Compiled and Edited by

Calvin H. Pearson
Colorado State University
Western Colorado Research Center at Fruita
1910 L Road
Fruita, CO 81521

Joe E. Brummer
Colorado State University
Soil and Crop Sciences
Fort Collins, CO 80523

Bob Hammon
Colorado State University
Tri River Area Extension
2775 Highway 50
Grand Junction, CO 81502

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Section II

Alfalfa
Alfalfa Insects

Alfalfa fields in the Intermountain West are alive with insects from the time they begin growth in the spring until growth ceases in the fall. There are many insect species that can harm alfalfa and also many beneficial insects that keep pests in check. The insect population in alfalfa fields changes throughout the year with very different insects present in the spring, summer, and fall.

It is important for a grower to be able to identify damaging and beneficial insects because of the diversity of insects found in alfalfa. There may often be as many beneficial insects as pests. Control measures that are aimed at beneficial insects may create problems that did not exist. Alternatively, not taking control measures while waiting for beneficial insects which are not present can lead to economic losses and possibly long term stand damage.

In general, damaging insect populations tend to be worse in lower elevation fields although insect damage can occur at any elevation. There are more pest species at lower elevations and many of these are present consistently from year to year. Insect pests can be more damaging in alfalfa under higher intensity management. Alfalfa under a four-cutting system will have fewer stored carbohydrate reserves that fuel growth than a similar field under a three-cutting system. A similar number of insects may inflict more damage to the four-cutting alfalfa.

Monitoring insect populations in alfalfa is essential for growers. Management decisions cannot be taken without knowledge of insect populations within a field, and populations can vary significantly between adjacent fields. An insect sweep net is an inexpensive tool for monitoring fields (Fig. 1).

Sweep nets are a cheap, effective way to sample insects in alfalfa.

Sweep sampling gives a quick and efficient diagnosis of insect activity within a field. Nets are available from many agricultural supply firms and a good net will cost less than $30. If you purchase a net, be sure it has a heavy duty rim and bag so it can be used in thick vegetation.

Successful pest management in alfalfa begins with maintaining a healthy crop with proper soil preparation at planting, good fertility management, avoiding water stress from over or under irrigation, and good harvest timing. Insect management decisions will vary with the production goals of individual producers. Pest damage levels that are acceptable to one grower may be unacceptable to another. The following sections describe insect pests commonly found in alfalfa in the Intermountain West and some of the management options.

Specific insecticides are not mentioned because of their constantly changing status.
and availability. Please refer to local Extension agents or chemical suppliers for timely information on product choices. The High Plains IPM web site, http://wiki.bugwood.org/HPIPM, provides an excellent source of biology, management and control options for most pests affecting alfalfa in the Intermountain West.

**Alfalfa Weevil**

Alfalfa weevil, *Hypera postica* (Gyllenhal), is possibly the most widespread insect pest of alfalfa fields lower than 6000 ft elevation in the Intermountain West. It is present to some extent in almost all fields at lower elevations, although its abundance varies significantly from year to year. In many years, locations, and management schemes, damage is severe enough to justify chemical control.

Adult weevils are approximately 3/16 inch long and have a long snout, which is characteristic of the beetles known as weevils. The body is light brown, with a dark stripe on their back. Winters are spent as adults in the crowns of dormant alfalfa plants or in debris. Many weevil adults spend the winter outside of alfalfa fields. The overwintering adults become active when average temperatures approach 60°F.

They reenter alfalfa fields, then chew holes in leaves as soon as the plants start growing. They typically do not feed on anything other than alfalfa (Fig. 2).

Overwintering weevils typically do not begin to lay eggs for several weeks after they become active. Egg laying begins after alfalfa stems have begun to elongate. The female weevils use their beak to chew holes in the alfalfa stem, then deposit up to 40 eggs within the cavity (Fig. 3). The eggs are bright yellow when first laid and then darken before hatching. Growers can monitor for eggs by searching for the oviposition holes, then split the stem when they are found. The color of the egg masses will give an indication of the time to egg hatch. Eggs hatch one to two weeks after they are laid.

