EFFICACY AND YIELD PROTECTION FROM FUNGICIDE INPUTS FOR THE CONTROL OF FOLIAR DISEASES IN COTTON

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Abstract

Studies were conducted at the Brewton Agricultural Research Unit (BARU) in 2017 and 2018 and Gulf Coast Research and Extension Center (GCREC) in 2018 in Southwest Alabama to determine the yield protection and efficacy of registered and experimental fungicides against target spot on PhytoGen 499 WRF in 2017 and PhytoGen 490 W3FE cotton in 2018. The experimental design was a randomized complete block. Individual plots consisted of four, 30-foot rows on 3-foot (BARU) or 3.2-foot (GCREC) centers in four replications. Fungicides were broadcast with a high-clearance sprayer with a four row boom in 15 gal/A of spray volume at 40 psi. Each study was irrigated as needed and managed to maximize yield. With the exception of the 6 oz/A Priaxor + 1 pt/A Bravo WeatherStik umbrella program, remaining fungicide treatments were applied at the third and fifth week of bloom. Target spot intensity was assessed on a 1 to 10 scale at 7 to 14 day intervals at the third until the tenth or eleventh week of bloom. Final defoliation values will be presented. In 2017, all programs except for Velum Total applied in-furrow, reduced the level of target spot-incited defoliation. When compared with the non-treated control, significant yield gains were obtained with all fungicide programs except for Amistar Top, Quadris, 6 oz/A Priaxor, and Velum Total in-furrow. In 2018, the level of premature defoliation attributed to target spot at both study locations differed by fungicide program. At BARU, lowest defoliation levels for the Priaxor + Bravo WeatherStik umbrella program were matched by two application Priaxor, Miravis TOP + Quadris, Miravis TOP, as well as multiple rates of the experimental fungicide BAS 75302F (revysol) programs. All in-furrow and broadcast Propulse programs, Proline and Elatus failed to reduce premature defoliation when compared with the non-fungicide treated control. Efficacy of Topguard was intermediate between the non-treated control and the Priaxor + Bravo WeatherStik umbrella program. Similar seed yields were obtained for all fungicide program and for the non-fungicide treated control. When compared with the non-fungicide treated control, significant reductions in final defoliation were obtained at GCREC with all fungicide programs except for Helmstar and Propulse in-furrow and early post broadcast programs. Miravis TOP + Quadris provided better target spot protection than all fungicide programs except for Miravis TOP, Elatus, and Propulse in-furrow fb Propulse fb Proline 480SC. Significant reductions in premature defoliation were also obtained with Proline 480SC, both rates of Priaxor, Amistar TOP, and the Priaxor + Bravo WeatherStik umbrella program. As was noted at BARU, no significant differences in seed yield were recorded between any of the fungicide programs and the non-fungicide treated control.

Introduction

For the past six years, target spot has been a consistent threat to significantly reduce cotton yield in the southern half of Alabama. Along with partially resistant/tolerant cultivars, protective fungicides have proven to be a useful tool for managing target spot and providing yield protection in cotton. In 2018, areolate mildew, which previously was at best a minor issue, emerged as a damaging foliar disease in cotton in Alabama, especially in counties in the center of the state. Disease onset occurred in late July to early August and significant premature defoliation in excess of 50% was observed within a few weeks, particularly on the widely planted and high yielding cultivar Deltapine 1646 B2XF. Currently, the efficacy and yield response as well as optimum application timing and number for fungicides against areolate mildew in U.S. cotton is largely unknown.

