

Biology and Management of Phytophthora Root Rot of Alfalfa

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Phytophthora root rot (PRR) is a major stand decline of disease of alfalfa throughout North America. This disease is common in irrigated alfalfa in Wyoming, and is prevalent and particularly severe in the Big Horn and Wind River basins. Phytophthora root rot is caused by the soilborne fungus *Phytophthora megasperma* f. sp. *medicaginis* (*P. megasperma*).

Root rot and stand decline due to *P. megasperma* are most severe in varieties that have little or no resistance (fig. 1). *Phytophthora megasperma* also causes a damping-off and blight during and shortly after planting.



Figure 1. Stand decline in experimental plots in Fremont County due to *Phytophthora* root rot (left=resistant, right=susceptible).

New seedlings may be attacked by *P. megasperma*, resulting in spotty stands or inadequate plant numbers for maximum production. The presence of PRR in established stands results in loss of hay yield, loss of hay quality due to weed invasion, and shortened stand life.

Symptoms

Phytophthora root rot is worse in poorly drained areas of a field where water tends to collect. In fields having a clay loam soil, which increases retention of soil moisture, the disease may be widespread throughout the field.

New stands: Newly seeded stands often suffer the greatest damage from *P. megasperma* (fig. 2). Seedlings may be killed before or immediately after emergence, which is referred to as the "damping off" phase of the disease. Usually the disease progresses quickly, and infected seedlings collapse and die rapidly. Many infected seedlings that survive, or are infected shortly after emergence, become diseased and may die within several weeks. Leaves of seedlings infected with *P. megasperma* initially turn reddish-yellow and may be shed. These seedlings can be easily removed from the soil, as the taproot will be rotted and collapsed. Death of seedlings that have survived emergence is referred to as "seedling blight". Infected seedlings that survive the seedling blight phase may live for a year or more but are usually severely stunted and unproductive. These plants eventually winterkill.

When cool, wet weather follows planting or when a field is kept overly wet, severe loss may occur during the first two weeks after seeding even if resistant varieties are planted. Stand loss as high as 88 percent has been recorded in a susceptible variety in Wyoming. Stand failures may also occur when old alfalfa stands, declining from PRR, are interseeded. Varieties with PRR resistance have only partial resistance at the seedling stage, as resistance is not expressed until after 3-4 weeks. Consequently, even PRR-resistant varieties may suffer seedling death if soil populations of *P. megasperma* are high and cool, wet conditions prevail. Seedling death may be more severe in solid-seedings than when alfalfa is seeded with a nurse (companion) crop.

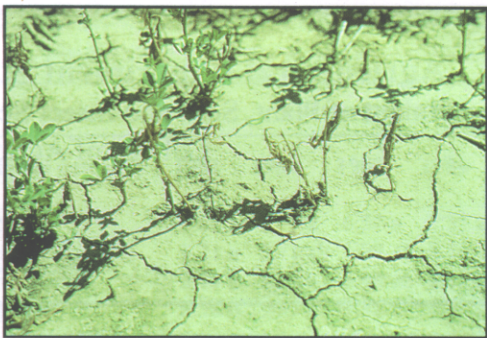


Figure 2. Seedling blight of susceptible alfalfa caused by *P. megasperma*.

Established stands: Above ground symptoms of older plants infected with *P. megasperma* are nondescript and consist mainly of moderate to severe stunting. In contrast to seedlings, foliage of older plants infected with *P. megasperma* often shows no significant color change. Therefore, the disease can easily be misdiagnosed unless numerous plants are removed and examined for root rot. The taproot of infected plants exhibits a reddish-brown, firm rot of the cortex and vascular cylinder. Under dry conditions, rotted tissues frequently become brownish to black in color. Infection and eventual rot of mature taproots typically initiates 4 to 6 inches below the soil surface (fig. 3). Roots may have one or more decayed areas on the taproot or lateral roots. Under moist conditions roots are eventually girdled by decay. In cases of severe infection, the taproot or lateral roots may be entirely rotted away (fig. 4a, 4b). Plants with PRR are more easily removed from soil than healthy plants.