Alfalfa weevil larvae are responsible for the bulk of feeding damage to leaves. They skeletonize leaves, feeding on the leaf surface between the veins, leaving the veins. Newly hatched larvae feed within the egg cavity for a couple of days after hatching and then move to newly expanding leaflets. Most larvae are found on the leaf tips. Larvae are green, legless grubs with a distinct brownish to blackish head capsule, and a white stripe down their back. Young larvae are less than 1/8 inch long and mature larvae are about 3/8 inch long. Severe weevil dam-

![Fig. 2. Alfalfa weevil larvae feed on newly expanding leaves, leaving the veins, which results in a ragged appearance. Heavily damaged fields appear frosted.](image)

![Fig. 3. Alfalfa weevils chew a hole in alfalfa stems and deposit eggs inside. They are yellow when first laid, turning darker before hatching.](image)
age in alfalfa usually occurs two or three weeks before the first flowers appear.

Adult weevils remain in the field for a few weeks and feed on newly emerging shoots or buds until they disperse to spend the summer in diapause in nearby protective cover. These adults sometimes move back into the alfalfa for a short time in the fall although no significant damage occurs at that time.

**Cultural Control**

Any crop management practice that helps produce a dense, uniform stand will make the crop tolerant to insect feeding. Mixtures of grass and alfalfa tend to be less susceptible to alfalfa weevil than pure alfalfa stands. Planting a mix may be a management option for some producers when alfalfa weevil is a persistent problem.

If scouting for eggs shows that an economic infestation is imminent, immediate cutting can be an alternative to spraying if the crop is in the early bud to bloom growth stage. Many larvae are destroyed by the cutting process, and others are left exposed to predators and environmental elements. However, if cutting is taken with high numbers of larvae in the field, feeding damage from survivors of the cutting process may feed on regrowth. When this happens, there can be yield loss and delays in second cutting growth. In extreme situations, stand decline can occur from alfalfa weevil larva feeding on regrowth.

**Biological Control**

Most alfalfa fields support a diversity of beneficial insects. Generalist predators are often abundant in alfalfa. They include lady beetles, lacewings, damsel bugs, minute pirate bugs, and many other types. Many of these feed on alfalfa weevil larvae.

Several species of parasitic wasps are established in the Intermountain West as biological control agents for alfalfa weevil. *Bathypectes curculionis* was established in 100% of the fields surveyed in 2008 by the Colorado Department of Agriculture Insectary in Palisade, CO. Two other species of *Bathypectes* were established in 25% or less of alfalfa fields sampled in Colorado. *Tetrastichus insertus* was established in 72% of the Colorado alfalfa fields surveyed in 2008. All of these parasitic wasps are specific on alfalfa weevil and can assist in reducing their numbers over time. Parasitism rates can be as high as 35% in some fields. Biological control agents can be effective at keeping alfalfa weevil numbers below economic levels and it is important to consider their abundance before taking spray decisions (Fig. 4).

![Fig. 4. Several species of parasitic wasps attack alfalfa weevil larvae. These wasp cocoons can be found on the ground when parasites are present.](image)

**Chemical control**

Insecticide treatments should be used only when justified by weevil numbers and economic considerations. Unnecessary and poorly timed sprays are expensive and can trigger secondary insect outbreaks by eliminating beneficial insects from the system. Alfalfa aphid and spider mite outbreaks are often triggered by insecticide applications. There are many methods for determining the need for insecticide treatments. Any method should consider the number of weevil larvae present in the field, the time until cutting.
potential yield, the value of the hay and the cost of treatment.

The percentage of damaged terminals can be calculated by a random sample of stems. Larval abundance within infested stems can be estimated by slapping the stems into a pan to remove them from the foliage.

Another quick and effective method is to use a sweep net. In general, if there are more than 1.5 larvae per stem or more than 20 larvae per 180° sweeps, and the alfalfa will not be cut for several days, a treatment may be justified. Fewer larvae can be tolerated with higher valued alfalfa or if highest quality hay is desired. Several mathematical models are available which use larva abundance, alfalfa value, control cost and other factors as variables to estimate control economics. These models can be found by searching Extension sites on the Internet.

If high populations of alfalfa weevil are present when first cutting is taken, surviving larvae may damage the regrowth. If the field does not green up within seven to ten days after cutting, or more than 50% of new growth shows feeding damage, a stubble spray may be beneficial.

**Clover Root Curculio**

Clover root curculio (*Sitonia hispidula* (Fabricus)) is a small weevil similar in appearance to alfalfa weevil, but with different life history and damage potential. These beetles are native to Europe, and were introduced into North America in the mid 1800’s. They are present in virtually every established alfalfa field in the Intermountain West, and their feeding can lead to stand decline and decreased longevity. Cicer milkvetch, sainfoin, birdsfoot trefoil, and several clover species as well as several other legumes are susceptible to clover root curculio damage to some degree.

