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Response of pigeonpea to organic and inorganic fertilization

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ABSTRACT : A field experiment was conducted on PKV-TARA pigeonpea during the *Kharif* season of 2009 at Pulse Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of integrated nutrient management on yield, quality, available nutrient status and its uptake of pigeonpea. Grain yield and harvest index were significantly increased due to increased level of fertilizer. Incorporation of 5 t. FYM ha^{-1} enhanced the nutrient status of soil. Seed inoculation of *Rhizobium* + PSB + PGPR significantly improved the quality of seed, available nutrient status and nutrient uptake of pigeonpea.

Key Words : FYM, *Rhizobium*, PSB, PGPR, Nitrogen, Phosphorus, Potassium, Sulphur

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The sole dependence on chemical input based agriculture is not suitable in long run, so the combination of fertilizers, organic manures and bio fertilizers are essential to sustain crop production, to preserve soil health and soil biodiversity.

FYM improves organic carbon status of soil as well as increases the content of available N, P, K and secondary nutrients (Badnur *et al.*, 1990). *Rhizobium* is most widely used biofertilizer which colonizes the roots of specific legumes to form root nodules. *Rhizobium* fixes the atmospheric nitrogen symbiotically and made available to plant. Inoculation of *Rhizobium* and application of fertilizers improved the yield attributes, grain and straw yield in pigeonpea (Sharma *et al.*, 2009). Phosphorus solubilizing bacteria posses the ability to bring insoluble phosphate into soluble form by secreting organic acids. Plant growth promoting rhizobacteria (PGPR) helps in increasing nitrogen fixation in legumes, promotes free living nitrogen fixing bacteria, increase supply of other nutrients as phosphorus, sulphur, iron and copper and solubilization of mineral phosphates. Inoculation of Plant growth promoting rhizobacteria (PGPR) increases the dry matter production and yield in pigeonpea (Devanand *et al.*, 2002).

Research Procedure

A field experiment was conducted on PKV-TARA pigeonpea at Pulse Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Kharif* season of 2009. The total rainfall received during the crop season was 513.9 mm as against normal of 619.7 mm. Experimental soil was mediun deep black. The initial soil was low in available nitrogen (259.24 kg ha^{-1}), medium in available phosphorus (19.49 kg ha^{-1}), high in potash (407.68 kg ha^{-1}), and low in available sulphur (9.30 ppm). The soil was medium in organic carbon (0.42 %) and slightly alkaline in nature with pH 8.2.

An experiment was laid out in factorial Randomized Block Design with three replications. Treatments consisted of two levels of fertilizer 25 : 50 : 20 : 20 kg NPKS ha^{-1} and 12.5:25:10:10 kg NPKS ha^{-1}, two levels of FYM, *i.e.* no FYM and 5 t. FYM ha^{-1} and four levels of biofertilizer were no seed inoculation, *Rhizobium* inoculation, PSB inoculation and *Rhizobium* + PSB + PGPR inoculation. Sowing of pigeonpea was taken up on 31 June, 2009 (25th MW). The sowing was undertaken by drilling method keeping 60 cm distances between two rows, while plant to plant distance maintained was 20 cm. Recommended package of practices were followed. Seeds were inoculated with *Rhizobium*, PSB and PGPR @ 25 g kg^{-1} of seeds. Observations on yield attributes were recorded at harvest of crop.

The data recorded pertaining to grain yield, nutrient uptake and quality parameters were analysed statistically for interpreting the results. In order to know the nutrient status of the experimental site, the soil samples to the depth of 0-30 cm were randomly collected from the experimental site before sowing and after harvesting of crop. For nutrient uptake, the plant samples were collected at the time of harvesting. The analysis of soil and plant samples was carried out as per the standard methods.

Research Analysis and Reasoning

The findings of the present study as well as relevant discussion have been presented under the following heads :

Yield attributes :

The data pertaining to yield attributes revealed that, the fertilizer treatment 25 : 50 : 20 : 20 kg NPKS ha^{-1} significantly increased the grain yield (25.70 q ha^{-1}) and harvest index (32.23 %) (Table 1). This might be because of nitrogen is being an essential constituent of chlorophyll, protoplasm and enzymes and as it governs utilization of P and K, its ample availability might have resulted in significant increase in grain yield. Phosphorus also enhanced root growth which helps to absorb more plant nutrients from deeper layers of soil resulting in increase in yield components and grain yield. Results of present studies are similar to those reported by Sharma *et al.* (2009). However, the difference in stalk yield was not found significant.

