OVERVIEW OF SPIDER MITE RESEARCH IN THE MID-SOUTH

J. Gore
D. R. Cook
A. Catchot
F. R. Musser
Mississippi State University
Starkville, MS
S. D. Stewart
The University of Tennessee
Knoxville, TN
B. R. Leonard
LSU AgCenter
Winnsboro, LA
G. Lorenz
G. Studebaker
D. S. Akin
University of Arkansas
Little Rock, AR
R. E. Jackson
USDA-ARS
Stoneville, MS

Abstract

Multiple experiments were conducted across the Mid-South to investigate the impact of two-spotted spider mite, *Tetranychus urticae* (Koch), infestation timing on cotton yields. Mites were infested at the third true leaf stage, first flower, and at 200 heat unit increments after first flower. Two-spotted spider mites significantly reduced yields of cotton when infestations were initiated at the three leaf stage to first flower plus 400 heat units. Additional experiments were conducted to determine the response of eight different varieties to spider mite injury. No consistent differences in mite injury ratings were observed among the varieties tested. Additionally, no significant differences were observed in yield losses caused by spider mites among the eight varieties. These data will be used to refine current IPM strategies for spider mites in Mid-South cotton.

Introduction

The pest status of two-spotted spider mite, *Tetranychus urticae* (Koch), has changed over the last 7 years across the Mid-South. Historically, spider mites were considered a late season pest, and pesticide applications were rarely needed during the pre-flowering and early flowering stages of cotton development. Since 2005, the percentage of acres in Mississippi that are sprayed for spider mites has more than doubled in recent years (Williams 2010). The majority of that increase can be attributed to applications made during the pre-flowering and early-flowering stages that were not made immediately prior to 2005. Several factors may have contributed to the increase in the importance of spider mite as a season long pest. Insecticide, fungicide, and nematicide seed treatments replaced the use of Temik in most fields across the Mid-South. The neonicotinoids used as the insecticidal component (imidacloprid [Gaucho Grande] and thiamethoxam [Cruiser 5FS]) of these seed treatments has been shown to result in higher mite densities compared to aldicarb (Temik 15G) (Troxclair 2007). Similar results have been observed with neonicotinoids in other crops (Sclar et al. 1998, Beers et al. 2005). Additionally, the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), has become a serious pest of cotton in the Mid-South (Musser et al. 2007). Multiple applications of broad spectrum insecticides are needed every year to minimize yield losses from this insect. Because of widespread resistance, high rates of organophosphates or neonicotinoids applied in a tank mix with pyrethroids are the most common treatments for tarnished plant bug. These applications are very toxic to beneficial arthropods and create an ideal environment for rapid population increases in pests such as spider mites.

Currently, little information exists about the impact of two spotted spider mites on yields of cotton in the Mid-South. In the Mid-South, yield losses ranged from 30 to 35 percent during the early fruiting period (Furr and Pfrimmer 1968). In more arid environments such as California and Australia, greater than 90 percent yield losses have been observed from spider mites (Wilson 1993, Sadras and Wilson 1997). Given the lack of information about yield losses from spider mites in cotton in the Mid-South, thresholds in most states are vague and not very reliable. For instance, the thresholds in Mississippi, Arkansas, and Tennessee state that acaricides should be applied when 30 to 50 percent of plants are infested and populations are increasing. Additional research is needed to improve the thresholds for spider mites across the Mid-South. The objectives of the current experiment were to determine the impact of two-spotted spider mite on cotton yields at different times during the season and on cotton varieties with different leaf characteristics.

Methods

Impact of Two-Spotted Spider Mite on Cotton Yields

In this experiment cotton was infested with high densities of mites at 3 true leaves, first flower, and at 200 heat unit intervals from flowering to cutout, resulting in a total of 6-7 infestation-timing treatments plus a non-infested control. Plot size was be 4 rows (38-in centers) by 20ft long. The experiment was arranged as a randomized complete block with 4-5 replications. Plots were separated by 2 unplanted rows and 10 ft alleys consisting of unplanted bare ground to reduce migration of mites between plots. Heavily infested cotton or green bean leaves were used to infest cotton with mites. Once infested, every effort was made to maintain damaging densities of mites on the cotton until defoliation. If densities began to decline, plants were re-infested and/or treated with acephate to reduce predatory insects. A Bollgard II or Widestrike variety was planted at each location to minimize the impact of lepidopteran pests on yields. Additionally, prophylactic applications were made with pyrethroid and organophosphate tank mixtures to manage plant bugs and assist with establishment of mite populations. When the non-infested plots reached first flower, mites were removed from the third true leaf treatment by applying a high rate of etoxazole, spiromesifen, or abamectin.