Methods

Field studies were conducted in 2017 and 2018 at the Brewton Agricultural Research Unit (BARU) along with the Gulf Coast Research and Extension Center (GCREC) in 2018 in Southwest Alabama to determine the level of yield protection and efficacy of registered and experimental fungicides against target spot and areolate mildew on cotton. For the 2017 BARU trial, PhytoGen 499 WRF was hill dropped at a rate of 3 seed/row ft on 10 May. In 2018, planting dates for the cotton cultivar PhytoGen 490 W3FE sown at the above seeding rate were 8 May at BARU and 1 June on GCREC. The experimental design was a randomized complete block with four replications. Individual plots consisted of four, 30-ft rows on 3-ft (BARU) or 3.2-ft (GCREC) centers. Each study was irrigated as needed and managed to maximize yield. Fungicides were broadcast with a high-clearance sprayer with a four-row boom in 15 gal/A of spray volume at 40 psi. With the exception of the 6 oz/A Priaxor + 1 pt/A Bravo WeatherStik three or four application umbrella and Propulse or Velum Total in-furrow programs, most of the remaining fungicide treatments were broadcast at the third and fifth week of bloom. At both locations in both study years, target spot intensity was assessed on a 1 to 10 scale at 7 to 14 day intervals from the third through the tenth week of bloom and converted to % defoliation values. At BARU in 2018, a combined target spot and areolate mildew rating was also recorded using the above rating scale on 26 Sep, while only target spot was rated on 17 Sep. Areolate mildew defoliation ratings were calculated by subtracting the 17 Sep from the 26 Sep % defoliation ratings. The level of premature defoliation attributed to target spot at both study locations in 2017 and 2018 significantly differed by fungicide program.

Results

In 2017 at BARU, counts of open, unopen, hardlock, and rotted bolls did not significantly differ among any fungicide treatments, including the non-fungicide treated control (Table 1). Significant reductions in final defoliation ratings were recorded for all programs except for Velum Total in-furrow when compared with the non-fungicide treated control. The low % defoliation levels noted for the four application Priaxor + Bravo WeatherStik umbrella program was equaled by the two application 6 fl oz/A Priaxor, Topguard, Miravis, Amistar TOP, and Miravis programs. Similar fiber MIC and strength values were recorded across all fungicide programs including the non-fungicide treated control (Table 2). In contrast, greater fiber lengths were obtained for the Topguard-, Miravis-, and Headline-treated cotton. Uniformity fiber values were also superior for the Topguard- and Miravis-treated cotton. Among all fungicide programs, a significant increase in lint turn out when compared with the non-fungicide treated control was obtained with Elatus. In contrast, Velum Total-treated cotton had lower turn out than Elatus and Topguard. When compared with the non-fungicide treated control, significant ($P \leq 0.10$) yield gains were recorded for all fungicide programs except for Velum Total in-furrow, Amistar TOP, 6 fl oz Priaxor, and Quadris (Table 2). High yields obtained with Velum Total + Propulse and the Priaxor + Bravo WeatherStik umbrella programs were matched by all programs except for Velum Total in-furrow. While superior season-long target spot control was obtained with the 6 than 4 fl oz/A Priaxor, seed yields for these two programs were similar.

Table 1. Impact of registered and experimental fungicides on boll counts and final target spot % defoliation on PhytoGen 499 WRF at the Brewton Agricultural Research Center (BARU) in 2017.

Fungicide treatments [z]	Boll counts [y]				% defoliation [x]
	Open	Unopen	Hardlock	Rotted	
Non-fungicide treated control	32.6 a [w]	14.6 a	4.1 a	1.3 a	13.6 a
A20259 13.7 fl oz	40.8 a	14.0 a	3.5 a	1.3 a	6.9 b-e
Amistar Top 2.72SC 14 fl oz	32.0 a	4.7 a	3.3 a	2.0 a	7.0 b-e
Elatus 45W 7.3 oz	35.7 a	4.0 a	3.7 a	1.0 a	8.8 bc
Headline 2.09SC 6 fl oz	43.5 a	11.3 a	3.3 a	0.5 a	8.2 bcd
Miravis 1.67SC 5.13 fl oz	40.0 a	14.0 a	4.0 a	0.7 a	6.9 b-e
Priaxor 4.17SC 4 fl oz	42.7 a	13.7 a	4.0 a	1.0 a	8.0 bcd
Priaxor 4.17SC 6 fl oz	36.0 a	11.8 a	4.3 a	1.0 a	4.2 de
Quadris 2.08SC 6 fl oz	43.0 a	13.3 a	3.0 a	0.3 a	7.7 bcd
Topguard 1.14F 14 fl oz	29.7 a	7.7 a	2.3 a	1.0 a	5.8 cde
Velum Total 3.67SC 18 fl oz IF [v]	33.8 a	16.8 a	4.3 a	1.3 a	10.2 ab
Velum Total 3.67SC 18 fl oz IF [v] fb Propulse 3.34F 13.7 fl oz	42.5 a	17.0 a	2.8 a	1.5 a	8.1 bcd
Priaxor 4.17SC 8 fl oz + Bravo WeatherStik 6F 1 pt	52.5 a	13.8 a	3.3 a	0.8 a	3.2 e

