Integrated management of Alternaria blight (*Alternaria* spp.) of Linseed (*Linum usitatissimum* L.) in West Bengal, India

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Integrated management of Alternaria blight (*Alternaria* spp.) of Linseed (*Linum usitatissimum* L.) in West Bengal, India

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Field experiments were conducted during 2010-11, 2011-12 and 2012-13 to assess the yield losses due to Alternaria blight disease caused by *Alternaria lini* and *A. linicola* and their management with the integration of *Trichoderma viridae*, fungicides and neem leaf extract. Minimum disease severity of leaf (9.80 %) and bud (10.06 %) with maximum disease control (Leaf-72.24%, Bud-62.17%) were recorded with treatment i.e. seed treatment (ST) with Carboxin 37.5% + Thiram 37.5% (2g kg^{-1} seed) + 2 foliar sprays (FS) of Carbendazim 25% + Mancozeb 63% (0.1%). Maximum seed yield (1354.12 kg ha^{-1}) with maximum net return (Rs. 13953.60/ha) was obtained from the treatment ST with Carboxin 37.5% + Thiram 37.5% (2g kg^{-1} seed) + 2 FS of Carbendazim 25% + Mancozeb 63% (0.1%) followed by treatment ST with *Trichoderma viridae* + 2 FS of Carbendazim 25% + Mancozeb 63% @ 0.1% .

Key words: Alternaria blight, fungicides, linseed, neem leaf extract, *Trichoderma viridae*

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is an important *rabi* (dry season) oilseed crop and a major source of oil and fibre. There are different varieties of linseed meant for dual purposes. It is one of the most important oilseed crops of temperate and subtropical region of the world. It has nutritional, medicinal, industrial and agricultural uses. The major cause behind low production of linseed is that the crop mainly is cultivated in rainfed marginal/sub-marginal lands and also due to the biotic and abiotic stresses. Alternaria blight caused by *Alternaria lini* Dey and *A. linicola* Grooves and Skolko, is a major biotic stress limiting crop yield in hot and humid environment (Singh and Singh, 2004, 2005). Only few resistant genotypes are available at national level against this disease (Singh *et al*. 2006; Singh *et al.* 2009). The present study was undertaken to assess the yield losses due to blight in linseed cultivars caused by *Alternaria lini* and *A. linicola* and its management by integrated application of bio-agent, plant product and fungicides.

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MATERIALS AND METHODS

Investigations were carried out during *rabi* (dry season) of 2010-11, 2011-12 and 2012-13 at the experimental site of Pulses and Oilseeds Research Station, Berhampore, West Bengal (Lat. 24°50' N, Lon. 88°13' E, Alt. 66.69 m above msl. Soil type was clay loam and neutral in pH). Trials were conducted using a randomized block design with ten treatments (T1-T10) and a control (T11) replicated thrice using Shekhar, a highly susceptible variety of Alternaria blight. Seeds were sown on third week of November during testing years and grown under prevailing epiphytotic condition for the disease. The experimental plot was divided into 33 sub-plots arranged in three blocks-R1, R2 and R3, representing the three replications 1.5 m apart. Nitrogen (N), Phosphate (P_2O_5) and Potash (K_2O) fertilizers were applied at the rate of 80:40:40 kg ha^{-1} in which nitrogen was used in two split doses. Irrigation was given thrice. The plot size was 4 x 2 m. The row to row spacing was maintained at 20 cm apart and plant to plant distance was 10 cm. The treatments were T1 : Seed Treatment with *Trichoderma viridae (*Bio-Cure-F) @ 4g/kg seed, T2 : Seed Treatment with Carboxin 37.5% + Thiram 37.5% (Vitavax Power) @ 2g/kg of seed, T3 : ST with *T. viridae* + Spray of Neem leaf extract (home made) @ 5% (w/v), T4 : ST with *T. viridae* + Spray of Propiconazole 25 % EC (Tilt) @ 0.1%, T5 : ST with *T. viridae* + Spray of Mancozeb 75 % WP (Dithane M-45) @ 0.25%, T6 : ST with *T. viridae*+ Spray of Carbendazim 25% + Mancozeb 63% (Saff) @ 0.1%, T7 : ST with Carboxin 37.5% + Thiram 37.5% (2g/kg seed) + Spray of Neem leaf extract (NLE) @ 5%, T8 : ST with Carboxin 37.5% + Thiram 37.5% (2g/kg seed) + Spray of Carbendazim 25% + Mancozeb 63% (0.1%), T9 :ST with Carboxin 37.5% + Thiram 37.5% (2g/kg seed) + Spray of Propiconazole 25 % (0.1%), T10 : ST with Carboxin 37.5% + Thiram 37.5% (2g/kg seed) + Spray of Mancozeb 75 % WP (0.25%), T11 : Control. *T. viridae* (4 g kg^{-1} seed) was mixed with seed and soaked with water. The *Tricoderma* coated seeds was incubated for 24 h at 25°C to facilitate the germination of spores. The incubated seeds were dried under shade for 2 to 3 h before sowing. Carboxin 37.5% + Thiram 37.5% (2 g kg^{-1} seed) was also mixed with seed before sowing. Aqueous Neem leaf extract (5% w/v) was prepared by mixing 50 g leaves with 1 lt. sterile water in warring blender. Extracts was filtered through double layered muslin cloth. Two foliar sprays were given, first at 30 days after sowing (DAS) as prophylactic and second at disease initiation. The disease severity on leaves at 90 DAS was recorded by using 0-5 scale (Conn *et al.* 1990) and per cent disease severity (PDI) was calculated using formula, PDI = [Sum of numerical rating/total number of observations taken x maximum disease score] x 100. Per cent bud damage at 15 days before harvesting (DBH), 1000 seed weight (g) and seed yields (kg ha^{-1}) were also recorded. Per cent disease control (PDC) was recorded as per formula: PDC = (DC-DT/DC) x 100, where DC = Disease in control (untreated) plot, DT= Disease in treated plot. Ten plants were randomly selected and tagged after each treatment for disease assessment. Finally the disease severity on leaf and bud, per cent increase in yield over the control and the economics of the foliar sprays were also calculated. An economic evaluation of the fungicide treatments was based on the value of the additional yield obtained after foliar spray subtracting the cost of the fungicides.

