Integrated disease management of cotton

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ABSTRACT : The effect of fungicides and bio agents on cotton against foliar and soil borne diseases and yield were assessed in field experiment conducted at Cotton Research Station Junagadh Agricultural University Junagadh during 2014, 2015 and 2016. Total eight modules were tested against cotton diseases. All modules were suppressed diseases and increase yield as compare to control. Out of them module 7 seed treatment (ST) *Pseudomonas fluorescens* (JAU isolate) @ 10g/ kg of seed, *Trichoderma harzianum* (JAU isolate) @2.5 kg/ha in 250 kg of FYM in soil application (SA), *P. fluorescens* (JAU isolate) 1 per cent for Alterneria leaf spot and copper oxychloride(0.2%) +Streptocycline (0.01%) for Bacterial leaf blight two spray 15 days interval on initiation of diseases was significantly superior. In module 7 highest germination per cent 92.13 was recorded with minimum mortality 7.16 per cent as compare to control 92.13 and 11.81 per cent respectively was recorded, minimum Alterneria leaf spot 9.16 per cent as compare to control 13.62 per cent was recorded, minimum bacterial leaf blight 4.55 per cent as compare to control 7.15 per cent was recorded, highest seed cotton yield 2284 kg/ha was recorded. Module 7 was statistical *at par* with module 6 in this module seed treatment and soil application were common in module-7 only foliar sprays with Kresoxim methyl (44.3 % SC) @ 1ml/lit followed by captan (70%) + hexaconaxole (5%) @1.5 g/lit for fungal diseases was diverse. Looking to economics highest net realization of Rs 30837 / and Incremental Benefit Cost Ration (IBCR) 1:4.22 was obtained in module 7.

Key words: Cotton, foliar, integrated disease management, soil borne diseases

Cotton is one of the most important fiber and commercial cash crops of India. It plays a key role in national economy in terms of activities, employment and foreign exchange earnings. In the cotton growing states, Gujarat has a place in the forefront. Cotton cultivated area in Gujarat (2018-2019) was 27 lac ha and production was 91.80 lac bales (Anonymous 2016). More disease are infected in cotton leaves and boll under favorable environment condition. Resulting, considerable economical loss is being occurred. The important foliar diseases are bacterial blight caused by *Xanthomonas axonopodis* pv. *malvacearnum* (E.F. Smith), leaf

spots caused by *Alternaria macrospora* Zimm are observed in all cotton growing areas, but more serious in Maharashtra, Gujarat, Karnataka, Andhra Pradesh and Tamil Nadu and estimated a loss upto 26.6 per cent (Monga *et al.,* 2013) Grey mildew disease (*Ramularia areola* Atk) is commonly occurring in Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh and Tamil Nadu. There was reduction of loss up to 29.20 per cent at Dharwad, Guntur and Nanded during 2009-2011 (Monga *et al.,* 2013). This disease was occurs in heavy rainy periods with serious defoliation occurring. Foliar diseases account up to 20 to 30 per cent losses in cotton. More

specifically the diseases are at best a secondary issue following a reduction in leaf potassium as a result of boll set. Nutrients shifting from the leaves (course) to the bolls (sink) reduce the concentration of nutrients in the leaves and make them easy targets for weak pathogens. Boll rot incidence is a completely different issue and will likely be the focus of a blog update later in the season. Moreover, spots can develop on leaves, the stem and bolls as a result of any of the foliar diseases listed above.

MATERIALS AND METHODS:

The field trial was conducted at Cotton Research Station, Junagadh Agricultural University, Junagadh in randomized block design (RBD) with 8 treatments along with three replications having plot size of 6.30 x 4.8 m. and variety G.Cot hy 8 BG-II with spacing of 1.20 x 0.45 m. All the recommended agronomical practices were followed during experimentation.

