Biological control of root rots disease causing *Rhizoctonia solani* in French bean

Khilendra Singh[1], Juhi Shah[1], Kalpana Gairola[1*], and Meenakshi Rana[2]

ABSTRACT

Efficacy of different application method of biological control agents were evaluated against root rot disease of french bean in field. Among the tested bio control agents significantly minimum root rot incidence was found in T8 *Trichoderma viride* as seed treatment, soil application with foliar application Pseudomonas florescence followed byT7,T4.Significantly maximum seed germination was found in T8 seed treated with *Trichoderma viride*, soil application with foliar application Pseudomonas florescence followed by T6,T5 and T4.Significantly maximum seedling growth at 35 DAS, no. of pods/plant at 55 DAS, length of plant at 45 DAS, no. of branches /plant, no. of pods /plant, yield, economic were found inT8 *Trichoderma viride* as seed treatment and soil application and with foliar application Pseudomonas florescence followed by T7, T6 and T5.

Keywords: Bio control agents, Root rot, French bean

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INTRODUCTION

French bean (*Phaseolus vulgaris*) is an important food crop in different parts of the country.Various disease have been reported on French bean.Among them root rot caused by *Rhizoctonia solani* is the most destructive disease. The pathogen survives in soil and destroys the crop under congenial condition. The pathogen causes considerable yield loss in leguminous crop. The yield loss reported from the disease is 8.5 to 65 percent in Bangalore (Sharma and Sohi, 1980&1981).Use of bio-control agents is place of chemicals is best the alternative method to control the plant diseases. Various methods i.e. chemical, biological control, use of resistant source, volatile compounds, herbal extract, have been reported to manage plant diseases (EI Mougy *et al.,* 2007).The potential of *Trichoderma* species have been investigated by several workers to manage root rot and damping off disease in leguminous crop affected by *Rhizoctonia* and *Phythium* species (Dubey, 2002; Dubey *et al.,* 2007).Integrated application of vermicompost tea (5-10 %), *Serratia marcescens* and *Trichoderma harzianum* have been reduced pre and post emergence damping off (95 %) in common bean cv. Giza 6 in green house (Helmey and Abu-Hussain, 2024). Seed dressing of PUSA 5 SD with *Trichoderma* and Pseudomonas alone and in combination reduced root rot severity, increased seed germination, root and shoot length, plant dry weight and pod yield in vitro (Dubey *et al.,* 2017).Application of *Trichoderma* species provided protection against pre and post emergence damping off and managed disease severity compared to chemical fungicides (KAbd-El-Khair *et al.,* 2011).Seed PUSA 5 SD treated with *T. harzianum* (IARI P-4) combined with *P. florescence* increased seed germination, root and shoot length, plant dry weight, pod yield and reduced root rot incidence in green house condition (Dubey *et al.,* 2017). Application of VCT+EM1 or *Trichoderma harzianum* suppressed root rot severity by 65.6 % and 64.34% respectively in field (Helmey and Abu-Hussain, 2024). Different combination of *Trichoderma harzianum* + *Pseudomonas florescence* have been reported to decreased the root rot incidence and increased the grain yield and net return in Mothbean (Godara and Singh 2021). *Trichoderma* based formulation treated seed increased height and weight of plant and significantly inhibited incidence of root rot and damping off in various leguminous plants (Abd-El-

Khair *et al.,* 2011; Negi *et al.,* 2014). Seed and soil treatment of different isolates of *Trichoderma* have been reduced root rot incidence, increased grain pod yield in French bean (Bhagwat and Pan 2010). Therefore, present study aims to carried out to test the efficacy of combination of different application methods of biological control agents against *Rhizoctonia solani.*

Research gap

The study was aimed to screen out the efficacy of different application methods of bio control agents against root rot disease of French bean caused by *Rhizoctonia solani* for eco-friendly management.

