

PERFORMANCE OF LENTIL VARIETIES AS INFLUENCED BY DIFFERENT *Rhizobium* INNOCULATIONS

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Key words: Yield, inoculation, lentil

Abstract

A field experiment was conducted at the farm of Bangladesh Agricultural University, Mymensingh during November 2009 to March 2010 to study the response of three lentil varieties (viz., BARI Masur-1, BARI Masur-2 and BARI Masur-3) to *Rhizobium* inoculations to yield. There were three *Rhizobium* inoculants (*Rhizobium* strain BINA L₄, *Rhizobium* strain TAL 640, and mixed culture) with uninoculated control and urea @ 50 kg ha⁻¹. Phosphorus and potassium @ 26 kg P ha⁻¹ from TSP and 33 kg K ha⁻¹ from MP were used as basal. It was observed that *Rhizobium* inoculation alone increased plant height, grain yield and crop residues yield of plant significantly compared to uninoculated control. Local inoculants BINA L₄ performed better than the exotic culture TAL 640 in respect of yield. 50 kg urea ha⁻¹ also recorded better results than control but not superior to any of the inoculation treatments. The highest seed (1,565 kg ha⁻¹) and crop residue yields (3,303 kg ha⁻¹) were recorded from the lentil variety BARIMasur-3 inoculated with mixed culture.

Introduction

Lentil (*Lens culinaris* Medik) is one of the most important pulse crops grown in Bangladesh. It belongs to the sub-family Papilionaceae under the family Leguminosae. In Bangladesh, it is popularly known as masur. Lentil grain contains 25% protein, 0.7% fat, and 59% carbohydrate (Afzal *et al.*, 1999). The lentil crop covers 33.33 percent of the total area of pulse in the country (BBS, 2012). Total production of lentil in Bangladesh, during 2010-2011 was 228568 tons from an area of 180574 hectare with an average yield of 1.2657 t ha⁻¹ (BBS, 2012). Pulses are considered as the poor man's meat as they are the cheapest source of protein for the underprivileged people who cannot afford to buy animal proteins (Gowda and Kaul, 1982). The Stover of the plants together with husk popularly known as bhushi is highly protein concentrated feed for cattle, horse, pig and sheep (Tomar *et al.*, 2000). Lentil being a legume crop can fix atmospheric nitrogen through root nodules by *Rhizobium* bacteria, which may reduce the pressure of nitrogenous fertilizer application to the crop. It is evident that pulse included in the cropping pattern helped to increase the organic matter in the soil (Islam, 1988).

Seed inoculation with appropriate *Rhizobium* sp is recommended to improve legume growth. They can reduce nitrogenous fertilizer use and protect environment. Response to *Rhizobium* inoculation to lentil depends on the soil type, crop cultivars and effectiveness of *Rhizobium* strains. Research work on contribution of *Rhizobium* inoculation on growth and yield of lentil is, however, scanty in this country. The selection of strain of Rhizobia particularly adapted to specific host plant is important. Judicious matching of *Rhizobium* stains with host plants and prudent use of large viable inocula prepared with these organisms is the only way to attain maximum nitrogen fixation and yields of leguminous crops. Keeping these in view, the investigation was undertaken to evaluate the effectiveness of three *Rhizobium* inoculants to lentil varieties in respect of yield.

Materials and Methods

A field experiment was conducted during the winter (*rabi*) seasons of 2009 -2010 at the farm of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh. The land was situated to the North East side of the farm and situated at latitude of 24.75 °N and a longitude of 90.50° E. The initial soil sample of the experimental field was collected and analyzed following standard procedures in the laboratory and presented in Table 1.

Table 1. Initial soil nutrient status of the experimental field

Constituents	pH	OC (%)	OM (%)	Total N (%)	Available P (ppm)	Exchangeable K (me 100 g ⁻¹ soil)	Ca	Mg	CEC
Experimental field	6.7	1.085	1.875	0.089	11.95	0.12	0.12	3.95	18.50
Critical level	2.0	0.1	0.8	14	0.2	14	3.1	0.12	

