J. Mycopathol. Res. **40 (1)** : 37- 40 (2002) *Printed in India*

Improvement of the yield of Bengal gram (*Cicer arietinum* L.) and lentil (*Lens esculentum* L.) through enrichment of rhizosphere with native rhizobia in the district of Hooghly, West Bengal

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Pulses are grown in about 15,000 acre of land in the district of Hooghly. Cultivation of pulses is restricted to the non-irrigated land along the catchments of the river Ganga and Damodar. Usually very little inputs are provided for pulse cultivation and as such average yield of pulses is far below the national average. In order to combat the situation extensive survey works for nodule bacteria from two rabi pulses, viz. Cicer and Lentil were conducted in eight specific blocks out of seventeen. The serotyping of these nodule bacteria were made by following standard agglutination method. In addition pH, organic carbon and organic matter percentage of the rhizospheric soil was also recorded. Field experiments were also conducted in farmer's field at least in five mouza in each block. It was observed that nodulation, growth and seed yield would be augmented significantly if the enrichment of the soil was made with native rhizobia from where they had been isolated.

Key words : Cicer, lentil, native rhizobial inoculant, yield improvement.

INTRODUCTION

An extensive survey of winter pulses was conducted throughout the state of West Bengal in order to evaluate native *Rhizobium* status in the soil of different district as well as to understand the symbiotic efficiency of these isolated rhizobia. In fact these native rhizobia proved their effectiveness in increasing the yield if they are reinoculated in the same soil from where they have been isolated (Bandyopadhyay, 1998). Keeping this idea in view the present work was taken up particularly to study the ability of improving the yield *Cicer arietinum* L. and *Lens esculentum* L. in eight blocks of Hooghly district through enrichment of the rhizosphere with the same serotyoe of *Rhizobium* that were isolated from the respective locations.

MATERIALS AND METHODS

Experiments in the farmer's field were conducted in different mouza under eight blocks of Hooghly district to demonstrate the effect of enrichment of Cicer (*Cicer arietimum* L. (cv. Mahamaya-1) and Lentil (*Lens esculentum* L. (cv. Asha) rhizosphere with the native rhizobial serotype isolated earlier and were found to be predominantly distributed in the respective soil (Table 1). All the treatments had five replications. Serological identification of the isolated strains was made by simple agglutination test (Johnson and Means, 1963).

Sowing operations were made during the middle of November 1998, a primary dose of P2O5 @ 60 kg/ha were given during soil preparation. For enrichment treatment the rows were inoculated with broth culture of *Rhizobium* with sufficient concentration. Uninoculated plots were kept as control. Both the treatments were replicated thrice.

The ultimate sub-plot size 35 sq.m. and the distance between the rows were 22 cm. The seed rates were 25 kg/ha and 40 kg/ha for lentil and Cicer respectively. Soil type, pH of the soil, percentage of organic carbon and organic matter of the rhizosphere were recoded carefully (Table 1).

At the onset of flowering data on nodulation and dry weight of plants were recorded. After maturity the crops were harvested and yield of each sub-plot was recorded separately. The data were then analysed statistically.

Table-1. List of experimental locations, their soil characters and respective native strains *of Rhizobium* for Cicer (*Cicer arietinum* L.) and Lentil (*Lens esculentum* L.) in the district of Hooghly, West Bengal

