

EFFECTS OF RHIZOBIAL STRAINS AND UREA FERTILIZER ON LENTIL AT DIFFERENT LOCATIONS OF BANGLADESH

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Abstract

The response of yield and yield attributes of lentil to no inoculation, *Rhizobium* strain 1, *Rhizobium* strain 2, mixed culture of strains 1 and 2 and urea @ 50 kg/ha was studied. The seeds were treated with 10^7 cells per gram peat of *Rhizobium* strains. It was observed that *Rhizobium* inoculation alone increased nodule number, nodule dry weight, plant height, grain and hay yield of lentil significantly compared to uninoculated control and 50 kg urea/ha treated lentil. The treatment 50 kg urea/ha also showed better results than control but not superior to any of the inoculated treatments. The highest seed (0.87 t/ha) and hay yield (1.93 t/ha) were recorded from the treatment of *Rhizobium* strain 1. In respect of locations, maximum seed (1.53 t/ha) and hay (2.25 t/ha) yield of lentil were observed in Rangpur, while the lowest seed and hay yield were found in Satkhira. Based on these results it may be suggested that *Rhizobium* strain 1 and mixed culture of *Rhizobium* strains 1 and 2 are suitable for harvesting maximum yield of lentil.

Introduction

Lentil (*Lens culinaris* Medik.) is one of the most important pulse crops grown in Bangladesh. It covers 41.56% of the total area of pulse in the country (BBS 2017). Lentil is mostly grown as a rainfed crop. The yield of lentil in Bangladesh is much lower than its potential yield due to many factors. Lack of effective *Rhizobium* symbiosis with lentil is one of the important reasons for low yield of this crop.

Response of *Rhizobium* inoculation to lentil depends on the soil type and crop cultivars. Judicious matching of *Rhizobium* strains or its mixture with host plant and suitable soil type is the only way to attain maximum nitrogen fixation and yield of leguminous crops (Haque *et al.* 2014). Research work on the contribution of single or mixture of *Rhizobium* inoculants and urea fertilizer in different soil types on growth and yield of lentil is, however, scanty in Bangladesh. Keeping these in view, the investigation was undertaken to evaluate the effectiveness of two *Rhizobium* strains and urea fertilizer on lentil.

Materials and Methods

Field experiments, namely (i) Rangpur, (ii) Ishwardi, (iii) Magura and (iv) Satkhira were conducted to study the effect of different *Rhizobial* strains and urea on growth and yield of lentil (*Lens culinaris* Medik.) at four locations of Bangladesh. Treatment combinations were (i) no inoculation, (ii) *Rhizobium* strain 1, (iii) *Rhizobium* strain 2, (iv) mixed culture of strains 1 and 2 and (v) urea @ 50 kg/ha. Soil properties of different locations are presented in Table 1.

The land was prepared by ploughing and cross ploughing with the country plough followed by laddering uniformly. Fresh seeds of lentil were mixed with peat based carrier material. Seed containing 10^7 cells per gram peat of *Rhizobium* strain were maintained. The seeds were dried in

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shade. The inoculated seeds were randomly placed in furrow of the plot. Experiment was laid out in a randomized block design with three replications. Plot size was 4 m × 3 m. The recommended dose of 26 kg/ha P and 33 kg/ha K was applied as basal. All other management practices such as irrigation, weeding were kept uniform for all the treatments and locations. Data on nodule number and plant height from five randomly selected plants from each plot were carefully measured and their mean values were determined. The nodules per plant were counted and plant dry weight was taken after oven dry at 60°C after 48 hrs. The yield was taken plot wise by harvesting from each plot and then it was converted to hectare basis. Data were analyzed using computer package MSTAT-C and LSD test at 5% level of probability was used to compare the treatment means (Steel and Torrie 1984).

Table 1. Soil properties of four locations of Bangladesh selected for the study.

Parameters	Rangpur	Ishwardi	Magura	Satkhira
Texture	Loamy	Silty loam	Sandy loam	Loamy
pH	4.90	7.26	7.40	6.72
OC (%)	0.69	0.98	0.72	1.50
Salinity (dS/m)	-	-	-	6.00

Results and Discussion

The effect of inoculation on nodule number, nodule dry weight, plant height, plant dry weight, seed yield and hay yield of lentil is presented in Table 2. The highest number of nodules (10.29) was produced in the plants treated with *Rhizobium* strain 1, which was significantly different from the other treatments. The second highest number of nodules (7.96) was found in *Rhizobium* strain 2. Mixed culture of *Rhizobium* strains 1 and 2 produced the lower nodules (7.58) than single strain of *Rhizobium*. Urea @ 50 kg N/ha produced slightly higher number of nodules (3.82) than control (3.14) i.e. uninoculated treatment. The lowest nodule number (3.14) was found in uninoculated treatment. Maximum dry weight of nodule in gram was obtained from *Rhizobium* strain 1 followed by mixed culture of *Rhizobium* strains 1 and 2. The lowest nodule dry weight (3.80 g) was observed in uninoculated treatment.

