

Field Evaluation of Fungicides against *Alternaria* and *Corynespora* Leaf Spot Pathogens on Cotton

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ABSTRACT: In India, cotton crop is affected by foliar diseases estimated to cause yield losses ranging from 20 to 30 per cent. Among them *Alternaria* and *Corynespora* are the major leaf spot diseases. In view of the importance a field experiment was conducted to evaluate common fungicides for both leaf spots during *kharif* 2020-21. The experiment was laid out in randomized block design (RBD) with seven treatments *viz.*, myclobutanil @ 0.1%, propiconazole 0.1%, hexaconazole @ 0.2%, metiram + pyraclostrobin @ 0.3%, copper oxychloride @ 0.3% and fluxapyroxad + pyraclostrobin @ 0.06% along with control and three replications. Severity of leaf spots was recorded by adopting 0-4 scale at seven days interval before and after spraying and per cent disease index (PDI) was calculated. Propiconazole @ 0.1% was found effective against *Corynespora* leaf spot with lowest per cent disease index of 4.67 and 87.61 per cent decrease in disease whereas hexaconazole @ 0.2% reduced *Alternaria* leaf spot (6.08 per cent disease index) to an extent of 70.08 per cent. The highest cotton seed yield (2493kg ha⁻¹), benefit cost ratio (1.68) and maximum incremental benefit cost ratio (15.25) were obtained with propiconazole @ 0.1% with 37.50 per cent increase in yield over unsprayed control. Next best was hexaconazole @ 0.2% with 2347 kg ha⁻¹ seed cotton yield, 1.55 benefit cost ratio and 8.31 incremental benefit cost ratio.

Keywords: *Alternaria*, *Corynespora*, Cotton, fungicides, management.

INTRODUCTION

Cotton (*Gossypium* spp.), is grown as annual crop in tropical and sub-tropical regions for fiber and oilseed predominantly. It belongs to the family Malvaceae, and generally referred as “White Gold” or as “King of Fibres”. In India, cotton occupies an area of 120.69 lakh ha with an annual production of 362.18 lakh bales of 170 kg and a productivity of 510 kg lint/ha. (ICAR-AICRP on Cotton, Annual Report, 2021-22). Globally cotton crop is affected by fungal, bacterial and viral diseases. In India, foliar diseases were estimated to cause yield losses ranging from 20 to 30% (Bhattiprolu and Monga 2018). Among the foliar diseases, *Alternaria* blight (*Alternaria macrospora*) was reported to cause yield loss of 26% (Sandipan *et al.*, 2017).

Corynespora cassiicola was reported to cause leaf spot on cotton from different parts of the world (Jones, 1961; Fulmer *et al.*, 2012 and Price *et al.*, 2015). In India, it was first reported from the Junagadh district of Gujarat in cotton Hybrid-4 and Hybrid-6 during 1984-1985 (Parakhia *et al.*, 1989) and yield losses of 100 to 200 lb per acre of lint was reported (Hagan and Sikora,

2012). In recent years *C. cassiicola* has been increasing in its prevalence on soybean and cotton. This pathogen was also reported on cotton from Brazil and China (Austin and Kira 2018). Recently Mohana Venkata Siva Prasad Bandi *et al.* (2022) confirmed the pathogenicity of *C. cassiicola* causing target leaf spot in cotton.

In Andhra Pradesh cotton was crop mostly affected by *Alternaria* leaf spot until 2016-2017, but due to favorable conditions for *Corynespora* development, it surpassed the *Alternaria* leaf spot and emerged as major cotton disease. In view of the economic importance of these leaf spots the present studies were conducted to find out the effective management for both *Alternaria* and *Corynespora* leaf spots of cotton.

MATERIALS AND METHODS

Field experiment was conducted during *kharif* 2020-21 at Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh. Cotton hybrid, Jaadoo BG II was sown on 27.07.2020 and the experiment was laid out in randomized block design (RBD) with seven treatments (Table 1). The treatments selected based on *in vitro* testing were imposed with three replications.

Table 1: List of fungicides used in field evaluation.