ST= Seed treatments FS= Foliar spray SA=Soil application

Three foliar spray were carried out at initiation of diseases. Data on foliar diseases including bacterial leaf blight and *Alternerial* leaf spot were recorded at 0-4 scale as per Raj(1988). Based upon the disease scores per cent disease

Details of Treatment

Sr	Module	Details of treatments
T_1	**Module 1**	**ST:** *Trichoderma viride* (TNAU isolate)@ 10g/kg of seed ;**SA:** *T. viride* @ 2.5 kg/ha ; **FS:** *T. viride* @ (1%) .
T_2	**Module 2**	**ST:** *Bacillus subtilis* (TNAU isolate) @ 10g/kg of seed; **SA**: *B. subtilis* @ 2.5 kg/ha; **FS:** *B. subtilis* @ (1%) .
T_3	**Module 3**	**ST:** *Pseudomonas fluorescens* (TNAU isolate) @ 10g/kg of seed; **SA:** *P. fluorescens* @ 2.5 kg/ha; **FS:** *P. fluorescens* @ (1%) .
T_4	**Module 4**	**ST:** *Pseudomonas fluorescens* (CICR isolate) @ 10g/kg of seed;**SA:** *P. fluorescens* @ 2.5 kg/ha in 250 kg of FYM; **FS:** *P. fluorescens* - (1%) .
T_5	**Module 5**	**ST:** *Pseudomonas fluorescens* (CICR isolate) @10g/kg of seed; **SA:** *Trichoderma viride* @ 2.5 kg/ha (TNAU isolate) **FS:** Propiconazole (0.1%) for foliar diseases and COC (0.3%) + Streptocycline (0.01%) for BLB or Carbendazim (0.1%) for grey mildew on need basis
T_6	**Module 6**	**ST:** *Pseudomonas fluorescens* (CICR isolate)@ 10g/kg of seed;**SA:** *Trichoderma viride* @ 2.5 kg/ha (TNAU isolate) in 250 kg of FYM; **FS:** Ergon @ 1ml/l followed by Taqat @1.5g/l for fungal diseases or COC (0.3%) + Streptocycline (0.01%) for BLB
T_7	**Module 7JAU**	**ST:** *Pseudomonas fluorescens* (JAU isolate) @ 10g/ kg of seed**SA:** *Trichoderma harzianum* (JAU isolate) @ 2.5 kg/ha in 250 kg of FYM**FS:** *P. fluorescens* (JAU isolate) (1%) for ALS and COC (0.2%) + Streptocycline (0.01%) for BLB on need basis
T_8	**Module 8JAU**	**ST :** Carboxin (37.5 %) + Thiram (37.5%) DS @ 3.5 g/ kg of seed; **SA**: Nil **FS**: **1**. Captan70% + Hexaconazole 5 % WP 2.0 g/l **2**. COC (0.2%) + Streptocycline (0.0(1%)) 40 +1g/l **3.** Carbendazim (12%) + Mancozeb (63%) WP 2.5 g/l On need basis
T_9	**Module 9**	Control

intensity (PDI) was calculated by using the formula:

Per cent disease indensity (PDI) : $\dfrac{\text{Sum of numerical ratings}}{\text{Total leaves observed x Maxmium grade}}$

Based upon the PDI per cent disease control in each treatment was computed. Data on seed cotton yield was recorded in each treatment. *Pseudomonas fluorescens* and *Trichoderma viride* were obtain Department of Plant Pathology from JAU, Junagadh that is local strain and Tamil Nadu Agricultural University respectively.

RESULTS AND DISCUSSION

The field experiment was conducted with total nine Modules including the control during *kharif,* 2014, 2015 and 2016. The germination per centages at initial stage of seedlings in all the Modules were calculated on the basis of initial plant stand. The results indicated that the highest germination per centage was recorded in Module 7 (97.87%) and Module 6 (97.47%). The lowest germination per centage was recorded in control (92.13%). The three years pooled results revealed that the significantly minimum Alternaria leaf spot was recorded in Module 7 (9.16%) and it was *at par* with Module 6 (10.07%), Module 5 (10.28%) and Module 8 (10.39%) in RCH 2 BG II hybrid. While all the remaining Modules found statistical *at par* with each other except Module 4 and control against alternaria leaf spot at Junagadh center. The maximum Alternaria leaf spot (13.62%) was recorded in Module 9 *i.e.* control. Bacterial leaf blight was recorded minimum in Module 7 (4.03%) and it was *at par* with Module 5 (4.55%), Module 6(4.83%) and Module 8 (4.97%) in RCH 2 BG II hybrid as compared to the control. The maximum bacterial leaf blight (7.15%) was recorded in Module 9 *i.e.* control.

