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Effect of organic sources on yield, nutrient content and fertility status of pigeonpea in Vertisols

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Abstract
The given study was conducted during *Kharif* season of 2019-20 at Extra Assistant Director Farm, College of Agriculture, Nagpur. The experiment was laid out in Randomized Blok Design with three replications and eight treatment combinations, organic fertilizer applied before sowing and PKV- TARA seeds were treated with Rhizobium and PSB at the time of sowing. The result revealed that, the content of nitrogen and phosphorus in seed of pigeonpea was significantly improved and slight improvement in content of potassium receiving 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB seed treatment over all other treatments and recommended dose of fertilizer.

Keywords: Pigeonpea, FYM, vermicompost, rhizobium and PSB

Introduction
Pulses are gaining more important position in Indian agriculture. After green revolution, India becomes self-sufficient in case of food grain production. However, India is still lagging behind in case of pulses production and is dependent on their imports for the domestic consumption particularly in recent year. Therefore, there is immediate need of another revolution in case of pulse production. As there is little scope to increase area under pulses, the production can increase by enhancing the productivity by various agro-techniques.
Pigeonpea (*Cajanus cajan* L. Mill sp.) is a important legume crop, plays a vital role in daily diet and belongs to family *Leguminoceae*. It is also known as red gram, tur, arhar. It is often cross-pollinated crop (20 to 70%) with diploid chromosome number 2n = 22. Its drought tolerance and the ability to use residual moisture during the dry season make it an important crop. Food values of pigeon pea is protein 22.3%, fat 1.7%, mineral 3.5%, fibre 1.5% and carbohydrates 57.5% in 100 g edible portion.
Organic farming is holistic management system which promotes and improves the health of agro system related to biodiversity nutrient bio-cycle and soil microbial and biochemical activities. Organic farming in India not new earlier before use of chemicals, manure like FYM, compost where already known to Indian farmers for improving soil fertility and crop productivity. However, negligence of organic inputs resulted in deterioration of productive soil for maintain soil physico-chemical and biological properties. For increasing the productivity of soil, use of FYM, vermicompost and biofertilizer inoculation in combination may prove to be beneficial.
There is a strong need of alternative source of nitrogen, especially biofertilizer, in order to supplement the nutrient supply through chemical fertilizer as biofertilizer are cheaper, pollution free and renewable. Symbiotic bacteria like Rhizobium have potential to fix nitrogen to number of legume crops and phosphorus solubilizing bacteria (PSB) solubilize the unavailable phosphorus in soil to plant.

Materials and Methods
Experimental site: The field experiment entitled "Effect of organic sources on yield, nutrient content and fertility status of pigeonpea in Vertisols" was carried out at EDA Farm, College of agriculture, Nagpur. The field selected for conducting the experiment was fairly uniform and levelled.

Soil of experimental area: The soil under experimental area is medium in depth and well drained. In order to study the physico-chemical characteristics, a composite soil sample was prepared for whole field by collecting soil samples up to 0-15 cm depth from randomly selected plots over the experimental field before sowing. This composite soil sample was analyzed for the initial fertility status of soil.

Table 1: Physico-chemical properties of experimental soil at the start of experiment

Sr. No.	Particulars	Values
A	**Physical properties**	
1	Depth	1-15cm
2	Slope	1-3%
2	**Mechanical analysis (International Pipette Method)**	
	Sand	20.7%
	Silt	25.5%
	Clay	53.8%
3	Textural class	Clay
4	Order	Vertisol
5	Bulk density (Mg m^{-3})	1.44
6	Hydraulic conductivity (cm hr^{-1})	0.59
B	**Chemical Properties**	
8	pH (1:2.5)	8.17
9	EC (dS m^{-1})	0.33
10	Organic carbon (g kg^{-1})	4.1
11	Available N (kg ha^{-1})	201.3
12	Available P (kg ha^{-1})	14.84
13	Available K (kg ha^{-1})	327.9
14	Available S (mg kg^{-1})	11.05
15	Available Fe (mg kg^{-1})	4.88
16	Available Mn (mg kg^{-1})	3.88
17	Available Zn (mg kg^{-1})	0.63

Results and Discussion

Effect of organic sources on grain and straw yield of pigeonpea

The yield data pertaining to grain and straw is given in Table 1. Yield of grain and straw were found statistically significant under different treatments during the 2019-20.

The significant highest yield of grain (2396 kg ha^{-1}) and straw (7311 kg ha^{-1}) was recorded by the treatment T_7 receiving 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB which is followed by the treatment T_8 with 25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB i.e. (2259 and 7047 kg ha^{-1} grain and straw yield) and treatment T_4 with 50% RDN through FYM + 50% RDN through vermicompost i.e. (2111 and 6667 kg ha^{-1} grain and straw yield). Treatment T_7 were significantly superior over all other treatments in grain and straw yield. However, lowest grain and straw yield was obtained in T_1 (1638 and 5423 kg ha^{-1}). Similar results were recorded by Singh. (2007) [7] and Sajitha *et al.* (2007) [6].

