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Field Efficacy of Seed Dressing Fungicides against Seed Borne Diseases of Cotton

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A B S T R A C T

Seed dressing fungicides *viz*., thiram, and carboxin and combination product of thiram + carboxin were evaluated in cotton during kharif seasons of 2012 to 2014. Cotton variety Narasimha was raised in plots of 31.5 sq. m adopting a spacing of 105 x 60 cm. Ten treatments *viz*., T1 - Seed treatment (ST) with thiram @ 2g/kg seed; T2 - ST with thiram @ 3g/kg seed; T4 - ST with thiram @ 4g/kg seed; T4 - ST with carboxin @ 1g/kg seed; T5 - ST with carboxin @ 2g/kg seed; T6 - ST with carboxin @ 3g/kg seed; T7 - ST with thiram + carboxin @ 2.5g/kg seed; T8-ST with thiram + carboxin @ 3.5g/kg seed; T9-ST with thiram + carboxin @ 3.5g/kg seed and T10 - Untreated control were imposed at the time of sowing in randomized block design with three replications. Data on seed borne diseases was collected by adopting 0-4scale and disease intensity was calculated. Treatment wise yield data was recorded and Incremental Benefit Cost Ratio (IBCR) was calculated. Combination of carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg resulted in lowest mortality (4.11%) and lowest intensity of Alternaria leaf spot (4.11%) with maximum yield of 9.65q/ha. IBCR of different treatments varied between 4.82 and 4.93. Hence thiram @ 3g/kg or carboxin @ 2g/kg or combination product @ 3.5g/kg is recommended for seed treatment in cotton.

Introduction

Cotton is an important commercial crop in India with a production of 351 lakh bales of 170kg lint in 2016-2017 from an area of 105 lakh ha with a productivity of 568kg/ha, which is far behind the leading countries. Andhra Pradesh stood 6th in area (4.49 lakh ha) but 8th in production (13.10 lakh bales) and 2nd in productivity (719 kg/ha) during 2016 – 2017 (Anonymous, 2017). Seed borne diseases affect germination and cause seedling mortality. Several pathogens including bacterial blight (*Xanthomonas axonopodis* pv *malvacearum*), fungal leaf spots caused by *Alternaria macrospora*, *A. alternata*, *Myrothecium roridum*, *Colletotrichum capsici* are seed borne while *Rhizoctonia solani*, *R. bataticola* (*Macrophomina bataticola*), *Fusarium oxysposum* f. sp. *Vasinfectum*, *Verticillium dahlia* are mainly soil borne in cotton.

In Andhra Pradesh Alternaria leaf spot is the most commonly occurring disease starting from the germination and cause economic losses under congenial conditions (Bhattiprolu and Prasada Rao, 2009).

Importance of seed treatments in sustainable agriculture was reviewed by Sharma *et al.*, (2015). Seed treatment with thiram @ 3g or

carboxin @ 2g or captan @ 3g or carbendazim @ 2g was recommended to manage seed/soil borne diseases in cotton. However these seed dressing fungicides need validation in course of time. Hence the present investigation was carried out to verify the efficacy of label claimed fungicides against seed and/or soil borne diseases in cotton.

Materials and Methods

A field experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during kharif seasons of 2012 to 2014 to validate the seed dressing fungicides against seed borne diseases of cotton.

The label claimed chemicals namely thiram, carboxin and combination product of thiram + carboxin were tested at three doses each. Cotton variety Narasimha was raised in plots of 31.5 sq. m adopting a spacing of 105 x 60 cm. Ten treatments *viz*., T1 - Seed treatment (ST) with thiram @ 2g/kg seed; T2 - ST with thiram @ 3g/kg seed; T4 - ST with thiram @ 4g/kg seed; T4 - ST with carboxin @ 1g/kg seed; T5 - ST with carboxin @ 2g/kg seed; T6 - ST with carboxin @ 3g/kg seed; T7 - ST with thiram + carboxin @ 2.5g/kg seed; T8 - ST with thiram + carboxin @ 3.5g/kg seed; T9 - ST with thiram + carboxin @ 3.5g/kg seed and T10 - Untreated control were imposed at the time of sowing in randomized block design with three replications. Data on germination and plant stand was recorded and seedling mortality was calculated 30days after sowing.

Data on seed borne diseases was collected up to 45days of sowing by adopting 0-4scale (Sheo Raj, 1988): 0 = No disease; 1 = <5%; 2 = 6-20%; 3 = 20-40% and 4 = >40% leaf area is diseased. Depending on the scores collected percent disease intensity (PDI) was calculated using the formula of Wheeler (1969).

