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ORIGINAL ARTICLE

On Farm Management of Soil borne diseases of vegetables by *Trichoderma viride*

Ashish Kumar Tripathi[1] and R.D. Barpete[2]
[1] Scientist (Plant Pathology), Jawaharlal Nehru Agricultural University,
Krishi Vigyan Kendra, Sagar (M.P.) 470002 INDIA
[2]Scientist (Plant Pathology), Jawaharlal Nehru Agricultural University,
Krishi Vigyan Kendra, Betul (M.P.) INDIA

Email: aktjnkvv@gmail.com

ABSTRACT
To assess the economic feasibility of Trichoderma viride application as seed treatment and Soil applications, 185 on farm trails in Betlvine, Chilli Ginger, Soybean, Chickpea and lentil were conducted from 2013-18 in Sagar districts. Each trail was conducted in 0.2 ha area and same area adjacent to the trial kept as control (farmer practice). Trichoderma viride is found compatible with Carboxin, Mancozeb and theophanate methyal at 1500 ppm but not Thiram, capton, Carbendazim and Metalaxy mercurials. Soil application of Trichoderma viride @ 2.5 kg/ha with oilseed cake before planting and drenching in rainy season reduced the incidence of sclerotial wilt and phytophthora foot and leaf rot disease by 18.9 to 8.1 and 16.8 to 3.1, respectively. The rhizome rot incidence was recorded as 6.4% in Trichoderma viride treated plots whereas 28.6% was recorded in control plot. The wilt disease in Chilli decreased from 10.9 per cent to 2.9 in the Trichoderma treated plots. Rhizoctonia root rot disease incidence in Soybean was 1.8 % in the plots where seed treatment done with Trichoderma viride @ 10 g/kg seed and disease incidence was 6.0 % where soil application and seed treatment done with Trichoderma viride in comparison to 9.8% in control plot. Seed treatment and soil application of T.viride decreased wilt disease incidence by 68.6 per cent in lentil and 68.1 per cent in chickpea which increased seed yield by 20.7 per cent and 37.3 per cent, respectively over farmers practice
Key words: *Trichoderma viride, Betelvine, Ginger, Chilli, Soybean, Chickpea, Lentil*

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INTRODUCTION

Economically important agricultural, horticultural and ornamental crop plants are attacked by various pathogens resulting crop losses. Soil borne pathogenic fungi viz., *Pythium, Fusarium, Rhizoctonia* and *Phytopthora* attack most of the economically important crop plants (either through seed before germination or seedling after germination) resulting in heavy losses. Presently, the most widely used control measures for suppressing the pathogens is the use of fungicides. However, problem encountered, such as development of resistance by the pathogen to the fungicide, and requirement of repeated applications, added to the increase cost of chemical have given impetus to alternative measures for control of plant disease.

In recent years, biological control of plant pathogens has received increasing attention as a promising supplement or alternative to chemical control. Biological control of plant pathogens is an attractive proposition to decrease heavy dependence of modern agriculture on costly chemical fungicides, which not only cause environmental pollution but also lead to the development of resistant strains. The genus *Trichoderma* by virtue of its broad spectrum action against a number of plant diseases caused by fungi, bacteria and even nematodes has occupied the top position among the bio-protectants developed for plant disease management [14]. These have long been recognized as biological agents to control plant diseases. Since the first application in 1930s, *Trichoderma* species became popular biological agents to protect crops against plant pathogens all over the world. Past research indicated that *Trichoderma* can parasitize fungal pathogens and produce antibiotics. Weindling [29] described in detail the mycoparasitism of a fungal pathogen causing damping off disease (*Rhizoctonia solani*) by the hyphae of *Trichoderma*, including coiling around the hyphae, penetration, and subsequent dissolution of the host

cytoplasm. He also described an antibiotic which was toxic to both *R. solani* and *Sclerotinia americana*, and named it gliotoxin.

