FURTHER STUDIES ON THE CONTROL OF TARGET SPOT WITH FUNGICIDES

A. Hagan
Auburn University
Auburn, AL
M. Pegues
J. Jones
Gulf Coast Research and Extension Center
Fairhope, AL

Abstract

Efficacy of recommended fungicides, as well as fungicide application timing on target spot control in cotton was evaluated in 2013 at the Gulf Coast Research and Extension Center (GCREC). Among evaluated treatments, little difference in target spot control was noted between recommended rates of Headline 2.09SC, Quadris 2.08SC, and Twinline. On Phytogen 499WRF, significant yield gains were obtained with all fungicide treatments except for 9 fl oz/A Headline 2.09SC, while higher yields were noted only with 9 fl oz/A Quadris on Deltapine 1252B2RF compared to non-treated plots. Headline 2.09SC application timing significantly impacted target spot control and yield response on Phytogen 499WRF and Deltapine 1252B2RF. Best disease control and higher yield response was obtained with the two later rather than recommended and early application timing schedules. The full season Bravo WeatherStik 720 and Headline 2.09SC + Bravo WeatherStik programs gave equal and better disease control, but not higher yields than the two late application timing schedules. Results suggest that fungicide applications scheduled on the basis of scouting or rescue treatments, i.e. after defoliation due to disease has begun, may be effective in preventing some target spot-induced yield loss.

Introduction

Target spot, caused by the fungus *Corynespora cassiicola*, was first reported by Jones (1961) in cotton in Mississippi and subsequently not reported for 40 years. Recently, target spot has reemerged, initially in southwest Georgia (Kemeriat et al., 2011), where Fulmer et al. (2012) reported 70% premature defoliation and 200 lb lint/A losses. In the past two years, disease outbreaks occurred in cotton in Alabama (Campbell et al., 2012; Conner et al., 2013), Arkansas, Florida (Donahue, 2012), Louisiana, South Carolina, North Carolina (Edminsten, 2012), and Virginia. While target spot may not impact yield in the mid- and upper-South (Edmisten, 2012), a 15% yield loss was recorded for 'Phytogen 499WRF' as compared with approximately 5% for 'Deltapine 1050B2RF' in 2012 in a rainfed study in coastal southwest AL (Hagan et al., 2013a). In a 2013 study, target spot incited yield declines in 'Deltapine 1252B2RF' and 'Phytogen 499WRF' approached 15 and 20%, respectively (unpublished data) in cotton with a 3 bale yield potential. While reaction of cotton varieties to target spot differs (Hagan et al., 2013c), disease impact on the yield of most cotton varieties, except for those mentioned above, is unknown.

The efficacy of fungicides for the control of target spot in cotton has not been extensively studied. Previously, Kemeriat et al. (2011) noted that Headline 2.09SC significantly reduced defoliation and sometimes increased cotton yield. In a 2012 Alabama study, two applications of Twinline and Headline 2.09SC gave better control than Stratego YLD, Muscle 3.6F or Bravo WeatherStik 720; however, even the most efficacious fungicides allowed nearly 50% defoliation as compared with 80% defoliation for the non-fungicide treated controls on Phytogen 499 WRF (Hagan et al., 2013b). Fulmer et al. (2013) obtained the best target spot control with applications of Twinline or Headline 2.09SC at the 1st and 3rd week of bloom. Hagan *et* al. (2013a) noted extensive leaf spotting and 30% premature defoliation on Phytogen 499 WRF even with five pyraclostrobin applications made at two-week intervals starting at first bloom. Yield gains obtained with the recommended two-application 9 fl oz/A Headline 2.09SC program in the above Alabama studies ranged from approximately 115 to 125 lb lint/A in cotton that yielded approximately 1400 lb lint/A (2.9 bales/A).

The objective of this study was to assess the efficacy of a preventative fungicidal program with recommended Headline 2.09SC, Quadris 2.08E, and Twinline fungicides for the control of target spot as well as their impact on seed cotton yield.

