IMPACT OF COTTON CULTIVAR SELECTION ON *FUSARIUM OXYSPORUM* F. SP. *VASINFECTUM* DENSITY AND FUSARIUM WILT DEVELOPMENT

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Abstract

A microplot study was conducted over the 2008, 2009, and 2010 growing seasons to investigate the impact of planting combinations of susceptible and/or resistant/tolerant cotton cultivars, FiberMax 9058F (FM) and Stoneville 4554B2RF (ST), respectively on soil populations of *Fusarium oxysporum* f. sp. *vasinfectum* (*Fov*). The hypothesis was that cultivars can affect the population density of *Fov* over time in the soil. Damage caused by root-knot nematode, *Meloidogyne incognita* (*Mi*) facilitates entry of *Fov*. Microplots were augmented with field soil naturally infested with *Fov* and *Mi.* Baseline soil populations were enumerated for each microplot which was similar across all the treatments. It was observed that a susceptible cultivar FM planted in three sequential seasons increased *Fov* populations in soil by 97%; however, *Fov* populations in microplots planted to a resistant cultivar ST over three seasons decreased by 35%. Results from this study indicate that cultivar selection can impact Fusarium wilt management in cotton and should be considered when developing management strategies.

Introduction

Texas is the leading cotton production state, which contributes $5.2 billion to state's economy (Smith and Anisco, 2000). The Fusarium wilt – Root-knot nematode complex is caused by a soilborne fungus *Fusarium oxysporum* f. sp. *vasinfectum* (*Fov*), and a root-knot nematode *Meloidogyne incognita* (*Mi*). It is an economically important disease of cotton causing loss of $20 million each year across the cotton belt (Beltwide, 2008). *Fov* is capable of surviving extremely long periods of time in the soil as specialized resting structure, chlamydospores (Smith and Snyder, 1975). Losses caused by Fusarium wilt are greatest on sandy soils infested with *Mi.* Growth of fungal mycelia results in a systemic infection of the vascular system. Leaves of infected plants exhibit cholorosis and necrosis. Plants appear stunted and galling of roots is often noticeable. Complete mortality may occur. *Fov* inoculum density in soil and wilt incidence are correlated with each other (DeVay et al., 1997; Starr et al., 1989). Field observations indicate a reduction in disease incidence following years where resistant/tolerant cultivars were grown. The objective of this study was to determine the effect of cotton cultivar selection on release of *Fov* inoculum in soil over time and its impact on wilt development in cotton.

Materials and Methods

A microplot study was conducted over the 2008, 2009, and 2010 growing seasons at the Texas Tech University Quaker Research Farm, Lubbock, Texas. The microplots (90cm diameter × 60cm deep) were augmented with field soil naturally infested with *Fov* and *Mi.* There were six treatments consisting rotation schemes over three years utilizing all the possible combinations of a susceptible cultivar FiberMax 9058F (FM), and a resistant/tolerant cultivar Stoneville 4554B2RF (ST) (Table 1). Treatments were arranged in a randomized complete block design with nine replications.

Four soil cores per microplot were taken before planting and after harvest over a period of three years for quantification of *Fov*. Enumeration of inoculum was done using dilution plating technique (Nash and Snyder, 1962) utilizing Komada's selective medium (Komada, 1975). The cores were mixed together, air dried for 7 days, and ground with a rolling pin. A 20 cm^3 (cc) sub-sample 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 dish (10 replications) containing the selective medium. After 4 days of incubation at room temperature numbers of *Fusarium* spp. colonies were counted for each plate. Five colonies from each Petri dish were selected for enumeration of colony forming units (CFU's) per cc of soil using a hemocytometer. Disease incidence ((No. of wilted plants in a microplot/Stand count in that microplot) × 100) ratings were taken for three growing seasons. Plant height (cm) and lint yield/plot was also taken after applying last rotation scheme in 2010. Data were analyzed using Proc MIXED (SAS Version 9.2).