The experiment was laid out in split-plot design having four replications with 3 lentil varieties in main plots and 5 inoculation (no inoculation, BINA L₄ as a local *Rhizobium* strain, TAL 640 as an Exotic *Rhizobium* strain, BINA L₄ and TAL 640 as mixed culture and urea at the rate of 50 kg/ha in sub plots. The recommended dose of 26 kg P, 33 kg K was applied as basal. The land was prepared by ploughing and cross-ploughing with the country plough followed by laddering uniformly. Fresh seeds of lentil were dipped in the respective culture broth of 5 days growth for two and half an hours. The seeds were dried in shade. The inoculated seeds of three inoculation treatments were randomly placed in the 5 unit plots of each main plot with spacing of 30 cm using 50 kg seed ha⁻¹ sowing at 22 November, 2009 and harvested at 12 March, 2010. The harvested area of each plot was 4m x 2.5m. The crop was raised following recommended agronomic practices. Data on plant height from each plot 5 randomly selected plants were carefully measured and their mean values were determined. The yields were taken plot-wise by harvesting of each plot and then it was converted to hectare basis. The collected data were analyzed statistically using the analysis of variance technique with the help of computer package MSTAT and mean differences were adjudged by Duncan's Multiple Ranged Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Plant height

The effect of inoculation on plant height (cm), grain yield (kg ha⁻¹), crop residues yield (kg ha⁻¹) and percent yield increase over control are presented in Table 2 and Table 3.

Effect of *Rhizobium* inoculation

The results showed that the Mixedculture gave the highest plant height (11.49 cm) at 40 days of sowing, the percent increase over uninoculated control being 8.8. At 60 days of sowing BINAL₄ gave highest plants height (18.03 cm) and percent increases over control being 16. At 80 days of sowing recorded the highest plant height (28.32 cm), percent increase over control being 15.26. The maximum plant height (34.30 cm) was produced by mixed culture at 95 days of sowing, which was statistically superior to other treatments. Gwal *et al.* (1995) reported that the *Rhizobium* inoculants when applied resulted in the tallest plants and more branches/plant than the control. Similar results were obtained by Maurya and Sanoria (1986) in chickpea.

Varietal response

At vegetative stage (40 days of sowing), the maximum plant height was produced by the variety BARI Masur-3 (11.12 cm) followed by BARIMasur-1 (11.09 cm) and BARI Masur-2 (10.93 cm). Variety BARI Masur-3 gave tallest plant (16.92 cm) at 60 days of sowing, which was statistically superior to all other varieties. At 80 days of sowing, variety BARI Masur-2 gave the maximum plant height (27.54 cm) which was statistically similar with BARI Masur-3 (27.40 cm) but significantly higher than BARI Masur-1 (Fig. 2). Variety BARI Masur-3 gave the maximum plant height (33.26 cm) at 95 days of sowing which was statistically similar with BARI Masur-2 (32.83 cm) but significantly higher than BARI Masur-1 (31.23 cm) The above results are in agreement with the findings of Sattar *et al.* (1995) who found that

seed inoculation with *Bradyrhizobium* increased plant height of five chickpea cultivars. Similar results were obtained by Fakir *et al.* (1988) in pigeonpea.

Table 2. Effect of *Rhizobium* inoculation and variety on seed and hay yield of lentil

Factor	Seed yield (kg ha ⁻¹)	Crop residue (kg ha ⁻¹)	Yield increase over control (%)
Inoculant			
No inoculated	894d	1,870c	-
<i>Rhizobium</i> strain BINA L ₄	1,163b	2,537b	35.67
<i>Rhizobium</i> strain TAL 640	1,114b	2,520b	34.76
Mixed inoculation	1,309a	2,965a	58.56
Urea @ 50 kg N/ha(U ₅₀)	960c	1,915c	2.41
	**	**	
Variety			
BARIMasur-1	944c	2,199b	
BARIMasur-2	1,044b	2,404ab	
BARIMasur-3	1,276a	2,482a	
	**	*	

In a column, figures having common letter(s) do not differ significantly and those having different letter(s) differ significantly at 5% (*) and 1% (**) level of significance.

Table 3. The interaction effect of *Rhizobium* inoculation and variety on plant height, grain yield and hay yield of lentil