Considering the plant mortality per cent, minimum plant mortality (7.16%) was recorded in Module 7 and it was *at par* with Module 6 (8.14%). However Module 5 was found (8.78%) statistically *at par* with rest of the Modules except Module 9 (11.81%) *i.e.* control. The maximum plant mortality per cent (11.81%) was recorded in Module 9 *i.e.* control. Significantly height seed cotton yield was recorded in Module 7 (2284 kg/ha) and it was *at par* with Module 6 (2143 kg/ha) as compared to rest of Modules .The minimum seed cotton yield of 1476 kg/ha was recorded in Module 9 *i.e.* control.

Economics : Looking to economics of various treatments/Modules of bio control agents alone and with fungicides and soil amendments, the highest net realization of Rs 30837/ ha was obtained in M7 and followed by M6 Rs 23643/ha. The maximum ICBR (1:4.22) was obtained also in T7. However, ICBR among the next best Modules was obtained in M1, M2, and M6 1:3.99, 1:3.97 and 1:3.43, respectively. Comparison of the efficacy between the bio control agents used in different Modules indicated that Module 7 (seed treatment with *Pseudomonas fluorescence* (PF-JAU) @10g/kg seed; soil application of *Trichoderma harzianum* (TH-JAU) @2.5 kg/ha in 250 kg of FYM; foliar sprays with *Pseudomonas fluorescens* (PF-JAU) (1%) for Alternaria leaf spot and Copper oxychloride (0.2%) + Streptocycline (0.01%) for Bacterial leaf blight on need basis)

Table 1. Effect of IDM on germination, ALS, BLB, mortality and seed cotton yield of cotton (Pooled-2014-2015, 2015-2016 and 2016-2017)

Sr.	Treatnent	Germination (%)	PDI ALS	PDI BLB	Mortality (%)	Seed cotton yield (kg/ha)
T₁	**Module 1**	95.85	3.30 (10.89)	2.37 (5.62)	3.07 (9.40)	1965
T₂	**Module 2**	95.25	3.35 (11.20)	2.33 (5.41)	3.13 (9.82)	1961
T₃	**Module 3**	94.63	3.46 (11.95)	2.27 (5.15)	3.17 (10.07)	1850
T₄	**Module 4**	94.79	3.57 (12.77)	2.58 (6.64)	3.19 (10.15)	1801
T₅	**Module 5**	95.76	3.21 (10.28)	**2.13 (4.55)**	2.96 (8.78)	1940
T₆	**Module 6**	**97.47**	**3.17 (10.07)**	2.20 (4.83)	**2.85 (8.14)**	**2143**
T₇	**Module 7**	**97.87**	**3.03 (9.16)**	**2.01 (4.03)**	**2.68 (7.16)**	**2284**
T₈	**Module 8**	95.44	3.22 (10.39)	2.23 (4.97)	2.98 (8.88)	1951
T₉	**Module 9 (Control)**	92.13	3.69 (13.62)	2.67 (7.15)	3.44 (11.81)	1476
	S. Em.±	—	0.09	0.08	0.08	58.51
	C.D. (p=0.05)	—	0.26	0.24	0.23	166.53
	C.V.(%)	—	7.27	9.38	7.80	9.09
	Y	—				
	S.Em.±	—	0.05	0.03	0.05	33.78
	C.D. (p=0.05)	—	0.15	0.09	0.13	96.15
	Y x T	—				
	S.Em.±	—	0.16	0.10	0.14	101.34
	C.D. (p=0.05)	—	NS	0.28	NS	NS

ALS: Alterneria Leaf Spot, BLB: Bacteria Leaf Blight, PDI: Per cent Disease Index

and Module–6 (seed treatment with *Pseudomonas fluorescens* (PF-CICR)@ 10g/kg seed; soil application of *Trichoderma viride* (TV-TNAU) @2.5 kg/ha in 250 kg of FYM; foliar sprays with Ergon@ 1ml/l followed by Taqat @1.5g/l for fungal diseases or COC (0.3%)+ Streptocycline(0.01%) for BLB) were found effective in reducing the alternaria leaf spot, bacterial leaf blight diseases, mortality per cent of soil borne diseases and improving seed cotton yield in RCH 2 BG II hybrid cotton.

