

# BIOLOGY AND MANAGEMENT OF STAND-DECLINE DISEASES OF IRRIGATED ALFALFA IN THE WESTERN U.S.

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## ABSTRACT

A total of 80 different diseases attack alfalfa in the U.S., most have been reported from the western states. Three of these diseases are widespread in the West and cause decline of alfalfa stands and reduced forage yields. These include Verticillium wilt (*Verticillium albo-atrum*), Phytophthora root rot (*Phytophthora megasperma* f. sp. *medicaginis*) and the Alfalfa stem nematode (*Ditylenchus dipsaci*). Verticillium wilt, first reported in Washington state in 1976, has since spread throughout the northern tier of states. Optimum conditions for this fungus are cool temperatures and rainy weather or sprinkler irrigation. This disease occurs throughout the U.S. with the exception of the southeastern states. It is favored by heavy soil and is worse in areas of high rainfall and in areas receiving furrow or flood irrigation. The Alfalfa stem nematode has similar distribution and is favored by similar environmental conditions as Phytophthora root rot. Control of these three diseases is obtained by modifying the field environment, rotating with a non-host crop and replanting with a resistant variety. Over 250 certified alfalfa varieties with multiple disease resistance are currently available in the U.S. Use of the appropriate variety will result in increased plant stand longevity and prolonged forage yield. Brown root rot (*Phoma sclerotoides*) is a newly discovered disease in the Rocky Mountain states. First discovered in western Wyoming in 1996, it now has been identified in eastern Idaho and in Montana. Its presence in other western states is unknown. Brown root rot was first reported in Canada in 1933. Unlike the other three stand-decline diseases, Brown root rot occurs in alfalfa fields grown under dryland conditions, as well as in fields grown under irrigation. It has a wide host range and is able to attack many forage legume crops. Control of this disease in Canada is obtained by rotation with small grains and reseeding with the resistant variety 'Peace.' U.S. varieties have not been knowingly bred for resistance to Brown root rot and their reaction to this disease is unknown. Current research in Wyoming is addressing the reaction of some U.S. varieties to Brown root rot, as well as developing a resistant variety for the Rocky Mountain states.

**Key Words: alfalfa, diseases, nematodes, stand decline, disease management**

## INTRODUCTION

Like most crop plants, alfalfa is attacked by many disease-causing organisms. Seedlings, as well as seeds, stems, leaves, and roots of older plants, all serve as food sources for a number of disease-causing organisms. Of the 80 different diseases reported on alfalfa from North America, the majority occur in the western states. Crown rots, root rots and wilts, which can cause plant death, are usually worse than leaf and stem diseases. Under certain conditions, seedling diseases

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can cause severe damage in newly seeded stands. The severity of plant diseases are largely dependent on the susceptibility of the variety grown and the occurrence of environmental conditions favorable for disease development. Most stand decline diseases in the western states are intensified by irrigation.

