.5 lb a.i. — 48 — —
WSSA MODE OF ACTION GROUP NUMBER[1]: 4
COMMENTS: Apply late fall or early winter when weeds are 3 inches or shorter. Rates vary with formulation and weed size. Apply between 40°–90°F. Do not graze or harvest within 60 days for seedling alfalfa. Restricted use from Mar 15 - Oct 15 in some Central Valley counties. Check with your County Agricultural Commissioner.

D. PELARGONIC ACID (Scythe) — 3–10% volume/volume — 12 — —
WSSA MODE OF ACTION GROUP NUMBER[1]: 27
COMMENTS: A nonselective contact herbicide for control of emerged weeds. Can be used anytime before alfalfa emergence. Weed size and growth stage determine the rate needed for control: large perennial weeds require the highest rate. This material can also be used during winter dormancy to control winter weeds but cool weather reduces its efficacy. Because this is a contact herbicide, good spray coverage is essential for satisfactory weed control.

	Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)
	Herbicide combinations			
A.	BENEFIN (Balan) 60DF WSSA MODE OF ACTION GROUP NUMBER[1]: 3	1.2–1.5 lb a.i.	12	—
	. . . PLUS . . .			
	EPTC (Eptam) 7EC WSSA MODE OF ACTION GROUP NUMBER[1]: 8	3–3.9375 lb a.i.	12	—
	COMMENTS: Incorporate immediately, preferably in the same operation as application, to a 2- to 3-inch depth, so the disk or ground-driven tiller should be set to 4–6 inches. When planting on flat ground, broadcast these herbicides and incorporate by disking twice at right angles at a speed sufficient to mix the soil, or by using a power driven rotary tiller set at 2-3 inches. EPTC has a relatively short soil life; under cropping conditions expect it to last 1–2 months. Benefin has a moderate soil life and may persist 3–5 months. Fall application of benefin and incorporation to 3-inch depth will cause growth retardation of the alfalfa.			
	POSTPLANT (ROUNDUP-READY ALFALFA ONLY)			
A.	GLYPHOSATE (Roundup) WSSA MODE OF ACTION GROUP NUMBER[1]: 9	0.94–1.89 lb a.i. 22–44 fl oz	4	—
	COMMENTS: In Roundup-ready varieties, over-the-top applications can be made at any stage of growth. Do not use more than 132 fl oz/acre per year.			
	POSTPLANT (CONVENTIONAL AND ROUNDUP-READY ALFALFA)			
A.	BROMOXYNIL (Buctril) WSSA MODE OF ACTION GROUP NUMBER[1]: 6	0.25-0.375 lb a.i.	24	30–spring alfalfa 60–fall and winter alfalfa
	COMMENTS: A contact herbicide that has no soil residual. Apply when alfalfa is in the second trifoliolate leaf stage. Broadleaf weeds should be 2 inches or less. Thorough coverage is essential for best control. Do not apply when temperatures exceed 80°F. Combining with sethoxydim (Poast), clethodim (Select Max), imazethapyr (Pursuit), or 2,4-DB(Butyrac) will broaden control. When combined with the herbicides requiring oil adjuvants, crop injury will increase. Nonionic surfactants have shown to be less injurious to crop than oil concentrates. *Alfalfa injury symptoms:* leaf burn. *Weed symptoms:* browning and necrosis within 2-4 days.			
B.	2,4-DB* (Butyrac 200) WSSA MODE OF ACTION GROUP NUMBER[1]: 4	0.5-1.5 lb a.i.	48	60
	COMMENTS: A foliar-applied systemic herbicide that has no soil residual. Apply when alfalfa is in the second trifoliolate leaf stage. Broadleaf weeds should be 3 inches or less. Weed control increases with clear and warm conditions. If significant rainfall or irrigation occurs before 4 days after application, crop injury may occur. Can be combined with sethoxydim (Poast), clethodim (Select Max), bromoxynil (Buctril), or imazethapyr (Pursuit). When mixed with herbicide requiring an adjuvant, nonionic surfactants have shown to be less crop injurious than oil concentrates. Restricted use from Mar 15 - Oct 15 in some Central Valley counties. Check with your County Agricultural Commissioner. *Alfalfa injury symptoms:* leaf narrowing and plant twisting. *Weed symptoms:* twisting, epinasty and chlorosis in 2-10 days.			
C.	PARAQUAT* (Gramoxone Inteon) WSSA MODE OF ACTION GROUP NUMBER[1]: 22	0.125–0.2 lb a.i.	24	70
	COMMENTS: A contact herbicide that has no soil residual. Apply when alfalfa is in the third trifoliolate leaf stage. Broadleaf weeds should be between 1 to 3 inches and grasses below 6 inches. Thorough coverage is essential for best control. Rate increases with larger alfalfa size: use the 8 fl oz rate (0.125 lb a.i.) if alfalfa has at least 3 trifoliate leaves and 12.8 fl oz (0.2 lb a.i.) if alfalfa has 6 trifoliate leaves. Tank mixing information with other herbicides is limited. Always use a nonionic surfactant. *Alfalfa injury symptoms:* leaf bleaching to browning. Stand reduction on smaller seedlings. *Weed symptoms:* bleaching and necrosis in 1-3 days.			

	Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)
D.	PRONAMIDE* (Kerb) 50WP	0.5–2 lb a.i.	24	25 – below 1.5 lb a.i. 45 – 1.5-2 lb a.i.
	WSSA MODE OF ACTION GROUP NUMBER[1]: 3 COMMENTS: A contact herbicide that is also taken up by the roots. Apply when alfalfa is in the first trifoliolate leaf stage. Control is best when applied before weed germination; some postemergent control on seedling weeds. Control is dependent upon adequate moisture following application. Tank mixes with bromoxynil (Buctril) or imazethapyr (Pursuit) can be helpful on emerged broadleaf weeds. *Alfalfa injury symptoms:* occasional white speckling of leaves. *Weed symptoms:* leaf browning and necrosis and root inhibition in 2 weeks.			
E.	SETHOXYDIM (Poast)	0.09-0.46875 lb a.i.	12	See label
	WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: A systemic herbicide that has no soil residual. Can be applied when alfalfa is in the first trifoliolate leaf stage. Control is best when alfalfa is in the 3rd trifoliolate leaf stage and grass weeds are between 2-6 inches tall, growing vigorously before tillers develop. Control is reduced when grasses are moisture-stressed. Oil adjuvant is required. Can be combined with bromoxynil (Buctril), 2,4-DB (Butyrac) and imazethapyr (Pursuit) herbicides. Oil concentrate adjuvant will increase crop injury when mixed with bromoxynil (Buctril) or 2,4-DB (Butyrac). *Alfalfa injury symptoms:* none observed. *Weed symptoms:* chlorosis followed by necrosis at growing point in 6-10 days.			
F.	CLETHODIM (Select Max)	0.095-0.2425 lb a.i.	24	15
	WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: A systemic herbicide with no soil residual. Apply when alfalfa is in the first trifoliolate leaf stage. Control is best when alfalfa is in the 3rd trifoliolate leaf stage and grass weeds are between 2-6 inches tall, growing vigorously before tillers develop. Control is reduced when grasses are moisture-stressed. Oil adjuvant is required. Can be combined with bromoxynil (Buctril), 2,4-DB (Butyrac) and imazethapyr (Pursuit) herbicides. Oil concentrate adjuvant will increase crop injury when mixed with bromoxynil (Buctril) or 2,4-DB (Butyrac). *Alfalfa injury symptoms:* none observed. *Weed symptoms:* chlorosis followed by necrosis at growing point in 6-10 days.			
G.	IMAZETHAPYR (Pursuit)	0.047–0.094 lb a.i.	4	30
	WSSA MODE OF ACTION GROUP NUMBER[1]: 2 COMMENTS: A systemic herbicide with soil residual. Apply when alfalfa is at least in the second trifoliolate leaf stage. Control is best when broadleaf weeds and some grass weeds are less than 3 inches in height and growing vigorously. Weed control is greatly reduced when plants are moisture stressed. Can be combined with sethoxydim (Poast), clethodim (Select Max), bromoxynil (Buctril), or 2,4-DB (Butyrac) herbicides. Oil adjuvants will increase the potential of crop injury when used with bromoxynil (Buctril) or 2,4-DB (Butyrac). Using a nonionic surfactant may be a safer choice. *Alfalfa injury symptoms:* temporary growth reduction. *Weed symptoms:* chlorosis followed by necrosis in 1-2 weeks.			
H.	IMAZAMOX (Raptor)	0.032–0.047 lb a.i.	4	0
	WSSA MODE OF ACTION GROUP NUMBER[1]: 2 COMMENTS: A systemic herbicide with soil residual that controls broadleaf and grass weeds. Has the same mode of action as imazethapyr (Pursuit), and it is not recommended that these two products be applied alternately. Apply when alfalfa is at least in the second trifoliolate leaf stage. Control is best when broadleaf weeds and grass weeds are less than 3 inches in height and growing vigorously. Control is reduced when weeds are moisture-stressed. Does not adequately control prickly lettuce, annual sowthistle, and fiddleneck but can be tank mixed with another herbicide to broaden the spectrum of weeds controlled. Must use an adjuvant. Useful tank mixes include bromoxynil (Buctril) and 2,4-DB (Butyrac). Oil adjuvants will increase the potential of crop injury when used with bromoxynil (Buctril) or 2,4-DB (Butyrac). Using a nonionic surfactant may be a safer choice. *Alfalfa injury symptoms:* temporary growth reduction. *Weed symptoms:* chlorosis followed by necrosis in 1-2 weeks.			
I.	HEXAZINONE (Velpar)	0.25–0.375 lb a.i	48	30
	WSSA MODE OF ACTION GROUP NUMBER[1]: 5 COMMENTS: A contact herbicide that also has a soil residual. Use caution on sandy soil. Apply when alfalfa is between the sixth to ninth trifoliolate leaf stage with multiple stems, and root length is greater than 6 inches. Has both pre- and postemergent activity on small broadleaf weeds less than 2 inches in size. This ideal timing required for treatment of larger alfalfa and smaller weed size, however, is difficult to achieve. See label for additional restrictions. Useful tank mixes include sethoxydim (Poast) and clethodim (Select Max). *Alfalfa injury symptoms:* leaf burn and chlorosis. *Weed symptoms:* chlorosis and necrosis in 1-2 weeks.			

Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)

‡ 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.