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). Module 7 involving *P. fluorescens* confirms these findings. Management of bacterial blight with combination of COC and

streptocycline in modules 6 and 7 validates the previous work (Jagtap *et al.*, 2012; Bhattiprolu, 2013). Efficacy of Module 6 using foliar applications with kresoxim methyl and combination of captan and hexaconazole also confirms reports of (Meena *et al.*, 2013; Bhattiprolu, 2015).

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Table 2. Economics of various treatments in IDM Modules for controlling diseases of cotton (2016-17)

S/N	Treatment / Module	Seed yield (kg/ha) Pooled	Yield increase over control (kg/ha)	Additional income (Rs) (From column No.4)	Cost of treatment (Pesticides, labor charge etc(Rs/ha)	Net realization	ICBR
1	2	3	4	5	6	7 (5-6)	8 (5/6)
M_1	**ST:** *Trichoderma viride* (TV-TNAU) @10g/kg seed; **SA:** of *T.viride* (TNAU isolate) @ 2.5 kg/ha; **FS:** with *T.viride* (TNAU isolate) (1%)	1965	489	24450	6120	18331	**1:3.99**
M_2	**ST:** *Bacillus subtilis* (TNAU isolate) @ 10g/kg seed; SA: of *B. subtilis* (TNAU isolate) @2.5 kg/ha; **FS:** with *B.subtilis* (TNAU isolate) (1%)	1961	485	24250	6098	18152	**1:3.97**
M_3	**ST:** *Pseudomonas fluorescens*(TNAU isolate)@10g/kg seed; **SA:** of *P. fluorescens* (TNAU isolate) @2.5 kg/ha; **FS:** with *P. fluorescens* (1%)	1850	374	18700	5487	13213	1:3.40
M_4	**ST:** *Pseudomonas fluorescens* (CICR isolate) @10g/kg seed; **SA:** of *P. fluorescens*(CICR isolate) @ 2.5 kg/ha in 250kg of FYM ; **FS:** with *P. fluorescens* (CICR isolate) (1%)	1801	325	16250	5593	10658	1:2.90
M_5	**ST:** *Pseudomonas fluorescens* (CICR isolate) @10g/kg seed ; **SA:** of *T. viride* (TNAU isolate) @2.5 kg/ha; FS: with propiconazole (0.1%) for fungal diseases and COC (0.3%) + Streptocycline (0.01%) for BLB or Carbendazim (0.1%) for grey mildew on need basis	1940	464	23200	9776	13424	1:2.37
M_6	**ST:** *Pseudomonas fluorescens* (CICR isolate)@ 10g/kg seed; **SA:** of *T.viride* (TNAU isolate) @2.5Kg/ha in 250kg of FYM ; **FS:** with Ergon@ 1ml/1 followed by Taqat @1.5g/1 for fungal diseases or COC (0.3%)+ Streptocycline(0.01%) for BLB	**2143**	667	**33350**	9707	23643	**1:3.43**
M_7	**ST:** *Pseudomonas fluorescens* (JAU isolate) @10g/kg seed; **SA:** of *T.harzianum* (JAU isolate) @2.5 kg/ha in 250 kg of FYM; **FS:** with *Pseudomonas fluorescens* (JAU isolate) 1% for ALS and COC (0.2%) + Streptocycline (0.01%) for BLB on need basis.	**2284**	**808**	**40400**	**9563**	**30837**	**1:4.22**
M_8	**ST:** Carboxin (37.5 %) + Thiram (37.5 %) DS @3.5 g/ kg of seed; **SA:** Nil; **FS:** **(1)** Captan70% + Hexaconazole (5%) WP 2.0 g/ lit **(2)** COC (0.2%) + Streptocycline (0.01%) **(3)** Carbendazim(12%)+Mancozeb (63% WP) 2.5 g/1 On need basis	1951	475	23750	8925	14825	1:2.66
M_9	Control	1476	—	—	—	—	—

(1) Labor charge for seed treatment/ha : Rs 50/ 2.5 kg seed   **(2)** Labor charge for one spray/ha : Rs 500
(3) Price of seed cotton: Rs 50/kg   **(4)** Labor charge for soil application of treat./ha : Rs 500   **(5)** Picking charge: Rs 110/20 kg seed cotton

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