RESULTS AND DISCUSSION

The effort was made to integrate plant product and bio-agent as eco-friendly component along with fungicides for effective management of this disease in linseed. Perusal of the Table 1 indicates all the treatments significantly reduced the severity of disease on leaves as compared to the untreated check. Minimum mean disease severity (9.80 %) with maximum disease control (72.24%) was recorded with treatment T8 followed by treatment T6 and T9. Minimum bud damage (10.06%) with maximum control (62.17%) was recorded with treatment T8 followed by T6 and T9. Maximum disease severity of leaf (35.30 %) and bud damage (26.59%) were recorded in control (untreated) plot.

Average yield increase per cent ranged from 8.14% to 57.54%. Maximum pooled seed yield of 1354.12 kg ha^{-1} was recorded with treatment T8 followed by T6 and T9. Most of the treatments were statistically similar in respect of seed yield during three years of testing (Table 2). As regard the test weight no significant difference was recorded between the different treatments, although the treatment T8, T6 and T9 had significantly higher test weight than check during all three years. All the treatments increase the test weight over check. Same result was observed by Singh *et al.* 2015. Among seed dressers Carboxin 37.5% + Thiram 37.5% (2 g kg^{-1} seed) was found significantly superior over *T. viridae* (4 g kg^{-1} seed) in reducing disease severity on leaves as well as buds. Effectiveness of Vitavax was also recorded in seed born diseases of wheat (Srivastava *et al.* 1997; Srivastava and Yadav, 2006). Foliar sprays of Carbendazim 25% + Mancozeb 63% (0.1%) was found most effective in combination with Carboxin 37.5% + Thiram 37.5% as seed dresser followed by ST with *T. viridae* +2 FS of Carbendazim 25% + Mancozeb 63% (0.1%). Thus in this study it was identified that Carbendazim 25% + Mancozeb 63%, a combination of Carbendazim and Mancozeb appears to have synergistic effect in managing the disease as noted in case of leaf spot of groundnut (Singh *et al.* 2004). Propiconazole also managed this disease efficaciously but less economically. This fungicide was reported to be effective in managing leaf blight disease elsewhere (Biswas and Singh, 2005; Kumar *et al.* 2009).

