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Growth and yield of pigeonpea as affected by organic and inorganic fertilization

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ABSTRACT : A field experiment was conducted on PKV-TARA pigeonpea during the *Kharif* season of 2009-10 at Pulse Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of integrated nutrient management in pigeonpea with an object to optimize the fertilizer dose for getting maximum yield per hectare and the effect of FYM and biofertilizer on growth and yield of pigeonpea. Growth and yield attributes were significantly increased due to the increased level of fertilizer. Incorporation of FYM @ 5 t. ha^{-1} significantly increased the yield parameters like shelling per cent, 100 seed weight and grain yield. Number of pods plant^{-1}, number of grains pod^{-1}, weight of grains plant^{-1} and stalk yield were more in seed inoculation of *Rhizobium* + PSB + PGPR.

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 biofertilizers are essential to sustain crop production, preserve soil health and soil biodiversity. The economic burden and environmental cost of applying such huge quantity of additional fertilizer is enormous. The expense can be minimized by use of organic manures *viz.*, farm yard manure and bio fertilizers.

Farm yard manure is mostly used as organic source. It serves as a potential source of plant nutrients and has important role in improving soil fertility and productivity. Biofertilizers do not directly supply nutrient to the crop plant, but have capacity to fix atmospheric nitrogen and convert insoluble phosphate into soluble form. Biofertilizer mainly *Rhizobium*, PSB and PGPR which are commonly used have an enormous potential to increase the nutrient use efficiency. Inoculation of *Rhizobium* and application of fertilizers improved the yield attributes, grain and straw yield in pigeonpea (Sharma *et al*., 2009). Subba Rao (1988) observed that seed inoculation with *Rhizobium* enhanced the productivity of pigeonpea by 16 to 32 per cent under varying agro ecological conditions. 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 2009-10. The total rainfall received during the crop season was 513.9 mm as against normal of 619.7 mm. Experimental soil was medium 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 such as no seed inoculation, *Rhizobium* inoculation, PSB inoculation and *Rhizobium* + PSB + PGPR inoculation.

Sowing of pigeonpea was taken up on 31st 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 growth and yield attributes were recorded and by considering standard prices net monetary returns and B:C ratio were calculated.

Research Analysis and Reasoning

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

Growth attributes :

The data pertaining to growth parameters revealed that, application of 25:50:20:20 kg NPKS ha^{-1} increased the plant height, number of branches $plant^{-1}$, dry matter accumulation and number of nodules $plant^{-1}$ over half dose of fertilizer (Table 1). Increase in plant height might be due to the nitrogen application, since nitrogen as a major component of protoplasm helps in photosynthesis and enhances the metabolic rate, cell division and cell elongation which allow the plant to grow faster. Phosphorus enhances the root elongation, leaf expansion and helps in cell elongation. NPK not only enhances the physiological process but also involved in boosting of number of branches through participating in cell enlargement during development of auxiliary buds of plant. Nitrogen impart dark green colour (Chlorophyll) in leaf, due to that leaf synthesize more photosynthesis in plant. Phosphorus and potash also involve in production of carbohydrate and translocation of starch, sugar and protein to different parts of the plant to produce maximum dry matter. Results of Sharma *et al.* (2009) and Dubey and Namdeo (1994) are in accordance with above results.

Application of 5 t FYM ha^{-1} recorded significantly higher plant height, number of branches $plant^{-1}$, total dry matter accumulation and number of nodules $plant^{-1}$ over no FYM. Increase in the height of plant may be due to increase in rhizosphere temperature with the application of FYM and there by hastened the emergence of seedlings 2 to 3 days earlier to achieve crop growth. Similar results were also reported by Sarkar and Chakraborty (1997) and Sharma *et al.* (2009). Increase in number of branches attributed to better supply of nutrients resulted in enhanced crop growth by cell enlargement in meristematic region and thereby more plant height ultimately increased the nodes and internodes and more number of branches $plant^{-1}$ (Sharma *et al*., 2009). Application of FYM influence the vigor of the plant which was probably accelerated the nitrogen fixing power of the plant by increasing the activity of nodule bacteria and resulting in more dry matter accumulation.

Inoculation of *Rhizobium* + PSB + PGPR recorded significantly highest plant height (176.54 cm), number of branches $plant^{-1}$ (24.67), total dry matter accumulation (104.54 g) and number of nodules $plant^{-1}$ (32.50) over rest of the treatments. Seed inoculation of *Rhizobium* was found to be at par with PSB inoculated and significantly higher over uninoculated. This might be due to nitrogen provided through symbiotic fixation of atmospheric nitrogen and growth

