

Integrated management of foliar diseases in cotton

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ABSTRACT: Evaluation of 3 modules {Seed treatment (ST) with *Pseudomonas fluorescens* @ 10g/kg seed and soil application (SA) of *P. fluorescens* @ 2.5kg/ha followed by 2 foliar sprays (FS) with *P. fluorescens* (1%) at 60 and 90 days after sowing (DAS)); ST with *P. fluorescens* @ 10g/kg seed followed by need based FS with propiconazole (0.1%) for Alternaria leaf spot at 60 DAS and copper oxy chloride, COC (0.3%) + streptocycline (0.01%) for bacterial blight at 90 DAS (or) carbendazim (0.1%) at 60 DAS against grey mildew and propiconazole (0.1%) for Alternaria leaf spot and rust at 90 DAS; and ST with *P. fluorescens* @ 10g/kg seed and SA of *Trichoderma viride* @ 2.5kg/ha followed by need based FS with kresoxim methyl @ 1ml/l at 60 DAS and combined product of captan+hexaconazole @ 1.5g/l at 90 and 120 DAS for fungal diseases or COC (0.3%) + streptocycline (0.01%) for bacterial blight at 60 and 90 DAS) for integrated management of foliar diseases in cotton revealed that the modules were significantly superior against Alternaria leaf spot and bacterial blight in Jadoo BG II and RCH BG II. Modules I and II significantly reduced grey mildew in both the hybrids. Module II and III gave best control of rust in Jadoo BG II while module I and III were superior in RCH 2 BG II. All the 3 modules resulted in significant increase in the yield of Jadoo BG II while modules I and II gave superior yields in RCH 2 BG II. Module III resulted in highest Incremental Benefit Cost Ratio (IBCR) of 1.35 in Jadoo BG II followed by module I (1.31) while module II gave maximum IBCR of 1.30 in RCH 2 BG II.

Key words: Cotton, foliar diseases, integrated disease management

Cotton is an important fibre crop in India. Cotton crop is affected by a foliar diseases throughout the season. Alternaria leaf spot, bacterial blight, grey mildew and rust diseases cause significant yield losses under congenial conditions. Spraying copper fungicide (0.3%) mixed with streptocycline (0.01%) control bacterial blight (Bhattiprolu, 2013). Propiconazole is effective against Alternaria leaf spot and rust diseases (Bhattiprolu, 2015b). Carbendazim is recommended to prevent losses due to grey mildew (Bhattiprolu, 2012). With these recommendations against individual diseases, an experiment was conducted to develop modules for integrated management of foliar diseases in cotton.

MATERIALS AND METHODS

A field trial was laid out at Regional Agricultural Research Station, Lam, Guntur during *kharif*, 2011 to 2013. Eight treatments (3 modules with 2 *Bt* hybrids plus controls) were replicated thrice in plots of 50 sqm by adopting a spacing of 105 x 60 cm in randomized block design. Module I (T1 and T4) was composed of seed treatment (ST) with *Pseudomonas fluorescens* @ 10g/kg seed and soil application (SA) of *P. fluorescens* @ 2.5kg/ha followed by 2 foliar sprays with *P. fluorescens* (1%) at 60 and 90 days after sowing (DAS). Module II (T2 and T5) involved ST with *P. fluorescens* @ 10g/kg seed followed by need based foliar sprays with

propiconazole (0.1%) for Alternaria leaf spot at 60 DAS and copper oxy chloride (COC) (0.3%) + streptomycin (0.01%) for bacterial blight at 90 DAS (or) carbendazim (0.1%) at 60 DAS against grey mildew and propiconazole (0.1%) for Alternaria leaf spot and rust at 90DAS. Module III (T3 and T6) included ST with *P. fluorescens* @ 10g/kg seed and SA of *Trichoderma viride* @ 2.5kg/ha followed by need based foliar sprays with kresoxim methyl @ 1ml/l at 60 DAS and combined product of captan+hexaconazole @ 1.5g/l at 90 and 120 DAS for fungal diseases or COC (0.3%) + streptomycin (0.01%) for bacterial blight at 60 and 90 DAS. Control plots (Jadoo BG II of T7 and RCH 2 BG II T8) received no protection for diseases. Data on bacterial blight, Alternaria leaf spot, grey mildew and rust were recorded using 0 to 4 scale and per cent disease intensity was recorded. Per cent disease control in each treatment was calculated using Wheeler's formula:

