SHORT COMMUNICATION

Management of root rot and damping off complex in French bean by biocontrol agents

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ABSTRACT: French bean (*Phaseolus vulgaris*) is one of the important food legume crops used as green vegetable and pulse in different parts of India. Among the diseases, root rot (*Rhizoctonia solani*) and damping off (*Pythium ultimum*) complex are considered an important factor for low productivity of the crop. The experiments were conducted during 2013 and 2014 at IARI, New Delhi to evaluate the performance of different seed dressing and soil application formulations of *Trichoderma* species and talc based formulation of *Pseudomonas fluorescens* (IBSD-P137) against root rot and damping off complex in French bean. The seeds treated with seed dressing formulations of *Trichoderma* and *Pseudomonas* alone and in combinations increased the seed germination, root and shoot lengths, plant dry weight and pod yield and decreased the disease incidence. The seeds treated with Pusa 5SD (*T. harzianum*-IARI P4) in combination with *P. fluorescens* gave the highest seed germination, shoot and root length, dry plant weight and pod yield along with the lowest disease incidence followed by Pusa 5SD (*T. harzianum*-IARI P4) alone and Pusa 5SD (*T. viride*; IBSD T-20) in combination with IBSD isolate of *P. fluorescens*. Seed germination, root length and disease incidence in these treatments did not differ significantly. Soil application of Pusa bio-pellets of *T. harzianum* (IARI P4) and *T. viride* (IBSD T-20) also enhanced the seed germination, shoot and root lengths, dry plant weight and pod yield and reduced disease incidence. Thus, the root rot and damping off in French bean could be managed by soil application and seed treatment with bio-formulations of *T. harzianum* alone and in combination with *P. fluorescens*.

Keywords: French bean, bio-formulation, disease management, root rot, damping off, *Trichoderma*, *Pseudomonas*

French bean (*Phaseolus vulgaris* L.) is one of the most important vegetable food legumes directly consumed worldwide. Root rot and damping off of French bean caused by *Rhizoctonia solani* Kühn and *Pythium ultimum* Trow, respectively are the most devastating diseases occurring together as a complex (El-Mougy *et al.*, 2007). The pathogens survive in the soil as sclerotia in case of *R. solani* and as fungal mycelia/oospores in case of *Pythium ultimum* separately or embedded with host tissues and may destroy the entire crop under favorable conditions.

Use of bio-control agents in place of fungicides is an alternative to manage the plant diseases, which can reduce the environmental pollution and enhance the safety of agricultural produces. Various methods to manage such diseases namely, chemical, cultural practices, plant volatile compounds, plant extracts including the use of resistant varieties and biological methods, particularly the use of species of *Trichoderma* have been investigated (El-Mougy *et al.*, 2007). The potential of *Trichoderma* species has been demonstrated by several workers in controlling the damping-off and root rot diseases of crop plants caused by *Rhizoctonia*

and *Pythium* species (Dubey, 2002; Dubey *et al.*, 2007).

The application of *Trichoderma* species provided protection against pre- and post-emergence damping off and reduced the disease incidence as compared to fungicide (Abd-El-Khair *et al.*, 2011). The seed treatment with *T. harzianum* based bioformulation significantly increased the heights and weight of plants and significantly reduced the incidence of damping-off in various leguminous crops (Abd-El-Khair *et al.*, 2011; Negi *et al.*, 2014). *Trichoderma asperellum*, *T. harzianum*, and *T. viride*, checked the black mould rot severity in onion (Prajapati and Patil, 2017).

The objective of the present study was to evaluate the efficacy of *T. harzianum* and *T. viride* based bio-formulations alone and along with *P. fluorescens* against root rot and damping off complex caused by *R. solani* and *P. ultimum* in French bean.

Pot experiments were conducted during 2013 and 2014 at Division of Plant Pathology, IARI, New Delhi in completely randomized block design to evaluate the performance of different seed dressing and soil application formulations of *Trichoderma* species and

