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Verticillium Wilt of Alfalfa

by Gary C. Bergstrom
Department of
Plant Pathology
Cornell University

Nature and Importance

Verticillium wilt is a serious disease of alfalfa with the potential to reduce yields as soon as the second harvest year and to limit productive stand life to 3 years or less. Verticillium wilt (VW), a fungus-incited disease, was discovered in Sweden in 1918 and was responsible for major crop losses in the cooler alfalfa-growing regions of Europe during the 1950s. The disease was detected in 1962 in Quebec and British Columbia, but didn't become established in North America until the mid 1970s. Following its detection in Washington State in 1976, the disease became widely distributed throughout the Pacific Northwest where it caused substantial losses. This is also the production region for much of New York's alfalfa seed. Infested seedlots have played a major role in the spread of VW into most of the northern tier of states and the provinces of Canada where the disease is now found.

VW was first detected in New York State in 1981 in 6 counties, but may have been present since at least 1979. By 1984 the presence of VW was confirmed in 25 New York counties representative of the major alfalfa-growing regions of the state; even so, less than 5 percent of the state's alfalfa acreage was known to be affected. With the promise of VW-resistant alfalfa varieties and the employment of strategies to retard the spread and reintroduction of the pathogen, VW should soon be mitigated as a severe threat to alfalfa production in New York.

Symptoms and Effects

Species of *Verticillium* fungi cause wilt diseases in a wide range of plants. VW of alfalfa is caused by a strain of *Verticillium albo-atrum* that appears to be a specific pathogen of alfalfa. This fungus infects alfalfa through the roots

Figure I. Signs of water shortage (wilting, yellowing, and stunting) on individual plants widely scattered in an alfalfa stand are important clues that Verticillium wilt may be present.

Figures 2–5. Yellowing and death of upper leaflets progressing in a V-shaped pattern from the leaf tip are early symptoms of Verticillium wilt (2). Light tan, twisted leaves cling to a still green stem of an infected shoot (3). Plant dying from Verticillium wilt in a sparse patch (notice

or through wounds in aboveground plant parts and then grows systemically through the water-conducting (vascular) tissues, causing them to become plugged.

The first noticeable effects of this fungus-induced "water shortage" are reversible wilting (flagging) of upper leaflets of infected shoots and a yellowing of leaflets starting at the leaf tips. As the water-deprived leaves die, they become curled and twisted and may take on a light tan to pink coloration, while the stems remain green. Symptoms often develop on only one side of the plant until the fungus gets distributed throughout the vascular tissue and blocks water to all parts of the plant. Advanced infections are associated with a browning of vascular tissues, which is evident when stems and roots are observed in cross section.

Killing of alfalfa plants can be a gradual process. Regrowth that appears healthy can often be observed from wilted plants that have been cut. Symptoms reappear by the time the plants have produced 8–10 inches of new growth; this is the time that VW can most easily be discerned on scattered plants in a field. As plants continue to grow, wilted and stunted (bushy with shortened stem segments and petioles) plants become hidden beneath the canopy of healthy shoots. This has greatly impeded detection of the disease. Losses can be realized not only as a progressive decline in harvest yield during a growing season but also as a decrease in winter survival.

A generalized scenario for the impact of VW on a field of susceptible alfalfa infested at the time of seeding is as follows: no detection in the seeding year, detection of disease and some harvest decrease (up to 20%) by the end of the second year, and steady decrease in harvest with the productive stand life being depleted by the end of the third year. However, there is great variability in the time it takes for the disease to make a field unprofitable. It is likely that VW interacts with other stresses such as parasitic nematodes, root and crown rots, defoliating insects and diseases, nutrient deficiencies, and damage by machinery. All these stresses tend to increase with stand age and contribute to stand decline.

Disease Cycle

V. albo-atrum is introduced into an area primarily via infested seed. The usual source of infestation is infected fragments of plant debris (accounting for less than 1% of the weight of alfalfa seed), but seed coats may also be contaminated. In certain infected seedlots, less than 0.01 percent of seed have been found to be internally contaminated. Infection occurs and symptoms typically develop in a small number of plants scattered widely in a field. Cutter bars become contaminated with sap from these infected plants and introduce fungal spores directly into

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surrounding dandelions) of the stand gives evidence that neighboring plants have already been killed by this disease (4). Regrowth from a

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previously wilted plant exhibits stunting and a bushy growth habit (5).