Table 1: Effect of organic sources on yield of pigeonpea (kg ha^{-1}).

	Treatments	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
T_1	100% RDN through FYM	1638	5423
T_2	100% RDN through vermicompost	1812	5917
T_3	75% RDN through FYM + 25% RDN through vermicompost	1725	5654
T_4	50% RDN through FYM + 50% RDN through vermicompost	2111	6667
T_5	25% RDN through FYM + 75% RDN through vermicompost	1966	6261
T_6	75% RDN through FYM + 25% RDN through vermicompost + Rhizobium + PSB	1886	6093
T_7	50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB	2396	7311
T_8	25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB	2249	7047
SE (m)±		103	323
CD 5%		312	979

Effect of organic sources on content of nutrient in pigeonpea

Content of nutrient in pigeonpea grain

Content of nutrient in pigeonpea grain is presented in Table 5. The various treatments significantly influenced nutrient content in the present study. Increasing trend in content of N and P by pigeonpea grain was observed with the organic sources and seed treatment with Rhizobium + PSB and content of K increased non-significantly over all treatments. Highest content of N and P by pigeonpea grain was recorded in the treatment (T_7) 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB followed by (T_8) 25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB. Similar results were found by Qureshi *et al*. (2016) [3] and Rai *et al*. (2015) [5].

The highest content of N and P in pigeonpea grain was observed in the treatment T_7 *i.e.*, 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB i.e. (N 2.81% and P 0.62%). Treatments T_4, T_5, T_6 and T_8 found to be at per with treatment T_7 in content of N and Treatment T_8 found to be at per with treatment T_7 in P content of pigeonpea grain. The lowest content was found in treatment T_1 *i.e.*, N 2.63%, P 0.54% and K 1.20%.

Table 2: Effect of organic sources on content of nutrient (%) in pigeonpea grain.

Treatments		N	P	K
T_1	100% RDN through FYM	2.63	0.54	1.20
T_2	100% RDN through vermicompost	2.68	0.56	1.23
T_3	75% RDN through FYM + 25% RDN through vermicompost	2.65	0.55	1.20
T_4	50% RDN through FYM + 50% RDN through vermicompost	2.76	0.61	1.27
T_5	25% RDN through FYM + 75% RDN through vermicompost	2.74	0.60	1.25
T_6	75% RDN through FYM + 25% RDN through vermicompost + Rhizobium + PSB	2.73	0.58	1.24
T_7	50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB	2.81	0.65	1.29
T_8	25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB	2.80	0.63	1.28
SE (m)±		0.04	0.01	0.02
CD 5%		0.12	0.04	NS

Content of nutrient in pigeonpea straw

Content of nutrient in pigeonpea straw is presented in Table 3. The highest N and P content in pigeonpea straw was observed in the treatment T_7 *i.e.*, 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB *i.e.*, (N 0.38%, P 0.25%). The content of K in pigeonpea straw was increased non-significantly over all treatments. Treatments T_4 and T_8 found to be at par with T_7 in N and P content of pigeonpea straw. The lowest NPK content in straw was observed in treatment T_1.

Table 3: Effect of organic sources on content of nutrient (%) in pigeonpea straw

Treatments		N	P	K
T_1	100% RDN through FYM	0.31	0.16	1.20
T_2	100% RDN through vermicompost	0.33	0.17	1.23
T_3	75% RDN through FYM + 25% RDN through vermicompost	0.33	0.17	1.20
T_4	50% RDN through FYM + 50% RDN through vermicompost	0.36	0.20	1.27
T_5	25% RDN through FYM + 75% RDN through vermicompost	0.34	0.19	1.25
T_6	75% RDN through FYM + 25% RDN through vermicompost + Rhizobium + PSB	0.34	0.18	1.24
T_7	50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB	0.38	0.25	1.29
T_8	25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB	0.37	0.23	1.28
SE (m)±		0.01	0.02	0.02
CD 5%		0.04	0.06	NS

Effect of organic sources on fertility status

Effect of organic sources on physical properties of soil

Bulk density

The bulk density of soil was determined at harvest of crop and data presented in Table 4 under different treatment. The bulk density of soil influenced by various treatments was statistically non-significant and it range from 1.41 to 1.38 Mg m^{-3}, indicating that the lowest (1.27 Mg m^{-3}) bulk density was recorded with the application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB (T_7) and 25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB (T_8). The higher value of bulk density was found in treatment (T_1) *i.e.*, 1.41 Mg m^{-3}.

Hydraulic conductivity

The data (Table 4) pertaining to the hydraulic conductivity of soil as influenced by various treatments was statistically significant and it ranged from 0.60 to 0.68 cm hr^{-1}, indicating that the highest (0.68 cm hr^{-1}) hydraulic conductivity was recorded with the application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB (T_7) and it was found to be on at par with 25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB (T_8), 25% RDN through FYM + 75% RDN through vermicompost (T_5) and 50% RDN through FYM + 50% RDN through vermicompost (T_4) The lower value of hydraulic conductivity was found in treatment (T_1) *i.e.*, 0.60 cm hr^{-1}.