Neem leaf extract (NLE) @ 5% (w/v) spray was also found to be significantly effective in controlling the disease severity and enhancing the seed yield with eco-friendly management. Effectiveness of NLE and other Neem products were reported

Table 1: Effect of treatments on Blight severity and bud damage in Linseed

Treatments	Disease severity on leaves (PDI)									Bud damage (%)								
	2010-11		2011-12		2012-13		Mean		Control (%)	2010-11		2011-12		2012-13		Mean		Control (%)
T_1	22.3	(28.2)*	30.2	(33.3)	26.4	(30.9)	26.37	(30.9)	25.30	16.3	(23.8)	25.1	(30.1)	23.4	(28.9)	23.42	(28.9)	11.92
T_2	20.5	(26.9)	26.2	(30.8)	23.8	(29.2)	23.80	(29.2)	32.58	12.7	(20.9)	22.2	(28.1)	21.4	(27.6)	21.40	(27.6)	19.52
T_3	19.3	(26.1)	24.9	(29.9)	23.4	(28.9)	23.43	(29.0)	33.63	10.5	(18.9)	20.8	(27.1)	19.9	(26.5)	19.90	(26.5)	25.16
T_4	16.6	(24.0)	19.1	(25.9)	18.2	(25.3)	18.23	(25.3)	48.36	7.5	(15.9)	17.3	(24.6)	16.5	(24.0)	16.52	(24.0)	37.87
T_5	17.4	(24.7)	21.8	(27.8)	20.2	(26.7)	20.20	(26.7)	42.78	8.5	(17.0)	19.1	(25.9)	17.0	(24.3)	16.99	(24.3)	36.10
T_6	13.6	(21.7)	15.1	(22.9)	13.7	(21.7)	13.70	(21.7)	61.19	4.4	(12.1)	13.1	(21.2)	12.3	(20.6)	12.34	(20.6)	53.59
T_7	18.3	(25.3)	23.1	(28.7)	21.6	(27.7)	21.57	(27.7)	38.90	9.6	(18.0)	20.5	(26.9)	19.5	(26.2)	19.45	(26.2)	26.85
T_8	12.5	(20.7)	10.7	(19.1)	9.8	(18.2)	9.80	(18.2)	72.24	3.5	(10.7)	11.0	(19.4)	10.1	(18.5)	10.06	(18.5)	62.17
T_9	14.3	(22.2)	16.4	(23.9)	14.7	(22.6)	14.73	(22.6)	58.27	5.7	(13.8)	15.4	(23.1)	13.7	(21.8)	13.74	(21.8)	48.33
T_{10}	16.9	(24.3)	17.8	(24.9)	16.2	(23.8)	16.23	(23.8)	54.02	6.6	(14.9)	16.7	(24.1)	15.6	(23.3)	15.64	(23.3)	41.18
T_{11}	36.4	(37.1)	38.2	(38.2)	35.3	(36.5)	35.30	(36.5)	0.00	27.6	(31.7)	28.2	(32.1)	26.6	(31.0)	26.59	(31.0)	0.00
SEm(±)	0.346		0.347		0.35		0.38			0.120		0.124		0.12		0.12		
CV (%)	2.45		2.42		2.42		2.42			1.240		1.24		1.24		1.24		
CD (0.05)	1.024		1.002		1.00		1.00			0.367		0.359		0.36		0.36		

*Figures in parentheses are angular transformed value

Table 2: Effect of treatments on seed yield and test weight (1000 seed weight) of Linseed

Treatments	Seed yield (kg ha^{-1})					Test weight (g)				
	2010-11	2011-12	2012-13	Mean	Increase (%)	2010-11	2011-12	2012-13	Mean	Increase (%)
T_1	900.00	969.23	919.44	929.56	8.14	7.14	7.28	7.28	7.23	0.28
T_2	988.67	1020.01	961.11	989.93	15.17	7.15	7.29	7.30	7.25	0.55
T_3	1010.89	1116.12	1019.44	1048.82	22.02	7.20	7.52	7.33	7.35	1.94
T_4	1190.00	1225.51	1150	1188.50	38.27	7.32	7.5	7.49	7.44	3.19
T_5	1113.56	1199.25	1088.89	1133.90	31.92	7.27	7.39	7.46	7.37	2.22
T_6	1248.00	1332.86	1188.89	1256.58	46.19	7.91	7.75	7.74	7.80	8.18
T_7	1072.67	1150.81	1061.11	1094.86	27.37	7.26	7.45	7.41	7.38	2.36
T_8	1324.67	1476.58	1261.11	1354.12	57.54	8.00	7.90	7.80	7.90	9.57
T_9	1219.00	1260.66	1177.78	1219.15	41.83	7.87	7.70	7.71	7.76	7.63
T_{10}	1099.67	1241.76	1169.44	1170.29	36.15	7.37	7.29	7.52	7.39	2.50
T_{11}	834.22	886.11	858.33	859.56		7.11	7.34	7.19	7.21	
SEm(±)	20.33	37.49	38.78	21.42		0.23	0.16	0.20	0.13	
CV (%)	3.2	5.55	6.23	3.33		5.40	4.31	4.54	3.03	
CD (0.05)	58.71	108.26	111.99	61.86		0.67	0.45	0.57	0.31	

