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Compatibility of fungicides and neem products against *Fusarium solani* f. sp. *glycines* causing root rot of soybean and *Trichoderma* spp.

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Evaluation and compatibility of fungicides, neem products and biocontrol agents against Fusarium root rot of soybean caused by *Fusarium solani* f. sp. *glycines* was conducted. Out of the six fungicides tested, Mancozeb at all concentration (0.05, 0.1, 0.15%) was most effective in reducing the mycelial growth followed by Carbendazim. Mancozeb was also found compatible with *T. harzianum* and *T. viride* at 0.05 and 0.1% concentration. Copper oxychloride was next compatible fungicide to it, whereas Carbendazim proved to be the least compatible. In comparative efficacy studies between two antagonists *T. viride* was most antagonists to *Fusarium solani* f. sp. *glycines*. Neemgold (commercial product) was most effective in reducing the mycelial growth of *Fusarium solani* f. sp. *glycines* and also found compatible with *T. harzianum* and *T. viride*.

Key words : Soybean, biocontrol, neem, fungicides, compatibility, antagonistic

INTRODUCTION

Over for the last few years, Fusarium root rot problem in the soybean crop has emerged as a major threat to the soybean cultivation. Fusarium blight or wilt was first reported in 1917, Fusarium root rot in 1961, Fusarium pod and collar rot was first reported in India in 1972. Survey of five states indicated that the frequency of root rotting isolates of *F. solani* from roots of adult plants was 58%. Economic losses of 59% and 64% were reported from blight or wilt and root rot respectively. Estimated reduction in soybean yield during 1994 due to Fusarium root rot (*F. solani*) was 220,600 MT in China, 134,400 MT in Argentina, 68,000 MT in USA, 35,000 MT in India and 15,000 MT in Brazil (Wrather *et al.,* 1997). Due to hazardous effect of pesticides, there is a lot of emphasis on the use of bio-control agents/botanical pesticides to replace the former as an intergral component of Integrated Disease Management (IDM). A persue of the literature on the manangement of this disease shows that systematic studies on evaluation of local bio-control agents/neem products is limited. Keeping this view in mind this study was undertaken.

MATERIAL AND METHODS

The experiment was conducted to see the efficacy of fungicides against *Fusarium solani* f. sp. *glycines* causing root rot of soybean. Six fungicides viz. Carbendazim (Zoom 50 WP, United Phosphorus Ltd, Mumbai), Carboxin (Vitavax 75% WP, Northern Minerals Ltd, Haryana), Captan (Captaf 50% WP, Rallis (I) Ltd, Mumbai), Copper oxychloride (Fytolon 50% WP, TCM, Ltd., Chennai), Mancozeb (Indofil M-45 75% WP, Indofil (India) Ltd.) and Thiram (Thiride 50% DS, The Alkali Corpn. of India Ltd. Calcutta) were evaluated by using poison food technique. Similar technique was used to study the compatibility of fungicides and neem products against the two biocontrol agents. Commercially available neem products viz. Jai Neem (Jai Chemicals, Faridabad), Jivdan Neem Herbal (Saurabh Industries, Jalgaon, M.S.) and Neemgold (Southern Petrochemical Industries Corporation Ltd., T.N.) were used. Observations on colony diameter of test fungus were taken after 4 and 8 days of inoculation. Percentage inhibition was also calculated by using the formula :

$$\text{Inhibition (\%)} = \frac{C - T}{C} \times 100$$

Where : C = Mean radial growth of fungus in control.
T = Mean radial growth of fungus in respective treatments.

Antagonistic activity of *Trichoderma viride and T. harzianum* against Fusarium root rot pathogen (*F. solani* f. sp. *glycines*) was studied. For this purpose presumptive test as described by Broadbent *et al.* (1971) were followed.

