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Field Efficacy of Fungicides towards Management of Fungal Foliar Diseases in Cotton

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ABSTRACT

Four fungicides *viz.,*hexaconazole, propiconazole, hexaconazole + captan, mancozeb, individually and their combinations were tested against fungal foliar diseases in cotton at Regional Agricultural Research Station, Lam, Guntur during *kharif* 2018-2019. Hexaconazole @ 0.2% was superior with 4.41 per cent disease index (PDI) against Alternaria leaf spot, Corynespora leaf spot (2.50 PDI), grey mildew (4.17 PDI) and rust (4.66 PDI) followed by hexaconazole + captan @ 0.1% which found effective towards Alternaria leaf spot (5.00 PDI), Corynespora leaf spot (3.06 PDI), grey mildew (4.73 PDI) and rust (5.00 PDI), whereas unsprayed controlrecorded Alternaria leaf spot (23.5PDI), Corynespora leaf spot (7.0 PDI), grey mildew (10.33 PDI) and rust (12.5 PDI).The fungicides, hexaconazole, hexaconazole + captan, mancozeb were statistically on a par with each other.The yields in different treatments ranged between 3613 to 3373kg/ha which were significantly *at par* while control recorded 2587kg/ha. The highest yield increase was recorded with hexaconazole (39.69%) followed by hexaconazole + captan (37.63%). Cost benefit ratio varied from 2.20 to 3.06 in different treatments.

Key words: *Alternaria leaf spot,Corynespora leaf spot, Cotton, Field efficacy, Fungicides, Grey mildew and Rust.*

Cotton (*Gossypium* spp.) referred as 'King of Fibre' and 'White Gold', is an important commercial cropin India with a cultivated area of 122.38 lakh ha, annual production of 361 lakh bales of 170 kg and a productivity of 501kg lint/ha during 2018-19. Andhra Pradesh rank 4th in area (6.66 lakh ha) but 7th in production (20.0 lakh bales) and 5th in productivity (617 kg/ha) (ICAR-AICRP on Cotton, 2019). Cotton crop is affected by number of foliar, soil borne pathogens, of which foliar diseases account for 20 to 30% yield losses (Mayee and Mukewar, 2007). Losses due to leaf spots such as Alternaria leaf spot(Chattannavar *et al*., 2006), Myrothecium leaf spot (Taneja *et al*., 1989) and Helminthosporium leaf spot (Bhattiprolu, 2010) were up to 26%, 15%, 32%, respectively. Hagan and Sikora (2012) recorded 100-200 lb/acre losses due to Corynespora leaf spot. Sandipan *et al.* (2017) estimated losses due to Alternaria leaf spot as 26.6% and Myrothecium leaf spot as 29.1%. In view of the economic importance of these fungal foliar diseases in cotton, certain fungicides and their combinations were evaluated *in vivo* against fungal foliar diseases in cotton.

MATERIALS AND METHODS

A field trial was carried out at Regional Agricultural Research Station, Lam, Guntur during *Kharif* 2018 – 2019. Cotton variety LHDP-1 was sown on second fortnight of July in plots of 27 sq. m. by adopting a spacing of 75 cm x 10 cm. Four fungicides along with their combinations comprising seven treatments and untreated control as detailed below were imposed.The treatments were replicated thrice in randomized block design.

Treatment details:

Treatments	Dosage (%)
T_1 - Hexaconazole 5% EC	0.20%
T_2 - Propiconazole 25% EC	0.10%
T_3 - Mancozeb 75% WP	0.30%
T_4 - Hexaconazole 5% EC + propiconazole 25% EC	0.1% + 0.05%
T_5 - Hexaconazole 5% EC + mancozeb 75% WP	0.1% + 1.5%
T_6 - Propiconazole 25% EC+ mancozeb 75% WP	0.05 % + 1.5%
T_7 - Hexaconazole + captan 75% WP	0.10%
T_8 - Untreated control	-

Two sprays were given at 15 days interval with first on 01.11.2018 (80 DAS) and second on 16.11.2018 (95 DAS) against Alternaria leaf spot. Corynespora leaf spot, grey mildew and rust disease symptoms appeared in the month of December 2018 (125 DAS) and third spray was given on 15.12.2018. Data on Alternaria leaf spot, Corynespora leaf spot, grey mildew and rust was recorded using 0 to 4 scale given by Shoe Raj (1988). Depending on the scores collected, per cent disease index (PDI) was calculated by using the formula of Wheeler (1969).

