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Effect of *Trichoderma harzianum* strains and IRRI BMP on Growth, Nodulation, Yield and Economics of Lentil under Low land Rainfed Ecology of Bihar

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ABSTRACT

Productivity of lentil in rainfed ecology is very low and crop was infested with different soil and seed born fungal disease. In light of fragment information available on response of seed treatment with *Trichoderma harzianum* strains S1 and S3, a field experiment was conducted during winter seasons of 2013-14 and 2014-15 at experimental farm of Krishi Vigyan Kendra, Buxar and farmers field. Among different seed treatment practices coupled with IRRI BMP, *Trichoderma* strain S3 produced the highest number of pods/plant (59.6) and 100-grain weight (2.60 g) followed by seed treatment with S1+ IRRI BMP and Thiram+IRRIBMP. However, farmers' practice recorded lowest value of all these traits. Highest number of nodules/plant (15.80) and dry matter of nodules, (37.12 mg/plant) were recorded under seed treatment with S3+IRRI BMP followed by S1+IRRI BMP and Thiram+IRRI BMP in order. Seed treatment with S3+IRRI BMP recorded highest root length (25.2 cm), root dry weight (0.90 g/plant) and seed yield (13.33 q/ha) followed by seed treatment with S1+IRRI BMP and Thiram+IRRI BMP in order. However, farmers' practice recorded minimum value of these traits. Economic analysis of data showed that maximum net return (Rs 23489/ha) and cost-benefit ratio (2.42) was recorded under seed treatment with strain S3+IRRI BMP followed by seed treatment with S1+IRRI BMP and Thiram+IRRI BMP. However, minimum economic return was recorded with farmers' practice.

Key words : Economics, Nodulation, Seed treatment, *Trichoderma*, Yield

INTRODUCTION

Pulses are valued for their importance in nutritional security, soil amelioration and sustainable crop production. The also play an important role in protecting the environment from the risk associated with high input agriculture (Singh *et al.,* 2015). Lentil is one of the most nutritious cool season food legumes and rank next only to chickpea. It is grown throughout the northern and central India for grains. Besides its utilization as a dal, whole or dehulled grains are also used in various other preparations. It is one of the prominent source of vegetable protein in the Indo Gangetic Plain (IGP) region, essentially grown as a rainfed crop on the residual soil moisture of preceding crop (generally rice) (Ali *et al.,*2012). The need for increasing agricultural productivity and quality has led to an excessive and unbalanced use of chemical fertilizers, creating serious environmental pollution. The use of biofertilizers and biopesticides is an alternative for sustaining high production with low ecological impact. Different soil-borne bacteria and fungi are able to colonize plant roots and may have beneficial effects on the plant (Hermosa *et al.,*2012). Besides the classic mycorrhizal fungi and *Rhizobium* bacteria, other plant-growth-promoting *rhizobacteria* and fungi such as *Trichoderma* spp. can stimulate plant growth by suppressing plant diseases (Van Wees *et al.,*2008). These micro-organisms can form endophytic associations and interact with other microbes in the rhizosphere, thereby influencing disease protection, plant growth and yield. *Trichoderma*is a fungal genus found in many ecosystems. Some strains have the ability toreduce the severity of plant diseases by inhibiting plantpathogens, mainly in the soil or on plant roots, through their high antagonistic and mycoparasitic potential (Viterbo and Horwitz, 2010).

Some *Trichoderma rhizosphere*- competent strains have been shown to have direct effects on plants, increasing their growth potential and nutrient uptake, fertilizer use efficiency, percentage and rate of seed germination, and stimulation of plant defensesagainst biotic and abiotic damage (Shoresh *et al.,*2010).Certain *Trichoderma* spp. has beneficial effects on plant growth and enhances resistance to both biotic and abiotic stresses.

*Trichoderma*s pp. are most popular research tools as microbial inoculants which have been largely used against several plant pathogenic fungi causing soil borne, air borne and post-harvest diseases of plant through their high antagonistic and mycoparasitic potential in lab conditions. In recent years, they have become popular as plant growth promoter (Hermosa *et al.,* 2012). Seed treatment with microbial strains can enhance the root growth which helps in absorbing water from deeper layer of the soil and maintain proper crop growth during moisture stress condition. Microbial seed treatment can enhance their tolerance level of moisture stress. Productivity

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of rainfed ecology is very low and lentil crop faced the problem of fungal disease. Some monetary (sowing method, weed management, plant protection, nutrient and water management) and non-monetary (sowing time, spacing) management practices assumes the great significant and it brings considerable change in plant environment with respect to temperature, photoperiod, availability of soil moisture, nutrient uptake and consequently influences the crop weed competition, biotic and abiotic stress and crop productivity. Keeping these facts experiment was planned to evaluate the performance of lentil crop with microbial strain of S1 and S3 coupled with IRRI BMP (Best Management Practices) in rainfed lowland ecology.