FYM application @ 5 t. ha^{-1} recorded higher grain yield and stalk yield over no application of FYM. Harvest index was not significantly influenced by FYM treatment. Seed inoculation of *Rhizobium* + PSB + PGPR application resulted significantly higher grain yield and stalk yield over other biofertilizer treatments. Inoculation of *Rhizobium* treatment was found to be at par with PSB inoculated and significantly superior over uninoculated with respect of grain yield and stalk yield. Similar results were also obtained by Jadhav and Andhale (2009) and Kachhave *et al.* (2009).

Quality :

The data shown in the Table 1 revealed that, application of full dose of fertilizer 25:50:20:20 kg NPKS ha^{-1} recorded significantly highest protein yield (545.57 kg ha^{-1}). Application of 5 t. FYM ha^{-1} recorded higher protein content and yield over no FYM. Seed inoculation of *Rhizobium* +

Table 1 : Yield attributes and quality of pigeonpea as influenced by various treatments

Treatments	Grain yield (q ha^{-1})	Stalk yield (q ha^{-1})	Harvest index (per cent)	Protein content (per cent)	Protein yield (kg ha^{-1})
Fertilizer					
25:50:20:20 $N:P_2O_5:K_2O:S$ $kgha^{-1}$	25.70	54.04	32.23	21.20	545.57
12.5:25:10:10 $N:P_2O_5:K_2O:S$ $kgha^{-1}$	22.79	52.70	30.20	20.45	466.90
S.E. ±	0.37	0.57	0.45	0.13	8.71
C.D. (P=0.05)	1.07	NS	1.31	0.38	25.15
FYM					
0 t ha^{-1}	23.68	52.27	31.18	20.62	489.32
5 t ha^{-1}	24.81	54.47	31.26	21.04	523.15
S.E. ±	0.37	0.57	0.45	0.13	8.71
C.D. (P=0.05)	1.07	1.65	NS	0.38	25.15
Seed inoculation of biofertilizer					
No seed inoculation	22.59	50.42	30.95	20.34	460.93
Rhizobium inoculation	24.64	53.94	31.31	20.98	525.46
PSB inoculation	24.11	52.25	31.56	20.45	493.91
Rhizobium + PSB + PGPR	25.64	56.90	31.03	21.22	544.65
S.E. ±	0.52	0.81	0.64	0.19	12.32
C.D. (P=0.05)	1.51	2.33	NS	0.54	35.57

NS=Non-significant

Table 2 : Available N, P, K and S in soil as influenced by various treatments

Treatments	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (ppm)
Fertilizer				
25:50:20:20 N:P_2O_5:K_2O:S kg ha^{-1}	284.85	22.70	439.04	11.24
12.5:25:10:10 N:P_2O_5:K_2O:S kg ha^{-1}	269.17	21.41	424.48	10.08
S.E. ±	1.44	0.24	1.55	0.15
C.D. (P=0.05)	4.15	0.69	4.47	0.42
FYM				
0 t ha^{-1}	272.83	21.67	428.96	10.27
5 t ha^{-1}	281.19	22.44	434.56	11.04
S.E. ±	1.44	0.24	1.55	0.15
C.D. (P=0.05)	4.15	0.69	4.47	0.42
Seed inoculation of biofertilizer				
No seed inoculation	269.70	20.77	420.00	9.98
Rhizobium inoculation	281.19	21.41	425.60	10.66
PSB inoculation	271.79	22.82	437.92	10.85
Rhizobium + PSB + PGPR	285.38	23.21	443.52	11.14
S.E. ±	2.03	0.34	2.19	0.21
C.D. (P=0.05)	5.87	0.97	6.32	0.60

