YIELDS AND RESPONSE OF FULL-SEASON FLEX COTTON VARIETIES TO TARGET SPOT IN ALABAMA

Austin Hagan
Katherine Burch
Department of Entomology and Plant Pathology
Auburn University, AL
H. Brad Miller
Brewton Agricultural Research Unit
Brewton, AL

Abstract

The reaction of cotton varieties to target spot with and without fungicide inputs was conducted at an irrigated Southwest Alabama site. Cotton variety was the main plot and fungicide program consisting of three applications of 9 fl oz/A Headline SC + 1.0 pt/A Bravo Ultrex was the split-plot treatment. A significant cotton variety × fungicide interaction were noted for defoliation ratings at the 12 August, 24 August, 1 September, and 15 September but not July 21 and July 30 rating dates as well as season-long area under the disease progress curve (AUDPC) values for defoliation. Characteristic target spot symptoms, which were noted on the leaves of Phytogen 499WRF and Phytogen 487WRF on 21 July, appeared on the remaining varieties by 30 July. Noticeable defoliation, which was first observed on August 12, rapidly worsened on all varieties through 1 September except for Phytogen 499WRF, which suffered approximately 70% defoliation by 15 September. For the non-fungicide treated controls, equally high defoliation levels were noted for Phytogen 499WRF, Phytogen 487WRF, Stoneville 4946B2RF, and Fibermax 1944GLB2, while the low defoliation levels recorded for DPL 1538 B2XF were matched by Stoneville 6448B2RF, DPL 1252B2RF, DPL 1137B2RF, and Phytogen 575WRF. Significant reductions in defoliation were obtained with the Headline SC + Bravo Ultrex fungicide program on all varieties except for DPL 1137B2RF, which had similar defoliation ratings for both the fungicide-treated and non-fungicide treated control. In this study, three fungicide applications allowed an average increase in lint yield of 5% (80 lb/A) on the varieties evaluated with the highest yield gains recorded for Phytogen 499WRF, Fibermax 1944GLB2, and Stoneville 4946B2RF.

Introduction

Target spot, which is caused by the fungus *Corynespora cassiicola*, has spread to all cotton producing states across the South (Butler et al. 2016; Conner et al. 2013; Donahue 2012; Edmisten, 2012; Fulmer et al. 2012; Price et al. 2016), as well as Brazil (Galbieri et al. 2014) and China (Wei et al. 2014). Characteristic 'target spot' leaf spots typically first appear in mid- to late-July in the lower to mid-canopy after the cotton has lapped the middles. Disease spread continues upwards through the canopy towards the shoot tips until early to mid-September when defoliation levels ranging from 50 to 80% may be seen on susceptible varieties. Hagan (2014) reported lint losses up to 300 lb/A in Southwest Alabama cotton with a yield potential of 3+ bales/A. A combination of high nitrogen rates coupled with frequent showers and/or irrigation favors rapid disease development and increases the risk of sizable yield losses. Drier late summer weather patterns and an open canopy appears to suppress disease development, particularly in rainfed cotton. In Alabama, the further rainfed and to a lesser extent irrigated cotton is grown from the Gulf of Mexico, the lower the risk of damaging target spot outbreaks.

Since fungicides have proven less than effective, cotton varieties, which greatly differ in their susceptibility to target spot, may be the key to managing this disease. Hagan (2014) reported that Phytogen 499WRF suffered greater leaf spotting and premature defoliation in excess of 75% compared with Deltapine 1137B2RF, Deltapine 1252B2RF, and Fibermax 1944GLB2, which had lower but still notable levels of premature defoliation. Similar results were also noted in a 2014 cotton variety trial in Central Alabama (Hagan et al. 2015). Despite higher defoliation levels, yields of Phytogen 499WRF were comparable or better than those of Deltapine 1137B2RF, Deltapine 1252B2RF, Fibermax 1944GLB2, and a number of other commercial cotton varieties in 2013 and 2014 studies (Hagan, 2014; Hagan et al, 2015).

The objective of these studies was to assess the reaction of commercial cotton varieties to target spot in an irrigated production system as well as quantify yield losses attributed to this disease for each of the varieties screened.

