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Verticillium Wilt of Alfalfa

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About 3 years ago *Verticillium* wilt of alfalfa was discovered in the Columbia Basin in Oregon and Washington. This was the first report of this fungus disease in the United States, although it is a major problem in Europe and had been reported in one area of Canada. *Verticillium* wilt may make alfalfa stands unproductive as early as the second cutting year, but usually becomes severe the third cutting year. Since no efforts were made to breed resistance into our alfalfa, all domestic varieties are susceptible. Investigations since the discovery of this disease in the Pacific Northwest indicate that the causal organism, *Verticillium albo-atrum*, probably has been present in Oregon and other areas of the Pacific Northwest for many years.

Although the pathogen is fairly widespread in Oregon, there are marked differences in incidence and severity of the disease from one geographic location to another. The most severely affected area is in the Columbia Basin, around Hermiston, where some fields decline so rapidly that they are uneconomic after the second harvest year. Most of these fields are on sandy soil under sprinkler irrigation—either wheel line or circle irrigation systems. In the Butter Creek area, where the soil is heavier and generally is flood irrigated only once or twice per year, alfalfa stands have been less affected by *Verticillium* wilt.

In Malheur County, the wilt occurs in about 5 percent of the fields, but rapid death and severe thinning of the stands are not prominent in this area. Nevertheless, some fields have been affected severely.

In western Oregon, the disease occurs in only a few fields scattered over an area from Woodburn to Roseburg and on most soil types in the area.

A fairly intensive survey failed to detect the disease in the Klamath Falls area, and no specimens have been collected from Klamath Falls since that time. Central Oregon, the Medford area,

and the remainder of eastern Oregon have not been surveyed for the disease. Because the disease has not yet been found by Extension agents in these areas, we assume the disease is not present.

The alfalfa *Verticillium* wilt pathogen

The *Verticillium* wilt organism that attacks alfalfa is *Verticillium albo-atrum*. Strains of this fungus that attack other crops have been in Oregon for years, but no strains causing alfalfa wilt were detected until recently. *Verticillium* wilt of mint and potatoes is caused by another species of *Verticillium*, *V. dahliae*. Although these two fungi are similar in many ways, they differ in several important characteristics that affect control methods.

The alfalfa pathogen grows and causes plant disease at a relatively low temperature. The Pacific Northwest, where the pathogen causes the most severe problem, is on the edge of its ecological niche. Generally mid-summer temperatures in this region exceed the maximum for rapid fungus development. Possibly sprinkler irrigation has created a micro-climate that allows disease development. *Verticillium dahliae*, on the other hand, is more tolerant of high temperatures and consequently is better adapted to the Northwest's relatively high summer temperature.

The alfalfa pathogen (*V. albo-atrum*) forms a resting structure that consists of thickened special mycelium (threadlike fungus growth). These resting structures survive in soil for only 3 or 4 years if no susceptible crops or susceptible weeds are present.

Verticillium dahliae forms special resting structures (micro-sclerotia) that survive in soil for up to 10 years without the presence of host plants. Because of these differences in resting bodies, crop rotation may be more effective in controlling alfalfa wilt than it has been for *Verticillium* wilts of other Oregon crops.

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Symptoms of the disease

The first symptom of alfalfa wilt is death of leaves and stems on portions of plants or on entire plants. Unlike plants with bacterial wilt, the plants generally are not dramatically stunted and yellowed. Maximum visual expression of the disease occurs as the plants are nearing harvest. Rapid yellowing occurs, followed by browning of the leaves on erect central stems. Development of the pathogen within the plant is progressive, and eventually the entire plant will die. It is not uncommon for a crown to have several apparently healthy stems while other stems on the crown are dead or dying. Dead or wilted leaves may occur on only one side of the stem. This unilateral wilting, characteristic of many wilt diseases, may occur on individual leaflets. One sector of the leaflet turns yellow and dies, while the remainder dies later as the fungus spreads to the vascular system feeding that part of the leaf. When stems of the infected plants are cut, a brownish-red discoloration may appear in the central portion of the root. This discoloration is not necessarily present in all *Verticillium*-infected alfalfa plants, and death may occur when no discoloration is present. The discoloration caused by bacterial wilt of alfalfa is less red, and it occurs immediately beneath the bark, not in the central core of the root. Because it is difficult to differentiate between these two diseases on the basis of field symptoms, laboratory analysis (culturing infected tissue on media to isolate the causal organism) usually is necessary for positive diagnosis.

Under European conditions *Verticillium albo-atrum* produces a white growth at the base of infected stems in the field. In the Columbia Basin, sporulation of this fungus has been observed on stems near the center of circle irrigation systems. Spores of this organism probably are more prevalent than observation indicates, as shown by the patterns of spread in the infected fields.