Visual damage ratings were taken to capture and describe the physical damage caused by two-spotted spider mites within the growing season. Plots were rated at bloom, each subsequent infestation date, and after the final infestation but before defoliation. The first visual rating was a symptomology or leaf reddening index: on a 0-5 scale where 0 = no damage and 5 = nearly complete reddening and/or defoliation on nearly all leaves. Rankings were assigned as follows: 1) light stippling occurring on sporadic leaves, 2) stippling and reddening present on 15-20% of leaves, 3) 50% of leaves have very apparent reddening on basal portions of leaf, 4) > 50% of leaves contain extensive reddening of entire leaves and area where leaves begin to excise. The second rating was a stunting index on 0-100% scale that estimates stunting in infested plots compared to non-infested plots. The third rating was a defoliation rating (0-100%).

Injury Response of Cotton Varieties to Spider Mite Infestations

Experiments were conducted across the mid-South to measure the response of multiple cotton varieties to injury from spider mites. The treatments were arranged in a split-block design with 4 replications. The main-plot factor had two levels and included infested with spider mites or non-infested. The sub-plot factor was cotton variety. A total of eight commercially available cotton varieties were planted at each location. The varieties were chosen based on phenotypic differences in leaf characteristics ranging from smooth to hairy. The varieties included Phytogen 375 WRF (semi-smooth), Phytogen 499 WRF (semi-smooth), Stoneville 5288 B2F (very hairy), Stoneville 5458 B2F (Hairy), Deltapine 1133 B2F (smooth), Deltapine 0912 B2F (semi-smooth), Deltapine 0949 B2F (light-hairy), and Deltapine 1034 B2F (smooth). Plot size was 2 rows by 20 ft. In the infested blocks, mites were infested on all varieties between the third true leaf and six true leaf stages. The infestation procedures followed those described in the previous experiment. The non-infested blocks were sprayed with miticides as needed to minimize migration of mite into those plots. Ratings of spider mite densities and injury were measured weekly beginning one week after infestation and continued for 6 weeks after infestation. The ratings included the number of mites from 10 leaves (10 sq in.). Additionally, leaf reddening ratings were taken on a scale of 0-5 as described above. At the last rating (6 weeks after infestation) plant heights were recorded from 10 plants in each plot. Percent defoliation was estimated on the last sampling date. At the end of the season, plots were harvested and seedcotton weights were determined. A sample of seedcotton from each plot will be ginned to determine percent lint of each variety.

Results

Impact of Two-Spotted Spider Mites on Cotton Yields

A total of 16 experiments were conducted across the Mid-South from 2009 to 2011. Of those experiments, only seven experiments were able to successfully establish and maintain spider mite infestations at a level to sufficiently analyze their impact on cotton yields. Therefore, two separate analyses were conducted on these data. The first analysis included all 16 experiments (Fig. 1). When analyzed across all experiments, two-spotted spider mites significantly reduced cotton yields when infested at the third true leaf and first flower stages. Yields averaged 864.3 and 972.5 lbs lint per acre at the third true leaf and first flower infestation, respectively, compared to 1096.3 lbs lint per acre in the non-infested (Fig. 1). The second analysis only included those experiments where mite infestations were successfully established and maintained throughout the season. In those experiments, mites significantly impacted cotton growth and development (Figs. 2 and 3). Because injury ratings and stunting were recorded at different times in each experiment, those factors were analyzed separately for each experiment. In Tennessee (Fig. 2, blue bars) and Louisiana (Fig. 3, blue bars), significant stunting was observed for the third true leaf and first flower infestations. In Louisiana, significant stunting was also observed for the first flower plus 200 heat unit infestation timing. In Tennessee, significant leaf reddening was observed for the third true leaf and first flower infestations (Fig. 2, red line). In Louisiana, significant leaf reddening was observed for all infestation timings up to first flower plus 600 heat units (Fig. 3, red line).