Materials and Methods

The study site at the Brewton Agricultural Research Unit in Brewton AL, which was cropped to peanut the previous year, was prepared for planting with a KMC ripper bedder. A 16 March broadcast pre-plant application of 270 lb/A of 20-60-60 fertilizer (54, 162, and 162 lb N, P, K/A, respectively), supplemented with 10% sulfur was followed with layby applications of 100 lb/A urea (45 lb actual N/A) + 50 lb/A murate of potash (0-0-60) (30 lb actual K/A) on 2 June and 17 June. On 13 May, nine cotton varieties were hill dropped at a rate of 3 seed/row ft. Weed control was obtained with a pre-emergent incorporated application of 1.5 pt/A Prowl H_20 on 5 May followed by 19 May and 25 June broadcast applications of 1 qt/A Roundup WeatherMax. Cotton growth was managed with 25 June and 10 July broadcast applications of 6 fl oz/A Pix + 1.5 fl oz/A Centric and 8 fl oz/A Pix on 21 July. Stink bug control was obtained with a 6 August broadcast application of 6 fl oz/A Bidrin. Cotton was prepared for harvest with an application of 1.5 pt/A Finish 6 + 1 pt/A Def defoliants on 1 October. Plots received 0.3 in. of water on 13 May followed by 0.5 in. on 12 June, 18 June, 17 July, 4 August, and 12 August. The experimental design was a factorial set of treatments arranged as a split-plot with cotton variety as the whole plot and fungicide treatment as the split-plot treatment. Individual split-plots consisted of four 25 ft rows spaced 3 ft apart. Five replications of treatments were included. Alleys between replications were cut with a bushhog several weeks prior to harvest. Broadcast applications of 9 fl oz/A Headline 2.09SC + 1.0 pt/A Bravo Ultrex were made on 15 July (1st week of bloom), 29 July, and 12 August with a 'high-boy' sprayer with TX-12 nozzles on a 20 in. spacing at spray volume of 20 gal/A at 60 psi. A non-fungicide treated control was included.

Target spot intensity was rated on 21 July, 30 July, 12 August, 24 August, 1 September, and 15 September using a 1 to 10 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 $\leq$ 10% defoliation, 5 = lesions noticeable and $\leq$ 25% defoliation, 6 = lesions numerous and $\leq$ 50% defoliation, 7 = lesions very numerous and $\leq$ 75% defoliation, 8 = numerous lesions on few remaining leaves and $\leq$ 90% defoliation, 9 = very few remaining leaves covered with lesions and $\leq$ 95% defoliation, and 10 = plants defoliated. Defoliation values were calculated from leaf spot intensity ratings using the formula [% Defoliation = 100/(1+e(-(Florida scale value-6.0672)/0.7975)]. Cotton was mechanically harvested on 14 October. Counts of open and locked bolls were made on 3 ft of row in a border row on 12 October. Area under disease progress curve (AUDPC) values for defoliation were calculated from the target spot intensity data recorded over time. Significance of interactions was determined using PROC GLIMMIX procedure in SAS. Statistical analyses were done on rank transformations for non-normal final target spot defoliation and locked boll count data. Non-transformed data are reported. Means were separated using Fisher's protected least significant difference (LSD) test ($P \leq 0.05$) unless otherwise indicated.

Results

While mean monthly temperatures from May to mid-October in 2015 at BARU were above the 30 yr average, rainfall totals were below average in June but average for the remainder of the study period. Daily rainfall (blue bars) and irrigation (orange bars) totals can be found in Fig. 1.

