Progressive Research 9 (1) : 62-65 (2014)　　*Society for Sci. Dev. in Agric. and Tech.*

EVALUATION OF THE POSSIBILITY OF ESTABLISHING SOYBEAN (*Glycine max* L. Merrill) IN SOME SOILS OF WEST BENGAL

Kh. Chandrakumar Singh, S.C. Poi, S.K. Mandal and T. Basanta Singh
Nodule Research Laboratory, (Agricultural Chemistry and Soil Sciences)
Research Building No. 2, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, 741252, India
E-mail: chandrakumarkh@gmail.com　Tel No.: +91 9233941779

ABSTRACT

Experiment was carried out (pot culture and field trial) at Nodule Research Laboratory of department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, to evaluate the possibility of establishing soybean (*Glycine max* L. merrill) in some soils of West Bengal (neutral soil and lateritic acid soil). Pot culture and field experiments were conducted using soybean (variety Bragg) with acidic and neutral soils using seven different strains of *Bradyrhizobium japonicum*. It was observed that in both cases inoculated plants were found to produced better growth, yield etc. over the un-inoculated plants (control). It was also observed that soybean is poorly perform in acidic soils and better in neutral soils. The yield of soybean was found to increased or improved in acidic lateritic soils by judicial use of bacterial inoculation along with basal doses of nitrogen (N), phosphorus (P) and potash (K).

Key Words : *Acid soils, bradyrhizobium japonicum, inoculation, neutral soils, soybean.*

Soybeans, the grain legume, ranked much higher place constituting a major part in world Agriculture as supplier of protein and oil. They did contribute in filling protein gap in diet of a vast multitude of human and animal population in developing countries of tropics. Soybean is also the chief source of very important amino acid, lysine.

Apart from their nutritional properties soybean also occupied a key position in the world Agriculture because of a few unique features exhibited by them. The most important one was their ability to fix atmospheric nitrogen at the expense of renewable energy sources. Like other legumes, they bound molecular nitrogen through symbiotic association with the nitrogen fixing bacteria *Bradyrhizobium japonicum.* They added many times more nitrogen to our total soil area than was supplemented in the form of chemical fertilizers.

If the soil was very poor in nitrogen, a small amount of nitrogenous fertilizer must be applied. If micronutrients were lacking, pelleting seeds with these would ensure early formation of root nodules (1). Therefore, the effective use of *Rhizobial* inoculants was one of the important steps for improving the productivity of soybean. The inoculation practice was a low cost as well as a promptly responsive way to augment the yield at existing agro-climatic conditions of cultivation. However, desirable results of inoculation could only be obtained after right strains of nodule bacteria were used.

MATERIALS AND METHODS

Seven strains of *Bradyrhizobium japonicum* (S_1, S_2, S_3, S_4, S_5, S_6 and S_7) were taken from Nodule Research Laboratory, BCKV. The seed variety Bragg was collected from Pulse and Oil Seed research Station Berhampore, West Bengal.

Bradyrhizobium japonicum **strains taken.**

Sl. No.	Strain No.	Strain Code No.	Source
1	NT-102	S_1	NifTAL
2	DS2	S_2	Isolated from acid soils, Darjeeling
3	IC-1-04	S_3	Collected from Manipur
4	JS5	S_4	Nodule Research Laboratory, BCKV
5	JS7	S_5	Nodule Research Laboratory, BCKV
6	RGP – 1	S_6	Isolated from Raghunathpur, Purulia

While selecting an ideal inoculant, it is important to know before hand, the relative efficiency of Bradyrhizobium strain in respect of their symbiotic ability, but at the same time one should keep in mind that even the best strain might not been able to reflect its superiority under varying soil condition (2) because the same host with the most efficient strain might fail to perform its best in extreme soil types like acidic or alkaline (3).

Pot cultures

Pot culture experiments were carried out using porcelain pots (a slight modification of (4) filled with acidic lateritic soils and alluvial soils which were moistened with nitrogen free seedling solution [2]. The pots were covered with waxed paper and subsequently sterilized in an autoclave at 121 ^{0}C for 2 hours. Seeds were surface sterilized by rinsing them in 95% ethanol for 3 minutes. The seeds were then washed thoroughly in sterile water and planted in pots at the rate of 3 seeds/ pot. Soon after germination, seedlings were inoculated with broth culture of *Bradyrhizobium japonicum* at the rate 10 ml/pot. The sterile nutrient solution was added at regular intervals to these pots. After 60 days, plants were taken out carefully. Observations on nodulation were recorded from each plant. Fresh and dry weights of plants were recorded separately. Dried plants were finely pulverized in a Wiley Mill (at 200 mesh) for estimation of nitrogen.

Field trial

Field experiments were conducted at Goyeshpur

Table-1 : Relative efficiency of *B. japonicum* strains of soybean in pot cultures with neutral soils.