The use of *Trichoderma* as a biological agent of plant diseases has long been known, however, these were introduced to Vietnam only in the last two decades [24]. Research has been done on biological control potential of *Trichoderma* spp. against several pathogens attacking vegetables, fruits, field and industrial crops. *Trichoderma* species are ubiquitous soil and compost borne saprophytes that have received enormous scientific interest as biocontrol agents of plant diseases caused by destructive root and soil pathogens. *Trichoderma* species compete well for food and site, produce antibiotics and had an enzyme system capable of attacking a wide range of pathogens through mycoparasitism.

MATERIAL AND METHODS

To develop an effective disease management programme, the compatibility of potential bio agents with fungicides is essential. Combinations of fungicides and compatible bio agents in an IDM strategy protects the seeds and seedlings from soil borne and seed borne inoculums [7]. Integration of compatible bio agents with fungicides may enhance the effectiveness of disease control and provide better management of soil borne diseases [17]. In view of this, investigation was conducted to test the possibility of combining *Trichoderma* species with fungicides under laboratory condition. The long term goal is to develop an effective IDM package for managing soil borne plant disease as well as to prevent the resistance development in pathogens to fungicides. Integrating chemical resistant *Trichoderma* species has an importance in the framework of integrated disease management. Disease prevention can be increased by using such tolerant species that keeps pathogens under sufficient pressure so that they cannot thrive. Keeping the above in view, the compatibility of *Trichoderma viride* with seven fungicides were tested by the poisoned food technique. The culture of *Trichoderma viride* was obtained from Biofertiliser Production Centre, JNKVV Jabalpur.

To assess the economic feasibility, 185 on farm trails in Chickpea, lentil, Betlvine, Chilli and Ginger crops were conducted in light to medium soil during 2012-18 in Chhatapur and Sagar districts. Each trail was conducted in 0.2 ha area and same area adjacent to the demonstration plot was kept as farmer practice. 10 gm per Kg Trichoderma used for seed treatment before sowing. For nursery treatment, 10 - 25 g of *Trichoderma* powder applied in nursery bed of 100 m^2. For cuttings and seedlings, mixed 10g of *Trichoderma* powder along with 100 g of well rotten FYM per liter of water and dip for 10 minutes before planting. For soil treatment, 2.5 Kg of Trichoderma powder mixed with 100 kg of farmyard manure and cover it for 7 -10 days with polythene. Sprinkle the heap with water intermittently. Turn the mixture in every 3-4 days interval and then broadcast in the field of one hectare.

RESULTS AND DISCUSSION

Compatibility of *Trichoderma viride* with fungicides

Trichoderma is compatible with Carboxin, Mancozeb and theophanate methyal at 1500 ppm but not Thiram, capton, Carbendazim and Metalaxy mercurials. Bio control agents that can tolerate a certain level of fungicides were mixed with agrochemicals, resulting in eradication of diseases [5]. The *Trichoderma* was more compatible with mancozeb followed by copper oxychloride [6]**. M**ancozeb was compatible with *Trichoderma* species [28]. Seed treatment of *Trichoderma viridae* would be high compatible with fungicide mancozeb at 3000 ppm. Moderate compatibility were recorded in the treatments of Tebuconazole (1000 ppm), Carbendazim (1000 ppm) alone [26]

Diseases management in Betelvine Crop:

Twenty on farm research trails were conducted for disease management in Betelvine growing villages Garhimalhera and Maharajpur of Chhatarpur district. Soil application of *Trichoderma viride* @ 2.5 kg/ha with oilseed cake before planting and drenching in rainy season reduced the incidence of sclerotial wilt and phytophthora foot and leaf rot disease by 18.9 to 8.1 and 16.8 to 3.1, respectively. Application of bio-agents like *T. viride* as seed treatment and soil drenching reduces the growth of soil borne fungi i.e. *Phytophthora* and *Sclerotium rolfsii* in fields of betelvine due to its quality of fast multiplication and myco-parasitism [22].

