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Effect of dual inoculation with *Rhizobium* and PSB on nodulation and yield of mungbean in field

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Effect of inoculation with *Rhizobium* sp and phosphate solubilizing bacteria (PSB) on mungbean [*Vigna radiata* (L.) Wilczch] variety SML-264 in regards to nodulation and grain yield were studied. Field trials were conducted taking eight treatments which were replicated four times in a randomized block design with 6 sq. m net plot size. Results from the field trial revealed that seed treatment with dual bacterial cultures recorded increased rate of nodulation , N-content and grain yield. Per cent increase of grain yield over control was reorded to be higher significantly in the plant when *Rhizobium* strain M-10 and AKR-1 were treated at seed in combination with PSB containing *Bacillus polymyxa*.

Key words : *Rhizobium* sp.,*Bacillus polmyxa* , Dual inoculation, mungbean

INTRODUCTION

Research in the last few decades has established that phosphatic biofertilizers solubilize fixed forms of phosphorus already present in the soil and make it available for use of plants. Moreover, on the basis of available literature,(Singh and Pareek, 2003), on the existence of associative effects between different P-solubilizers and N_2 fixers under natural condition, it might be rightly suggested that dual effect of P-solubilizers microorganisms and specific N_2 fixing rhizobia can be exploited for better nitrogen and phosphorus nutrition of the order to study the response of mungbean inoculated with strains of *Rhizobium* and PSB in different combination with reference to nitrogen and phosphorus nutrition of the plant.

MATERIALS AND METHODS

Field trials were conducted with mungbean (*Vigna radiata*) variety SML-264,with eight different treatments in a randomized block design with 6 sq. m net plot size in Bidhan Chandra Krishi farm in two consecutive *rabi* seasons.Seeds were inoculated with charcoal based inoculum of the respective symbiont cultures, namely M-10 and AKR-1 strains of cowpea group *Rhizo*bium at a strength of 31.33 x 10^6 cells/ml and 33.66 x 10^6 cells/ml. Phosphate solubilizers containing *Bacillus polymyxa* at a strength of 7 x 10^8 cells/ml at the time of sowing. *Rhizobium* cells were grown in Yeast Mannitol Agar (YMA) medium (Vincent,1970). Phosphate solubilizing bacteria were grown on Pikovskaya broth (Pikovskaya,1948). Total N-content of the dried plant sample was estimated following the methods as described by Jackson (1962).

Observations were made on 45 days after sowing in terms of nodulation and N-fixation on sample plants @ 5% of the plants population for estimation of nodulation yield of mungbean were estimated by harvesting and weighing of grains obtained per plot and represented as q/ha.

RESULTS AND DISCUSSION

Effect on nodulation

The plants inoculated with the combined strains of *Rhizobium* namely M-10 and AKR-1 along with phosphobactaria, *B. polymyxa* showed increased nodulation. The number of nodules were estimated as 38.25 and 39.20 in the 1st and 2nd year respectively. In regards to per cent increase over control it was estimated as 117.71% and 88.23% in the respective two years, followed by the plants treated with combined strains of cowpea group *Rhizobium* which was estimated as 100.40% increase in the 1st year and 74.66% in the 2nd year respectively over control. (Table 1).

Table 1: Response of mungbean by inoculation with *Rhizobium* and PSB on nodulation in field at 45 DAS

Treatment	Noudle number/ plant (Mean)		Pre cent increase or decrease over control		Fresh nodules (g)/plant	
	X	Y	X	Y	X	Y
Uninoculated Control	16.75	19.00			0.06	0.04
R_1+Seed	30.50	34.80	72.23	72.71	0.07	0.07
R_2+Seed	30.75	32.50	73.23	64.14	0.10	0.12
PSB+Seed	22.00	28.26	25.35	41.02	0.06	0.04
R_1+PBS+Seed	32.20	29.00	84.50	41.66	0.12	0.13
R_2+PBS+Seed	36.00	37.00	110.14	85.14	0.15	0.18
R_1+R_2+Seed	34.75	35.00	100.40	74.66	0.15	0.17
R1+R2+PBS+Seed	38.25	39.20	117.50	88.23	0.17	0.22
CD at 5%	9.15	12.81			0.029	0.049
CD at 1%	12.20	17.18			0.038	0.065
S.Em±	12.95	18.80			0.042	0.071

R_1 = M-10 Strain of Cowpea *Rhizobium*, R_2 = AKR-1 Strain of Cowpea *Rhizobium*, PSB = Phosphate solubilizing bacteria (B. polymyxa), X = First year; Y = 2nd Year, DAS = Days after Sowing.

