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College of Agricultural, Consumer and Environmental Sciences

report on
PLANT
DISEASE

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ROOT AND CROWN TROUBLES OF ALFALFA

Root and crown troubles of alfalfa may have several causes. The chief possibilities are: (1) cold or winter injury; and (2) root and crown rots caused by a number of common soilborne fungi. These fungi weaken affected plants and materially reduce the longevity of the stand, yield, and hay quality. Damage is most severe after winter injury, summer drought, mechanical injury to the crown, or root damage by insects. Alfalfa plants in fields with low fertility, poor drainage, a high water table, and cut or heavily grazed during the last 5 to 6 weeks of the growing season are usually the first to be attacked. Nematodes may also be involved in root and crown troubles.

Figure 1. Advanced Fusarium root and crown rot.

COLD OR WINTER INJURY

Several distinct types of cold or winter injury may damage alfalfa stands: frost injury to the growing plant in the spring or early fall; heaving from alternate freezing and thawing; low-temperature and desiccation damage to the taproot and crown; and ice-sheet injury. Winter injuries provide avenues of entrance for pathogenic fungi and bacteria, making the plant more prone to disease.

FROST INJURY

After alfalfa plants begin to grow in early spring, frost injury may kill the tops, turning dead leaves a light tan, delaying and reducing the first harvest. Water in the plants may sometimes remain unfrozen (supercooled) when temperatures are below the freezing point, however, if such plants are suddenly jarred, ice crystals form and the top growth is killed. If an animal walks through an alfalfa field that is supercooled below the freezing point, every plant that is disturbed will freeze. Peculiar brown streaks sometimes seen in alfalfa fields in the spring are the result. The foliage of alfalfa varieties differs in frost tolerance but this is not always associated with winter hardiness.

HEAVING

Heaving due to alternate freezing and thawing often severely injures stands of alfalfa by breaking off or mechanically injuring the taproot and lateral roots. Damage occurs most often on heavy, wet, poorly drained claypan soils that have a temporary or permanent water table that is high during the winter.

Further information concerning alfalfa and other field crops can be obtained from Extension Specialists, Department of Crop Sciences, University of Illinois at Urbana.

DAMAGE FROM LOW TEMPERATURES

Cold and desiccation may kill or injure crown buds resulting in weak shoots. New buds may form on the lower portions of the crown and as the season progresses, recovery may be nearly normal. Thus, stands that appear unproductive early in the spring may produce normal yields later in the season. When more severe, a dark, internal discoloration develops in the crown and taproot, particularly during winters with little or no snow cover. This is usually followed by root and crown rot when affected plants may die. Most damage occurs when unadapted varieties are grown. In Illinois, stands of California and Arizona common and other nonhardy alfalfas are likely to be killed by low temperatures during an average winter; adapted varieties may also be injured and killed.

ICE SHEETS

The most serious winter injury is produced by ice sheets which prevent normal exchange of gases with increased concentration of carbon dioxide and depletion of oxygen leading to tissue decline and death. Less damage usually occurs when stubble protrudes through the ice, permitting gas exchange. Sleet storms or freezing rain may cause ice to form over wide areas often resulting in a complete loss of the stand. Ice sheets can also form in poorly drained areas where water from rain or melting snow accumulates. The alfalfa varieties that are most resistant to extreme cold are also the ones most resistant to ice-sheet damage.

Winter injury is usually complicated and made more severe by the establishment of parasitic fungi and bacteria within the damaged plant tissue. Bacterial wilt of alfalfa is often most prevalent in plants damaged by winter injury.

DRY ROOT AND CROWN ROTS, AND DECLINE

Dry root and Crown Rots, and Decline are caused by a diverse complex of fungi (primarily species of *Fusarium, Rhizoctonia, Pythium, Phoma medicaginis, Mycoleptodiscus terrestris, Stagonospora meliloti* [sexual stage *Leptosphaeria pratensis*], and *macrophomina phaseoli*). The fungi associated with these rots vary greatly, depending on the area and season. Determining the specific fungus or fungi causing crown and root rot is extremely difficult because the same organisms may be associated with both healthy and diseased plants. In addition, the fungi isolated from diseased tissue may only be capable of causing disease under specific conditions or only in specific associations with other organisms.

