

RESPONSE OF LENTIL TO BIO AND CHEMICAL FERTILIZERS AT FARMER'S FIELD

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Abstract

Field trials were carried out at the Farming System Research & Development site, Hatgavindapur, Faridpur, On-Farm Research Division of Bangladesh Agricultural Research Institute during rabi seasons of 2006-2007 and 2007-2008 with the objectives to evaluate the response of lentil to *Rhizobium* biofertilizer and to reduce the use of N-fertilizer under farmer's field condition. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Unit plot size was 4 m x 5 m. Four fertilizer treatments viz. T₁: 24-22-42-20-5 kg N-P-K-S-Zn ha⁻¹, T₂: 50-22-42-20-5 kg N-P-K-S-Zn ha⁻¹, T₃: 0-22-42-20-5 kg N- P-K-S-Zn ha⁻¹ + *Rhizobium* Inoculum and T₄: Farmer's practices were studied. Farmer's practice was 25-18-21-0-0 kg N-P-K-S-Zn ha⁻¹. BARI Masur-4 and peat based rhizobial inoculum (strain BARI RLC-102) @ 1.5 kg ha⁻¹ were used. Result revealed that application of *Rhizobium* biofertilizer along with PKSZn chemical fertilizers produced the highest nodule number (11.62 plant⁻¹) and nodule weight (11.94 mg plant⁻¹), and the seed yield 1.44 t ha⁻¹. The seed yield was higher in T₃ treatments (N₀P₂₂K₄₂S₂₀Zn₅ + Inoculum) than T₁ (N₂₄P₂₂K₄₂S₂₀Zn₅) and T₂ (N₅₀P₂₂K₄₂S₂₀Zn₅) treatments. No variation was observed in seed yield in treatments T₁, T₂ and T₃ but significantly different from farmer's practice. Farmer's practice showed the lowest yield. Economic analysis revealed that T₃ treatment i.e. PKSZn plus *Rhizobium* inoculum gave the highest 5.36 benefit cost ratio (BCR) followed by T₁ 4.68 and T₂ 3.61. It is evident from the experiment that application of biofertilizer can be used as substitute of nitrogenous fertilizer for higher yield of lentil at farmer's field in Faridpur.

Keywords: Lentil, biofertilizer, chemical fertilizers, nodulation, yield, benefit cost ratio

Introduction

Lentil (*Lens culinaris* L.) occupies the top position in terms of popularity and has been placed second in respect of area and production in Bangladesh (BBS, 2012). It is cultivated during rabi season under rainfed condition. About 80% of total lentil in the country is grown in greater Faridpur, Kustia, Jessore, Rajshahi and Pabna districts of Bangladesh (BBS, 2012). The yield of lentil is very poor (928 kg ha⁻¹) (BBS, 2012). There is a great possibility to increase its production by

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exploiting better colonization of their root and rhizosphere through *Rhizobium*, which can also reduce the use of nitrogenous fertilizer as well as protect environment. But there is still lacking of sufficient, effective and resistant *Rhizobium* strains in soil. Moreover, degradation of *Rhizobium* occurs regularly. So, collection and screening of new *Rhizobium* strains and their sub-culturing and testing are necessary. For this reason, few indigenous *Rhizobium* strains were collected from different AEZs of Bangladesh and were screened, tested at research stations. Their efficiency in crop production is needed to be tested at farmers' level. Response of inoculation depends on soil type, cultivars and effectiveness of *Rhizobium* strains and its competitive ability with native *Rhizobium* (Dube, 1976; Khanam *et al.*, 1993). Khanam *et al.*, (1999) found 46% higher seed yield in lentil at Meherpur, 30% higher at Faridpur and 33% higher at Jessore districts of Bangladesh due to *Rhizobium inoculum*. They also observed that inoculated plant with chemical fertilizers gave 72%, 59% and 75% higher yield over farmers' practice at Meherpur, Faridpur and Jessore districts of Bangladesh, respectively. The present study was, therefore, undertaken with the following objectives; i) the response of lentil to *Rhizobium* biofertilizer along with chemical fertilizers and ii) to evaluate the reduction of the uses of N-fertilizer for lentil cultivation under farmer's field condition.

