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EFFECT OF VERTICILLIUM AND FUSARIUM WILTS ON COTTON YIELD AND QUALITY

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Abstract

One of the most significant constraints to increasing cotton productivity and quality is losses due to pathogens, especially those inciting root diseases. These losses contribute to yield stagnation and reduce growers profit. Verticillium wilt is one of the major diseases of cotton in the US and many cotton producing countries, where cotton is grown under relatively cool night temperatures (<23 to 25°C). Yield losses in the US ranged from 0.75% to 2.8% during the past 20 years, and are as high as 30 to 50% in other parts of the world (i.e. China, Spain, Uzbekistan). In 2001, losses across the US Cotton Belt averaged 0.62% ranging from no loss to as high as 4% in different states, with an estimated yield loss of 134,877 bales.

Fusarium wilt occurs in almost every cotton growing region of the world, and has recently been discovered in Australia. For the past 40 years, average yield losses to Fusarium wilt in the US ranged from 1.4% in 1960 to 0.25% in 1999. Yield losses in 2001 averaged 0.5% and ranged from 0.1 to 2.5% in different states. Thus, there is a resurg of Fusarium and Verticillium wilts.

The interaction between the Fusarium fungus and root-knot nematode causes higher incidence of wilt, and is perhaps the most widely recognized and economically important disease complex worldwide. The *Verticillium dahliae* fungus is genetically divergent and includes several pathotypes designated as defoliating (P-1) or non-defoliating (P-2) based on symptomology. Based on vegetative compatibility tests (VCGs) and isozyme analyses, at least four VCGs exist in *V. dahliae*, and two or three subgroups can be distinguished in each. Using seven differential hosts, six physiological races of *Fusarium oxysporum* f. sp. *vasinfectum* have been identified. Use of random amplified polymorphic DNA (RAPD) analysis to differentiate races has identified three groups separated geographically: Race A (includes races 1, 2, and 6), race 3 and race 4.

No single method is highly effective in controlling the wilt diseases. Consequently, an integrated management system is necessary to minimize losses from the diseases. Disease progress and severity depends primarily on the cultivar, virulence of the pathogen, inoculum density, growth stage of the host, fruit set, nutrient availability, soil moisture and temperature. The most effective control is achieved by growing adapted resistant cultivars and using cultural and management practices known to reduce disease severity. Biological and chemical control options should be considered if they are available and economical.

Control measures may be implemented before, at or after planting. If the initial inoculum density of the pathogen is high, most control measures may not lower the number of infective propagules enough to reduce disease severity and maintain yield and quality, and the main option is crop rotation. Pre-plant practices include sanitation, site selection, weed control, reduced row spacing and fertilization. At planting practices include management practices that raise soil temperature such as planting on beds, an early planting date, increased plant density, and the choice of an adapted resistant cultivar.

The choice of cultivar is one of the most important decisions the grower makes in his integrated crop management system. The cultivar sets the framework for the level of susceptibility to pests, the tactics applied to manage the crop, and production cost. Modern cultivars such as the Acala's released recently from California and New Mexico, as well as the Pima's *G. barbadense* are highly resistant to *V. dahliae*. Other Upland cultivars such as Paymaster HS-26, Deltapine 5690 and Stoneville 495 have moderate resistance to Verticillium wilt.

Post-planting practices include fertilization rate and source, irrigation frequency and amount, and promotion of rapid boll set and early maturity. In tests conducted in California over three years, the highest irrigation treatment of 22 acre inches in four applications significantly reduced yield (1,214 lbs/acre) compared to the 12 and 17 acre inches (1,373 and 1,356 lbs/acre, respectively). A significant increase of both foliar and vascular Verticillium wilt symptoms was obtained as the frequency and amounts of irrigation water were increased. A significant negative correlation was obtained between wilt symptoms and lint yield, lint percentage, fiber length (2.5% span length) and strength. Chemical controls can be effective, but are generally not used because of their prohibitive cost.

Several commercial cultivars have moderate to high levels of resistance to the Fusarium pathogen. In fields where Fusarium is associated with root-knot nematode, disease incidence may be decreased by controlling the nematodes with nematicides. Planting cultivars with resistance to the root-knot nematode (*Meliodogine incognita*) also helps to reduce the incidence of

Fusarium wilt. Rotations with barley and wheat, maize, mustard and clover reduce the incidence of Fusarium wilt the following season. High rates of ammonium nitrogen tend to increase Fusarium wilt incidence. Certain soils are known to be suppressive to Fusarium wilt, due to the presence of antagonistic microorganisms (i.e. *Azotobacter* spp., *Trichoderma harzianum*).

Agricultural biotechnology offers opportunities to enhance our efforts in developing new cottons with higher levels of resistance to multi-pests and other important traits. DNA marker-assisted selection can be used in early segregating generations (F_2 or F_3) to screen large numbers of plants more efficiently, saving many years of field testing and selection. Other new technologies will allow the creation and engineering of adapted cotton cultivars, with sources of resistance never envisioned in the 20th century, to make cotton profitable for the US growers and industry.