

## EFFECT OF *RHIZOBIUM* INOCULATION ON NODULATION AND YIELD OF CHICKPEA IN CALCAREOUS SOIL

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### Abstract

Two field experiments were carried out during two consecutive *rabi* seasons of 2002-03 and 2003-2004 at Farming System Research Site, Chabbish Nagar, Rajshahi (AEZ 11) with a view to assessing the effect of *Rhizobium* inoculation on four varieties of chickpea viz., BARI Chola-3, BARI Chola-4, BARI Chola-5 and BART Chola-6. Each variety was tested with and without *Rhizobium* inoculation. Each plot received basal application of 22 kg P/ha as TSP, 42 kg K/ha as MOP, 20 kg S/ha as gypsum and 5 kg Zn/ha as zinc oxide. Peat based rhizohial inoculum (*Rhizohium* strain RCa-220) @ 1.5 kg/ha was used for seed inoculation. Inoculated plants gave significantly higher nodule number, nodule weight, stover yield and seed yield compared to uninoculated plants. Among four varieties, BARI Chola-3 produced the highest nodule number, nodule weight and stover yield, while the highest yield was obtained from BARI Chola-4.

Key Words: Chickpea, *Rhizobium*, nodulation, yield.

### Introduction

Chickpea (*Cicer arietinum* L.) is a major pulse crop in Bangladesh. It stands 5th in respect of area (13915 ha) and production (10380 tons), and 2nd in consumption priority (BBS, 2004). The average yield of chickpea is low (746 kg/ha) which can be attributed to lack of high yielding varieties and suitable rhizobial strains capable of fixing high atmospheric nitrogen. The soils of Bangladesh, especially Rajshahi regions are deficient in nitrogen fixing bacteria (*Rhizohium* spp.) which causes poor yield of chickpea (Bhuiyan *et al.*, 1998; Khanam *et al.*, 1999). The Bangladesh Agricultural Research Institute (BARI) has developed a good number of varieties of chickpea. There is a good possibility to increase its production by exploiting better colonization of the roots and rhizospheres through application of effective nitrogen fixing bacteria to the seed or to the soil. This can minimize uses of nitrogenous fertilizer, which is very costly in this country. Using high yielding varieties of chickpea along with use of effective rhizohial strains can enhance the yield. The present investigation was undertaken to study the response of different chickpea genotypes to *Rhizobium* inoculation in High Ganges River Floodplain (AEZ 11) soil of Bangladesh.

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### Materials and Method

Two field experiments with chickpea were carried out during *rabi* seasons of 2002-03 and 2003-04 at Farming System Research Site, Chabbish Nagar, Rajshahi of On-farm Research Division, Bangladesh Agricultural Research Institute. The site belongs to the Agro-ecological Zone 11 (High Ganges River Floodplain). The treatments were designed in Randomized Complete Block having 4 replications for each treatment. The unit plot size was 4m x 3m. Four varieties of chickpea, namely BARI Chola-3, BARI Chola-4, BARI Chola-5 and BARI Chola-6 were tested with and without *Rhizobium* inoculation. Basal application was made with  $P_{22}K_{42}S_{20}Zn_5$  kg/ha with no N application. Peat based rhizobial inoculum 1.5 kg/ha was used for inoculation treatment. The *Rhizobium* strain was BARI RCa-220 and the number of *Rhizobium* cells/g inoculant was  $2.4 \times 10^8$ . Before application of fertilizers, composite soil samples were collected from 0 to 15 cm depth and analyzed for chemical properties (Table 1). The seeds were coated with *Rhizobium* inoculum before sowing and sowing was made 25 November 2002 and 16 November 2003. Row to row distance was 30 cm and plant to plant was 15 cm. Thinning, weeding and other intercultural operations were done as and when necessary. Ten randomly selected plants were uprooted at 50% flowering stage from each plot to record nodule weight and nodule number. Crops were harvested on 01 April 2003 and 21 March 2004. Stover and seed yields for each unit plot were recorded. Data on 1000-seed weight was also taken. All data were analyzed statistically.

**Table 1. Nutrient status and rhizobial population of the initial soil sample (0-15cm depth).**

Year	pH	Organic matter (%)	Ca	Mg	K	NH <sub>4</sub> -N	P	S	Rhizobial population/g soil
			(meq/100g)			(µg/g)			
2002-03	7.1	0.45	16.3	4.21	0.22	32	39	20	$2.1 \times 10^1$
2003-04	6.6	0.55	19.1	5.57	0.21	29	32	19	$3.2 \times 10^1$
Critical level			2.0	0.8	0.20	75	14	12	-

### Results and Discussion

Effects of varieties on nodule number, nodule weight, 1000-seed weight, stover yield and seed yield have been presented in Table 2. Among the varieties studied, BARI Chola-3 gave significantly higher nodule number, nodule weight and stover yield. BARI Chola-6 produced higher 1000-seed weight in 2002-03. The highest seed yield was recorded in BARI Chola-4, which was significantly higher

than other varieties in 2002-03 but identical to all other varieties in 2003-04. Khanam *et al.* (1994) in Bangladesh and Gupta and Namdeo (1986a) have also reported varied in nodulation and yield of chickpea due to use of different varieties. In the present experiment, BARI Chola-3 produced the highest nodule number and nodule weight, while BARI Chola-4 gave the highest seed yields which were significantly higher over all other varieties in 2002-03, but identical to other varieties in 2003-04. In another study, Eusuf Zai *et al.* (1999) found significantly more nodules in variety BARI Chola-6.

