Crop Profile for Alfalfa Grown For Seed in Montana

Revised: August 2002

Please visit the Montana Pest Management Center For Updated Information
http://montanacrops.org

General Production Information

ALFALFA SEED
Acreage, Production, Price, and Total Value, Montana, USA

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<th>Total Pounds (000)</th>
<th>Price Per Cwt. Dols.</th>
<th>Value of Production (000) Dols</th>
<th>Harvested Acres (000)</th>
<th>Yield Per Acre Pounds (Cleaned)</th>
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Montana’s ranking in national production of seed alfalfa - [unknown]*
Montana’s contribution to total U.S. production of seed alfalfa - [unknown]*

* The alfalfa seed program in Montana is a state-level program, there are no national statistics programs for collection of alfalfa seed production.

Production Regions

Southeast Counties: 21.1%
Carter, Custer, Fallon, Powder River, Prairie, Rosebud, Wibaux

North Central Counties: 13.5%
Blaine, Chouteau, Glacier, Hill, Liberty, Phillips, Pondera, Toole

Central Counties: 5.8%
Broadwater, Cascade, Golden Valley, Judith Basin, Lewis and Clark, Meagher, Musselshell, Petroleum, Wheatland

Northeast Counties: 5.5%
Daniels, Dawson, Garfield, McCon, Richland, Roosevelt, Sheridan, Valley

Western Counties: 0.6%
Beaverhead, Deer Lodge, Gallatin, Granite, Flathead, Jefferson, Lake, Lincoln, Madison, Mineral, Missoula, Powell, Ravalli, Sanders, Silver Bow

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.
Cultural Practices

Field Selection

The most important factor in field selection is the weed spectrum present. Consequently, it is important to eliminate perennial weed problems before seeding down to alfalfa. Sweet clover is considered a weed in these circumstances. It is advisable to avoid fields with a history of sweet clover to control the problem of carry-over seed in the soil.

The importance of starting alfalfa seed production on a clean field, requires field management practices to start two years earlier. Begin by assessing the weed spectrum and initiating an appropriate weed control program. Cereals are the preferred crops to grow at this time as they allow the broadest range of weed control. If perennial grasses, such as quack grass, are present consider a fall application of Roundup or an equivalent.

Although alfalfa is adapted to a wide range of soil conditions, best results are achieved when using deep, medium textured, well drained soils. Avoid poorly drained or saline soils. For certified production ensure neighboring fields pose no hazard. Keep other alfalfa at least 165 feet from the seed field. A field sheltered from the wind benefits the bees, increasing the chances for pollination in the field. Keep in mind the difficulties of maintaining isolation posed by removing stray alfalfa plants from bush areas. Another requirement for good establishment is a well worked seedbed. Summer fallow the year prior to establishment is advisable.

Cultural practices for alfalfa seed production are significantly different than for hay production. Alfalfa seed is produced primarily in the western U.S. and Canada, where the climate is sunny and warm in the summer and there is little rainfall. These conditions allow for the adjustment of irrigation to encourage maximum flowering activity, requiring judicious water use to prevent over-development of foliage. Spare irrigation also provides a favorable foraging environment for alfalfa leafcutter bees, a species that is managed for the purpose of increased pollination and seed yields.
In addition, row widths are wider with fewer plants in a row, weed control critical, and pesticide use is limited. If growing certified seed, a buffer zone between alfalfa fields is critical to lower the chances of cross-pollination.

Soils with good drainage, moderate pH level, and low concentration of soluble salts are best for growing seed alfalfa; soil depth must be at least one meter deep, to accommodate the long tap root. Soil texture should be moderately clay-rich to enhance water retention. Soils underlain by coarse gravel should be avoided, due to problems with excess leaching. Conversely, soils underlain by hardpan layers should also be avoided, because of poor drainage.

Land preparation typically involves disking or plowing to break up heavy subsoil, with final leveling. Pre-irrigation of 8 – 12 inches of water settles and recharges the soil before planting. Phosphorous and potash can be applied before planting to correct soil nutrients, if these are low. Seeds may be sown in late fall or spring; in cold climates with extended freezing periods, spring planting is recommended.

Alfalfa grown for seed is planted in much thinner stands than that grown strictly for forage. This a practice enhances seed production by reducing the number of aborted flowers, reducing competition between plants and lodging, reducing foliar disease levels and allows pollinators to work much more efficiently. It also allows more even application of pest control agents, and better control of weed alfalfa, with more seeds per plant. Row width is usually 24 – 30” for irrigated fields and wider for dryland fields. Seeding rates of 5.4 to 8.2 lbs/acre are recommended, or about 5 plants per square foot.

Harvesting

After pollination, it takes five to six weeks for the plant to produce mature seed. Therefore, growers can plan on starting harvest approximately six weeks after either the bees are removed from the field or the crop has finished blooming. The crop can be swathed, then wait until two-thirds to three-quarters of the seed pods have turned dark brown or black. It is advisable to swath when it is damp enough to avoid the loss of seed pods. Swathing in the direction of the prevailing wind helps to prevent the rolling of swaths and subsequent seed loss. A roller can be used to further anchor the swath. Some growers also leave a narrow strip of standing alfalfa between every couple of swaths to limit the wind action. One advantage of swathing is that it allows seed that is nearly ripe to mature before combining.

To cut down on seed losses, many growers turn to desiccation and straight combining. Normally, this involves spraying diquat to kill the green tissue and dry out the standing crop. However, any early hard frost will give the same effect. After spraying diquat, the crop will be ready to combine in 3 to 5 days.

Post Harvest Control Practices

Burning stubble and debris in the spring aids in the control of many of the over-wintering insect pests as well as crop disease found in stubble and debris. Care should be given to annual burning as it has a negative impact on soil improvement. An alternative to burning may be early spring cultivation. Cultivation incorporates stubble, and removes winter and early spring weeds. Currently a number of disease and insect resistant alfalfa species are available. Growers should select from these species based on the pest resistance needed in their area. Growers can contact the Montana Agricultural Experiment Stations in their area for recommended species. http://plantsciences.montana.edu/Crops/Default.htm, http://www.montana.edu/agriculture/Station/, http://www.alfalfa.org

Stand Maintenance

A well established, clean seed field needs little maintenance to keep it productive to the full life of stand. Weed control and insect pest control programs are carried out on an annual basis. Spring burning for pest management also controls most diseases. Generally, growers do not apply an annual application of fertilizer unless their stands show an obvious nutrient deficiency that can be confirmed by soil test and plant tissue analysis.
One factor in maintaining yields that is frequently overlooked is the stand density. Most stands thicken up after the first or second harvest and should be thinned back to 30,000 plants per acre.

There is no standard method used for thinning but most frequently cross-cultivating is used. Often it requires more than one thinning operation to achieve the desired results. Growers are advised that thinning in the spring is preferred, as fall thinning can lead to increased winter injury.