Affected plants are often stunted, off-color, and lack vigor, then commonly wilt, become yellow to straw-colored, turn brown, and finally die. The stand is thinned, sometimes in circular or irregular patches; the taproot and lateral roots and crowns are discolored and rotted; light brown-to-black areas appear on and within affected roots and crowns (Figure 1). Fungus growth (mycelium) may be found in or on diseased areas with roots and crowns shredded leaving a lack of feeder roots and nodulation. Various plant stresses, including foliar diseases, injury from foliar and root-feeding insects, frequent or untimely harvests, early frosts, poor fertility, severe winter weather, low light intensity, low soil pH, poorly drained soils, or soils with poor structure, increase the rapidity of this crown and root rot complex. The full effect of dry root and crown rots that develop during one growing season may not be evident until the following spring when plants fail to recover.

Secondary fungi and bacteria commonly enter rotted tissue to confuse the symptoms, especially under conditions of high moisture. The causal fungi overseason in soil and plant tissues with spread occurring

by the water, all types of equipment, and by sowing infected seed. This can cause seeds to rot, seedlings to wilt, dry up, and die (damp-off). Stands may be poor after cool, wet weather in the spring.

PHYTOPHTHORA ROOT ROT

Unlike the dry root and crown rot complex, Phytophthora root rot, which is caused by the soilborne fungus *Phytophthora megasperma*, develops rapidly in fields where there is an excess of soil moisture caused by inadequate vertical or horizontal drainage and/or irrigation. The disease can be devastating to seedling stands in cool, very wet weather, but may also cause a severe loss of stand in established fields (Figure 2). When conditions are favorable for infection and disease development—extended periods of cool, rainy weather and standing water—affected plants wilt and die with little or no stunting. When conditions are less favorable—warm and dry weather after infection—the plants are often stunted, turn yellowish, and die much more slowly ("melting-out"). Regrowth of diseased plants is often slow after cutting. Infected corn and taproot tissue becomes soft, water-soaked, and turns yellow to dark brown—often in an area surrounding a lateral root wit rotted areas later turning black (Figure 3). Taproots of surviving plants in the field rot off at various depths. When decay is near the crown, affected plants can be pulled up easily, leaving the taproot in the soil. The Phytophthora fungus may also cause seedlings to damp-off before or after emergence with young plants suddenly turning yellow or reddish, then wither and die. The causal fungus is believed to survive between crops in soil and plant residues, primarily as thick-walled resting spores (oospore). These spores are spread by flowing water, tillage equipment, and any means that moves infested soil and crop debris. Optimum growth of the *Phytophthora* fungus and infection occurs at 76° to 82°F (24° to 27°C); maximum is about 86°F (30°C).

Figure 2. Pattern in a diseased alfalfa field, plants killed-out in the low spots by Phytophthora root rot.

Figure 3. Diseased tissue soft, water-soaked, turning dark; caused by Phytophthora root rot. (Courtesy Dr. F.I. Frosheiser).

ANTHRACNOSE

Anthracnose, caused by the fungus *Colletotrichum trifolii*, appears following prolonged periods of hot and wet summer weather in the southern part of Illinois. Scattered, dead, pearly- white to straw-colored stems with the shoot tips commonly curved downward into "shepherd's crooks" occur in late summer. Symptoms vary from a few irregularly shaped blackened areas on resistant stems to large, sunken, tan-to-dark brown, oval to diamond-shaped lesions, ½ to 1 ½ inches long with a dark brown border, on the lower stems of susceptible plants. These straw-colored lesions are soon sprinkled with black specks (acervuli) that are easily seen with a hand lens or reading glass. The lesions enlarge, merge, girdle, and kill one to several stems on a plant. Invasion of the crown results in a bluish-black crown rot (Figure 4). This

Figure 4. Anthracnose crown rot; infected plant to right (Courtesy Dr. A.S. williams).

symptom is often observed when killed stems are broken off at the crown. Other symptoms of anthracnose include blackening and killing of petioles.

