INFLUENCE OF CULTIVAR SELECTION ON SOIL POPULATIONS OF *VERTICILLIUM DAHLIAE* AND POTENTIAL IMPLICATIONS FOR COTTON (*GOSSYPIUM HIRSUTUM*) PRODUCTION IN WEST TEXAS

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Abstract

A microplot study was conducted over the 2008 and 2009 growing seasons to investigate the influence of planting combinations of susceptible and/or partially resistant/tolerant cotton cultivars, Stoneville (ST) 4554B2F and AFD 5065B2F, respectively on soil populations of *V. dahliae*. The hypothesis was that cultivars can affect population density of *V. dahliae* in the soil. Microplots were augmented with field soil naturally infested with *V. dahliae.* Baseline soil populations (1.3 ms/cm^3 soil) were enumerated for each microplot. It was observed that ST 4554B2F planted in sequential seasons increased *V. dahliae* populations (6.2 ms/cm^3 soil); however, populations in microplots planted to AFD 5065B2F over two seasons remained static (1.8 ms/cm^3 soil). Soil populations in microplots initially planted to ST 4554B2F followed by AFD 5065B2F remained static (1.8 ms/cm^3 soil); whereas, *V. dahliae* populations in microplots initially planted with AFD 5065B2F followed by ST 4554B2F were not different from those planted to ST 4554B2F for two seasons.

Introduction

Texas is the leading cotton production state, which produces approximately 25% of nation's crop, and contributes $5.2 billion to state's economy (Smith *et al.* 2000). Most of the cotton production is concentrated in West Texas. Verticillium wilt, caused by the soilborne fungus *Verticillium dahliae* Kleb., is an economically important disease of cotton in portions of this region.

During the 1970-1980's, severe Verticillium wilt epidemics occurred in cotton, but a decrease in disease incidence was observed with the introduction of resistant germplasm. Inoculum density of *V. dahliae* at planting has been found to play an important role in disease development in cotton (Paplomatas, *et al*. 1992). In California, a positive linear relationship was observed between inoculum density and wilt incidence and severity in susceptible Acala cotton (Pullman and DeVay 1982). There is a need to better understand this relationship in Upland cotton production systems in West Texas.

V. dahliae can survive for many years as microsclerotia in the soil (Bell, 2001). Microsclerotia are small, black, survival structures composed of masses of melanized hyphae. Root exudates stimulate germination of these microsclerotia, and the fungus directly penetrates the root tips. The fungus colonizes the root cortex and invades the xylem vessels, where conidia are formed. The conidia are transported to the rest of the plant through the xylem, and the vascular system becomes plugged leading to wilt. As the host plant senesces, the fungus produces microsclerotia, which are released into the soil as the plant decomposes.

Leaves of affected plants exhibit interveinal chlorosis, necrosis, curling, and may eventually die from the margins inward. Ramification of fungus in the xylem vessels leads to tan to brown discoloration of the vascular system, and plants become stunted, wilt, and may eventually die. The fungus favors cool and wet conditions for disease development, and the temperature range of 25 - 28 °C is best suited for its growth and survival. Planting susceptible cotton cultivars is believed to increase the inoculum of *V. dahliae* in soil. With the survival of microsclerotia approaching 20 years, the longevity of *V. dahliae* greatly impacts management options once the fungus becomes established in the soil. There are currently no means of chemical control, but information on upland cotton cultivar performance is available for West Texas, which can be utilized for understanding the relationship of soil inoculum density and Verticillium wilt development

Materials and Methods

The experiment was conducted in microplots (90 cm diameter × 45 cm deep) at the Texas Tech University Quaker Research Farm, Lubbock, Texas. The microplots were augmented with field soil naturally infested with *V. dahliae.* There were six combinations of rotation schemes over two years utilizing all the possible combinations of susceptible (Stoneville (ST) 4554B2F), and partially resistant/ tolerant cultivars. The full experiment consists of six treatments, and will be conducted over three years, with the last year occurring in 2010. In 2008, AFD 5065B2F was the partially resistant cultivar, but it was replaced by an advanced breeding line that was considered more resistant in 2009. Treatments were arranged in a randomized complete block with seven replications.