Pollination

Alfalfa leafcutting bees (*Megachile rotundata*) are necessary for optimum seed set of alfalfa. Because of these very efficient pollinators, alfalfa seed growers can double to quadruple the amount of seed produced per acre. Unlike the honeybee, the alfalfa leafcutting bee is undeterred by the tripping mechanism found in alfalfa flowers and prefers this crop over competing bloom from nearby crops or weeds. The bees collect alfalfa pollen as a food source, and in doing they transfer some pollen from the flowers of one plant to the flowers of another. This process, called cross-pollination, is necessary for seed set in alfalfa. Honey bees tend to harvest only nectar from alfalfa, because the tripping mechanism of the alfalfa floret which releases the staminal column deters them from probing into the flower for nectar. Instead, they probe the flower from its side, thus not tripping the flower. If pollen is required the honey bees will gather it from other floral sources such as canola. Leafcutting bees, on the other hand, must collect pollen in order to provision their nests, and therefore actively trip the alfalfa flowers they visit, exposing the pollen for collection and the sticky stigmatic surface for cross-pollination.

The introduced leafcutting bee has supplemented and to some extent replaced native pollination. It has extended the boundaries of the alfalfa seed producing region and has allowed a more constant production. Experimentation by research and extension personnel and growers has resulted in the development of current management techniques.

The seed grower must decide whether to purchase leafcutting bees and become involved with bee management or to contract out the pollination to a leafcutting beekeeper. Management of bees is very labor-intensive throughout the growing season and especially in May and June, and a substantial capital expenditure is initially necessary. Leafcutting bee populations do tend to increase each year, and while the sale of extra leafcutting bees will offset startup and operating costs, markets are time-consuming to establish. Contracting with a leafcutting beekeeper is on a cropshare basis. If the contracting route is chosen, the grower and beekeeper need to establish the management responsibilities of each and the cost share arrangements.

The Montana Alfalfa Seed Committee manages the alfalfa leafcutting bee certification program in Montana and is administratively attached to the Montana Department of Agriculture. Alfalfa leaf-cutting bees are reared in Montana primarily for the purpose of pollinating alfalfa raised for seed. Bee diseases and parasites can dramatically decrease leaf-cutter bee reproduction. Registration and certification of leaf-cutting bees is a means of controlling and monitoring diseases and parasites.

Parasites, Diseases and Predators of Leafcutting Bees

The annual combined value of crops requiring cross-pollination in the U.S. is valued at over $10 billion. Although honey bees are extensively used as orchard pollinators, the recent introduction of the Varroa and tracheal mites into the U.S. is decimating honey bee populations. Decreases of 80-90% in feral populations and 40-80% in managed populations are common throughout the country. The advance of Africanized honey bees is causing concern about moving managed honey bee hives near populated areas. This and the additional cost of managing for mite control is reducing the numbers of colonies available for crop pollination and increasing rental fees. Without effective pollinators, there are no blueberry or cranberry crops. In the case of alfalfa seed, this shortfall extends to alfalfa hay, dairy and even beef production. CheckMite miticide strips are available in Montana under a Section 18 to control Varroa mites and small hive beetles. This Section 18 expires on February 1, 2003.

Also of great concern to bee producers is a chalkbrood disease. The pathogen is a fungus, *Ascosphaera aggregata* Skou. It is similar to honeybee chalkbrood, but is specific to the family of leafcutting bees. Infected larvae die before reaching maturity. They become hardened, and appear chalky, cream colored, gray or black. The disease was first noted in Nevada in 1973 and has since spread to most areas in western North America. Because the disease is less common in Canada, most leafcutting bee
production now takes place in British Columbia, Saskatchewan, Alberta and Manitoba. While some seed growers in the United States are able to replace their bee stock in a good year, a loss of 50% or greater is more typical. Alfalfa seed growers in the United States buy most of their bees from Canadian sources each year. There are now concerns that chalkbrood may be increasing in Canada. If this disease becomes endemic in Canada, leafcutting bee production could be jeopardized.

Several management practices can reduce the incidence of chalkbrood. Phasing out used nest material is important in the solid wood system to limit spread of chalkbrood. Dipping nest materials in a 3% solution of sodium hypochlorite has been shown to reduce the losses from chalkbrood. Used solid wood boards or laminates can be heated in a kiln at 120°C to kill chalkbrood spores. The fumigants paraformaldehyde and methyl bromide have been shown to kill chalkbrood spores and other microorganisms without adverse affects on nesting and paraformaldehyde has been registered for this use in Canada; however, these chemicals will probably never be registered in the United States for this use. Researchers have also found that certain fungicides, such as Captan, Benlate and carbendazim, can reduce chalkbrood when incorporated into food provisions but these chemicals are not yet registered for this use.

The second most important problem facing leafcutting bee management is losses from parasitism and predation. At least 8 parasitic species and 28 predator or nest destroyer species are known to infest leafcutting bees or their nest materials. Parasitoids from four genera (Pteromalus, Monodontomerus, Tetrastichus and Melittobia) attack the alfalfa leafcutting bee. They emerge before the bees, usually from about day 8 to day 13 of incubation, and if undisturbed, they will heavily parasitize the developing bees, especially in the loose-cell system.

An ultraviolet light placed over a pan of water on the floor of the incubator will attract and drown most of the parasitoid. A few drops of liquid soap in the water reduces the surface tension of the water so that when a parasitoid falls in, it is immediately wetted and unable to escape. These light traps show the importance of managing parasitoids. It is not uncommon to find them 1 cm deep on the floor around a trap in a large incubator. Research has shown that dichlorvos resin strips (Vapona) are effective in controlling parasitoids and safe for bees when used from day 8 to 13 followed by 24 hr of active ventilation. The repellent N, N-diethyl-m-toluamide (DEET) was also shown to reduce parasitism when loose cells were dipped in dilute solutions or covered with DEET treated vermiculite.

Adults of one parasitoid, Sapyga pumila Cresson (Sapygidae), were found to spend the night in leafcutting bee holes, but when offered a choice, preferred smaller hole, therefore, a night station trap that takes advantage of this behavior was developed. This trap is a hollow plastic pipe which has small (2.5 mm diameter) holes. Adult Sapyga are attracted to these smaller holes at night, but once inside the trap, the wasps are killed by an insecticide that is placed inside.

The checkered flower beetle is a serious predator of leafcutting bee cells. For this predator, a highly effective trap has been developed which uses an aromatic attractant. This trap is capable of killing up to 94% of the emerging beetles.

The third difficulty is the loss of bees from insecticide poisoning. Bees can be killed by insecticides applied to alfalfa for pest control, especially those sprays that are applied during bloom. Bees are also exposed to insecticide residues in nectar, pollen and on leaf pieces. There is also the danger of bee losses when Vapona strips are used carelessly during incubation. The alfalfa leafcutting bee is more tolerant to most insecticides than the honeybee. However, the leafcutting bee has a larger surface-to-volume ratio than the honeybee, allowing it to accumulate a lethal dose more efficiently. The ongoing evaluation of insecticides for their toxicity to leafcutting bees, honeybees and alkali bees continues to provide valuable information to seed producers.