The anthracnose fungus overwinters as mycelium in living stem-crown tissue and crop refuse and on the surfaces of protected harvesting equipment. This is an important means of spread from an old field to a new planting. The *Colletotrichum* fungus is also commonly disseminated by waterborne microscopic spores (conidia) during warm humid weather. Spore masses form on stem lesions throughout the growing season supplying a ready source of secondary infections. The fungus can grow down infected stems into the crown and cause decay and predisposing the plant to winter injury; or it may kill the plant directly. Stands of susceptible alfalfa varieties can be reduced significantly in two or more years.

Figure 7. Fusarium wilt. (Courtesy Dr. F.I. Frosheiser).

Figure 5. Sclerotinia crown and stem rot. Note cottony mold, black round bodies (sclerotia) embedded (British Ministry of Ag.).

SCLEROTINIA CROWN AND STEM ROT

Sclerotinia crown and stem rot, caused by the fungus *Sclerotinia* (*Whetzelinia*) *sclerotiorum* or *trifoliorum*, is evident by the small-to-large patches of dead and dying plants in the early spring. Plants of all ages are susceptible. Infected leaves and stems become yellow, wilt, and collapse from a light brown, mushy rot of the stem bases and crown. A cottony mold grows over the dead plant parts and adjacent soil surface. Round-to-irregular black bodies (sclerotia), up to 8 to 10 mm in diameter, form in the cottony mold and in or on the dead stem and crown tissue (Figure 5). The sclerotia fall to the soil and germinate in cool, moist weather to produce one to several small, light brown, cup-shaped structures called apothecia (Figure 6). Large numbers of microscopic ascospores are shot out of the apothecia and spread to nearby plants by air currents. Infections occur during cool, moist periods. The fungus is also spread by moving infested soil and diseased crop refuse. Sclerotinia crown and stem rot is favored by a prolonged snow cover, cool and wet spring and autumn weather, and rank foliar growth. The fungus grows between 28° and 82°F (-2° and 27°C) with an optimum around 60°F (15° to 16°C).

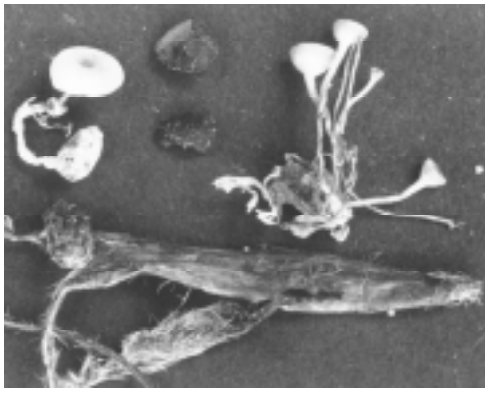

Figure 6. Sclerotia and apothecia of Sclerotinia sclerotiorum (Courtesy Dr. K.T. Leath).

FUSARIUM WILT

Although usually caused by the soilborne fungus *Fusarium oxysporum* f. sp. *medicaginis,* Fusarium wilt may also be incited by *F. o.* f. sp. *vasinfectum* races 1 and 2, and *F. o.* f. sp. *cassia.* Scattered plants in a field wilt partially or completely, gradually turn a bleached yellow, then wither and die. A dark or reddish brown discoloration is seen in the stele, between the bark and the wood, when the taproot is cut through (Figure 7). A considerable loss of stand may occur over several years. The *Fusarium* fungi can live almost indefinitely in soil and plant debris as chlamydospores and mycelium. The fungi are spread by soil water, equipment, and infected hay. Fusarium wilt is favored by relatively high soil temperatures, moist weather, and a lack of crop rotation. The only practical control is to grow resistant alfalfa varieties. A number of cultivars contain a moderate to a high percentage of resistant plants.

STAGONOSPORA LEAF SPOT AND ROOT ROT

Figure 8. Stagonospora crown and root rot.

