Evaluation of different *Rhizobium* strains on growth, nodulation and seed yield in urdbean

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ABSTRACT

A three-year field trial was conducted during kharif season of 2005, 2006 and 2007 at the Pulses and Oilseeds Research Sub-station, Beldanga, Murshidabad, West Bengal to evaluate the performance of different Rhizobium strains on growth, nodulation and seed yield of urdbean. The results revealed that significantly higher seed yields were recorded under Rhizobium strains, namely, PUR 34, BKR 1-04, CRU 7 and UP 3 due to significant improvement in most of the parameters studied, as compared with the others. Basal application of 20 kg N ha^{-1} also gave significantly the highest seed yield, being 16.32% higher than uninoculated control. Compared with uninoculated control (1023 kg ha^{-1}), yield advantages under seed inoculation with Rhizobium strains PUR 34, BKR 1-04, CRU 7 and UP 3 were 35.09, 30.30, 25.71 and 25.32,respectively (mean of three-year data).

Key words: Crop growth, nodulation, *rhizobium,* seed yield and urdbean.

Rhizobium is a symbiotic nitrogen-fixing, slow-growing and gram-negative bacterium which helps the legume to maintain the soil fertility by the way of their symbiotic association and nitrogen fixation. A legume plant having effective root nodules not only can meet its own nitrogen requirement but also enrich the soil nitrogen content, thereby improving soil fertility and sustainability (Kannaiyan, 2000 and 2002). Being an important *kharif* legume, urdbean [*Vigna mungo* (L.) Hepper] fixes atmospheric nitrogen and improves the soil fertility. There is a great potential in utilizing large amount of gaseous nitrogen available above ground through improved practice of legume inoculation (Brockwell *et al.,* 1995). Sometimes, indigenous rhizobial population may not be able to form effective symbiosis in field condition due to strain competition between introduced and native rhizobia (Pareek *et al*., 2002). Seed inoculation with appropriate *Rhizobium* strain is required to ensure adequate nodulation for maximum growth and yield of pulse crops (Kumar and Chandra, 2005). With this view, the present study was taken up to evaluate the performance of different *Rhizobium* strains on growth, nodulation and seed yield of urdbean.

MATERIALS AND METHODS

A three-year field trial was conducted during *kharif* season of 2005, 2006 and 2007 at the Pulses and Oilseeds Research Sub-station, Beldanga, Murshidabad, West Bengal, located at 23^{o} 55$^{/}$N latitude and 88^{o}15$^{/}$E longitude with an altitude of 19.0m AMSL. The experimental soil was sandy loam having pH 7.6, organic carbon 0.30%, available P_2O_5 67 kg ha^{-1} and available K_2O 117 kg ha^{-1}. The crop variety Sarada (WBU 108) was sown on August 30, 22 and 18 during 2005, 2006 and 2007, respectively. The experiment was laid out in a randomized block design with eight treatments replicated four times. Besides uninoculated control and basal dose of inorganic N at 20 kg ha^{-1}, there were six treatments of seed inoculation with *Rhizobium* strains *viz*., CUR 8, UP 3, BKR 1-04, PUR 34, CRU 7 and AUBR 10. Of these, carrier-based *Rhizobium* inoculants (CRI) obtained from All India Coordinated Pulses Improvement Project were CUR 8, UP 3, PUR 34, CRU 7 and AUBR 10 whereas BKR 1-04 was produced at the biofertilizer laboratory of the Pulses and Oilseeds Research Station, Berhampore, West Bengal. Seeds were inoculated with respective *Rhizobium* inoculants prior to sowing using 60 g kg^{-1} of seed. Initial rhizobial counts of all the carrier-based inoculants were around 10^9 cells g^{-1} as per serial dilution plate count method in all the years of experimentation. The crop was fertilized with a uniform basal dose of 40 kg P_2O_5 and 20 kg K_2O ha^{-1}, applied through single super phosphate and muriate of potash, respectively. The crop was raised following the recommended agronomic package of practices (Anon., 1997) and harvested on November 24, 25 and 24 during 2005, 2006 and 2007, respectively.

In order to study the nodulation, five randomly selected plants from each plot were uprooted at 45 days after sowing (DAS), their roots were gently washed with water, and nodules were removed and counted. The dry weight of root nodules and crop plants was recorded after drying in hot air oven at 80ºC to constant weight. Plant height was recorded at periodic intervals whereas observation on dry matter accumulation (DMA) was made at 45 DAS and at harvest. Seed yield and yield attributes were also recorded after crop harvest.

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Table 1: **Effect of different *Rhizobium* strains on growth attributes and nodulation in urdbean (Three-years pooled data)**

Treatments	Plant height (cm)			Dry matter accumulation (g m^{-2})		Nodule number $plant^{-1}$	Nodule weight (mg) $plant^{-1}$
	30 DAS	45 DAS	Harvest	45 DAS	Harvest		
CUR 8	22.47	39.23	48.87	132.06	251.10	20.65	29.28
UP 3	24.51	39.14	48.79	153.14	281.48	22.85	33.28
BKR 1-04	26.48	39.87	53.21	161.20	311.24	24.09	34.95
PUR 34	26.73	40.09	53.31	166.16	318.06	24.23	36.08
CRU 7	24.44	39.38	50.44	144.15	291.09	21.00	31.82
AUBR 10	22.92	40.13	46.60	150.97	265.98	20.04	30.39
20 kg N ha^{-1}	22.67	37.42	48.28	146.63	264.43	20.10	32.28
Uninoculated control	21.62	34.99	42.95	101.06	203.98	16.67	22.23
SEm(±)	**0.58**	**1.29**	**1.22**	**4.96**	**9.61**	**0.76**	**1.28**
LSD (0.05)	**1.71**	**3.80**	**3.59**	**14.57**	**28.52**	**2.24**	**3.76**
CV(%)	**5.0**	**6.87**	**5.33**	**7.07**	**7.03**	**7.23**	**8.5**

