AN ESTIMATE OF YIELD LOSS TO TARGET SPOT (CORYNESPORA LEAF SPOT) ON COTTON

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Abstract

Potential impact of target spot (Corynespora leaf spot) on cotton yield was evaluated at the Gulf Coast Research and Extension Center (GCREC) in Fairhope, AL on a site cropped the previous two years to cotton. The experimental design was a split plot design with cotton variety as the main plot and Headline 2.09SC application number as the split plot treatment. Phytogen 499 and Deltapine 1050 cotton varieties were planted at both study sites. Headline 2.09SC at 9 fl oz/A treatments started at first bloom and were repeated at 14-day intervals as specified for a total of one, two, three, four, and five applications at the former site and from one to six applications at the latter site. A non-fungicide treated control was included. Disease intensity was rated beginning 3 weeks after first bloom at one to two week intervals through mid-September using 1 to 10 rating scale. The cotton was not irrigated. Target spot intensity was higher on Phytogen 499 than Deltapine 1050. Disease intensity on Phytogen 499 and Deltapine 1050 gradually declined, particularly on the former variety, as Headline application number increased. No further decline in defoliation occurred with more than three and four Headline applications on Deltapine 1050 and Phytogen 499, respectively. For seed yield, the variety x application number interaction was significant. Regression analysis showed a significant yield gain with each additional Headline application on Phytogen 499 and to a lesser extent on Deltapine 1050. Yield declined significantly with increasing target spot intensity on Phytogen 499 but not Deltapine 1050.

Introduction

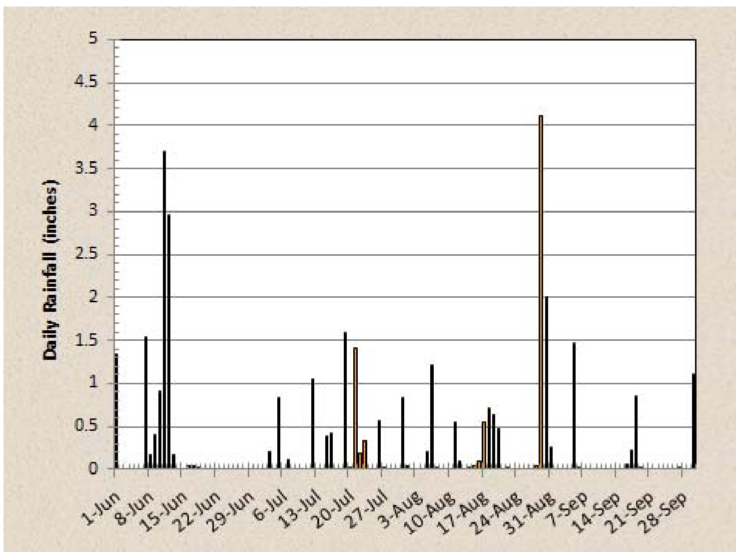
Target spot or Corynespora spot, which is caused by the fungus *Corynespora cassiicola*, was first noted in irrigated cotton in southwest Georgia in 2003 and is now endemic in Georgia cotton (Kemeriat *et al.* 2011). Disease outbreaks of varying intensity have been observed in dryland and irrigated cotton for the past two years in Alabama (Campbell *et al.* 2012) as well as in 2012 in Florida (Donahue, 2012), North Carolina (Edmisten, 2012), South Carolina (Hagan, personal communication), and Virginia (Phipps, personal communication). In Alabama, highest disease intensity has been in cotton receiving plenty of summer rain or irrigated cotton (Campbell *et al.* 2012). Fungicides have been widely used, particularly in the southern portions of Alabama and Georgia, to protect cotton from target spot. While disease related premature defoliation has been reduced, yield gains resulting from improved target spot control with fungicide inputs have been harder to define (Kemeriat *et al.* 2011). Yield loss in heavily defoliated cotton in Georgia have been estimated at 200+ lb/A of lint cotton (Fulmer et al., 2012) but the relationship between target spot and cotton yield had not been described. Since the susceptibility of cotton varieties to disease-related defoliation greatly differs (Kemeriat *et al.* 2011, Hagan *et al.* 2012), yield gains from fungicide inputs on susceptible and partially resistant varieties is likely to vary as well.

