MANAGING FOLIAR AND ROOT ROT DISEASES OF ALFALFA FOR IMPROVING YIELD AND PERSISTENCE

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ABSTRACT

Resistance to the six most common diseases across the United States is available in modern alfalfa cultivars. However, several diseases are becoming increasing problems in many parts of the country. Recognizing these problems is the first step in using crop management strategies to minimize diseases and the damage they cause to yield, quality, and stand persistence. Here we describe the symptoms and management of diseases of emerging concern: seed rot and damping off, Aphanomyces root rot, brown root rot, and spring blackstem and leaf spot.

Keywords: Alfalfa, brown root rot, Aphanomyces root rot, seed rot and damping off, Headline, ApronXL, Stamina

INTRODUCTION

Over 50 pathogens have been identified that cause significant damage to alfalfa and prevent it from reaching its full potential for producing high yields of quality forage. There has been excellent progress by plant breeders and plant pathologists in developing varieties with resistance to the major diseases and nematode pests in the United States. Yet, despite these advances, problems in stand establishment due to seed rot and seedling damping off have been observed. Root rots affect plant establishment and mature plants, leading to poor stand establishment and reducing winter survival. Also, pathogens previously considered to cause minor damage may be becoming more problematic, particularly with shifting agricultural practices and changing climate.

Disease is the result of the interaction of a susceptible alfalfa plant, a pathogen capable of causing disease, and a favorable environment. In particular, the occurrence of disease is highly affected by environmental conditions. Planting high quality certified seed of a locally adapted, disease resistant cultivar is the most economical, efficient, and easiest way to reduce disease problems. The National Alfalfa and Forage Alliance (NAFA) annually publishes *Alfalfa Variety Ratings* with disease and pest resistance ratings for certified alfalfa varieties. Growers should select a variety with resistance to the most serious diseases in their locations. However, because resistance is not available for all diseases, an integrated use of other management measures is necessary to reduce damage from diseases: planting in a weed-free, well-drained seedbed with a pH between 6.5 and 8; adequate and balanced levels of phosphorus (P, phosphate), potassium (K, potash), and micronutrients; controlling weeds; and harvesting forage to maintain plant vigor.

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Several fungicides have recently been labeled for use on alfalfa giving producers additional options for managing foliar and seedling diseases. Headline (BASF), Quadris (Syngenta), Kocide (DuPont), and Fontelis (Dupont) are registered for foliar application and Stamina (BASF) is labeled for use as a seed treatment.

SEED ROT AND SEEDLING DAMPING OFF

A vigorous and productive alfalfa stand starts with strong and uniform seedling establishment. However, many factors can interfere with seed germination and growth. Seed rot and seedling damping-off are a significant cause of poor stand establishment in wet soils. Seeds may be infected before or during germination and reduced to a soft, brown mass. Damping-off, the rotting of a seedling, can occur either before or after the seedling emerges from the soil (Figure 1). Seedling not killed by the infection can have "forked" roots and reduced growth. Roots of adult plants can also be attacked during periods of wet soil conditions. These ongoing, chronic root rots reduce the energy available for growth in established stands, causing yield reductions and shortened stand life.

The primary organisms causing seed rot and seedling damping off are several species of *Pythium* and *Fusarium*. Recent results suggest that crop rotation will not reduce disease caused by *Pythium* species because many strains attack a wide range of crop plants. As members of the oomycetes or 'water molds', *Pythium* species have mobile spores called zoospores. Swimming through water films on soil particles the zoospores quickly home in on the trail of chemicals released by seeds and roots. Using mechanical pressure to pierce plant tissue, the invading organisms employ toxins to kill plant cells. The oospore of *Pythium* species can survive on plant debris or in soil for years, germinating under the right conditions to produce either the mobile zoospores or to directly infect plant roots. We tested strains of seven species of *Fusarium* isolated from infected alfalfa seedlings. Depending on strain used in the test, from 10-50% of the alfalfa seeds were killed. *Fusarium* strains are likely contributing to seed rot in the field.

Figure 1. Symptoms of seedling damping off. Compare the diseased seedlings on the right to healthy seedlings on the left.