Results and Discussion

Baseline *Fov* inoculum density was found to be 4.6 $\pm 1.1 \times 10^5$conidia/cc of soil across all the treatments (Fig. 1). Planting a susceptible cultivar (FM) for three sequential years was found to increase *Fov* inoculum density in soil by 97%; whereas, planting a resistant cultivar (ST) over the same period was found to decrease *Fov* populations in soil by 35% (Fig. 2). *Fov* inoculum density in the microplots initially planted with a resistant cultivar (ST) followed by a susceptible cultivar (FM) planted for two years was not different from those planted to a susceptible cultivar for three years (Fig. 2). Disease incidence was lowest for the RRR rotation scheme (4.3%) compared the SSS rotation scheme (69.0%) (Fig. 3). Significant differences in the plant height and lint yield/plot were observed among treatments after applying last cultivar rotation scheme in 2010 and plants were significantly stunted (Fig. 4) and lint yield was also low (Fig. 5) in the treatments planted with a susceptible cultivar for two or more years. Thus, adoption of a resistant cultivar for at least two years was required to negatively impact *Fov* inoculum density in soil and also avoided stunted plants with low lint yield.

In Texas, a high degree of genetic diversity appears to be present in *Fov* populations (Woodward, unpublished data); however, the disease occurs in combination with *Mi*. Management options are limited due to longevity of chlamydospores in plant debris and soil. The scheduled loss of the nematicide aldicarb will also limit the management options. While reducing damage caused by *Mi* is the primary method for managing Fusarium wilt, resistant cultivars have been identified. Disease severity is dependent upon inoculum density of *Fov* in soil. The present study suggests that the adoption of resistant cultivars can negatively impact inoculum density of *Fov* over time, thus reducing Fusarium wilt incidence. This strategy can be implemented into integrated programs for sustaining the production of cotton in fields infested with *Fov* and *Mi* and may be useful in developing long term management strategies.

Table 1: Cotton cultivar rotation schemes for three years (Treatments), utilizing possible combinations of a partially resistant (Stoneville 4554B2F) and/or a susceptible cultivar (FiberMax 9058F)

Treatment	Planting season 1 (2008)	Planting season 2 (2009)	Planting season 3 (2010)
SSS	FiberMax 9058F	FiberMax 9058F	FiberMax 9058F
SSR	FiberMax 9058F	FiberMax 9058F	Stoneville 4554B2RF
SRR	FiberMax 9058F	Stoneville 4554B2RF	Stoneville 4554B2RF
RRR	Stoneville 4554B2RF	Stoneville 4554B2RF	Stoneville 4554B2RF
RRS	Stoneville 4554B2RF	Stoneville 4554B2RF	FiberMax 9058F
RSS	Stoneville 4554B2RF	FiberMax 9058F	FiberMax 9058F