Adult clover root curculios are about 2/3 the size of adult alfalfa weevils, with a shorter, blunter snout. They have mottled brown coloration on their back rather than the dark brown stripe of alfalfa weevil. It is important to differentiate between the two species when scouting for alfalfa weevil adults, because both are present in the field at the same time (Fig. 5).

Adults feed on foliage of the legume crop but do little damage, leaving a characteristic notch on the leaf margin when they feed. They also chew on stems and eat leaf buds on the plant crown. Most adult activity occurs between temperatures of 50 to 70°F. Newly emerged adults appear in mid-summer, then become sexually active and mate in the fall. A few eggs are laid in the fall, but most are laid in the following spring after adults overwinter.
Overwintering occurs under trash and debris on the soil surface within alfalfa fields. Adult curculio mortality is significant during the period between emergence and egg laying. Each female is capable of laying up to 200 eggs, which are mostly just dropped onto the soil surface beneath the host plant. Adults move mostly by crawling from spot to spot, but are capable of flying long distances.

Newly emerged larvae crawl through cracks in the soil until they reach plant roots. Small larvae feed on rootlets and nodules. As they increase in size, they feed on larger and larger roots, finally attacking the taproot. The legless, C-shaped larvae have cream colored bodies and brown head capsules. The larval feeding period is relatively short, possibly only three weeks. Larval feeding can occur as deep as eight to ten inches below the soil surface. Pupation occurs in small cells near larval feeding sites. The pupation period lasts one to three weeks.

In addition to causing direct damage on roots, larval feeding opens wounds which serve as entrance points for other pathogens. Inspection of the taproots from any established perennial legume stand will reveal significant scarring, of which much can be attributed to clover root curculio feeding damage.

Control of larval feeding on taproots is difficult if not impossible. Adult control is untested, and probably not feasible. There are no insecticides registered for use on clover root curculio. Using best management practices to keep the legume stand as healthy as possible is the only method of management of clover root curculio that can be recommended at this time. Alfalfa and legume varieties that are resistant to soil borne fungal and bacterial diseases may aid in minimizing secondary effects of clover root curculio larval feeding damage.

A new larval feeding scenario has emerged in western Colorado in the past few years. Clover root curculio larvae have been found boring within alfalfa stems at crown level. This feeding has caused significant damage to first and second cutting growth, and had killed stands in extreme situations. This damage was widespread in 2004, but not seen in other years. Control of larval boring type feeding will be near impossible once it is found. There is much to be learned about this apparent change in feeding strategy by clover root curculio (Fig. 6).

**Aphids in Alfalfa**

Several species of aphids feed on alfalfa and economic damage is not uncommon in intensively managed fields. It is important to scout for aphids in alfalfa and to be able to distinguish between the three primary species that are found in the region. There are many types of beneficial insects that feed on aphids and it is also important to be able to consider their presence before taking any control measures.

**Pea Aphid**

Pea aphid, *Acyrthosiphum pisum* (Harris), is the most common and widely distributed aphid in alfalfa in the Intermountain West. Pea aphids are pale green in color with long, thin legs. They have long cornicles (tailpipes) which are black toward the tip.
There are occasional light pinkish individuals in many pea aphid populations. This species is difficult to confuse with other species except when its range overlaps with blue alfalfa aphid, which may occur in the southern portion of the Intermountain region.

Pea aphids can be abundant in alfalfa and occasionally become economic pests in first cutting (Fig. 7), but high populations are usually found in second or third cuttings. Natural enemies can be very effective in keeping pea aphids below economic levels and elimination of beneficial insects with improper use of insecticides, especially those aimed at alfalfa weevil, can trigger aphid outbreaks.

Pea aphids prefer feeding on stems as opposed to leaves (Fig. 8). Aphids inject a toxin that retards growth, and may reduce yield and hay quality. When aphid populations are really high, a sooty mold fungus may grow on the honeydew excreted by the aphids. This sticky residue can interfere with harvest and hay curing, and reduce palatability to livestock.