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

Percent disease control in each treatment was calculated. Recommended protection measures against insect pests were taken on need basis. Yield data from three replications of each treatment was recorded. Decrease / increase in the disease/ yield over control were calculated using the formula:

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

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

C = PDI or yield of control

Treatment wise Incremental Benefit Cost Ratio (IBCR) was calculated by dividing additional benefit with additional cost.

Results and Discussion

During 2012-13 and 2014-15 carboxin 37.5% WP + thiram 37.5 % DS 4.5g/kg recorded the lowest mortality of 6.0 and 3.5, respectively while thiram 75WS @ 4g/kg, carboxin 75% WP @ 3g/kg and carboxin 37.5% WP + thiram 37.5 % DS 3.5g/kg were at par with it. Carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg (1.67%), carboxin 75% WP @ 3g/kg (1.67%) and thiram 75WS @ 4g/kg (2.5%) were on par and statistically superior to other treatments during 2013-14 (Table 1). Pooled data (2012-14) revealed that carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg resulted in the lowest seedling mortality (4.0%); carboxin 75% WP @ 3g/kg (4.11%) and thiram 75WS @ 4g/kg (4.61%) were on par with it while control plots recorded 13.27%. Tomer *et al.,* (2012) obtained 63.96% to

68.77% germination by protecting against seed borne *Myrothecium roridum*, *Aspergillus niger* and *Curvularia lunata* in J 4 cotton cultivar.

Alternaria leaf spot was observed on seedlings (Fig.1 a) and pathogen was isolated and confirmed for pathogenicity (Fig.1b). Carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg recorded the lowest intensity of Alternaria leaf spot (2.5%) whereas carboxin 75% WP @ 3g/kg (2.83%), carboxin 37.5% WP + thiram 37.5% DS 3.5g/kg (3.33%) and thiram 75WS @ 4g/kg (4%) were statistically at par during 2012-13 (Table 1). All the treatments were superior to untreated control during 2013-14. Carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg recorded the lowest intensity of Alternaria leaf spot (3.67%) whereas carboxin 75% WP @ 3g/kg (4.33%), carboxin 37.5% WP + thiram 37.5% DS 3.5g/kg (4.33), thiram 75WS @ 4g/kg (4.67%) and carboxin 75% WP @ 2g/kg (5.0) were statistically at par during 2014-15. Pooled results revealed that combination of carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg resulted in lowest intensity of Alternaria leaf spot (4.11%) while the same at 3.5g/kg (5.22%) or carboxin @ 3g/kg (4.61%) were found on par with it while control plots recorded disease intensity of 15.14%. Maximum reduction of 72.85% was obtained in carboxin 37.5% WP + thiram 37.5 % DS 4.5g/kg followed by 69.55% in carboxin 75% WP @ 3g/kg and 65.52% in carboxin 37.5% WP + thiram 37.5 % DS 3.5g/kg (Table 1). These results were in conformity with previous reports. Tomer *et al.*, (2012) evaluated carboxin @ 2g/kg and found highly effective in controlling the seed borne pathogens. Ebadollah Baniani *et al.*, (2015) recommended Goucho and carboxin-thiram, Larvin and carboxin-thiram for seed disinfection cotton. Oktay Erdogan *et al.*, (2016) found that vitavax was very effective against *Rhizoctonia solani* and *Fusarium* sp. with highest germination (76.1%) in cotton cultivar Carman. Eisa (Nawal) *et al.*, (2005) recorded vitavax-T 70 (carboxin + thiram 70%) and Vitavax-T40 (carboxin + thiram 40%) were the best seed treatments root pathogens in cotton cultivars Giza-86 and Giza-89 with increased yields. Asghar Heydari (2015) observed that delinting with 98% acid was more effective against *Rhizoctonia solani* causing seed decay (rot) and seedling damping-off in Sahel and Varamin cotton varieties in Iran. Seed delinting with 80 and 60% acid and seed treatment with carboxin-thiram fungicide also significantly reduced the disease incidence in comparison with linted seeds.