Rhizome rot diseases management in Ginger:

Ginger (*Zingiber officinale* Rose) is an herbaceous perennial, it occupying 4400 ha In Madhya Pradesh, with very low productivity 1.27 tonnes per ha. The reason of low productivity seems to be continuous use of degraded seed which is prone to various diseases like rhizome rot or soft rot. Rhizome rot is widely prevalent throughout the ginger producing area. It is mostly caused by different species of *Fusarium* and / or *Pythium*. The soil application and rhizome treatment with *Trichoderma viride* was tested at 45 farmer's field in Chhatarpur and Sagar districts.

The application of Trichoderma viride protected the seed thus, 91 per cent germination was found in treated plots in comparison to 72 per cent in control. The rhizome rot incidence was recorded as 6.4% in *Trichoderma viride* treated plots whereas 28.6% was recorded in control plot. The yield of Ginger was found 126 q/ha in *Trichoderma viride* treated plots in comparison to control (61 q/ha). Previously other workers also reported that rhizome pelleting with *Trichoderma viride* suppressed Rhizome rot disease [15, 19].

Management wilt disease in Chilli:

Chilli, *Capsicum annuum* L., an important vegetable and commercially grown condiment, is essential for all Indian dishes. The Chilli crop suffers with many fungal, bacterial and viral diseases resulting in huge yield losses. Among the fungal diseases, Wilt of chilli is a serious problem since past decade, the yield losses due to the disease are known to vary from 10 to 80 per cent depending upon the variety being grown prevailing climatic conditions. In view of the importance of disease and crop, KVK Sagar conducted 17 On Farm Trials on integrated management of wilt in chilli. Seed and seedling treatment with *Trichoderma viride* @ 10 g/kg seed/lit of water and soil application of *Trichoderma viride* 5 kg/ha with FYM decreased wilt incidence from 10.9 per cent to 2.9 per cent which increased green chilli yield from 74.1 to 101 q/ha. Additional cost of 8600 per ha of technology demonstrations of chilli given additional net return of Rs. 37945 per hectare to the farmers. *Trichoderma viride* was effectively managing *Fusarium* wilt of chilli and incidence of 15.4 and 6.2% was recorded in *T. viride* treatment as against 31.4 and 15.4% respectively in untreated control [4, 20, 21].

Management of Rhizoctonia root and stem rot of Soybean:

Rhizoctonia root and stem rot, caused by the fungus ***Rhizoctonia solani***, is an important disease of soybean in Madhya Pradesh. Keeping the importance of this disease, On farm trials were conducted at 30 farmer's fields during *Kharif* season of the year 2015 to 2017. The disease management technology assessed was T_1- No seed treatment (Farmers practice), T_2- Seed treatment with *Trichoderma viride* @ 10 g/kg seed, T_3- Soil application of *Trichoderma viride* @ 2.5 kg/ha with FYM and Seed treatment with *Trichoderma viride* @ 10 g/kg seed. The results revealed that Rhizoctonia root rot incidence was 1.8 % in the plots where seed treatment done with *Trichoderma viride* @ 10 g/kg seed and disease incidence was 6.0 % where soil application and seed treatment done with *Trichoderma viride* in comparison to 9.8% in farmer practice plot. The effectiveness of *T. viride* and *T. harzianum* against collar rot and root rot diseases of Soybean [13]. The genus *Trichoderma* comprises of a large species complex having potential as biocontrol agents against *R. solani*. *Trichoderma* isolates can parasitize hyphae, sclerotia and other structures of *R. solani*. The metabolites of *Trichoderma* spp. induce competitiveness against the pathogen and induce resistant to host plant [3].