RESULTS AND DISCUSSION

Evaluation of fungicides against *F. solani* f. sp. glycines

The data presented in Table 1 indicated that the mycelial growth ranged from 0.0 to 80.0 mm after 8 days of inoculation as compared to growth of 81.5 mm in control. As the concentration of fungicides increases there was decrese in radial growth. However, the decrease was significant in Captan and Carboxin. Minimum mean radial growth (0.0 mm) was recorded in Mancozeb followed by Carbendazim (15.7, 6.5 and 6.3 mm). Maximum mean radial growth of 61.9 and 52.3 mm were recorded in Carboxin and Copper oxychloride respectively.

The results obtained indicated that Mancozeb @ 0.05, 0.1 and 0.15% was the most effective and Carbendazim was found to be next effective fungicide. Several workers have reported the effectiveness of Mancozeb and Carbendazim against *F. solani.* Sumitha and Gaikwad (1995) and Sharma *et al.* (2000) reported that Dithane M-45 was the effective fungicide in inhibiting the growth of *F. udum* and *F. oxysporum* f. sp. *lini* respectively. Kamathan *et al.* (2002) and Sharma *et al.* (2000) reported inhibition of *Fusarium* spp. by Carbendazim in *in vitro* studies. Thiram and Captan were found to be equally effective in controlling the pathogen. These results are comparable with that of

Table 1 : Mean radial growth of *Trichoderma viride, T. harzianum* and *Fusarium oxysporum* f. sp. *glycines* on PDA amended with different concentrations of fungicides after 8 days of incubation

Treatment/	*Trichoderma viride*				*Trichoderma harzianum*				*Fusarium solani* f. sp. *glycines*			
Concentration	0.05%	0.1%	0.15%	Mean	0.05%	0.1%	0.15%	Mean	0.05%	0.1%	0.15%	Mean
Control	89.3 (9.5)	89.3 (9.5)	89.3 (9.5)	89.3 (9.5)	90.0 (9.5)	90.0 (9.5)	90.0 (9.5)	90.0 (9.5)	81.5 (9.1)	81.5 (9.1)	81.5 (9.1)	81.5 (9.1)
Captaan	7.3 (2.8)	7.5 (2.8)	5.3 (2.4)	6.7 (2.7)	85.0 (9.2)	58.0 (7.6)	27.5 (5.3)	56.8 (7.4)	37.8 (6.2)	24.7 (5.0)	21.2 (14.6)	27.9 (5.2)
Mancozeb	49.8 (7.1)	78.0 (8.9)	21.3 (4.7)	49.7 (6.9)	90.0 (9.5)	90.0 (9.5)	59.5 (7.7)	79.8 (8.9)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)
Thiram	13.5 (3.7)	10.0 (3.2)	0.0 (0.7)	7.8 (2.6)	27.5 (5.3)	25.0 (5.0)	24.3 (4.9)	25.6 (5.1)	41.8 (6.5)	42.5 (6.6)	39.2 (6.3)	41.2 (6.4)
Carbendazim	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	15.7 (4.0)	6.5 (2.6)	6.3 (2.6)	9.5 (3.1)
Carboxin	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	57.0 (7.6)	15.2 (3.9)	14.8 (3.9)	29.0 (5.2)	80.8 (9.0)	58.2 (7.7)	46.8 (6.9)	61.9 (7.9)
Copper	26.7 (5.2)	34.3 (5.9)	25.3 (5.1)	28.8 (5.4)	61.0 (7.8)	57.5 (7.6)	45.3 (6.8)	54.6 (7.4)	57.5 (7.6)	51.8 (7.2)	47.8 (6.9)	52.3 (7.2)
Mean	26.6 (4.2)	31.3 (4.5)	20.1 (3.4)	–	58.6 (7.1)	47.9 (6.3)	37.3 (5.6)	–	45.0 (6.2)	37.9 (5.6)	34.6 (5.3)	–
C.D. at 5%												
Fungicides		0.08				0.05				0.66		
Concentratin		0.05				0.03				0.04		
Interaction (FxC)		0.15				0.08				0.11		

*Mean of 6 replications, Figures in parenthesis are square root transformed values.

