

Examining the taproot can usually identify alfalfa wilt. When the bark immediately below the crown is peeled, a yellowish or pale brown discoloration of the outer wood indicates infection. In recently infected plants, the yellow stain extends downward from the crown in streaks which merge into a continuous ring beneath the bark. If the taproot is cut across with a sharp knife, scattered discolored dots or a dark ring of discolored tissue is usually visible.

The bacteria enter the plant through wounds. The wounds may be caused by winter injury, soil fauna, or mechanical injury. The bacteria also can spread to healthy plants by mowing when machinery becomes contaminated. The water-conducting tissues are invaded and clogged by rapidly multiplying bacteria, resulting in yellowing, stunting, and the eventual death of the plant. In advanced stages of the disease, bacteria multiply in the crown and stems and are released into surrounding soil water.

Environmental Conditions: The disease favors abundant moisture. It is usually most severe in low, poorly drained spots in alfalfa fields.

Control: Use of resistant varieties is a practical means of wilt control. The producer should also follow cultural practices that may aid in retarding disease development in new areas. These practices are maintaining high soil fertility levels, particularly potassium and phosphorous; preventing injuries to crown and root; mowing when plants are dry; avoiding contamination of young, healthy stands by mowing them before mowing the older diseased fields; waiting to re-seed old alfalfa fields until complete rotting of the infected roots has occurred and; not seeding fields that receive surface drainage from infested areas.

Spring Black Stem and Leaf Spot

<http://www.ag.ohio-state.edu/~ohioline/ac-fact/0014.html>

<http://www.ent.iostate.edu/imagegal/plantpath/alfalfa/sblackstem/>

<http://www.agr.okstate.edu/alfalfa/images/diseases/spblkstm.htm>

This fungus attacks leaves, petioles, and stems, frequently causing defoliation and death of plant parts. The organism causing this disease reduces yield and quality of forage.

A complex of similar diseases develops on alfalfa, sweetclover and the clovers.

Symptoms: All aboveground parts of the plant may become infected, and the fungus may extend to the crown and upper root. In early spring, numerous small black to dark brown spots develop on the lower leaves, petioles and stems. Young shoots are often girdled and killed. Irregular shaped areas on leaves increase in size, coalesce, and become lighter brown. The leaves turn yellow and often wither before falling. Lesions on stems and petioles enlarge and may girdle and blacken large areas near the base of the plant. The fungus causes a crown and root rot.

The fungus overwinters principally on plant residue. In early spring, spores (fungal structures) emerge and are splashed by rain onto new shoots. The fungus is carried within the seed and in the soil, thus providing other sources of infection.

Environmental Conditions: The fungus overwinters on stems and fallen leaves. The fungus is spread by water, wind, and insects. In early spring, new shoots are infected as they grow through the crop residue or stubble. Dew or rain is necessary for infection to occur. The first cutting usually is the most damaged. In cool moist periods in the fall, the disease often builds up again. When plants mature in the field or when seed is produced in cool humid areas, pods may become infected, and the fungus becomes seedborne.

Control: If severe primary infection occurs in the spring, early harvesting to remove the diseased growth helps reduce secondary infection. Seed should be treated with a fungicide to prevent seedborne introduction. If the infection is severe, the field should be plowed under. Scientists are working to develop disease-resistant strains of alfalfa.

Summer Black Stem and Leaf Spot

Develops on alfalfa, clover, and sweetclover during warm moist weather.

Symptoms: Small brown spots on both leaf surfaces enlarge to form roughly circular but indefinite reddish brown to smoky brown spots which later become ashy gray. Heavy infections kill leaflets and cause severe defoliation. As the season progresses, elongate dark brown stem spots enlarge and join together to bring about discoloration of most of the stem. Small stems, petioles, and peduncles on nearly mature plants may die, resulting in further leaf drop.

Environmental Conditions: The fungus overwinters on old infected stems and occurs under warm moist conditions. The disease increases as the plants grow taller and form a natural humidity. Wind and rain spread the fungus to new foliage and to other plants. The fungus can be seedborne in warm humid areas. Secondary spread of the fungus on infected stems and leaves occurs during summer and fall. The disease is most damaging when harvesting is delayed.

Control: Harvest the crop on schedule. Resistant cultivars are not available, but some cultivars are less susceptible than others.