[z] All foliar fungicide programs consisted of two applications at the 3rd and 5th week of bloom except for the Priaxor + Bravo WeatherStik positive control, which consisted of four total applications made at the 3rd, 5th, 7th, and 9th week of bloom.

[y] Boll counts were recorded on 3 foot of row immediately prior to harvest.

[x] Target spot intensity was rated using a 1 to 10 leaf spot scoring system on 18 Sep and converted to % defoliation values.

[w] Means in each column followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$), except for yield which used $P < 0.10$.

[v] The application of Velum Total was made over the seed in the open seed furrow with a single nozzle center over the row middle in 18 gal/A spray volume at 30 psi.

Table 2. Fiber quality values along with turn out and lint yield of PhytoGen 499 WRF as influenced by fungicide program at the Brewton Agricultural Research Unit in 2017.

	Fiber Quality				Turn	Lint yield
Fungicide treatments [z]	MIC [y]	Length	Strength	Unif [y]	out	lb/A
Non-fungicide treated control	5.0 a [x]	1.09 bc	30.4 a	83.1 cd	0.421 bc	1025 c
A20259 13.7 fl oz	4.9 a	1.10 abc	31.3 a	83.6 a-d	0.425 abc	1197 ab
Amistar Top 2.72SC 14 fl oz	5.2 a	1.08 c	31.0 a	83.2 bcd	0.423 abc	1147 abc
Elatus 45W 7.3 oz	5.0 a	1.10 abc	30.2 a	83.8 abc	0.437 a	1254 a
Headline 2.09SC 6 fl oz	5.1 a	1.12 a	31.0 a	84.0 abc	0.433 abc	1203 ab
Miravis 1.67SC 5.13 fl oz	5.0 a	1.13 a	31.3 a	84.2 ab	0.430 abc	1217 ab
Priaxor 4.17SC 4 fl oz	4.7 b	1.15 ab	30.8 a	83.3 bcd	0.423 abc	1176 ab
Priaxor 4.17SC 6 fl oz	4.9 a	1.10 abc	30.4 a	83.8 abc	0.423 abc	1137 abc
Quadris 2.08SC 6 fl oz	5.1 a	1.10 abc	29.7 a	84.0 abc	0.427 abc	1173 abc
Topguard 1.14F 14 fl oz	5.0 a	1.13 a	31.5 a	84.6 a	0.430 ab	1186 ab
Velum Total 3.67SC 18 fl oz IF[w]	4.9 a	1.10 abc	31.3 a	82.5 d	0.420 c	1090 bc
Velum Total 3.67SC 18 fl oz IF[w] fb Propulse 3.34F 13.7 fl oz	5.2 a	1.10 abc	30.6 a	83.3 a-d	0.425 abc	1243 a
Priaxor 4.17SC 8 fl oz + Bravo WeatherStik 6F 1 pt	5.0 a	1.10 abc	30.5 a	83.0 cd	0.428 abc	1271 a

[z] All foliar fungicide programs consisted of two applications at the 3rd and 5th week of bloom except for the Priaxor + Bravo WeatherStik positive control, which consisted of four total applications made at the 3rd, 5th, 7th, and 9th week of bloom.