Stagonospora leaf spot infections, caused by *Stagonospora meliloti* (sexual stage *Leptosphaeria pratensis*), sometimes invade the crown and taproot. When large stems, crowns, and taproots are cut open, small pockets of an orange-red material give the solid and dry diseased tissue an irregularly speckled appearance (Figure 8). The fungus progresses slowly in root tissue, but often fine, bright red streaks occur in the stele (xylem) well beyond the decayed areas in the crown and taproot. The exterior of an infected root has a rough texture. Eventually, the root decays and the plant dies. The Stagonospora fungus overseasons as mycelium in crop debris, and is believed to be spread by air- and water-borne spores (conidia and ascospores). The root rot phase appears to develop from stem and crown infections and proceeds slowly for two or three years. The disease is most severe during prolonged periods of warm, moist weather and where alfalfa or sweetclover are not rotated with corn, soybeans, small grains, sorghum, or forage grasses.

RHIZOCTONIA STEM BLIGHT, ROOT CANKER, CROWN AND BUD ROT

Figure 9. Rhizoctonia stem blight and canker. (Dr. D.C. Erwin).

These diseases are caused by the very common soilborne fungus *Rhizoctonia solani* and occur throughout the world. The foliage on affected plants wilts and blights during prolonged periods of hot, wet, and humid weather from dark, somewhat sunken, girdling cankers near the base of stems, at the crown and the taproot near where lateral roots emerge (Figure 9). Brown bands often develop in the older, light-colored lesions. Coarse brown mycelium may be evident on the surface of diseased tissue. *Rhizoctonia solani* survives in soil and crop debris as mycelium and small (less than 0.5 mm in diameter), roundish-to-irregular, dark brown-to-black bodies (bulbils; sclerotia-like structures). The fungus is spread primarily by equipment and infected hay. Optimum growth of the fungus occurs at 77° to 87°F (25° to 30°C) with a maximum around 95° F (35°C).

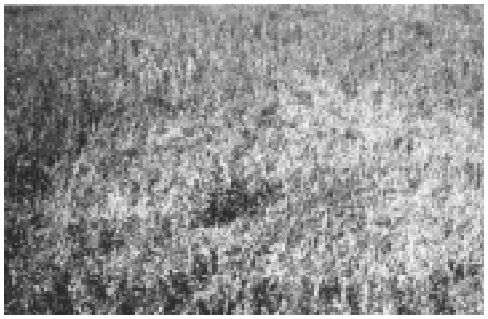

Figure10. Circular patch of alfalfa affected by violet root rot (U. Of Wis. Photo).

VIOLET ROOT ROT

Violet root rot, caused by the soilborne fungus *Rhizoctonia crocorum* (*R. Violaceae*), is a widely distributed but generally minor root rot of alfalfa that is most common after midsummer. The foliage of affected plants turns straw-yellow then brown in enlarging, circular to irregular patches. All or nearly all the plants within a patch die (Figure 10). Affected plants at the margin of a patch are conspicuously brown when compared to surrounding green healthy plants.

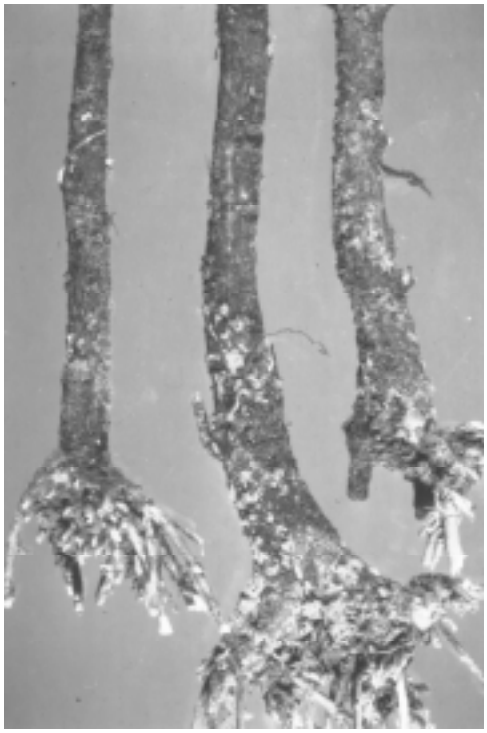

Figure 11. Alfalfa stems and roots covred with felt-like mantle of mycelium of violet root rot fungus (U. Of Wis. photo).