Sclerotinia Crown and Stem Rot (See Clover Diseases)

<http://ss.ngri.affrc.go.jp/disease/IMG/img0227.jpg>

Leptosphaerulina Leaf Spot

<http://www.ag.ohio-state.edu/~ohioline/ac-fact/0023.html>

<http://www.ent.iastate.edu/imagegal/plantpath/alfalfa/leptoleafspot/>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0234.jpg>

This disease was a minor disease of alfalfa in the United States until 1956-1960, when it reached epidemic proportions in the eastern and central states. It continues to pose a serious economic threat during cool, wet summers in Canada and the United States.

Symptoms: Young leaves are primarily affected, but petioles and older leaves sometimes can be attacked. Leaf symptoms vary with the environment and the leaf's physiological state. Infected areas often start as small, black spots and remain as "pepper spots" or may enlarge to "eyespot" 1-3 mm in diameter. The spots have light brown to tan centers with dark brown borders and are often surrounded by a yellow area. When conditions favoring infection and disease development coincide with rapid regrowth, spots become large and coalesce into a bleached area. Under these conditions, leaflets are killed and will remain attached for a short time. Early infection on spring growth can cause stunting.

Environmental Conditions: In northern areas, the disease is generally more prevalent in the spring, early summer, and fall. In moist weather, epidemics may occur at any time during the growing season.

Control: Resistant cultivars are not available, but some have less leaf loss. Harvest should be on schedule or earlier to prevent leaf loss and further spread of the disease.

Pseudopeziza Leaf Spot

<http://www.ent.iastate.edu/imagegal/plantpath/alfalfa/comleafspot/1785.17comlspot.html>

This is called common leaf spot. Although the disease does not kill the plants, defoliation causes loss of vigor and reduces hay quality and yield. In general, the second and third hay crops are more damaged than the first.

Symptoms: Small, circular brown spots approximately 1/16 inch in diameter develop on the leaflets. When spots are fully developed, the centers become thickened and a tiny, light-brown, cup-shaped fruiting body forms on the upper surface of green leaves. There is a sharp line between spots and the healthy appearing tissue that is usually not discolored.

Spores (fungal structures) are discharged from the fruiting body and are carried by wind to other plants. The fungus overwinters on dead, undecayed leaves. The pathogen is probably not seedborne.

Environmental Conditions: During cool, wet weather, only the topmost leaves may escape infection, particularly if the plants are growing slowly. Stands that are grown under a thick cover crop can be severely diseased.

Control: Though adapted alfalfa varieties are only moderately resistant to leaf spot, highly resistant lines have been selected and are being incorporated into new varieties. Harvesting before major defoliation and destroying plants in waste areas may reduce damage by removing infection sources. This should be done in pre-bloom or bud stage before foliage falls.

Stemphylium Leaf Spot

Symptoms: Spots on leaves are oval, slightly sunken, and dark brown with lighter centers; they are usually surrounded by a pale yellow halo. Older spots may have a target board pattern. Usually a single large spot causes a leaflet to yellow and fall prematurely. The fungus can blacken stems.

Environmental Conditions: The fungus overwinters on dead stems and leaves. The fungus is carried on seed. The disease is most prevalent during warm moist periods in late summer and fall. The same fungus also causes a disease of red clover.

Control: Some cultivars have low to moderate resistance in the field. Timely harvesting of forage reduces leaf loss.

Root Rot (See Clover Diseases)

<http://www.ag.ohio-state.edu/~ohioline/ac-fact/0042.html>

Anthracnose

<http://www.ag.ohio-state.edu/~ohioline/ac-fact/0015.html>

Symptoms: Symptoms vary from a few irregularly shaped blackened areas on resistant stems to large sunken, oval to diamond-shaped areas on stems of susceptible plants. The areas are straw color with brown borders. Black fruiting structures of the fungus develop in the bleached areas and are readily visible with a hand lens. The lesions enlarge, coalesce, girdle, and kill one to several stems on a plant. A conspicuous symptom is straw to pearly white dead shoots scattered through the field in summer and fall. Bluish black discoloration of the crown occurs. This symptom is often observed when killed stems are broken off at the crown. Other symptoms of anthracnose include blackening and killing of petioles and formation of a shepherd's crook when the stem dies suddenly while wilted.

The fungus can persist from one harvest season to the next in debris on the surfaces of protected harvesting equipment. This is an important means of spread from an old field to a new planting. The fungus also persists on stems, in the living stem-crown junction, and in the crowns of plants.

