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Effect of liquid and carrier based *Rhizobium* inoculants on growth, nodulation and seed yield of urdbean

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ABSTRACT

A two-year field study was conducted during kharif, 2003 and 2004 at the Pulses and Oilseeds Research Sub-station, Beldanga, Murshidabad, West Bengal to evaluate the performance of liquid and carrier based Rhizobium inoculants in urdbean.The results revealed that though the basal application of inorganic N either at 20 or 40 kg ha^{-1} gave the highest seed yield, it was closely followed by the seed inoculation treatment with liquid Rhizobium inoculant (LRI) prepared at the Pulses and Oilseeds Research Station (PORS), West Bengal and carrier based Rhizobium inoculant (CRI) prepared at the PORS, W.B. Yield advantages due to inoculation with LRI (PORS) and CRI ((PORS) were 13.06 and 9.61%, respectively, over the uninoculated control. There was positive correlation between symbiotic traits (nodule number, nodule dry weight and total dry matter per plant) with seed yield of urdbean.

Key Words : Carrier based Rhizobium inoculant, Liquid Rhizobium inoculant, Nodulation, Seed yield, Urdbean.

Biofertilizer inoculum has been proved as the cheapest source of nitrogen for better yield and nodulation, particularly in legumes. These plants can meet up their nitrogen needs through both symbiosis (biological nitrogen fixation) and nitrogen fertilization, or through native soil nitrogen (Rupela and Khurana, 1997). Urdbean [*Vigna mungo* (L.) Hepper] is such an important legume grown mainly during *kharif* season in the state of West Bengal. But the average productivity of the crop is far below the potential yield level because of its cultivation on marginal lands without any inoculation. Though seed inoculation with *Rhizobium* has established its potential in increasing productivity of pulses, it may fail to exhibit the inoculation response under field conditions when poor quality inoculants are in use. Shorter shelf life, contamination in carrier and non-availability of protective carrier material chiefly contribute to the poor quality of *Rhizobium* inoculant (Hegde, 2002). Recent studies showed the possibility of making rhizobia to survive in a liquid medium for more than a year with the help of cell protectants (Brahmaprakash *et al*., 2004). There is no chance for contamination in case of liquid inoculants as the *Rhizobium* bacteria are grown in liquid medium to 10^9 cells/ml in the fermentor and directly dispended into bottles or sachets aseptically. Liquid inoculants may be cost-effective, whereas use of carrier material involves high cost for its transportation, pulverization, neutralization and sterilization etc. (Hegde, 2002). Thus, the prospect of liquid biofertilizer is highly encouraging and even better than carrier-based biofertilizer (Bhattacharyya and Kumar, 2002). Meagre information is available on the response of urdbean to liquid inoculant under field conditions. Keeping all these in view, the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive *kharif* seasons of 2003 and 2004 at the Pulses and Oilseeds Research Sub-Station, Beldanga, Murshidabad, West Bengal to evaluate the performance of liquid and carrier based *Rhizobium* inoculants in urdbean grown in inceptisol. The soil of the experimental site was sandy loam having pH 7.8, organic carbon 0.28%, available P_2O_5 48 kg ha^{-1} and available K_20 82 kg ha^{-1}. In all, six treatments *viz*. two carrier based *Rhizobium* inoculants or CRI (one from All India Coordinated Pulses Improvement Project and another produced at the Biofertilizer Laboratory of Pulses and Oilseeds Research Station, Berhampore, West Bengal), two liquid *Rhizobium* inoculants or LRI (one from AICPIP and another of local best strain produced at the Biofertilizer Laboratory, P.O.R.S., Berhampore,W.B.) and two levels of inorganic N (20 and 40 kg ha^{-1}) were tested against uninoculated control. These treatments were replicated four times in a randomized block design. Seeds were inoculated with respective *Rhizobium* inoculants prior to sowing using 60 g carrier based and 20 ml liquid inoculant per kg of seed. Initial rhizobial counts of all the carrier based and liquid inoculants were around 10^9 cells /g and 10^9 cells/ ml, respectively, as per serial dilution plate count method in both the years of study.

In order to study the adaptability and symbiotic traits like nodule number, nodule dry weight and plant dry matter (PDM) accumulation, five plant samples were randomly uprooted from

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each plot at 45 days after sowing (DAS). The roots of uprooted plants were carefully washed with water and nodule counts were made after detaching from the plant roots in a white paper. The nodules were dried at 80^{O} C in the hot air oven and weighed. Simultaneously total plant dry matter weight was recorded. Seed yield in kg ha^{-1} was recorded after crop harvest. Simple correlation was also worked out for symbiotic traits with seed yield.