Scale	Percent of leaf area infected
0	No infection
1	Few spots of less than 2 mm size, leaf area covering less than 5%
2	Spots of 3 mm size, covering 6-20% of leaf area
3	Spots of 3-5 mm size, irregular in shape coalesce and covering 21-40% of leaf
4	Spots covering more than 40% of leaf

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Total No.of leaves scored x Max. rating}} \times 100$$

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:

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

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

Treatment wise net returns were calculated and cost benefit ratio was derived based on gross returns and gross expenditure.

RESULTS AND DISCUSSION

Efficacy of fungicides against Alternaria Leaf Spot

All the test fungicides were effective against Alternaria leaf spot. The PDI in different treatments ranged from 4.41 to 7.75 as against control (23.5). The least PDI was recorded in 0.2% hexaconazole (4.41) with the highest per cent decrease over control (81.2) which was statistically on a par with hexaconazole + captan @ 0.1% (5.0 PDI), 0.1% propiconazole (5.5 PDI). The highest PDI was recorded in 0.05% propiconazole + 0.15% mancozeb (7.75) with least per cent decrease over control (67%) which was statistically on a par with 0.3% hexaconazole @ 0.1% + mancozeb @ 0.15% (6.33 PDI) and 0.1% hexaconazole + 0.05% propiconazole (6.58 PDI). After first spray, hexaconazole @ 0.2%, hexaconazole + captan @ 0.1% and propiconazole @ 0.1% were statistically on par and the disease reduction was 48.0 to 49.7%. After the second spray hexaconazole @ 0.2%, hexaconazole + captan @ 0.1%, propiconazole @ 0.1% and mancozeb @ 0.3% were statistically on par and the disease reduction was 66.5 to 69.2%. After third spray, hexaconazole @ 0.2%, hexaconazole + captan @ 0.1% and propiconazole @ 0.1% were statistically on par and the disease reduction was 76.5 to 81.2% (Table 1, Fig 1).

All the fungicides tested were effective individually, in different crops as reported by several workers. Present findings are in accordance with Singh and Majumdar (2002), who reported that propiconazole was most effective in controlling *A. alternata*. Mesta *et al*. (2011) found hexaconazole @ 0.1% and propiconazole @ 0.1% were effective against Alternaria blight of sunflower with higher yields. Propiconazole (0.1%) recorded the lowest PDI when sprayed at fortnightly intervals starting from first appearance of Alternaria leaf spot (Arunakumara *et al*., 2010). Mancozeb (0.2%) was found effective in controlling the Alternaria blight of cotton (Chattannavar *et al*., 2006). The combination fungicide, captan + hexaconazole (Taqat) at 500 g/ha and 700 g/ha significantly reduced fungal foliar leaf spots in cotton (Bhattiprolu, 2010). Taqat @ 750 g/ha followed by propiconazole @ 0.1% recorded the lowest per cent disease incidence of Alternaria leaf spot (Kapadiya *et al*., 2015).

Efficacy of Fungicides on Corynespora Leaf Spot

All the test fungicides reduced the intensity of Corynespora leaf spot disease (Table 1, Fig 1). The PDI in different treatments ranged from 2.50 to 4.80 as against control (7.0). The least PDI was recorded with 0.2% hexaconazole (2.50) with the highest per cent decrease over control (64.2%) which was on a par with hexaconazole + captan @ 0.1% (3.06 PDI) and were significantly superior. The highest PDI was recorded in 0.05% propiconazole + 0.15% mancozeb (4.80) with least per cent decrease over control (31.4%) which is statistically on a par with 0.3% mancozeb (3.75 PDI), 0.1% hexaconazole + 0.15% mancozeb (4.25 PDI) and 0.1%hexaconazole + 0.05% propiconazole (4.50 PDI). Chowdhury *et al.* (2011) also observed the efficacy of mancozeb @ 0.25% against target spot (*Corynespora cassiicola).*

Efficacy of Fungicides against Grey mildew

All the test fungicides reduced the intensity of grey mildew (Table 1, Fig 1). The PDI in different treatments varied from 4.17 to 6.58 as against control (10.33). The least PDI was recorded with 0.2% hexaconazole (4.17) with the highest per cent decrease over control (59.6) which was on a par with hexaconazole + captan@ 0.1% (4.73 PDI) and 0.1% propiconazole (5.08 PDI) and were significantly superior in reducing the disease.