Material and Method

Field trials were carried out at the Farming System Research & Development (FSRD) site, Hatgavindapur of On-Farm Research Division, Bangladesh Agricultural Research Institute in Faridpur district during rabi seasons of 2006-2007 and 2007-2008 in randomized complete block design having four replications with four treatments. The unit plot size was 4 m × 5 m. The variety was BARI Masur-4 and peat based rhizobial inoculum BARI RLc-102 was used for the experiment. There were four treatments viz. T₁: 24-22-42-20-5 kg N-P-K-S-Zn ha⁻¹ (BARC, 2005), T₂: 50-22-42-20-5 kg N-P-K-S-Zn ha⁻¹ (Recommended by Soil Science Division, BARI), T₃: 0-22-42-20-5 kg N-P-K-S-Zn ha⁻¹ + *Rhizobium* Inoculum and T₄: Farmer's practice was studied. Farmer's practice was 25-18-21-0-0 kg N-P-K-S-Zn ha⁻¹. Peat based *Rhizobium* inoculum was prepared in the Soil Microbiology Laboratory of BARI. The above peat based rhizobial inoculum @ 1.5 kg ha⁻¹ containing about 10⁸ cells g⁻¹ inoculum was used. Chemical fertilizers i.e. N, P, K, S and Zn were applied in the treatments @ 24 kg N ha⁻¹ in T₁ and 50 kg N ha⁻¹ in T₂ from urea, 22 kg P ha⁻¹ from TSP, 42 kg K ha⁻¹ from MoP, 20 kg S ha⁻¹ from gypsum and 5 kg Zn ha⁻¹ from zinc oxide in T₁, T₂ and T₃ treatments but in farmer's practice, 25-18-21-0-0 kg N-P-K-S-Zn ha⁻¹ was used. The seeds were sown on 16 November 2006 and 27 November 2007.

Table 1. Effect of rhizobial inoculum and chemical fertilizers on nodulation, dry matter production and yield of lentil at Faridpur, Bangladesh (pooled data of 2 years).

Treatment	Nodule number plant ⁻¹	Nodule weight (mg plant ⁻¹)	Root weight (g plant ⁻¹)	Shoot weight (g plant ⁻¹)	Plant height (cm)	Stover yield (t ha ⁻¹)	1000 seed weight (g)	Seed yield (t ha ⁻¹)	Yield increase over FP (%)
T ₁ : N ₂₄ P ₂₂ K ₄₂ S ₂₀ Zn ₅	7.20b	6.70b	0.09	1.25	32.4	1.57	17.4	1.40a	41.4
T ₂ : N ₅₀ P ₂₂ K ₄₂ S ₂₀ Zn ₅	6.16b	6.45b	0.11	1.41	34.1	1.59	17.2	1.34a	35.4
T ₃ : N ₀ P ₂₂ K ₄₂ S ₂₀ Zn ₅ +Inoc.	11.62a	11.94a	0.11	1.44	31.6	1.60	17.4	1.44a	45.5
T ₄ : FP (N ₂₀ P ₁₂ K ₁₇ S ₀ Zn ₀)	6.85b	6.67b	0.09	1.29	32.4	1.53	17.0	0.99b	-
CV (%)	15.5	14.5	13.6	12.0	6.8	11.4	4.7	9.3	-

Means followed by common letter are not significantly different at 5% level by DMRT

T₁: N₂₄P₂₂K₄₂S₂₀Zn₅ kg ha⁻¹, T₂: N₅₀P₂₂K₄₂S₂₀Zn₅ kg ha⁻¹, T₃: N₀P₂₂K₄₂S₂₀Zn₅ kg ha⁻¹ + *Rhizobium* inoculum,

T₄: FP (N₂₀P₁₂K₁₇S₀Zn₀ kg ha⁻¹), FP = Farmer's practice

During the experiment, growth and development of plants in the field were carefully observed. Ten plants along with roots were collected at 50% flowering stage from each unit plot. The dry weight of roots; shoots and nodules including nodule numbers were recorded. The plants were harvested on 07 March for 2007 and 02 March for 2008. Data on plant height, 1000-seed weight, stover yield and seed yield were taken. All data were analyzed statistically.