**Pest Management**

**Critical Pest Management Issues In Montana**

Dodder, a parasitic weed, causes problems in areas where alfalfa is grown for seed.
Lygus Bug
Alfalfa weevil
Herbicide-resistant kochia
Grassy weeds - pigeon grass
Canada thistle
Winter annual weeds such as mustard
Pigweed

NOTE: Alfalfa seed grown in Montana is sold exclusively as forage seed. The pesticides used are not certified for food or fresh market use (for sprouts etc.).

Insect Pests

Adequate control of seed alfalfa during pollination and seed set is complicated by the fact that care must be taken not to harm pollinators working the fields. In Montana, as elsewhere in the Pacific Northwest and Western Canada, the alfalfa leafcutter bee, is the most commonly used pollinator. Females of this species use alfalfa leaves to construct a series of thimble-shaped nest-cups, each of which is stocked with a small amount of pollen and nectar to feed a developing larva. Each foraging female cross-pollinates numerous flowers, generating up to 1/4 lb. of seed in her lifetime. In addition to promoting increased yields, the use of alfalfa leafcutter bees improves seed quality as well. For this reason, this species is intensively managed by alfalfa seed producers. Bee management is costly, requiring an investment in temperature-controlled winter storage, spring incubation facilities, and large-scale commercial shelters that provides shade, ventilation, and nesting materials for roughly 10,000 nesting females per acre.

In Montana, nesting female leafcutters are active from the first week of July to mid-August. Before their field release, the alfalfa crop should be inspected carefully to identify pests and make estimates of pest density. Pre-spray inspection by seed producers has resulted in a significant reduction in the application of pesticides. Appropriate chemicals can be applied early enough in the season to clear the field of pests and harmful residual toxins before the leafcutter nesting season. Most growers put out 2 – 4 gallons of leafcutter bees. Each gallon has approximately 10,000 bees; half of these bees are females.

Alfalfa weevil

Alfalfa weevils (*Hypera* spp.) are pale brown snout beetles, less than 1/4 inch in length, with a darker brown stripe extending from the head down most of the length of the wing covers.

**Damage.** Early in the spring, adult females chew holes into alfalfa stems, laying 10-40 eggs in each hole. The tiny larvae hatch in one to two weeks. Larvae have pale green bodies and shiny black heads, often with a white streak running down the back. The larval stage is the damaging stage causing the most damage to the foliage. Young larvae feed on the unfurled leaves of stem buds, where damage may be heavy without being clearly visible. Older larvae, the most damaging stage, will feed on opened leaves as well. Larvae complete development in 3 to 4 weeks. Adults emerge in one to two weeks, feeding briefly and mating. Adults remain in the fields for the remainder of the summer and the following winter, but are not damaging at this stage. Severe attack results in dried foliage and a grayish or frosted appearance, or completely stripped foliage.

**Cultural control:** The growing season in Montana is too short to control alfalfa weevils by an early cutting. Some alfalfa cultivars, such as Arc, Perry, Liberty, Team, and Weevlcheck, are somewhat tolerant of alfalfa weevil damage; however, their resistance level generally does not obviate the need for chemical application; in addition, they appear to be vulnerable to root rot, *Verticillium* wilt, and stem nematode.

**Biological control:** Ladybird beetles, lacewings, damsel bugs, and parasitoid wasps all attack alfalfa weevil larvae. Limiting insecticide use to the minimum necessary best encourages their activity, to conserve their natural populations. The parasitic wasp *Bathyplectes curculionis* is present throughout the range of the alfalfa weevil. Biological control has limited effectiveness and most growers spray.

**Chemical control:** When temperature exceeds 48°F in the early spring, larvae begin development. Frequent checks must be
made within the folds of axial buds for early instar larvae to detect lighter infestations that may cause economic damage later. When larvae are in the second or third instar stage, if there are 20 or more larvae in one sweep, chemical control should be undertaken. See insecticides listed below.

**Army cutworm**

Cutworm (*Euxoa auxiliaris* (Grote)) larvae are light gray caterpillars with mottled lighter markings and a pale stripe running down the center of the back. Older larvae may be nearly 2 inches long.

**Damage.** Cutworm outbreaks are sporadic, often isolated by many years in which there is little damage. Cutworms overwinter in the older larval stages, and commence feeding early in the spring on new alfalfa growth, feeding some on early-season foliage. The main damage occurs when larvae snap off top growth at the stem. Established stands are not likely to be killed, but seed yields can be reduced. Caterpillars cut stems at night, withdrawing to the soil during the day. Feeding occurs throughout the spring, until pupation in early summer.

**Cultural Control:** Seed growers should avoid rotations from winter wheat to alfalfa, as winter wheat is another early-spring host of army cutworm. Adequate irrigation and fertilization of new stands will help plants past the most vulnerable phase for cutworm damage.

**Biological Control:** Soil dampness elevates fungal pathogens that kill many larvae in wetter years. However, no biological controls are known to affect this pest.

**Chemical control:** See insecticides listed below.

**Blister Beetle**

The adult beetle has a conspicuous head and the first segment of the thorax of the adult beetle is narrow and neck like. The wing covers are soft and do not completely cover the abdomen. Most species of blister beetle have one generation per year. Adults emerge from the soil throughout the growing season, but periods of peak activity vary with the species.

**Damage:** The adult feeds on the upper leaves and flowers of the plants leaving ragged leaves and stunted plants, generally in small areas of a field. These insects generally leave the field before detection or chemical application. The blister beetle larvae become parasites of grasshopper and ground-nesting bees’ eggs.

**Chemical control:** See insecticides listed below.

**Flea Beetle**

Two species of the flea beetle are a problem in Montana: The potato flea beetle and the western flea beetle. Adult beetles are typically small, often shiny, and have large rear legs. Flea beetles overwinter in the adult stage hidden under leaves, dirt clods, or in other protected sites. Many flea beetles are strong fliers and locate emerging host plants by chemical cues the plants produce. They lay eggs in soil cracks around the base of the plants.

**Damage:** The tiny, worm-like larvae feed on small roots and root hairs of the plant. The larval stage last about a month when the insect pupates and emerges from the soil as an adult. There may be a second generation during the summer. Flea beetles produce a characteristic injury known as "shot-holing." The adults chew many small holes or pits in the leaves. Young plants and seedlings are particularly susceptible, growth may be seriously retarded, and plants even killed.

**Chemical control:** See insecticides listed below.

**Grasshoppers**
Grasshoppers (*Melanoplus* spp) are one of a number of forbs-feeding species that can severely damage seed alfalfa fields. There are generally five nymphal stages, which look like the adults but are wingless. Nymphs of species that feed on alfalfa are generally brown, gray, or green, with white or cream-colored banding across the eyes and hind-legs. Adults of most species are winged, and are strong fliers. Most species in alfalfa overwinter in the egg stage of development, and hatch out early in the spring. **Damage** on alfalfa are generally leaf feeders, causing defoliation. However, if densities are unusually high (an unusual occurrence), they will eat the entire alfalfa plant, including the crown, stems, buds, flowers, and unripe seedpods. Older nymphal stages often clip flowering or seed-bearing stalks off at the base, to feed on soft stem tissue.