### **RECOGNIZED STAND-DECLINE DISEASES OF IMPORTANCE IN THE WEST**

***Verticillium wilt.*** Verticillium wilt (VW), caused by the fungus *V. albo-atrum* (Vaa), was first identified in the U.S.A. in 1976 in Washington state. VW is now widespread in the northern tier of states from California, north to Washington state on the west coast, to northern Virginia, north to Maine on the east coast. Long-distance spread of Vaa is believed to have occurred by the distribution of diseased, certified seed. Spread within and between fields can occur from wind-blown spores of Vaa, as well as from movement of infected stems and leaves on harvesting equipment. VW has not been reported in the southern tier of states, with the exception of California. Vaa is an aggressive fungal parasite attacking the vascular tissues of the root and stems, as well as leaves, petioles, flowers and seed. Infection occurs when wind-blown spores of Vaa infect freshly cut stems of the alfalfa plant following harvest. Cool, rainy weather conditions favor the disease. Optimum temperature for growth of Vaa is 75EF. Moisture can also be provided by sprinkler irrigation. Usually, VW does not occur when alfalfa is grown under dryland conditions. In studies conducted in Wyoming, symptoms of VW first appear either in the fall of the second year or spring of the third year following seeding and peaks in the fifth year. VW does not attack seedling alfalfa. Symptoms consist of scattered plants throughout the field that show drought stress. Leaves on one or more stems show symptoms of wilting, later twisting and turning a yellow to tan and pinkish color, remaining attached. Advanced symptoms consist of collapse and death of diseased plants. Plant death usually occurs during the hot summer months. Like most wilt diseases, vascular discoloration may be present when the tap root is cross-sectioned. Dead plants are later replaced by opportunistic weeds reducing the quality of harvested forage. Decline of plant stand is accelerated by VW beginning in the second or third production year. Stand decline and yield loss is greater in susceptible than in resistant varieties. Average annual yield reductions of 0.5 T/A in susceptible varieties are first detected during the third or fourth production year (one or two years after symptoms first appear). Since plant infection by Vaa occurs via cut stems, increased disease incidence may occur if harvested more frequently. Vaa produces no long-term survival structures. Therefore, a 2-3 year rotation will rid the field of Vaa. Since Vaa is fairly host-specific, most crops can be grown. Of several forage legumes tested in Wyoming, only sainfoin (*Onobrychis viciifolia*) was susceptible to Vaa. Even if a nonhost crop is grown and the field is replanted with a resistant variety, spores blown from a nearby field can infect the new stand.

***Alfalfa stem nematode.*** This parasitic nematode was first reported on alfalfa in 1923, and now occurs throughout the U.S. It can attack seedlings, as well as older plants. It is worse when alfalfa is grown in areas of high rainfall or under irrigation and especially in fields having a heavy soil which enhances its spread and parasitism. The alfalfa race of the stem nematode (ASN) is an endoparasite attacking emerging stem buds near or below the soil surface when sufficient moisture is present. If environmental conditions are favorable for infection, stems of susceptible plants often fail to break the soil surface. Optimum temperature at the infection site is 70EF. Plant symptoms consist of stunted plants. Many stem buds may fail to emerge through the

soil. Infected stems that do emerge have swollen nodes and shortened internodes. While some stems may be normal in length, others may be of varying lengths and swollen at their base. Severely infested stem buds will be stunted, white and swollen. A small percentage of plants may have stems and leaves that are white. This symptom is referred to as 'white flagging'. Although this symptom is diagnostic for the presence of the ASN in a field, it does not relate to the severity of the problem. However, it does serve as a 'flag' indicating ASN is present in the field. Parasitized plants are stunted and have fewer stems that contribute to hay production. These plants do not store adequate carbohydrates for the winter and many die during the winter months in colder climates. Death of such plants in warmer climates usually occurs during the hot summer months. Thus, loss may occur as reduced yield of parasitized plants, as well as from missing plants. The percentage of alfalfa in an infested field will decline over time as stands are invaded by opportunistic weeds. When alfalfa is plowed out and the field is rotated to a non-host crop such as a small grain, the ASN will soon decline. Clover is the only known alternate host of the race which attacks alfalfa. Reseeding or inter-seeding of stands which have declined from the ASN is not recommended as infection of seedlings can result in stand failure. Spread of the ASN between fields usually occurs via irrigation water or movement of moist soil with machinery. However, since the parasite can survive in semi-dried, infected stem tissue, it can be spread long distances with unclean seed. Management is provided by rotation with a non-host crop and replanting with a resistant variety. Fall burning of frosted-down alfalfa stubble may reduce infection and revive stands.