against *Alternaria species* causing leaf blight in different crops in vitro condition (Babu *et al.* 2001; Pandey *et al.* 2002; Singh *et al.* 2003).

Different fungicidal treatments gave different net profits as well as different Incremental cost benefit ratio (ICBR) and Net incremental cost benefit ratio (NICBR). The profit or net monetary return varied from Rs. 2450.00 ha^{-1} to Rs. 17309.60 ha^{-1} in different treatments (Table 3). The maximum net profit was obtained from the T8 (Rs. 13953.60 ha^{-1}), followed by T6 (Rs. 10555.70 ha^{-1}) and T9 (Rs. 8941.65 ha^{-1}). The economics of various fungicides revealed that the highest net realization over control was obtained from the treatment T8 (Rs. 17309.60 ha^{-1}), followed by T6 (Rs. 13895.70 ha^{-1})

Table 3: Economics of treatments for the management of Alternaria blight of linseed (Pooled data of 2010-11, 2011-12 and 2012-13**)**

Treatments	Total cost of insecticides and labour (P)	Yield (Kg/ha)	Avoidable losses (%)	Gross realization (Rs./ha)	Net realization over control (Rs./ha)(A)	Net Profit (Rs/ha) (A-P)	IBCR (A/P)	NIBCR (A-P)/P
T_1	124	929.56	7.5	32534.60	2450.00	2326.00	19.8	18.8
T_2	140	989.93	13.2	34647.55	4562.95	4422.95	32.6	31.6
T_3	2624	1048.82	18.0	36708.70	6624.10	4000.10	2.5	1.5
T_4	3628	1188.50	27.7	41597.50	11512.90	7884.90	3.2	2.2
T_5	3844	1133.90	24.2	39686.50	9601.90	5757.90	2.5	1.5
T_6	3340	1256.58	31.6	43980.30	13895.70	10555.70	4.2	3.2
T_7	2640	1094.86	21.5	38320.10	8235.50	5595.50	3.1	2.1
T_8	3356	1354.12	36.5	47394.20	17309.60	13953.60	5.2	4.2
T_9	3644	1219.15	29.5	42670.25	12585.65	8941.65	3.5	2.5
T_{10}	3824	1170.29	26.6	40960.15	10875.55	7051.55	2.8	1.8
T_{11}		859.56		30084.60				

Cost of fungicides- Mancozeb 75 % WP: Rs. 540/kg, Propiconazole 25% EC- Rs. 1170/kg, Carbendazim 25% + Mancozeb 63% -Rs. 930/kg, Carboxin 37.5% + Thiram 37.5%-Rs. 1330/kg; *Trichoderma viridae*- Rs. 400/kg, Efficasy of sprayer: 1 ha/day, Rent for sprayer : Rs. 50/day, For spraying one hectare area 5 man days @ Rs. 200 were considered for fungicide spray, 6 man days for Neem leaf extract and half man days for seed treatment, linseed seed @ Rs.35 per kg, Water necessary for spray 600 lt. ha^{-1}, ICBR- Incremental cost benefit ratio, NICBR- Net incremental cost benefit ratio.

and T9 (Rs. 12585.65 ha^{-1}). In contrast to the net profits, a different trend was observed with ICBR and NICBR. ICBR was worked out for each treatment during 2010-11, 2011-12 and 2012-13 by calculating prevailing market prices of fungicides, linseed seed and cost of labours (Table 3). Most favorable NICBR was registered from T2 (1:31.6), followed by T1 (1:18.8) and T8 (1:4.2) while poor NICBR was observed in both T5 (1:1.5) and T3 (1:1.5) followed by T7 (1:2.1). This difference between the net profit and NICBR can perhaps be attributed to the cost of the fungicides involved. The observation was similar in mustard (Das, 2015). The economics of various fungicides used during three years revealed that T2 *i.e.* seed treatment with Carboxin 37.5% + Thiram 37.5% (2 g Kg^{-1} seed) was the most economic fungicides with cost benefit ratio followed by T1 and T8 (Table 3). However, the lowest disease severity (9.80 % on leaf and 10.06 % on bud) and highest increase of seed yield (57.54 %) and maximum increase of test weight (9.57 %) were recorded from seed treatment with Carboxin 37.5% + Thiram 37.5% (2 g Kg^{-1} seed) followed by two sprays of Carboxin 37.5% + Thiram 37.5% (2 g Kg^{-1} seed) at 30 DAS and at disease initiation (T8).