Treatments	Common Name	Trade Name	Formulation	Conc. (%)
1	Myclobutanil	Index	10% WP	0.1%
2	Propiconazole	Tilt	25% EC	0.1%
3	Hexaconazole	Contaf	5% SC	0.2%
4	Metiram + Pyraclostrobin	Cabrio top	60% WG	0.3%
5	Copper oxychloride	Blitox	50% WP	0.3%
6	Fluxapyroxad + Pyraclostrobin	Priaxor	50% SC	0.06%
7	Control	-	-	-

Three foliar sprays were given at fifteen days interval starting from the initial disease symptom appearance. Fungal foliar disease severity was recorded at seven days interval before and after spraying using 0 to 4scale given by Sheo Raj (1988): 0 = No disease; 1 = 0 to 5%;

2 = 5.1 to 20%; 3 = 20.1 to 40% and 4 = >40% leaf area are diseased. Depending on the scores collected, per cent disease index (PDI) was calculated by using the formula of Wheeler (1969):

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves scored} \times \text{maximum rating}} \times 100$$

Per cent disease control in each treatment was calculated. Treatment wise yield data were recorded. Decrease/ increase in the disease/ yield over control were calculated using the formula:

$$\frac{C - T}{C} \times 100 \text{ where}$$

C = PDI or yield of control;

T = PDI or yield (kg/ha) of respective treatment

Benefit cost ratio (B:C ratio) was calculated by dividing gross returns with gross expenditure for each treatment in comparison to untreated control. Incremental Cost: Benefit ratio (ICBR) was calculated by dividing net profit with plant protection cost for each treatment in comparison to untreated control.

RESULTS AND DISCUSSION

Effect of Fungicides on the severity of Alternaria

Leaf Spot in Cotton: All the fungicides were found to be effective in reducing Alternaria leaf spot disease in cotton after 14 days of first spray (Table 2). The per cent disease index (PDI) in unsprayed control (18.00) was significantly high compared to all other treatments (8.25 to 15.83). After 14 days of first spray the lowest PDI of 8.25 with maximum of 54.17% reduction in disease was recorded with propiconazole @ 0.1% (Fig 1). After 14 days of second spray PDI ranged from 7.07 (propiconazole @ 0.1%) to 14.92 (myclobutanil @ 0.1%) as against control (19.33 PDI). Propiconazole @ 0.1% and hexaconazole @ 0.2% were on par with 63.45% and 58.62% disease control, respectively. After 14 days of third spray PDI ranged between 6.08 (hexaconazole @ 0.2%) and 13.50 (myclobutanil @ 0.1%) over control (20.33 PDI). The least PDI was recorded in hexaconazole @ 0.2% (6.08) with the highest per cent decrease over control (70.08). However it was on par with propiconazole @ 0.1% (6.17 PDI and 69.67% inhibition) which was followed by combination fungicides. Copper oxy chloride @ 0.3% and myclobutanil @ 0.1% recorded less than 50 % inhibition of pathogen under field conditions (Table 2). Area under disease progress curve (AUDPC) data showed significant differences among treatments. The difference in AUDPC with number of fungicide application was statistically significant. The results

revealed propiconazole @ 0.1% as most effective fungicide against Alternaria leaf spot with least AUDPC value (578.5) followed by hexaconazole 5% (646.25) with PDI of 6.17 and 6.08, respectively (Fig. 3).

Present results were in accordance with Anand (2021), who reported that propiconazole @ 0.1% and metiram + pyraclostrobin@ 0.05% as most effective fungicides in controlling Alternaria leaf blight with minimum PDI of 2.94 and 3.15, respectively. Propiconazole (0.1%) was reported with the lowest PDI of 28.5 when sprayed at fortnightly intervals starting from first disease appearance of Alternaria leaf spot (Arunakumara *et al.*, 2010). Bhattiprolu and Monga (2017) reported propiconazole (0.1%) as effective fungicide against Alternaria leaf spot. Sangeetha *et al.* (2018) recorded hexaconazole @ 0.1% and propiconazole @ 0.1% as effective fungicides in managing the disease under field conditions