The objective of this study was to monitor disease development over time as influenced by cotton variety and fungicide inputs to determine the relationship between target spot intensity and cotton yield response along as well as fungicide inputs.

Materials and Methods

A cover crop of wheat, which was drilled at a rate of 2.5 bu/A on December 14, 2011, was killed with 22 fl oz/A of Roundup WeatherMax on February 27, 2012. On March 19, 200 lb/A of 10-21-21 fertilizer with 10 lb/A sulfur and 3 lb/A zinc was broadcast. A layby application of 23 gal/a 28-0-0-5S (70-0-0) liquid fertilizer was made on June 19. On May 9, Phytogen 499 and Deltapine 1050 cotton varieties were hill dropped behind a KMC strip till unit at a rate of 3 seed/1.1 row ft in a Malbis fine sandy loam (organic matter <1%) at the Gulf Coast Research and Extension Center in Fairhope, AL. Seed in the hopper were treated with Prevail seed dressing for seed rot and seedling disease control. Weed control was obtained with a pre-emergence incorporated application of a tank mixture of 22 fl oz/A Roundup WeatherMax + 2 pt/A Prowl H_2O + 2 pt/A Cotoran followed by a June 13 broadcast application of 32 fl oz/A Roundup WeatherMax + 1 pt/A Dual Magnum, and a post-directed application of 1 qt/A Diuron + 2.5 pt/A MSMA + 1 pt/50 gal Induce on 2 Jul. An application of the plant growth regulator Mepichlor at 6 fl oz/A + Induce at 1 pt/50 gal on July 5 was followed by two additional application of 8 fl oz/A Mepichlor + 1 pt/50 gal Induce + 4 fl oz/A Bidrin + 1 gal/A of 5-0-20 liquid fertilizer on July 17 and July 30. Cotton was prepared for harvest with an application of Diuron at 1 oz/A + Dropp 50W at 2 oz/A + Ethephon at 21 fl oz /A on September 22 and September 27. Plots were not irrigated but monthly rainfall totals exceeded the 30 yr average in June, July, and August but below average for September (Fig. 1). The experimental design was a split plot with cotton variety as the whole plot and Headline 2.09SC application number as the split plot treatment. Individual split plots consisted of four 30-ft rows spaced 3.2 ft apart. Four replications of treatments were included. Headline 2.09SC at 6 fl oz/A applications were made with a Spider sprayer with 11002 tips mounted on a four row boom in 15 gal/A of spray volume at 45 psi on July 5 (first bloom), July 23, August 7, August 22, and September 4 (2, 4, 6, and 8 wk, respectively, after first bloom) on schedules specified below. Headline 2.09SC programs included application(s) at 1) first bloom; 2) first bloom and 2 wk later; 3) first bloom, 2 wk and 4 wk later; 4) first bloom, 2 wk, 4 wk, and 6 wk later; and 5) first bloom, 2 wk, 4 wk, 6 wk, and 8 wk later. A non-fungicide treated control was included. Cotton was mechanically harvested on October 11.

Figure 1. Daily rainfall from June 1 through September 30, 2012 at the Gulf Coast Research and Extension Center, Fairhope, AL.



Target spot intensity was assessed on July 31, August 13, August 27, September 6, and September 13 using a leaf spot scoring system where 1 = no disease, 2 = very few lesions in canopy, 3 = few lesions noticed in lower and upper canopy, 4 = some lesions seen and < 10% defoliation, 5 = lesions noticeable and < 25% defoliation, 6 = lesions numerous and < 50% defoliation, 7 = lesions very numerous and < 75% defoliation, 8 = numerous lesions on few remaining leaves and <90% defoliation, 9 = very few remaining leaves covered with lesions and < 95% defoliation, and 10 = plants defoliated (Chiteka, 1988). Area under disease progress curves (AUDPC) values for target spot were calculated from the disease intensity value data (Shaner and Finney, 1977). Significance of interactions was determined using the PROC GLIMMIX procedure in SAS. Statistical analyses on disease ratings were done on rank transformations of data. For presentation, data are back transformed. Means were separated using Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Results

While the cotton variety x fungicide interaction for target spot intensity was not significant (Table 1), data presented for each variable are presented by cultivar due to the significant differences in the reaction of Phytogen 499 and Deltapine 1050 to this disease (Table 1).