Environmental Conditions: The fungus spreads rapidly during warm humid weather. Rain and dew wash the fungus onto growing stems and petioles. The disease builds up to maximum severity between harvests in late summer and early fall. Stands of susceptible cultivars can be reduced significantly in two or more years.

Control: Plant resistant cultivars. Clean all harvesting equipment of debris before the first harvest in the spring and again during the growing-season when going from fields with infected plants to other plantings.

Yellow Leaf Blotch

Symptoms: Yellow, elongated blotches develop parallel to the leaflet veins. Blotches often extend from the mid-rib to the leaf margin. Small orange to black fruiting bodies develop on the upper surface of diseased areas. Diseased leaflets do not wither and die immediately, but, after a period of wet weather, considerable defoliation may result. Dark brown blotches occasionally appear on the stems. On dead leaves in late summer and fall, many cup-shaped bodies form on the lower leaf surface.

In late spring, spores (fungal structures) from overwintered bodies supply the initial infection.

Environmental Conditions: Small, oval, colorless spores are discharged from the fruiting bodies and are carried by wind to other plants. In cool, moist weather, particularly if cutting has been delayed and stands are high, the disease develops rapidly and damage may become severe.

Control: Cutting or grazing diseased leaves may reduce the severity of the disease on the subsequent crop before much defoliation occurs. Crop rotation for two years with a non-susceptible host such as corn can help control disease. Weeds or high stubble also can add to the problem.

Stemphylium Leafspot

<http://ss.ngri.affrc.go.jp/disease/IMG/img0223.jpg>

Symptoms: Spots on leaves are oval, slightly sunken, dark brown with lighter-colored centers, and are usually surrounded by a pale yellow halo. Older spots may be concentrically ringed and may resemble a target. Usually, a single, large spot causes the leaflet to yellow and fall prematurely. Black areas may appear on the peduncles, petioles, and stems. On red clover, spots are irregular, brown to black, and are not ringed. Clover stems are seldom damaged, but the fungal agent may attack petioles and cause leaflets to die.

Environmental Conditions: On alfalfa, this leaf spot is serious in wet years, particularly in dense stands.

Control: No adequate control exists, except to practice good cultural practices; however, some cultivars do differ in susceptibility. Cutting the stand early can save foliage and allow plants to dry out.

Downy Mildew

<http://www.iastate.edu/imagegal/plantpath/alfalfa/downymildew/1355.77downymildew.html>

Downy mildew occurs during wet or humid weather, particularly in spring. It commonly occurs on young plants, weakening them and causing defoliation.

Symptoms: Upper leaves are attacked first and turn light green; they later become yellow, twisted, and rolled. Large, irregular-shaped necrotic areas also may develop on the leaves. A fine, gray, mold-like growth develops on the underside of the leaves. The fungus is systemic in new shoots, where it causes stunting and yellowing. If the entire stem is affected, all leaves and the stem become yellow, with stems being larger in diameter and shorter than normal.

The numerous spores (fungal structures) produced on diseased leaves and shoots are carried by the wind. In late fall, resting spores are formed in diseased leaves, where they remain dormant during winter and germinate in spring. The fungus survives the winter inside the plant and on seed.

Control: Resistant lines of alfalfa are being tested for possible use in new varieties. Alfalfa can be cut in the pre-bloom stage to save foliage.

Clover Diseases

Target Spot

Target leaf spot is common on red clover. The disease occurs throughout the growing season, but damage is most evident in dense stands in late summer and fall, thus reducing the crop quality and quantity.

Symptoms: Leaf lesions are slightly sunken, round to irregular, and are characterized by light and dark brown concentric rings. If spots are numerous and merge, infected leaves turn dark brown, wither, and die.

Environmental Conditions: The fungus grows best at 68 to 75° F and requires high humidity for infection. The fungus apparently does not attack alfalfa or other clover species in the field. It is seedborne and can survive on old plant parts or in the soil. Spores are splashed by rain or blown by wind to infect new leaves. The spores (infectious agents) are hardy and can withstand drying for 18 to 20 months.

Control: Local adapted varieties are moderately resistant.

Powdery Mildew

<http://ss.ngri.affrc.go.jp/disease/de32.htm>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0257.jpg>

Powdery mildew is one of the most common diseases of red clover. It can attack plants at any stage of maturity, but develops best during late summer and fall.