When averaged across the 7 experiments where good infestations were established, there was a significant effect of two-spotted spider mites on cotton yields (Fig. 4). Two spotted spider mites significantly reduced yields below that observed in the non-infested plots when infestations were established up to first flower plus 400 heat units. Yields averaged 654.3, 829.6, 887.8, and 929.6 lbs lint per acre in the third true leaf, first flower, first flower plus 200, and first flower plus 400 heat unit infestations, respectively, compared to 1038.1 lbs lint per acre in the non-infested plots.

Injury Response of Cotton Varieties to Spider Mite Infestations

At select locations, significant differences were observed in spider mite injury ratings. At the Tennessee location, significant differences were observed in injury ratings among the 8 cotton varieties (Fig. 5). In general, Phytogen 499 WRF and Stoneville 5458 B2F were consistently among the varieties with the highest injury ratings. In contrast, Deltapine 1034 B2F was consistently among the varieties with the lowest injury rating. Overall, injury ratings remained low to moderate throughout the duration of the experiment. At the Stoneville, MS location, injury ratings were fairly low (around 1) during the first rating period (Fig. 6). Spider mite population densities increased rapidly and all of the varieties averaged at or near 5 by the third rating period (July 7). At the second rating period (June 30), significant differences were observed in ratings among the varieties. Phytogen 375 WRF, Phytogen 499 WRF, Deltapine 1133 B2F, Deltapine 0912 B2F, and Deltapine 1034 B2F had the highest injury ratings. Similar results were observed at other locations, but no consistent differences among locations were found. When averaged across all locations and ratings, no differences in mite injury ratings were observed among the 8 varieties (Fig. 7). Similarly, when the data were combined across varieties with similar leaf morphologies (smooth, semi-smooth, or hairy), no significant differences were observed (Fig. 8).

Significant differences in yield were observed between the infested and non-infested treatments for four of the varieties (Fig. 9). They included Phytogen 375 WRF, Deltapine 0912 B2F, Deltapine 1133 B2F, and Stoneville 5288 B2F. There was a considerable amount of variability in yields among the experiments in 2011. As a result, no significant differences in percent yield loss between the infested and non-infested treatments were observed among the eight varieties (Fig. 10).

Summary

In these experiments, mites significantly impacted yields of cotton a various infestation timings. Based on the results of experiments where mites infestations were successfully established, significant yield losses were observed for infestations that were initiated from the third true leaf stage to 400 heat units beyond first flower. Similar results have been observed in previous research in the Mid-South (Furr and Pfrimmer 1968). Although significant differences in mite injury ratings were observed among the different varieties, no consistent trends were found among the different experiments. Additionally, percent yield losses were not significantly different among the varieties tested. Therefore, variety and varietal leaf characteristics do not appear to be important factors that influence the expression of spider mite injury in cotton. Results of these experiments will be used to refine IPM strategies for spider mites in cotton in the Mid-South.

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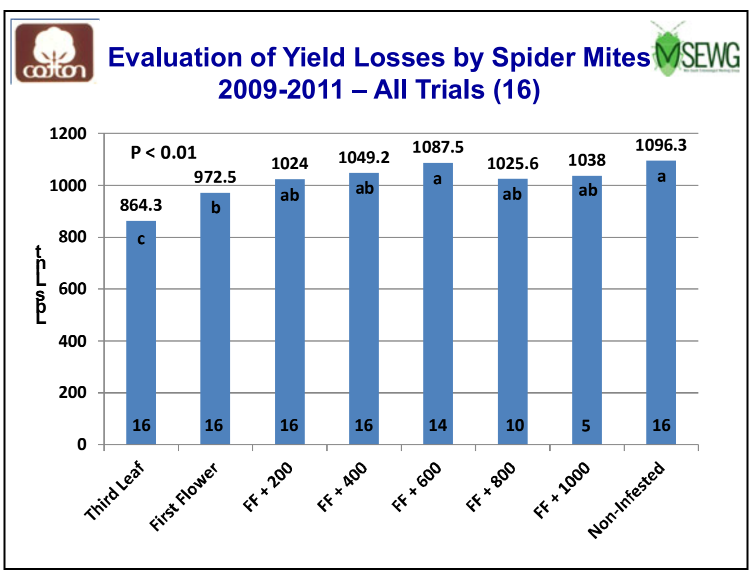

Figure 1. Mean impact of spider mite infestation timing on cotton yields across all experiments.