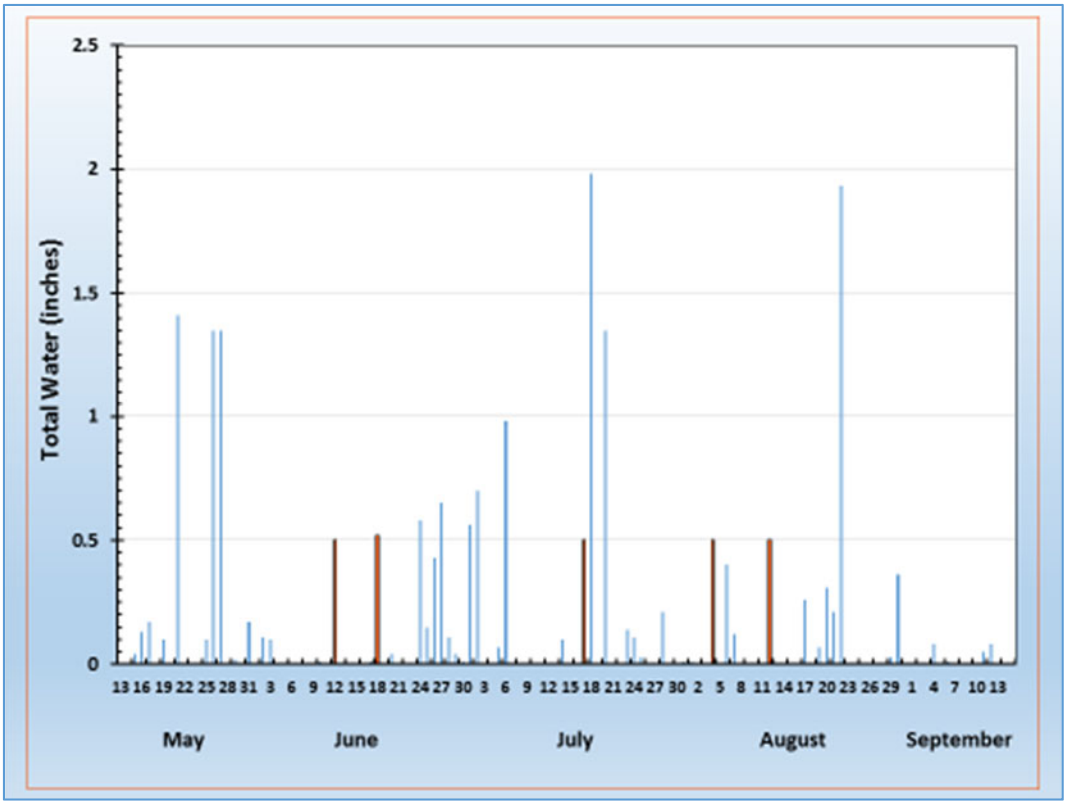

Figure 1. Total daily rainfall and irrigation during study period in BARU in 2015. Irrigation event are indicated by the orange bars.

Due to a significant variety × fungicide interaction at the latter four rating dates for target spot defoliation (Table 1), data are presented by cotton variety and fungicide program. Characteristic target spot symptoms, which were first noted on leaves of Phytogen 499WRF and Phytogen 487WRF on 21 July, were observed on the remaining varieties by 30 July (Fig. 2). Defoliation, which was first observed on 12 August, rapidly increased on all varieties, particularly the non-fungicide treated controls through 1 September when disease development slowed due to the onset of drier weather patterns on all varieties except Phytogen 499WRF (Fig. 1). By the 15 September rating date, defoliation levels for the non-fungicide treated Phytogen 499WRF reach 70% as compared with approximately 50% for Phytogen 487WRF and Stoneville 4946B2RF (Fig. 2). Defoliation levels of 25 to 35% were recorded for Deltapine 1538B2XF, Stoneville 6448B2RF, Deltapine 1252B2RF, Deltapine 1137B2RF, and Phytogen 575WRF. Significant reductions in defoliation were obtained with the Headline SC + Bravo Ultrex fungicide program on all varieties except for Deltapine 1137B2RF and Deltapine 1538B2XF, which had similar final defoliation ratings for both the fungicide-treated and non-fungicide treated plots.

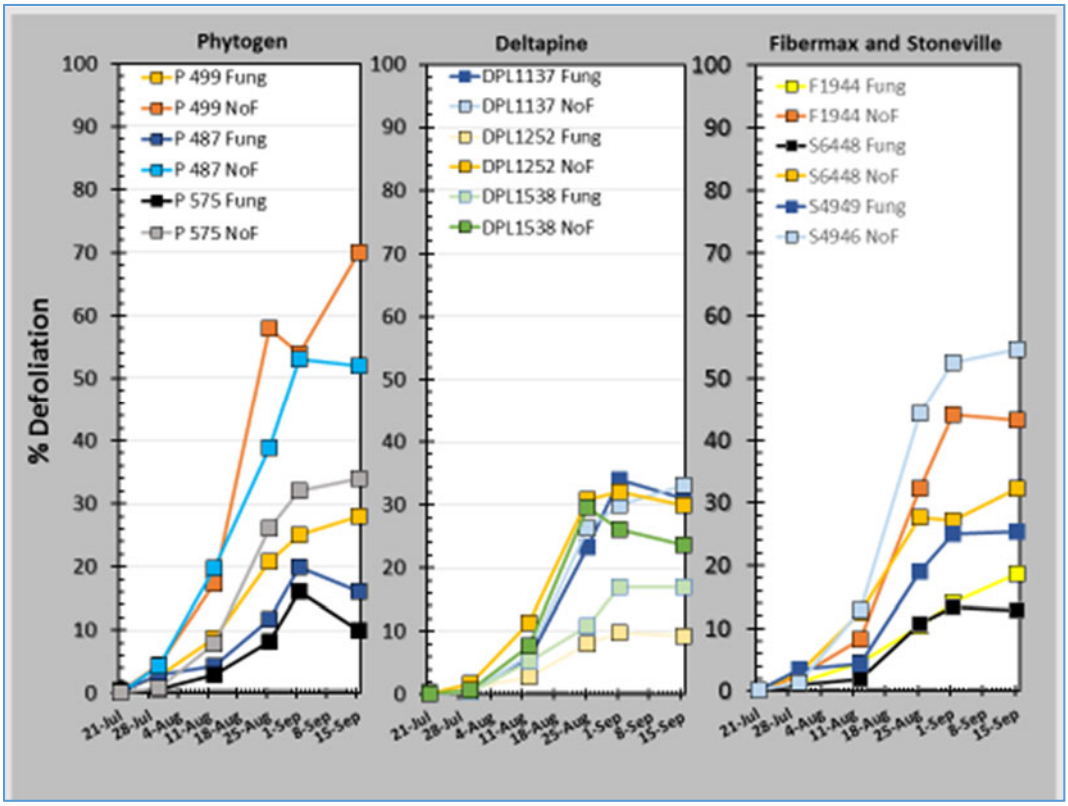

Figure 2. Intensification of target spot defoliation over time as influenced by variety selection and fungicide program. Cotton varieties are segregated by brand.