The highest PDI was recorded in 0.05% propiconazole+ 0.15% mancozeb (6.58) with least per cent decrease over control (36.3%) which was

Table 1.Effect of fungicides on disease severity of cotton fungal foliar diseases during *kharif* 2018-19

Treatments		Per cent disease index (mean of three replications)*					
		Alternaria leaf spot			Corynespora leaf spot	Grey mildew	Rust
		After 1st spray	After 2nd spray	After 3rd spray	After 3rd spray	After 3rd spray	After 3rd spray
T_1	Hexaconazole 5% EC @ 0.2%	7.75 (16.14)^{a}	5.58 (13.64)^{a}	4.41 (12.11)^{a}	2.5 (9.06)^{a}	4.17 (11.77)^{a}	4.66 (12.46)^{a}
T_2	Propiconazole 25% EC @ 0.1%	8.00 (16.38)^{a}	6.08 (14.26)^{ab}	5.50 (13.55)^{abc}	3.33 (10.49)^{b}	5.08 (12.98)^{abc}	5.33 (13.32)^{ab}
T_3	Mancozeb 75% WP @ 0.3%	9.66 (18.10)^{b}	7.16 (15.49)^{abc}	6.25 (14.46)^{bcd}	3.75 (11.15)^{bc}	5.40 (13.42)^{bcd}	5.50 (13.51)^{ab}
T_4	Hexaconazole 5% EC @ 0.1% + propiconazole 25% EC @ 0.05%	11.50 (19.81)^{bc}	8.83 (17.28)^{cd}	6.58 (14.85)^{cd}	4.50 (12.23)^{cd}	6.33 (14.56)^{cd}	6.08 (14.26)^{b}
T_5	Hexaconozole 5% EC @ 0.1% + mancozeb 75% WP @ 0.15%	11.16 (19.50)^{bc}	7.75 (16.15)^{bcd}	6.33 (14.56)^{bcd}	4.25 (11.86)^{cd}	6.08 (14.26)^{cd}	6 (14.16)^{b}
T_6	Propiconazole 25% EC @ 0.05% + mancozeb 75% WP @ 0.15%	11.75 (20.03)^{c}	9.25 (17.69)^{d}	7.75 (16.14)^{d}	4.8 (12.65)^{d}	6.58 (14.85)^{d}	6.33 (14.56)^{b}
T_7	Hexaconazole + captan 75% WP @ 0.1%	7.83 (16.24)^{a}	6.00 (14.16)^{ab}	5.00 (12.91)^{ab}	3.06 (10.05)^{ab}	4.73 (12.53)^{ab}	5.00 (12.90)^{ab}
T_8	Unsprayed Check	15.41 (23.07)^{d}	18.16 (25.15)^{e}	23.5 (28.93)^{e}	7.00 (15.31)^{e}	10.33 (18.68)^{e}	12.5 (20.65)^{c}
	SEm ±	0.56	0.67	0.59	0.44	0.52	0.55
	CD (P ? 0.05)	1.71	2.05	1.8	1.35	1.59	1.68
	CV (%)	5.24	7.02	6.44	6.64	6.46	6.63

*Figures in parentheses are arc sine transformed values Treatments with same alphabet are not significantly different.

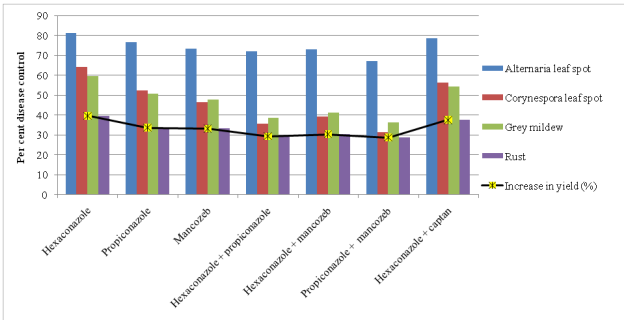

Fig 1. Efficacy of fungicides against fungal foliar diseases in cotton

statistically on a par with 0.3% mancozeb (5.40 PDI), 0.1% hexaconazole + 0.15% mancozeb (6.08 PDI) and 0.1% hexaconazole + 0.05% propiconazole(6.33 PDI). These results are in conformity with previous findings. Propiconazole was found most effective against grey mildew (Shastry and Tomar, 2008; Khodke and Raut, 2019). Ashtaputre *et al.* (2011) observed the least incidence of grey mildew with penconazole (10.30 PDI) followed by hexaconazole (11.10 PDI) whereas Bhattiprolu and Monga (2017) found carbendazim (0.1%) was effective against grey mildew.