The majority of alfalfa seed is treated with mefenoxam (Apron XL). This treatment provides protection against Pythium seed rot and damping-off and boosts resistance to Phytophthora root rot during seedling growth. However, Apron XL does not provide protection against *Fusarium* species attacking seeds and does not protect adult plants from *Pythium*. We recently tested *Pythium* strains for their reaction to ApronXL and Stamina seed coatings. The seed coatings were commercially prepared in a rotostat seed-coating machine with the recommended rate of fungicide. About 30% of the strains were resistant to ApronXL and fewer

than 20% of the seedlings were protected from disease while the remaining strains were moderately to fully sensitive to ApronXL with 50-90% of plants protected from disease. Over 90% of the strains were resistant to Stamina used as a seed coating with 0-20% of plants protected from disease.

These results indicate that there is a significant level of resistance to ApronXL and Stamina in *Pythium* strains infecting alfalfa, corn, and soybean and could explain the high amount of damping off of alfalfa observed in some locations. Seed treatments that include a fungicide in addition to ApronXL may help to reduce early seedling diseases. Increasing soil drainage where possible in problem areas of fields can be beneficial. Prepare a firm seedbed and adjust soil pH and fertility to optimal levels for growth of alfalfa. Plant when soil and weather conditions favor rapid emergence and early growth of seedlings.

APHANOMYCES ROOT ROT OF ALFALFA

Aphanomyces root rot, caused by the oomycete *Aphanomyces euteiches,* is one of the most important disease problems for alfalfa production. The importance of this disease has likely been overlooked in the past. The disease is associated with wet and poorly drained soils. Seedlings infected with *Aphanomyces* usually become stunted and yellow before they wilt and die. Roots turn light to dark brown. Symptoms typically appear on slopes or low areas of fields. The disease causes loss of feeder roots and nodules in adult plants during periods of extended wet soil conditions resulting in yellow and stunted plants (Figure 2). Varieties with resistance became available in the 1990s; however, failure of resistant varieties identified a second race of the pathogen.

Figure 2. Symptoms of Aphanomyces root rot. Left, seedling “corpses.” Right, symptoms on adult plants. Note the lack of lateral roots and nodules.

To determine which races were present in commercial production fields, we surveyed soil from 40 commercial alfalfa fields in New York and 45 fields in Minnesota. We found that race 2 was the most common race (Figure 3). Testing of 60 individual strains of the pathogen isolated from these soils found no evidence for additional races of the pathogen. Surveys in Illinois and Wisconsin have also found that race 2 is the most common race in those states. Planting resistant

varieties is the most effective way to manage Aphanomyces root rot in commercial production. An increasing number of commercial varieties have resistance to both race 1 and race 2. Cultivars with the highest level of resistance available should be chosen and planted. Practices that improve soil drainage can reduce the risk of Aphanomyces root rot. Resistant varieties or alternative crops that are not hosts of *A. euteiches* should be considered for field rotations.