[y] MIC = micronaire, Unif = uniformity.

[x] Means in each column followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$), except for yield which used $P < 0.10$.

[w] The application of Velum Total was made over the seed in the open seed furrow with a single nozzle center over the row middle in 18 gal/A spray volume at 30 psi.

At BARU in 2018 at the 17 Sep rating date, significant reductions in % defoliation attributed to target spot were obtained with all fungicide programs except for those that included one or more applications of Propulse and/or Proline and Elatus. Miravis TOP, Miravis TOP + Quadris, and all rates of BAS 75302F proved as effective in controlling target spot as the Priaxor + Bravo WeatherStik umbrella control. The total disease rating recorded on 27 Sep accounts for defoliation caused by target spot and areolate mildew. Areolate mildew % defoliation ratings represent the difference between % defoliation ratings recorded on 17 and 26 Sep. Again, similarly high defoliation ratings were obtained for all of the Propulse, Proline, and Elatus programs, while similarly low defoliation ratings were noted for Miravis TOP, Miravis TOP + Quadris, BAS 75302F, and Priaxor + Bravo WeatherStik. Regardless of the application timing, Propulse and Proline along with Elatus failed to protect cotton from areolate mildew, while the remaining fungicide programs, except for Topguard, displayed superior residual activity against this disease and target spot. Despite differences in disease control, similar seed yields were obtained at BARU in 2018 for all fungicide programs and for the non-fungicide treated control (Table 3).

Table 3. Defoliation attributed to target spot and areolate mildew along with lint yield of PhytoGen 490 W3FE as influenced by fungicide program at the Brewton Agricultural Research Unit in 2018.

Fungicide program and rate/A	Application timing [z]	% defoliation [y]		Areolate mildew % defoliation [y]	Seed yield lb/A
		Target spot [x]	Total disease [w]		
Non-fungicide treated control	---	19.9 a [v]	45.2 a	26.6 a	2840 abc
Propulse 3.34F 13.7 fl oz	At-plant	16.8 a	37.5 a	20.6 a	2971 a
Propulse 3.34F 13.7 fl oz	59 and 73 DAP	20.0 a	38.0 ab	18.0 abc	2485 d
Propulse 3.34F 13.7 fl oz fb Propulse 3.34F 13.7 fl oz fb Proline 480 SC 4.0SC 5.7 fl oz	At-plant 59 DAP 73 DAP	13.6 a	49.6 a	36.0 a	2776 abc
Proline 480 SC 4.0SC 5.7 fl oz	3rd & 5th week	18.8 ab	39.7 a	20.8 abc	2766 a-d
Priaxor 4.17SC 4 fl oz	3rd & 5th week	7.8 cd	10.0 d	2.1 e	2586 cd
Miravis TOP 1.67SC 13.7 fl oz	3rd & 5th week	5.5 cd	10.0 d	4.9 de	2840 abc
Miravis TOP 1.67SC 13.7 fl oz + Quadris 2.08SC 5.47 fl oz	3rd & 5th week	6.2 cd	15.3 cd	9.2 cde	2881 ab
Elatus 45W 6 oz	3rd & 5th week	14.6 ab	36.7 ab	22.1 abc	2772 a-d
Topguard 14 fl oz	3rd & 5th week	9.0 bc	19.6 bc	10.6 bcd	2590 cd
BAS 75302F 8 fl oz	3rd & 5th week	6.1 cd	10.0 d	3.9 de	2586 cd
BAS 75302F 12 fl oz	3rd & 5th week	5.4 cd	9.1 d	3.7 de	2635 bcd
BAS 75302F 15 fl oz	3rd & 5th week	4.9 cd	8.6 d	3.7 de	2576 cd
Priaxor 4.17SC 8 fl oz + Bravo WeatherStik 6F 1 pt	3rd, 5th & 7th week	4.5 d	8.2 d	3.7 de	2812 abc

[z] Application timing was 3rd and 5th week of bloom unless otherwise indicated.
[y] Target spot and areolate mildew intensity were rated using a 1 to 10 leaf spot scoring system and converted to % defoliation values.
[x] Target spot defoliation assessed on 17 Sep.
[w] Total disease rating = target spot and areolate mildew intensity rated together on 26 Sep.
[v] Means in each column followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P<0.05$).