Symptoms: Symptoms consist of light gray to white powdery growth of the fungus on the upper surface of a leaf. The same symptoms also can occur on lower leaf surfaces. Infected leaves remain green for some time, but ultimately lose their color, turning first yellow and then brown before drying. The fungus is found on the leaf surface, but specialized feeding strands penetrate the walls of plant cells and develop inside.

The fungus is carried by wind and air currents to neighboring plants. The dormant fungus probably overwinters within the host. An entire field may appear white with a severe fungal attack.

Environmental Conditions: The fungal agent causing the disease is favored by relatively dry weather. Frequent rains reduce its spread and development. Powdery mildew occurs on many hosts, including other species of clover and alfalfa.

Control: Most American varieties show some resistance.

Spring Black Stem

Spring black stem of clovers is caused by a group of fungi closely related, but somewhat different, depending on the host species attacked.

Symptoms: Symptoms on petioles and stems are blackened areas that are variable in size and shape. Small brown to black spots on leaves usually enlarge and unite to cause leaf yellowing and premature dying. Tiny, sunken, brown to black fruiting bodies develop in ashy-gray to light-tan areas on mature stems or on dead stubble from earlier cuttings. The fruiting bodies contain masses of spores (fungal structures) that infect new growth during periods of cool, wet weather.

The fungi overwinter on dead stems, and the new developing shoots become infected from the surrounding disease stubble.

Environmental Conditions: The fungi responsible for black stem of clovers are widely distributed and may cause extensive damage during cool, wet weather in spring and fall. On sweet clover, the greatest injury usually occurs in the second year's growth. If the first 6 to 8 inches of spring growth become diseased, leaves and young shoots in thick stands may be so heavily infected that plants are killed. Blackening may increase when clover is not cut at the proper time or is left to seed.

Control: Since the fungi involved do not persist long in old crop residue, rotation is a practical control measure. Burning stubble before new growth develops in spring also may aid in reducing infection. Where early infection occurs, cutting or grazing earlier than usual may aid in reducing disease incidence on the subsequent crop. Sow only disease-free seed.

Northern Anthracnose

<http://ss.ngri.affrc.go.jp/disease/de32.htm>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0247.jpg>

Northern anthracnose is one of the major diseases of red clover in the cooler parts of North America. Fifty percent or more losses have been reported in some fields. Hay production and quality as well as seed yield are affected seriously during periods of heavy attack.

Symptoms: Symptoms are confined chiefly to the petioles and stems, although leaflets are occasionally affected. Earliest symptoms on petioles consist of dark brown to black spots that become light colored with dark margins. The lesions enlarge and crack or girdle, killing the stem and causing the leaf to wilt, and the petiole to bend over in a "shepherd's crook." Plants in heavily attacked fields look as though they were scorched by fire.

There is evidence that the fungus is transmitted on or in the seed. Presumably, the fungus overwinters in perennial green stems or in dormant crown tissues. There also is a possibility that the disease can survive on old, infected stems. The disease is probably not soilborne.

Environmental Conditions: The fungus causing northern anthracnose develops best during the humid weather of spring and summer and at temperatures of 68° to 77° F. Wind and splashing rain carries spores (fungal structures) from diseased areas to healthy plant parts. The fungus does not attack alfalfa, but has been reported on black medic, alsike, and white crimson clovers.

Control: Locally adapted varieties offer the best means of control. Using seed from disease-free fields is a good precaution.

Southern Anthracnose

<http://ss.ngri.affrc.go.jp/disease/de32.htm>

This disease, similar to northern anthracnose, also occurs on alfalfa, crimson clover, and white sweet clover, but has not been observed on white clover. Alsike clover is almost immune.

Symptoms: A conspicuous symptom on alfalfa is the presence of white, dead shoots in late summer or fall. The causal fungus attacks the upper part of the taproot and crown. This causes crown rot or taproot decay weakening or killing affected plants. Diseased crowns often become so brittle that stems break off readily at the soil level. Tissues where the break occurs usually show a brown to bluish-black discoloration. Southern anthracnose is more likely to be present on the new growth of the second crop in the northern and mid western United States. Dark brown, irregularly shaped spots develop on the leaves, causing the leaflets to droop. Stems can be killed when girdled by a lesion or infected area. The entire plant will wilt and die when the crown is affected.