Figure 3. Plant with Phytophthora root rot showing girdling lesions. Note lower root of center plant is rotting away.

Fields having thin plant stands with irregular growth may be an indication of PRR. Regrowth of diseased plants is often slow after harvest. Yields of severely affected plants may be reduced by 75 percent. The resulting thin stand is quickly invaded by weeds, which lowers hay quality.

Alfalfa plants weakened by PRR are predisposed to winterkill. Severe stand loss due to PRR in established fields may occur during late winter or early spring, following extremely cold winters, especially when hard freezes occur without snow cover.



Figure 4a. Phytophthora root rot. Plant with lower portion of root rotted away.



Figure 4b. Phytophthora root rot. Close up showing reddish-brown discoloration of diseased root tissue.

If you suspect PRR but lack confidence in your field diagnosis, collect several live, diseased plants, including roots. Place in a plastic bag with pencil size holes for ventilation and take them to your county extension office. Send the sample to the author for diagnosis. Having a confirmed diagnosis is essential so you can select an alfalfa variety when the field is replanted with resistance to PRR, as well as other stand-decline diseases that may be present.

Disease Cycle

Phytophthora megasperma survives in soil as thick-walled, microscopic resting spores (oo-spores) (fig. 5). Oospores form in infected roots and eventually are released into the soil as infected tissues decompose. Oospores of *P. megasperma* can be spread in soil on machinery, animal hooves, boots, or in wind-blown soil particles. When soils are nearly saturated and temperatures are optimum, oospores in the root zone of alfalfa plants germinate and produce motile "zoospores" that are attracted to and infect susceptible alfalfa roots, especially nitrogen-fixing *Rizobium* nodules. Zoospores in surface irrigation water may spread the fungus within a field or between adjacent fields.

Because the fungus requires free water for zoospores to form, the disease is most serious when the soil remains saturated for extended periods. Saturated soil conditions favorable for PRR can result from a 25 percent or more clay content, poor drainage, over irrigation, excessive rainfall, or a combination of these factors. Optimum soil temperatures for infection range from 65° F to 75° F.

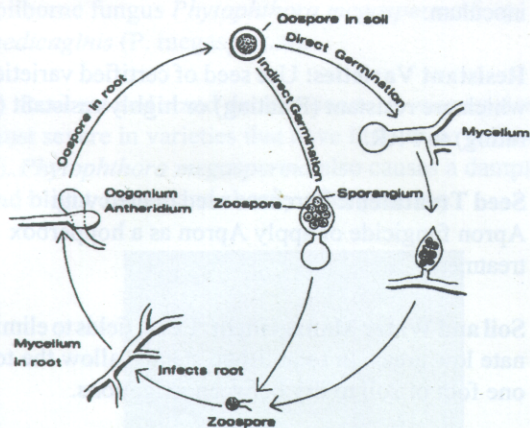


Figure 5. Life cycle of *Phytophthora megasperma* F. sp. *medicaginis*.

Management

Resistant varieties: Alfalfa varieties with resistance to PRR are recommended in fields with a history of the disease and especially those having a high clay content or poor drainage. Numerous alfalfa varieties with multiple disease and insect resistance, adapted to Wyoming conditions, have been developed and are available. Planting a variety with resistance to PRR increases protection not only during establishment but throughout the life of the alfalfa stand.

Select only certified varieties with known levels of resistance to PRR. Alfalfa varieties differ in the level of resistance, and are rated accordingly (Table 1). Because of the genetic variability within the population of alfalfa plants, even highly resistant varieties have individual plants that are susceptible to disease. However, optimal yields and stand longevity in soils infested with *P. megasperma* can only be obtained by selecting a variety with a *high level of resistance (R or HR)* to PRR, as well as other major stand-decline diseases present in the field.

Table 1. Disease resistance in alfalfa varieties is characterized by the percent of resistant plants within the population.*

Classification	Percent of plants having resistance
HR = Highly Resistant	more than 50
R = Resistant	31-50
MR = Moderately Resistant	16-30
LR = Low Resistant	6-15
S = Susceptible	less than 6

* Disease resistance ratings of certified alfalfa varieties are based on standardized tests conducted by USDA-ARS and university scientists and have been evaluated and approved by the National Alfalfa Certification Review Board.