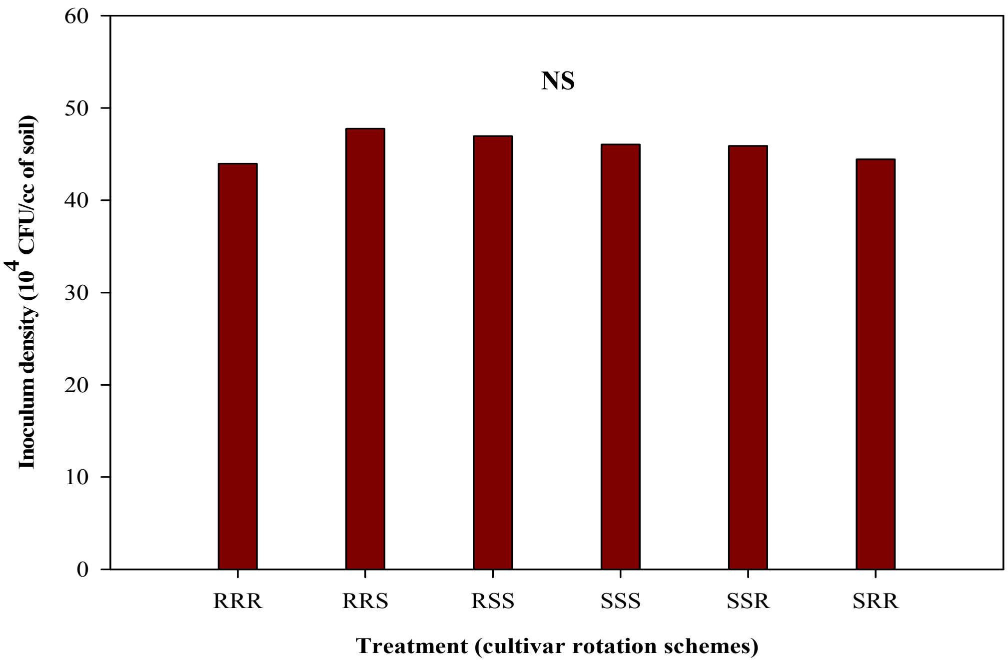

Figure 1: Baseline soil populations of *Fusarium oxysporum* f. sp. *vasinfectum* at the start of an experiment investigating the effect of cultivar selection on inoculums density. CFU = colony forming units. NS = no statistical differences in treatment means according to Fisher Protected LSD (P=0.05). Mean across treatments= 45.8, Standard deviation= ±1.1.

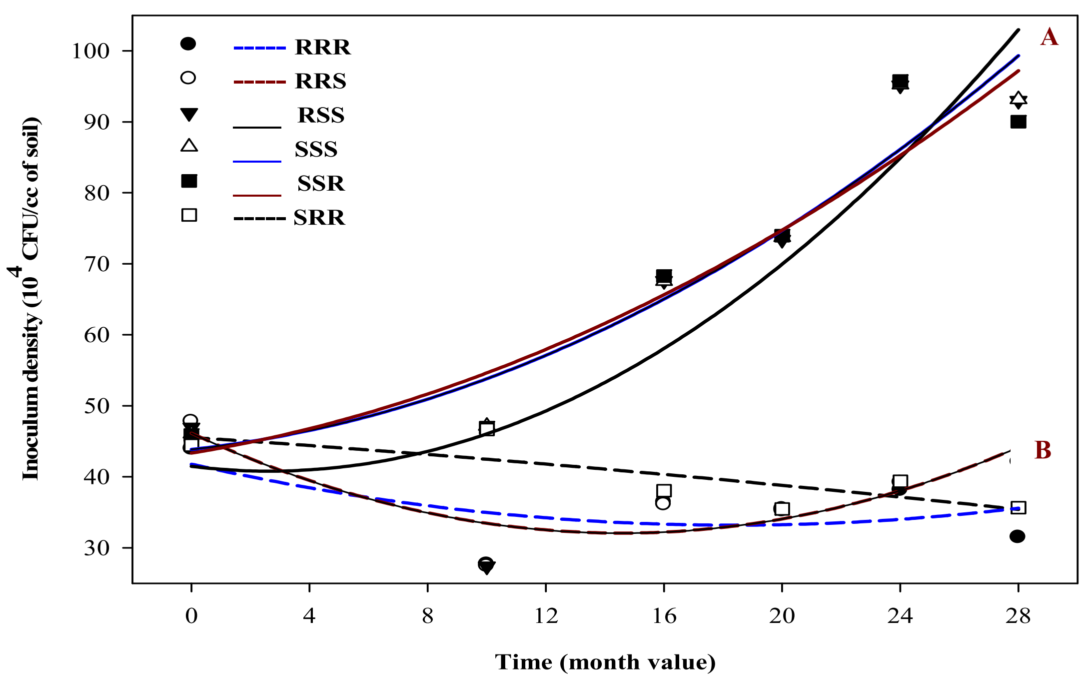

Figure 2: Effect of cultivar rotation on *Fusarium oxysporum* f. sp. *vasinfectum* inoculum dynamics in soil over time. CFU = colony forming units.