Many alfalfa varieties have resistance to pea aphids. Resistance ratings are available on the alfalfa variety leaflet published by the National Alfalfa Alliance, http://alfalfa.org. When using published resistance ratings, those labeled HR (Highly Resistant) have the best rating, with more than 51% of plants in the sample tested showing some resistance. Those labeled R (Resistant) or less are all susceptible to some degree.

Several economic thresholds for pea aphid treatment thresholds are published. Colorado State University recommends 40 pea aphids per stem in alfalfa less than 10” tall, 75 per stem in alfalfa between 10” and 20” tall and 100 per stem in alfalfa more than 20” tall. If thresholds have been
reached and the alfalfa is at a stage that it can be harvested, that is an excellent alternative. The cutting process will kill many aphids, and they cannot survive the open field after the hay is cut. The harvest process is relatively easy on beneficial insects, and they will clean up surviving aphids (Fig. 9).

Chemical control is an option if economic thresholds are reached and the alfalfa will not be harvested for a week or more. A current listing of pesticides labeled for use against aphids in alfalfa is available at http://wiki.bugwood.org/HPIPM.

**Cowpea Aphid**

Cowpea aphids, *Aphis craccivora* Koch, are becoming more common as alfalfa pests since about 2000. They are small shiny, black aphids (Fig. 10). Cowpea aphids cannot be confused with any other aphid species in alfalfa in the Intermountain West. They can be present in high numbers early in the growing season, sometimes being present in economic numbers as soon as the fields green up in the spring.

Cowpea aphids feed on several weed species in addition to alfalfa. They include, but are not limited to shepherd's-purse, lambsquarters, prickly lettuce, pepperweed, *Polygonum* sp., and *Rumex* sp. Cowpea aphids inject a toxin into plants when they feed and can cause severe plant stunting. Treatment thresholds are lower than those used for pea aphids (Fig. 11).

**Spotted Alfalfa Aphid**

Spotted alfalfa aphid, *Therioaphis maculata* (Buckton), is an occasional pest of Intermountain alfalfa, especially of new seedings. It is the smallest of the three common aphid species in alfalfa, pale yellow in color, with four to six rows of darker spots on the upper abdomen (Fig. 12). These spots may be difficult to see without magnification. Spotted alfalfa aphids are easily overlooked in sweep samples, and even when observed, it is easy to misidentify them as something other than an aphid. Spotted alfalfa aphids prefer low humidity and warm temperatures found in late summer, but they can occasionally be found in

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Fig. 10. Cowpea aphids are the only black aphid that commonly attacks alfalfa. They can become abundant on stems at times.

Fig. 11. Early season damage from cowpea aphids can cause delay in spring greenup after a mild winter. The stunted strip in this picture, taken near Fruita CO, was heavily infested with cowpea aphids in March 2003.

Fig. 12. Spotted alfalfa aphids have four to six rows of darker spots on the upper abdomen.
first cutting alfalfa. They damage plants by sucking sap from the plant and also by injecting a toxic material which causes leaf death. They feed preferentially on older leaves, moving upwards on the plant as leaves die. The greatest threat of damage from spotted alfalfa aphids is in new late summer seedings.

**Alfalfa Caterpillar**

Alfalfa caterpillars are the larvae of the common yellow alfalfa butterfly, Boisduval, which flies above almost every alfalfa field in the western US at some time. Natural enemies and climatic conditions usually keep alfalfa caterpillars well below economic threshold numbers, but populations occasionally blow up and alfalfa yield, usually final cutting, can be impacted (Fig. 13).

Alfalfa butterflies are medium sized (<2” wingspan) yellow or white butterflies with black borders on the wings. They are commonly seen flying over alfalfa fields from which they often stray in search of nectar from flowers.

Female butterflies lay eggs on the underside of alfalfa leaves. Eggs hatch within a week under normal conditions, and larvae grow rapidly while feeding on leaves. Entire leaves are consumed, leaving only stems. This can be differentiated from armyworm damage since they skeletonize leaves, consuming everything but veins and midribs (Fig. 14).

**Fig. 12.** Spotted alfalfa aphids cannot be confused with any other alfalfa insect although they can be difficult to see in a sample.

**Fig. 13.** Adults of alfalfa caterpillars are the common sulfur or alfalfa butterfly. They can become abundant and love to feed from flowers near alfalfa fields. There is typically a 1-2 week delay between large butterfly flights and the appearance of caterpillars.