Sl. No.	Location	Block	Soil Type*	pH	Organic C (%)	Organic matter (%)	Native *Rhizobium* Strain	
							Cicer	Lentil
1.	Saptagram	Chinsura Mogra	GA	6.6	1.54	2.69	Hg-c-25 1	Hg-L-106 2
2.	Halusa	Polba Dadpur	BA	8.2	1.84	3.16	Hg-c-20 2	Hg-L-101 2
3.	Abdulpur	Balagarh	GA	7.9	1.07	2.85	Hg-c-14 2	Hg-L-91 1
4.	Rajbalhat	Jangipara	BA	7.8	2.54	4.10	Hg-c-281	Hg-L-42 1
5.	Radhaballavpur	Khanakul - I	BA	8.0	2.56	4.22	Hg-c-16 1	Hg-L-40 1
6.	Gurup	Dhaniyakhali	BA	7.4	1.12	3.30	Hg-c-13 2	Hg-L-21 4
7.	Aminpur	Haripal	BA	8.9	2.39	4.15	Hg-c-18 1	Hg-L-52 6
8.	Goghat	Goghat	RS	8.7	1.64	2.81	Hg-c- 4 2	Hg-L-27 2

* Soil Type; GA=Gangetic alluvium; BA=Bindh aluvium; RS=Red soil

RESULTS AND DISCUSSIONS

In case of *Cicer* in most of the locations nodulation, nodule dry weight of plants improved significantly due to enrichment of soil with native rhizobia (Table 2). The increase in yield of *Cicer* due to inoculation was recorded to be 12.03%- 21. 52% over those of uninoculated control which suggested the necessity of inoculation of *Cicer* seed with *Cicer* specific rhizobia in this district for boosting up of yield in general. Out of eight locations only in two - Abdulpur and Aminpur the inoculation effect was found to be statistically insignificant. The maximum increase in nodule number and module dry weight was found in Saptagram.

The increase of plant dry weight was found to be significant in Rajbalhat, Saptagram and Halusa. The seed yield in two locations viz. Abdulpur and Rajbalhat was not significant even after reinoculation (Table 4). However, in Rajbalhat the yield of *Cicer* became maximum (20.20 q/ha).

Table-2. Effect of *Rhizobium* enrichment on nodule number, nodule weight and plant dry weight per plant of Cicer (*Cicer arietinum* cv. Mahamaya-1)

Treatment	LOCATION[a]							
	1	2	3	4	5	6	7	8
1. NODULE NO. PER PLANT								
CONTROL	43.87	29.66	32.66	31.00	30.33	29.33	25.00	26.80
ENRICHMENT	74.66	44.82	40.96	48.33	44.01	41.56	35.68	41.32
C.D. at 5%	18.15	10.34	N.S.	11.03	9.03	8.63	N.S.	9.42
2. NODULE WT. PER PLANT								
CONTROL	0.129	0.140	0.189	0.193	0.196	0.188	0.138	0.166
ENRICHMENT	0.187	0.192	0.247	0.284	0.286	0.251	0.198	0.253
C.D. at 5%	18.74	4.19	N.S.	15.98	5.99	4.71	N.S.	4.58
3. PLANT DRY WEIGHT (gm.) PER PLANT								
CONTROL	0.342	0.331	0.298	0.425	0.292	0.349	0.282	0.367
ENRICHMENT	0.450	0.479	0.362	0.585	0.405	0.522	0.456	0.368
C.D. at 5%	8.20	3.92	N.S.	11.62	0.079	0.057	N.S.	N.S.

[a] Serial no. of locations as on Table 1; N.S. = Not significant

Table 3. Effect of *Rhizobium* enrichment on nodule number, nodule weight and plant dry weight per plant of Lentil (*Lens esculentum* cv. Asha)

	LOCATION[a]							
Treatment	1	2	3	4	5	6	7	8
1. NODULE NO. PER PLANT								
CONTROL	38.62	48.94	28.33	25.66	29.33	43.66	20.48	26.80
ENRICHMENT	71.00	99.62	39.65	33.90	59.30	87.67	24.33	92.56
C.D. at 5%	5.89	16.89	9.36	N.S.	3.71	N.S.	N.S.	6.30
2. NODULE WEIGHT PER PLANT								
CONTROL	0.103	0.088	0.084	0.078	0.148	0.122	0.105	0.116
ENRICHMENT	0.135	0.145	0.115	0.104	0.290	0.257	0.125	0.193
C.D. at 5%	2.19	15.03	7.15	N.S.	0.0	0.98	N.S.	9.52
3.PLANT DRY WEIGHT (gm.) PER PLANT								
CONTROL	0.258	0.310	0.345	0.254	0.345	0.263	0.269	0.283
ENRICHMENT	0.363	0.442	0.487	0.438	0.543	0.540	0.383	0.408
C.D. at 5%	5.37	5.52	4.96	N.S.	12.59	1.32	N.S.	13.53