Material and Methods

The study site was tilled with a KMC ripper/roller on 19 March. On 24 April, 180 lb/A of 11-0-33 fertilizer with 10 lb/A sulfur and 0.5 lb/A boron was broadcast. A layby application of 23 gal/A 28-0-0-5S (70-0-0) liquid fertilizer was made on 19 June. On 9 May, Phytogen 499WRF and Deltapine 1252 varieties were hill dropped behind a KMC strip till unit at 3 seed/row ft in a Malbis fine sandy loam (OM <1%) at the Gulf Coast Research and Extension Center in Fairhope, AL. Weed control was obtained with a pre-emergence application of 1 qt/A Roundup Weathermax + 2 pt/A Prowl H_20 + 2 pt/A Cotoran followed by a 12 June broadcast application of 1 qt/A Roundup Weathermax + 1 pt/A Dual Magnum II and a post-directed application of 2.5 pt/A MSMA + 1 pt/A Diuron on 27 June with a hooded sprayer. A banded application of mepichlor at 8 fl oz/A on 17 June was followed by a broadcast application of 12 fl oz/A mepichlor on 27 June and 8 oz/A mepichlor + 6 fl oz Bidrin on 17 July. Cotton was prepared for harvest with an application of 1 fl oz/A ET + 3 fl oz/A Takedown + 1 qt/A Boll Buster on 26 September followed by 1 qt/A Diuron + 2 oz/A Dropp 50W + 21 fl oz/A Ethephon on 8 October. The study site was not irrigated. The experimental design was a factorial arranged in a split plot with cotton variety as the main plot and fungicide program as the split plot treatment. Individual split plots consisted of four 30 ft rows spaced 3.2 ft (38 inches) apart in four replications. All fungicide applications were made with a Spider sprayer with 11002 tips mounted on a four row boom in 15 gal/A of spray volume.

For the recommended fungicide screening study, Twinline at 7.0 and 8.5 fl oz/A and Quadris 2.08SC at 6 and 9 fl oz/A were applied at 2nd, 4th, and 6th week of bloom on16 July, 31 July, and 12 August, respectively, while applications of Headline 2.09SC at 6, 9, and 12 fl oz/A were made at the 2nd and 4th week of bloom on 16 and 31 July, respectively (Table 1). A non-fungicide treated control was included.

For the fungicide timing study, fungicides were applied at pinhead square, 2nd, 4th, 6th and 8th week of bloom, which corresponded to18 June, 16 July, 31 July, 12 August, and 27 August, respectively (Table 2). Timing treatments included two applications of 9 fl oz/A Headline 2.09SC at 1) pinhead square & 2nd week of bloom, 2) 2nd & 4th week of bloom, 3) 4th & 6th week of bloom, and 4) 6th & 8th week of bloom. For the full season 1.5 pt/A Bravo WeatherStik 720 and 9 fl oz/A Headline 2.09SC + 1.5 pt/A Bravo WeatherStik 720 programs, applications were made on 2 July, 16 July, 31 July, 12 August, and 27 August. A non-fungicide treated control was included.

Target spot intensity was visually assessed on 15 July, 29 July, 14 August, 26 August, 9 September, and 24 September using the 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 (Chiteka et al. 1988). Data collected on 24 September is displayed in the table. Cotton was mechanically harvested on 14 October. Significance of interactions was determined using the PROC GLIMMIX procedure in SAS. Statistical analysis on target spot intensity was done on rank transformations of data, which were back transformed for presentation. Means were separated using Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Temperatures during the study period were below to near the 30-year historical average. Rainfall totals for May through August were above to well above normal but were relatively dry in September and October.