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

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

Weed Management in Established Alfalfa
(Section reviewed 11/06)

INTEGRATED WEED MANAGEMENT IN ESTABLISHED ALFALFA (11/06)

Uncontrolled weeds in alfalfa can seriously reduce yield as well as quality and retail value of alfalfa hay because some weeds are less palatable to livestock and less nutritious than alfalfa. The presence of poisonous weeds in hay, such as common groundsel, fiddleneck, and hemlock further lower the value or make it totally unmarketable. Tough, fibrous weeds may damage equipment during harvesting. Weeds that retain moisture can cause rotting or start fires in stored hay.

The need for treatment depends on weed species, their competitiveness and toxicity to livestock, the potential market for the alfalfa, and time of year. Vigor of the alfalfa stand is an important factor; weakened stands will require treatment when denser ones don't. Weeds are managed with adjustments of cutting schedules, cultivation in winter, grazing, interplantings of other legumes or grasses, and herbicides.

MONITORING

Monitor for weed seedlings just after alfalfa is cut. Most winter annual weeds start to germinate in late September or October and continue to germinate until late January whenever soil moisture and temperature conditions permit. Summer annual weeds, especially grasses, start to germinate in late February and early March (late March and April in the Intermountain Region) and can continue to germinate until midsummer with each irrigation. Survey for weeds in winter, summer, and early fall after alfalfa has been cut. Record observations on a monitoring form (*available online*).

Identifying weeds correctly is fundamental to planning a weed control program. It is important to know the kind and abundance of weeds present in an alfalfa field. Weeds are easiest to identify when full grown and flowering; seedling weeds can be difficult to identify. Many weed control decisions, however, must be made quickly, on the basis of identifying weed seedlings.

CUTTING SCHEDULES

Short cutting intervals (alfalfa reaching only the bud stage between cuts) reduce alfalfa vigor and encourage weed growth. Cutting alfalfa on longer schedules (letting it reach 60% regrowth with buds averaging 0.75 inch long or in the Intermountain Region when 90% of the alfalfa is in the bud stage) keeps the alfalfa vigorous and competitive with weeds. However, high quality hay for dairy cows should be cut before any flowers appear, or when very few crown buds have started to grow. Cutting schedules are thus a compromise between producing high quality hay and maintaining a strong alfalfa stand. Precise cutting schedules are hard to recommend because the growth rate of alfalfa depends on location and time of year.

Delay the first cutting of a fall-planted seedling field at least 2 to 3 weeks past the normal cutting date for established stands. The interval between the first and second cutting of a new alfalfa stand should be about 2 weeks longer than normal. This allows root reserves to build up, keeping the alfalfa vigorous.

CULTURAL CONTROLS IN SUMMER

Irrigate fields as shortly before harvest as practical. This allows the alfalfa time to regrow after harvest before an irrigation is needed, thus reducing the threat of root rot or scald. In addition, the soil can dry out after harvest, thus minimizing weed germination at the time when the alfalfa canopy is missing. Delaying irrigation following a harvest also helps suppress summer annual grasses by giving the alfalfa time to grow back and shade the ground; this is more difficult to accomplish on sandy soil than on loamy or clay soils.

Flaming vegetation with a propane or diesel burner can provide satisfactory control of dodder. Foliage should be as dry as possible for flaming. Observe all agricultural burn regulations.

CULTURAL CONTROLS IN WINTER

Established alfalfa is sometimes cultivated with a spring-toothed harrow during late winter. Such cultivations uproot weed seedlings but may also injure alfalfa crowns; crown injuries can delay the first cutting, reduce yields, and permit invasion of crown diseases.

Grazing off (sheeping-off) fall and winter alfalfa growth can aid chemical weed control by exposing the soil and seedling weeds. A large number of animals should graze a field rapidly. If the grower only allows the animals to graze until the forage removed approximates a cutting, alfalfa vigor can be maintained through winter. However, alfalfa should not be grazed repeatedly or continuously, because overgrazing can deplete root reserves, reduce crop vigor, and lead to a thin, weedy alfalfa stand. Also, avoid grazing too early in fall or when the field is excessively wet.

INTERPLANTING GRASSES OR LEGUMES

Oats and other annual or perennial grasses or clovers can be planted into an older, declining alfalfa stand to increase yields and suppress weeds without the use of herbicides. This is done typically in stands with a low alfalfa population. Plant grasses in December or January, during alfalfa dormancy, or after sheeping-off the alfalfa. In the cold, northeastern part of California, plant grasses in March or early April or in early fall. Interplanting with perennial grass can often extend stand live for more than one year.

The best oat-seeding rate is 50 to 60 pounds per acre. Broadcast oats, then disc or use a spring-tooth harrow to cover the seed. Or harrow the ground first, then use a grain drill to plant. To help oat growth, add nitrogen at 30 to 40 pounds per acre. The combination of oat competition and harrowing or disking at planting will suppress most weeds.

A short-season variety, such as 'Montezuma,' produces the most growth by the time of harvesting. Fine-stemmed, leafy oat varieties produce the most valuable forage. Cut oat-alfalfa hay when alfalfa would usually be cut. This cutting will be about 15 to 50% oats, depending on the alfalfa stand density and vigor. Oat plants that are cut before heading are likely to regrow during the next cutting cycle, adding to the next yield.