MATERIALSANDMETHODS

The experiment was conducted in Randomized block design (RBD) during rabi season 2021-2022 at Agricultural Research Farm, Shri Guru Ram Rai University, Dehradun, with three replication, plot size 8.4 m².The plot was divided into 27 equal plots with nine treatment combinations. The details of treatments are given in(Table 1).The field was prepared by thorough ploughing, and harrowing. Soil was ploughed 2- 3 times with spade.Planking was done during the last plough to make soil beds for sowing. Recommended dose of FYM @ 25T/ha was applied on one side of Ridges during last plough. Soil applications of Bio-agents were done on individual plot at the time of last ploughing. Treated Seeds with biocontrol agents and Neem oil were sown at the rate of 50 to 60 kg /ha at a row spacing of 30 cm. Seeds were sown by opening the furrow with the help of Kudal and covered with soil. The manual weeding was done in field after 25-30 DAS. Each bio-control agents were sprayed on individual plot at 35, 45 and 50 DAS. Observation on seed germination was recorded at initial stage.Percent disease incidence, seedling growth, number of branches/plant, length of plants/plot was recorded at different growth stages. Number of pods/plant was recorded at 45, 50 and 55 DAS.Yield % and economics were recorded at harvest.Percent yield increase was recorded by using the following formula:

$$\text{Yield increase (\%)} = \frac{X-Y}{Y} \times 100$$

Where, X = average yield of treated plot;Y = average yield of untreated plot.

The following describes the specific uses of bioagents in the field study:T1-*Trichoderma harzianum* (seed treatment 10g/kg seed + soil Treatment 2.5 kg/ha), T2-Neem oil (Seed Treatment 10ml/kg seed+ Foliar application 10ml/Ltr water), T3-*Pseudomonas Fluorescence* (Seed Treatment 10g/kg seed + Foliar application 10ml/Ltr Water), T4-*Trichoderma viride* (seed treatment 10g/kg seed + soil Treatment 2.5 kg/ha), T5-*Trichoderma harzianum* (seed treatment 10g/kg seed +*Pseudomonas Fluorescence* Foliar application10g/Ltr Water), T6-*Trichoderma viride* (seed treatment 10g/kg seed+*Pseudomonas Fluorescence* Foliar application 10g/Ltr Water), T7-*Trichoderma harzianum* (seed Treatment 10g/kg seed+ Soil application 5 kg/ha + *Pseudomonas Fluorescence* Foliar application 10 g/Ltr Water), T8-*Trichoderma viride* (Seed Treatment 10g/kg seed + Soil application 5 kg/ha + *Pseudomonas Fluorescence* Foliar application 10 g/Ltr Water) and control.

Statistical analysis

Data obtained on various traits were assessed to estimate coefficient of variation (CV %) and critical difference (CD5%) among and within the population. All data in percentage were analyzed after arc sin transformation and both actual and transformed values of mean with (CD 5%). Data were analyzed as per the design using ANOVA.

RESULTS

Growth parameters-Seed germination

The seed germination in (Table 1) revealed significantly maximum seed germination was found in T8 followed by T8, T5, and T4 compared to the control.

Disease incidence

Significantly minimum disease incidence of 17.8 percent was found in T8 (seed treated with *Trichoderma viride* and soil application with foliar application *Pseudomonas florescence*) followed by T7, T4, T1 and T9.

Seedling growth at 35 DAS

The seedling growth in Table 1 revealed that significantly maximum seedling growth was found in Treatment 8 (35 DAS) followed by Treatment T7 31.02 cm (35 DAS), Treatment T6 30.09cm (35 DAS) as compared to control plot 27.04cm (35 DAS).

Table 1. Effect of seed treatment, foliar spray and soil application on growth attributing factors in French bean

Treatment Name	Germination (%)	Disease incidence (%)	Seedling growth (35 DAS)	Number of Pods/Plant (55 DAS)	Length of the Plant cm (45 DAS)	Branches/ plants
Tri. hr (ST) + Soil appl.	82.83	24.7	29.22	64.22	30.30	2.56
Neem oil (ST) + Foliar	81.37	35.3	28.62	62.33	28.90	1.16
Ps. fl (ST) + Foliar	82.73	32.6	29.12	63.87	29.85	2.33
Tri. vi (ST) + Soil appl.	83.30	22.5	29.74	64.31	31.40	2.89
Tri. hr (ST) + Ps fl	83.53	26.7	29.84	64.77	32.80	3.41
Tri vi (ST) + Ps fl	84.22	28.3	30.09	65.22	35.01	3.77
Tri hr (ST) + soil appl. + Ps fl	70.75	19.4	31.02	65.32	37.76	4.04
Tri vi (ST) + Soil appl. + Ps fl	88.45	17.8	32.55	66.78	37.08	5.05
Control	58.25	68.7	27.04	60.10	26.80	0.85
SE(m)	0.381	0.409	0.134	0.138	0.207	0.047
C.D (P=0.05)	1.187	1.237	0.405	0.418	0.627	0.143
C.V	0.813	2.434	0.781	0.377	0.825	2.837