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Pseudomonas fluorescens (IBSD-P137) against root rot (*R. solani*) and damping off (*P. ultimum*) of French bean. Surface sterilized plastic pots (15 cm diameter) were filled with sterilized (formalin 1.0%) soil (2 kg pot⁻¹). The inoculum of both the pathogens was multiplied on sorghum grains (*Sorghum bicolor*) and the pot soil were inoculated with the 10 days old mixed inoculum of *R. solani* (5 g kg⁻¹ of soil) and *P. ultimum* (5 g kg⁻¹ of soil) two days before sowing (Dubey *et al.*, 2009). The seeds were treated with bioformulations separately and in combination with fungicides. Twelve treatments evaluated against the disease were consisted of Pusa 5SD (*T. viride*, IBSD T20) from IBSD, Imphal, Pusa 5SD (*T. harzianum* IARI-P4) from IARI, New Delhi, talc based formulation of *Pseudomonas fluorescens* (IBSD-P137), Pusa 5SD (*T. viride* IBSD T20) + talc formulation of *P. fluorescens* (IBSD-P137), Pusa 5SD (*T. harzianum* IARI-P4) + talc formulation of *P. fluorescens* (IBSD-P137), carbendazim + thiram, Pusa biopellets prepared from *T. viride* (IBSD T20) and *T. harzianum* (IARI-P4) including controls. Each pot was sown with 6 seeds of susceptible French bean variety Contender on February 18, 2013 and February 21, 2014. Each treatment was replicated three times. The seed treatment was performed with bioformulations at 6 g kg⁻¹ seed and soil application formulations were applied at 0.5 g kg⁻¹ soil in required pots prior sowing. The fungicides were applied in 1:1 ratio at 2 g kg⁻¹ seed.

Germination of seeds was recorded at 10 days after sowing. Shoot and root lengths, and dry weight were recorded on the basis of two plants uprooted at maturity stage from each pot. Pod weights were recorded at harvesting time from each pot. Number of diseased plants from each pot were counted periodically and finally, disease incidence was calculated based on total diseased plants per pot. The data pertaining to all the

observations were subjected to ANOVA (Gomez and Gomez, 1984) using the SAS Software (SAS Institute, version 9.1, Cary, NC). The data were analyzed as per the procedure for a completely randomized design for the test of significance. Mean of two years data were presented. Fisher's Protected Least Significant Differences (LSD) was computed only when ANOVA showed significant differences for any particular effect.

The seeds treated with seed dressing formulations of *Trichoderma* species and *P. fluorescens* alone and in combination increased the seed germination, root and shoot lengths, plant dry weight and pod yield and decreased the disease incidence (Table 1). The highest seed germination, shoot and root lengths, dry plant weight and pod yield along with the lowest disease incidence were recorded in the seeds treated with Pusa 5SD (*T. harzianum*-IARI P4) in combination with IBSD, Imphal isolate of *P. fluorescens* (P-137) followed by Pusa 5SD (*T. harzianum*-IARI P4) alone, Pusa 5SD (*T. viride*, IBSD T-20) in combination with *P. fluorescens* (IBSD P-137) and Pusa 5SD (*T. viride*, IBSD T-20) alone were the next effective treatment in order of performance. Seed germinations, root length and disease incidence recorded in these treatments did not differ significantly. Soil application of Pusa biopellets of *T. harzianum* (IARI P4) and *T. viride* (IBSD T-20) also enhanced the seed germination, shoot and root lengths, dry plant weight and pod yield and reduced disease incidence. Seed germination, shoot and root lengths and dry plant weight, pod yield and disease incidence recorded in these treatments were significantly superior over the control having mixed inoculum of both the pathogens.

The seed germination and disease incidence recorded in the seeds treated with *T. harzianum* + *P. fluorescens* were statistically similar with non-inoculated

Table 1. Effect of seed treatment and soil application on yield attributing factors and disease incidence in French bean (mean of two year 2013 and 2014)