Effect of Fungicides on the severity of Corynespora

Leaf Spot in Cotton: All the fungicides reduced *Corynespora* leaf spot disease after first spray (13.00 to 25.00 PDI) as against unsprayed control with 27.50 PDI (Table 2). After 14 days of first spray, propiconazole @ 0.1% recorded the lowest PDI (13.00) and highest per cent disease inhibition of 52.73 and hexaconazole @ 0.2% was on par with 14.58 PDI and 46.97 per cent control (Fig. 2). After 14 days of second spray, PDI ranged from 10.33 (propiconazole @ 0.1%) to 23.17 (myclobutanil @ 0.1%) as against 33.08 PDI in control. The highest per cent disease inhibition was observed with propiconazole @ 0.1% (68.77%). It was found that hexaconazole @ 0.2% (12.08 PDI and 63.48% inhibition) was on par with propiconazole (10.33 PDI). After 14 days of third spray least PDI (4.67 PDI) and highest per cent decrease over control (87.61% inhibition) was recorded with propiconazole @ 0.1% (4.67 PDI). It was followed by hexaconazole@ 0.2% (10.00 PDI and 73.45% control) which in turn was on par with metiram + pyraclostrobin @ 0.3% (11.50 PDI) and fluxapyroxad + pyraclostrobin @ 0.06% (12.67 PDI and 66.37% control). Myclobutanil @ 0.1% recorded the least disease control of 42.26% with 21.75 PDI after third spray (Table 2 and Fig. 3).

Propiconazole @ 0.1% and hexaconazole @ 0.2% were statistically superior and on par against *Corynespora* leaf spot after 1st and 2nd sprays whereas after the 3rd spray, propiconazole @ 0.1% alone was found superior over all their treatments (Table 2).

Area under the disease progress curve (AUDPC) data showed significant differences among treatments. The results revealed that propiconazole @ 0.1% as effective fungicide against *Corynespora* leaf spot with least AUDPC value (803.75) followed by hexaconazole @ 0.2% (998.75) with 4.67 and 10.00 PDI, respectively. The highest AUDPC value was obtained in control plots with 2356.25 (Fig. 3).

Similar results were obtained by Tyler (2021) who reported that combination of propiconazole and fluxapyroxad + pyraclostrobin significantly reduced the target spot and also enhanced the yield. Bob (2021) found that fluxapyroxad + pyraclostrobin was the fungicide that performed best against the *C. cassiicola*. Mushrif *et al.* (2020) observed metiram + pyraclostrobin as the effective fungicide against *Corynespora* leaf fall disease in nursery fields of Rubber. Katrina (2018) reported that two applications of fluxapyroxad + pyraclostrobin gave the best season-long target spot control.

Effect of Fungicides on Seed Cotton Yield: Yield (kg ha⁻¹) among the treatments ranged from 1680 kg ha⁻¹ (unsprayed control) to 2493 kg ha⁻¹ (propiconazole @ 0.1%). All the chemicals evaluated were effective in

decreasing the foliar diseases thereby increasing yield compared to control. Propiconazole sprayed plots obtained increased yield (48.41 per cent) than unsprayed check and followed by hexaconazole @ 0.2% (2347 kg ha⁻¹) (Table 3).

The highest B: C ratio was obtained with propiconazole @ 0.1% (1.68) followed by hexaconazole @ 0.2% (1.55), metiram + pyraclostrobin @ 0.3% (1.47), copper oxy chloride @ 0.3% (1.33), fluxapyroxad + pyraclostrobin @ 0.06% (1.32), myclobutanil @ 0.1% (1.32) as against control (1.15) (Table 3).

Maximum ICBR of 15.25 was obtained with propiconazole @ 0.1% followed by metiram + pyraclostrobin @ 0.3% (9.36) and hexaconazole @ 0.2% (8.31). Least ICBR was obtained fluxapyroxad+pyraclostrobin @ 0.06% (3.05) (Table 3).

Dighule *et al.* (2011) reported that mancozeb (0.3%) and propiconazole (0.1%) were effective in reducing the losses due to leaf spot diseases (*Alternaria* leaf blight, *Myrothecium* leaf spot, *Helminthosporium* leaf spot) and increased the seed cotton yield. Sangeetha *et al.* (2018) observed both hexaconazole and propiconazole at 0.1 % concentration to be effective in managing the *Alternaria* leaf spot by recording a kapas yield of 15.37 and 14.84 q ha⁻¹ with a benefit cost ratio of 2.04 and 1.70 respectively. Price *et al.* (2015) found that fluxapyroxad + pyraclostrobin was best for control of target spot on cotton in United States.