Control: Resistant strains of red clover have been developed in areas where the disease is prevalent. Use of disease-free, certified seed is recommended.

Pepper Spot

<http://ss.ngri.affrc.go.jp/disease/de32.htm>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0254.jpg>

This disease also is called pseudoplea leaf spot. In early stages, pepper spot is somewhat inconspicuous, but the damaging effects of the disease soon become apparent. Although the disease is most frequently observed on Ladino and white clovers, other species are attacked in the humid, temperate parts of the United States. Pepper spot is most damaging in dense stands of clover.

Symptoms: During periods of cool, wet weather throughout the growing season, infected leaves and petioles are peppered with tiny, black sunken spots caused by the fungus. The spots occur on both sides of the leaf and are sometimes so numerous that the infected leaves appear darkened or grayish. The tiny spots rarely enlarge, but their presence in great numbers seems to sap the leaf's strength; it soon yellows and falls or withers and turns brown. The lower leaves in a thick stand of clover are most conspicuously affected and most severely damaged. Some plants are so heavily attacked during spring that they fail to survive summer drought or a severe winter. When flower stalks and floral parts are attacked, seed may become diseased.

Infection occurs from spores (fungal structures) that develop in fruiting bodies on dead, overwintered leaves and petioles. Infection spots occur on the first new leaves that emerge in the spring. As leaves die, the fungus again produces fruiting bodies and the spores infect new leaves that develop during the growing season.

Control: There is no suitable control other than to cut hay before the disease becomes too severe.

Curvularia Leafspot

<http://ss.ngri.affrc.go.jp/disease/de32.htm>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0250.jpg>

Observations and tests suggest that Ladino clover is more susceptible than white clover to this particular leaf spot.

Symptoms: Infected leaves usually are distinguished by the presence of a large, yellowed area that soon turns watery gray and translucent and then light brown. A yellowish band generally outlines the advancing edge of the area. In some cases, diseased areas that originate at a leaf tip become v-shaped. Sometimes the dead, v-shaped part of a leaf curls downward. The fungus can invade the entire leaflet and grow down the petiole, causing wilt and killing the leaves. The fungus does not attack stolons.

Environmental Conditions: The fungus is spread by windborne spores. The disease develops most rapidly during warm, wet weather; temperatures of 75° to 80° F are most favorable.

Control: Since the disease occurs mainly on leaves, grazing or clipping the clover when the disease is first observed will remove much of the infected tissue. This in turn reduces the potential to infect new growth.

Cercospora Leaf and Stem Spot

Cercospora leaf and stem spot, also called summer black stem, occurs extensively on clovers throughout the north central and eastern United States. Similar species of the fungus cause leaf spot on sweet clover and cause stem blackening on alfalfa. Although damage varies from year to year and is dependent on weather conditions, summer black stem is always present and frequently causes extensive leaf-shriveling and premature defoliation.

Symptoms: On clovers other than sweet clover, the leaf spots range from light brown to almost purplish-black. The

spots on affected leaves are usually rectangular and lie between the veins of the leaf. When dew is on the leaves, the lesions appear silvery from the many spores (structures) produced by the fungus. Sunken areas may nearly cover the stems of diseased plants. As spots on the leaves enlarge or merge, the affected areas shrivel and turn brown and the leaves either drop off or prematurely die. On sweet clover and alfalfa, large, circular, ashy-gray spots develop on older leaves, which later shrivel and drop. On first-year stems of sweet clover, reddish-brown lesions sometimes develop in the fall after frost. The disease becomes noticeable on second-year sweet clover when plants begin to blossom. Occasionally, the fungus is found early on shoots that are dying back after cutting or grazing. The fungus also attacks the flower heads, causing maturing seed to fall. Diseased seeds may be shriveled and discolored, or they may show no visible sign of infection.

Environmental Conditions: The fungus persists on old stems; it produces fruiting structures abundantly during warm, wet weather. Fungal structures (spores) disseminated by wind and rain cause infection.

Control: Removing old residues by clipping or grazing may reduce damage to successive crops. Resistant varieties are being developed, and seeds can be treated with a fungicide.

Rusts

<http://ss.ngri.affrc.go.jp/disease/de32.htm>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0250.jpg>

The fungus that causes rusts attacks clovers each year, but damage is difficult to evaluate because infection usually occurs late in the season.