Treatment details	Germination (%)	Shoot length (cm)	Root length (cm)	Dry weight (mg/plant)	Pod weight (g/pot)	Disease incidence (%)
Pusa 5SD (<i>Trichoderma viride</i> , IBSD T-20)	95.8 (84.0) ^{abc}	24.1 ^b	9.3 ^{ab}	1194.4 ^c	19.3 ^b	6.6 (10.5) ^{ab}
Pusa 5SD (<i>T. harzianum</i> , IARI P-4)	95.8 (84.0) ^{abc}	24.4 ^b	9.8 ^{ab}	1298.6 ^b	25.9 ^a	4.5 (9.0) ^{ab}
<i>Pseudomonas fluorescens</i> (IBSD P-137)	87.5 (71.9) ^{cde}	23.3 ^{bc}	7.6 ^c	1058.2 ^{de}	17.6 ^{cd}	13.1 (19.4) ^{bc}
Pusa 5SD (<i>T. viride</i> , IBSD T-20) + <i>P. fluorescens</i> (IBSD P-137)	95.8 (84.0) ^{abc}	24.3 ^b	9.7 ^{ab}	1295.8 ^b	19.5 ^b	5.0 (9.4) ^{ab}
Pusa 5SD (<i>T. harzianum</i> , IARI- P4) + <i>P. fluorescens</i> (IBSD P-137)	97.9 (87.0) ^{ab}	27.1 ^a	10.0 ^a	1538.9 ^a	26.7 ^a	4.5 (9.0) ^{ab}
Carbendazim + Thiram	83.3 (65.9) ^{de}	22.9 ^c	7.0 ^{cd}	1054.5 ^{de}	16.6 ^d	13.1 (19.4) ^{bc}
Pusa Biopellet (<i>T. viride</i> , IBSD T-20)	89.6 (74.9) ^{bcd}	23.5 ^{bc}	8.8 ^b	1074.0 ^{de}	17.6 ^{cd}	9.0 (14.4) ^{abc}
Pusa Biopellet (<i>T. harzianum</i> , IARI P-4)	89.6 (74.9) ^{bcd}	23.6 ^{bc}	9.4 ^{ab}	1130.8 ^{cd}	18.8 ^{bc}	9.0 (14.4) ^{abc}
Control (<i>Rhizoctonia solani</i>)	75.0 (60.3) ^e	22.3 ^{cd}	5.9 ^{de}	1002.1 ^{ef}	13.3 ^{ef}	20.7 (27.0) ^{cd}
Control (<i>Pythium ultimum</i>)	79.2 (63.1) ^{de}	22.9 ^c	5.9 ^{de}	1027.7 ^{ef}	14.6 ^e	20.7 (27.0) ^{cd}
Control (<i>R. solani</i> + <i>P. ultimum</i>)	72.9 (58.9) ^e	21.2 ^d	5.4 ^e	945.5 ^f	12.8 ^f	21.9 (27.9) ^d
Control (No inoculum)	100.0 (90.0) ^a	24.7 ^b	6.9 ^{cd}	1077.0 ^{de}	18.4 ^{bc}	2.3 (4.6) ^a

Figures in parentheses are transformed angular values

The values within a column with different letters are significantly different at 5% level by using Fisher's least significance difference test

control. Whereas, pod yield and other yield attributing parameters like shoot and root lengths, dry plant and pod weight were higher than the non-inoculated control showed the growth enhancing ability of the bioagents used for treatments. The present results are supported by the observations of Nashwa *et al.* (2008) that *T. harzianum* and *T. viride* showed greatest antagonistic efficacy on *Fusarium oxysporum* f. sp. *phaseoli* and *R. solani* causing damping-off and wilt in bean plants. Soil treatment with *Trichoderma* formulation reduced significantly the disease incidence and enhanced the green yield of bean plants under green house and field conditions. Abd-El-Khair *et al.* (2011) observed that soil treatment with *Trichoderma* species significantly reduced the pre and post emergence damping-off incidence in beans caused by *F. solani* and *R. solani*. In present results also, the soil application of *Trichoderma* based formulations Pusa Biopellets, significantly reduced the disease in French beans and increase yield attributing parameters, but their performance was less than seed treatment. Hamid *et al.* (2012) managed the root rot in pea caused by *F. solani* f. sp. *pisi* using *T. harzianum*, carbendazim and *P. fluorescens*.

Negi *et al.* (2014) also observed increase in shoot, root and seedling lengths, number of pods, grains per pod, pod weight and yield of vegetable pea raised with the seeds treated with a combination of *T. harzianum* and *P. fluorescens*. The seed treatment reduced the root rot complex caused by *R. solani* and *F. solani* in vegetable pea. In the present findings also, combined application of *T. harzianum* and *P. fluorescens* significantly enhanced the yield attributing parameters and yield of French bean and minimized the disease incidence. The treatment also enhanced the shoot and root lengths of the French bean plants indicating the growth promoting properties of the formulations. Plant growth enhancement properties of *Trichoderma* has been observed in beans (Hoyos-Carvajal *et al.*, 2009). The seed priming of cowpea with *T. harzianum* improved the seed germination, vigour of plants, pod number and pod vigour and reduced root and collar rot caused by *R. solani* (Pan and Das, 2011). Soil application of *T. harzianum* along with vermi-compost reduced the disease (Pan and Das, 2011). Abd-El-Khair *et al.* (2011) also observed that soil treatment with *Trichoderma* species significantly reduced the pre- and post-emergence damping-off incidence in beans caused by *F. solani* and *R. solani*. In present results also, the soil application of *Trichoderma* species formulations Pusa Biopellets, significantly reduced the disease in French bean and increase yield attributing parameters, but their performance was less than seed treatment.

Trichoderma viride along with salicylic acid increased growth parameters and yield, and reduced the damping off and root rot/wilt in Faba bean (Abdel-Monaim, 2013). El-Mohamedy *et al.* (2015) managed the root rot of green bean caused by *R. solani* and *F. solani* using seed treatment with *T. harzianum* and resistance inducer chemicals sorbic or benzoic acid. In the present study, a combination of *T. harzianum* and *P. fluorescens* proved effective in managing the root rot and damping

off complex in French bean and increased yield attributing parameters and yield.

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