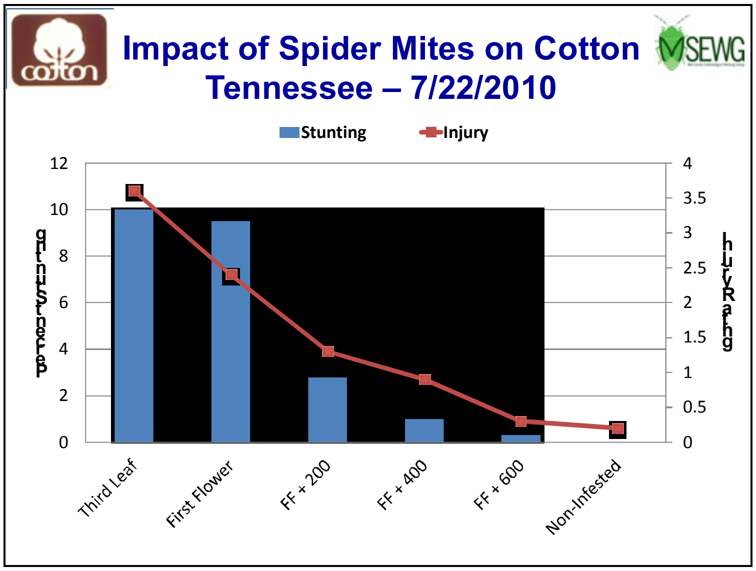

Figure 2. Mean percent stunting and injury rating from spider mite infestations in Tennessee.

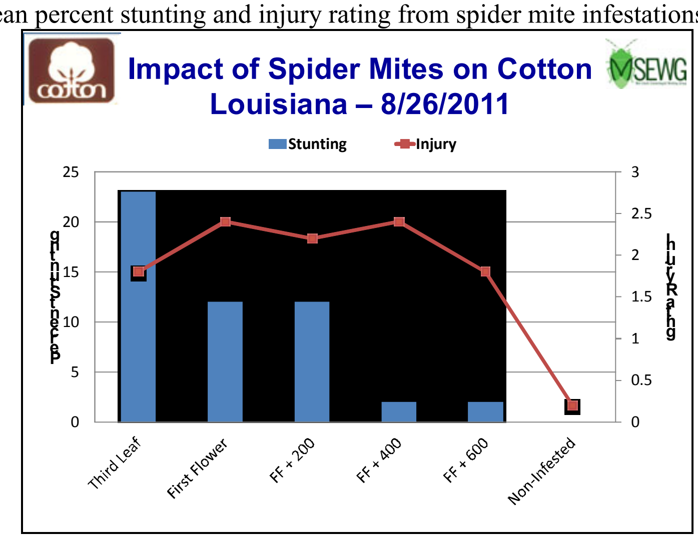

Figure 3. Mean percent stunting and injury rating from spider mite infestations in Louisiana.

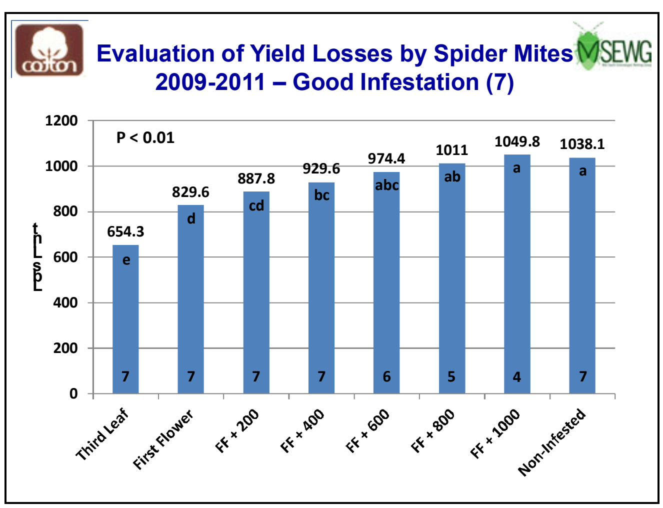

Figure 4. Mean impact of spider mite infestation timing on cotton yields across seven experiments.