Season-long AUDPC defoliation values also differed by cotton variety and fungicide program (Table 1). The non-fungicide treated Phytogen 487WRF, Fibermax 1944GLB2, and Stoneville 4946B2RF had AUDPC defoliation values that matched those recorded for the heavily defoliated Phytogen 499WRF (Fig. 3). Deltapine 1538B2XF, Deltapine 1137B2RF, Deltapine 1252B2RF, Phytogen 575WRF, and Stoneville 6448B2RF defoliation AUDPC values were similar. With the exception of Deltapine 1137B2RF, significant reductions in season-long AUDPC defoliation values were obtained with the Headline SC + Bravo Ultrex fungicide program on all remaining cotton varieties as compared with the non-fungicides treated control. When treated with Headline SC + Bravo Ultrex, Phytogen 499WRF had higher defoliation AUDPC values than Phytogen 575WRF, Deltapine 1252B2RF, Fibermax 1944GLB2, and Stoneville 6448B2FR but not Phytogen 487WRF, Deltapine 1137B2RF, Deltapine 1538B2XF, and Stoneville 4946B2RF.

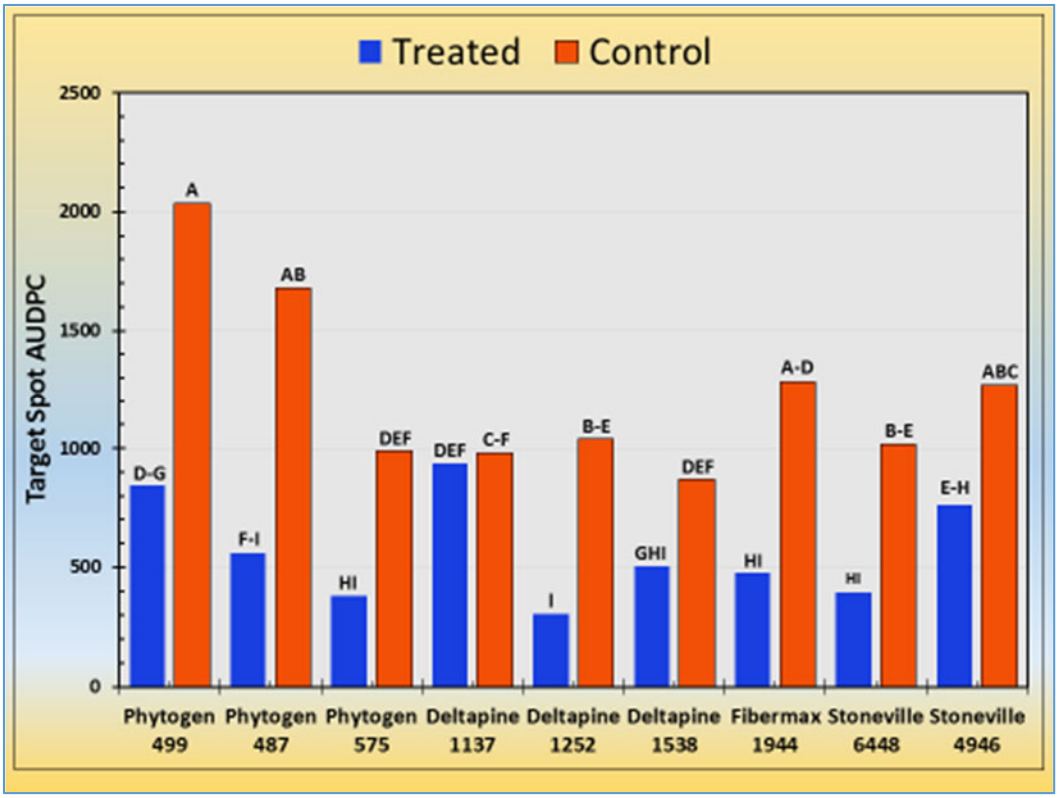

Figure 3. AUDPC defoliation values as influenced by variety selection and fungicide program. Means in followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Since all interactions for open and locked boll counts as well as yield are not significant, data presented for each of these variables are pooled (Table 1). Similar open boll counts were recorded across all nine cotton varieties (Fig. 4A). Stoneville 6448B2RF has a greater number of locked bolls than all other variety except for Phytogen 487WRF. Locked boll counts for the remaining cotton varieties were similar (Fig. 4B). Also, no differences in locked boll counts were found between the non-fungicide treated control and Headline SC + Bravo Ultrex fungicide program (Fig. 6B).