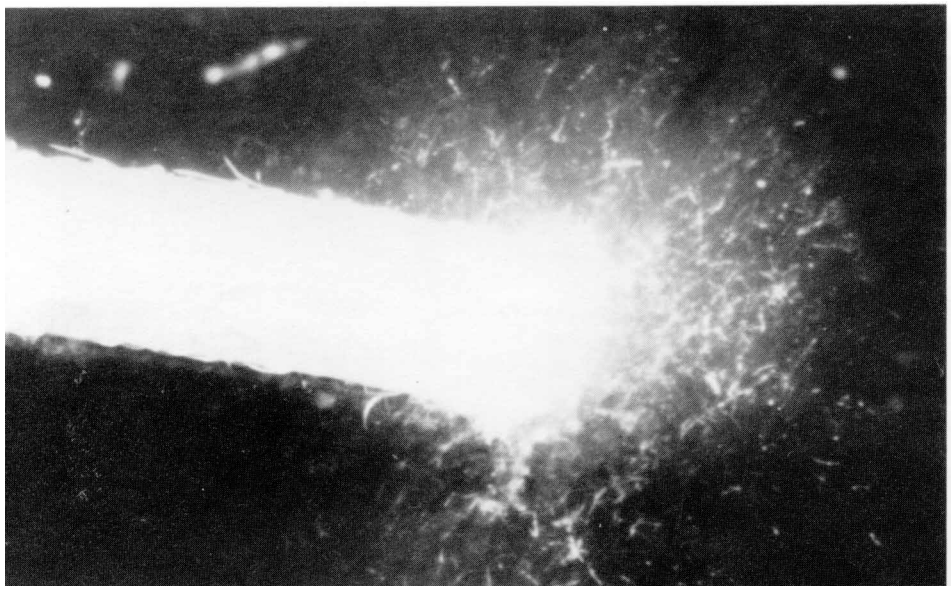
the wounded vascular tissues of healthy plants, thus increasing the number of infected plants at each harvest. This is the most efficient and common means of spreading the fungus within and between fields, but there is a potential for spread whenever soil or plant material is moved from infested fields. For example, *Verticillium* may be disseminated by spreading manure that has become mixed with nonensiled, infected hay on the barn floor.

The fungus sporulates on the surface of killed, but not of living, plant tissues. Spores dispersed by air currents or splashing rain may account for some limited spread of the pathogen within a field. Chewing and sucking insects as well as nematodes have been implicated as vectors of *V. albo-atrum*, but there is little evidence to suggest that they cause significant spread of the fungus. Natural root grafting may also transmit the pathogen between adjacent plants.

Unlike some *Verticillium* fungi, the alfalfa pathogen does not persist long in soil in the absence of plant material. However, the fungus has been shown to survive in the roots of a large number of plant species in which it doesn't induce symptoms. The long but certainly incomplete list includes common dicot weeds (e.g., dandelion, dock, lambsquarter, yellow rocket) and crop plants (e.g., birdsfoot trefoil, clovers, soybean, strawberry, tomato, watermelon). The fungus does not appear to infect any grasses or other monocots. The fungus survives New York winters mainly in infected alfalfa plants, in plant debris, and in the roots of nonsusceptible plants.

Diagnosis

Identification of VW is an important step in making stand management decisions. A positive diagnosis requires laboratory culture of the causal fungus recovered from infected tissues and microscopic observation of the characteristic sporulating structures of *Verticillium*. Many stress factors, literally anything that interferes with water movement, can produce symptoms that may be confused with VW. These include drought stress, boron deficiency, anthracnose, Fusarium wilt, root and crown rots, and potato leafhopper injury. Your Cooperative Extension agent can help to rule out some of these possibilities and to submit specimens for laboratory diagnosis.



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Figures 6-7. Laboratory diagnosis of Verticillium wilt involves isolation of the fungus from infected stem segments (6) and microscopic observation of the characteristic sporulating structures of *Verticillium* (7).

Sanitation in infested areas. When VW is confirmed, care must be exercised to prevent movement of the fungus in soil or plant material from infested to noninfested fields. Operations such as mowing and raking should be done in infested fields last, and equipment (especially cutter bars) should be picked free of debris and disinfected with 10 percent bleach solutions before being moved out of infested areas. Since airborne spores and plant debris may account for some secondary spread of the pathogen, use of an infected crop as haylage (fungus does not survive ensiling) is advisable.

Stand management. Until more is known, management practices that promote the vigor of a stand and reduce other stresses are suggested to minimize losses to VW. These include the maintenance of balanced fertility, liming to maintain a pH of 6.5–7, and a timely cutting schedule. Harvesting infested fields just before flowering may help to reduce losses.

Crop rotation. When the stand becomes unprofitable, it should be plowed under, and a rotation to corn or small grains should be employed before returning the field to alfalfa. The currently recommended rotation period of 2 years may be reduced if research underway supports observations that the fungus doesn't persist in the soil in the absence of host plants. Clean cultivaton and control of dicot weeds (including volunteer alfalfa) should be employed during the rotational period.

Resistant varieties. Varietal resistance to VW represents the only long-range solution to the VW problem. All varieties recommended in New York before 1984 are susceptible to this disease. New varieties already developed and others being developed combine the VW resistance of European varieties with the desired traits (e.g., bacterial wilt resistance and winterhardiness) of Northeast-adapted varieties.

Although no alfalfa is immune to VW, varieties (populations composed of individual plants differing in disease reaction and other traits) have been developed by selection for an increased percentage of resistant plants. Forage crops, which possess remarkable compensation ability, can tolerate a certain amount of symptom development and even loss of plants to disease before a significant yield reduction occurs. A resistant plant population of approximately 35 percent in European varieties has been sufficient to achieve satisfactory control of VW in Europe for many years. Apollo II, DK-135, Excalibur, Oneida VR, Trumpetor, and WL-316 are the first of a group of varieties with increased percentage of VW-resistant plants and promise for use in New York State.

Because of limited information on yield performance of the new VW-resistant varieties in New York, they are initially recommended only for those farms where VW is present. Growers should follow publications such as *Cornell Recommends for Field Crops* for updated information on the performance of new varieties as data becomes available. Varietal resistance will undoubtedly eliminate the devastating potential of VW, but the disease may remain as one of the many factors contributing to decline problems in alfalfa stands maintained for more than 3 years.

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Quantity discount available.

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