***Phytophthora root rot.*** *Phytophthora* root rot (PRR), caused by the soil-borne fungus *Phytophthora megasperma* f. sp. *medicaginis*, was first identified in the U.S. in 1953. Optimum temperature for growth of the fungus is around 77EF. High temperature isolates from southern California grow optimally at 85EF. It is widely distributed except in the southeastern states where soils are acidic. It is worse in areas of high rainfall or in areas that are irrigated. It is especially severe in fields having a heavy clay soil. This fungus is a water mold, requiring free water for the production and release of its motile zoospores which infect the root of the susceptible alfalfa plant. The fungus can attack both seedlings, where it can cause damping-off, and roots of older plants, which results in the rotting of tap and lateral roots. Above ground symptoms of infected plants range from necrotic dead seedlings to stunted older plants. Young plants (2-6 months old) that are diseased, may have lower leaves that are chlorotic and/or red in color while infected older plants may only appear stunted. However, removal of these infected plants reveals the characteristic root rot. Root symptoms consist of a cortical rot that is a reddish-brown in color. Diseased roots may only be several inches in length. These plants eventually die from water stress in warmer climates and from winterkill in colder climates. Long-term survival is insured by the production of oospores in the rotted roots. Oospores can survive for many years in soil and are stimulated to germinate in the root rhizosphere of susceptible plants. Long distance spread is with soil peds containing oospores that are with seed. Loss of plant stand and forage yield may occur in the seeding year and continue throughout the life of the stand. Since this fungus has a very narrow host range other crops planted in rotation with alfalfa do not become infected. Although rotation for 3-5 years will reduce the number of viable oospores in the soil, it will not irradiate them. Control is obtained with the use of resistant varieties. Avoiding over-irrigation, breaking hard pans and deep tillage will reduce conditions favorable for the fungus, resulting in better performance of the resistant varieties. Seedlings can be protected with Apron®

seed dressing. This should be used even on seed of resistant varieties when conditions favor PRR and/or in fields with a history of the disease.

### A NEW DISEASE OF ALFALFA IN THE CONTINENTAL U.S.

In the spring of 1969, we observed dead and dying alfalfa plants in several sprinkler-irrigated fields near Farson, Wyoming. Examination of plants indicated it was not *Phytophthora* root rot, which is common throughout much of Wyoming. Isolations from diseased roots resulted in the identification of the fungus, *Phoma sclerotioides*, the causal agent of Brown root rot (BRR) of alfalfa. This disease is common in alfalfa fields in the western four provinces of Canada (British Columbia, Alberta, Saskatchewan and Manitoba). Field surveys in Wyoming found BRR to be widespread throughout much of the state. It was also identified from several fields in eastern Idaho and was reported from at least one field in Montana (Figure 1). Its presence in other northern states is currently unknown. This soil-borne fungus is believed to be native to Canada where it attacks many leguminous plants. It prefers yellow sweet clover (*Melilotus officinalis*) and sainfoin over alfalfa. *P. sclerotioides* is a root pathogen attacking the tap and lateral roots of leguminous plants. Roots have a dry, brown rot which differs from plants with PRR. Optimum temperature for *P. sclerotioides* is 59EF but it can grow as low as 19EF.

Symptoms in the spring consist of stunted and dying or dead plants. When plants are removed, tap and lateral roots are rotted resulting in death of many plants (Figure 2, next page). Roots of established plants are initially attacked in the early spring as plants come out of winter dormancy. The disease is first noticed in alfalfa fields on plants 2-3 years of age. This root pathogen survives in the soil as pycnosclerotia which are initially formed on rotted roots. Losses due to winterkill in certain fields in Sweetwater County are such that fields are plowed down and planted with less valuable crops of small grains. Other fields that are not affected as severely show a slow decline over several years. Individual plants are stunted and produce less forage similar to PRR. This disease occurs in fields under sprinkler irrigation and has been reported on dryland alfalfa in Canada. It appears not to increase in severity with flood or furrow irrigation.



1. Distribution and severity of Brown root rot.

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**Figure 2.** (Clockwise from upper left photo) Alfalfa field showing severe winterkill and stunting in a 3-year-old stand of alfalfa in the early spring due to Brown root rot (BRR); close-up of field described in first photo showing winterkill of an alfalfa plant due to BRR; alfalfa plant removed from the 3-year-old stand shown in first photo showing severe rot of the tap root caused by BRR (note adjacent dead plant with root entirely rotted off); severe BRR symptoms on 3-year-old plants. Photos by Fred A. Gray©.