[a] Serial number of locations as in Table 1; N.S.= Not Significant

Table 4. Effect of native *Rhizobium* enrichment on the seed yield (q ha) of Cicer (*Cicer arietinum* L.) cv. Mahamaya – 1

	LOCATION[a]							
Treatment	1	2	3	4	5	6	7	8
CONTROL	14.08	14.95	14.60	18.60	14.67	15.28	14.15	16.50
ENRICHMENT	16.86	17.16	16.30	20.23	17.08	17.70	16.78	19.85
C.D. at 5%	2.04	2.57	N.S	N.S.	4.85	4.23	1.46	1.88

[a] Serial number of locations as in Table 1; N.S. = Not Significant

Table 5. Effect of native *Rhizobium* enrichment on the seed yield (q ha) of Lentil (*Lens esculentum* L. cv. Asha)

	LOCATION[a]							
Treatment	1	2	3	4	5	6	7	8
CONTROL	4.26	5.80	3.20	3.96	5.71	4.58	4.52	3.69
ENRICHMENT	6.71	7.62	5.83	6.68	7.80	7.69	6.06	4.92
C.D. at 5%	3.67	2.06	4.85	N.S.	1.35	4.89	N.S.	N.S.

[a] Serial number of locations as in Table 1; N.S.= Not Significant

Similar insignificant yield has been found in Goghat (Table 4). This proves that the native rhizobial flora of these locations are most effective. Isolation and selection of nodule bacteria, from these regions would, therefore be a rational approach to obtain a better inoculant for this particular crop.

Out of eight locational trials in lentil neither Nodule number nor nodule dry weight nor plant dry weight showed significant effect to inoculation in Abdulpur and Aminpur (Table 3). However, in the rest six locations significant increase of these characters has been identified. In Halusa the nodule number and weight per plant showed maximum increase. In Goghat and Radhaballavpur the increase in dry weight of plant showed very significant value. In general indirect correlation between the increase of nodulation and

plant dry weight has been noticed.

Increase in yield in lentil due to inoculation varies 14.8 – 36.6%. In Rajballavpur, Aminpur and Goghat the increase in yield was statistically insignificant in contrast to other locations (Table 5). In Gurup, Rajbalhat and Halusa bumper yield through enrichment of soil with rhizobia has been noticed. This suggests the existence of effective native rhizobia in this locality.

Response of both the crop to enrichment of rhizosphere with native rhizobia corroborates with the earlier report made by Kabi and Behari, 1990 and Bandyopadhyay, 1998. This can be explained as the adaptation of the native strains in the respective soil through the long course of time. Besides this, the competitive ability of these strains has been found to be always greater than the other strains (Kabi, 1976; Bandyopadhyay, 1986). Still the question remains as to how such fresh inoculation with these native rhizobia respond to increase crop yield over the uninoculated control as these strains are already inhabiting in the respective soil. The answer might be that both the crop are winter pulses and hence their rhizobia may not thrive well during extreme hot summer thereby causing poor survivality in the soil (Marshall, 1964, Vincent, 1958, Bandyopadhyay, 1998) and therefore, a fresh inoculation with rhizobial strain that is native to the soil, caused a boosting effect.

So in order to obtain optimum yield of winter pulses it is suggested to inoculate the soil each time with native rhizobia particularly when the crops are to be grown in a humid, sub-tropic area like gangetic plain of West Bengal.

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(Accepted for publication January 31, 2002)