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Yield and yield attributing parameters of organically cultivated mungbean as influenced by PGPR and organic manures

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Indiscriminate use of synthetic chemicals and the problems arising from them forced all concerned to think about the alternative means. Organic manures such as farmyard manure, compost, vermicompost, biofertilisers etc. can be used at least as supplement, if not as substitute. Among the components of organic farming cited above, biofertilizers (*Rhizobium* for legumes, *Azotobacter* for non legume crops, *Azolla* for low land paddy) are very important as they are ready to use live formulates of beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity in particular and help build up the micro flora and in turn the soil health in general. Root colonizing bacteria (rhizobacteria), which exert beneficial effects on plant development, have been defined as "Plant Growth Plant Rhizobacteria" (PGPR). Mungbean, being a leguminous crop fixes 31-85 kg N ha^{-1}. *Rhizobium* which supplies about 20-40 kg N ha^{-1}, can be considered as a complementary or supplementary source of plant nutrient. Roy and Hore (2012) demonstrated highes soil fertility build up with organic manure microbial inoculants combination compared to inorganic nutrient. Inoculation of *Rhizobium* to mungbean enhances nodulation, nitrogen fixation and grain yield. Yield increase from 10 to 37 per cent following inoculation has been reported in mungbean (Mortan *et al.,* 1982).

The field experiment was conducted at research farm of the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during *kharif* season of 2009. The organic manures like Farm yard manure (FYM), Cereal compost and Legume compost were applied @ 5 t ha^{-1} each. 10 treatments were made by combining the above manures alongwith PGPR [PGPR: *Rhizobium* + *Azotobacter* + *Pseudomonas* + *Trichoderma*]. Before sowing the seeds in the field, these were treated with PGPR for overnight on a day before sowing. *Rhizobium, Azotobacter, Pseudomonas* and *Trichoderma* were prepared by Yeast Extract Mannitol Agar medium method, Ashby's Mannitol Agar medium method, Pikovskaya's medium method and potato dextrose agar method respectively. Plant samples were taken from each experimental plot just after flowering stage and grain samples were collected after harvesting the crop. Morphological features such as no. of nodules root and shoot length, no. of pods were studied in the laboratory.

Number of nodules per plant varied from 23 to 41. It was higher in FYM treated plots (34) in comparison to the other treatments without PGPR. The application of PGPR produced higher no. of nodules in comparison to the treatments without PGPR. Highest no. of nodules per plant (41) was found in FYM+ PGPR treated plot. It was followed by the combined application of all the three organic manures. It might be due to higher microbial activity in the soil by the combined application. Hamaoui *et al*. (2001) also reported that inoculation with PGPR significantly enhanced nodulation by native *Rhizobia* in chickpea and faba bean. According to Grimes and Mount (1984) and Petersen *et al.* (1996), some PGPR strains from a range of genera, enhance legume growth, nodulation and nitrogen fixation when coinoculated with rhizobia. Similar results were also obtained by Nishijima *et al.* (1988) who reported that inoculation of legumes with root colonizing bacteria (PGPR) and *Rhizobium* affect symbiotic nitrogen fixation by enhancing root nodule number or mass.

Root and shoot length of the plants varied from 19 to 24.7 cm and 33.9 to 40 cm, respectively. Root and shoot lengths were more in FYM treated plots (21.7 cm and 40 cm, respectively). Application of organic manures enhanced root growth of mungbean, resulting in greater branching which is responsible for most nutrient and water uptake as reported by Sangakkara (1999). PGPR applications along with organic

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manures showed higher root and shoot lengths as compared to the sole application of organic manures. The highest root and shoot lengths (24.7 cm and 44.8 cm respectively) were seen in FYM+ PGPR treated plot. The root and shoot lengths of plants were more in case of combined application of all the three manures along with PGPR. Legume compost treated plots showed higher root and shoot length. Parmar and Dadarwal (1999); Hamaoui *et al*. (2001); Sindhu *et al.* (2002); Zaidi *et al*. (2003); Gull *et al*. (2004) also showed coinoculation with PGPR and *Rhizobium* spp. increased root and shoot biomass in chickpea.