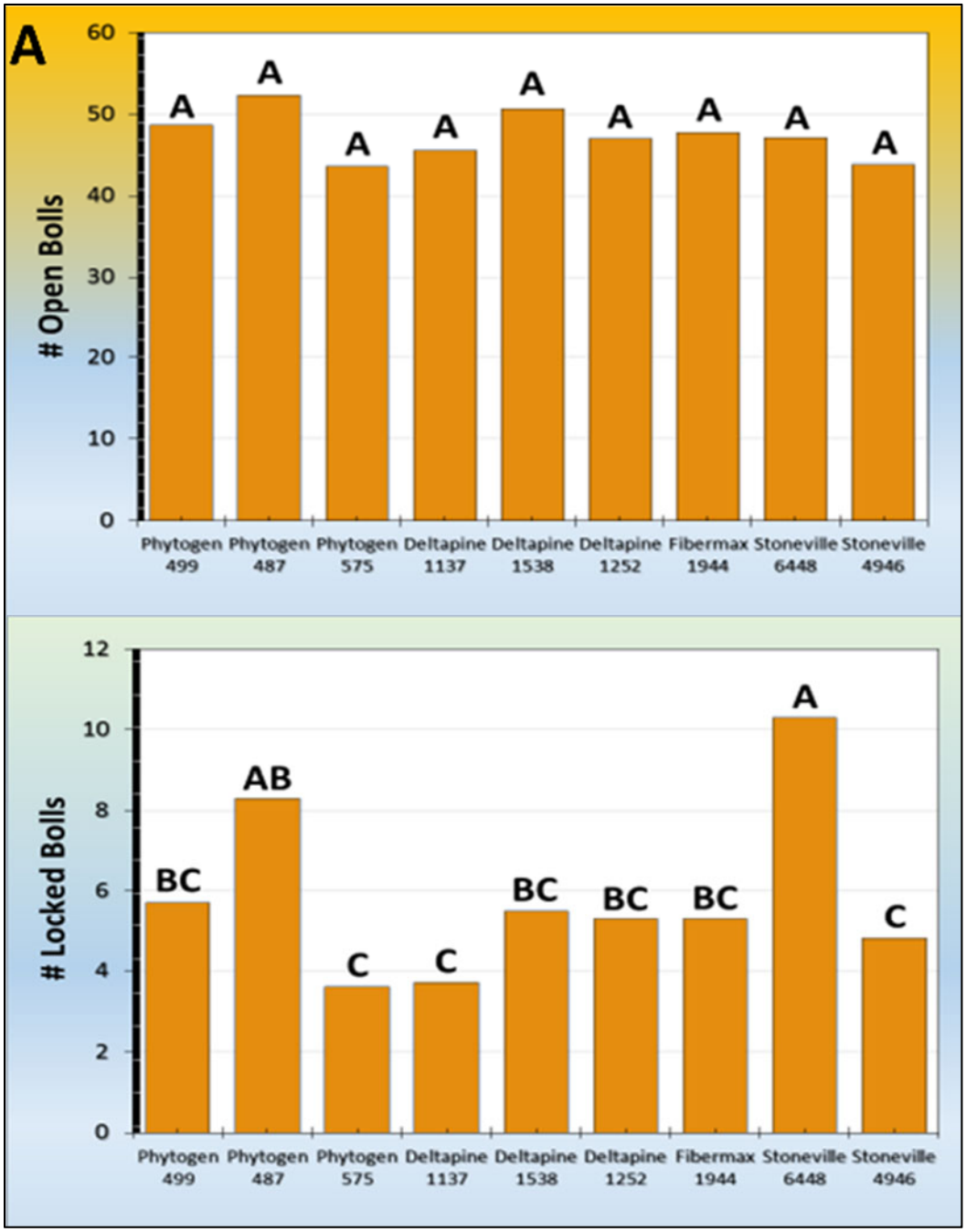

Figure 4. Counts of A) open and B) locked bolls per 3 ft of row as influence by variety selection. Means followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

While gin out (% lint) and lint yield were impacted by cotton variety and fungicide program, no interaction between these variables were noted (Table 1). Deltapine 1252B2RF, Deltapine 1538B2XF, and Phytogen 499WRF had similarly high gin out rates (Fig. 5A). Similarly low gin out rates to those recorded for Fibermax 1944GLB2 and Stoneville 4946B2RF were obtained for Stoneville 6448B2RF and Phytogen 575WRF. Deltapine 1252B2RF had higher lint yields than all varieties except for Deltapine 1538B2XF and Fibermax 1944GLB2 (Fig. 5B). Lowest lint yields were reported for Stoneville 4946B2RF.