MATERIALS AND METHODS

A field experiment was conducted during winter season 2013-14 and 2014-15, at the Research farm(25°34'6.33″N, 83°59'0.18″ E and 63 m above sea level) of KrishiVigyan Kendra (ICAR Research Complex for Eastern Region),Buxar and farmers field of Buxar district. The soil of experimental site was sandy clay loam in texture with neutral in reaction (pH-7.2). It was low in organic C (0.33%) and available nitrogen (168.9 kg/ha), medium in available phosphorus (26.6 kg/ha) and potassium (242.5 kg/ha) in soil surface. The field was kept under rice - wheat cropping system for the last five years. The experiment was laid out in randomized block design and replicated ten times; five at KVK, farm and five at farmer's field. Each treatment trial at farmers' field consists of part of one field, ideally of a 400 m^2 size. Different fields of participating farmers will serve as replications. This part of the field was then split into four equal parts (100 m^2 each), all separated by a small strip (at least 0.5 m wide) where no lentil is sown. Treatment comprised viz., T_1- S1 @ 10g/kg seed+IRRI BMP,T_2- S3 @ 10g/kg seed+IRRI BMP,T_3- Thiram 2.5 g/kg+IRRI BMP and, T_4- Farmers' practice (control). Lentil variety HUL-57 used for test crop.

Crop was sown on first week of December in each year. IRRI BMP included seed treatment, line sowing, proper seed rate, pre-emergence application of herbicides, fertilizer management (20:50:30:N:P:K), use of plant protection measure for managing insect and diseases and good water management practices. The data on various growth and yield attributes, nodule, seed and straws were recorded under various treatments. Before sowing composite soil samples representing the whole field were collected. The organic carbon, pH, available N, P and K were analyzed as per the method described by Jackson (1973). Statistical analyses of all the data were done as per the methodology of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on crop growth

Germination percentage, number of plants/m^2, number of branches/plant and number of pods/plant were significantly influenced by different seed treatment practices (Table 1). Higher germination percentage (83.5%) and number of plants/m^2 (28.1) were recorded under seed treatment with S1+IRRI BMP followed by S3+IRRI BMP and Thiram+IRRI BMP. The number of branches/plant in seed treatment with S1+IRRI BMP and S3+IRRI BMP were similar (6), and significantly higher than other two treatments. Number of pods/plant (59.6) was recorded highest with seed treatment with S3+IRRI BMP followed by S1+IRRI BMP and Thiram+IRRI BMP. However, farmers' practice recorded lowest value of all these traits. This might be due to seed treatment with *Trichoderma* colonies which may be responsible for better germination, plant stand and growth promotion (Sharma *et al.*,2012)

The data on days taken to 50% flowering as well as maturity, and no of grains/pod and 100-grain weight were significantly influenced by different seed treatment practices (Table 1). Seed treatment with strain S1+IRRI BMP recorded minimum days taken to 50% flowering (86 days), whereas maximum days (90) were taken under farmers' practice. Whereas seed treatment with S3+IRRI BMP and Thiram+IRRIBMP being equal (88) in days to 50 % flowering was significantly higher than S1+IRRI BMP but lower than farmers' practice. Days taken to maturity were similar in S1+IRRI BMP and S3+IRRI BMP (121 days), but significantly lower than seed treatment with Thiram+IRRIBMP (125) andfarmers' practice (126). Number of grains/pod was not influenced by any seed treatment practices. Seed treatment with S3+IRRI BMP recorded highest 100-grain weight (2.60 g) followed by seed treatment with S1+IRRI BMP and Thiram+IRRIBMP, whereas minimum (2.41g) was recorded with farmers' practice. The colonization of *Trichoderma harzianum* in the root resulted in increase in growth of root thus providing enough strength for more nutrient uptake by the roots in fields resulting higher number of grain and 100 grain weight (Masunaka *et al.*,2011).

Table 1 : Effect of Trichoderma strains and IRRI BMP on plant growth, nodulation and yield attributes of lentil (mean data over 2 years)

Treatments	Germination (%)	No. of plants/m^2 at maturity	No. of branches/ plant	No. of pods/ plant	Days taken to 50% flowering	Days taken to maturity	No of grains/ pod	100 grain weight (g)	No of nodules/ plant at maturity
Seed treatment with *Trichoderma harzianum* S1+IRRI BMP	83.5	28.1	6.0	51.9	86	121	1.49	2.52	15.33
Seed treatment with *Trichoderma harzianum* S3+IRRI BMP	82.9	27.9	6.0	59.6	88	121	1.50	2.60	15.80
Seed treatment with Thiram+IRRI BMP	82.5	24.0	5.0	51.3	88	125	1.51	2.51	13.68
Farmers' practice	81.2	19.9	4.0	44.1	90	126	1.50	2.41	8.99
CD (P=0.05)	2.9	0.9	0.2	2.3	2	3.8	NS	0.09	0.66