Diseased roots and crowns are covered with a felt-like bright violet to cinnamon mantle of mycelium that often extends 8 inches (20 cm) or more below the soil line (Figure 11). As the root decays, its bark loosens while the central cylinder becomes soft and shredded. Speck-sized black bulbils are commonly present on dying roots. The *Rhizoctonia* fungus may persist in the soil and plant debris for 3 to 20 years. The optimum temperature for growth of the causal fungus is about 77°F (25°C).

VERTICILLIUM WILT

Verticillium wilt, caused by the common soilborne fungus *Verticillium albo-atrum*, is a disease of cool temperate regions throughout the world. It was first reported in the United States in 1977 and in northern Illinois in 1984. The upper leaves of affected plants temporarily droop and wilt on warm summer days. Later, the lower leaves and shoots wilt, become pale, then yellow, and finally bleached and withered

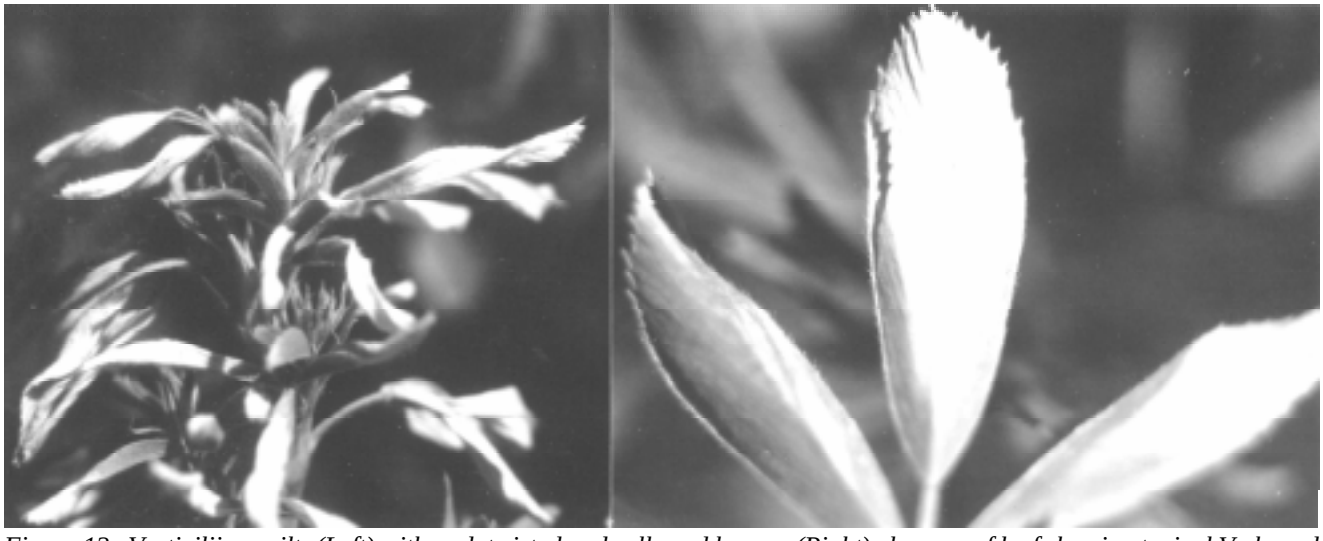

Figure 12. Verticiliium wilt: (Left) withered, twisted and yellowed leaves; (Right) close-up of leaf showing typical V-shaped chlorotic areas (Dr. K.T. leath).

(Figure 12). The stems may remain green after the leaves turn yellow and new shoots can develop from the crown but they rapidly wilt and die. Diseased plants are commonly stunted with yellowed and withered shoots and twisted leaves. Fungus growth (conidiophores bearing conidia) over the base of infected stems in humid weather gives them a gray appearance. When the roots of diseased plants are sliced through, a light to dark brown discoloration is evident internally in the vascular (xylem) tissue.