Results and Discussion

Effect of *Rhizobium* inoculation and the application of chemical fertilizers on nodule number (plant^{-1}), nodule weight (mg plant^{-1}), root weight (g plant^{-1}), shoot weight (g plant^{-1}), plant height (cm), 1000-seed weight (g), stover yield (t ha^{-1}), seed yield (t ha^{-1}) and percent yield increased over farmer's practice have been presented in Table 1.

The highest nodule number (11.62 plant^{-1}) and nodule weight ($11.94 \text{ mg plant}^{-1}$) were recorded in PKSZn + Inoculum treated plot which was significantly higher over other treatments (Table 1). The treatments T₁, T₂ and T₄ produced identical nodule number and weight. Among the 4 treatments, T₂ treatments ($\text{N}_{24}\text{P}_{22}\text{K}_{42}\text{S}_{20}\text{Zn}_5$) produced the lowest nodule number and weight. Khanam *et al.*, (1993) reported higher nodule number (156-245%) and nodule weight (169-284%) due to *Rhizobium* inoculation in lentil. Khanam *et al.*, (1999) observed that *Rhizobium* inoculum gave 167%, 60% and 136% higher nodule mass over control at Kustia, Faridpur and Jessore, respectively while *Rhizobium* inoculum plus chemical fertilizers except N gave 342%, 106% and 264% higher nodule mass at Meherpur, Faridpur and Jessore, respectively. Bhuiyan *et al.*, (1996) also found higher nodule number (101%) at farmer's field of Faridpur, Bangladesh and 110% at farmer's field of Jessore, Bangladesh, and nodule weight 52% higher at Faridpur and 81% higher at farmer's field at Jessore due to *Rhizobium* inoculation in chickpea. Similar trends were also reported by Bhuiyan *et al.*, (2001) for chickpea at farmers' field of Meherpur and Rajshahi districts of Bangladesh. Root weight, shoot weight, plant height, stover yield and 1000-seed weight were found insignificant, though the highest values were observed in PKSZn + Inoculum treatment. Similar results were reported by Bhuiyan *et al.*, (2001) in chickpea at Rajshahi, Bangladesh. The seed yield was significantly influenced by inoculum. The highest seed yield 1.44 t ha^{-1} were recorded with the treatment $\text{P}_{22}\text{K}_{42}\text{S}_{20}\text{Zn}_5$ + Inoculum but identical with T₁ and T₂ treatments. The seed yield showed higher 1.44 t ha^{-1} due to higher pods plant^{-1} , seeds pod^{-1} and 1000-seed weight. The similar trend was also reported by Khanam *et al.*, (1993). They reported that *Rhizobium* inoculation gave 64-68% higher seed yield in lentil. In another study, Khanam *et al.*, (1999) found 46% higher seed yield in lentil at Meherpur, 30% at Faridpur and 33% at Jessore districts of Bangladesh due to *Rhizobium* inoculum. The lower seed yield was recorded in T₂ treatment than T₁ which might be due to excess plant growth and less pod setting. The lowest yield was with farmer's practice (0.99 t ha^{-1}). *Rhizobium* inoculum with

inorganic fertilizer T₃, showed better performance against only with inorganic fertilizers T₁ and T₂ treatments. The yield was 100 kg higher than T₂ due to application of *Rhizobium* inoculum. So, *Rhizobium* inoculum can be used as the substitute of urea for lentil cultivation at Faridpur area. Khanam *et al.*, (1999) also observed that inoculated plant with chemical fertilizers gave 72%, 59% and 75% higher yield over farmers' practice at Meherpur, Faridpur and Jessore districts of Bangladesh, respectively. The results are also an agreement with the findings of Bhuiyan *et al.*, (1998).