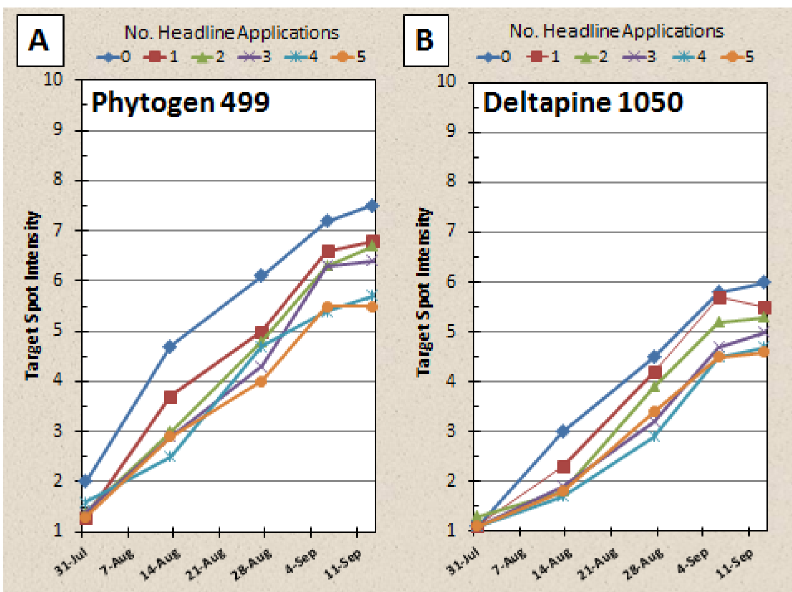
Table 1. Analysis of variance (ANOVA) table for effects of cotton variety and Headline 2.09SC application number on target spot intensity, AUDPC values, and seed cotton yield in 2012.

Split plot analysis (F)	Target spot intensity[z]	Target spot AUDPC	Seed cotton lb/A[y]
Cotton variety ……………………………………………………..	123.08***[x]	95.63***	0.25
No. Headline applications…………………………………………….	23.54***	19.59***	7.94***
Cotton variety x No. applications ……..	1.09	1.73	2.77*
Cotton varieties			
Phytogen 499 ………………………..	6.3 a[w]	143.6 a	3527 a
Deltapine 1050 ………………………………………………………	5.1 b	113.9 b	3476 a

[z]Target spot intensity was rated using a 1 to 10 leaf spot scoring system on September 13.
[y]Seed cotton yield = total weight of seed + lint.
[x]Significance of *F* values at the 0.05, 0.01, and 0.001 levels is indicated by *, **, or ***, respectively.
[w]Means in each column followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

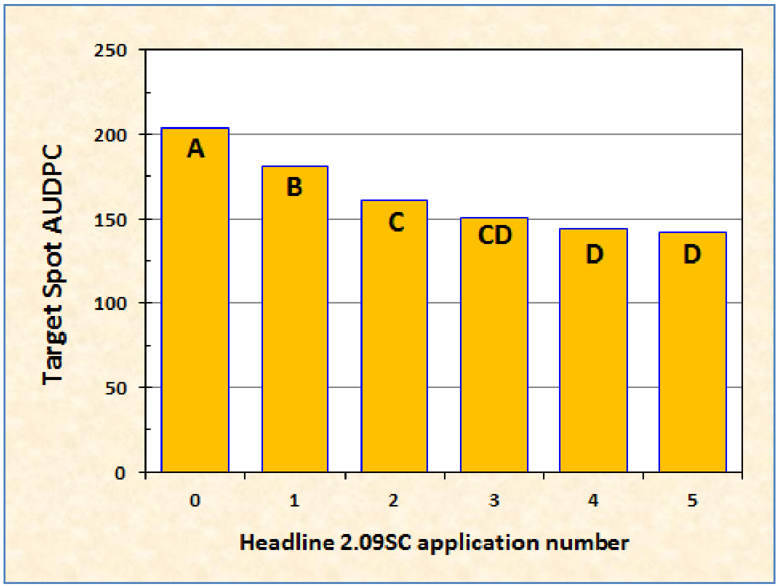
In 2012, leaf spotting was first noted on Phytogen 499 (Fig. 2A) and to a lesser extent on Deltapine 1050 (Fig. 2B) on July 31. Target spot intensified over the next six weeks with Phytogen 499 having higher disease intensity ratings regardless of the number of Headline 2.09SC applications compared to Deltapine 1050. On both varieties, the lowest target spot intensity values on the final rating date were noted for the 3 to 5 Headline 2.09SC application programs, while the non-treated controls had the highest ratings. Disease intensification was impacted by Headline 2.09SC application number but the multiple applications were surprisingly ineffective against target spot.