Symptoms: Symptoms of rust on the different clovers are identical. A few pustules (raised areas) of the brown rust stage form on the lower leaf surface and usually cause no damage. If pustules are numerous and well developed, the upper surface of an infected leaf becomes reddish-brown to yellow. The leaf then curls or withers and dies. Petioles also may be heavily attacked, and the supply of nutrients to the leaf may be curtailed; this reduces the quality of the forage. Sometimes during fall or early spring, small, swollen, yellow clusters of tiny cup-like structures develop on stems and petioles as well as on the leaf's mid-rib. This is another stage in the life cycle of the fungus, and, although it is usually less conspicuous than the brown rust form, it causes distortion of infected leaves and petioles.

Infection occurs in late winter or early spring from thick-walled spores (fungal structures) that overwinter on debris of diseased plants. Small, secondary spores produced by the overwintered spores infect young leaves. New spores are then formed that spread the rust to neighboring plants.

Environmental Conditions: The spores (fungal structures) are windborne and can infect plants under conditions of limited moisture, requiring only periodic heavy dews for germination. The spores can germinate over a wide range of temperatures.

Control: Some cultivars are more resistant than others.

Sclerotinia Crown and Stem Rot

<http://ss.ngri.affrc.go.jp/disease/de33.htm>

<http://ss.ngri.affrc.go.jp/disease/IMG/img0246.jpg>

A fungus that attacks plants in winter and early spring causes crown and stem rot. It is one of the most serious alfalfa and clover diseases. Most species of clover, as well as alfalfa and birdsfoot trefoil, are susceptible to the disease. The fungus also attacks about 80 other species of plants, including certain weeds.

Symptoms: This disease forms in patches that may merge to form large dead areas. Plants of all ages are susceptible, and symptoms vary accordingly. Earliest symptoms occur in the fall as small brown spots on leaves and stems. The leaves wither and die, and the fungus spreads to the crown and upper root area. In late winter or early spring, the crown or basal part of the stem becomes soft and discolored; stolons of Ladino clover become soft and flaccid over

small portions or over their entire length. As the plant parts die, a white fluffy mass grows over the diseased area and forms hard, black resting or overwintering bodies (sclerotia), which may adhere to the surface of the stem, crown, or roots. These sclerotia are the principal means by which the fungus survives and spreads. They can remain intact in the soil for several years.

From late September until snowfall--when the weather is moist and cool—small, flesh-colored, funnel-shaped fruiting cups develop from the sclerotia buried in the upper 1 or 2 inches of soil. Clouds of spores (fungal structures) are shot from the funnel-shaped cups and are carried by air currents to foliage of nearby plants, where they establish infection and repeat the disease cycle.

Environmental Conditions: The greatest damage occurs during mild winters or under snow cover. Dead and dying plants are usually most noticeable from March to June, found either singly or in patches throughout a field.

Control: The fungus' longevity in the soil makes the disease difficult to control. Planting seed free of the sclerotia, clean cultivation, deep plowing, and long rotations aid in controlling the disease. Adapted resistant varieties being developed should aid in reducing damage from this disease. Rotating clover with a non-susceptible host will gradually cause the sclerotia to decompose or the fungus to die out.

Root Rot

<http://cygnus.tamu.edu/Texlab/Forage/Alfalfa/asrcrc.html>

Root rot is one of the principal factors limiting production and maintenance of legumes. Depending on environmental conditions, several different organisms may attack the root successively and thus become involved in the root-rot complex. Species of *Fusarium* are among the fungi most commonly associated with root rot of clovers and alfalfa. Other fungi such as *Pythium*, *Rhizoctonia*, and *Phoma* have also been associated with rotted root and crown tissue.

Symptoms: Stand loss is most conspicuous during the second year of plant development, although the plant may be killed during any stage of development. External symptoms develop first in the leaves, which curl at the edges, turn gray, and wilt; plants may seem unthrifty, stunted, and yellowish during hot, dry weather. When the taproot of a diseased plant is cut lengthwise, a light brown to black discoloration is evident. The discoloration sometimes occurs in localized areas, and sometimes extends the length of the root in the central core. The taproot in dying plants is almost always completely rotted; new lateral roots are attacked as rapidly as they replace older damaged roots. This weakens plants, and they succumb following mowing or during periods of hot, dry weather.

The root rot fungi enter plants principally through wounds caused by root insects, winter injury, or mechanical injuries to the crown.