Tri. hr – *Trichoderma harzianum;* Tri. vi – *Trichoderma viride;* ST – Seed Treatment ; Ps fl – *Pseudomonas florescence;* Soil appl. –Soil Application

Number of Pods/Plant

The significantly maximum pods/plant showed by seeds treated with *T. viride,* soil application with foliar application *P. florescence* showed 66.78 per cent at 55 DAS followed by T7 64.32 (55 DAS), T6 65.22 (55 DAS) as compared to control plot 60.10per cent(55 DAS).

Length of the Plant

The data in table 2 revealed that significantly maximum height of plants showed in seeds treated with *T. harzianum* and soil application and foliar application *P. florescence* T7 37.76 cm (45 DAS) which was at part to treatment 8 seed treatment with *T. viride,*soil application and with foliar application *P. florescence* 37.08 cm (45 DAS) as compared to control plot 26.80 cm (45 DAS).

Number of branches

The data in Table 1 revealed that significantly maximum number of branches per plant was found in *Trichoderma viride* as seed treatment, soil application and with foliar application *Pseudomonas florescence* 5.05 (T8) followed by T7 and T6as compared to control plot.

Yield attributing characters

The data in Table 3 revealed significantly maximum no. of pods per plant was found in *Trichoderma viride* as seed treatment and soil application and with foliar application *P. florescence* T8 (169.46) followed by T7 (165.44), T6 (164.09) compared to control plot 152.98.

Yield

The data in Table 2 revealed that significantly maximum yield was found in T8 seed treated with *T. viride* and soil application,with foliar application *P. florescence* followed by T7, T6,T5 compared to control plot (4.01).

Economy

The data in Table 3 revealed that the best results were found in T8 seed treatment with *T.viridi,*soil application and foliar application *P. florescence* 2.9 followed by T7, T6 and T5 i.e., 2.8, 2.6, 2.3 as compared to the control 1.5.

DISCUSSIONS

In the present investigation combination of different application methods of bio-control agents were evaluated against root rot in French bean to find out the most effective method. Significantly maximum seed germination found in T8 *T. viride* as seed, and soil treatment with foliar application *P. florescence* followed by T6, T5 and T4. Significantly minimum root rot incidence was observed in T8 seed treated with *T. viride* and soil application and with foliar application *P. florescence* followed by T7, T4 and T1. Maximum seedling growth at 35 DAS, no. of pods/plant at 55 DAS, length of plant at 45 DAS, no. of branches /plant, no. of pods /plant, yield, higher return were found in T8 *Trichoderma viride* seed treatment, soil application and with foliar application of *Pseudomonas florescence* followed by T7, T6 and T5.

Table 2. Effect of seed treatment, foliar spray and soil application on yield attributing factors in French bean

Treatments	Pod length	No. of pods/plants	Pod weight (g/pod)	Yield T/ha
Tri. hr (ST) + Soil appl.	11.02	162.33	373.36	5.99
Neem oil (ST) + Foliar	10.12	159.2	366.16	4.97
Ps. fl (ST) + Foliar	10.98	161.29	370.97	5.23
Tri. vi (ST) + Soil appl.	11.65	162.24	373.15	6.02
Tri. hr (ST) + Ps fl	12.09	163.28	375.54	6.78
Tri vi (ST) + Ps fl	12.77	164.09	377.41	7.69
Tri hr (ST) + soil appl. + Ps fl	13.98	165.44	380.51	8.09
Tri vi (ST) + Soil appl. + Ps fl	14.5	169.46	389.76	8.55
Control	9.06	152.98	351.85	4.01
SE(m)	**0.398**	**0.334**	**1.300**	**0.277**
C.D (P=0.05)	**N/A**	**1.011**	**3.931**	**0.839**
C.V	**17.472**	**1.071**	**1.809**	**7.457**