Table 2. Effect of different *Rhizobium* strains on yield attributes and seed yield of urdbean (Three-years pooled data)

Treatments	Branches $plant^{-1}$	Productive pods $plant^{-1}$	Seeds pod^{-1}	100-grain weight (g)	Seed yield (kg ha^{-1})
CUR 8	3.17	15.74	5.43	3.66	1197
UP 3	3.49	17.29	5.81	3.76	1282
BKR 1-04	3.51	19.23	6.06	3.89	1333
PUR 34	3.66	18.52	6.09	3.93	1382
CRU 7	3.33	16.20	5.76	3.81	1286
AUBR 10	3.16	15.90	5.76	3.71	1174
20 kg N ha^{-1}	3.09	15.16	5.56	3.59	1190
Uninoculated control	2.38	11.93	4.96	3.37	1023
SEm(±)	**0.12**	**0.46**	**0.20**	**0.15**	**37.26**
LSD (0.05)	**0.35**	**1.36**	**0.59**	**0.44**	**109.58**
CV(%)	**7.33**	**5.57**	**7.07**	**6.97**	**6.30**

RESULTS AND DISCUSSION

Effect on crop growth

Compared with uninoculated control, all the *Rhizobium* strains increased the mean DMA of crop plants by 1.31 to 1.62 and 1.23 to 1.56-fold at 45 DAS and harvest, respectively. The *Rhizobium* strain PUR 34 recorded the highest mean DMA of 166.16 and 318.06 g m^{-2} at 45 DAS and harvest, respectively. Significant increase in plant DMA with *Rhizobium* inoculation over the uninoculated control was earlier reported by Chandra *et al.* (2002) and Prasad *et al*. (2002) in urdbean. Such positive effect of *Rhizobium* inoculation was possibly due to the presence of either low and / or ineffective population of native rhizobia in the soils (Tripathi *et al*., 1994). Seed inoculation with *Rhizobium* recorded more plant height of 22.47-26.73, 39.14-40.13 and 46.60–53.31 cm in comparison to the uninoculated control (21.62, 34.99 and 42.95 cm) at 30 DAS, 45 DAS and harvest, respectively (Table 1).

Effect on nodulation

Seed inoculation with *Rhizobium* strains increased both the nodule number (20.22-54.35% more) and dry weight (31.71-62.35% more) as compared to uninoculated control (mean nodule number 16.67 with dry weight of 22.23 mg $plant^{-1}$). Three-year mean data (Table 1) showed that the *Rhizobium* strain PUR 34 recorded the highest nodule number (24.23 nos. $plant^{-1}$) and nodule weight (36.08 mg $plant^{-1}$), and was followed by BKR 1-04 (24.09 number of nodules weighing 34.95 mg $plant^{-1}$) and UP 3 (22.85 number of nodules weighing 33.28 mg $plant^{-1}$). These results corroborated with the findings of Chandra *et al.* (2002) and Tripathi *et al.* (1994). *Rhizobium* strains could remarkably increase the mean nodule number by 1.20 to 1.45 times and dry weight by 1.32 to 1.62 times over the uninoculated control (16.67 numbers of nodules with dry weight of 22.23 mg $plant^{-1}$). This was due to better compatibility and efficiency of inoculated rhizobia compared to the native rhizobia in forming effective nodules in the root system. There were reports on increased nodule

number and dry weight under seed inoculation with *Rhizobium* in urdbean (Biswas and Bhowmick, 2007; Prasad *et al*., 2002).

Effect on seed yield

All the *Rhizobium* strains significantly increased the seed yield by 14.76 to 35.09% over the uninoculated control (1023 kg ha^{-1}). The basal application of inorganic N at 20 kg ha^{-1} also increased the seed yield by 16.32% over uninoculated control. Seed inoculation with *Rhizobium* strain PUR 34 recorded the highest mean seed yield of 1382 kg ha^{-1} , and was closely followed by *Rhizobium* strains BKR 1-04 (1333 kg ha^{-1}), CRU 7 (1286 kg ha^{-1}) and UP 3 (1282 kg ha^{-1}). The strains PUR 34, BKR 1-04, CRU 7, UP 3 and CUR 8 increased seed yield by 16.13, 12.02, 8.07, 7.73 and 0.59% over basal application of 20 kg N ha^{-1} (1190 kg ha^{-1}). As compared with uninoculated control, yield advantages occurred due to seed inoculation with *Rhizobium* strains *viz*. PUR 34, BKR 1-04, CRU 7, UP 3, CUR 8 and AUBR 10 by 35.09, 30.30, 25.71, 25.32, 17.01 and 14.76%, respectively (Table 2). Such increase in seed yield could be attributed to better crop growth, better nodulation and improvement in yield attributes. These results corroborated with the findings of Prasad *et al*. (2002), and Biswas and Bhowmick (2007).

It could, thus, be inferred that seed inoculation with appropriate *Rhizobium* strain would be the best suitable option for improving the crop growth, nodulation and seed yield in urdbean. However, more studies under different agro-ecological situations are needed to arrive at a valid conclusion and make an effective recommendation on the use of a particular *Rhizobium* strain.

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