**Cultural control**: The grasshopper species that damage seed alfalfa fields are almost all forbs feeders, not grass feeders. One good solution is to reduce the attractiveness of field margins by encouraging a dense grassy cover that contains few broad-leaved plants. This significantly reduces the numbers of pest grasshoppers migrating into the alfalfa crop from the field edge. Dense stands of sweet clover, especially, should be avoided.

**Biological control**: A disease-causing microbial organism, *Nosema locustae*, has been used successfully to reduce grasshopper densities. *N. locustae* is introduced into the crop incorporated into wheat bran at the rate of 1 X 10^9 spores per acre. When grasshoppers eat the bait, they ingest the spores. The spores subsequently germinate internally, killing or weakening the grasshopper. Typically, *N. locustae* takes longer to kill grasshoppers than chemicals do, but it can provide an effective way to keep grasshopper numbers under control. There are several important natural enemies that help control grasshopper populations. These include blister beetles, ground beetles, and several parasitic flies. Many species of birds and mammals also feed on grasshoppers.

**Chemical control**: Grasshoppers are easiest to control before they become adults. Grasshopper numbers should be assayed routinely as soon as hatch occurs in early spring. If grasshopper numbers reach 8 per square yard within the alfalfa field, chemical control should be considered. Grasshoppers can be killed most effectively in the nymph stages of development, before adult wings develop. If a range of rates is recommended for a chemical, use the higher rate late in the summer when the adult stage is most common, as adults are harder to control. Insecticide may be applied as spray or incorporated into baits. Border treatments of insecticide in 150-foot swaths around the periphery of the alfalfa field are often sufficient to prevent re-entry of grasshoppers from other areas. In years with high grasshopper populations, control may be difficult and multiple border treatments may be required. A border spray should be effective for at least 7-14 days. The residual activity of the treatments will vary with the chemical and the environmental conditions. It is important to monitor the borders and the crop margins after treatment to make sure grasshoppers do not re-enter the field. See insecticides listed below.

There is also a CD-ROM and web site that provides land managers with the best management resources to deal with grasshoppers. [http://www.ars.usda.gov/is/pr/2002/020207.htm](http://www.ars.usda.gov/is/pr/2002/020207.htm)

**Lygus bug**

Lygus bugs (*Lygus hesperus*) pose the greatest threat to alfalfa seed production and many growers spray to control lygus bugs in their fields. They are about 3/16 inch long and approximately half that wide. Coloration is reddish brown, pale brown, or pale green. Lygus can be recognized by the distinct pale triangle behind the shield, about 1/3 of the way down the back. Very early stages are sometimes mistaken for aphids, but are far more active. Both juveniles and adults cause feeding damage.

**Damage**. Lygus bugs feed on many plant tissues, causing several types of injury. The piercing/sucking mouth parts puncture holes in plant tissue, from which these insects remove plant juices. In addition, their saliva is toxic and causes a plant reaction. A great deal of damage is done when the lygus bugs feed on flower and leaf buds. Fields take on a tan or grayish-white cast as buds wither, if feeding is excessive. Older lygus nymphs and adults feed on the juices of immature seeds, resulting in black shriveled seeds that will not germinate. Lygus feeding can also cause blossoms to drop. However, not all dropped blossoms can be ascribed to lygus damage, as untripped or aborted flowers also drop. Lygus overwinter as adults; in the spring, eggs can hatch in as little as 1 week. The five nymphal stages are completed in five or six weeks, with 3 or 4 generations per summer possible.
Cultural control: Suppression of weed hosts in and around alfalfa seed fields is important. Known alternative host plants include mustards, lamb’s-quarters, kochia, Russian knapweed, and Russian thistle.

Chemical control: See insecticides listed below.

**Alfalfa seed chalcid**

The alfalfa seed chalcid (*Bruchophagus roddi* (Gussakovsky)) is a minute, shiny, black wasp, about 1/12th inch in length. Females have a long ovipositor projecting off the end of the abdomen. They inject young, developing alfalfa seeds with one egg, which rapidly develops into a larva. There may be multiple generations in a summer. Overwintering occurs in the larval stage inside the seed, with emergence occurring late in the following spring.

**Damage:** Young seeds infested with chalcid larvae are plump with a light brown coloration, in contrast to healthy, uninfested seeds, which have a healthy green appearance at this stage of development. Infested seeds will not develop. Seed loss can be as high as 15%.

**Cultural Control:** There are two management approaches that should begin in May to help in reducing levels of infestation in the seed crop. The first of these is to keep volunteer alfalfa outside of field areas clipped as much as possible to prevent seed set and remove potential habitats for population increases of the chalcid. Secondly, it is important to begin growth for the seed crop after the first forage harvest in May, so that seed can mature and be harvested in late July or early August. This harvest timing will be early enough to avoid the highest levels of infestation by the chalcid during late August and September.

**Biological Control:** There is no biological control for this pest.

**Chemical Control:** It is important that a control program for the seed chalcid be started in the spring, as this species cannot be controlled by insecticide applications during production of the seed crop. The adult wasp inserts eggs inside the pods, and larval and pupal stages develop inside the alfalfa seeds. The chalids overwinter as pupae in seed that was spilled in the previous season or in seed that was produced by alfalfa growing in field border areas and roadsides. Adults emerging in May and June lay eggs in seed being set on alfalfa wherever it is available, with the most common seed source being plants growing outside of fields. Several generations of the chalcid are completed each year, with the levels of infestation in seed becoming progressively higher as chalcid populations increase in mid- and late summer. Research has shown that up to 80% of seed harvested in September may be infested. See insecticides listed below.

**Aphids**

Spotted alfalfa aphid (*Therioaphis maculata* (Buckton)) and pea aphid (*Acyrthosiphon pisum* (Harris)) are important pests of seed alfalfa in Montana. The spotted aphid is the smaller of two species. It is pale grayish yellow, with four to six rows of raised dark spots on the back. Small spines emerge from these dark spots. Adult pea aphids are about 1/8 of an inch long, with yellow, green, or pinkish coloration. Pea aphids can produce winged forms as well.

**Damage:** Spotted aphids are generally found on the undersides of leaves on the lower portions of the plant, where they feed on mature leaves. Pea aphids concentrate at the newer growing tips in the top portion of the plant. Nymphs and adults of both aphids feed by piercing leaf tissue and sucking on the plant juices. In addition to causing stress through feeding, aphids inject a harmful toxin into the feeding site. Feeding can kill alfalfa seedlings and cause severe stunting and yellowing of leaves in more mature plants. Spotted aphids, in particular, secrete large quantities of honeydew from their hindguts, encouraging the growth of black sooty mold on alfalfa foliage. Fields with heavy aphid infestation appear dried. Severe damage can be caused by as few as 20-40 spotted aphids per stem; populations expand quickly, so they should be treated before reaching this level. Peak populations of spotted aphids tend to develop late in the summer under hot, dry conditions; for pea aphids, cooler dry conditions are more favorable.