Three soil cores per microplot were taken before planting and after harvest for quantification of *V. dahliae*. The cores were mixed together, air dried for 14 days, and ground with a rolling pin. A 20 cm^3 subsample was combined with 80 ml of de-ionized water, and then stirred well using a magnetic stir plate. A 1-ml aliquot of the soil solution was distributed on each Petri plate (10 replications) containing Sorensen's NP-10 semi-selective medium (Sorensen *et al*. 1991). After 14 days of incubation, the soil was rinsed from the Petri plates, then air dried for about 5 hours prior to counting microsclerotia (ms/cm^3 of soil) per plate under a microscope. Disease incidence ratings in microplots were taken throughout the growing season. Data were analyzed using Proc ANOVA in SAS Version 9.1.

Results and Discussion

Baseline populations were found to be 1.3 ms/cm^3 soil across all six treatments (Figure 1). It was observed that planting a susceptible cultivar, ST 4554B2F, for two consecutive years increased the soil microsclerotia density (ms/cm^3 of soil) from 1.3 to 6.2 (Figure 2), and also increased disease incidence from 7 to 34% (Figure 3).

Planting a partially resistant / tolerant cultivar, AFD 5065B2F (2008) or Advanced breeding line (2009), for two consecutive years was found to keep the soil microsclerotia density almost static (1.3 to 1.8 ms/cm^3) (Figure 2) and the disease incidence almost static (0% to 2%) (Figure 3).

Rotating a susceptible cultivar, ST 4554B2F, with a partially resistant/tolerant cultivar, resulted in similar microsclerotia increases as using the continual partially resistant cultivars (1.3 to 1.8 ms/cm^3) (Figure 2).

Due to the longevity of microsclerotia, strategies that influence inoculum density may have positive effects when implemented in a preventative manner. Results from this study may be useful in developing long term management strategies that can be implemented into integrated programs for sustaining the production of cotton in fields infested with *V. dahliae.*