Table 1 : Growth parameters of pigeonpea as influenced by various treatments

Treatments	Plant height (cm) at harvest	No. of branches $plant^{-1}$ at harvest	No. of root nodules $plant^{-1}$ at 120 DAS	Total dry matter (g) $plant^{-1}$ at harvest
Fertilizer				
25:50:20:20 $N:P_2O_5:K_2O:S$ kg ha^{-1}	174.09	24.17	31.00	102.65
12.5:25:10:10 $N:P_2O_5:K_2O:S$ kg ha^{-1}	171.28	22.18	29.65	100.70
S.E. ±	0.63	0.31	0.21	0.42
C.D. (P=0.05)	1.83	0.89	0.59	1.20
FYM				
0 t ha^{-1}	171.67	22.73	29.77	101.00
5 t ha^{-1}	173.70	23.62	30.88	102.35
S.E. ±	0.63	0.31	0.21	0.42
C.D. (P=0.05)	1.83	0.89	0.59	1.20
Seed inoculation of biofertilizer				
No seed inoculation	168.76	22.18	28.50	98.84
Rhizobium inoculation	173.39	23.33	30.46	102.36
PSB inoculation	172.05	22.50	29.83	100.95
Rhizobium + PSB + PGPR	176.54	24.67	32.50	104.54
S.E. ±	0.90	0.43	0.29	0.59
C.D. (P=0.05)	2.59	1.25	0.84	1.70

regulators produced by *Rhizobium* and also due to solubilization of insoluble phosphates by production of various organic acids such as lactic acid and acetic acid (Tomar *et al*., 1995). These results are in agreement with the results obtained by Shankarnarayana *et al*. (2002) and Khatkar *et al*. (2007).

Yield attributes :

The data shown in the Table 2 revealed that the fertilizer treatment 25:50:20:20 kg NPKS ha^{-1} recorded significantly highest shelling per cent (65.54 %), 100 seed weight (10.58 g) and grain yield (25.70 q ha^{-1}) as compared to other treatments. Application of fertilizer 25:50:20:20 kg NPKS ha^{-1} significantly increased the number of pods plant^{-1}, number of grains pod^{-1}, weight of grains plant^{-1}, shelling per cent, 100 seed weight and grain yield over the fertilizer treatment 12.5:25:10:10 kg $N:P_2O_5:K_2O:S$ ha^{-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 enhance root growth which helps to absorb more plant nutrients from deeper layers of soil resulting in increase in yield components and grain yield (Sharma *et al*., 2009).

FYM application @ 5 t. ha^{-1} increased the number of pods plant^{-1}, weight of grains plant^{-1}, grain yield and stalk yield over no application of FYM (Pujari *et al*., 1998). Number of grains pod^{-1}, shelling per cent and 100 seed weight were not significantly influenced by FYM treatments. This might be due to good growth of plant because of availability of nutrients leading to more accumulation of carbohydrates and proteins and their translocation to respiratory organs. These results are supported by the findings of Sharma *et al*. (2009) and Shinde *et al*. (2009).

Seed inoculation of *Rhizobium* + PSB + PGPR application resulted significantly highest number of pods plant^{-1} (126.46), number of grains pod^{-1} (3.53), weight of grains plant^{-1} (29.73 g) and stalk yield (56.90 q ha^{-1}) 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 number of grains pod^{-1}, grain yield and stalk yield. *Rhizobium* inoculation fixes nitrogen through nodules of the plant, whereas PSB solubilizes native P rendering more phosphorus to soil solution. Thus, combined inoculation of *Rhizobium*, PSB and PGPR improved the nutrient status of soil and ultimately increased the nutrient uptake which enhanced the yield of stalk. Similar results were also obtained by Jadhav and Andhale (2009) and Kachhave *et al*. (2009). However, the difference in shelling per cent and 100 seed weight between different biofertilizer inoculations were not found significant. Similar work related to the topic was aslo done by Singh *et al.* (1998).

Table 2 : Yield attributes of pigeonpea as influenced by various treatments

Treatments	No. of pods plant^{-1}	No. of grains pod^{-1}	Weight of grains (g) plant^{-1}	Shelling per cent	100 seed weight (g)	Grain yield (qt ha^{-1})	Stalk yield (qt ha^{-1})
Fertilizer							
25:50:20:20 $N:P_2O_5:K_2O:S$ kg ha^{-1}	122.59	3.47	28.94	65.54	10.58	25.70	54.04
12.5:25:10:10 $N:P_2O_5:K_2O:S$ kg ha^{-1}	114.21	3.40	27.34	63.83	10.21	22.79	52.70
S.E. ±	1.03	0.02	0.38	0.20	0.05	0.37	0.57
C.D. (P=0.05)	2.97	0.05	1.08	0.59	0.14	1.07	NS
FYM							
0 t ha^{-1}	114.43	3.42	27.53	64.42	10.38	23.68	52.27
5 t ha^{-1}	122.38	3.45	28.75	64.96	10.41	24.81	54.47
S.E. ±	1.03	0.02	0.38	0.20	0.05	0.37	0.57
C.D. (P=0.05)	2.97	NS	1.08	NS	NS	1.07	1.65
Seed inoculation of biofertilizer							
No seed inoculation	113.00	3.28	27.34	64.25	10.31	22.59	50.42
Rhizobium inoculation	121.19	3.48	28.02	64.75	10.43	24.64	53.94
PSB inoculation	112.95	3.45	27.47	64.67	10.32	24.11	52.25
Rhizobium + PSB + PGPR	126.46	3.53	29.73	65.08	10.51	25.64	56.90
S.E. ±	1.46	0.02	0.53	0.29	0.07	0.52	0.81
C.D. (P=0.05)	4.20	0.07	1.53	NS	NS	1.51	2.33

NS=Non-significant

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