**Cultural Control:** Newly planted fields are most susceptible to aphid damage. Therefore, efforts to establish a healthy, vigorous, mature stand are an effective strategy for minimizing aphid damage. Newly planted fields should be treated with chemicals more aggressively.
Biological Control: Parasitic wasps, syrphid flies, and ladybird beetle adults and larvae are the most important natural enemies of aphids; conservation of their populations should be considered in deciding whether to use chemical control. Many varieties of aphids are resistant to pesticides.

Chemical control: See insecticides listed below.

Two-spotted spider mites

Individual two-spotted mites (*Tetranychus urticae* Koch) are difficult to find with the naked eye. Established colonies, however, can be recognized by patches of yellow, brown, green, or occasionally orange coloration.

Damage: Mites overwinter as adults in debris or other protected locations. Mite colonies spin fine sheets of webbing that can enclose flower stalks, seriously inhibiting pollination. Mites feed by puncturing the undersides of leaves. Affected foliage takes on a white, stippled appearance on the upper leaf surfaces. Heavy infestations kill plants.

Cultural Control: Mite infestations are mainly an issue in plants that have been stressed by drought in July. Adequate irrigation during early drought reduces mite infestations.

Biological Control: Predacious mites, such as *Phytoseiulus persimilis*, can be used to control two-spotted mite. Under certain conditions this phytoseiid mite can completely eradicate two-spotted mite from a greenhouse. When using predators to help control spider mites, it is extremely important to release the predators as soon as spider mites are observed on the plants.

Chemical Control: Chemical control of spider mites in alfalfa hay is usually not recommended, but if severe infestations do occur, sulfur may be used to suppress the populations. Before deciding to treat for spider mites, consider the effects of that application. Most insecticides have a detrimental effect on spider mite natural enemies. Few insecticides/miticides are toxic to two-spotted spider mites. See insecticides listed below.

### Insecticides Used in Montana

**See Montana Pesticide Profiles for more details**

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Alfalfa Weevil</th>
<th>Aphids</th>
<th>Army Cutworm</th>
<th>Blister Beetles</th>
<th>Chalcid</th>
<th>Flea beetles</th>
<th>Grass hoppers</th>
<th>Leaf hoppers</th>
<th>Lygus Bug</th>
<th>Spider mites</th>
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<tbody>
<tr>
<td>Ambush permethrin</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Restricted Use</td>
<td></td>
<td></td>
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</table>

| Capture bifenthrin | X | | | | | | | | | |
| Restricted Use | Section 24C | | | | | | | | | |

| Comite propargite | | | | | | | | | | |
| Section 24C | | | | | | | | | | |

| Dibrom naled 864 | X | | | | | | | | | |
| Section 24C | | | | | | | | | | |

| Dimethoate 4EC dimethoate | X | X | | | | | | | | |

**NOTE:** Alfalfa seed grown in Montana is sold exclusively as forage seed. The pesticides used are **not certified** for food or fresh market use (for sprouts etc.).
<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Notes</th>
<th>S24C</th>
<th>Notes</th>
<th>Notes</th>
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<td>Fulfill Pymetrozine Section 24C</td>
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<td>Imidan 70-WSB phosmet + thimethoate</td>
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<td>Lannate LV methomyl Restricted Use</td>
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<td>Lorsban 4-E chlorpyrifos</td>
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<td>Malathion 5 malathion</td>
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<td>Malathion and Methoxychlor</td>
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<td>Metasystox R Oxydemeton-methyl</td>
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<td>Methoxychlor</td>
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<td>Onager 2E Hexythiazox Section 24C</td>
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<td>Sevin SLR plus carbaryl</td>
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<td>Warrior lambda cyhalothrin Restricted Use Section 24C</td>
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<td>X</td>
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</tr>
</tbody>
</table>

Compiled data from The Greenbook, Crop Data Management Systems, and Montana Alfalfa Seed Growers. Contact the Montana Department of Agriculture for use in Montana.

**Weeds**

**Cultural control:** Start with clean fields, free of perennial weeds. This can be accomplished by delaying planting slightly, to
allow weed seeds to germinate. Weeds can then be destroyed by shallow cultivation, to avoid bringing new weed seeds to the surface. Purchase only certified weed-free seed, to avoid introducing new and troublesome weeds. Use weed screens on irrigation water to sieve many of the larger seeds out before irrigating. Cultivation between alfalfa rows and hand weeding are also effective measures. After cutting, a light spring-tooth harrow and row cultivation will help control weeds and volunteer alfalfa.

**Damage.** Weeds compete with seed alfalfa for nutrients, and increase seed cleaning costs. In addition, some act as alternate hosts for pest insects. Loopers and armyworm moths, for example, are highly drawn to lamb’s-quarters and blue mustard, where they lay eggs. Some mustards as well as Russian thistle are early-season hosts for lygus bugs. Checkered flower beetles (*Trichodes ornatus*), an important nest-predator of alfalfa leafcutter bees, can be suppressed by the control of weed pollen sources such as mayweed, wild carrot, sunflower, knapweed, and yarrow. Weeds are best controlled as seedlings; if control at the seedling stage is not entirely effective, remaining weeds should be eradicated before harvest, to reduce problems with seed cleaning after.

**Barnyardgrass**

*Echinochloa crus-galli* is an annual grass that prefers wet sites. It is not usually a problem in well-drained cultivated fields but can grow heavily around irrigation pipe leaks and other wet spots in the field. It is a vigorous, warm season annual grass reaching 1 - 5’ in height with bases of many stems reddish to dark purple. Leaf blades are flat, broad, smooth, and without a ligule or auricle at the junction of sheath and blade. Seeds are the only source of reproduction.

**Canada Thistle**

*Cirsium arvense* is a member of the Aster or Sunflower family. Canada thistle, introduced from Europe, is a creeping perennial that reproduces by seeds and fleshy, horizontal roots. The erect stem is hollow, smooth, slightly hairy, 1 - 5’ tall, simple, and branched at the top. The leaves are set close on the stem, slightly clasping, and dark green. Leaf shape varies widely from oblong to lance-shaped. Sharp spines are numerous on the outer edges of the leaves and on the branches and main stem of the plant. The flowers are small and compact, about 0.75” or less in diameter and light pink to rose-purple in color (occasionally white). The seeds are oblong, flattened, dark brown, and approximately 0.125” long. Because of its seeding habits, vigorous growth, and extensive underground root system, control or eradication is difficult.