Table 2: Efficacy of fungicides against *Alternaria* and *Corynespora* leaf spots in cotton.

T. No.	Treatments	<i>Alternaria</i> leaf spot (PDI) ^a			<i>Corynespora</i> leaf spot (PDI) ^a		
		After 1 st spray	After 2 nd spray	After 3 rd spray	After 1 st spray	After 2 nd spray	After 3 rd spray
T1	Myclobutanil 10% WP	15.83 (23.43) _{ef}	14.92 (22.71) _{ef}	13.50 (21.55) _{ef}	25.00 (29.98) _{ef}	23.17 (28.71) _f	21.75 (27.76) _f
T2	Propiconazole 25% EC	8.25 (16.66) _a	7.07 (15.37) _a	6.17 (14.33) _{ab}	13.00 (21.09) _a	10.33 (18.74) _a	4.67 (12.28) _a
T3	Hexaconazole 5% EC	9.25 (17.66) _{ab}	8.00 (16.42) _{ab}	6.08 (14.26) _a	14.58 (22.40) _{ab}	12.08 (20.30) _{ab}	10.00 (18.38) _b
T4	Metiram 55% + Pyraclostrobin 5% WG	11.58 (19.88) _{cd}	10.33 (18.74) _c	8.50 (16.88) _{cd}	16.67 (24.08) _{bc}	14.00 (21.95) _{bc}	11.50 (19.81) _{bc}
T5	Copper oxy chloride 50 % WP	14.17 (22.09) _{de}	12.75 (20.91) _{cde}	11.42 (19.73) _e	21.83 (27.80) _{de}	17.42 (24.64) _{de}	14.17 (22.10) _{cde}
T6	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l SC	11.17 (19.50) _{bc}	10.25 (18.62) _{cd}	8.00 (16.35) _c	18.83 (25.70) _{cd}	14.67 (22.49) _{bcd}	12.67 (20.84) _{bcd}
T7	Control	18.00 (25.05) _{fg}	19.33 (26.04) _g	20.33 (26.79) _g	27.50 (31.60) _g	33.08 (35.09) _g	37.67 (37.03) _g
	SEm ±	0.73	0.74	0.65	0.91	0.86	0.80
	CD (P ≤ 0.05)	2.25	2.27	2.00	2.81	2.65	2.47
	CV (%)	6.14	6.44	6.07	6.06	6.06	6.12

^aMeans of three replications; Figures in parentheses are arc sine transformed values.

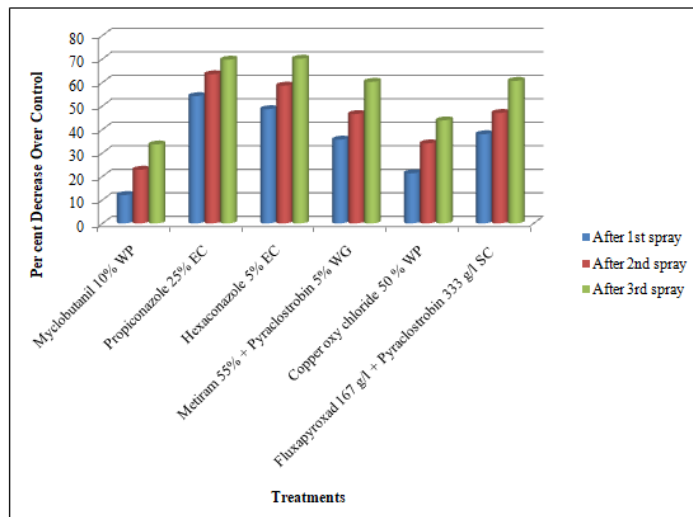


Fig. 1. Efficacy of fungicides against Alternaria leaf spot.