Strains	Nodule No. of plant	Weight of nodule/plant (g)		Weight of plant/plant (g)		Total N (%)	Total P (%)
		Fresh	Dry	Fresh	Dry		
Control	0	0	0	0.536	0.250	1.390	0.400
S1	16	0.747	0.466	3.747	1.737	4.689	0.400
S2	8	0.653	0.310	3.163	1.237	3.781	0.420
S3	14	0.727	0.327	3.650	1.637	2.583	0.440
S4	2	0.387	0.125	2.358	0.863	2.571	0.414
S5	15	0.370	0.120	2.168	0.670	2.691	0.418
S6	10	0.347	0.110	2.145	0.640	2.391	0.437
S7	26	0.833	0.410	4.183	1.947	4.391	0.437
CD at 5% level	2.216	0.089	0.087	0.219	0.135	0.125	0.009

g = gram, % = percentage, no = number.

Table-2 : Relative efficiency of *B. japonicum* strains of soybean in pot cultures with acid soils.

Strains	Nodule No./plant	Fresh weight of nodule /plant (g)	Weight of plant/plant (g)		Plant length (cm)	Total N (%)	Total P (%)
			Fresh	dry			
Control	0	0	0.690	0.123	50.510	1.530	0.450
S1	17	0.323	1.527	0.463	41.500	2.410	0.430
S2	22	0.652	2.713	0.717	73.178	3.600	0.507
S3	12	0.232	1.293	0.230	51.538	1.767	0.450
S4	17	0.349	0.813	0.173	39.302	1.780	0.450
S5	8	0.127	0.757	0.157	52.363	1.697	0.450
S6	14	0.133	1.250	0.340	83.550	1.677	0.463
S7	12	0.478	1.693	0.587	75.242	1.747	0.427
CD at 5% level	1.268	0.023	0.024	1.715	5.715	0.187	0.018

g = gram, % = percentage, no = number

Farm, BCKV, Nadia, West Bengal (for neutral soil) and Raghunathpur farm, BCKV, Nadia, West Bengal (for acid soil) in properly replicated designs. The ultimate sub-plot size was 2×2 m^2. To avoid cross contamination between the plots, design developed Rothamstead Experimental station was followed (5). Seeds inoculated with charcoal based inoculants of the respective *Rhizobial* strains were sown in lines at the rate of 40 kg/ha. Distance between lines was 30cm. The inoculants of respective strains were prepared in Yeast Extract Mannitol (YEM) broth to get a viable count of 10^9 cells per ml. The basal dose of NPK @ 30:60:40 were added.

RESULTS AND DISCUSSION

In a pot culture experiment with neutral soils when a single variety (Bragg) was inoculated with different strains of *B. japonicum,* variations among strains with respect to nodule number, nodule fresh weight (g/plant), plant fresh and dry weight (g/plant), nitrogen and phosphorus content of the plant were observed. It was also evident that S_1 and S_7 produced higher number of nodule than other strains. But significantly higher nodular fresh weight (g/plant) was recorded from the strains S_1, S_2 and S_7. Fresh weight and dry weight (g/plant) of plants were also significantly increased by S_1, S_2 and S_7 over the other strains. Significant inter-strain difference in respect of producing dry matter by the host plant could be discerned. Nitrogen content of the plant (%) was significantly higher in those plants inoculated by S_1, S_2 and S_7. All the strains significantly higher mean value in respect of % nitrogen uptake over the un-inoculated control (Table-1).

When the pot culture was conducted with acid soils, variations among strains with respect to nodule number, nodule fresh weight (g/plant), plant fresh and dry weight (g/plant), % nitrogen and % phosphorus

Table-3 : Relative efficiency of *B. japonicum* strains of soybean in fields with neutral soils

Strains	Nodule no./plant	Nodule fresh wt/plant (g)	Weight/ plant (g)	Root fresh wt/plant (g)	Plant length (cm)	Seed weight (q/ha)	Yield increased over control (%)	Pod no. /m^2	Total N (%)	Total P (%)	
			Fresh	dry							
Control	0	0	17.930	4.600	2.467	37.083	13.877	-	947	2.958	0.455
S_1	33	1.177	42.383	16.550	3.343	67.833	18.515	33.422	1449	4.930	0.494
S_2	16	0.760	38.000	10.717	2.740	63.083	17.429	25.593	1167	3.755	0.486
S_3	24	0.537	35.167	10.573	2.627	60.167	16.675	20.163	1213	3.953	0.491
S_6	21	0.447	28.383	10.600	2.440	61.333	16.157	16.430	1031	2.758	0.466
CD at 5% level	2.663	0.128	2.914	0.518	0.945	3.046	0.229	-	61.115	0.097	0.089

g = gram, % = percentage, no = number, wt = weight

Table-4 : Relative efficiency of *B. japonicum* strains of soybean in fields with acid soils