**Common Lambsquarters**

*Chenopodium album* was introduced from Europe and reproduces by seeds. Flowering season is from June to September. The stem is erect, stout, smooth, grooved, often striped with pink or purple, branched and grows 1 - 6’ high. The leaves are alternate with the lower ones being ovate and upper ones becoming narrower. The flowers are small, green, and crowded in the axils and at the tips of the stems and branches. It is a succulent, fast growing plant that rapidly removes moisture from the soil and is found in cultivated crop fields, gardens, pastures, vacant lots, waste ground, and other disturbed areas.

**Curly Dock**

*Rumex crispus* is a perennial weed native of Eurasia. It forms a rosette the first year and then develops a large taproot and sends up a tall stem. The flowers are inconspicuous but the capsule is rusty brown in the fall and is easily recognized. Seeds and root segments are the source of reproduction and is found in pastures, gardens, farmsteads, lawns, and disturbed areas. Tillage reduces weed populations. It has become a problem in alfalfa in recent years.

**Dodder**

*Cuscuta spp.* is the only economically important parasitic plant. It is an annual with a colorless flower which produces very small, light seed. Flowering occurs from July to October. It tolerates wet sites so the seed often gets into irrigation water and is carried to the fields. The dodder plant is yellow because it has no chlorophyll and cannot produce its own food. Therefore,
it must get its nutrients by penetrating the desirable plant with haustoria and obtaining its food from the host plant.

**Downy Brome (Cheat Grass)**

*Bromus tectorum* is a cool season grass introduced from Europe. It usually germinates in the fall, lies over winter, and produces seed early in the spring. It has smooth, slender, erect stems. The plant grows 6" to 2' high from a branched base. Fine, soft hairs cover the sheathes and leaves. The leaves are 0.125 - 0.25' wide and flat. The head is branched and somewhat drooping. Seeds are long and flat with an awn about as long as the seed. It matures and sets seed in early spring before most other grass species or crops. Downy brome is a strong invader and creates a serious fire hazard when the mature plant dries. Mature plants turn purple or brown.

**Field bindweed**

*Convolvulus arvensis* L. is a perennial weed that originated from Eurasia. Flowering season is from June to September. Rhizomes and seeds are the source of reproduction and is found on both cultivated and uncultivated land. It is most common in small grain fields, waste places, gardens, and roadsides.

**Foxtail Barley**

*Hordeum jubatum* is a member of the Grass family. Foxtail barley is a native, short-lived perennial grass that is very opportunistic but not highly competitive with other dominant species. Foxtail barley spreads by seed and grows in dense bunches with shallow fibrous roots. The bunches can expand over time to an 8" diameter for a single plant. The stems (growing from 6" - 2' tall) are smooth and usually erect. The leaves are erect, rough, narrow, flat or U-shaped, gray-green, 2 - 5" long, and 0.25 - 0.5" wide. The pale green heads or spikes are 2 - 4" long and nodding, with spreading, slender, barbed awns that are 1 - 2.5" long. The nodding head is an identifying characteristic of the plant. The mature head is yellow, sometimes with a slight red highlight, and breaks up readily into three spikelet clusters of which only one is fertile. The seeds are yellow, hairy at the tip, and about 0.125" long. Foxtail barley acclimates well to a wide array of environmental conditions, allowing for a broad geographical distribution. Typical of many grasses, foxtail barley prefers fertile, wet, non-alkaline soils. However, infestations can be found under many conditions.

**Pigeon Grass**

Pigeon grass is a less common name for green foxtail and yellow foxtail. Green Foxtail, *Setaria viridis* is generally shorter with roughened leaf sheaths, without hairs, and has much smaller seeds than other foxtails. These plants are native to Eurasia, but common throughout most of North America. These plants are responsible for reductions in yields, increased cleaning costs, and expensive control measures. Yellow foxtail, *Setaria glauca (lutescens)*, is a tufted annual, 1 - 3' tall, with erect stems that branch at the base. The leaf blade is smooth, and 0.125 - 0.375" wide with distinct hairs on leaf margins near the base. Seeds are broadly oval, green to yellow to dark brown, coarsely roughened and approximately 0.125" long. Yellow foxtail can reduce yields, increase cleaning costs, and can be expensive to control.

**Knapweed**

Two types of knapweed are commonly found in Montana. Spotted knapweed (*Centaurea maculosa*) and diffuse knapweed (*Centaurea diffusa*). Both species originated in Europe, like dry, well-drained soils and favors disturbed areas such roadsides, gravel piles, overgrazed pastures or rangeland. Diffuse and spotted knapweed are readily controlled with herbicides, but unless cultural techniques are used the weeds will invade an area. Spotted knapweed is a short-lived, noncreeping perennial that reproduces from seed and forms a new shoot each year from a taproot. Seeds are brownish, less than 1/4 inch long. The seeds may germinate from spring through early fall. Seedlings emerging in the fall often overwinter as a rosette of leaves, resuming growth again in the spring bloom in May to June, set seed in June and July, and die. The plant grows 2 to 4 feet tall. Stems are erect and rough, with slender branches. Numerous flowers are produced from early July through August. Flowers are pink to light purple and are borne on tips of terminal or axillary stems. Involucre bracts are stiff and black-tipped, giving the flower
head a spotted appearance. Diffuse knapweed is a biennial reproducing and spreading by seed. Occasionally, a plant will germinate and set seed in the same year or produce a new shoot the year after seed production, growing as a short-lived perennial or an annual. The plant develops a single shoot (stem), 1 to 2 feet tall that is branched toward the top. Rosette and lower shoot leaves are finely divided. Leaves become smaller toward the top of the shoot and have smooth margins. Many solitary flowering heads occur on shoot tips. They are about 1/8 inch in diameter and 1/2 to 2/3 inch long. Flowers usually are white but may be purplish. Involucre bracts are divided like teeth on a comb and tipped with a slender spine that makes them sharp to the touch. Sometimes the bracts are dark-tipped or spotted like spotted knapweed. The long terminal spine differentiates diffuse from spotted knapweed.

**Kochia**

*Kochia scoparia*, a member of the Goosefoot family, was introduced from Europe. It is an annual with seeds its only source of reproduction. The stems are erect, round, slender, pale green, branched, and 1 - 6' high. Leaves are narrow, bright green, hairy, numerous and are attached directly to the stem. The flowers are inconspicuous in the axils of upper leaves. Seeds are about 0.0625" long, wedge shaped, dull brown, and slightly ribbed. In autumn the plants may become red and later turn brown, breaking away from the root, and tumbling over the ground scattering large amounts of seed. It is found on rangeland, pastures, fields, and disturbed sites.

**Mustards**

The mustard family (Brassicaceae) is widely distributed throughout the cooler regions of the United States found along roadsides, cultivated fields, or any disturbed site. The mustard can be both annual and perennial, with watery, acrid juices. The leaves are usually alternate and simple. Wild Mustard, black mustard, and birdsrape mustard are a few of the more commonly called mustard plants. All three were introduced from Europe, have yellow flowers, grow from 1 to 4 feet tall or taller, and the seed pods have a constricted beak above the upper most seed.