$$\text{PDI} = \frac{\text{Sum of all the numerical ratings}}{\text{Total leaves scored} \times \text{Maximum disease grade}} \times 100$$

Treatment wise yield data was recorded and increase in yield over control was calculated.

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

T = yield (q/ha) of respective treatment
C = yield in control

Treatment wise net returns and incremental benefit cost ratio (IBCR) was calculated.

RESULTS AND DISCUSSION

During 2011 lowest intensity of

Alternaria leaf spot (16.33%) was recorded with module II in hybrid RCH 2 BG II followed by module I (17.67%) in Jadoo BG II while it recorded the lowest intensity with module III (4.56%) in hybrid Jadoo BG II during 2012. Module I resulted in lowest ALS (7.93% and 8.67%) in both the hybrids during 2013. Pooled data revealed that module I recorded the lowest intensity (10.34%) in Jadoo BG II while module II was the next with 10.72 per cent in RCH 2 BG II. Control plots of Jadoo BG II and RCH 2 BG II showed 27.72 per cent and 27.77 per cent, respectively. All the 3 modules were superior against Alternaria leaf spot over control during the years of testing (Table 1). Module I and III recorded the lowest intensity of bacterial blight in hybrids Jadoo BG II and RCH 2 BG II, respectively (7.49% and 7.50%) while unprotected plots showed 16.46 per cent and 16.39 per cent, respectively.

With respect to rust, module II resulted in lowest intensity (8%) followed by module III (8.92%) in Jadoo BG II whereas module I and III were superior to module II in RCH 2 BG II during 2012. Lowest intensity of 10.2 per cent was recorded in RCH 2 BG II with Module I followed by module III in Jadoo BG II and RCH 2 BG II with 11 per cent and 13 per cent, respectively, during 2013.

Pooled data revealed that Module III recorded the lowest rust intensity (9.96%) in Jadoo BG II, while module II was *on par*. Module I (10.19%) and module III (11.59%) were superior against rust in RCH 2 BG II. Control plots of Jadoo BG II and RCH 2 BG II recorded 28.89 per cent and 26.72 per cent rust, respectively. Modules I and II significantly reduced grey mildew in Jadoo BG II and RCH 2 BG II. Intensity of rust was highest in unprotected Jadoo BG II (39%).

Different modules resulted in 58.04 per cent to 62.70 per cent control of Alternaria leaf

Table 1. Integrated management of foliar diseases in cotton (Pooled data, 2011-2013)