Table 4: Effect of organic sources on physical properties of soil

Treatments		Bulk density (Mg m^{-1})	Hydraulic conductivity (cm hr^{-1})
T_1	100% RDN through FYM	1.41	0.60
T_2	100% RDN through vermicompost	1.40	0.63
T_3	75% RDN through FYM + 25% RDN through vermicompost	1.41	0.61
T_4	50% RDN through FYM + 50% RDN through vermicompost	1.38	0.66
T_5	25% RDN through FYM + 75% RDN through vermicompost	1.39	0.66
T_6	75% RDN through FYM + 25% RDN through vermicompost + Rhizobium + PSB	1.40	0.63
T_7	50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB	1.38	0.68
T_8	25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB	1.38	0.67
SE (m)±		0.02	0.013
CD 5%		NS	0.039

Effect of organic sources on chemical properties of soil:

Fertility status of soil after harvest of pigeonpea at presented in Table 5.

Table 5: Effect of organic sources on fertility status of soil after harvest of pigeonpea.

Treatments		Organic carbon (%)	Available nutrients			
			N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}	S mg kg^{-1}
T_1	100% RDN through FYM	0.54	218.10	15.20	380.90	12.76
T_2	100% RDN through vermicompost	0.55	219.07	15.90	390.67	12.84
T_3	75% RDN through FYM + 25% RDN through vermicompost	0.54	218.50	15.60	385.33	12.78
T_4	50% RDN through FYM + 50% RDN through vermicompost	0.57	222.53	17.33	400.33	12.96
T_5	25% RDN through FYM + 75% RDN through vermicompost	0.57	220.40	17.03	398.67	12.91
T_6	75% RDN through FYM + 25% RDN through vermicompost + Rhizobium + PSB	0.55	219.47	17.01	395.10	12.90
T_7	50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB	0.58	224.83	19.80	409.80	13.04
T_8	25% RDN through FYM + 75% RDN through vermicompost + Rhizobium + PSB	0.57	223.87	19.33	407.33	13.03
SE (m)±		0.01	1.65	1.50	6.36	0.06
CD 5%		NS	NS	NS	NS	NS

Organic carbon (%)

Organic carbon content in the soil after harvest of pigeonpea under the influence of various treatments was non-significantly increased due to level of organic manure alone or in combination with Rhizobium + PSB application. The highest organic carbon content in soil (0.58 g kg^{-1}) was recorded with the application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB, while lowest organic carbon content in soil was found in treatment T_1. Similar results were reported by Malav *et al*. (2018) [2] and Ansari *et al*. (2017) [1].

Available N (kg ha^{-1})

Available N in soil after harvest of pigeonpea was increased statistically non-significant with the increasing organic manure in combination with the Rhizobium + PSB. Application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB showed highest values of available N content in soil (224.83 kg ha^{-1}). The lowest available N content was observed under treatment T_1 *i.e.,* 218.10 kg ha^{-1}.

Available P (kg ha^{-1})

Available P in soil after harvest of pigeonpea was statistically non-significantly increased with the increasing organic manure in combination with the Rhizobium + PSB. The available P content in soil varied from (15.20 to 19.80 kg ha^{-1}). Application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB showed highest values of available P content in soil (19.80). The lowest available P content was observed under treatment T_1 *i.e.,* 15.20 kg ha^{-1}.

Available P in soil may increase due to organic matter and biofertilizers *i.e.,* PSB which makes unavailable form of P into available form. Similar results were found by Rai *et al*. (2014) [4] and Tripathi *et al*. (2009) [8].

Available K (kg ha^{-1})

Result pertaining to available K in soil after harvest of pigeonpea embodied in Table 5. The result show that the application of organic manure in combination with the Rhizobium + PSB was statistically non-significant for available K in soil varied from (380.90 to 409.80 kg ha^{-1}). The Highest available K was found in Application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB (T_7), while lowest available K content in soil (380.90) was found in treatment (T_1).

Available S (kg ha^{-1})

Available S in soil after harvest of pigeonpea was non-significantly increased with the increasing organic manure in combination with the Rhizobium + PSB. Application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB showed highest values of available S content in soil (13.04). The lowest available S content was observed under treatment T_1 *i.e.,* 12.76 kg ha^{-1}.

The movement of S from the surface layer and accumulation in subsurface soil due to insufficient microbial activity as compared to the surface layer. Available S increased with increasing organic manure with biofertilizer application reaching a peak value. Similar result reported by Qureshi *et al*. (2016) [3].

Conclusion

Application of 50% RDN through FYM + 50% RDN through vermicompost + Rhizobium + PSB found to be beneficial for pigeonpea yield, physical and chemical properties of soil and content of NPK.

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