When compared with the non-treated control, significant reductions in final defoliation were obtained at GCREC with all fungicide programs except for Helmstar SC along with Propulse in-furrow and early post broadcast programs. Miravis TOP + Quadris provided better target spot protection than all fungicide programs except for Miravis TOP, Elatus, and Propulse IF fb Propulse fb Proline 480SC. Significant reductions in premature defoliation were also obtained with Proline 480SC, both rates of Priaxor, Amistar TOP, and the Priaxor + Bravo WeatherStik umbrella program. As was noted above at BARU in 2018, no significant differences in seed yield were recorded at GCREC between any of the fungicide programs and the non-fungicide treated control.

Table 4. Seed yield and target spot defoliation as influenced by registered and experimental fungicides on PhytoGen 490 W3FE at the Gulf Coast Research and Extension Center in 2018.

Fungicide program and rate/A	Application timing	Target spot % defoliation [z]	Seed yield lb/A
Non-fungicide treated control	---	49.6 a [y]	2270 a
Propulse 3.34F 13.7 fl oz	At-plant	29.1 ab	2339 a
Propulse 3.34F 13.7 fl oz	40 DAP	29.1 ab	2354 a
Propulse 3.34F 13.7 fl oz fb Propulse 3.34F 13.7 fl oz fb Proline 480 SC 4.0SC 5.7 fl oz	At-plant 40 DAP 60 DAP	12.1 cd	2384 a
Proline 480 SC 4.0SC 5.7 fl oz	1st & 3rd week	22.3 bc	2178 a
Priaxor 4.17SC 4 fl oz	1st & 3rd week	21.1 bc	2407 a
Priaxor 4.17 SC 6 fl oz	1st & 3rd week	22.6 bc	2216 a
Miravis TOP 1.67SC 13.7 fl oz	1st & 3rd week	9.5 cd	2017 a
Miravis TOP 1.67SC 13.7 fl oz + Quadris 2.08SC 5.47 fl oz	1st & 3rd week	7.6 d	2258 a
Amistar TOP 2.72SC 14 fl oz	1st & 3rd week	28.2 bc	2281 a
Elatus 45W 6 oz	1st & 3rd week	10.7 cd	2304 a
Helmstar Plus SC 3.0 SC 13.0 fl oz	1st & 3rd week	30.2 ab	2190 a
Priaxor 4.17SC 8 fl oz + Bravo WeatherStik 6F 1 pt	PHS [x], 1st & 3rd week	21.4 bc	2186 a

[z] Target spot intensity was rated using a 1 to 10 leaf spot scoring system on 18 Sep and converted to % defoliation values.

[y] Means in each column followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P<0.05$).

[x] PHS = pinhead square.

Summary

Overall, Priaxor remains the registered fungicide of choice for foliar disease control in cotton. Typically, the lower 4 fl oz/A rate of this fungicide is sufficient to control target spot and other foliar diseases in cotton. Although not yet registered for use in cotton, Miravis TOP alone or in combination with Quadris is an effective fungicide for managing target spot and areolate mildew in cotton. The experimental fungicide BAS 75302F (revysol) also displayed excellent residual activity for controlling both of the above foliar diseases and proved equally efficacious over a range of application rates. Additional trials are needed to further access the efficacy of Propulse in-furrow and post plant programs against areolate mildew and target spot. Unfortunately, none of the fungicide programs screened in 2018 provided any protection from hard lock in cotton (data not shown).