Overseeding clovers offers several advantages over grasses, including higher crude protein and lower fiber, which makes the harvest suitable for dairy markets. Berseem clover is best adapted for California conditions and significantly increases yield for the first three to four harvests in the Central Valley. Berseem is primarily fall-planted, from September to early November with mid-October being optimal. Berseem is overseeded at 6 to 10 pounds per acre and planted shallow (less than 0.5 inch). Inoculating the seed with *Rhizobium trifolii* is recommended before planting. Because of vigorous winter growth of Berseem, earlier harvests than usual are necessary and could be problematic if rains occur. The forage is often difficult to cure so alfalfa and berseem mixtures are usually fed as sileage or greenchop.

Overseeding red clover can extend the life of a depleted alfalfa stand for 2 years or more. Seed bed preparation is similar to that used when planting Burseem clover. Red clover should be planted about the same time as alfalfa would be planted, using a 6- to 12-pound per acre seeding rate.

For additional information on interplanting, see *Overseeding and Companion Planting in Alfalfa*, UC ANR Publication 21594.

HERBICIDES

Herbicides are used along with proper cultural weed control techniques to obtain effective, economical weed control. If winter annuals need to be controlled, apply preemergent herbicides in established alfalfa in fall, winter, or spring before new growth begins and before weeds become established. Preemergent herbicides must be incorporated by winter rainfall or sprinkler irrigation. Some herbicides with soil activity can cause yellowing of foliage and delay the first cutting when used on alfalfa that has resumed growth. In California's southern desert valleys where nondormant varieties of alfalfa grow year-round, some preemergent herbicides with soil activity cannot be used. To protect water quality, do not use preemergent herbicides during the last year of the stand in areas where surface runoff is a concern.

Some postemergent herbicides, such as paraquat, work on contact, so complete coverage is necessary. Stage of weed growth is also important; young weeds are usually easier to kill.

The use of transgenic alfalfa varieties such as Roundup-ready alfalfa allows glyphosate (Roundup) to be applied to emerged alfalfa at any growth stage without the risk of crop damage. By applying glyphosate according to the size of the weed, and not the crop, weeds can be controlled early in the life of the alfalfa stand before they compete with and damage the crop, a problem that exists with conventional alfalfa herbicide programs. For more information, see TRANSGENIC HERBICIDE-TOLERANT ALFALFA.

SPECIAL WEED PROBLEMS IN ESTABLISHED ALFALFA

(7/09)

WEEDS POISONOUS TO LIVESTOCK

Several weed species found in California alfalfa fields are poisonous to livestock. The most dangerous are fiddleneck, common groundsel, poison hemlock, and yellow starthistle. Many other weeds, and even some crop plants, may accumulate nitrates, which are dangerous to cattle and hogs but not to horses or sheep. Some plants (sorghum, sudangrass, curly dock) accumulate nitrates during stress by drought, lack of sulfur or phosphorus, or unusual weather such as low temperatures or warm spring weather followed by a long cold spell. Plants that are injured but not killed by phenoxy herbicides such as 2,4-DB, may also pick up nitrates. Plants that accumulate nitrates during stress will convert nitrates into safe materials after the stress period is over.

SUMMER GRASSES

Summer grasses, like barnyardgrass (watergrass), yellow foxtail (pigeongrass), crabgrass, and cupgrass, are a major problem in many alfalfa stands. To reduce their numbers, keep the alfalfa growing vigorously with proper irrigation and allow enough time between cuttings to maintain crop vigor. Because different species of summer grass weeds may germinate at different times during spring and early summer, a field infested with several grass weeds may require several applications of herbicides to provide adequate control.

Summer grasses can be controlled in established alfalfa with trifluralin (Treflan TR-10 granules). Apply in winter or early spring before grasses germinate. January through mid-February is the best time to apply trifluralin in the Central Valley, but it can be applied up to early April in the Intermountain Region. In the low desert, apply after the February cutting. Trifluralin-treated fields must receive rain or irrigation within 3 days; moisture incorporates the herbicide.

To control some grasses and nutsedge, apply EPTC (Eptam) in irrigation water or use a granular formulation. The liquid formulation requires uniform metering of the herbicide into water during irrigation. Light irrigations on uniform, well-leveled soils are best. Apply before grasses emerge in mid-February in the Central Valley, or after a February or March cutting in the low desert. One application can control grasses for 30 to 45 days. The first application should be 3 pounds active ingredient per acre. Later applications of 2 pounds active ingredient per acre are necessary after the third and fourth cuttings. Read label for precautions concerning disposal of drainage water.

In a field where summer grasses have already germinated, apply sethoxydim (Poast) or clethodim (Select Max) to grass seedlings in early spring after a cutting. Early application, before grasses become large and well-tillered, has proved most effective; May to June is an appropriate time for application in the Central Valley and the low desert and June and early July in the Intermountain Region. The field should be cut, irrigated, and then treated within 2 to 4 days. At this time, grasses are actively growing and alfalfa growth won't interfere with spray coverage. Use a nonherbicidal crop oil adjuvant. Two applications may be needed in a season. In Roundup-ready alfalfa, glyphosate (Roundup) provides effective control.

NUTSEDGE

Yellow and purple nutsedgecan seriously affect weak alfalfa stands, especially in sandy soils. When sethoxydim (Poast) or clethodim (Select Max) has been used to remove a thick population of summer grasses, it may leave thin spots in the field; if nutsedge is present, it will take advantage of such open areas. Sethoxydim and clethodim do not control nutsedge.