Table 3 : N, P, K and S uptake of pigeonpea as influenced by various treatments

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	Grain	Stalk	Total	Grain	Stalk	Total	Grain	Stalk	Total	Grain	Stalk	Total
Fertilizer												
25:50:20:20 N:P_2O_5:K_2O:S kg ha^{-1}	87.30	68.46	155.76	8.84	6.34	15.18	24.31	48.18	72.49	6.96	13.17	20.13
12.5:25:10:10 N:P_2O_5:K_2O:S kg ha^{-1}	74.70	62.66	137.36	7.49	5.83	13.32	20.71	44.56	65.26	6.00	12.44	18.44
S.E. ±	1.46	1.28	2.13	0.12	0.08	0.13	0.37	0.71	0.72	0.11	0.14	0.16
C.D. (P=0.05)	4.20	3.69	6.14	0.36	0.23	0.38	1.07	2.04	2.09	0.31	0.39	0.46
FYM												
0 t ha^{-1}	78.62	62.59	141.20	7.92	5.91	13.83	21.60	44.30	65.90	6.25	12.36	18.61
5 t ha^{-1}	83.39	68.53	151.92	8.42	6.26	14.67	23.42	48.43	71.85	6.71	13.25	19.96
S.E. ±	1.46	1.28	2.13	0.12	0.08	0.13	0.37	0.71	0.72	0.11	0.14	0.16
C.D. (P=0.05)	4.20	3.69	6.14	0.36	0.23	0.38	1.07	2.04	2.09	0.31	0.39	0.46
Seed inoculation of biofertilizer												
No seed inoculation	73.75	58.88	132.63	7.29	5.45	12.74	20.13	40.88	61.01	5.81	11.54	17.34
Rhizobium inoculation	84.10	67.64	151.74	8.15	6.02	14.17	22.50	45.32	67.81	6.53	12.85	19.37
PSB inoculation	79.03	62.63	141.66	8.24	6.10	14.34	22.64	46.61	69.25	6.52	12.70	19.22
Rhizobium + PSB + PGPR	87.14	73.09	160.23	8.99	6.78	15.76	24.76	52.66	77.42	7.07	14.13	21.20
S.E. ±	2.06	1.81	3.01	0.18	0.11	0.19	0.52	1.00	1.03	0.15	0.19	0.22
C.D. (P=0.05)	5.94	5.22	8.69	0.51	0.32	0.54	1.51	2.88	2.96	0.44	0.56	0.64

PSB + PGPR recorded significantly highest protein content (21.22 %) over rest of the treatments. Inoculation of *Rhizobium* treatment was found to be at par with PSB inoculated and significantly superior over uninoculated with respect of protein content and protein yield. The improvement in quality of pigeonpea seed could be attributed to greater availability of N and P, regular supply of nutrients and, thus, improved translocation of nutrients from source to sink increased protein yield. Similar findings were also reported by Shukla and Dixit (1996) and Singh and Pareek (2003).

Available N, P, K and S :

The data pertaining to nutrient status of soil revealed that, application of 25 : 50 : 20 : 20 kg NPKS ha^{-1} recorded higher available N, P, K and S than fertilizer dose of 12.5 : 25 : 10 : 10 kg NPKS ha^{-1} (Table 2). Application of 5 t. FYM ha^{-1} recorded significantly higher available N, P, K and S over no FYM. Seed inoculation of *Rhizobium* + PSB + PGPR application significantly increased available N, P and K status in soil over rest of the treatments. The respected treatment increased 26.14 kg N ha^{-1}, 3.72 kg P ha^{-1} and 35.84 kg K ha^{-1} over initial (Sharma and Namdeo, 1999). This might be due to synergetic interaction among the phosphate solubilizing microorganism and *Rhizobium* which led to increase in the availability of nutrients. Application of 25 : 50 : 20 : 20 kg NPKS ha^{-1} significantly increased the available S (11.24 ppm) in soil.

N, P, K and S uptake :

The data shown in the Table 3 revealed that, application of 25 : 50 : 20 : 20 kg NPKS ha^{-1} recorded higher N, P, K and S uptake than half dose. Incorporation of FYM @ 5t ha^{-1} significantly increased nutrient uptake over no FYM. Highest total uptake of N (160.23 kg ha^{-1}), P (15.76 kg ha^{-1}), K (77.42 kg ha^{-1}) and S (21.20 kg ha^{-1}) in pigeonpea was recorded with application of *Rhizobium* + PSB + PGPR. It might be due to nitrogenase activity and greater availability of nutrients under combined inoculation of *Rhizobium*, PSB and PGPR which ultimately increased the nutrient uptake in grain and straw. Similar findings were also reported by Mathan *et al.* (1994) and Modak *et al.* (1994).

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