From the above results it may be concluded that the highest NICBR was registered in the treatment i.e. seed treatment with Carboxin 37.5% + Thiram 37.5% (2 g Kg^{-1} seed). Whereas, maximum disease control and highest yield was recorded in the treatment i.e. seed treatment with Carboxin 37.5% + Thiram 37.5% (2 g Kg^{-1} seed) followed by two sprays of Carbendazim 25% + Mancozeb 63% (0.1%) at 30 DAS and at disease initiation with low NIBCR ratio.

REFERENCES

Babu, S., Seetharaman, K., Nandkumar , R. and Jansan, L. 2001. Inhibitory effect of leaf extracts of some medicinal plants and weeds on *Alternaria solani*. *Plant Dis. Res*., **16**: 84-86.

Biswas, S. and. Singh, N.P 2005. Fungicidal management of foliar diseases of groundnut in Tirpura. *Indian Phytopathol*., **58**: 500-502.

Conn, K.L., Tewari, J.P. and. Awasthi, R.P 1990. A disease assessment key for Alternaria blackspot in rapeseed and mustard. *Can. Plant Dis. Surv*., **70**: 19-22.

Das, R. 2015. Evaluation of fungicides against alternaria blight disease of rapeseed-mustard in West Bengal. *Journal of Crop and Weed*, **11** (special issue): 220-223.

Kumar, S., Singh, R.B and Singh, R.N. 2009. Fungicides and genotypes for the management of foliar diseases of rapeseed-mustard. *Proc. Nat. Acad. Sci. B*, **79**: 189-193.

Pandey, M.K.,. Singh, M.K. and Singh, R.B. 2002. Mycotoxic potential of some higher plants. *Plant Dis. Res*., **17**: 51-56.

Singh, J., Singh, K., Prakash ,O. and Vajpeyi, M. 2006. Seed colour-not a diagnostic character for disease resistance in linseed (*Linum usitatissimum* L.). *Indian Phytopathol.*, **59**: 180-184.

Singh, R.B. and Singh, R.N. 2004. Occurrence and management of Alternaria blight of linseed in eastern India. *Plant Dis. Res.*, **19**: 120-124.

Singh, R.B. and Singh, R.N. 2005. Occurrence status and management of alternaria blight (*Alternaria species*) of linseed (*Linum usitatissimum*). *Indian J. Agric. Sci.*, **75**: 277-280.

Singh, R.B., Singh ,A.P. and N.K. Singh, 2004. Combined effect of systemic and non-systemic fungicides in managing the leaf spot of groundnut. *Ann. Plant Sci. Res*., **6**: 42-44.

Singh, R.B. Singh, R.N. and Singh, H.K. 2009. Evaluation of fungicides and genotypes for the management of Alternaria blight (*Alternaria* sp.) of linseed (*Linum usitatissimum* L.). *Proc. Natl. Acad. Sci*., **79**: 410-414.

Singh, R.P.,. Singh ,A.K. and Singh, R.N. 2003. Effect of neem product on the growth of *Alternaria triticina*. *Ann. Plant Prot. Sci*., **11**: 409-410.

Singh, R.B., Singh, H. K. and Parmar, A. 2015. Yield loss assessment due to Alternaria blight and its management in linseed. *Pakistan Journal of Biological Sciences*, **17**: 511-516.

Srivastava, J.P. and Yadav, R.D.S. 2006. Transmission and management of major seed born diseases of wheat (*Triticum aestivum* L.). *Crop Res*., **31**: 175-178.

Srivastava, K.D., Singh ,D.V. Aggarwal, R.. Dixit, A.K. and Bahadur, P.1997. Bio-efficacy and persistence of tebuconazole against loose smut in wheat. *Indian Phytopathol.*, **50**: 434-436.