Roundup Ready alfalfa varieties also provide an excellent management opportunity to control nutsedge. Research trials conducted in the Central Valley have demonstrated that 1 to 2 applications of glyphosate during the growing season adequately controlled and reduced the long-term population of nutsedge.

Halosulfuron (Sandea) is very effective for postemergent control of nutsedge in established alfalfa. It can cause temporary stunting and yellowing of the crop, however, when applied during the growing season in the Sacramento and San Joaquin valleys. Application of this product causes less injury and yield loss in the low desert regions of California.

The use of herbicides in rotational crops such as barley, cotton, corn, and in fallow fields can also be helpful in reducing populations of yellow nutsedge. Several seasons will be necessary in a rotational system to reduce

yellow nutsedge to a manageable level. By maintaining selective herbicide pressure in this weed, the population should be adequately reduced by the third year.

JOHNSONGRASS

Johnsongrass, a troublesome perennial weed, is not controlled by most alfalfa herbicides, though constant mowing slows its growth. Sethoxydim (Poast) and clethodim (Select Max), however, should help to control established johnsongrass in many fields. Johnsongrass is very susceptible to sethoxydim or clethodim applied when the grass is shorter than 12 to 18 inches. Multiple (two to three) treatments are required for effective control and eradication. Watch for new infestations developing from seeds in the soil. EPTC and benefin (Balan) control germinating johnsongrass from seed but only suppress growth of established plants for several weeks. In Roundup-ready alfalfa, glyphosate (Roundup) provides effective control.

DODDER

Dodder, a yellow-orange, threadlike parasitic weed, can seriously affect alfalfa fields. It has no roots in the soil and derives water and nutrition from the alfalfa. Dodder can be controlled culturally, chemically, and by flaming. A dense, vigorous stand of alfalfa discourages dodder, as it requires sunlight to germinate. A dodder infestation can be suppressed or killed by cutting the alfalfa below the point at which dodder is attached.

Trifluralin in the granular formulation, applied to established alfalfa, effectively controls dodder. Apply this herbicide before dodder emerges (mid-February in most of central and southern California) for adequate control. Twenty pounds of granules per acre (2 lb a.i./acre) provides dodder control into June; extended control requires a second application of 20 pounds after the first or second cutting. (Other herbicides, such as imazethapyr-Pursuit and imazamox-Raptor can be applied during stand establishment to control germinating dodder at early attachment before it becomes embedded in alfalfa stems. These herbicides are more effective in seedling alfalfa than in established alfalfa.) In Roundup-ready alfalfa, glyphosate is effective for controlling dodder. Research studies are currently underway to determine the frequency and rate of glyphosate for best control.

Flaming or nonselective herbicides can control dodder after it is attached to the alfalfa. For effective control, the alfalfa stems and foliage must be killed below the point of dodder attachment. Repeat treatments may be necessary after each cutting, as dodder continues to germinate through most of the growing season. To help prevent reinfestation, treat before dodder begins to seed.

Flail mowing effectively controls attached dodder. It involves cutting the alfalfa at the ground surface after the bales have been removed. This practice is less time-consuming and less injurious to the stand than burning. However, it may be less practical in flood-irrigated fields because of difficulty in mowing over the borders.

Because dodder is especially difficult to manage, the best strategy for preventing widespread infestations from developing is to eliminate isolated patches as they appear. Dodder is not effectively controlled by crop rotation because its seed is long-lasting.

FIELD BINDWEED

Bindweed is best controlled before planting alfalfa. It can be controlled in previous crops, such as grains, with broadleaf herbicides. Better yet, control bindweed in fallow, with intensive tillage and nonselective (e.g., glyphosate) or phenoxy (e.g., 2,4-D) herbicides. Fields infested with field bindweed should be planted in fall when the field bindweed is dormant or growing very slowly. A good stand of vigorously growing alfalfa competes effectively with field bindweed. In Roundup-ready alfalfa, glyphosate (Roundup) provides effective control.

BERMUDAGRASS

Bermudagrass is a troublesome weed that may crowd out alfalfa stands. In new plantings, seedlings may be controlled by preplant treatments of benefin or EPTC. In established alfalfa, repeated applications of sethoxydim or clethodim will provide effective control. In Roundup-ready alfalfa, glyphosate (Roundup) provides effective control.

COMMON and SCIENTIFIC NAMES OF WEEDS IN ESTABLISHED ALFALFA (11/06)