## **DISEASE MANAGEMENT STRATEGIES**

**Diagnosis.** Proper diagnosis of stand decline diseases is the first step in disease management. A representative plant sample consisting of several plants in various stages of disease development should be collected. The sample should be placed in a plastic bag with moist soil to prevent drying during shipment. Store in the refrigerator until you know where to mail the sample. Proper identification of stand decline diseases is critical to selection of a variety when the field is replanted to alfalfa.

**Cultural practices.** On declining stands, avoid over-irrigation, especially in fields with heavy clay soils. However, this seems not to affect BRR which occurs in fields with sandy soils. Time the last harvest to allow 6-10 inches of regrowth before the first killing frost. When the field is plowed out, level to provide optimum drainage. Rotate with a non-legume crop for three or more years and replant with a Certified alfalfa variety with resistance to the stand decline disease and to other major diseases which occur in your field. These cultural practices are aimed at reducing disease potential and previously favorable environmental conditions which will maximize performance of the Certified resistant variety.

**Host resistance.** Currently, there are 252 Certified alfalfa varieties available in the U.S. Fall dormancy (FD) ratings range from 2 (most fall dormant, similar to Vernal) to 11 (least fall dormant, similar to UC-1465). All have resistance to one or more pests and/or diseases. A list of these varieties and their fall dormancy and pest/disease ratings, as well as marketing information, are available in the publication developed by the Alfalfa Council ([www.alfalfa.org](http://www.alfalfa.org)). Selecting the right variety or varieties for your farm or ranch can be accomplished with the following steps. **Step 1** - Find out which FD rating(s) perform the best in your area. **Step 2** - In addition to the disease that was identified in your field, find out what other stand declining or yield limiting diseases and/or insect pests occur in your area. **Step 3** - Locate the varieties that meet these criteria. **Step 4** - Find out which of these varieties were field tested in your area and which performed to your satisfaction. Now, you are ready to replant your field. Note: Although resistance is reported in the Canadian variety Peace, reaction of U.S. varieties is unknown. Field studies in Farson, Wyoming, indicate the variety Ranger may be tolerant to BRR.

### SOME AVAILABLE PUBLICATIONS

- Alfalfa Analyst (Distribution and identification of disease and pests of alfalfa), Alfalfa Council.
- Fall Dormancy & Pest Resistance Ratings for Alfalfa Varieties 2001/2002 Edition (Up-to-date listing of available certified alfalfa varieties for the U.S.), Alfalfa Council.
- Compendium of Alfalfa Diseases, 2nd Edition (Information on the biology and identification of 80 diseases of alfalfa in the U.S.). American Phytopathological Society.
- Intermountain Alfalfa Management (University of California, Division of Agricultural and Natural Resources, Pub. 3366).
- Alfalfa Seed Production and Pest Management (Western Regional Extension Publication 12, Cooperative Extension Service, Washington State University)
- Brown Root Rot of Alfalfa (University of Wyoming, College of Agriculture, Department of Plant Sciences Timely Information Series, No. 1)
- Alfalfa Disease Management (University of Wyoming, College of Agriculture, Agricultural Experiment Station Bulletin No. (*In Preparation*)). Website Address: <http://www.uwyo.edu/ces/pubs2.htm>.
- Biology and Management of Phytophthora Root Rot of Alfalfa. Agricultural Experiment Station, College of Agriculture, University of Wyoming. B-791R
- Verticillium Wilt of Alfalfa. University of Wyoming, College of Agriculture, Agricultural Experiment Station. B-1022R
- Alfalfa Stem Nematode Biology and Management. University of Wyoming, College of Agriculture, Agricultural Experiment Station. B-761R
- Other Publications - Other publication are available from the College of Agriculture in western states as well as from Alfalfa Seed Companies.