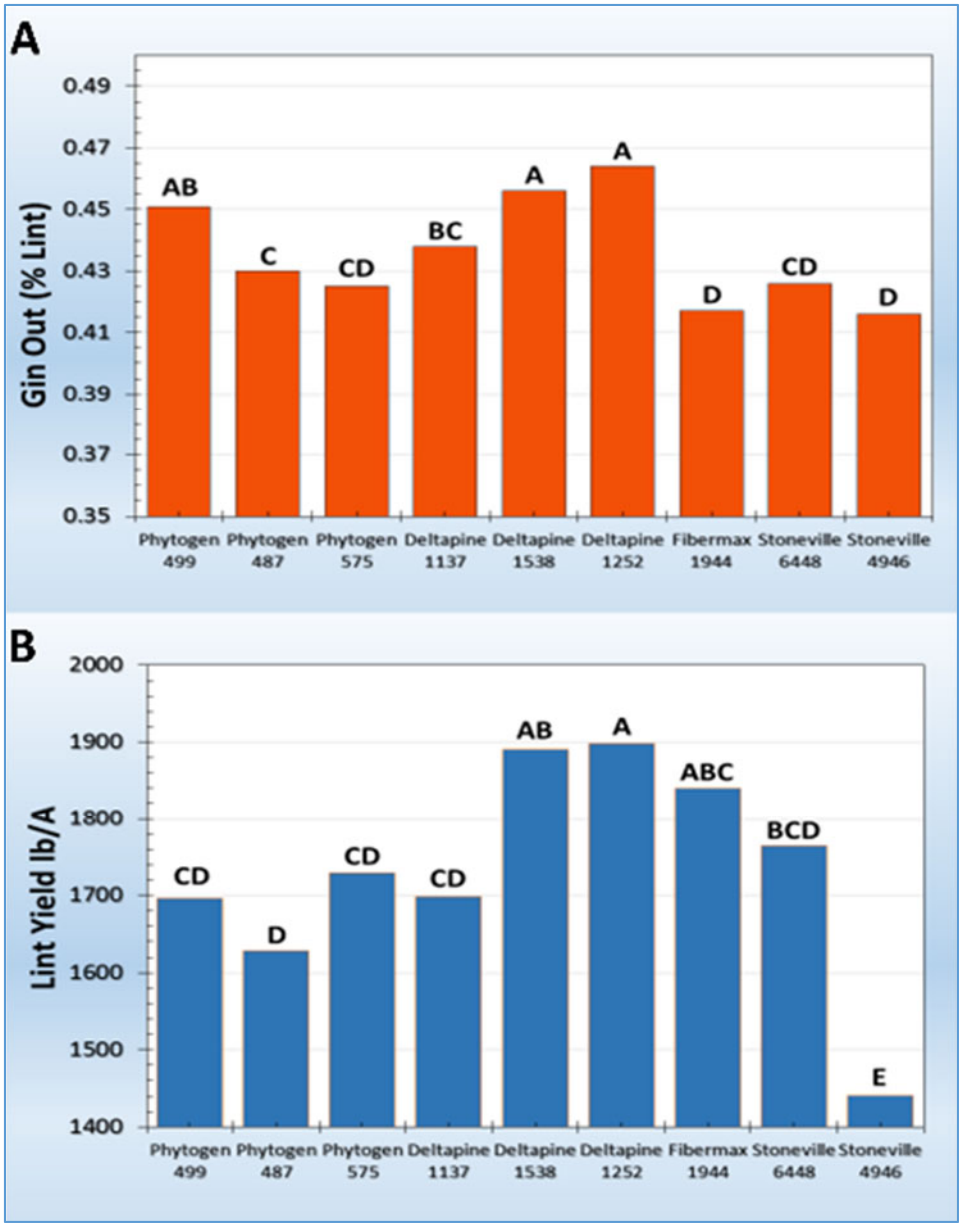

Figure 5. Cotton variety selection impacts A) gin out and B) yield of commercial cotton varieties at BARU in 2015. Means followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Fungicide treatment did not impact open (Fig. 6A) or locked boll (Fig. 6B) counts. Similar unopened and rotted boll counts were also recorded for the fungicide-treated and non-fungicide treated control (data not shown). Higher gin out values and lint yields were noted for the fungicide-treated than non-fungicide treated cotton (Fig. 6C-D).