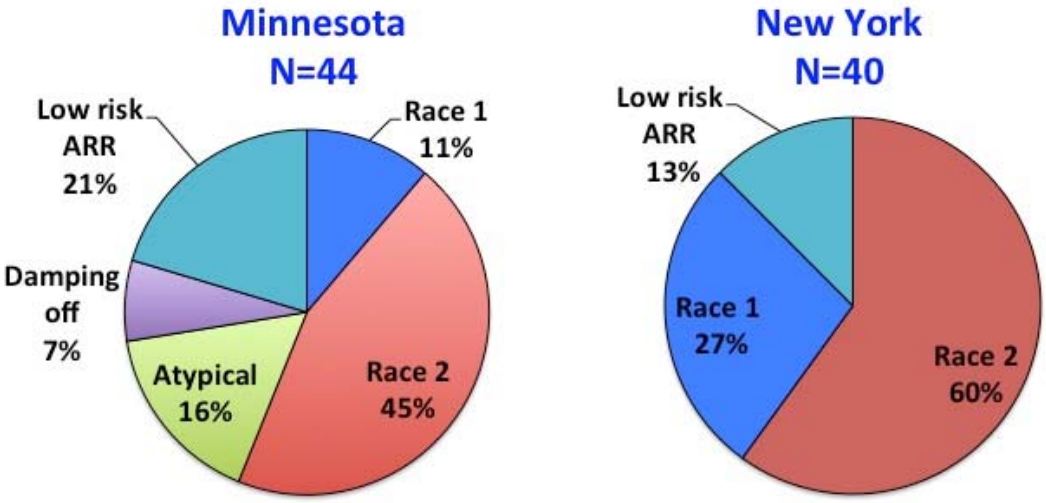

Figure 3. Race 2 was the most common race found in surveys of 44 Minnesota alfalfa fields and 40 fields in New York.

BROWN ROOT ROT OF ALFALFA

Figure 4. Symptoms of brown root rot.

Brown root rot of alfalfa, caused by the fungus *Phoma sclerotioides*, has been reported in states in the northern U.S. Disease occurs primarily during host dormancy from late fall to early spring and disease severity is highly dependent on weather conditions and plant stress levels. Symptoms may take three or more winters to become apparent. Aboveground symptoms of brown root rot consist of plants that are slow to green up in spring or die during the winter. Belowground symptoms consist of dark root lesions sometimes with a thin darker band at the perimeter (Figure 4). A dry, hard rot occurs on tap, lateral and feeder roots. Rot due to freezing injury is soft and light brown in color. In addition to alfalfa, *P. sclerotioides* causes disease on winter wheat and other perennial legume forage crops.

A survey for the pathogen was conducted in alfalfa stands of the Upper Midwest. Overall, plants from 266 fields were evaluated. The majority of plants were from Minnesota (113 fields in 38 counties) and Wisconsin (102 fields in 19 counties), with a small number of samples from Iowa (four fields), Illinois (five fields), Idaho (three fields), South Dakota (three fields) and Wyoming (four fields), as well as from Ontario

(five fields) and Manitoba (27 fields). From five to 20 plants were removed randomly across fields. DNA was isolated from roots and used in a PCR assay specific for the brown root rot pathogen. The fungus has been reported from 14 states (Figure 5). Disease may occur in younger as well as older stands but is most often associated with winter injury and stand decline.

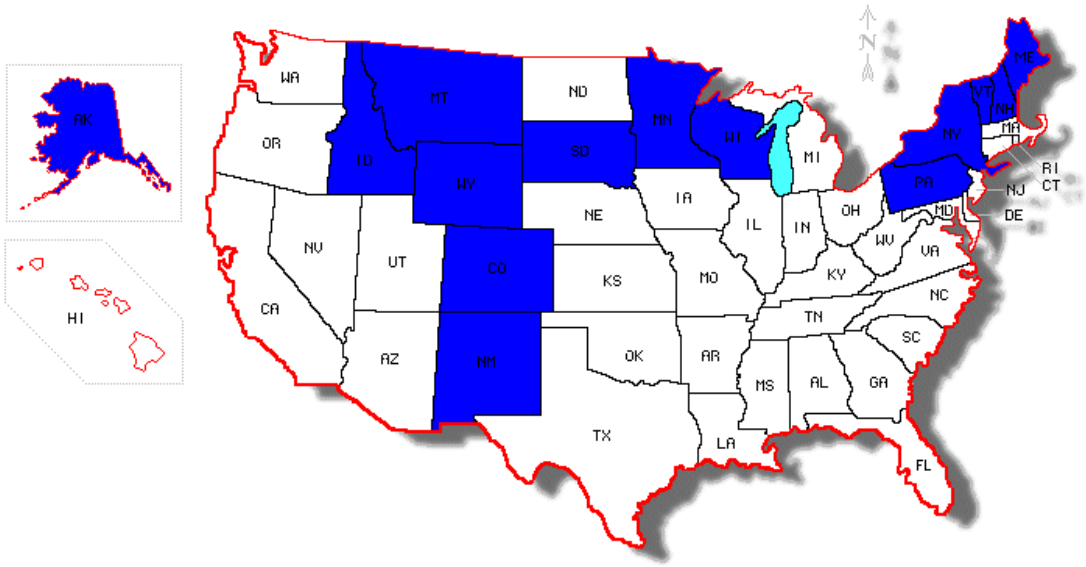

Figure 5. States in which brown root rot has been confirmed are in blue.