Table 2 : Response of mungbean by inoculation with *Rhizobium* and PSB on N- content and yield in field condition.

Treatment	Mean yield q/ha		Per cent increase or decrease		N-content (%) of the plant	
	X	Y	X	Y	X	Y
Uninoculated Control	8.54	9.00	-	-	0.012	0.016
R_1+Seed	13.56	12.00	60.12	28.89	0.21	0.19
R_2+Seed	13.08	14.33	52.16	56.47	0.26	0.28
PSB+Seed	13.01	11.06	52.14	20.79	0.14	0.12
R_1+PBS+Seed	10.51	14.50	25.12	62.21	0.24	0.24
R_2+PBS+Seed	17.71	17.92	107.38	96.92	0.31	0.33
R_1+R_2+Seed	15.28	15.00	76.35	66.95	0.24	0.26
R1+R2+PSB+Seed	19.95	21.00	124.00	139.12	0.58	0.47
CD at 5%	2.39	2.83			0.115	0.998
CD at 1%	3.14	3.72			0.150	0.130
S.Em±	3.43	4.04			0.164	0.142

R_1 = M-10 Strain of Cowpea *Rhizobium*, R_2 = AKR-1 Strain of Cowpea *Rhizobium*, PSB = Phosphate solubilizing bacteria (B. polymyxa), X = First year; Y = 2nd Year, DAS = Days after Sowing.

As regards nodule fresh weight,the significant increase was recorded where the plants have been inoculated with the combined strains of *Rhizobium* and phosphate solubilizing bacteria at seed. In this situation the nodule fresh weights were estimated as 0.17 g and 0.22 g in two consecutive years.

Effects on N-content of plants

As expected the N-content of the mungbean plants increase in all the treatments where the plants have been inoculated with N-fixing microorganism (Table 2). Dual inoculation with *Rhizobium* and PSB showed increased N-content compared to control, estimated as 0.58% increase in the 1st year and 47% in the 2nd year respectively.

Effect on grain yield

Yield content in mungbean was found to be augmented in the presence of phosphobacterium (Table 2). The rate of increase in yield over control was recorded to be significantly higher in the plants where they were subjected to combine inoculation with strains of *Rhizobium* and PSB at seed (R_1 +R_2+PSB+Seed), which was estimated as 124.00% in the 1st year and 139.12% in the 2nd year respectively followed by the plants treated with strains of *Rhizobium* (M-10+AKR-1) at seed, where the rate of increase was 76.35% in the 1st year and 66.95% in the 2nd year respectively over control plants.

It was interesting to note that the *Rhizobium* application was best in combination with seed rather than with seedlings (Patra and Bhattacharyya, 1998). Bhargara *et al.,* (1974) reported that there was better nodulation and higher leg hemoglobin content in the nodule in case of plants with *Rhozobium* inoculated at seed.

It is well known that a leguminous rhizosphere encourages proliferation of the growth of its own rhizoboia. But in the present investigation the mungbean rhizosphere appeared to be congenial for the growth at PSB as well. The most interesting feature, which has emerged out of the prasent investigation is that a synergistic effect may be achieved increase of the double inoculation. Effectiveness of legume *Rhizobium* symbiosis are reported to be improved in presence of a free living nitrogen fixing or a P-solubilizing microorganisms (Chatterjee and Bhattacharjee, 2002). Dual inoculation with *Rhizobium* + PSB might have been well exploited in improving the symbiotic efficiency of mungbean, and providing significant growth and yield increase (Singh and Pareek, 2003).Which has been confirmed in the present investigation. Dual inoculation with *Rhizobium* + VAM also leads to better nodulation and nitrogen activity (Zaghloul *et al.*, 2002). Only *Rhizobium* inoculation on seed showed increased nodulation,nitrogen activity and N-content (Salaiman *et al.*,2003), which was also confirmed in the present findings.

In the sub continent, the average yield of the pulses are far below the world average. It is in this contest, quite appropriate to think of sooting up of the pulse yields by effective use of the low cost biofertilizers, in combined form, at the same time utilizing available large deposits of rock phosphate. This would not only help to improve soil fertility in a better way but would also help to fill up the protein gap, now being seriously experienced by the third world.

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