Fig.1a Seed borne infection by *Alternaria macrospora* in cotton;
1b Culture of *Alternaria macrospora*

Table.1 Efficacy of seed dressing chemicals on seed and soil borne diseases of cotton (Pooled data, 2012-2014)

T. No.	Treatment	Seed ling Mortality (%)			Mean	Intensity of Alternaria leaf spot (%)			Mean	Decrease in Alternaria leaf spot (%)
		2012-13	2013-14	2014-15		2012-13	2013-14	2014-15		
1	Thiram 75WS @ 2g/kg	18.00^{e}	8.33^{de}	7.50^{h}	12.89^{de}	4.96^{defg} (12.92)	9.00^{a} (17.45)	7.67^{f} (16.06)	7.15^{de} (15.51)	52.77
2	Thiram 75WS @ 3g/kg	12.67^{cd}	5.83^{bc}	5.33^{cdef}	08.28^{bc}	4.83^{cdefg} (12.66)	8.33^{a} (16.74)	6.33^{def} (14.54)	5.89^{cd} (14.0)	61.10
3	Thiram 75WS @ 4g/kg	6.67^{ab}	2.50^{a}	4.00^{ab}	04.61^{a}	4.00^{abcd} (11.54)	7.67^{a} (16.56)	4.67^{abcd} (12.46)	5.50^{bc} (13.56)	63.67
4	Carboxin 75% WP @ 1g/kg	26.67^{f}	9.17^{de}	5.83^{cdefg}	13.39^{e}	5.17^{defg} (13.18)	8.33^{a} (16.74)	6.33^{def} (14.54)	6.44^{cde} (14.65)	57.46
5	Carboxin 75% WP @ 2g/kg	20.0^{e}	5.83^{bc}	5.00^{bcde}	10.28^{cd}	4.50^{cdef} (12.25)	7.67^{a} (16.56)	5.00^{abcde} (12.92)	5.72^{bc} (13.81)	62.22
6	Carboxin 75% WP @ 3g/kg	6.67^{ab}	1.67^{a}	4.67^{abc}	04.11^{a}	2.83^{ab} (9.63)	6.67^{a} (14.95)	4.00^{ab} (11.54)	4.61^{ab} (12.39)	69.55
7	Carboxin 37.5% WP + Thiram 37.5 % DS 2.5g/kg	10.67^{cd}	7.50^{cd}	5.67^{cdefg}	07.95^{b}	4.17^{bcde} (11.33)	7.67^{a} (16.56)	5.67^{bcd} (13.75)	5.56^{bc} (13.63)	63.28
8	Carboxin 37.5% WP + Thiram 37.5 % DS 3.5g/kg	9.34^{abc}	5.00^{b}	4.83^{bcd}	06.22^{ab}	3.33^{abc} (10.47)	6.67^{a} (14.95)	4.33^{abc} (11.97)	5.22^{abc} (13.18)	65.52
9	Carboxin 37.5% WP + Thiram 37.5 % DS 4.5g/kg	6.00^{a}	1.67^{a}	3.50^{a}	04.00^{a}	2.5^{a} (9.10)	6.00^{a} (14.19)	3.67^{a} (11.02)	4.11^{a} (11.68)	72.85
10	Untreated control	17.34^{e}	15.83^{f}	9.17^{i}	16.17^{f}	13.27^{h} (21.39)	23.0^{b} (28.56)	15.33^{g} (23.03)	15.14^{f} (22.79)	
	CD (p=0.05)	3.87	2.12	1.29	2.67	1.61	3.05	1.98	1.25	
	CV (%)	17.1	19.5	12.6	17.7	18.9	19.5	18.3	11.1	

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

Table.2 Efficacy of seed dressing chemicals on seed and soil borne diseases of cotton (Pooled data, 2012-2014)

T. No.	Treatment	Seed Cotton Yield (q/ha)			Mean Yield (q/ha)	Increase in yield (%)
		2012-13	2013-14	2014-15		
1	Thiram 75WS @2g/kg	6.57	7.10^{ef}	10.11^{bc}	7.82^{d}	11.87
2	Thiram 75WS @3g/kg	7.10	7.55^{cdef}	10.27^{bc}	8.31^{c}	18.28
3	Thiram 75WS @4g/kg	7.26	8.15^{abcde}	11.85^{a}	9.09^{a}	30.04
4	Carboxin 75% WP @ 1g/kg	6.67	7.30^{def}	10.16^{b}	8.04^{b}	15.02
5	Carboxin 75% WP @ 2g/kg	6.97	8.45^{abcd}	12.33^{a}	9.25^{ab}	32.33
6	Carboxin 75% WP @ 3g/kg	7.23	8.82^{ab}	12.42^{a}	9.49^{a}	35.77
7	Carboxin 37.5% WP + Thiram 37.5 % DS 2.5g/kg	6.87	7.77^{cde}	10.42^{b}	8.35^{c}	19.46
8	Carboxin 37.5% WP + Thiram 37.5 % DS 3.5g/kg	7.33	8.65^{abc}	12.60^{a}	9.53^{a}	34.34
9	Carboxin 37.5% WP + Thiram 37.5 % DS 4.5g/kg	7.55	9.24^{a}	12.88^{a}	9.65^{a}	38.05
10	Untreated control	6.01	6.49^{f}	8.45^{c}	6.99^{d}	
	CD at 5%	NS	1.25	1.21	1.04	
	CV (%)	14.8	9.2	6.3	7.0	