Plant height is one of the important growth contributing characters for lentil. Plant height ranged from 25.69 to 32.20 cm in the plants treated with *Rhizobium* strain 1 and uninoculated treatment, respectively. *Rhizobium* strain 1 produced the highest plant height (32.20 cm) of lentil which was statistically non-significant with other treatments. The treatment with urea fertilizer produced the second highest plant height (30.73 cm) of lentil. Uninoculated treatment produced the lowest plant height of lentil. Maximum dry weight (2.29 g/plant) per plant was found in the treatment of *Rhizobium* strain 1 followed by *Rhizobium* strain 2. The lowest dry weight (1.85 g) of plant was observed in uninoculated treatment. The dry weight of plants with mixed culture of *Rhizobium* strains 1 and 2, urea @ 50 kg N/ha and uninoculated treatments were not statistically significant. Maximum seed yield (0.87 t/ha) was found in *Rhizobium* strain 1 followed by mixed culture of *Rhizobium* strains 1 and 2 (0.80 t/ha). Seeds treated with inoculant produced higher seed yield than those with urea @ 50 kg N/ha. The lowest seed yield (0.51 t/ha) was observed in uninoculated treatment. The highest hay yield (1.93 t/ha) was found in *Rhizobium* strain 1 and the second highest hay yield (1.73 t/ha) was observed in mixed culture of *Rhizobium* strains 1 and 2 and urea 50 kg N/ha. The lowest hay yield (1.16 t/ha) was observed in uninoculated treatment. Seeds treated with all the strains recorded significantly higher nodule dry weight over

uninoculated control. The success of inoculant strains of *Rhizobium* in the nodulation of their host legumes often depends upon their ability to compete with indigenous strains already present in the soil. As a result, significant differences among strains in number of nodules/plant were also found for lentil. These results are more or less similar to the results reported earlier by Bhuiyan *et al.* (2000) and Zia *et al.* (2004). Such an increase of nodule dry weight in lentil due to *Rhizobium* inoculation was also observed by other investigators (Namdeo *et al.* 1996, Rahman *et al.* 2009).

Rhizobium inoculation alone increased plant height, seed yield and hay yield of lentil significantly compared to uninoculated control (Haque *et al.* 2014). In the present study, inoculated lentil seeds with different strains increased seed yield by 22.2 - 60.3% compared to uninoculated treatment. These results are in agreement with the findings of Khanam *et al.* (1999) on lentil. Namdeo *et al.* (1996) reported that inoculation increased seed yield by 17.5-23.2% compared to that with no inoculation. Sekhon *et al.* (2002) recorded that *Rhizobium* inoculation resulted in higher seed yield over no inoculation. Rebeschini *et al.* (2014) observed reduction of nodule number and dry weight of nodule with nitrogen application up to 20 kg N/ha. Several findings also indicated reduction of nodule formation and development by inorganic nitrogen application (Otieno *et al.* 2006, Shamseldin and Moawad 2010).

Table 2. Effect of different inoculants and chemical fertilizers on growth of lentil in different locations of Bangladesh.

Treatment	Nodules (No./plant)	Dry wt. of nodules (mg/plant)	Plant height (cm)	Dry wt. of plant (gm/plant)	Seed yield (t/ha)	Hay yield (t/ha)
Inoculants						
Uninoculated	3.14c	3.80d	25.69c	1.85b	0.51c	1.16d
<i>Rhizobium</i> strain 1	10.29a	9.92a	32.20a	2.29a	0.87a	1.93a
<i>Rhizobium</i> strain 2	7.96b	8.37b	29.75b	2.13a	0.68b	1.60c
Mixed culture (<i>Rhizobium</i> 1 and 2)	7.58b	9.45a	29.67b	1.87b	0.80a	1.73b
Urea @ 50 kg N/ha	3.82c	5.27c	30.73b	1.88b	0.69b	1.73b
Locations						
Rangpur	13.10a	11.78a	30.43b	1.42c	1.53a	2.25a
Ishwardi	6.40b	7.71b	38.87a	4.20a	0.53b	2.19a
Magura	4.73c	6.42c	30.00b	2.21b	0.57b	1.77b
Satkhira	2.00d	3.53d	19.13c	0.18d	0.19c	0.32c
LSD						
Inoculant	0.640	0.469	1.166	0.189	0.062	0.084
Location	0.715	0.524	1.304	0.211	0.069	0.094
CV (%)	13.19	8.620	5.330	12.73	11.79	6.910

In respect of locations, nodules number was not statistically significant among the treatments. Maximum nodule number (13.10) was found at Rangpur and the lowest (2.00) was observed at Satkhira. Nodule dry weight ranged from 3.53 to 11.78 mg/plant in Rangpur and Satkhira, respectively. The second highest nodule number (6.40) was found in Ishwardi. The highest dry

weight of nodule (11.78 g) was found in Rangpur, while the lowest nodule dry weight (3.53 g) was observed in Satkhira.