RESULTS AND DISCUSSION

Effect of treatments on nodulation

A perusal of data in Table 1 revealed that nodule number per plant ranged from 15.96 to 26.11 with mean number of 21.61. Maximum number of nodules (26.11) was observed in seed inoculation with LRI developed at P.O.R.S. The same treatment also recorded the highest nodule dry weight (18.15 mg/plant) at 45 days of crop growth. Next in order was CRI (PORS) which registered mean nodule number of 23.90 and dry weight of 16.64 mg/plant at 45 days of crop growth (Table 1). Irrespective of sources (AICPIP or PORS), all the inoculants (carrier based as well as liquid) could remarkably increase the nodule number by 1.30 to 1.64 times and nodule dry weight by 1.21 to 1.40 times over the uninoculated control (15.96 nodules with dry weight of 12.94 mg/plant). These results revealed that the inoculated rhizobia had better compatibility and efficiency as compared to the native rhizobia in forming effective nodules in the root systems. Better and effective nodulation might result in better nitrogen fixation and growth of urdbean. There were reports on increased nodule number under LRI in comparison to local inoculants (Bhattacharyya and Kumar, 2002).

Effect of treatments on crop growth

The treatments LRI (AICPIP and PORS), CRI (PORS) and inorganic N application at 40 kg ha^{-1} differed significantly from the uninoculated control in respect of total PDM accumulation during both the years of experimentation (Table 1). Among these treatments, the highest accumulation of PDM was noted under LRI of PORS (5.95 g /plant), which was closely followed by N application at 40 kg ha^{-1} (5.79 g /plant). There was 1.14 to 1.46-fold increase in PDM accumulation over the uninoculated control.

Table 1 : Effect of treatments on nodulation and plant dry matter accumulation at 45 DAS and seed yield of urdbean

Treatments	Nodule no. per plant			Nodule dry weight (mg/plant)			Dry matter accumulation (g/plant)			Seed yield (kg ha^{-1})		
	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
CRI (AICPIP)	24.55	22.88	23.71	14.20	17.33	15.76	4.85	4.40	4.63	1100	1065	1083
CRI(PORS)	23.90	23.91	23.90	16.20	17.08	16.64	5.48	4.75	5.11	1173	1108	1141
LRI(AICPIP)	21.25	20.13	20.69	14.85	16.50	15.68	4.68	5.20	4.94	1179	1094	1137
LRI(PORS)	26.78	25.45	26.11	16.40	19.90	18.15	6.15	5.75	5.95	1196	1158	1177
N @20 Kg ha^{-1}	19.25	22.33	20.79	15.90	15.25	15.58	4.55	4.28	4.41	1204	1160	1182
N @40 Kg ha^{-1}	22.45	17.80	20.13	16.50	14.43	15.46	6.03	5.55	5.79	1273	1156	1215
Uninoculated control	16.33	15.60	15.96	12.30	13.58	12.94	4.15	3.98	4.06	1071	1010	1041
CD (P=0.05)	2.28	2.33	1.76	1.19	2.04	1.36	0.61	0.59	0.30	117.40	117.0	75.00
CV (%)	7.10	7.50	5.50	5.40	8.50	5.90	8.10	8.30	4.10	6.90	7.20	4.40

Table 2 : Correlation coefficient between symbiotic traits and seed yield

Parameters studied	Correlation coefficient	
	2003	2004
Nodule number *vs.* seed yield	+ 0.21	+ 0.30
Nodule dry weight *vs.* seed yield	+ 0.49	+ 0.16
Dry matter accumulation *vs.* seed yield	+ 0.61	+ 0.36

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Effect of treatments on seed yield

Seed yield of urdbean was significantly increased with the treatments basal dose of N either at 20 or 40 kg ha^{-1} (1182 to 1215 kg ha^{-1})and LRI of PORS (1177 kg ha^{-1}) over the uninoculated control (1041 kg ha^{-1}). The treatment LRI (PORS) was followed by CRI of PORS (1141 kg ha^{-1}) and LRI of AICPIP (1137 kg ha^{-1}) in increasing seed yield (Table 1). The yield increments due to LRI (PORS) and CRI (PORS) over uninoculated control were noticed to the tune of 13.06 and 9.61%,respectively. This observation might have an indication that LRI performed better than CRI. This result corroborated the findings of Brahmaprakash *et. al.*(2004). Good performance of liquid biofertilizer in increasing soyabean yield had also been mentioned (Bhattacharyya and kumar,2002; Brahmaprakash *et al.*, 2004). Increase in seed yield under different inoculation treatments might be attributed to better nodulation, nitrogen fixation and crop growth as against uninoculated control (Table 1).Khurana and Dudeja (1997) reported that increase in seed yield was found to range from 0 to 77.3% due to *Rhizobium* inoculation over uninoculated control.

Correlation worked out for various symbiotic traits *viz.* nodule number, nodule dry weight and total dry matter accumulation per plant with seed yield (Table 2) had been found positive. This corroborated the findings of Gupta (2005) in chickpea.

The results indicated that urdbean could positively respond to liquid as well as carrier based *Rhizobium* inoculants. Since the liquid inoculant had extra advantage of possessing greater shelf life compared to carrier based inoculant, it may be better utilized at farmers' field for confirming such response to inoculation. The findings also need confirmation at other locations under different soils and agro-ecological situations towards reaching a valid conclusion for adopting liquid inoculants on a large scale.

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