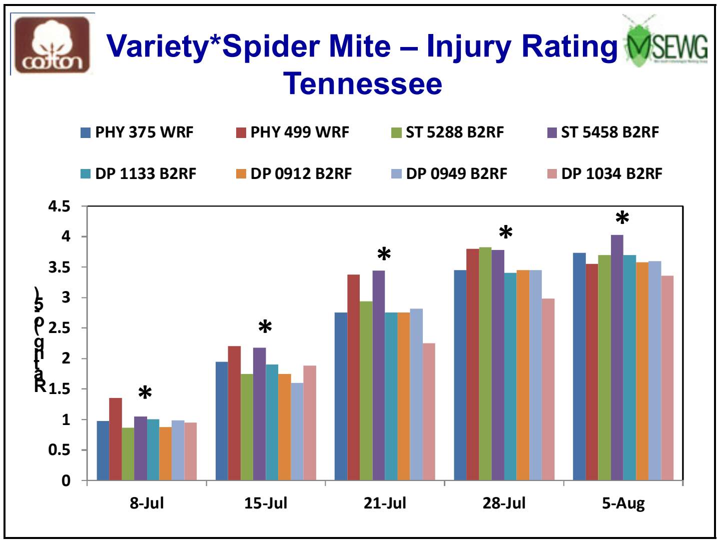

Figure 5. Mean injury rating among eight cotton varieties in Tennessee.

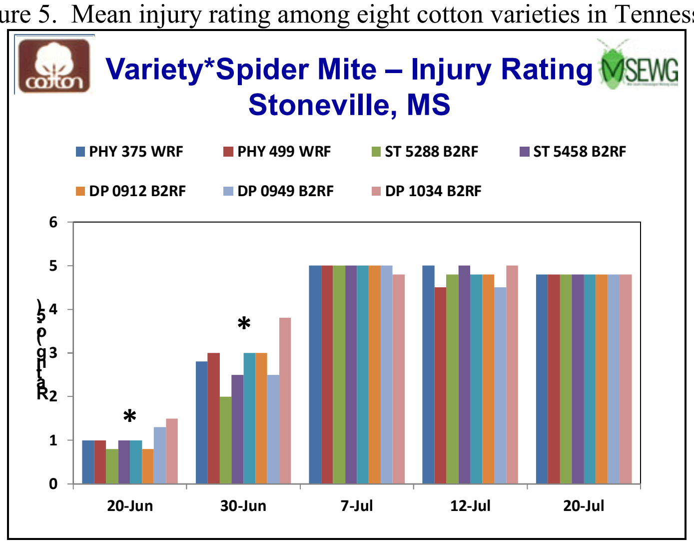

Figure 6. Mean injury rating among eight cotton varieties in Stoneville, MS.

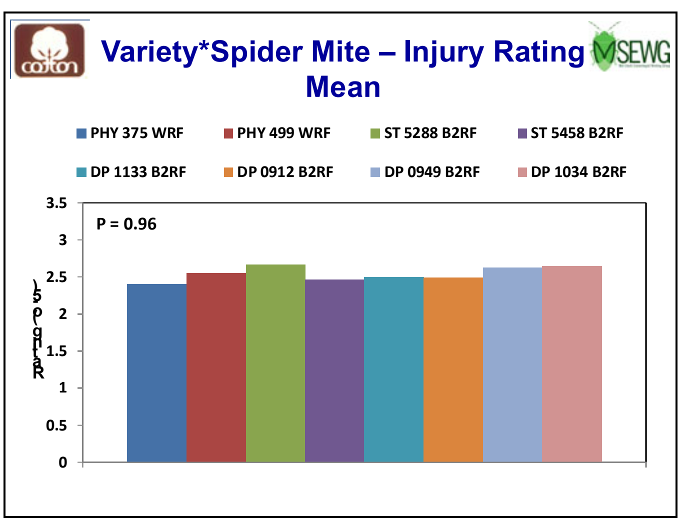

Figure 7. Mean injury rating among eight cotton varieties across all experiments.