This number varied from 24 to 34 in all the treatments. No. of pods per plant were higher in FYM treated plots. The application of PGPR along with organic manures proved to be more beneficial as compared to organic manures alone. Highest no. of pods (34) was found in FYM+PGPR treated plots. It was followed by the combined application of all the three organic manures with PGPR. Legume compost with PGPR showed higher no. of pods than cereal compost+ PGPR combination. Waseem *et al.* (2004) also found that *R. japonicum* showed better results than the uninoculated control increasing the number of pods per plant in mungbean. Also Ashraf *et al.* (2003); Bhuiyan (2004) showed that *Rhizobium* inoculation in mungbean increases number of pods.

Higher pod yield (15 q/ha) was found in FYM treated plot followed by the combination of all the three manures. Ramesh *et al.* (2006) reported that application of cattle dung manure (4 t ha^{-1}) recorded the highest seed yield on pigeon pea. PGPR application along with manures were found to be more beneficial than the sole application of manures. Highest pods were obtained from the FYM+ PGPR treated plots followed by the combination of all the manures. Comparatively higher pod yield was recorded from legume compost+ PGPR treated plot in comparison to the cereal compost+ PGPR. Similar results were found by Khurana and Dudeja (1997) who showed that in chickpea, the increase in grain yield due to inoculation of *Rhizobium* over noninoculated control varied from 6.5 to 30.9 per cent during 1991 to 92, 1.2 per cent to 40.9 per cent during 1992 to 93 and 0 to 37 per cent during 1993 to 94. Ashraf *et al.* (2003) showed that seed inoculation with *Bradyrhizobium* strain significantly increased mungbean seed yield.

Fresh and dry weight of plants varied from 93.7 to 117.5 g and 19.8 to 25.7 g respectively in all the treatments. Higher fresh weight (109.3 g) was observed in FYM treated plot without PGPR. Beneficial effect was more when manures were applied along with PGPR. Highest fresh weight was obtained in the plot with the application of FYM+ PGPR. PGPR along with all the manures showed higher fresh weight in comparison to other treatments. Combined application of cereal compost, legume compost and PGPR showed higher fresh weight as compared to their individual application. However, legume compost+ PGPR produced plants with higher fresh weight

Table 1: Yield and yield attributing parameters of mungbean as influenced by organic manures and PGPR

Treatments	No. of nodules $plant^{-1}$	Length (cm)		No. of pods $plant^{-1}$	Pod yield (q ha^{-1})	Weight (g)	
		Root	Shoot			Fresh	Dry
T_1: FYM	34	21.7	40	28	15.0	109.33	24.46
T_2:T_1+PGPR	41	24.7	44.8	34	16.3	117.57	25.77
T_3: Cereal compost	25	19.2	33.9	24	11.0	100.01	21.12
T_4: T_3+PGPR	28	21.2	35.6	26	12.0	101.86	22.23
T_5: Legume compost	27	19.6	34.2	25	12.6	102.77	22.14
T_6: T_5+PGPR	29	21.2	34.9	27	13.1	103.08	22.95
T_7:Cereal compost + legume compost	29	20.4	35.2	25	12.9	104.09	23.04
T_8:T_7+PGPR	31	21.5	36.1	27	13.3	105.89	23.98
T_9:FYM+cereal compost + legume compost	33	20.8	36.2	27	13.2	106.74	23.96
T_{10}: T_9+PGPR	35	21.3	37.8	30	14.0	108.05	24.69
T_{11}:Control	23	19.0	33.9	24	10.8	93.73	19.87
LSD (0.05)	**1.36**	**0.9**	**0.14**	**1.34**	**1.15**	**0.50**	**1.42**

compared with cereal compost+ PGPR. Similar results were also reported by Prasad *et al*. (2002).

Among all the manures tested for cultivation of mungbean, FYM was found to be superior. Combined application of all the manures was also effective. The combined application of both of the manures, namely cereal and legume compost was effective over sole application. Application of PGPR was beneficial. The most effective treatment was found to be FYM+ PGPR among all the manures.

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