**Fig. 14.** Alfalfa butterfly eggs are laid on the underside of leaves. Caterpillars are tiny when first hatched.

Alfalfa caterpillars are green larvae with a velvety texture. They often have thin white lateral stripes running the length of their bodies. They have 3 pair of true legs arising from the thorax and five pair of fleshy prolegs coming from the abdominal segments.

Economic infestations of alfalfa caterpillars are favored by hot dry weather and low densities of natural enemies. Problem populations of larvae will be preceded by very visible flights of the yellow butterflies. These flights will be one to two weeks before larvae defoliate fields.
Alfalfa caterpillars are easily monitored with a sweep net. Ten or more unparasitized caterpillars per 180° sweep can cause economic damage if the field is not going to be cut in the next few days. Diseased and parasitized caterpillars can be distinguished from healthy ones by their abnormal pale coloration and sluggish behavior.

Several insecticides are labeled for use against alfalfa caterpillars. Several products contain Bacillus thuringiensis kurstaki, a biological insecticide that is specific to butterfly and moth larvae. Many pyrethroid insecticides are effective and registered for use. For an up-to-date listing, visit http://wiki.bugwood.org/HPIPM.

**Yellowstriped Armyworm**

Yellowstriped armyworm (*Spodoptera ornithogalli* (Guenée)) occasionally damages established alfalfa in mid to late summer in the lower elevation production areas of the Intermountain West. Fall seedings of alfalfa are occasionally damaged by high numbers of yellow striped armyworms. Adult moths do not overwinter, but migrate to the area during the growing season.

Adult yellow striped armyworms are night-flying nondescript brown moths that are rarely seen. Egg masses are laid on the upper surface of leaves, and are covered with grey cottony scales. Caterpillars, which feed during the daytime, are usually black with prominent orange or yellow stripes and numerous smaller stripes running the length of the sides. There is an intense black spot on the lateral margin of the first abdominal segment. Considerable variation in appearance can be seen between yellowstriped armyworm larvae (Fig. 15).

Larvae skeletonize the leaves, giving the plants a grey, ragged appearance. Feeding damage can be severe, with several larvae per plant present. Fields should be monitored routinely for the presence of defoliating caterpillars. Sweep nets are very useful monitoring tools for many alfalfa insects. Skeletonized leaves are a telltale sign of yellowstriped armyworm and their daytime feeding habits along with the black coloration makes caterpillars visible in the field.

Many species of parasitic and predatory insects, and pathogenic bacteria and fungal disease may attack yellowstriped and other armyworm larvae. If these beneficial organisms are present in sufficient numbers, crop injury may be avoided. If several larvae per plant are present or if more than ten to fifteen larvae are captured per sweep with a sweep net, an insecticide may be beneficial. Pyrethroid insecticides tend to give good control of caterpillars. Chlorpyrifos-based (Lorsban) insecticides have also given very good control of caterpillars in alfalfa. Several formulations of *Bacillus thuringiensis* are labeled for use on alfalfa, and may give good control if applied when most of the larvae are small.

![Fig. 15. Yellowstriped armyworms feed during the daylight hours. Their black coloration with lateral yellow striping makes them easily identified. Outbreaks occur occasionally at lower altitudes.](image)
Alfalfa Diseases

Many diseases that influence alfalfa production in more humid areas are either absent or of minor importance in the Intermountain West. This is especially true for foliar fungal and bacterial diseases, which require free moisture for their existence. Foliar diseases such as downy mildew and leaf spots are present in many fields in the region, but are rarely present at economic levels. The major disease problems in alfalfa grown in the Intermountain West are those that occur either under the soil surface, or systemically within plants where the moisture environment is much different from that experienced by leaves and stems. The most important diseases are alfalfa stem nematode, and root rots including verticillium wilt, fusarium wilt, Rhizoctonia and Phytophthora. There are presently no chemical controls for these diseases. Management options are limited to resistant varieties and cultural practices.

Alfalfa Stem Nematode

Stem nematodes of alfalfa are among the most important pests affecting alfalfa production in the region (Fig. 16). They have been present in the region since at least the 1940's, when a survey showed they were widely distributed. Recent research has shown that there are at least two species of nematodes that have similar life histories and damage. *Ditylenchus dipsaci* is known as alfalfa stem nematode, and is the species that is commonly associated with stem nematode damage in alfalfa. A second species, *Aphelenchoides ritzemabosi*, has been found in association with *D. dipsaci* in most parts of the west. The effect of this second species on alfalfa production is unknown. The name alfalfa stem nematode will refer to the species complex for the purposes of this publication.