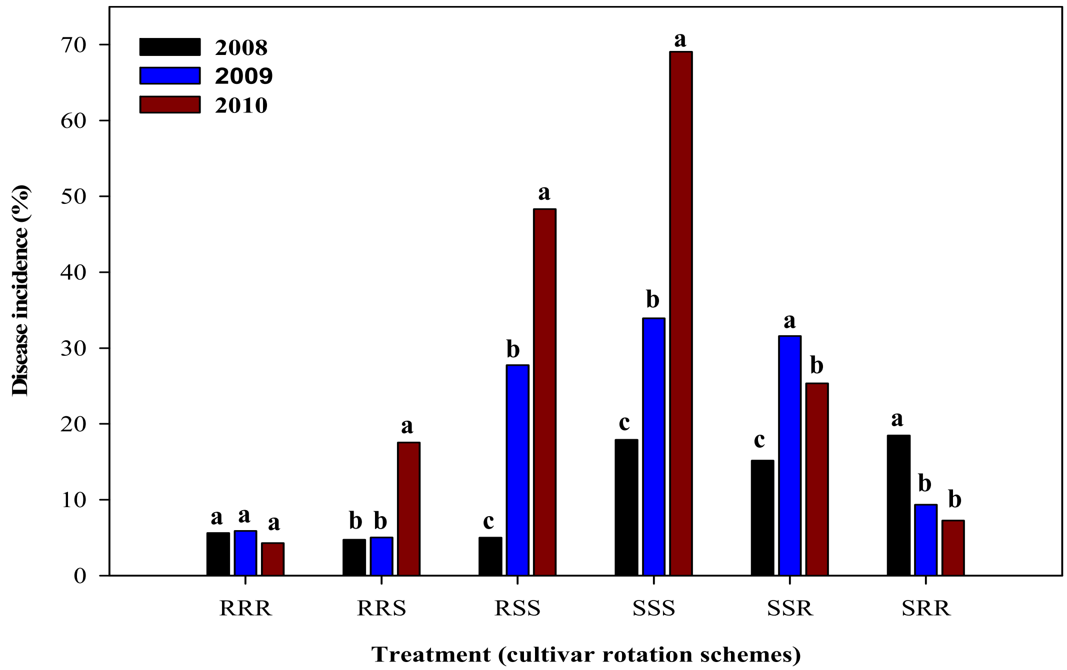

Figure 3: Effect of treatments (cultivar rotation) on Fusarium wilt incidence in cotton over a period of three year. Means with the same letter are not significantly different among years (P = 0.05).