Methods of long-distance spread

The alfalfa *Verticillium* can move from an infected area to a noninfected area by seed transmission. The fungus is not within the seed but often is in small pieces of leaf, stem, pod tissue associated with the seed, or on the seed surface. Furthermore, any movement of the infected alfalfa as loose, baled, or cubed hay will spread the disease. The passage of infected alfalfa through an animal does

not inactivate the fungus, so animals that have eaten the infected hay also spread the disease.

Spread within an infected field

Once in a field, the fungus can spread rapidly. Any cultural operation that moves soil or infected hay will spread the disease. For example, operations such as plowing, cultivating, or moving contaminated equipment will spread the disease. Mowing equipment rapidly spreads spores of the pathogen from one cut surface to another. The spore-contaminated alfalfa sap remains on the cutting bar and spreads in the direction of the cutting. Spread is most rapid when the hay is damp with dew, and can be reduced by cutting only when hay is completely dry.

Water can carry infested soil or plant debris and spores of the fungus. Furrow irrigation or sprinkler runoff from infected fields may contain the *Verticillium* organism. Workers in Europe have demonstrated that the fungus can move from one crown to an adjacent crown by root grafts. This method of spread is relatively slow and has little practical significance.

Limiting spread within infected field

Once *Verticillium* is widespread in a field, little can be done to contain the disease. If only small areas of the field are infected, however, there are several ways to limit the rate of spread. Spread of spores by the cutting equipment can be prevented by not cutting the infested areas. You can dike infested areas to limit water movement out of these areas. If you have only one infested field, cut the healthy fields before taking your equipment into the infested field. After cutting the infected hay, thoroughly clean your equipment with high-pressure water or steam to remove all soil and debris. Steam cleaning is best because high temperatures will inactivate some of the fungal resting structures. If you can prevent movement of soil from the infested area, you should be able to contain movement of the disease.

Crop rotation as a means of control

Crop rotation should be effective in reducing the *Verticillium* inoculum for this disease. Three or four years of rotation out of alfalfa should be sufficient to sharply reduce the disease in the field, but longer rotations are desirable.

When using crop rotation to control alfalfa wilt, avoid susceptible weeds and crop plants to prevent the fungus from surviving in the absence of alfalfa. Some weeds that propagate the *Verticillium* attacking alfalfa are various species of plantain, klamath weed, groundsel, poppy, and dock. Recent experiments at Oregon State University suggest that potatoes, although not severely damaged by the fungus, can serve as a host for the fungus between alfalfa crops. Crop rotation to eliminate the alfalfa pathogen should avoid susceptible weeds and potatoes in the rotation sequence.

Resistant varieties

At the present time, there are no locally adapted resistant varieties, but work at Washington State University to breed resistant varieties is encouraging. Europeans have produced several good resistant varieties, and this resistance should be incorporated into new Northwest varieties shortly. Check with your Extension agent or seed supplier before planting to determine if more resistant varieties are available. Currently, three alfalfa varieties show some tolerance in limited field testing, but they are not totally resistant. They are Agate, Pacer, and Valor.

Seed treatments

Work in Europe has demonstrated that several chemicals will control *Verticillium* in plant debris mixed with the seed. Both fumigation and direct application of chemicals to the seed have been successful.

Several compounds for fumigation have killed the *Verticillium* associated with alfalfa seed. Allyl

alcohol formalin, and chloropicrin were found effective, but none of these materials are registered for this use in the United States.

Two chemicals, Captan and Thiram, are registered for damping-off control in the United States. These were successful in the elimination of *Verticillium* from infested seed lots in Europe. If you have no *Verticillium* wilt, or disease occurs in only a few fields, consider using chemicals to prevent introduction of the pathogen into your fields.

One major drawback of these chemicals is their potential effect on the *Rhizobium* bacteria necessary for nitrogen fixation by alfalfa. Treat seed with the fungicide several days before the *Rhizobium* inoculation; never inoculate and treat with fungicide at the same time. Apply the *Rhizobium* inoculum immediately before seeding. Do not expose the *Rhizobium* inoculum to the fungicide for more than 3 or 4 hours before planting. If good fresh inoculum is applied in large quantity just prior to seeding, the inoculum will work in spite of the fungicide. Inoculum left in the proximity of the fungicide for more than 24 hours may be ineffective, so re-inoculate the seed.

The rate of Captan registered for use depends on the formulation and the method of application. Use 2.22 to 4.13 ounces of active ingredient per 100 pounds seed for slurry treated in a seed machine; 6.0 ounces of active ingredient per 100 pounds seed when applied dry in the machine; and 0.4 ounces of active ingredient per 100 pounds of seed when applied directly to seed on the farm in the planter box.

Thiram is registered at the rate of 6.0 ounces of active ingredient per 100 pounds of seed, regardless of the method of application.