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

Table.3 Economics of treatments against seed and soil borne diseases of cotton (Pooled data, 2012-2014)

T. No.	Treatment	Additional Expenditure (Rs)			Additional Returns (Rs)			Incremental Benefit Cost Ratio (IBCR)			Mean IBCR
		2013-14	2013-14	2014-15	2013-14	2013-14	2014-15	2013-14	2013-14	2014-15	
1	Thiram 75WS @2g/kg	453	493	1333	2224	2623	6059	4.91	5.32	4.55	4.93
2	Thiram 75WS @3g/kg	879.5	855.5	1463.5	4251	4558	6643	4.83	5.33	4.54	4.90
3	Thiram 75WS @4g/kg	1010	1338	2730	4875	7138	12410	4.83	5.33	4.55	4.90
4	Carboxin 75% WP @ 1g/kg	535	655	1375	2574	3483	6241	4.81	5.32	4.54	4.89
5	Carboxin 75% WP @ 2g/kg	782	1582	3118	3744	8428	14162	4.79	5.33	4.54	4.89
6	Carboxin 75% WP @ 3g/kg	997	1885	3197	4758	10019	14490	4.77	5.32	4.53	4.87
7	Carboxin 37.5% WP + Thiram 37.5 % DS 2.5g/kg	712	1048	1600	3354	5504	7190	4.71	5.25	4.49	4.82
8	Carboxin 37.5% WP + Thiram 37.5 % DS 3.5g/kg	1089	1761	3353	5148	10098	14273	4.73	5.73	4.26	4.91
9	Carboxin 37.5% WP + Thiram 37.5 % DS 4.5g/kg	1275	2243	3587	6006	11825	16169	4.71	5.27	4.51	4.83
10	Untreated control	0	0	0	0	0	0	0	0	0	0

Carboxin + thiram @ 0.2% was found most effective against seed borne fungal infections including *A. alternata*, *Fusarium* sp. and *Xanthomonas axonopodis* pv *malvacearum* by rolled towel method and controlled Alternaria blight in field (Hanasi, 2013).

Seed cotton yield was numerically superior to control in all the treatments during 2012-13 (Table 2). Carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg recorded the highest yield of 9.24q/ha while carboxin 75% WP @ 3g/kg (8.82q/ha), carboxin 37.5% WP + thiram 37.5% DS 3.5g/kg (8.65q/ha) and thiram 75WS @ 4g/kg (8.15q/ha) recorded on par yields during 2013-14. Carboxin 37.5% WP + thiram 37.5 % DS 4.5g/kg also recorded the highest yield of 12.88q/ha during 2014-15 followed by carboxin 37.5% WP + thiram 37.5% DS 3.5g/kg (12.60q/ha), carboxin 75% WP @ 3g/kg (12.42q/ha), carboxin 75% WP @ 2g/kg (12.33q/ha) and thiram 75WS @ 4g/kg (11.85q/ha). With respect to pooled data on seed cotton yield, carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg recorded maximum yield of 9.65q/ha while the same at 3.5g/kg (9.53q/ha), carboxin @ 3g/kg (9.49q/ha) or carboxin @ 2g/kg (9.25q/ha) and thiram @ 4g/kg (9.09q/ha) were found on par with it. Untreated control plot recorded 6.99q/ha.

Maximum yield increase of 38.05% was obtained with carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg followed by 35.77% with carboxin 75% WP @ 3g/kg, carboxin 37.5% WP + thiram 37.5% DS 3.5g/kg (34.34%), carboxin 75% WP @ 2g/kg (32.33%) and Thiram 75WS @ 4g/kg (30.04%) (Table 2).

Incremental Benefit Cost Ratio (IBCR) of different treatments varied between 4.82 and 4.93 (Table 3). Based on these results thiram @ 3g/kg or carboxin @ 2g or combination product @ 3.5g is recommended for seed treatment in cotton.

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