The maximum plant height (38.87 cm) was found in Ishwardi and the lowest (19.13 cm) in Satkhira. Similar results in respect of plant height of lentil were observed in Rangpur and Magura.

The highest dry weight (4.20 g) of plant was observed in Ishwardi and the lowest (0.18 g) in Satkhira. Rangpur had the maximum seed yield (1.53 t/ha) of lentil, whereas the lowest seed yield (0.19 t/ha) was found in Satkhira. Ishwardi and Magura had similar seed yield of lentil. The highest hay yield (2.25 t/ha) was observed in Rangpur followed by that in Ishwardi. The lowest hay yield (0.32 t/ha) was recorded in Satkhira. Argaw and Akuma (2015) reported that *Rhizobium* strain with urea fertilizer showed different nodule number, nodule dry weight, seed yield and total biomass in different locations. Saline soils of Satkhira probably deleteriously affected the nodule formation and the symbiotic N₂ fixation in lentil plants inoculated with all rhizobial strains.

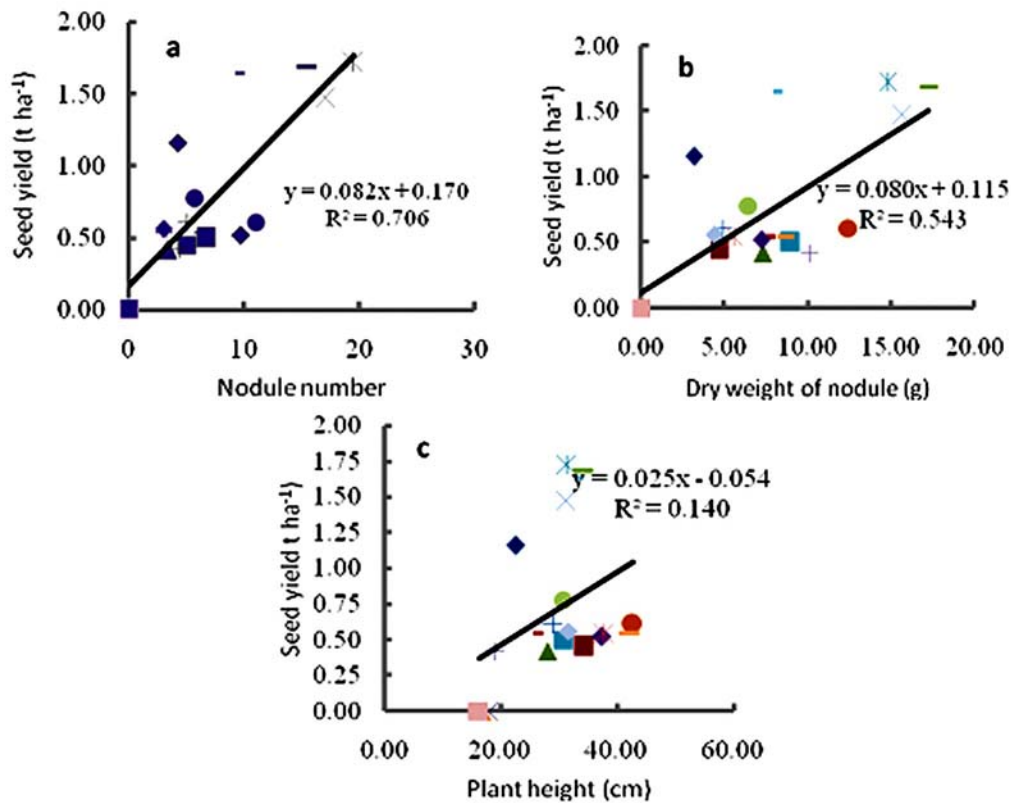


Fig. 1. Relationship between (a) nodule number and seed yield, (b) nodule dry weight and seed yield and (c) plant height and seed yield of lentil.

Correlation study was done to examine the relationship of nodule number with seed yield, nodule dry weight with seed yield and plant height with seed yield of lentil. The study revealed significant and positive correlation between nodule number (Fig. 1a) and nodule dry weight (Fig. 1b) with seed yield of lentil and followed the regression equation $y = 0.082x + 0.170$ ($R^2 = 0.706^{**}$), $y = 0.080x + 0.115$ ($R^2 = 0.543^{**}$) at 1% level of significance. Non-significant and

positive correlation was performed between plant height (Fig.1c) with seed yield of lentil following the regression equation $y = 0.025x + 0.054$ ($R^2 = 0.140^{NS}$). It indicates that the nodule number and dry weight of nodule helped to increase seed yield of lentil.

Symbiosis of lentil with all the strains evaluated leads to satisfactory yields compared to uninoculated and 50 kg N/ha treated treatments. Lentil grown in Rangpur had higher nodulation, plant growth, and shoot and grain N accumulation vis a vis greater grain yield. Nitrogen fertilization with 50 kg/ha reduced the number of nodules in relation to the inoculated treatments.

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