Figure 2. Intensification of target spot on A) Phytogen 499 and B) Deltapine 1050 as impacted by Headline 2.09SC application number.



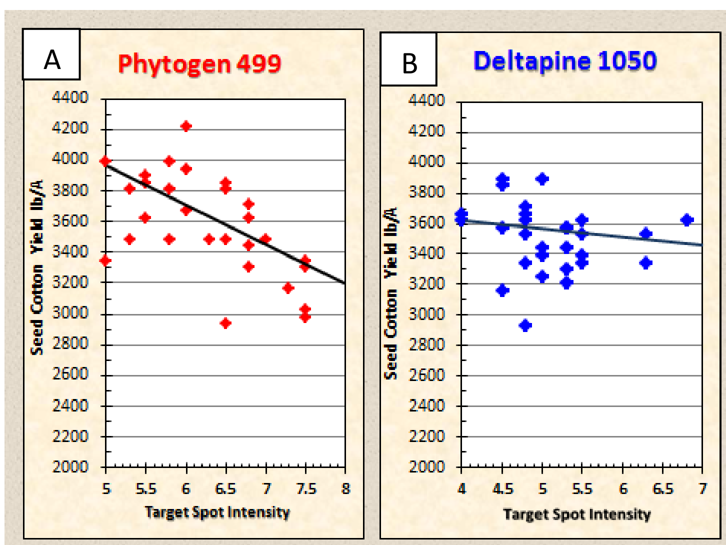
Since the cotton variety x fungicide interaction for target spot AUDPC values was not significant, data presented were pooled across cotton variety (Table 1). Mean target spot AUDPC values were higher for Phytogen 499 than Deltapine 1050 (Table 1). Target spot AUDPC values declined with increasing Headline 2.09SC application numbers with the highest disease rating recorded for the non-fungicide treated control (Fig. 3). The three, four, and five Headline application programs had similarly low target spot AUDPC values.

Figure 3. Impact of Headline application number on target spot AUDPC values.



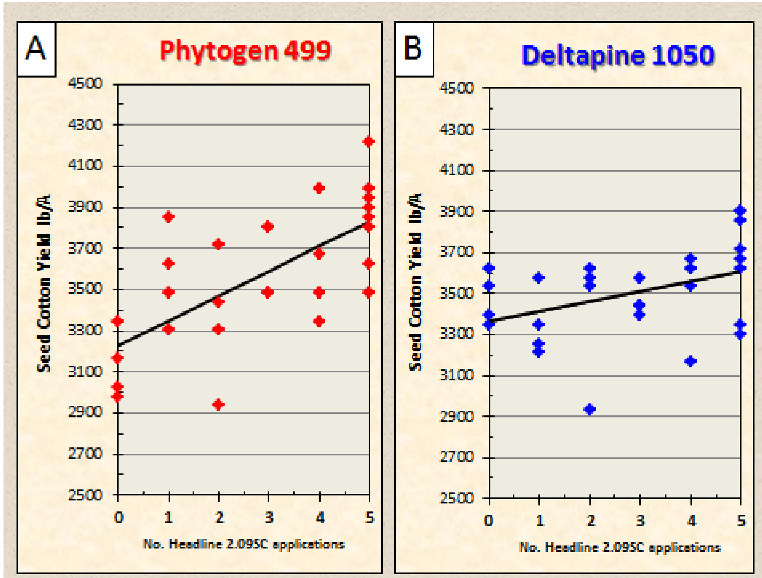
While the mean yield for Phytogen 499 and Deltapine 1050 did not significantly differ, yield data for two varieties is displayed separately in Figure 4 and 5 due to the significant variety x interaction for yield (Table 1). As described by the liner equation Y = 5122 – 246 (target spot intensity rating) [r^2=0.35***], yield of Phytogen 499 significantly declined as target spot intensified (Fig. 4A). In contrast, yield of Deltapine 1050 did not significantly decline (Y = 3788 – 55.8 (target spot intensity rating, [r^2=0.03]) with increasing target spot intensity ratings (Fig. 4B). Based on an average yield of approximately 3500 lb/A seed cotton, yield of Phytogen 499 declined an estimated 1300 lb/A as compared with 300 lb/A seed cotton for Deltapine 1050.