Blue Mustard, (*Chorispora tenella*) is a winter annual weed, with seeds germinating in late summer and fall. The plant overwinters as a rosette. The flower stalk usually elongates in March and with mild February weather the flower stalk may elongate in early March. Cold weather in February results in late March elongation. The flowers are bluish-purple to purple and appear in early April. Viable seed can be produced approximately 10 days after bloom.

**Nightshades**

The nightshade is a member of the Solanaceae family. Silver nightshade (*Solanum elaeagnifolium*), black nightshade (*S. nigrum*), and hairy nightshade (*S. sarrachoides*) are not native to Montana. Silver nightshade is found on rangelands, pastures, cropland, and disturbed areas. This plant is a perennial, spreading by rhizomes or seeds. The plant gets its name from the thick, short hairs that cover the stems and leaves. The leaves are lance-shaped and have purple to light blue, star-shaped flowers. This plant is poisonous to livestock. Black nightshade and hairy nightshade is found in cultivated fields and disturbed areas. These plants are annual growing 6 to 24 inches tall. The black nightshade has ovate leaves that taper to the tip and the hairy nightshade has arrow-headed shaped leaves that may feel sticky to the touch. The flowers on both species are, white to pale blue, and resemble that of the potato plant. The green fruit and foliage are toxic.

**Pigweed**

*Amaranthus* spp. are weed pests in several cropping systems. Pigweed is a native forb. *A. hybridus*, smooth pigweed was the first triazine resistant plant documented. *A. retroflexus*, redroot pigweed’s flowering season is from July to October. Seeds are the only source of reproduction. Redroot pigweed stems and leaves are covered with fine pubescence. Confirmed resistance to triazine herbicides. Found in cultivated and fallow fields, gardens, waste ground, and roadsides. *A. lividus*, is a prostrate species with a notch in the tip of the leaf. *A. spinosus*, spiny amaranth, has sharp, strong spines on the stem. *A. graezicans*, breaks off at the ground line and because of its round shape, is blown around by the wind.
Quackgrass

*Elytrigia repens* is an aggressive perennial grass reproducing by seed or spreading by a shallow mass of long, slender, branching rhizomes. Rhizomes are usually yellowish-white, sharp-pointed, somewhat fleshy. They are able to penetrate hard soil or even tuber and roots of other plants. Erect stems stand 1 - 3' tall. Leaf blades are 0.25 - 0.5" wide, flat pointed and have small auricles at the junction of blade and sheath. Leaf sheath and the upper surface of leaf blades may be thinly covered with soft hairs. These rhizomes are effectively spread by tillage, increasing the scope of the population in a field. Tillage is an effective control by depleting food reserves and bringing rhizomes to the surface.

Sunflowers

The sunflower is a member of the *Asteraceae* family, native to North America. It is an annual plant found along roadways, fence rows, or any disturbed site. The Common Sunflower (*Helianthus annuus* L.) can grow from 1 to 10 feet tall, with erect stems that may be branched. The leaves and stems are covered with short, coarse hairs that give them a rough texture. The leaves are simple, typically oval or heart shaped. The flower has bright yellow petals with a brown disk center. The Nuttall Sunflower grows from 2 to 20 feet tall, with rough or smooth stems and oval to lanceolate leaves. The flowers are much smaller than the Common Sunflower, but also have bright yellow petals with a brown disk center.

Tansy Mustard

*Descurania pinnata* is a broadleaf, native annual that reproduces by seeds. The plant is covered with fine hairs. The stem is erect, branched and 4 - 30" high. The leaves are alternate, 2 - 4" long, pinnatifid to give a lacy appearance. The flowers are small, pale yellow, and occur in small clusters at the tips of elongating racemes. Found on rangeland, roadsides, sparsely wooded areas, small grain and alfalfa fields, waste places, and abundant on dry and sandy soils. Tansy mustard spreads by seed from early to late summer.

Wild oats

*Avena fatua* is an annual grass and is primarily a weed in spring-seeded small grains. Wild oats flowers and produces seed from June to August. Seeds can be dormant at least 10 years. Dormancy is induced by burying the seed after deep tillage.

Yellow Sweetclover

*Melilotus officinalis*, is native to the Mediterranean area through central Europe to Tibet. The plant is an obligate, biennial with long taproots, and branched stems 3 to 6 feet tall. It has a sweet-scent, with alternate, pinnately three-foliate leaves. The margin of the leaves are serrate, glabrous, with awl-like stipules, flowers are white or yellow in narrow, erect racemes. The plant contains a bitter tasting compound "coumarin". It is extremely drought tolerant and winter hardy, but cannot withstand prolonged flooding. Sweetclover spreads from cultivation and thrives in waste places and roadsides throughout the U.S. and Canada.

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<thead>
<tr>
<th>Herbicide</th>
<th>Target Weeds/Use</th>
<th>Actual Rate/A</th>
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<tbody>
<tr>
<td>Basagran</td>
<td>Canada thistle, mayweed &amp; other weeds</td>
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<tr>
<td><strong>Section 24</strong></td>
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<tr>
<td>Boa</td>
<td>Dessicant</td>
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<td><strong>Paraquat</strong></td>
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<td><strong>Restricted Use</strong></td>
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See Montana Pesticide Profiles for more details
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<thead>
<tr>
<th>Herbicide/Ingredient</th>
<th>Target Weeds</th>
<th>Rate</th>
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<tr>
<td>Butoxone 2,4-DB</td>
<td>Canada Thistle</td>
<td>16 oz / 4-5 pints</td>
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<td>Butoxone 2,4-DB</td>
<td>Kochia, Lambsquarter</td>
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<td>Fusilade DX Fluazifop-p-ethyl</td>
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<td>LV6 2,4-D ester</td>
<td>Sweetclover, Broadleaf weeds</td>
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<td>2 pt - 2 qt</td>
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<td>Winter Annuals - mustards</td>
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<td>Dessicant</td>
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<tr>
<td>Sonalan Ethalfuralin Section 24</td>
<td>Broadleaf weeds and grasses kochia, nightshade, pigweed, lambsquarter, grasses</td>
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<tr>
<td>Sencor Metribuzin</td>
<td>Broadleaf weeds and grasses, Volunteer alfalfa, sweetclover, kochia, mustards</td>
<td>0.9 t 1 lbs</td>
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### Diseases

**Alfalfa Mosaic Virus** Alfalfa mosaic virus is transmitted to seed through pollen and ovules from infected plants and by aphids after feeding on infected plants. Typically, a yellow or light-green interveinal molting and yellow streaks parallel to the leaf veins appear in young developing leaves during cool weather. Infected leaves of entire plants often become distorted and stunted. Mosaic-infected plants may die within several weeks to several years. Symptom expression is often masked in hot weather; many infected plants may never show symptoms. The virus is seed-borne and overwinters in living alfalfa and other plants.