<i>Rhizobium</i> × Variety interaction	Plant height (cm)				Seed yield (kg ha ⁻¹)	Crop residue (kg ha ⁻¹)
	40 days	60 days	80 days**	95 days	*	*
V ₁ R ₀	10.63	15.55	20.95h	30.95	799i	1,784e
V ₁ R _L	11.25	17.50	26.50fg	30.00	1,004e	2,334d
V ₁ R _E	11.10	16.70	25.95g	30.05	979fg	2,309d
V ₁ R _M	11.45	16.40	27.15c-f	33.90	1,118de	2,722bc
V ₁ U ₅₀	11.00	15.75	26.10g	31.25	821hi	845e
V ₂ R ₀	10.07	15.35	26.65cfg	31.00	858hi	1,954e
V ₂ R _L	11.10	18.00	27.75bcd	33.90	1,107de	2,600c
V ₂ R _E	11.18	16.55	27.85bcd	33.20	1,106de	2,600c
V ₂ R _M	11.45	16.80	28.70ab	34.00	1,243c	2,869b
V ₂ U ₅₀	10.85	15.45	26.75efg	32.75	906gh	1,995e
V ₃ R ₀	10.98	15.60	26.10g	31.80	1,023ef	1,872e
V ₃ R _L	11.45	18.60	28.00bc	33.00	1,379b	2,675bc
V ₃ R _E	11.25	17.05	27.55cde	33.55	1,256c	2,651bc
V ₃ R _M	11.57	17.30	29.10a	35.00	1,565a	3,303a
V ₃ U ₅₀	10.35	16.05	26.25fg	32.95	1,154d	1,906e
CV (%)	5.80	2.79		4.18	5.65	6.35

In a column, figures having common letter(s) do not differ significantly and those having different letter(s) differ significantly at 5% (*) and 1% (**) level of significance.

