New Tools for Combating Seedling Diseases of Alfalfa

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Alfalfa seeds and seedlings are vulnerable to pathogens in the soil that reduce stand density and damage root systems. For alfalfa, strong seedling establishment is particularly important to achieve plant density needed to out-compete weeds and produce high biomass yields. Also, damage to seedling roots will decrease productivity of adult plants and reduce winter survival. Most alfalfa seed is treated commercially with the systemic fungicide mefenoxam (Apron XL). This provides protection against Pythium seed rot and damping-off and boosts resistance to Phytophthora root rot (PRR). However, Apron XL does not provide protection against Aphanomyces root rot (ARR). Although most modern alfalfa cultivars have resistance to *A. euteiches* race 1, fewer have been developed with resistance to race 1 and 2. Soils with race 2 are widely distributed in U.S. alfalfa growing regions. Establishing alfalfa under organic standards can be an even greater challenge since chemical fungicides are prohibited. Research in the ARS Plant Science Research Unit in St. Paul, MN, has investigated several new seed treatments for protecting alfalfa seeds.

A mineral seed coating using aluminosilicate (natural zeolite) was found to have strong activity against alfalfa pathogens. Zeolites are minerals found around the world in sedimentary deposits derived from volcanic materials. Because of their high ion-exchange capacity, zeolites are used in numerous industrial processes, in agriculture, and in environmental remediation. They are frequently applied to turf on golf courses to increase water infiltration, water holding capacity, and aeration. Application of zeolite was shown to reduce symptoms from fairy ring fungi on a golf fairway, suggesting natural zeolites may have antifungal activity.

Alfalfa seeds were coated at a rate of 0.33 g zeolite/g alfalfa seeds or treated with Apron XL at the 0.64 fluid ounces/100 pounds of seed recommended rate. Seed coatings were applied using a commercial rotostat machine. Seeds were grown in a growth chamber for 7 days and inoculated with *Aphanomyces*, *Phytophthora*, or a mixture of the two pathogens. Disease-free plants were counted two weeks after inoculation. The variety used was highly susceptible to both pathogens with an average of only 15% healthy plants in the PRR treatment and less than 2% healthy plants in the ARR or combined treatment (Figure 1). Zeolite coating was highly effective against both pathogens with 90% healthy plants from the PRR treatment and 66% healthy plants from the ARR or combined treatment. Zeolite coating was effective against both *Aphanomyces* race 1 and race 2. The same seed coatings were tested with three strains of *Pythium* isolated from diseased alfalfa plants. Zeolite coating provided greater protection against these pathogens than Apron XL. Coated seeds were also grown in soils from commercial alfalfa production fields with different levels of pathogens infecting

Figure 1. Effect of seed treatment on symptoms of PRR and ARR.

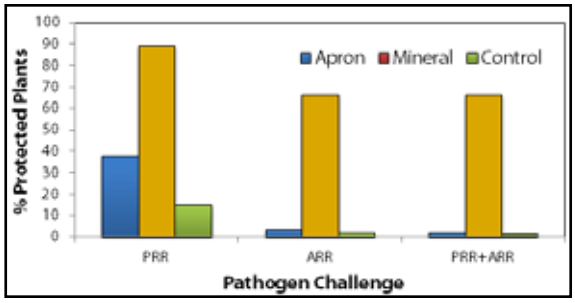

Figure 2. Effectiveness of seed treatments in naturally infested soil obtained from MN alfalfa fields. Treatments: Apron XL, zeolite, control.

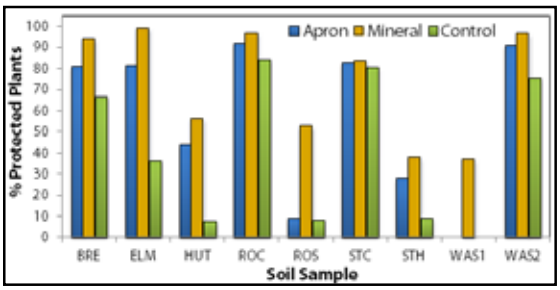

Figure 3. Protection of alfalfa seedlings.

alfalfa seeds and seedlings. Zeolite coating was as effective or more effective than Apron XL in the majority of soil samples (Figure 2). Zeolite coated seed is currently being tested in several locations for protecting alfalfa seed under field conditions. Results so far indicate zeolite coating is a promising means of controlling seedling diseases in organic and conventional alfalfa.

Recently, Stamina was labeled for use on alfalfa seed. The active ingredient was tested in an agar plate assay to determine amount needed to inhibit growth of *Aphanomyces* strains by 50% (EC_{50}). Race 1 and 2 were very sensitive to the fungicide with an EC_{50} ranging from 5-49 ppm depending on the strain and overall average EC_{50} for the six strains tested of 22 ppm. Seed of a race 2-susceptible cultivar were treated with Stamina at the labeled rate, grown for 7 days in a growth chamber and inoculated with *Aphanomyces* race 2 strains. Two weeks after inoculation, disease free plants were counted. On average, the Stamina treatment resulted in 47% healthy seedlings while all of the control and Apron XL-treated seed were diseased. Results indicate Stamina seed treatment is effective in protecting alfalfa seedlings from ARR. However, in tests with *Pythium*, Stamina resulted in an average of 15% healthy seedlings, Apron with 55% healthy seedlings, and the control with 0% healthy seedlings.

Microbial seed treatments have been tested intensively for promoting growth and reducing disease in other crops. However, few microbials have been tested for alfalfa. Many of the microbial seed treatments currently on the market require warm soil temperatures for the microbe to be active, which may not occur when alfalfa is planted. Streptomycetes are common soil bacteria that can inhibit plant pathogen growth and promote plant growth across a broad range of temperatures. Streptomycete isolates were tested for control of PRR in naturally infested field soil. Strain GS93-23 significantly reduced disease symptoms compared to the control (Figure 3). This strain also increased plant biomass in the absence of the pathogen and inhibited growth of *Aphanomyces*, *Pythium*, and other alfalfa pathogens in agar plate assays. Results suggest that in addition to potential for controlling alfalfa root rot, Streptomycetes may be useful in integrated control against diverse soilborne plant pathogens.