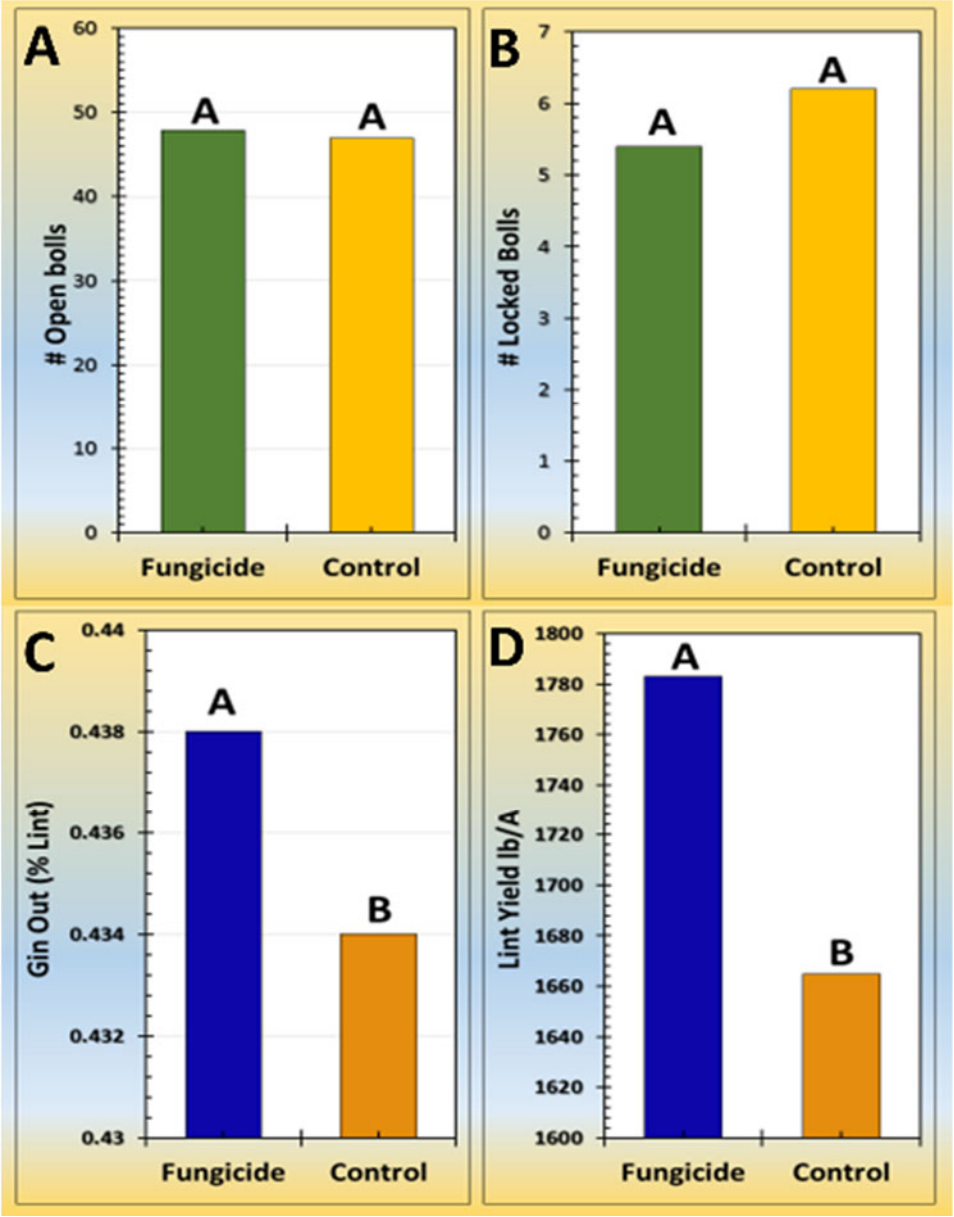

Figure 6. Influence of fungicide program on A) open and B) Locked boll counts per 3 ft of row as well as C) % Gin Out and D) Lint Yield of nine cotton varieties in 2015 at BARU. Means followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Summary

As previously reported by Hagan (2014), Hagan et al. (2015a), Hagan et al. (2015b) and Hagan et al. (2015c), Phytogen 499WRF remains among the most susceptible commercial cotton varieties to target spot. Here, leaf spot symptoms were noted on Phytogen 499WRF in the lower canopy shortly after first bloom and 70% defoliation was observed within 7 weeks of disease onset. In this study, other cotton varieties where early onset and/or high levels of premature defoliation were noted included Phytogen 487WRF and Stoneville 4946GLB2. In contrast to the results of this study, Stoneville 4946B2RF had lower final defoliation ratings than Phytogen 499WRF in a 2014 Central Alabama study (Hagan et al. 2015c). Phytogen 487WRF is a new release and no information concerning the susceptibility of this

variety to target spot is available. Reaction of the remaining cotton varieties to target spot observed here are comparable to those previously reported in Central (Hagan et al. 2015b; Hagan et al. 2015c) and South Alabama (Hagan 2014; Hagan et al. 2015a) studies.