Common Name	Scientific Name
Barley, foxtail	*Hordeum jubatum*
Barley, hare	*Hordeum leporinum*
Barnyardgrass	*Echinochloa crus-galli*
Bermudagrass	*Cynodon dactylon*
Bindweed, field	*Convolvulus arvensis*
Bluegrass, annual	*Poa annua*
Bluegrass, bulbous	*Poa bulbosa*
Brome, downy	*Bromus tectorum*
Canarygrasses	*Phalaris* spp.
Chickweed,common	*Stellaria media*
Cupgrass, prairie	*Eriochloa contracta*
Dandelion	*Taraxacum officinale*
Dodders	*Cuscuta* spp.
Fiddlenecks	*Amsinckia* spp.
Filarees	*Erodium* spp.
Flixweed	*Descurainia sophia*
Foxtails (yellow and green)	*Setaria* spp.
Goosefoot, nettleleaf	*Chenopodium murale*
Goosegrass	*Eleusine indica*
Groundsel, common	*Senecio vulgaris*
Johnsongrass	*Sorghum halepense*
Junglerice	*Echinochloa colona*
Knotweed, prostrate	*Polygonum aviculare*
Lambsquarters, common	*Chenopodium album*
Lettuce, prickly	*Lactuca serriola*
Mallow, little (cheeseweed)	*Malva parviflora*
Miner's lettuce	*Claytonia perfoliata*
Mustards	*Brassica* spp.
Nettle, burning	*Urtica urens*
Nightshades	*Solanum* spp.
Nutsedge, yellow	*Cyperus esculentus*
Oat, wild	Avena fatua
Pepperweeds	*Lepidium* spp.
Pigweeds	*Amaranthus* spp.
Plantain, buckhorn	*Plantago lanceolata*
Quackgrass	*Elytrigia repens*
Radish, wild	*Raphanus raphanistrum*
Redmaids (desert rockpurslane)	*Calandrinia ciliata*
Rocket, london	*Sisymbrium irio*
Ryegrass, italian	*Lolium multiflorum*
Ryegrasses	*Lolium* spp.
Shepherd's-purse	*Capsella bursa-pastoris*
Sowthistles	*Sonchus* spp.
Starthistle, yellow	*Centaurea solstitialis*
Stinkgrass	*Eragrostis cilianensis*
Thistle, russian	*Salsola tragus*
Witchgrass	*Panicum capillare*

SUSCEPTIBILITY OF WINTER WEEDS TO HERBICIDE CONTROL IN ESTABLISHED ALFALFA (7/09)

	24D*	CLE	DIU	EPT	FLU	GLY (RR)[1]	HAL	HEX	IMA	MET	NOR	PAR*	PEN	SET	TRI[2]
ANNUAL WEEDS															
Barley, hare	N	C	P	P	—	C	—	P	N	C	C	C	C	P	C
Bluegrass, annual	N	C	C	C	P	C	—	P	P	P	C	P	C	N	C
Bluegrass, bulbous	N	N	N	—	—	C	—	P	N	C	—	C	—	N	P
Brome, downy	N	C	P	C	—	C	—	C	N	C	C	C	C	C	C
Canarygrasses	N	P	C	C	—	C	—	P	P	C	C	P	C	C	C
Cereal, volunteer	N	C	C	C	—	C	—	P	N	P	C	P	C	P	N
Chickweed, common	N	N	C	C	C	C	C	P	C	C	C	P	C	N	P
Fiddlenecks (seedling)	N	N	C	P	C	C	—	C	P	C	P	P	C	N	C
Filarees (seedling)	P	N	C	N	C	C	—	C	C	C	N	N	N	N	N
Flixweed	C	N	C	N	—	C	—	C	C	C	N	C	—	N	N
Groundsel, common	N	N	N	P	C	C	C	C	P	P	N	P	N	N	N
Lettuce, prickly	C	N	P	C	C	C	—	C	N	C	N	P	N	N	N
Mallow, little (cheeseweed) (seedling)	N	N	P	N	C	C	C	P	C	C	P	N	P	N	N
Miner's lettuce	N	N	C	N	C	C	C	C	C	—	P	C	—	N	C
Mustards	C	N	P	N	C	C	C	C	C	C	C	P	P	N	N
Nettle, burning	P	N	C	P	C	P	C	C	C	C	N	P	N	N	C
Oat, wild	N	C	N	C	C	C	—	P	P	N	C	P	P	C	N
Pepperweeds	C	N	C	N	N	P	—	P	C	C	N	C	N	N	N
Radish, wild	N	N	C	N	—	C	C	C	C	C	C	P	N	N	N
Rocket, London	P	N	C	P	C	C	C	C	C	C	C	C	P	N	N
Ryegrass, Italian	N	C	P	C	—	C/P[3]	—	C	N	C	C	C	C	C	C
Shepherd's-purse	P	N	C	P	C	C	C	C	C	C	C	P	P	N	N
Sowthistles	C	N	P	C	P	C	C	C	N	N	P	N	N	N	C
Starthistle, yellow	C	N	C	C	C	C	—	C	N	C	N	P	N	N	N

C = control P – partial control N = no control — = no information

24D = 2,4-DB* (Butyrac)
CLE = clethodim (Select Max))
DIU = diuron (Karmex)
EPT = EPTC (Eptam)
FLU = flumioxazin (Chateau)
GLY[1] = glyphosate (Roundup)
HAL = halosulfuron (Sandea)
HEX = hexazinone (Velpar)
IMA = imazethapyr (Pursuit) (highest rate)
MET = metribuzin (Sencor)
NOR = norflurazon (Solicam)
PAR = paraquat* (Gramoxone Inteon)
PEN = pendimethalin (Prowl H2O)
SET = sethoxydim (Poast)
TRI = trifluralin[1] (Treflan, Trilin)

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

1 For use in Roundup-ready alfalfa only.

2 Not usually applied at times suitable for controlling winter weeds.

3 Resistant ryegrass resistance developing in many crops.

SUSCEPTIBILITY OF SPRING & SUMMER WEEDS TO HERBICIDE CONTROL IN ESTABLISHED ALFALFA (7/09)