Results

Recommended Fungicides Compared on a Preventative Schedule

Since the cotton variety x fungicide interaction on target spot intensity was not significant, data presented are pooled. Due to a significant variety x fungicide interaction, fungicide treatment yields are separated by cotton variety. Target spot intensity was higher and yield lower for Phytogen 499WRF than Deltapine 1252B2RF (Table 1). All fungicide treatments, except the 9 fl oz rate of Quadris 2.08SC, reduced target spot-incited intensity when compared with the non-fungicide treated control. Poorer disease control was obtained with 9 fl oz/A Quadris 2.08SC than 7 fl oz/A Twinline; however disease ratings for the remaining fungicide treatments were similar to the latter treatment. Significant yield gains on Phytogen 499WRF were obtained with all fungicide treatments when compared with the non-fungicide treated control. Superior yield response was noted with both rates of Twinline compared with Quadris 2.08SC and two lower but not highest rate of Headline 2.09SC. Yield was not impacted by

Twinline and Quadris 2.08SC application rate on Phytogen 499WRF, although higher yields were obtained with the 12 fl oz/A than two lower rates of Headline 2.09SC. With the exception of Quadris 2.08SC at 9 fl oz/A, similar yields were recorded for the fungicide treatments and the non-treated control on Deltapine 1252B2RF.

Table 1. Yield response and target spot control with recommended fungicides on two cotton varieties at the GCREC in 2013.

Split plot analysis (*F* value)	Application number	Target spot intensity[z]	Seed cotton yield lb/A[y]	
Cotton variety	--	105.37*** [x]	10.92**	
Fungicide	--	11.15***	6.17***	
Cotton variety x fungicide	--	1.09	3.28**	
Cotton variety means				
Phytogen 499WRF	--	6.0 a [w]	3032 b	
Deltapine 1252B2RF	--	5.1 b	3204 a	
Fungicide means (rate/A)			Phytogen 499WRF	Deltapine 1252B2RF
Non-treated control	--	6.1 a	2706 f	3096 b-e
Twinline 7 fl oz[v]	3	4.9 c	3291 ab	3222 a-d
Twinline 8.5 fl oz	3	5.3 bc	3394 a	3176 a-d
Headline 2.09SC 6 fl oz	2	5.5 bc	2981 de	3233 a-d
Headline 2.09SC 9 fl oz	2	5.3 bc	2904 ef	3165 a-d
Headline 2.09SC 12 fl oz	2	5.4 bc	3268 abc	3279 ab
Quadris 2.08SC 6 fl oz	3	5.7 ab	2981 de	3199 a-d
Quadris 2.08SC 9 fl oz	3	5.4 bc	3015 cde	3371 a

[z]Target spot intensity was rated using a leaf spot scoring system (scale = 1 to 10) on 24 September.
[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 ($P \leq 0.05$).
[v]Headline applications were made on 16 and 31 July, while Twinline and Quadris applications were made on 16 July, 31 July, and 12 August.

Application Timing Impacts Control of Target Spot

Target spot intensity was significantly higher on Phytogen 499WRF than Deltapine 1252B2RF; however, yield of the two varieties were similar (Table 2). Lower final target spot intensity ratings were recorded for the two later than two earlier application timing treatments and non-fungicide treated control on Phytogen 499WRF and Deltapine 1252B2RF. In addition, the full-season Headline 2.09SC + Bravo WeatherStik program provided better target spot control than all timed treatments except for the 6th & 8th week of bloom program on Phytogen 499WRF, as well as the 4th & 6th and 6th & 8th week of bloom programs on Deltapine 1252B2RF. Similar target spot control was obtained on both varieties with the full-season Bravo WeatherStik and 4th & 6th and 6th & 8th week of bloom programs. Higher yields were obtained with the 4th & 6th and 6th & 8th but not the pinhead square & 2nd and 2nd and 4th week of bloom programs, when compared with the non-fungicide-treated control. Yields recorded with the two later timing programs along with the full season Bravo WeatherStik and Headline 2.09SC + Bravo WeatherStik programs were similarly higher than the two earlier timing programs and the non-fungicide treated control.

Table 2. Application timing and control of target spot with Headline 2.09SC at GCREC in 2013.