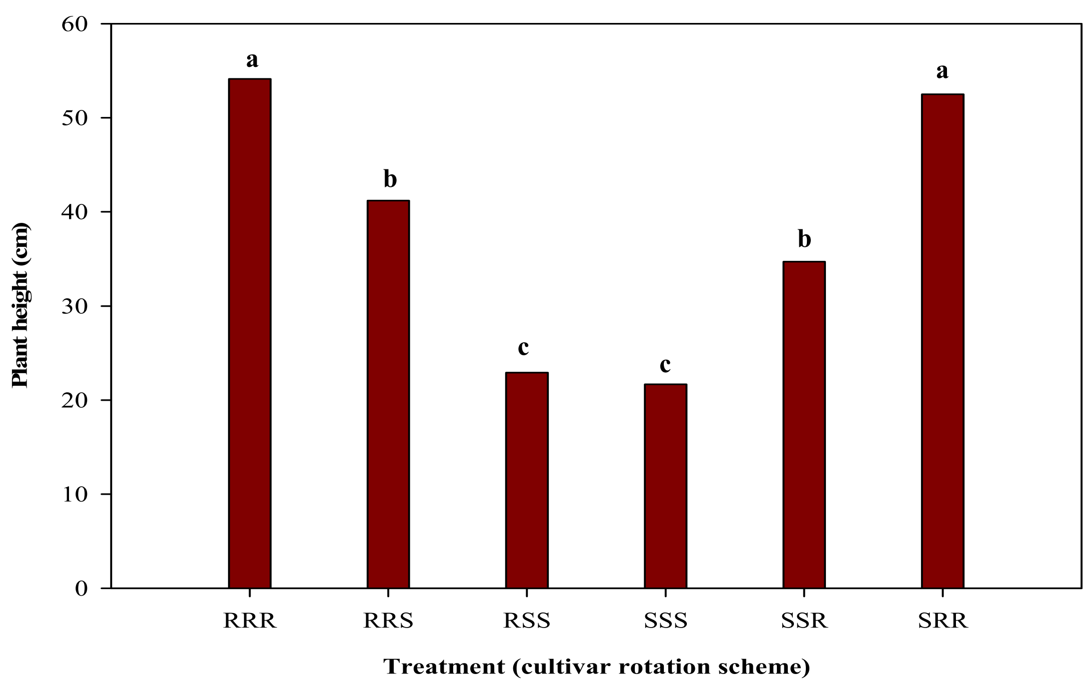

Figure 4: Effect of treatments (cultivar rotation) on plant height after applying last rotation of the scheme in 2010. Means with the same letter are not significantly different (P = 0.05).

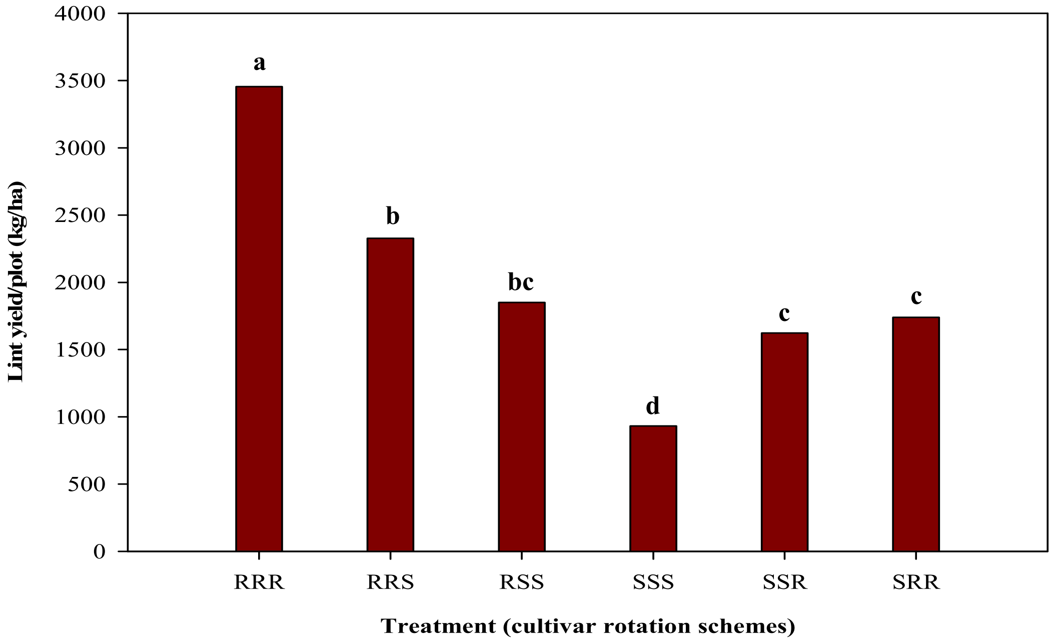

Figure 5: Effect of treatments (cultivar rotation) on lint yield after applying last rotation of the scheme in 2010. Means with the same letter are not significantly different (P = 0.05).

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