*Fusarium* pathogens are closely associated with nematode infected alfalfa in the state. Nematodes are transported in irrigation water, so any field that receives tailwater recycled from infested fields, is at risk of infection. This includes virtually all irrigated alfalfa receiving water from the Colorado, Gunnison, Uncompaghre, Green, and San Juan River drainages. The fields highest in these drainage systems are at lowest risk, while those lowest in the drainages are at highest risk of infection.

Plants infected with alfalfa stem nematodes have dead or distorted shoots and buds, and living shoots are swollen with shortened internodes. The nematodes invade and kill stem buds one by one, stunting growth, reducing the number of shoots, destroying the crown, and eventually killing the plant. Severely infected stems may turn black for up to ten inches above ground level. Nematode abundance within the stem may reach levels of several thousand individuals per gram of tissue. Some infected plants produce shoots that do not contain chlorophyll, causing them to be totally white. These flagged stems are a very good indicator of alfalfa stem nematode infestations, and are most common in mid-summer (Fig. 17). Plants weakened by stem nema-
Nematodes are susceptible to damage by abiotic factors such as drought or heat, and other diseases may have more impact than plants free from nematode stress.

Stem nematode activities are greatest at cooler temperatures (60°-80°F) and moderate to high moisture levels. Because of this characteristic, damage in the Intermountain West is most severe in first and second cutting, and again in the fall. The nematode completes its entire life cycle within plant tissues. A complete generation, egg to egg takes about three weeks to complete under favorable conditions. Nematodes migrate within a plant from dying tissues to healthy tissues to find acceptable food. If suitable food sources are not available, the nematode may persist as a dormant, fourth stage larva. While in this stage, the nematode can remain viable in dry plant debris in the soil or seeds for many years. It is resistant to drying, but cannot tolerate moisture without green host plant tissue to feed on. Stem nematodes have been recovered in infected alfalfa seed lots that have been in storage for twenty years.

Debris in alfalfa seed is considered one source of dissemination of nematodes from area to area. Up to 37 nematodes have been found in a gram of screenings from alfalfa seed. Anything that moves nematode infested soil, seed or debris from site to site will spread the nematodes. This includes harvest and cultivation equipment, livestock, and irrigation water. Reuse of waste irrigation water is probably the most common method of nematode movement.

The use of resistant varieties is the first step in alfalfa stem nematode management. It is important to select varieties that have resistance not only to stem nematodes, but also to a wide range of diseases and insects. Crop rotation is essential for controlling the initial infection of nematodes within a field. Fields should be planted to non host crops such as corn, beans or small grains for at least two years before returning to alfalfa. Stem nematodes also attack onions, but it is unclear if it is a separate race, and if nematodes that attack alfalfa will also attack onions. Following alfalfa with onions or onions with alfalfa may cause some problems, and should be approached with caution. There are no chemical controls presently registered specifically for stem nematode control.

Often, alfalfa fields that show severe early season stem nematode damage will recover after first cutting has been taken. Second, third, and fourth cuttings are often normal after a significant loss was taken in first cutting. If there is significant damage in first cutting and subsequent cuttings are near normal, and the field is not plowed out, care should be taken to avoid additional stress on the field. Residual herbicides that can stress alfalfa should be avoided in these situations.

**Verticillium Wilt**

Verticillium wilt is a fungal disease that attacks the vascular tissue of alfalfa and several other legumes. It was first found in the United States in 1976 in the Pacific Northwest, and has subsequently been found in many other parts of the nation. It was first confirmed from western Colorado in 1992, although it had probably been in the region for some time prior to its discovery. The
fungus was isolated from a majority of fields that were sampled in the Grand Valley during the summer of 1992. Verticillium wilt has the potential to reduce stand longevity and reduce yields by up to 50%. Alfalfa producers in the Intermountain West may be required to assume a higher level of management to effectively cope with the disease.