R₀= Uninoculated

R_L= Rhizobium strain BINA L4

R_E= Rhizobium strain TAL 640

R_M= Mixed culture of BINA L4 and TAL 640

U₅₀ = Urea @ 50 kg N ha⁻¹

V₁= BARI Masur-1

V₂=BARI Masur-2

V₃=BARI Masur-3

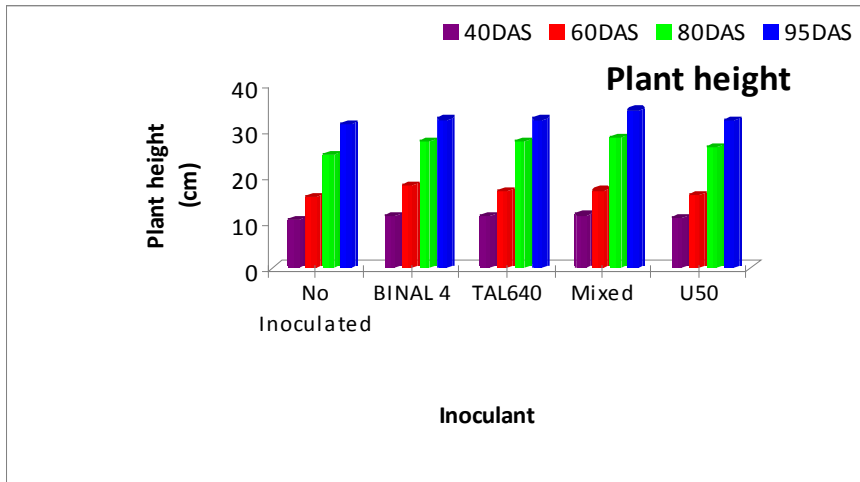


Figure 1. Effect of *Rhizobium* inoculation (upper) on plant height of lentil

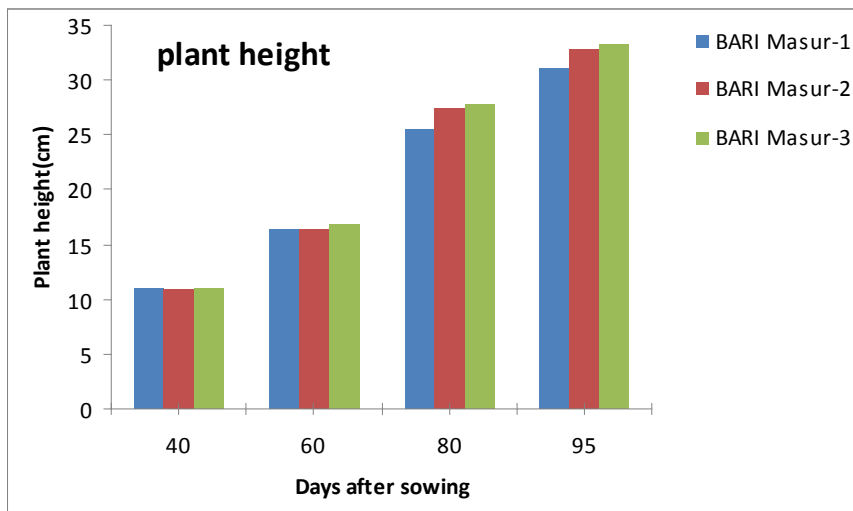


Figure 2. Effect of variety on plant height of lentil

Interaction of *Rhizobium* and variety

At 40 days of sowing the highest plant height (11.57 cm) was obtained by the treatment BARI Masur-3 x mixed culture (V_3R_M), followed by interaction treatment V_3R_L , V_3R_E , V_2R_M , V_2R_E , V_2R_L , V_1R_M , V_1R_L , V_1R_E , V_1U_{50} (BARI Masur-1 \times Urea @ 50 kg ha⁻¹) and V_3R_0 (Barimasur-3 \times Uninoculated control) which was statistically similar (Table 1). The highest plant height (18.60 cm) was produced by the interaction of V_3R_L at 60 days of sowing. The association V_3R_M , recorded the highest plant height (29.10 cm) at 80 days of sowing which was statistically superior to all other interaction treatments. The association V_3R_M , recorded the highest plant height (35.00 cm) at 95 days of sowing which was statistically superior to all other interaction treatments. The above results are supported with the findings of some investigators. Lee and Yun (1989) reported on soybean when inoculated with *Rhizobium stains* increased plant height over uninoculated control. Similar results were obtained by Sattar and Ahmed (1995) in mungbean.

Seed yield

Significant positive effect of *Rhizobium* inoculation on seed yield of lentil over non-inoculated control was observed (Table 2 & Table 3). The mixed culture inoculation produced the highest seed yield (1,309 kg ha⁻¹), which was statistically superior to all other treatments, the percent increases (46%) over uninoculated control. Bremer *et al.* (1990) reported that the *Rhizobium* increased seed yield of lentil by up to 135%. Namedo *et al.* (1996) also observed that inoculation increased lentil seed yield by 17.5-23.2% compared with no inoculation. Barimasur-3 recorded the highest grain yield (1,276 kg ha⁻¹), which was statistically superior to both varieties. The highest grain yield (1,565 kg ha⁻¹) was recorded from the combination of BARI Masur-3 with mixed inoculation (V₃R_{M0}), which was statistically superior to all other treatments (Table 3). Similar results were observed by Dziamba and Miroslaw (1994) in lentil.

Crop Residue

The highest crop residue (2,965 kg ha⁻¹) was recorded in mixed culture, which was significantly superior to all other treatments. It was higher than uninoculated control by 59%. The above results indicated that there was significant beneficial effect of inoculation on crop residue compared to uninoculated control. Similar results were also obtained by Podder *et al.* (1989) in lentil. The highest crop residue (2,482 kg ha⁻¹) was obtained by the variety BARI Masur-3, which was statistically superior to BARI Masur-1 (2,199 kg ha⁻¹) but similar to BARI Masur-2 (2,404 kg ha⁻¹). Similar results were found by Islam and Afandi (1980) in lentil. The interaction of V₃R_M recorded the highest crop residue (3,303 kg ha⁻¹), which was significantly superior to all other treatments. The above results are similar with that of Bhuiya *et al.* (1986).

Correlation

The relationship between total number of nodules at 60 days of sowing and grain yield has been found out. The correlation coefficient ($r = 0.6425$) was found significant at 1% level of probability. The relation was positive i.e. increase in nodule number results in an increase in the seed yield of lentil. The statistical relationship between total number of nodules at 60 days and crop residues has been calculated and found positive. The correlation coefficient ($r = 0.858$) was highly significant. The statistical relationship between nodule dry weight at 60 days and seed yield has been found positively correlated. The correlation coefficient ($r = 0.665$) was highly significant. The statistical relationship between total number of nodules at 60 days and crop residues has been found positively correlated. The correlation coefficient ($r = 0.858$) was highly significant. The statistical relationship between nodule dry weight at 60 days and crop residues has been positively correlated. The correlation coefficient ($r = 0.900$) was highly significant. The statistical relationship between grain yield and hay yield has been found positively correlated. The correlation coefficient ($r = 0.775$) was highly significant.

Conclusion

The present investigation suggested that lentil genotype BARI Masur-3 produced highest seed yield and crop residue. *Rhizobium* strain BINA L4 and TAL 640 were effective items in term of yield. A significant and positive correlation was observed between nodule number and nodule weight, crop residues and seed yield; nodule weight, crop residue and seed yield. Further study is necessary to draw a definite conclusion.

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