Tri. hr – *Trichoderma harzianum;* Tri. vi – *Trichoderma viride;* ST – Seed Treatment; Ps fl – *Pseudomonas florescence;* Soil appl. – Soil application

Table 3. Effect of seed treatment, foliar spray and soil application on economics in French bean

Treatment Name	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	B:C Ratio
Tri. hr (ST) + Soil appl.	68900	23789	1.9
Neem oil (ST) + Foliar	60980	23600	1.6
Ps. fl (ST) + Foliar	67900	23000	2.0
Tri. vi (ST) + Soil appl.	75460	23890	2.2
Tri. hr (ST) + Ps fl	79089	24100	2.3
Tri vi (ST) + Ps fl	88760	24890	2.6
Tri hr (ST) + soil appl. + Ps fl	95098	25000	2.8
Tri vi (ST) + Soil appl. + Ps fl	98700	25500	2.9
Control	58.25	22000	1.5

Tri. hr – *Trichoderma harzianum;* Tri. vi – *Trichoderma viride;* ST – Seed Treatment; Ps fl – *Pseudomonas florescence;* Soil appl. – Soil application

Different methods such as cultural, chemical, biological control, use of resistant sources, plant volatile compounds, plant extracts have been reported to control plant disease (El-Mougy *et al.,* 2007). Use of *Trichoderma* spp. has been reported to control plant diseases.Dubey, 2002 and Dubey et al. 2007 have been reported *Trichoderma* species against damping and root rot disease of crop plants caused by Rhizoctonia and Phythium species. *Trichoderma* and *Pseudomonas* seed dressing with PUSA 5 SD alone and in combination reduced root rot severity, increased seed germination, root and shoot length, plant dry weight and pod yield in vitro (Dubey *et al.,* 2017). Soil treatment with *Trichoderma* species significantly reduced the pre and post emergence damping- off incidence in beans caused by *F. solani* and *R. solani* (Abd-El-Khair *et al.,* 2011).Seed treatment, soil application of *Trichoderma harzianum* + *Pseudomonas florescence* decreased root rot incidence, increased grain yield and net return in Mothbean (Godara and Singh 2021). Increase in shoot, root and seedling lengths, number of pods, grains per pod, pod weight and yield of pea raised with the seeds treated with a combination of *T. harzianum* and *P. fluorescens* (Negi *et al.,* 2014). Combined seed PUSA 5 SD treatment of *T. harzianum* (IARI P-4) and *P. florescence* increased seed germination, root and shoot length, plant dry weight, pod yield and reduced root rot incidence in green house condition (Dubey *et al.,* 2017). Plant growth enhancement properties of *Trichoderma* have been observed in beans (Hoyos-Carvajal *et al.,* 2009). Seed and soil application of *Trichoderma* isolates have been reduced root rot incidence, increased grain pod yield in french bean (Bhagwat and Pan 2010). Nashwa *et al.* (2008) that *T. harzianum* and *T. viride* showed greatest antagonistic efficacy against damping off and wilt caused by and *Fusarium oxysporum* f. sp. phaseoli and *R. solani* respectively in bean plants. Seed PUSA 5 SD treated with *T. viride* IBSD T-20 in combination with *P. florescence* (IBSD isolate) increased seed

germination; root and shoot length, plant dry weight and pod yield in vitro (Dubey *et al.,* 2017). Managed the root rot in pea caused by *F. solani* f. sp. pisi using *T. harzianum*, carbendazim and *P. fluorescens* (Hamid *et al.,* 2012). Application of vermicompost tea, *S. marcesence* and *T. harzinum* reduced damping off (pre and post emergence) in common bean cv. Giza 6 in green house condition as well as combination of VCT with Effective microorganism EM1 or *T. harzianum* inhibited 65.4 % and 64.3 % root rot severity in field condition (Helmey and Abu-Hussain 2024).

Authors Contributions

Juhi Shah did the whole research. Meenakshi Rana analyzed data. Kalpana Gairola prepared the manuscript. Khilendra Singh supervised the research.

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Khilendra Singh[1], Juhi Shah[1], Kalpana Gairola[1*], Meenakshi Rana[2]

[1]Department of Plant Pathology, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India

[2]Department of Plant Pathology, School of Agricultural Sciences, Lovely Professional University, Jalandhar, Punjab

***Corresponding author**

E-mail: kgairola123@gmail.com