The value of using PRR-resistant varieties has been illustrated in research conducted in Fremont County. In a soil naturally infested with *P. megaspermas*, yields of varieties with resistance to PRR were consistently better than yields of susceptible varieties (Table 2). Increased yields of resistant varieties were attributed to better stand persistence. After four years, yields of resistant (R) and moderately resistant (MR) varieties were still increasing, while yields of varieties with low resistance (LR) or with no resistance (S) were stable or declining. Currently, adapted alfalfa varieties with high resistance (HR) to PRR are available; these should perform even better than the varieties with an R rating illustrated in Table 2.

Two other stand decline diseases that occur in Wyoming which should be considered in variety selection are the alfalfa stem nematode and Verticillium wilt. However, both have different symptoms than PRR.

Table 2. Relationships of increasing levels of resistance of *Phytophthora* root rot to yields in alfalfa¹

Resistance category	Forage yield (T/A)				
	1981	1982	1983	1984	Total
Resistant	1.07 a	5.89 a	6.52 a	7.55 a	20.94 a
Moderate resistance	1.21 a	5.71 ab	5.98 ab	6.56 b	19.46 ab
Low resistance	0.94 a	5.35 b	5.98 ab	6.12 b	18.35 b
Susceptible	0.58 b	3.53 c	4.82 b	4.55 c	13.48 c

¹ Values are the amount of forage removed from plots, converted to 12% moisture, and are the mean of four replications. Values followed by the same letter do not differ significantly ($P = 0.05$) according to Duncan's new multiple range test.

Information on certified alfalfa varieties with disease resistance is available in the publication, **Guide for Selecting Alfalfa Varieties With Disease Resistance for Wyoming**, Bulletin B-919R, available in the University of Wyoming, Ag Resource Center. This publication provides information on diseases prevalent in your area, as well as an updated list of multiple disease-resistant, certified alfalfa varieties adapted to Wyoming.

Soil and water management: Although the use of PRR-resistant varieties is the most important control measure for PPR, soil and water management practices are also important.

When possible, plant alfalfa on well-drained soils. Land leveling to eliminate low areas and maintaining good distribution flow of irrigation water will reduce disease development. Since the disease is aggravated by extended wet periods, do not allow irrigation water to stand on fields longer than required for soil saturation. In established stands allow the top foot of soil to dry out between irrigations. If moisture is present in the subsoil, alfalfa's deep root system will continue to supply adequate moisture for growth.

Stand establishment: The seedling stage of alfalfa is highly susceptible to infection by *P. megasperma*. In order

to protect seedlings during this critical stage, seed should be treated with the systemic fungicide metalaxyl, sold as Apron. This will provide protection against infection by *P. megasperma* for the first 14-21 days of growth. This seed treatment is especially important if the field is known to be infested with *P. megasperma*, and has a high clay content or poor drainage. In these situations, seed treatment with Apron is recommended regardless of the level of PRR resistance in the variety. Apron seed treatment or Apron-treated seed should be available through your seed supplier.

Oospores of *P. megasperma* may survive for several years in soil in the absence of alfalfa. Therefore, crop rotation effective in controlling several other diseases of alfalfa, is less effective in controlling PPR.

The combination of the following management practices will reduce loss from PPR and should maximize forage yield and stand longevity.

1. **Crop Rotation:** Although oospores of *P. megasperma* may survive for many years, rotation with any other crop for 3-5 years should reduce soil inoculum.
2. **Resistant Varieties:** Use seed of certified varieties which are resistant (R rating) or highly resistant (HR rating) to PPR.
3. **Seed Treatment:** Purchase seed treated with Apron fungicide or apply Apron as a hopperbox treatment.
4. **Soil and Water Management:** Level fields to eliminate low areas. In established stands, allow the top one foot of soil to dry between irrigations.
5. **Other Practices:** Soil test to provide optimum fertility for maximum plant growth. Purchase seed treated with Rhizobium inoculant or apply as a hopperbox treatment, especially in fields where alfalfa has not been recently grown.

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