Farmers' reaction

The farmer's of Faridpur district were very encouraged by observing the performance of BARI Masur-4 with rhizobial inoculum.

Economic analysis

Benefit cost ratio (BCR) analysis for lentil at Faridpur has been presented in Table 2. For BCR only cost of chemical fertilizers and *Rhizobium* inoculum were considered and other costs remain constant. Economic analysis revealed that T₃ treatment i.e. PKSZn with inoculum gave the highest BCR 5.36 at Faridpur. Khanam *et al.*, (1993) found that inoculated treatment with PKSZn fertilizers gave higher benefit cost ratio 6.44-7.68 in lentil. Bhuiyan and Khanam (1996) found BCR 8.71-9.61 by PKSZn + *Rhizobium* inoculum in chickpea.

Table 2. Benefit cost ratio analysis for lentil at Faridpur (mean of 2 years).

Treatments	Yield (t ha ⁻¹)	Variable cost (Tk. ha ⁻¹)	Gross return (Tk. ha ⁻¹)	Net return (Tk. ha ⁻¹)	Net return over farmer's practice (Tk. ha ⁻¹)	Benefit cost ratio
T ₁ : N ₂₄ P ₂₂ K ₄₂ S ₂₀ Zn ₅	1.40	5,948/-	1,05,000/-	99,052/-	27,848/-	4.68
T ₂ : N ₅₀ P ₂₂ K ₄₂ S ₂₀ Zn ₅	1.34	6,348/-	1,00,500/-	94,152/-	22,948/-	3.61
T ₃ :N ₀ P ₂₂ K ₄₂ S ₁₀ Zn ₅ +Inoc.	1.44	5,728/-	1,07,625/-	1,01,897/-	30,693/-	5.36
T ₄ : FP(N ₂₅ P ₁₈ K ₂₁ S ₀ Zn ₀)	0.99	2,671/-	73,875/-	71,204/-	-	-

Urea= Tk. 7.00 kg⁻¹, TSP= Tk. 17.00 kg⁻¹, MoP= Tk. 18.00 kg⁻¹, Gypsum= Tk. 8.00 kg⁻¹, ZnSO₄= Tk. 95.00 kg⁻¹, *Rhizobium* inoculum = Tk. 100 kg⁻¹, Lentil= Tk. 75.00 kg⁻¹

For both the years, positive and significant correlation was found in nodule number with nodule weight (Table 3). Nodule number was strongly correlated with nodule weight. Nodule number was also correlated with root weight in 2007 and nodule weight was correlated with shoot weight and stover yield in 2008 (Table 3). Bhuiyan *et al.*, (1996 and 2001) also reported positive and significant correlation for the inoculated chickpea.

Table 3. Relationship between different parameters of lentil at Faridpur

Parameters	r values	
	2007	2008
Nodule number vs nodule weight	0.939**	0.966**
Nodule number vs root weight	0.618*	-0.207 ^{NS}
Nodule number vs shoot weight	0.581 ^{NS}	0.532 ^{NS}
Nodule number vs stover yield	-0.075 ^{NS}	0.412 ^{NS}
Nodule number vs seed yield	0.223 ^{NS}	0.386 ^{NS}
Nodule weight vs shoot weight	0.523 ^{NS}	0.647*
Nodule weight vs stover yield	0.048 ^{NS}	0.459 ^{NS}
Nodule weight vs seed yield	0.299 ^{NS}	0.400 ^{NS}
Shoot weight vs stover yield	-0.417 ^{NS}	0.670*
Shoot weight vs seed yield	-0.015 ^{NS}	0.091 ^{NS}
Stover yield vs seed yield	0.172 ^{NS}	0.050 ^{NS}

*Significant at 5% level, ** significant at 1% level, NS: Non-significant

Conclusion

It is evident from the experiment that biofertilizer can be used as the substitute of nitrogenous fertilizer in lentil at farmer's field in Faridpur district of Bangladesh.

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