Figure 4. Relationship between target spot intensity and seed cotton yield on A) Phytogen 499 and B) Deltapine 1050.



Yield of Phytogen 499 and Deltapine 1050 rose significantly as the number of Headline 2.09SC applications increased. As indicated by linear regression equation Y = 3231.7 + 119.7 (# apps) [r^2 = 0.45***], seed cotton yield of Phytogen 499 increased approximately 120 lb/A with each additional Headline application, while the seed cotton yield gain with each additional Headline 2.09SC application for Deltapine 1050 was 49 lb/A (Y = 3363.6 – 48.4 (# apps.) [r^2 = 0.16*].

Figure 5. Relationship between seed cotton yield and Headline application number on A) Phytogen 499 and B) Deltapine 1050.



Discussion

Target spot significantly reduced the yield of the susceptible variety Phytogen 499, which was an estimated 600 lb/A of seed cotton, which is similar to the yield loss estimate made by Fulmer *et al.* (2012). Given the noticeable leaf spotting with approximately 25% premature defoliation on the Phytogen 499 cotton that received up to five Headline 2.09SC applications, the total yield decline attributed to target spot may be higher. In a wetter or irrigated setting that accelerated target spot onset and development, higher yield loss could also occur. The relationship between target spot intensity and yield of the partially resistant Deltapine 1050 is not as clear. Target spot intensification did not result in a significant decline in Deltapine 1050 yield. However, a significant yield gain of approximately 50 lb/A of seed cotton was linked with an increase Headline 2.09SC application numbers, which in turn reduced season-long target spot intensity as indicated by a significant decline in AUDPC values.

The observation that fungicide inputs have a greater impact on the yield of the target spot susceptible Phytogen 499 as compared with the partially resistant Deltapine 1050 is not a startling revelation. Previously, Munkvold *et al.* (2001) noted a higher probability of obtaining significant yield gains with fungicides on a gray leaf spot-susceptible than resistant corn hybrid. In addition, study results suggest that the recommended two fungicide application regime for controlling target spot is inadequate, particularly on a susceptible cotton variety, in preventing sizable disease-related yield loss (Hagan *et al.*, 2012). In irrigated cotton with a yield potential of 3+ bales/A in areas of the South where afternoon convection thundershowers are forecast almost daily, four or five protective fungicide applications may be required on a susceptible variety to delay disease onset and slow subsequent development to minimize premature leaf shed until boll maturation, particularly in the lower and middle canopy, is nearly complete. On a partially disease resistant variety in similar circumstances, however, the recommended two or possibly a three fungicide application regime may be sufficient to minimize disease-related yield loss. In a dryland setting, a multi-application fungicide treatment regime as previously described on a target spot susceptible variety would likely be unnecessary.

Considering the number of applications, Headline 2.09 proved surprisingly ineffective for target spot control on both varieties of cotton. While their use is limited due to the risk of control failures due to resistance, strobilurin fungicides like Headline 2.09SC are among the treatments of choice for target spot control on cucumber (Miyamoto *et al*. 2009) and tomato (Schlub *et al*. 2009). Possibly, difficulty in obtaining thorough coverage of the lower and mid-canopy of rank cotton due to nozzle placement or inadequate spray volume accounts for the lack of efficacy. It must also be noted that fungicides have been widely used to control rust, frogeye leaf spot, and to a lesser extent target spot on soybean in many of the same locations where target spot has recently emerged as a damaging disease on cotton. As a result, the possibility of strobilurin-tolerant or resistant isolates of *C. cassiicola* moving into cotton from vegetables or soybean cannot be ignored.

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