The Headline SC + Bravo Ultrex fungicide program was designed to reduce target spot-induced defoliation and maximize lint yield. Unfortunately only three of the four scheduled applications were made, so the desired level of target spot control was not obtained, particularly on Phytogen 499WRF, Phytogen 487WRF, and Stoneville 4946B2RF. A reduction in season-long defoliation, as indicated by lower AUDPC values, was obtained with the fungicide program on all varieties except for Deltapine 1137B2RF, which was among the cotton varieties with the least sensitivity to target spot. Results of this study were consistent with those of previous studies (Hagan 2014; Hagan et al. 2015a; Hagan et al. 2015b). In similar 2014 studies at two Alabama locations (Hagan et al. 2015a; Hagan et al. 2015b), reductions in defoliation at the final rating date were noted with a similar fungicide program when compared with a non-fungicide treated control on nearly all cotton varieties, including Deltapine 1137B2RF.

Open boll counts were similar across all cotton varieties and fungicide programs. In a 2013 Central Alabama study, similarly high open boll counts were recorded for Deltapine 1137B2RF, Fibermax 1944GLB2, Stoneville 6448B2RF, Phytogen 499WRF, and Phytogen 575WRF (Hagan et al. 2014), all of which were included in this study. While a higher open boll count was recorded for the fungicide treated- than the non-fungicide treated control, yields for both fungicide programs were similar (Hagan et al. 2014). Locked boll counts differed among cotton varieties with Stoneville 6448B2RF having higher counts than all varieties except for Phytogen 487WRF. While a reduction in the numbers of locked bolls was not obtained with the Headline SC + Bravo Ultrex program, fewer locked bolls have previously been noted in cotton receiving two applications of 9 fl oz/A Headline SC (Hagan, 2014).

Significant differences in gin out and lint yield were noted between cotton varieties. When compared with the majority of cotton varieties screened, higher gin out rates and lint yields were recorded for Deltapine 1252B2RF and Deltapine 1538B2XF. Fibermax 1944GLB2 yield but not gin out rate were similar to the former two cotton varieties. In contrast to the results of this study, Fibermax 1944GLB2 and Phytogen 499WRF significantly outyielded Deltapine 1252B2RF in South (Hagan et al. 2015a) and Central Alabama (Hagan et al. 2015b) study sites in 2014.

Impact of fungicide inputs on the yield of target spot damaged cotton have been inconsistent. Here, a significant but modest lint yield gain of approximately 80 lb/A was realized across all cotton varieties with the three application Headline SC + Bravo Ultrex fungicide program. In 2014, a similar magnitude lint yield gain was also recorded across seven cotton varieties at this South (Hagan et al. 2015a) but not a Central Alabama study site (Hagan et al. 2015b) as compared with an approximately 150 to 200 lb/A increase in lint yields seen in several 2013 trials at a second southwest Alabama site (Hagan, 2014). Yield at all of the above study sites ranged from 3 to 4 bales/A.

Given current low cotton prices coupled with the need to manage production inputs, planting a less susceptible cotton variety rather than relying on costly and erratic fungicide inputs is the preferred method of minimizing the risk of damaging target spot outbreaks in cotton. In this 2015 study, the cotton varieties Deltapine 1252B2RF and Deltapine 1538B2XF, which displayed partial target spot resistance along with high yields, would be excellent choices in intensively managed cotton at locations where the risk of damaging target spot outbreaks is high.

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Table 1. F-values for general linear models for the effects of cotton variety and fungicide program on target spot-incited defoliation, season-long target spot AUDPC, open and locked boll counts, gin out, and lint yield in 2015 at BARU

Source	Target spot defoliation						Target spot AUDPC	Boll count		Gin Out % lint	Lint Yield lb/A
	21 July	30 July	12 August	24 August	1 September	15 September		Open	Locked		
Variety	1.57	3.12*	2.67*	5.95***	3.04*	4.31**	4.42*	0.46	3.20**	9.54***	4.94***
Fungicide	0.00	1.33	52.29***	172.22***	57.31***	70.15***	110.60***	0.14	0.92	4.09^	7.11*
Variety × Fungicide	1.05	0.82	2.58*	2.78*	2.84*	2.84*	3.26**	0.78	1.21	0.75	1.30

[Z] Significance of *F* values at the 0.10, 0.05, 0.01, and 0.001 levels is indicated by ^, *, **, or ***, respectively.