Control: Control of root rot is difficult; however, adequate applications of lime and fertilizer enable plants to withstand infection. In addition, crop rotation and use of improved varieties help reduce the disease. Resistant varieties are being developed.

Viruses

<http://ss.ngri.affrc.go.jp/disease/IMG/img0240.jpg>

The viruses that attack clovers can also infect many related and unrelated hosts. In turn, some viruses from hosts such as peas, beans, potatoes, alfalfa, and certain weeds are readily transmitted to clovers. Thus, a virus-infected crop in one field or plants along a fencerow may act as the reservoir for virus infection of an entirely different crop in a neighboring field. The spread and severity of infection depend on insect populations carrying viruses from plant to plant, the relative susceptibility of the host to the viruses present, and the age of the plants when infected.

Symptoms: Virus symptoms on clovers vary somewhat, depending on host species and the virus involved. In general, viral infected plants have mild to severe leaf mottling. Narrow, pale to yellow discolored areas may be found along the veins, or large, light green to yellowish blotches may occur between the leaf veins. In some cases, leaves

curl, or are puckered or ruffled. Severely affected plants may be dwarfed or weakened and unable to withstand prolonged drought or severe winters. The weakening caused by viral infection may predispose plants to attack by other disease causing agents. Symptoms of most clover virus diseases are conspicuous during cooler periods, disappearing temporarily during hot weather.

Some examples of viral diseases of commonly grown clovers are

Red Clover

Red clover vein mosaic is one of the most prevalent and widely distributed viruses of this host. In the field, red clover also is a natural host for yellow bean mosaic and potato yellow dwarf viruses. The viruses of alfalfa mosaic, pea common mosaic, and white clover mosaic also can infect red clover.

Alsike Clover

Virus mosaic of alsike clover is widely distributed. In addition, alsike clover is known to harbor viruses of annual legumes, principally those of peas.

White Clover (including Ladino Clover)

In the field, white and Ladino clovers display at least two kinds of viral disease symptoms. Some plants develop vein clearing with mild mottling while others develop bright yellow patches or streaks between the veins of leaves. The vein clearing and mottling symptoms are commonly caused by white clover mosaic, which consists of a mixture of two viruses, pea mottle and pea wilt. Yellow blotches between the veins, particularly noticeable in Ladino clover, are caused by a strain of alfalfa mosaic virus. A similar strain of virus from alfalfa and Ladino clover causes a severe tuber necrosis in potatoes.

Sweet Clover

Many viruses can infect sweet clover in the field. For example, the following have been recovered from infected plants: alfalfa mosaic, yellow bean mosaic, several pea viruses, red clover vein mosaic, white clover mosaic, tobacco streak virus, and the Colorado rednode virus of bean.

Control: To date, very little has been done to control viral diseases of clover. Where the crop is being grown for seed, insecticides may be applied to reduce the number of insect carriers; clover viruses are rarely seedborne. When possible, clover fields should not be planted adjacent to other leguminous crops such as peas or beans. The ultimate solution is the development of varieties of clovers resistant to the most prevalent and damaging viral diseases.

Birdsfoot Trefoil Diseases

Stemphylium Leafspot and Stem Canker

<http://ss.ngri.affrc.go.jp/disease/de39.htm>

<http://ss/ngri.affrc.goljp/disease/IMG/img0295.jpg>

Stemphylium leaf spot and stem canker has been recognized as an important disease of birdsfoot trefoil. Strains of the fungus on birdsfoot trefoil will not attack red clover or alfalfa, and cultures from these plants will not infect birdsfoot trefoil.

Symptoms: Plants are partially defoliated, and shoots are sometimes girdled and killed. Young leaf spots are reddish-brown, slightly sunken, and round or semicircular. The spots turn darker and increase in size, becoming concentrically zoned. On stems, the copper-colored cankers vary from dots to boat-shaped lesions and are outlined by a water-soaked border. The fungus also causes irregular brown discolorations on pods and seeds.

The fungus can overwinter in black, raised fungus bodies on dead stems. Numerous spores (infectious agents) are produced in the infected areas in the spring. The fungus also is seedborne.