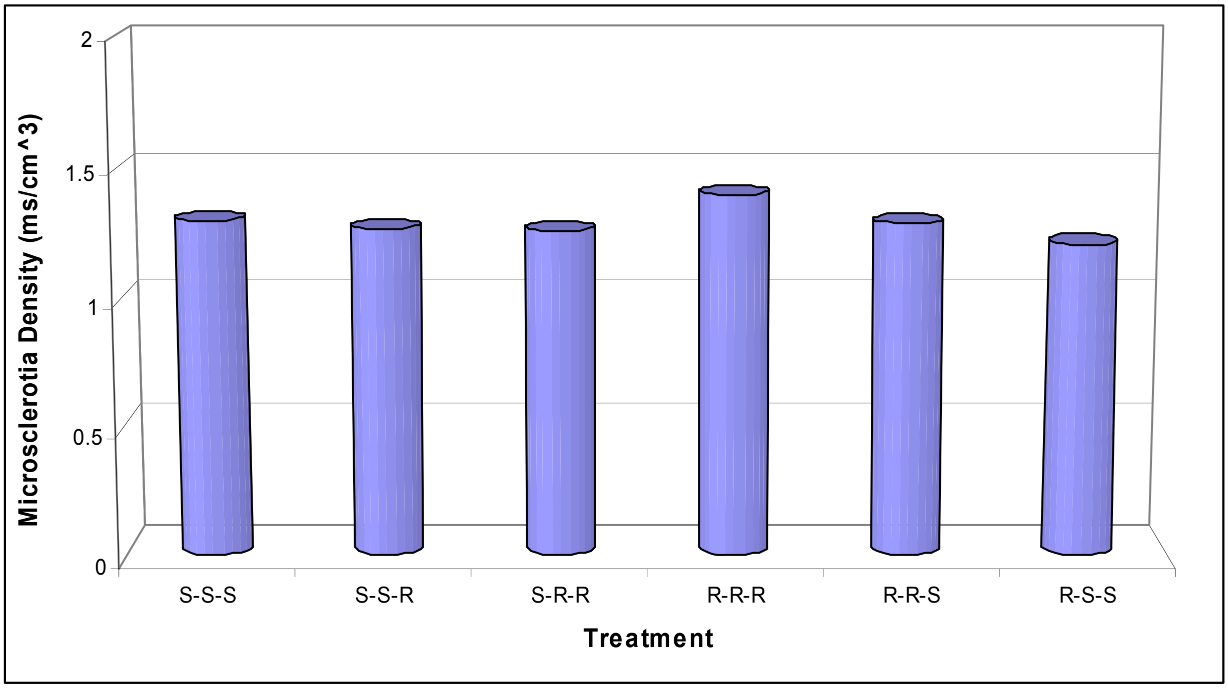

Figure 1: Baseline soil populations of *Verticillium dahliae* at the start of an experiment investigating the influence of variety selection on inoculum density. Mean density was 1.3 microsclerotia/cm^3 soil and standard deviation was 0.063.

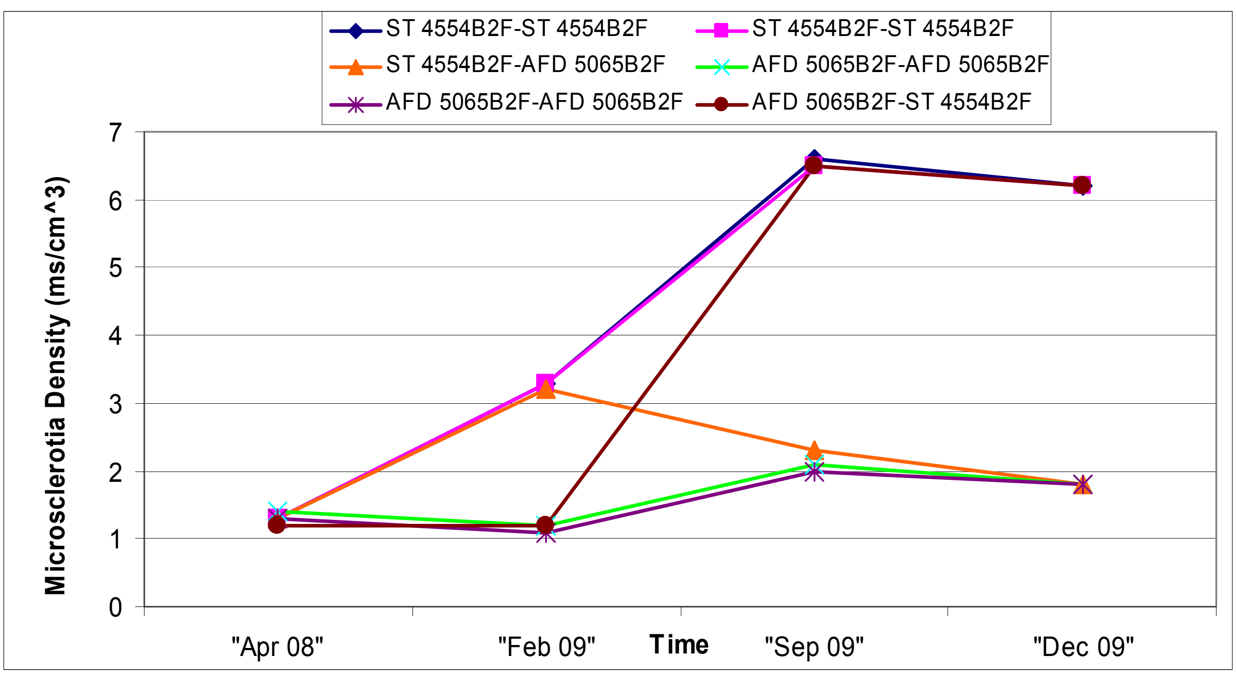

Figure 2: Influence of cultivar selection on microsclerotia density in soil over time. Stoneville (ST) 4554B2F was the susceptible cultivar and AFD 5065B2F was the partially resistant cultivar.