A total of 26 commercial and experimental alfalfa varieties were planted in three locations in Minnesota with high levels of the brown root rot pathogen. Plant persistence was measured after two or three winters. These varieties demonstrated good stand persistence in locations with high brown root rot pressure: Velvet, Labrador, 30-30, Sunstra 536, Sunstra 537, Integra 8400, 407TQ, 54V46, 55V48, and 54V09. The brown root rot fungus was found to increase in corn and soybean residue. Fields with high levels of the pathogen should be rotated for 2-3 years with a spring-sown annual cereal crop to decrease the fungus in soil. Crop management strategies to reduce plant stress will reduce the effect of brown root rot.

SPRING BLACK STEM AND LEAF SPOT

This is usually the first disease to appear on foliage in early spring. In cool and wet climates the disease can occur during the entire growing season. The first symptoms of this disease are small, dark brown to black spots on leaves. The spots enlarge irregularly and run together with leaves turning yellow and falling from the stem (Figure 6). Symptoms on stems appear as small dark spots that lengthen and run together, blackening most of the surface in severe infections. Young stems may be completely girdled and killed. The pathogen can also infect crowns and roots and is frequently isolated from plants with crown rot symptoms. Significant losses in yield and forage quality can occur with disease conducive environmental conditions.

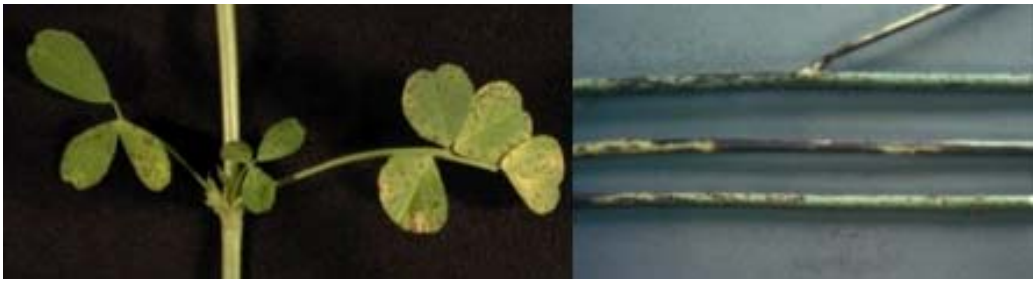

Figure 6. Symptoms of spring black stem and leaf spot.

Use of certified seeds and rotation with non-host crops reduces the amount of inoculum. The level of resistance is improved in newer cultivars although no highly resistant varieties are available. Fungicides reduce disease symptoms but must be applied before symptom development. Experiments done in Minnesota and Wisconsin in 2012 and 2013 found that the effect of treatment with the fungicide Headline on yield was inconsistent. In 26 dairy quality harvests, six harvests (23%) had a significant increase in yield ranging from 0.13-0.43 tons/acre. In 15 beef quality harvests, five (33%) had a significant increase in yield ranging from 0.13-0.22 tons/acre. In most harvests, the increase in yield did not compensate for the cost of fungicide application. Quality of forage was not significantly affected by fungicide treatment. Current research is focused on the benefits of fungicide application on stand life and productivity.

CONCLUSIONS

Planting disease resistant alfalfa varieties is the most effective way to reduce damage from diseases. Most new varieties have field-relevant levels of resistance to the most damaging diseases. However, because a variety is a mixture of genetically different plants, not all plants within the variety will have resistance to a particular disease even though the variety is rated as highly resistant. Susceptible plants, environmental stress, and physical damage all contribute to stand decline and reduced yields. Sound crop production practices will reduce crop losses. Although new chemical controls have been developed, it remains to be determined how these products fit into modern alfalfa disease management programs. A comprehensive resource for identification of alfalfa diseases is the *Compendium of Alfalfa Diseases and Pests*, which is available from APS Press (http://www.apsnet.org).