Split plot analysis (*F* value)	Application number	Target spot intensity[z]		Seed cotton yield lb/A[y]
Cotton variety	--	62.23***[x]		0.02
Fungicide	--	23.47***		8.60***
Cotton variety x fungicide	--	2.66*		0.46
Cotton variety means[w]				
Deltapine 1252B2RF	--	6.1 a[w]		3234 a
Phytogen 499WRF	--	4.7 b		3250 a
Fungicide program means		Phytogen 499WRF	Deltapine 1252B2RF	
Non-treated control	--	6.9 a	5.1 cde	2894 b
Pinhead square & 2nd week of bloom	2	6.8 a	5.2 cd	3027 b
2nd & 4th week of bloom	2	6.5 a	4.9 de	3107 b
4th & 6th week of bloom	2	5.9 b	4.5 fg	3342 a
6th & 8th week of bloom	2	5.5 bc	4.5 fg	3399 a
Bravo WeatherStik 720 1.5 p[v]	5	5.9 b	4.7 efg	3422 a
Headline 2.09SC 9 fl oz + Bravo WeatherStik 720 1.5 pt[v]	5	5.3 cd	4.4 g	3503 a

[z]Target spot intensity was rated using a leaf spot scoring system (scale = 1 to 10) on 24 September.
[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 ($P \leq 0.05$).
[v]Applications were made on 2 July, 16 July, 31 July, 12 August, and 27 August.

Discussion

As previously noted by Hagan et al. (2013b), Headline 2.09SC, Quadris 2.08SC, and Twinline, when applied preventatively at 2nd and 4th week of bloom, failed to give a high level of target spot control. Reductions in disease intensity that were obtained with the above fungicides in 2013 were comparable to those observed in the previous year (Hagan et al. (2013b). Headline 2.09SC, Quadris 2.08SC, and Twinline application rate had no impact on disease control in this and a previous study (Hagan et al. (2013b). Variety selection affected seed cotton yield but not disease intensity. On Phytogen 499WRF, similarly high yields were recorded with both rates of Twinline as well as 12 fl oz/A Headline 2.09SC, which yielded higher than the two lower rates of the same fungicide. Higher seed cotton yields on Deltapine 1252 were recorded only for 9 fl oz/A Quadris when compared with the non-fungicide treated control. In 2012, a significant yield gain was obtained on Phytogen 499WRF and Deltapine 1050B2RF only with 9 fl oz/A Headline 2.09SC (Hagan et al. 2013b), a treatment that failed to increase yield above that of the non-treated control on the former variety in 2013. Improved yield response to Twinline and Quadris 2.08SC in 2013 as compared to 2012 (Hagan et al. 2013b) may be attributed to an increase in application numbers from 2 to 3.

Application timing proved to have a significant effect on target spot control and yield response with Headline 2.09SC. Surprisingly, target spot control was better and yields higher with the two application programs that started at or after disease onset than with the two preventative programs. Previously, Walls et al. (2013) observed comparable target spot control but not yield gains with 1st and 3rd, as compared with 3rd and 5th, and 5th and 7th week of bloom programs with 8.5 fl oz/A Twinline. Overall, study results suggest that scouting-initiated fungicide programs triggered at first sign of disease around the 4th week of bloom or 'rescue treatments' begun as defoliation due to disease is first observed at or around the 6th week of bloom may prove equal if not superior to the recommended preventative programs in suppressing target spot intensity and protecting seed cotton yield. Increasing application numbers above the currently recommended two to five application full-season program resulted in, at best, a marginal improvement in disease control and inconsistent yield enhancement.
As was noted by Hagan et al. (2013b), available fungicides, regardless of application number, do not provide a high level of target spot control in cotton. In contrast to several previous studies (Kemeriat et al. 2011, Walls et al, 2013),

reductions in disease intensity often resulted in significant yield gains, particularly on Phytogen 499WRF, where yield gains of 500 to 600 pounds seed cotton/A were recorded. Further studies are needed to confirm the efficacy and optimum application schedule to obtain superior yield response with registered fungicides as well as identify efficacious candidate fungicides.

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