Treatments	Per cent disease intensity'													
	Alternaria leaf spot					Bacterial blight					Rust		Grey mildew	
	2011-2012	2012-2013	2013-2014	Mean	2011-2012	2012-2013	2013-2014	Mean	2012-2013	2013-2014	Mean	2013-2014	2013-2014	2013-2014
Module 1 Jadoo BG II	17.67 (24.84)a	4.67 (12.52)a	8.67 (17.11) a	10.34 (18.72) a	7.49 (15.79)a	13.33 (21.39)b	14 (21.97)b	13.67 (21.68)b	12 (20.27)c					
Module 2 Jadoo BG II	18.33 (25.33)a	5.38 (13.44)a	10 (18.44)a	11.24 (19.55) a	9.7 (18.15)a	8 (16.43)a	14 (21.97)b	11 (19.37)a	11 (19.37)c					
Module 3 Jadoo BG II	19 (25.84)a	4.56 (12.39)a	11.33 (19.64)b	11.63 (19.91)a	8.75 (17.21)a	8.92 (17.36)a	11.0 (19.37)a	9.96 (18.39)a	15 (22.79)d					
Module 1 RCH 2 BG II	20 (26.56)a	6.05 (14.30)a	7.93 (16.32)a	11.33 (19.64)a	7.66 (16.06)a	10.17 (18.63)a	10.2 (18.63)a	10.19 (18.58)a	2 (8.13)a					
Module 2 RCH 2 BG II	16.33 (23.81)a	5.83 (13.94)a	10 (18.44)a	10.72 (19.09) a	9.49 (17.90)a	14.33 (22.22)b	14 (21.97)b	14.17 (22.1)b	3 (9.89)a					
Module 3 RCH 2 BG II	18.33 (25.33)a	5.71 (13.81)a	9 (17.46)a	11.01 (19.37) a	7.5 (15.89)a	10.17 (18.63)a	13 (21.13)a	11.59 (19.87)a	5.9 (14.06)b					
Jadoo BG II	32.83 (34.94)b	29.33 (32.77)b	21 (27.28)c	27.72 (31.76)b	16.46 (23.89)b	21.78 (27.83)c	36 (36.87)d	28.89 (32.49)c	39 (38.65)e					
RCH 2 BG II	34 (35.67)b	27 (31.31)c	22.3 (28.86)c	27.77 (31.79)b	16.39 (23.85)b	21.44 (27.58)c	32 (34.45)c	26.72 (31.11)c	7.5 (15.89)b					
CD(p=0.05)	3.722	1.887	2.477	1.26	2.269	3.442	3.11	2.824	3.373					
CV (%)	9.6	9.7	11.3	4.7	12.4	14.5	9.9	10.40%	16.7					

*Figures in parentheses are transformed values. Figures marked with same letters are not significantly different.

T1 and T4 - Seed treatment (ST) with *Pseudomonas fluorescens* @ 10g/kg seed and soil application (SA) of *P. fluorescens* @ 2.5kg/ha followed by 2 foliar sprays (FS) with *P. fluorescens* (1%) at 60 and 90 days after sowing (DAS); T2 and T5 - ST with *P. fluorescens* @ 10g/kg seed followed by need based FS with propiconazole (0.1%) for Alternaria leaf spot at 60 DAS and copper oxy chloride (0.3%) + streptocycline (0.01%) for bacterial blight at 90 DAS (or) carbendazim (0.1%) at 60 DAS against grey mildew and propiconazole 0.1% for Alternaria leaf spot and rust at 90 DAS; T3 and T6 - ST with *P. fluorescens* @ 10g/kg seed and SA of *Trichoderma viride* @ 2.5kg/ha followed by need based FS with kresoxim methyl @ 1ml/l at 60 DAS and combined product of captan+hexaconazole @ 1.5g/l at 90 and 120 DAS for fungal diseases or COC (0.3%) + streptocycline (0.1%) for bacterial blight at 60 and 90 DAS; T7 and T8 - No protection for diseases. Jadoo BG II (T1, T2, T3 and T7) and RCH 2 BG II (T4, T5, T6 and T8) were the test hybrids.

Table 2. Integrated management of foliar diseases in cotton (Pooled data, 2011-2013)

Treatments	Reduction in disease (%)				Seed cotton yield (q/ha)				Increased yield (%)	Benefit Cost Ratio	Incremental BCR
	Alternaria leaf spot	Bacterial blight	Grey mildew	Rust	2011-2012	2012-2013	2013-2014	Mean			
Module 1 Jadoo BG II	62.70	54.50	69.23	52.68	13.33b	12.43a	14.60a	13.45a	30.20	1.18	1.31
Module 2 Jadoo BG II	59.45	41.07	71.79	61.90	13.09b	12.27a	13.33a	12.90a	24.88	1.11	1.25
Module 3 Jadoo BG II	58.04	46.84	61.54	65.52	14.73a	12.63a	14.40a	13.92a	34.75	1.16	1.35
Module 1 RCH 2 BG II	59.20	38.25	73.33	61.86	12.67b	13.10a	12.33a	12.70a	25.37	1.10	1.26
Module 2 RCH 2 BG II	61.40	42.10	60.0	46.99	14.37a	12.43a	12.67a	13.16a	29.91	1.12	1.30
Module 3 RCH 2 BG II	60.35	54.24	21.33	55.50	12.33b	11.73a	12.50a	12.19b	20.34	1.12	1.21
Jadoo BG II					11.33c	9.27b	10.4b	10.33c	0	0.92	
RCH 2 BG II					11.13c	9.77b	9.5b	10.13c	0	0.90	
CD(p=0.05)					1.168	1.438	2.38	0.80			
CV (%)					5.2	7.1	10.9	3.7			