Orchardgrass Diseases

Purple Leafspot

<http://ss.ngri.affrc.go.jp/disease/IMG/img0087.jpg>

Diseased areas appear on leaves as soon as new growth begins in the spring; they develop in the summer, except during periods of prolonged hot, dry weather. The disease reaches a peak either shortly before heading or at the time of heading; severely infected leaves frequently are killed. Even where orchardgrass is grazed, leaves become withered and brown from heavy attack by the fungus, and the quality of the forage is reduced. Infection develops abundantly in the fall, and new diseased areas can be found until snowfall.

Symptoms: Spots occur on the leaf which are small, somewhat elongated, blackish-brown to deep-purple. When these spots are abundant, they merge, causing the leaf to turn brown and die. Frequently, the browning develops at the tip of a leaf or along the margin in long, brown streaks. Small golden-brown bodies of the fungus develop in rows within the dead areas of a leaf.

Infection occurs from spores (fungal structures) that overwinter in dead stems and leaves. When spores emerge, they are spread by splattering rain or in wind-blown fragments of dead plant parts.

Control: The development of resistant varieties apparently is the only practical means for controlling the disease.

Bromegrass Diseases

Leaf Scald

Smooth bromegrass, as well as other species of grasses and cereals can be severely damaged by leaf scald. In a cool wet season, it may be found on leaves during much of the summer. Blotches occur most conspicuously on the leaf blade, but they may extend to the sheath.

Symptoms: Leaf scald first appears as dark, bluish-gray, water-soaked blotches that become light gray with darker brown margins. Under favorable conditions, the blotches enlarge and elongate until sizable areas of the leaf are affected and killed. Leaves die prematurely and forage quality is reduced.

Environmental Conditions: The fungus overwinters on dead leaves and old crop residues; in milder climates, it may produce new lesions throughout the winter. Spores (fungal structures) are produced during cool, moist weather and are carried to healthy leaves by wind and rain. New spores are produced on old diseased areas as long as conditions remain favorable.

The spores germinate best at temperatures from 65 to 70° F.

Control: Resistant lines of smooth bromegrass are available and are being used to develop varieties with superior characteristics. Elimination of old crop residues, crop rotation, and, sometimes, spring burning help reduce infection.

Brown Spot

Smooth bromegrass almost always is damaged severely by brown spot. The fungus attacks this host wherever it is grown.

Symptoms: Infection is first noticeable as small, dark brown, oblong spots on the first leaves that develop in spring. Older spots are generally somewhat elongated, dark purple to brown, and surrounded by a yellow band or halo. The spots may merge, forming large yellowed areas on leaves. Severely infected leaves frequently die back, from the tip to the base.

Environmental Conditions: Brown spot develops best during cool, wet weather, reaching a peak in late May or early June. The disease spreads very little during the hot, dry weather of midsummer, but becomes prevalent again in fall. Primary infection occurs early in spring from spores (fungal structures) discharged during cool, wet weather. The spores are carried by air-currents to new leaves, where they germinate and penetrate directly through healthy tissue. The fungus then becomes established in the plant cells and produces the characteristic spots.

Control: The disease is best controlled with brown spot resistant varieties.

Timothy Diseases

Eyespot

<http://ss.ngri.affrc.go.jp/disease/de15.htm#Bird's-eye>

Eyespot is one of the most common foliar diseases of timothy and related species. Spots may be so numerous that the leaves are killed prematurely, reducing the crop's forage value. Although eyespot is most prevalent during the summer months, it has been found on green leaves during almost any season.

Symptoms: Eyespot occurs on leaves as small, light-colored, oval spots with a narrow violet border, which later fades to brown. When the spots are abundant, the intervening tissue frequently becomes yellow. Affected leaves turn brown and wither prematurely.

Environmental Conditions: Spores (fungal structures) are capable of germinating in a wide range, which accounts for the occurrence of the disease in almost any season.

Control: Nothing has been developed to control the disease on timothy. New varieties of timothy are somewhat resistant to the disease.

Additional Reference:

Graham, J.H., Frosheiser, F.I., Stuteville, D.L., and Erwin, D.C. Compendium of Alfalfa Diseases 1980. The American Phytopathological Society. St. Paul, MN.

Elliott, Edward S., Baldwin, R.E., and Carroll, Robert B. 1969. Root Rots of Alfalfa and Red Clover. West Virginia University Agricultural Experiment Station. Bulletin 585T. 32p.

Dickson, James G. Diseases of Field Crops. 1956. McGraw-Hill Book Company, Inc., New York.