Management of wilt disease in Chickpea and lentil:

Chickpea and lentil are major pulse crops in *Rabi* season. Both the crops are heavily affected by Collar rot and wilt disease. Seed treatment and soil application of *T.viride* decreased wilt disease incidence by 68.6 per cent in lentil and 68.1 per cent in chickpea which increased seed yield by 20.7 per cent and 37.3 per cent, respectively over farmers practice (seed treatment by Carbendazim). Application of *T.viride* also given net return of Rs. 15230 and B:C ratio 3.37 in lentil crop and Rs. 25650 net profit and B:C ratio 4.0 cost benefit ratio in chickpea gram as compared to FP plots (Rs. 11520 net profit and B:C ratio 3.08 for lentil and Rs. 17300 net profit and 3.27 B:C ratio for gram). The quality of fast multiplication and myco-parasitism of *Trichoderma viridae* reduces the population of fusarium spp. in Gram and lentil fields which results in lower incidence of wilt. Results are in accordance with Sharma *et. al*. [19] and Tripathi [21] who reported that soil application of *T.viride* effective in inhibiting the growth of *Fusarium oxysporum* f. Sp. Ciceri under field condition which reduced the wilt incidence from 10.45 to 4.05.

Table- 1: Compatibility of *Trichoderma viride* with fungicides

Treatments	Concentrations (in ppm)		
	500	1000	1500
Thiram	18.6	0.0	0.0
Captan	0.0	51.3	0.0
Mancozeb	65.3	6.3	36.6
Carbendazim	69.3	21.3	0.0
Carboxin	78.6	39.3	59.3
Theophanate Methyle	49.3	36.2	22.6
Metalaxy	58.7	24.8	0.0
Control	90.0	90.0	90.0

Table-2: Effect of disease management practices on soil borne disease of Betelvine

Treatments	Disease incidence			Fresh leaf yield (q/ha)	B:C ratio
	Phytophthora Blight (%)	Sclerotial wilt (%)	Root rot (%)		
Soil application of *Trichoderma viride* @ 2.5 kg/ha with oilseed cake, the cuttings of betelvine treated with Streptocycline and then planted in rows.	8.1	3.1	4.2	72.0	4.56
Farmers practice (Cutting treatment with Copper fungicide and spray of any fungicide at disease appearance)	18.9	16.8	12.7	58.0	3.68

Table 3 : Efficacy of *Trichoderma viride* on the control rhizome rot disease

Treatment	Germination (%)	Rhizome rot (%)	Rhizome yield (q/ha)
The soil application and rhizome treatment with *Trichoderma viride*	91	6.4	126
Farmers practice (No rhizome treatment)	72	28.6	61

Table 4 : Efficacy of *Trichoderma viride* on the control wilt disease of chilli

Treatments of On Farm Testing	Disease incidence	Yield (q/ha)	Net return	B:C ratio
T1- Farmers practice (No Seedling Treatment)	10.9	74.7	70875	2.72
T2- Seedling Treatment by *Trichoderma viride* @10 g/lit of water	7.1	87.2	88910	3.12
T3- Seedling Treatment + Soil application of *Trichoderma viride* 2.5 kg/ha with FYM	2.9	101.0	108820	3.55

Table-5: Performance IDM module for management of Rhizoctonia Disease in Soybean

Details of Technology	Disease Incidence (%)	Yield (q/ ha)	Cost of cultivation (Rs./ ha)	Gross returns (Rs./ ha)	Net return (Rs./ ha)	B:C ratio
Sowing without seed treatment **(**Farmers' Practice **– T_1)**	9.8	9.3	9400	27900	19500	2.96
Summer ploughing, Seed treatment with *Trichoderma viride* @ 10 g/kg seed **(T_2)**	6.0	11.7	10800	35100	24300	3.25
Summer plounghing, Soil application of *Trichoderma viride* @ 2.5 kg/ha with FYM and Seed treatment with *Trichoderma viride* @ 10 g/kg seed **(T_3)**	1.8	13.1	11200	39300	28100	3.50

Table-6: Performance *Trichoderma viride* for the management of wilt Disease in Lentil and Chickpea

Crops	Disease incidence (%)		Grain yield (qtl/ha)		Cost of Cultivation (Rs./ha)		Additional cost of cultivation	Net return (Rs./ha)		Additional net return
	Demo	F P	Demo	FP	Demo	FP		Demo	FP	
Lentil	9.4	30.0	6.18	5.12	6400	5800	600	15230	11520	3710
Gram	7.2	22.6	11.4	8.30	8550	7600	950	25650	17300	8350

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