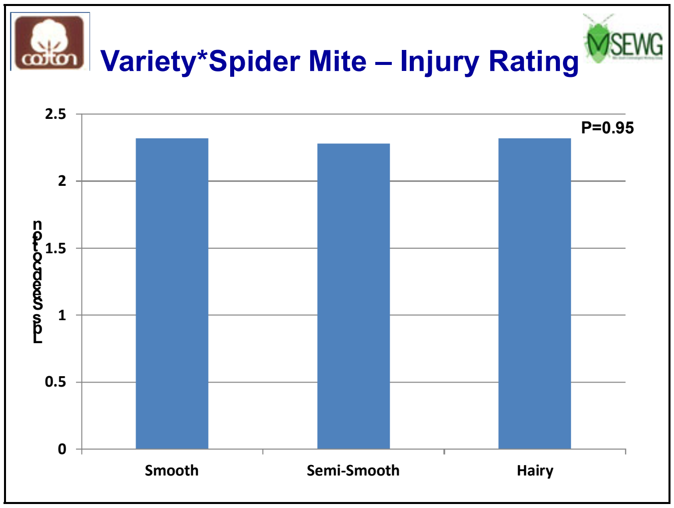

Figure 8. Mean impact of leaf morphology on spider mite injury in cotton.

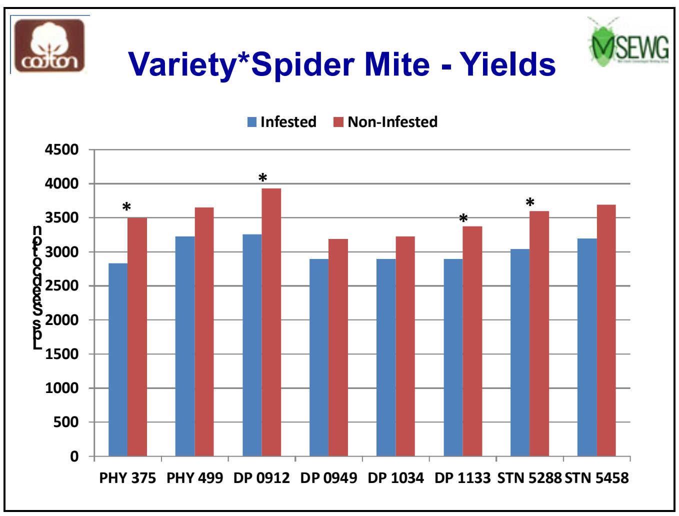

Figure 9. Impact of spider mites on yields of eight cotton varieties.

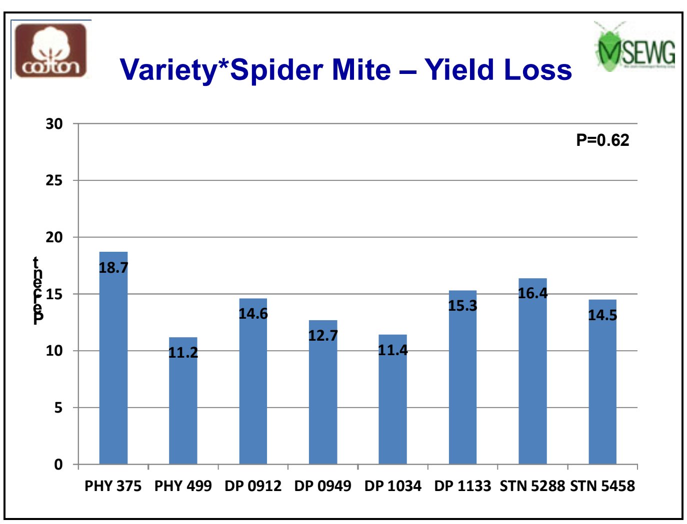

Figure 10. Percent yield loss from spider mites on eight commercial cotton varieties.