The *Verticillium* fungus overwinters as dark, thick-walled mycelium in plant debris, in infected plants, and possibly in weed hosts. Microscopic spores (conidia) are produced during cool wet weather and are spread primarily by wind currents and windblown debris. The fungus is also transported on trash with seed and can persist directly on alfalfa seed for only short periods of time. Secondary spread during the growing season is mainly by mowing and windblown conidia and infested debris. Optimum growth of the *Verticillium* fungus occurs at 68° to 73°F (20° to 22°C) with a maximum at 87°F (30°C).

NEMATODES

Dagger (*Xiphinema americanum*), lesion (*Pratylenchus penetrans*), and northern root-knot (*Meloidogyne hapla*) nematodes are the most common root-infecting types in Illinois. All three nematodes reduce plant vigor, cause yellowing and stunting in round to irregular patches throughout a field and may predispose plants to other root and crown problems (Figure 13). Dagger nematodes reduce the number of fine-feeder roots and the overall root mass. Lesion nematodes cause oblong, yellow to dark brown spots or lesions on the roots, ranging from pinpoint size to several millimeters in length. Root-knot nematodes produce

Figure 13. Lesion nematodes: (Left) poor stand discolored, stunted alfalfa; (right) two nematodes inside alfalfa root (J.A. Thies, USDA-ARS, MN).

small root galls visible only when the roots are closely examined. The nematodes may kill young plants and increase the incidence of bacterial and Fusarium wilts in older resistant as well as susceptible varieties. Dagger and lesion nematodes can only be diagnosed by submitting soil and root samples for analysis to a trained nematologist. Take soil and root samples to a depth of 10 inches from the base of the plants at the margin of the affected area, place them in a sturdy plastic bag, and keep them cool until they are submitted.

ADDITIONAL INFORMATION

Several of the same fungi that cause alfalfa roots and crowns to rot also induce seed decay and seedling blights. It is sometimes difficult to clearly separate stem- and crown-rotting problems.

Control

1. **Grow only well-adapted, high-yielding, winter-hardy varieties suggested for growing in your area**. Varieties differ in their resistance to bacterial wilt, Phytophthora root rot, Anthracnose, Verticillium wilt, and winter hardiness.

2. **Maintain vigorous growth by maintaining a high, well-balanced fertility level, especially of phosphorus and potassium, based on a soil test.**

3. **Sow certified, thoroughly cleaned, disease-free seed grown in arid regions**. Several leaf and stem diseases plus the organisms causing seed decay, seedling blights, and damping-off are spread by planting contaminated seed. Many of the fungi that cause dry root and crown rots are also carried in or on alfalfa seed.

4. **Plant in warm, well-drained soil in a well-prepared seedbed that is slightly acid to neutral (pH 6.5 to 7.0). Avoid low areas that are subject to flooding and/or excessive irrigation**. Deep tillage to break up compacted layers or plow soles and to improve internal percolation of water will help to eliminate conditions favoring infection of several root-rotting fungi.

5. **Control insects following suggestions of University of Illinois Extension entomologists**. Insects commonly provide wounds by which wilt, crown-rotting, and root-rotting fungi and bacteria gain entry.

6. **Maintain a proper cutting schedule**. Avoid rank growth and retain hay quality by harvesting on time and not applying excessive amounts of nitrogen. Avoid overgrazing or overcutting. Do not cut or graze alfalfa during the last 5 or 6 weeks of the growing season (about September 1 in northern Illinois to October 15 in southern Illinois). A top growth of 8 to 12 inches is needed to build reserves before winter. Fields on well-drained soils may be cut or pastured after the growing season has ended.

7. **Thoroughly clean all harvesting equipment of debris before the first harvest in the spring and again periodically during the growing season when going from fields with infected plants to other plantings.**

8. **Where root and crown rots have limited alfalfa production, a three-year or longer rotation with corn, sorghum, small grains, or forage grasses is desirable**. Exclude other forage legumes in the rotation—such as sweetclover, clovers, birdsfoot trefoil, lespedezas, and crown vetch.

9. **Avoid mechanical injuries to the stems and crowns as much as possible.**