Efficacy of Fungicides on Rust

All the test fungicides evaluated were effective in reducing the rust disease (Table 1, Fig 1). The PDI in different treatments ranged from 4.66 to 6.33 as against control (12.5). Hexaconazole @ 0.2% recorded the lowest PDI (4.66) with the highest per cent decrease over control (62.7%) which was statistically on a par with hexaconazole + captan @ 0.1% (5.00 PDI), 0.1% propiconazole (5.33 PDI), 0.3% mancozeb (5.50 PDI) and were significantly superior in reducing the disease. The highest PDI was recorded in 0.05% propiconazole + 0.15% mancozeb (6.33) with least per cent decrease over control (49.3%). Shridhara Shetty Pindikur (2012) and Bhattiprolu (2015) recorded effective management of rust with hexaconazole and propiconazole, respectively.

Table 2. Effect of fungicides on seed cotton yield (kg/ha) and Benefit cost ratio during *kharif* 2018-19

Treatments		Spray fluid Conc. (%)	Yield (kg/ha)*	Percent increase in yield over control	Gross expenditure (Rs)	Gross returns (Rs)	Net returns (Rs)	Benefit cost Ratio
T_1	Hexaconazole 5% EC @ 0.2%	0.2	3613[a]	39.69	64908	198715	133807	3.06
T_2	Propiconazole 25% EC @ 0.1%	0.1	3460[a]	33.76	65040	190300	125260	2.92
T_3	Mancozeb 75% WP @ 0.3%	0.3	3447[a]	33.24	65170	189200	124030	2.9
T_4	Hexaconazole 5% EC @ 0.1% + propiconazole 25% EC @ 0.05%	0.10 + 0.05	3347[a]	29.38	64974	183700	118726	2.82
T_5	Hexaconozole 5% EC @ 0.1% + mancozeb 75% WP @ 0.15%	0.10 + 0.15	3373[a]	30.41	65039	185350	120311	2.84
T_6	Propiconazole 25% EC @ 0.05% + mancozeb 75% WP @ 0.15%	0.05 + 0.15	3333[a]	28.8	65105	183150	118045	2.81
T_7	Hexaconazole + captan 75% WP @ 0.1%	0.1	3560[a]	37.63	65235	195800	130565	3
T_8	Unsprayed Check	-	2587[b]	-	64500	141900	77400	2.2
	SEm (±)		134.04					
	CD (P?0.05)		406.59					
	CV (%)		6.95					

*Means of three replications; Treatment means with same alphabet do not differ significantly

Effect of Fungicides on Seed Cotton Yield

The highest yield (3613 kg/ha) was obtained from hexaconazole sprayed plots which recorded 39.69% more yield than unsprayed control (2587 kg/ha). Hexaconazole @ 0.2% wasfound to be on a par with hexaconazole +captan @ 0.1% (3560 kg/ha), 0.1% propiconazole (3460kg/ha), 0.3% mancozeb (3446 kg/ha), 0.1% hexaconazole + 0.15% mancozeb (3373 kg/ha), 0.1% hexaconazole+ 0.05% propiconazole (3347kg/ha) and 0.05% propiconazole + 0.15% mancozeb (3333 kg/ha) (Table 2). Khodke and Raut (2009) achieved maximum seed cotton yield with tridemorph and propiconazole. Chowdhury *et al.* (2011) observed the lowest PDI of Corynespora leaf spot and the highest yield with mancozeb @ 0.25%.Bhattiprolu (2010) reported that the combination fungicide, captan + hexaconazole (Taqat) at 0.1% significantly reduced fungal leaf spots *viz*., *Alternaria, Helminthosporium and Myrothecium* and increased yield by 22%. Dighule *et al*. (2011) found 0.3% mancozeb and 0.1% propiconazole effective in reducing the losses due to leaf spot diseases and increased the seed cotton yield.

The highest B: C ratio was obtained with 0.2% hexaconazole (3.06) followed by 0.1% hexaconazole + captan (3.00), 0.1% propiconazole (2.92), 0.3% mancozeb (2.90), 0.1% hexaconazole + 0.15% mancozeb (2.84), 0.1% hexaconazole + 0.05% propiconazole (2.82), and 0.05% propiconazole + 0.15% mancozeb (2.81) (Table 2). Khodke and Raut (2009) obtained the highest cost benefit ratio with tridemorph @ 0.07%, followed by propiconazole @ 0.05%.

CONCLUSION

The study revealed broadspectrum activity of hexaconazole @ 0.2%, hexaconazole + captan @ 0.1% and propiconazole @ 0.1% against Alternaria and Corynespora leaf spots, grey mildew and rust diseases in cotton which were statistically on a par with 0.3% mancozeb, 0.1% hexaconazole + 1.5% mancozeb, 0.1% hexaconazole + 0.05% propiconazole and 0.05% propiconazole + 1.5% mancozeb and their use in integrated disease management of cotton.

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