T1 and T4 - Seed treatment (ST) with *Pseudomonas fluorescens* @ 10g/kg seed and soil application (SA) of *P. fluorescens* @ 2.5kg/ha followed by 2 foliar sprays (FS) with *P. fluorescens* (1%) at 60 and 90 days after sowing (DAS); T2 and T5 - ST with *P. fluorescens* @ 10g/kg seed followed by need based FS with propiconazole (0.1%) for Alternaria leaf spot at 60 DAS and copper oxy chloride (0.3%) + Streptocycline (0.01%) for bacterial blight at 90 DAS (or) carbendazim (0.1%) at 60 DAS against grey mildew and propiconazole (0.1%) for Alternaria leaf spot and rust at 90 DAS; T3 and T6 - ST with *P. fluorescens* @ 10g/kg seed and SA of *Trichoderma viride* @ 2.5kg/ha followed by need based FS with kresoxim methyl @ 1ml/l at 60 DAS and combined product of captan+hexaconazole @ 1.5g/l at 90 and 120 DAS for fungal diseases or COC (0.3%) + streptocycline (0.01%) for bacterial blight at 60 and 90 DAS; T7 and T8 - No protection for diseases. Jadoo BG II (T1, T2, T3 and T7) and RCH 2 BG II (T4, T5, T6 and T8) were the test hybrids.

spot. Module I gave maximum control of bacterial blight (54.50%) in Jadoo BG II, while module III recorded 54.24 per cent control in RCH 2 BG II. Module II gave highest control of grey mildew (71.79%) in susceptible hybrid, Jadoo BG II. Rust was controlled to the tune of 65.52 per cent in Jadoo BG II in module III and 61.86 per cent in RCH 2 BG II with module I (Table 2).

Efficacy of biocontrol agent, *P. fluorescens* as seed treatment followed by foliar applications was found effective against Alternaria leaf spot, bacterial blight and grey mildew Raghavendra *et al.*, (2013) adopted seed inoculation followed by foliar sprays and found *P. fluorescens* and *T. harzianum* effective in controlling bacterial blight under field conditions. Efficacy of seed treatment

with endospore forming bacteria against foliar, seed/soil borne diseases of cotton was reported by Medeiros *et al.*, (2015). Module I involving *P. fluorescens* confirms these findings. Efficacy of carbendazim against grey mildew as part of module II and III, in susceptible *Bt* hybrid like Jadoo is in agreement with Bhattiprolu (2012). Management of bacterial blight with combination of COC and streptocycline in modules II and III validates the previous work (Jagtap *et al.*, 2012; Bhattiprolu, 2013). Efficacy of Module III using foliar applications with kresoxim methyl and combination of captan and hexaconazole also confirms reports of Meena and Ratnoo (2013) reported the efficacy of hexaconazole against cotton leaf spot caused *Alternaria* spp.

All 3 modules resulted in significant increase in the yield in the range of 20.34 per cent to 34.75 per cent. Maximum IBCR of 1.35 was recorded with module III followed by module I in Jadoo BG II (1.31) and module II (1.30) in RCH 2 BG II (Table 2). In conclusion farmers are advised to adopt integrated management of foliar diseases using recommended biocontrol agents and/or chemicals in *Bt* cotton hybrids.

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