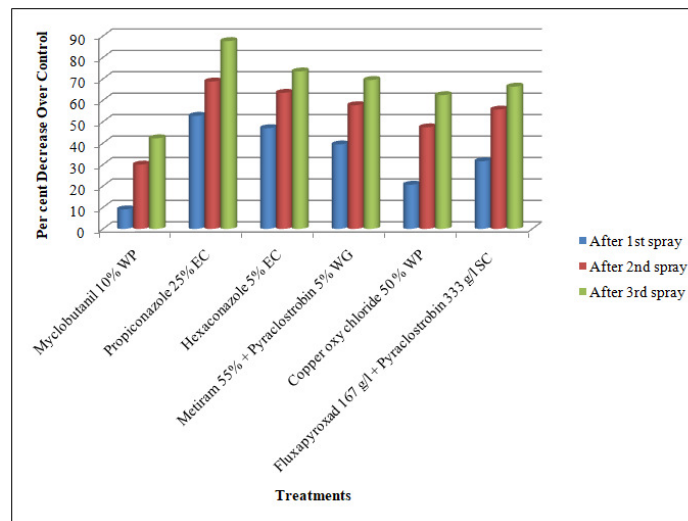


Fig. 2. Efficacy of fungicides against Corynespora leaf spot.

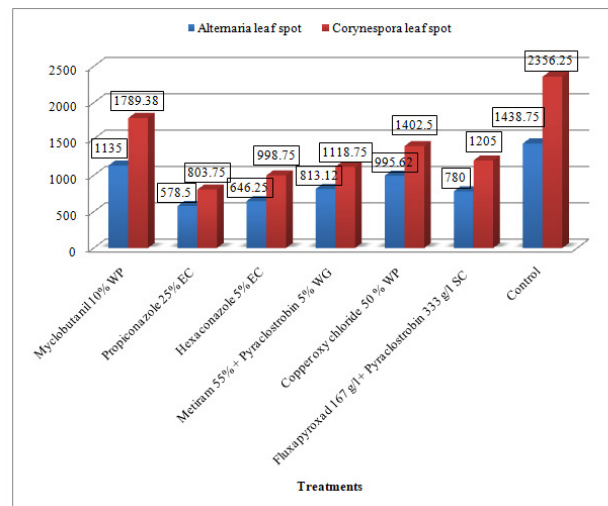


Fig. 3. Area under disease progress curve (AUDPC) for Alternaria and Corynespora leaf spots in different treatments.

Table 3: Effect of disease management on cotton seed yield (kg ha⁻¹) and Benefit cost ratio and ICBR ratio during kharif 2020-2021.

Treatments	Spray fluid Conc. (%)	Yield (kg ha ⁻¹)**	Per cent increase in yield over control (%)	Gross expenditure (Rs)	Gross returns (Rs)	Net returns (Rs)	Benefit cost Ratio	ICBR
Myclobutanil 10% WP	0.10%	1973 ^b	17.46	77600	102613	25013	1.32	5.32
Propiconazole 25% EC	0.10%	2493 ^a	48.41	77000	129653	52653	1.68	15.25
Hexaconazole 5% EC	0.20%	2347 ^a	39.68	78750	122026	43276	1.55	8.31
Metiram 55% + Pyraclostrobin 5% WG	0.30%	2187 ^b	30.16	77420	113706	36286	1.47	9.36
Copper oxy chloride 50 % WP	0.30%	2013 ^b	19.84	78200	104693	26493	1.33	4.95
Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l SC	0.06%	2093 ^b	24.60	82250	108853	26603	1.32	3.05
Control	-	1680 ^c	-	75500	87360	11860	1.15	
SEm (±)		73.34						
CD (P≤0.05)		225.99						
CV (%)		6.00						

**mean of three replications. Treatment means with the same alphabet do not differ significantly

CONCLUSION

On the basis of these results it is concluded that three sprays of hexaconazole @ 0.2% and propiconazole @ 0.1% at 15 day interval gave highest disease control of 70.08 per cent and 69.67 per cent, respectively, against *Alternaria* leaf spot. In case of *Corynespora* leaf spot disease, three sprays of propiconazole @ 0.1% at 15 days interval resulted in the highest disease reduction of 87.61 per cent Propiconazole @ 0.1% recorded the highest seed cotton yield of 2493 kg ha⁻¹ with B:C ratio of 1.68 and maximum ICBR (15.25) followed by hexaconazole @ 0.2% with seed cotton yield of 2347 kg ha⁻¹, 1.55 BCR and 8.31 ICBR.

FUTURE SCOPE

Alternaria and *Corynespora* leaf spot pathogens cause major damage in cotton than other leaf spots. So selection of common fungicides for both *Alternaria* and *Corynespora* leaf spot pathogens under combined infection conditions in cotton is best for the management of the diseases.

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Conflict of Interest. None.

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