Table 2 : Effect of Trichoderma strains and IRRI BMP on plant growth, root growth, yield and economics of lentil (mean data over 2 years)

Treatments	Plant height at maturity (cm)	Root length at Maturity (cm)	Root dry weight (g/plant) at maturity	Seed yield (kg/ha)	Straw yield (kg/ha)	Net return (Rs/ha)	Cost-benefit ratio
Seed treatment with *Trichoderma harzianum* S1+IRRI BMP	25.0	25.0	0.68	1309	2860	22761	2.38
Seed treatment with *Trichoderma harzianum* S3+IRRI BMP	25.2	25.2	0.90	1333	2930	23489	2.42
Seed treatment with Thiram+IRRI BMP	22.0	22.0	0.45	1209	2730	19764	2.20
Farmers' practice	18.9	18.9	0.33	1152	2600	18146	2.11
CD (P=0.05)	0.7	0.8	NS	70	20	1075	0.07

Effect on nodulation and plant height

No. of nodules/plant and plant height at maturity, were influenced by seed treatment practices (Table 1 and 2). Highest number of nodules/plant (15.80) and plant height (38.0 cm) were recorded under seed treatment with S3+IRRI BMP followed by S1+IRRI BMP and Thiram+IRRIBMP in order. This could be ascribed due to seed treatment with Trichoderma strain and BPM increases nodulation and plant height (Sharma *et al.*,2012).

Effect on root growth and yield

Root length at maturity, root dry weight, seed yield and straw yield was influenced by different seed treatment practices (Table 2). Seed treatment with S3+IRRI BMP recorded highest root length (25.2 cm), root dry weight (0.90 g/plant), seed yield (1333 kg/ha) and straw yield (2930 kg/ha) followed by seed treatment with S1+IRRI BMP and Thiram+IRRIBMP in order. However, farmers' practice recorded minimum value of these traits. Colonization of *Trichoderma* with lentil roots stimulated plant growth, more nodulation and provided favorable environment in root zone for enhancing root growth, nutrient uptake and seed yield (Harman *et al.*, 2004; Sallam *et al.*,2008).

Economics

Economic analysis of data showed that net return (Rs 23489/ha) and cost-benefit ratio (2.42) was recorded under seed treatment with strain S3+IRRI BMP followed by seed treatment with S1+IRRI BMP and Thiram+IRRI BMP (Table 2). However, minimum economic return was recorded with farmers' practice. This might be due to more yield of lentil under these treatments with minimum cost of cultivation.

Soil fertility changes

Seed treatment with *Trichoderma harzianum* strain+BMP and thiram+BMP showed no effect on changes in soil pH after the crop harvesting (Table 3). However, the response on organic carbon content was observed significant. The maximum organic carbon (0.35%) observed with seed treatment with strain S3+IRRI BMP and seed treatment with strain S1+IRRI BMP confirming that inoculation with *Trichoderma harzianum* strain helped in enhancing the soil microbial population and sequestering the mineralized carbon.

Table 3 : Effect of Trichoderma strains and IRRI BMP on fertility status of soil after harvest (mean data over 2 years)

Treatments	pH	OC (%)	Available Nutrients (kg/ha)		
			N	P	K
Seed treatment with *Trichoderma harzianum* S1+IRRI BMP	7.1	0.35	181.0	27.1	245.1
Seed treatment with *Trichoderma harzianum* S3+IRRI BMP	7.1	0.35	184.6	27.5	245.5
Seed treatment with Thiram+IRRI BMP	7.2	0.33	175.2	27.0	243.2
Farmers' practice	7.2	0.33	175.0	27.0	243.0
CD (P=0.05)	NS	0.01	6.8	1.2	NS

All the treatment recorded significantly higher available nitrogen content in soil after the crop over farmers practice. Maximum available nitrogen (184.6 kg/ha) was observed with seed treatment with strain S3+IRRI BMP followed by seed treatment with strain S1+IRRI BMP. Maximum available phosphorus (27.5 kg/ha) was recorded with seed treatment with strain S3+IRRI BMP followed by seed treatment with strain S1+IRRI BMP. Maximum available potassium did not influenced by any treatment. However minimum available nitrogen, phosphorus and potassium content were recorded with farmers practice.

CONCLUSION

On the basis of above results lentil seed treatment with *Trichoderma harzianum* strain S3+BMP was found suitable for enhancing the crop growth, nodulation, root growth and produced the higher seed yield. Net return and cost-benefit ratio were also higher under seed treatment with strain S3+IRRI BMP.

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