	24D*	CLE	DIU	EPT	FLU	GLY (RR)[1]	HAL	HEX	IMA	MET	NOR	PAR*	PEN	SET	TRI[2]
ANNUAL WEEDS															
Barley, foxtail	N	C	P	P	—	C	—	P	N	C	C	P	—	C	P
Barnyardgrass	N	C	P	C	—	C	—	P	C	C	C	P	C	C	C
Cupgrass, prairie	N	C	P	P	—	C	—	P	N	—	C	P	—	C	C
Dodders	N	N	N	N	—	C	—	N	P	N	N	P	C	N	C
Foxtail, green	N	C	C	C	—	C	—	C	C	P	C	—	—	C	C
Foxtail, yellow	N	C	P	C	—	C	—	C	C	P	C	N	C	C	C
Goosefoot, nettleleaf	C	N	C	C	C	C	—	C	P	C	C	C	C	N	C
Goosegrass	N	C	C	C	—	P	—	—	—	P	C	P	C	—	C
Junglerice	N	C	C	C	—	C	—	C	P	P	C	P	—	C	C
Knotweed, prostrate	P	N	C	P	C	C	—	C	C	N	P	P	C	N	C
Lambsquarters, common	C	N	C	C	C	C	N	C	P	P	P	N	C	N	P
Nightshades	C	N	C	C	C	C	N	C	C	N	C	P	N	N	N
Pigweeds	C	N	C	C	C	C	P	C	C	C	C	P	C	N	C
Quackgrass	N	—	P	P	—	C	—	P	P	—	—	N	—	L	N
Stinkgrass	N	—	C	C	—	C	—	P	N	P	C	P	—	C	C
Thistle, Russian	P	N	N	P	—	C	—	P	P	P	C	P	P	N	P
Witchgrass	N	C	N	C	—	C	—	P	N	C	C	P	—	C	C
PERENNIAL WEEDS															
Bermudagrass (established)	N	P	N	N	—	C	N	N	N	N	P	N	N	P	N
Bermudagrass (seedling)	N	C	N	C	—	C	N	P	P	N	C	P	C	C	C
Bindweed, field (established)	P	N	N	N	N	P	N	N	N	N	N	N	N	N	P
Bindweed, field (seedling)	C	N	P	N	—	C	—	C	—	N	P	P	P	N	P
Dandelion (established)	C	N	N	N	—	C	—	P	N	P	N	P	N	N	N
Dandelion (seedling)	C	N	C	C	—	C	—	C	P	C	N	N	N	N	N
Johnsongrass (established)	N	C	N	N	—	C	—	N	P	N	C	N	N	C	N
Johnsongrass (seedling)	N	C	C	C	—	C	—	C	C	N	C	C	C	C	C
Nutsedge, yellow	N	N	N	P	P	P	C	N	P	P	P	N	N	N	N
Plantain, buckhorn (seedling)	C	N	C	—	—	C	—	C	—	—	—	C	—	N	—
Plantain, buckhorn (established)	P	N	N	—	—	P	—	P	N	N	N	N	N	N	N

C = control P = partial control N = no control L = controlled according to herbicide label— = no information

24D = 2,4-DB* (Butyrac)
CLE = clethodim (Select Max))
DIU = diuron (Karmex)
EPT = EPTC (Eptam)
FLU = flumioxazin (Chateau)
GLY[1] = glyphosate (Roundup)
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HERBICIDE TREATMENT TABLE FOR ESTABLISHED ALFALFA (7/09)

	Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)

When choosing an herbicide, consider the environmental impact. Not all registered pesticides are listed. Always read label of product being used.

PREPLANT

Before Weeds Emerge

A.	DIURON (Karmex DF, Direx 4L) WSSA MODE OF ACTION GROUP NUMBER[1]: 7 COMMENTS: Restricted entry interval: 12 hours. Apply after dormancy begins until January, but before weeds are well established. Treat only stands 1 year or older. Do not replant treated areas within 1 year (2 yr if over 2 lb/acre). Do not use on coarse soils or in areas where crop does not go dormant. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas.	1.2–2.4 lb a.i.	12	0
B.	NORFLURAZON (Solicam) DF WSSA MODE OF ACTION GROUP NUMBER[1]: 12 COMMENTS: Application may be made to both dormant and actively growing alfalfa. Will not control emerged weeds, only germinating weed seed and nutsedge tubers. For 16 months after last application of this material the only rotational crop that can be planted is cotton. Bioassays are required for all other crops. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas.	1–1.965 lb a.i.	12	28
C.	EPTC (Eptam) 7EC WSSA MODE OF ACTION GROUP NUMBER[1]: 8 COMMENTS: Apply in spring before weed emergence. Must be mechanically incorporated or apply as water-run. Use low rate on sandy soil, high rate on heavy soil. Repeat treatments may be needed, up to 12.25 lb a.i./season.	2–3 lb a.i.	12	14–graze/harvest
D.	HEXAZINONE (Velpar) WSSA MODE OF ACTION GROUP NUMBER[1]: 5 COMMENTS: Apply during alfalfa dormancy. Do not use more than 0.675 lb a.i. on alfalfa less than 1 year old. Do not use in low desert valleys, on frozen ground, or at high rates in high rainfall areas. Hexazinone is persistent in the soil and can injure crops following alfalfa. Follow label directions carefully; observe plantback restrictions.	0.495–1.5 lb a.i.	48	30
E.	METRIBUZIN (Sencor) WSSA MODE OF ACTION GROUP NUMBER[1]: 5 COMMENTS: Apply in fall (during dormancy) or spring before new growth. Use on stands 1 year or older. Use only north of Interstate 80. Do not exceed 1 lb a.i./acre per season. Follow label directions carefully; observe plantback restrictions.	0.375–0.9975 lb a.i.	12	28–graze/harvest
F.	FLUMIOXAZIN (Chateau) WSSA MODE OF ACTION GROUP NUMBER[1]: 14 COMMENTS: Apply to semi-dormant crop.	0.1275 lb a.i. 4 oz	12	25–graze/harvest
G.	PENDIMETHALIN (Prowl H2O) WSSA MODE OF ACTION GROUP NUMBER[1]: 3 COMMENTS: Higher rates applied in Jan-Feb provide long season grass control into late summer (August). PHI is 50 days for forage or hay and 90 days for seed.	1.9–3.8 lb a.i. 2–4 qt	24	See comments

	Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)
H.	TRIFLURALIN (Treflan TR-10) WSSA MODE OF ACTION GROUP NUMBER[1]: 3 COMMENTS: Apply before dodder and grass germination. Requires 0.5 inch rain or irrigation water within 3 days after treatment. One application controls dodder into June; for longer control apply again after the first or second cutting.	2 lb a.i.	12	21

AFTER WEEDS EMERGE (ROUNDUP-READY ALFALFA ONLY)

A.	GLYPHOSATE (Roundup WeatherMax) WSSA MODE OF ACTION GROUP NUMBER[1]: 9 COMMENTS: In Roundup-ready varieties, over-the-top applications can be made at any stage of growth. Do not use more than 132 fl oz/acre per year.	0.9453–1.89 lb a.i. 22–44 fl oz	4	5

Conventional and Roundup-ready Alfalfa

A.	HEXAZINONE (Velpar) WSSA MODE OF ACTION GROUP NUMBER[1]: 5 COMMENTS: Weeds must be smaller than 2 inches tall or wide. Do not use on alfalfa under stress. Use on dormant or slowly growing, healthy plants.	0.45–1.35 lb a.i	48	30
B.	PARAQUAT* (Gramoxone Inteon) WSSA MODE OF ACTION GROUP NUMBER[1]: 22 COMMENTS: Can be applied during dormant period in winter, rates vary depending on weed growth stage, crop leaf burn will occur but recovery is rapid. See label for grazing restrictions. Always use a nonionic surfactant with paraquat. Do not apply more than once per season.	0.26–0.49 lb a.i.	24	60–cut/harvest
C.	SETHOXYDIM (Poast) WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: Apply when grass weeds have emerged but are still small. Add oil concentrate at 2 pt/acre. Irrigate before application or 2 days after. Preharvest interval is 7 days for grazing, feeding, or cutting for undried forage; 14 days for cutting for dry hay.	0.1–0.46 lb a.i.	12	See comments
D.	2,4-DB* (Butyrac 200) WSSA MODE OF ACTION GROUP NUMBER[1]: 4 COMMENTS: Apply when weeds are 3 inches or shorter. Rate varies with formulation and weed size. See label for grazing restrictions and regulatory restrictions for sensitive cropping areas. Apply when temperature is between 40°–90°F. Treated area should not receive irrigation or rainfall within 4 days. Restricted use from Mar 15 - Oct 15 in some Central Valley counties; check with your County Agricultural Commissioner.	0.5–1.5 lb a.i.	48	30–graze/feed per harvest
E.	IMAZETHAPYR (Pursuit) WSSA MODE OF ACTION GROUP NUMBER[1]: 2 COMMENTS: Apply when the weeds are 1–3 inches. Do not apply 12 months before the alfalfa is taken out of production because of plantback restrictions. Add a nonionic surfactant (0.25% v/v) or a crop oil concentrate (2 pt/acre). During winter months under cold conditions, use the highest label rate. Pursuit has postemergent and preemergent activity. Soil residual activity is considerably long (e.g., sugarbeets cannot be planted for 40 months). Postemergent herbicide activity is generally slow, up to 50 days. Use resistance management practices (i.e., alternate use with an herbicide of different chemistry).	0.047–0.094 lb a.i.	4	30–graze/feed per harvest

	Common name (example trade name)	Amount per acre	R.E.I.‡ (hours)	P.H.I.‡ (days)
F.	CLETHODIM (Select Max) WSSA MODE OF ACTION GROUP NUMBER[1]: 1 COMMENTS: Do not apply within 15 days of grazing or harvest. For control of annual grasses use a minimum of 17 oz. Apply only to actively growing grasses at the height recommended on label. Use higher rate for perennial grasses, annual bluegrass, and under heavy grass pressure.	0.095–0.2425 lb a.i.	24	15–graze/feed per harvest
G.	HALOSULFURON (Sandea) WSSA MODE OF ACTION GROUP NUMBER[1]: 2 COMMENTS: Effective for postemergent control of nutsedge in established alfalfa. Can cause temporary stunting and yellowing of crop when applied during growing season in Sacramento and San Joaquin valleys; less injury and yield loss results following applications in low desert region of California.	0. 0312–0.0468 lb a.i. 0.667–1 oz	12	14

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

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1 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.

This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

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.