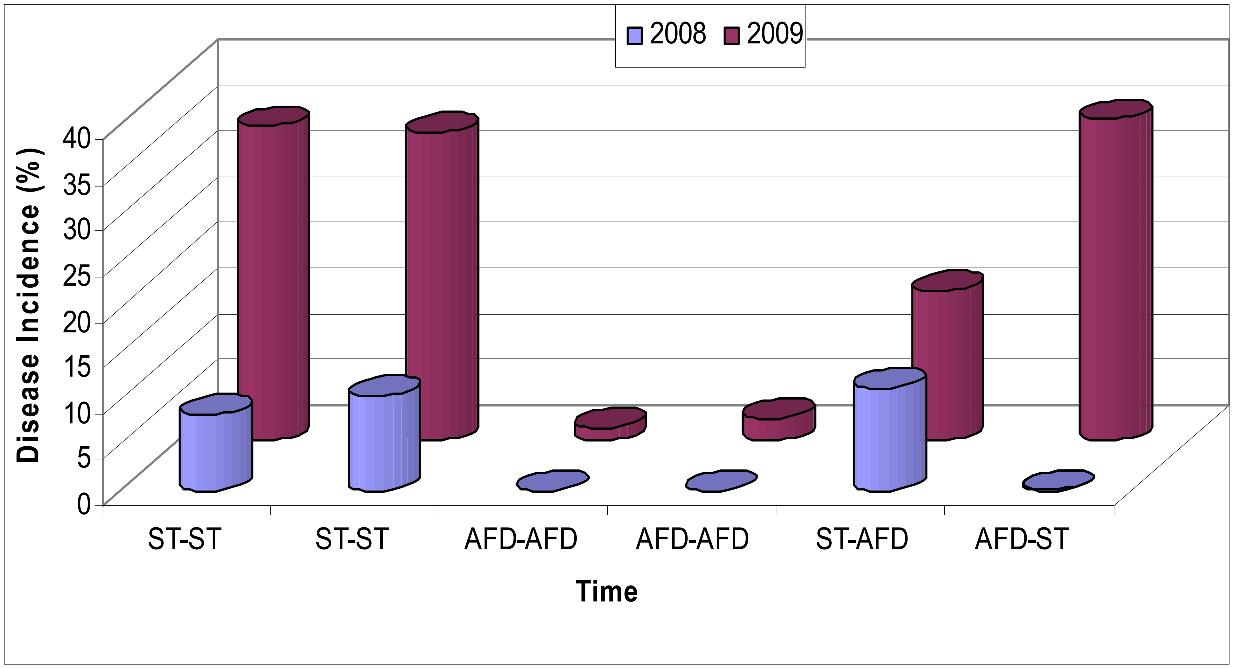

Figure 3: Influence of cultivar selection on Verticillium wilt incidence 2008-2009. Stoneville (ST) 4554B2F was the susceptible cultivar and AFD 5065B2F was the partially resistant cultivar.

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References

Bell, A.A. 2001. Verticillium Wilt. p. 28-31 *In* T.L. Kirkpatrick and C.S. Rothrock. eds. Compendium of Cotton Diseases 2nd Edition. APS Press.

Isaac I., P. Fletcher, and J. A. C. Harrison, 1971. Quantitative isolation of *Verticillium spp*. from soil and moribund potato haulm. Annals of Applied Biology 67:177-83.

Paplomatas, E.J., D. M. Bassett, J. C. Broome, and J. E. DeVay. 1992. Incidence of Verticillium wilt and yield losses of cotton cultivars (*Gossypium hirsutum*) based on soil inoculum density of *Verticillium dahliae.* Phytopathology 82:1417-1420.

Pullman, G.S., and J. E. DeVay. 1982. Epidemiology of Verticillium wilt of cotton: A relationship between inoculum density and disease progression. Phytopathology 72:549-554.

Smith, D. and J. Anisco, Cotton in Texas: Crop Brief on Production, Pests, & Pesticides. November, 2000. http://aggie horticulture.tamu.edu/extension/cropbriefs/cotton.html.

Sorensen, L. H., A. T. Scheider, and J. R. Davis. 1991. Influence of sodium polygalacturonate sources and improved recovery of *Verticillium* spp. from soil (Abstr.) Phytopathology 81:1347.