Symptoms first appear in new fields as scattered plants having one or more stems with chlorotic leaves. The stems are erect, with only the chlorotic or partially chlorotic leaves showing wilt. Some apical leaflets may become narrow and roll upward parallel to the midrib. Infected leaves may twist and form a loose spiral along the midrib of the leaf. As the disease progresses, a higher proportion of the stems develop symptoms and eventually the plant dies. The most diagnostic symptom of verticillium wilt is the V-shaped chlorosis and necrosis of leaflet tips. These symptoms frequently appear within the two weeks prior to harvest. Regrowth of moderately infected plants appears normal until plants reach the prebud stage. Verticillium wilt may cause stunting of plants in a similar manner as alfalfa stem nematode. Symptoms may be observed the year following fall establishment, but several factors can influence their development. Insect feeding, soil fertility, water management, cultural practices and other diseases may produce symptoms that individually or in combination produce one or more symptoms that may be confused with verticillium wilt. These may also alter the typical symptoms of verticillium wilt.

Verticillium wilt of alfalfa does not pose a threat to non legume crops, but it can kill sainfoin, soybeans, and possibly some other legumes. The causal fungus can survive in several weed species. It can be transported both internally and externally on alfalfa seed. Because the disease can be spread by seed, a new seeding of alfalfa can become quickly infected by contaminated seed. The fungus infects alfalfa roots and also enters through wounds. Secondary spread of the pathogen within a field most likely occurs through infection of cut stems following the harvest of hay. The disease has been shown to pass unharmed through the digestive system of sheep. As a result it could be passed from field to field as sheep graze during the fall and winter. It is most severe when alfalfa is grown under irrigation.

Growers should select varieties that have a high level of resistance to verticillium. When the incidence of disease reaches an undesirable level the field should be rotated to a non host crop for three years. Planting high quality, debris free seed is important to minimize the initial amount of inoculum in the field. Harvest equipment should be cleaned before it is moved from infected fields to healthy fields. Non infected fields should be harvested before heavily infected fields to prevent spread by equipment. Proper management of other factors, including water, fertility, and other pests will help minimize the damage from verticillium wilt.

Resistant cultivars are the most effective means to control verticillium wilt

Fusarium Wilt

Fusarium wilt of alfalfa occurs in alfalfa growing areas throughout the world. It is favored by relatively high soil temperatures, and is therefore more severe in warm areas such as the lower valleys of the Intermountain region. Wilting shoots are the first indication of the disease. In the earliest stages leaves may wilt during the day and regain turgidity at night. Bleaching of leaves and stems occurs, and a reddish tinge may develop in the leaves. Dark reddish or brown streaks occur in the central portion of the vascular tissue in the taproot. They appear in cross section as small, partial or complete
rings. In advanced stages the entire vascular bundle of the taproot may be discolored. The discoloration of the vascular bundle can be distinguished from that caused by verticillium wilt by the lack of the reddish tinge in the verticillum.

Many species of fusarium attack plants, but only one or two cause damage to alfalfa. The fungus lives in the soils as spores and in live plant tissue as mycelia. It may occur and be moved in plant debris. Soil may remain infested for years. The fungus infects small roots or enters through wounds in the taproot, from where it progresses through the water conducting elements of the vascular tissue. As the disease progresses, these tissues become plugged and the plants die. Fusarium wilt usually progresses slowly within an alfalfa stand. Scattered plants show symptoms at any time. Stand loss may occur over several years.

The only practical control against a pathogen that can persist in soil for many years is the use of resistant varieties. Many of these resistant cultivars are available. As with other diseases, management to keep the alfalfa vigorous and healthy will reduce the impact of fusarium wilt.

**Crown and Root Rot Complex**

Crown and root rots are important chronic disease problems of alfalfa throughout the world, and they may lead to stand decline in the irrigated regions of the Intermountain West. There are many causal organisms both within fields, and in different areas of the region. The causal organisms are mostly fungi, but bacteria and nematodes may cause some symptoms. Clover root curculio and other root feeding organisms play an important role in the disease cycle when they damage the taproots and open wounds that allow infection by disease pathogens. The symptoms of crown and root rots are usually brown or necrotic areas associated with the crown or root cortex. In severe cases the central core of the taproot may be rotted hollow. Plant vigor declines as the root system rots, and plants will die as the disease progresses.

Management of root and crown rots begins with choosing alfalfa varieties that have multiple pest resistance. Mechanical damage to plants, especially when soils are wet allows for infection, so it should be avoided to the greatest extent possible. This damage occurs during the cutting cycle from machinery traffic, and it may occur with large animal traffic. Maintenance of a proper cutting schedule and adequate soil fertility, especially potassium, is important in controlling root and crown rots.