**Alfalfa Stem Nematode** Alfalfa stem nematode occurs in most areas where irrigated alfalfa is grown, but it is worse in areas that have high clay content (>30%). The most common symptom of stem nematode parasitized plants is an overall stunting. Scattered plants or areas in the field may grow out slowly in the spring and may continue to have poor growth throughout the season. Localized areas infested with the stem nematode are usually round or oval in shape and vary in size from 3 - 6' in
diameter. Stems of stunted plants are swollen and distorted. A very small percentage of the parasitized plants may have one or more stems, including leaves, which are completely white. This is referred to as "white flagging" and is a useful tool in diagnosing this disease. Contact your extension agent or the Agricultural Research Station in your region for resistant varieties.

**Fusarium Wilt**  Fusarium wilt is favored by high air and soil temperatures. This disease overwinters in soil, plant debris, and weeds. It is commonly spread through infected transplants. The first symptoms seen are drooping and epinasty (downward twisting) of leaves followed by yellowing, stunting, and death. Symptoms may be one sided and progress upward killing foliage. A cross section of the stem near the base will have characteristic vascular discoloration. Control is primarily through use of resistant cultivars. These diseases become problems in older stands when roots and crowns are damaged by cultivating practices, freezing weather, water and nutrient stress and by nematodes or insects such as weevils. Contact your extension agent or the Agricultural Research Station in your region for resistant varieties.

**Phytophthora Root Rot**  Phytophthora root rot is a serious disease throughout the region and a major cause of seedling death on newly established alfalfa and causes a progressive decline of established stands. It is most damaging on susceptible cultivars, and where the soil remains wet due to high clay content, poor drainage, over-irrigation or a combination of these. The fungus *Phytophthora megasperma* causes damping-off of seedlings, root rot, and rot of lower stems. It may also weaken plants making them more susceptible to winter injury during severe winters. Symptoms of root rot are seen first in the above ground parts of the plant as chlorosis, wilting, stunting, necrosis, collapse, reduced yield, and eventual plant death. The affected roots, crown, or stem will have darkened lesions and cankers. Contact your extension agent or the Agricultural Research Station in your region for resistant varieties.

**Rhizoctonia Stem Canker**  Rhizoctonia stem canker is caused by the fungus, *Rhizoctonia solani*. Scattered, round to irregular areas of affected plants are evident in a field. Tan to reddish or dark brown lesions form on the lower stem, crown, and taproots. If severe, stems and roots are girdled causing the leaves and shoots to turn yellow, wilt and die. Seedlings are killed before or after emergence. The fungus survives for years in the soil as minute, irregular, dark brown-to-black sclerotia or as a saprophyte in plant debris.

**Spring Black Stem**  *Phoma medicaginis* primarily infects stems but attacks all above ground parts. Disease development is favored by cool, moist weather in the spring and fall and usually the first cutting is the most damaged. Dark green, water soaked, girdling lesions develop in the stems and petioles, turning dark brown to black with age. The lesions may enlarge and merge until most of the lower parts are blackened. Young shoots may be girdled, turn yellow-to-brown, and die. Numerous small, irregular, dark brown or black spots form on the lower leaves. The lesions enlarge and may merge to cover most of the leaflet. If severe, the leaves turn yellow, wither, and drop prematurely. A crown and root rot may also develop. The fungus overwinters in diseased plant tissue and may be seed-borne.

**Stem Nematode**  *Ditylenchus dipsaci* infests stems and crowns. Affected stems are stunted and often turn yellow. Young infested shoots appear swollen, with shortened internodes, which gives the stems a dwarfed appearance. The thickened stems are usually spongy and brittle and are especially prone to frost damage, they may succumb to only moderate frosts. The stem nematode also attacks buds and leaves and may destroy young seedlings if present in large numbers. Normally, symptoms of stem nematode damage appear in patches of the field, reflecting the patchy distribution of the nematode. The nematode moves in free water, so infestation and damage are most severe during moist, cool, cloudy periods when water films persist for extended times. Accordingly, stem nematode is most often a problem in cool valleys under sprinkler irrigation. Stem nematode may present a problem only in the first or possibly the second cuttings, because hot, dry summer weather reduces nematode activity. Crop damage and yield loss from this nematode can be severe nonetheless. Nematode infestation begins in one or more stems and, if weather conditions remain favorable, spreads throughout the crown. The nematode persists in the crown throughout the year. The nematode survives in plant debris or on the soil surface. Stem and bulb nematodes are spread from field to field in infested plant debris that may be carried by harvest or tillage equipment, wind, irrigation water, or animals. Contact your extension agent or the Agricultural Research Station in your region for resistant varieties.

**Bacterial Wilt**  *Corynebacterium insidiosum* occurs in poorly drained wet areas. The bacterium is easily spread in the field by mowing and tillage equipment, surface water, and animal life in the soil. Symptoms first appear as the dying of scattered plants
throughout a field, usually starting in the second or third year after seeding. Severely infected plants are stunted and dwarfed, bunchy, and yellow-green to bleached. Such plants are more susceptible to winterkill. Under moisture stress, young succulent growth wilts and dies. A cut through a diseased taproot or crown reveals a yellow to brown discoloration in the vascular cylinder. The bacterium overwinters in crop debris in the soil and infects plants through a variety of wounds. Contact your extension agent or the Agricultural Research Station in your region for resistant varieties.

**Damping off and Seedling Blight** Pre- and post-emergence damping-off and seedling blights occur in alfalfa. Soil-inhabiting fungi (*Fusarium spp.*, *Penicillium spp.* *Pythium spp.*, and *Rhizoctonia solani*) cause these diseases. They are characterized by missing or collapsed plants. When pre-emergence damping-off occurs, seedlings fail to break the soil surface. The germinating seed rots while still in the ground. With post-emergence damping-off, seedlings still in the cotyledon stage will rot at the soil line. The stem appears pinched and plants fall over. Seedling blights occur after true leaves emerge. The developing root system rots and plants collapse. Seedling diseases are problems when soils are cold and wet at or immediately following planting. These conditions can delay germination or stress developing seedlings, which allows pathogens to attack. Crusting caused by poor soil preparation, hard rain, or excessive trash on the surface also contributes to disease. Fungicide seed treatment combined with avoiding cold wet soils and good soil preparation will best manage these diseases.

**Root Rot and Crown Rot (Fusarium Wilt)** Most alfalfa plants that are more than two years old show some signs of crown and upper root rot. Symptoms of root and crown rots are seen first in the above ground parts of the plant as chlorosis, wilting, stunting, necrosis, collapse, reduced yield and plant death. The affected roots, crown, or stem will have darkened lesions and cankers. Fungi are the primary organism associated with crown and upper root rot.

**Verticillium Wilt** Verticillium wilt, caused by *Verticillium albo-atrum* and *V. dahliae*, infects alfalfa. It is of extreme concern because once it is in the field it remains in the soil for many years forcing producers to abandon production in that field. Wilting and chlorosis are seen in upper leaves (flagging) followed by defoliation and death. These plants also exhibit vascular discoloration. Verticillium wilt is more prevalent in hotter regions. Both these diseases overwinter in soil, plant debris, and weeds. Control is primarily through use of resistant cultivars.

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