Strains	Nodule no./plant	Nodule fresh wt (g) /plant	Weight/ plant (g) (Fresh)	Seed weight (q/ha) (Dry)	Yield increased over control (%)	Pod no. /m^2	Total N (%)	Total P (%)	
Control	3	0.010	17.933	2.400	11.590	-	714.000	1.979	0.432
S1	25	2.84	29.633	9.398	13.927	20.164	992.667	3.758	0.455
S2	35	3.23	39.000	13.467	17.676	52.511	1316.333	4.725	0.496
S3	15	0.88	26.333	7.317	14.279	23.201	841.667	2.696	0.474
S6	12	2.28	29.600	9.302	13.850	19.500	1015.667	2.545	0.487
CD at 5%	3.113	0.216	2.801	0.819	1.311	-	75.230	0.058	0.034

wt = weight, g = gram, % = percentage, no = number content of the plant were observed to be statistically significant. It was further observed that the strains S_1, S_2 and S_4 produced significantly higher number of nodules than other strains. But higher number of nodules, nodule fresh weight (g/plant), fresh weight and dry weight (g/plant) of plant were significantly increased by the strains S_1 and S_2 over other strains. Nitrogen content (%) of the plant was significantly higher in those plants inoculated by the strains S_1 and S_2, but the strain S_2 showed higher value (Table 2).

The variabilities were once again confirmed when the above experiment was conducted in neutral soil in field condition. Significantly higher fresh and dry weight of plant (g/plant), root fresh weight (g)/plant, plant length (cm), %N and %P content were observed from S_1. The per plant grain yield as well as yield per hectare were significantly higher in S_1. All the inoculating strains of *Bradyrhizobium japonicum* showed significantly higher yield over the un-inoculated control. The strains S_1, S_2 and S_3 showed increased the yield 33.42%, 25.59% and 20.16% respectively over the un-inoculated control (Table-3).

Field trial conducted in acid soils showed nodulation in control plots. From the preliminary study it was noted that *Bradyrhizobium japonicum* was apparently absent in this soil. However, such nodules were very few in number. Differences in performance of strains were statistically significant and significantly higher numbers of nodules were also recorded from the strain S_2. Higher mean values of plant fresh weight (g/plant) and plant dry weight (g/plant) were also scored by S_1, S_2 and S_6. Seed weight (q/ha) was significantly higher with S_2. The average yield of the crop was poor in acid soils. It has been noticed from the Table-4 that S_2 gave the highest yield (52.51%) over the un-inoculated control and S_2 and S_1 gave the higher total N (%) uptake than others (Table-4). Yield improvement due to inoculation with *B. japonicum* was not an uncommon effect (6). According to (7) by simple Bradyrhizobium inoculation alone an increased yield up to 71% could achieved in certain soils. The strain S_2 showed acid tolerance (Table 4) which result in better multiplication in acidic region and persist in that soil. The strain seemed to have adapted to such acid condition and performed better than the un-adapted to such acid condition and performed better than the un-adapted one (8).

CONCLUSION

From the present study, it appeared that the average yield of soybean is poor in acidic soils but it could be best improved by judicial use of effective Rhizobial inoculation along with the basal doses of NPK. So, with such a little effort the production of soybean in the state particularly in neutral and lateritic acid soils could be substantially increased right at the moment and in years to come, would help to restrict the further widening of the protein gap and poor farmers would be benefitted from this crop.

REFERENCES

1. Norris, D.O. (1959a). Legume bacteriology in tropics. J. *Aust. Inst. Agric. Sci., 25 :* 202-7.
2. Sundara Rao, W. V. B. (1971). Field experiment on nitrogen fixation by nodulated legumes. *Plant and Soil, (Special Volume) :* 287-297.
3. Munns, D.N. (1965). Soil acidity and growth of legume. I. Interactions of lime with nitrogen and phosphate on growth of *Medicago sativa* L. and *Trifolum subterraneum* L. *Aust. J. Agric. Res., 16 :* 733-41.
4. Leonard, L.T. (1944). *Method of testing bacterial cultures and results of tests of commercial inoculants. U.S.D.A Circ.* No. 703, Washington, D.C.
5. Vincent, J.M. (1970). A Manual for the Practical Study of the Root Nodule Bacteria. In IBP Hand book No. 15: *Blackwell Scientific Publishing Company, Oxford, pp.* 164.
6. Sawashe, S.G. and Patil, P. L. (1990). Effects of Rhizobium in combination with different levels of nitrogen on grain yield of mung. *Proc. of the VIII th Southern Regional Conf. on Microbial Inoculants,* p.30.
7. Subba Rao. N. S. (1976). Field response of legumes in India to inoculation and fertilizer application. In Symbiotic Nitrogen Fixation in Plants, pp 255-268 ed. *P.S. Nutman, International Biological Programme, Vol. 7 : Cambridge Univ. Press,* London.
8. Poi, S. C. (1986a). Competitiveness amongst Ecotypes of Rhizobium, specific to *Cicer arietenum* L. in West Bengal soils. *Zbl. Microbiol., 141 :* 11-16.