**Table 2. Effects of different varieties on nodulation and yield of chickpea.**

Variety	Nodules /plant	Nodule wt (mg/plant)	1000-seed wt (g)	Stover yield (t/ha)	Seed yield (t/ha)
<u>2002-03</u>					
BARICho1a-3	42.6a	288a	138a	2.42a	1.08c
BARICho1a-4	24.4c	144c	122b	2.15b	1.35a
BARI Chola-5	24.6c	172b	113c	2.34a	1.23b
BARI Chola-6	30.3b	186b	144a	2.17b	1.11c
SE±	2.43	10.0	2.82	0.07	0.05
<u>2003-04</u>					
BARICho1a-3	46.9a	239a	162a	2.01a	1.27
BART Chola-4	36.4b	169c	143b	1.84b	1.29
BARICho1a-5	31.4c	175bc	134c	1.57c	1.12
BARICho1a-6	43.0a	192b	160a	1.84b	1.19
SE(±)	1.44	7.2	2.12	0.05	NS

Means followed by different letters are significantly different at 5% level by DMRT

NS: Not significant

Effects of rhizobial inoculation on nodule number, nodule weight, 1000-seed weight, stover yield and seed yield have been presented in Table 3. Inoculated plants gave significantly higher nodule number, nodule weight, stover yield and seed yield compared to uninoculated control. Khanam *et al.* (1994) reported that inoculation with *Rhizobium* strains gave higher nodule number, nodule dry weight, stover yield and seed yield compared to uninoculated plants. Bhuiyan *et al.* (1998) found that *Rhizobium* inoculation increased nodulation and seed yields upto 35%. Gupta and Namdeo (1996b) found that seed inoculation with *Rhizobium* increased chickpea seed yields by 9.6-27.9%.

**Table 3. Effects of rhizobial inoculant on nodulation and yield of chickpea.**

Inoculants	Nodules /plant	Nodule wt (mg/plant)	100-seed wt (g)	Stover yield (t/ha)	Seed yield (t/ha)
<u>2002-03</u>					
Uninoculated	25.8b	167b	129	2.06b	1.09b
Inoculated	35.2a	229a	129	2.48a	1.29a
SE(±)	1.72	7.1	NS	0.05	0.04
<u>2003-04</u>					
Uninoculated	32.1b	176b	147b	1.73b	1.15b
Inoculated	46.8a	212a	153a	1.90a	1.29a
SE(±)	1.02	5.08	1.50	0.04	0.04

Means followed by different letters are significantly different at 5% level by DMRT

NS: Not significant

Interaction effects of varieties and rhizobial inoculation on nodule number, nodule weight, 1000-seed weight, stover yield and seed yield have been presented in Table 4. The highest nodule number, nodule weight and stover yield were recorded with BARI Chola-3 with inoculation, but the highest seed yield was observed in inoculated BARI Chola-4 (16.0% higher in 2002-03 and 11.6% higher in 2003-04 over uninoculated control). Response to *Rhizobium* inoculation was more pronounced in BARI Chola-5 which was 21.6% higher over uninoculated control in 2002-03 and 11.7% higher in 2003-04.

Positive and significant correlations of nodule number were observed with nodule weight, and 1000-seed weight and stover yield in both years. On the contrary, there was no significant correlation between seed yield and nodule number or weight.

The nitrogen content of soil was below critical level in both the years (Table 1). Hence, inoculation with *Rhizobium* strains no. RCa-220 gave higher nodule number and weight in BARI Chola-3, but higher seed yields in BARI Chola-4 variety. Again, the seed yield varied significantly with the varieties in 2002-03 showing the highest result recorded by BARI Chola-4 and the lowest by BARI Chola-3. No significant difference was observed between varieties in 2003-04.

**Table 4. Interaction effects of varieties and rhizobial inoculant on nodulation and yield of chickpea.**

Treatment	Nodules /plant	Nodule wt (mg/plant)	1000-seed wt (g)	Stover yield (t/ha)	Seed yield (1/ha)
2002-03					
BARI Chola-3xU	35.2	260	138	2.17	0.98
BARIChoIa-3xI	50.0	316	138	2.66	1.17
BARIChoIa-4xU	22.8	126	122	1.94	1.25
BARI Chola-4xI	26.0	162	122	2.36	1.45
BARI Chola-5xU	20.6	132	111	2.14	1.11
BARIChoIa-5xI	28.6	212	116	2.54	1.35
BARI Chola-6xU	24.4	148	148	2.00	1.03
BARI Chola-6xI	36.2	224	140	2.34	1.19
SE(±)	ns	ns	ns	ns	ns
CV (%)	15.9	10.2	4.4	6.3	8.7
2003-04					
BARI Chola-3xU	36.8	217	158	1.97	1.23
BARI Chola-3xI	57.0	261	166	2.05	1.31
BARI Chola-4xU	29.3	150	141	1.67	1.20
BARIChoIa-4xI	43.5	188	146	2.00	1.39
BARI Chola-5xU	27.3	158	129	1.51	1.03
BARIChola-5xI	35.5	193	139	1.63	1.21
BARI Chola-6xU	35.0	179	159	1.75	1.14
BARI Chola-6xI	51.0	204	160	1.93	1.26
SE(±)	ns	ns	ns	ns	ns
CV (%)	10.4	10.5	4.0	8.2	12.8

U= Uninoculated, I= Inoculated, NS= Not significant

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