Kamathen *et al.* (2002) and Sharma *et al.* (2000). During the course of the present coincide with the findings of Gupta *et al.* (1997). Vrataric *et al.* (2002) reported that Carboxin was effective against *F. solani.*

Effect of seed dressing fungicides on the growth of *Trichoderma viride* and *T. harzianum (in vitro)*

Fungicidal compatibility studies with the biocontrol agent showed that Mancozeb with *T. viride* was found to be compatible followed by Copper oxychloride. Carbendazim and Carboxin were highly toxic. These results are in confirmation with the findings of Panday and Upadhyay (1999) and Somasekhara *et al.* (2000). Fungicidal compatibility studies with *T. harzianum* showed Mancozeb at all the concentrations was the most compatible fungicide followed by Captan and Copper oxychloride. Carbendazim is highly toxic. These results are comparable with those of Deepak *et al.* (2000), Lacicowa and Pieta (1994) and De *et al.* (1996) who reported Carboxin as next compatible fungicide to Captan.

Evaluation of neem products against *Trichoderma* spp.

The data (Table 2) revealed that all the three neem products were inhibitor to *T. harzianum* and *T. viride* as the mycelial growth ranged from 19.5 to 46.5 and 13.0 to 39.3 respectively. Neemgold was found slightly compatible with *T. harzianum* and *T. viride.* During the search of substrate for mass multiplication of *T. viride* neem cake was found inferiour over other cakes (Shamarao *et al.,* 1998). Moreover neem cake supported the production of maximum number of chlamydospores (Raguchandra *et al.,* 1998). These findings clearly indicates that neem directly/indirectly reduced that efficacy of *T. harzianum* and *T. viride* under field conditions. The present study therefore supports above findings.

Evaluation of neem products against *Fusarium solani* f. sp. *glycines*

The data presented in Table 2 indicated that maximum inhibitio in growth of *F. solani* f. sp. *glycines* was observed in Neemgold (68.0%) followed by Jai Neem and Jivdan Neem Herbal.

The results also revealed that all the three commercial products *viz.* Neemgold, Jivdan Neem Herbal and Jai Neem @ 0.3% were effective in controlling the *F. solani.* The above findings are in confirmation with the finding of Anuja *et al.* (2001) and Singh *et al.* (2002).

Table 2 : *In vitro* testing of Neem products against *Trichoderma viride* and *Trichoderma harzianum* and *Fusarium solani* f. sp. *glycines*

Nee Products	Radial growth (mm) after 8 days		
	T. viride	*T. harzianum*	*F. solani* f. sp. *glycines*
Jai Neem	19.5	13.0	35.3
Jivdan Neem Herbal	23.5	20.7	20.7
Neemgold	46.5	39.3	39.3
Control	88.5	90.0	90.0
C.D. at 5%	1.8	1.2	1.8

Evaluation of antagonists against *Fusarium solani* f. sp. *glycines*

The antagonistic effect of *Trichoderma viride* and *Trichoderma harzianum* isolated from local soils were tested *in-vitro* against *Fusarium solani* f. sp. *glycines* by biculture technique. It is evident from the data that *T. viride* as well as *T. harzianum* were able to check the growth of *Fusarium solani* f. Sp. *glycines.* The per cent inhibition of *F. solani* f. sp. *glycines* was 67.5% with *T. viride,* while it was 41.25% in case of *T. harzianum* (Table 3).

Table 3 : Mean radial growth of *Trichoderma* spp. of PDA grown against *Fusarium solani* f. sp. *glycines* after 8 days of incubation at 25°C

Treatments	Growth (mm)	Inhibition (%)
T. viride	6.50	67.50
T. harzianum	11.75	41.20
Control	20.00	00.00
CD at 5%	1.8	

*Mean radial growth of 6 replications.

Results indicated that both the antagonists were effective, but *T. viride* was found to be more inhibitory than *T. harzianum,* Similar trend of antagonism was observed by Somasekhara *et al.* (2000) Biswas (1999) and Singh *et al.* (2002),

reported that *T. viride* followed by *T. harzianum* were found to be antagonistic against *Fusarium* spp.

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