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Studies on effect of different organic manures and bio-fertilizers on yield attributes and yield of chickpea

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Abstract
The field experiment was conducted to evaluate the effect of biofertilizers and P levels on soil fertility, yield and nodulation in chickpea crop at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India during *rabi* season 2015-16. The experimental soil having silty loam in texture, pH (1:2.5) 8.24, electrical conductivity (EC) 0.34 dS m-1, organic carbon 3.4 g kg-1, available N 180, P 18.2 and K 226 kg ha-1. All treatments were randomly allocated and replicated three times in a randomized block design was adopted for the experimentation. Better response in respect to improvement in count of microbial population was also observed in the same treatment after harvest of the crop. The improvement in soil properties was also observed with the same treatment after harvest of the crop. Thus, the recommendation of T_7 (recommended dose of nitrogen through vermicompost + Rhizobium + PSB) may be made of eastern U.P. for profitable cultivation of chickpea in Rabi season.

Keywords: Improvement, response, recommended

Introduction
Chickpea (*Cicer aritienum*) belongs to family 'fabaceae'. It is a cool season legume crop and is grown world wide as food source. Chickpea commonly known as Bengal gram has been known in this country for a long time. It is said to be one of the oldest pulses known and cultivated from ancient time both is Asia and Europe. The probable place of origin of chickpea lies in South Western Asia that is in the countries lying to the North- West of India such as Afghanistan and Persia (Iran). According to Aykroid and Doughty (1964) the centre of origin of chickpea is Eastern Mediterranean. The important gram growing countries are India, Pakistan, Ethopia, Burma and Turkey. In India chickpea grows on about 106 lakh ha area producing 111.58 lakh tone with an average yield of 1056 kg ha^{-1}.In UP its total area is 6.11 lakh ha, production 6.84 lakh tones and productivity 1120 kg ha^{-1}(Pulse revolution from food to nutritional security 2017-2018). India is the largest Chickpea producing country accounting for 67% i.e. (8.8 Million metric ton) (FAO, 2014). India ranks first in the world in respect of production as well as acreage followed by Pakistan. India has alone nearly 52.5 percent of the world acreage and production of gram. Chickpea occupies 38 percent of area under pulse and contributes about 50% of the total pulse production of India. The major chickpea production areas are situated in Madhya Pradesh, Rajasthan, Uttar Pradesh, Haryana, Maharashtra and Punjab.
Chickpea is considered to have medicinal effect and it is used for blood purification. Chickpea contains 21.1% protein, 61.5 per cent carbohydrate, 4.5% fat. It is also rich in calcium, iron and niacin. It is used for human consumption as well as for feeding to animals. Keeping the above aspect in view, a study was undertaken to determine the effectiveness of doses of organic sources in combination with bio fertilizers on yield, uptake of nutrients and available of nutrients status in soil after the harvest of chickpea crop.

Materials and Methods
The field experiment was conducted to evaluate the effect of biofertilizers and P levels on soil fertility, yield and nodulation in chickpea crop at Instructional Farm of Narendra Deva

University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India during *rabi* season 2015-16. The experimental soil having silty loam in texture, pH (1:2.5) 8.24, electrical conductivity (EC) 0.34 dS m-1, organic carbon 3.4 g kg-1, available N 180, P 18.2 and K 226 kg ha-1. All treatments were randomly allocated and replicated three times in a randomized block design was adopted for the experimentationT_4 Recommended dose of Nitrogen through vermicompost, T_5 Recommended dose of Nitrogen through Poultry manure T_6 -T_3 + Rhizobium + PSB, T_7- T_4 + Rhizobium + PSB and T_8- T_5 + Rhizobium + PSB. The recommended dose of NPK was applied through urea, DAP and muriate of potash, respectively.

Summary and Conclusion

Yield attributes and yield

Number of pods plant^{-1} & seeds pod^{-1} and test weight

Data on number of pods plant^{-1} and number of seeds pod^{-1} under influence of different organic manures and biofirtilizer. The T_7 treatment (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB) had significant effect on the number of pods plant^{-1} and number of seeds pod^{-1}. The number of pods plant^{-1} and number of seeds pod^{-1} is affected by the number of branches and vegetative growth of plant. When sufficient amount of nitrogen, phosphorus and other all microorganisms are delivered to the plant they increase the growth parameter which increases the nitrogen and phosphorus availability. (N. Togay *et al*., R. K. Sharma *et al*.,).The balanced nutrition through sufficient supply of phosphorus and nitrogen increases the vegetative growth which later on converted into reproductive phase, resulted more number of pods plant^{-1}. These results are in close agreement with Takankhar *et al* and Khoja *et al*.

Data presented in Table-4.9 further revealed that the inoculation of *Rhizobium* and PSB increases the test weight significantly in comparison to control. The increase in test weight was due to the combined inoculation of *Rhizobium* and PSB. The increases in test weight was highest with the treatment T_7 (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB). The similar trend was observed by A. Namvar *et al*.

Seed yield, straw yield and harvest index

Data pertaining to seed and stover yields as influenced by various treatments indicated that seed yield of chickpea increased significantly with the different organic manures and biofertilizers. The data shown in the Table-4.9 shows the significant effect of organic manures and biofirtilizers on seed yield, straw yield and harvesting index. The T_7 treatment (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB) had the significant effect on seed yield, stover yield and harvesting index. The vermicompost is a well decomposed material and rich in nutrient like nitrogen, phosphorus and potassium. The appropriate amount of nitrogen and phosphorus of vermicompost give the better result in leguminous crop and the legumes crop fixes the atmospheric nitrogen for increasing their growth character. The inoculation of Rhizobium and PSB also enhances the growth character like number of branches, number of nodules and plant height. All these growth character increase the seed yield. The similar trends were also observed by Giri, N. and Joshi, N.C. (2010).

Straw yield also showed similar trend with the different combination of organic manures and biofirtilizers. The organic manures with the inoculation of bio-fertilizers give the better result in respect of straw yield. The increase in straw yield was highest with the T_7 treatment (recommended dose of nitrogen through vermicompost + *Rhizobium* + PSB). These results are in conformity with the findings of Rabieyan *et al*. (2011). The increase in harvest index was highest with the *Rhizobium* inoculation along with vermicompost. The harvest index is the ratio of economical yield to the biological yield here the economical yield is seed yield and biological yield is seed + straw yield. The crop having the more harvest index which has more seed yield.

Chemical analysis in plant

Nitrogen content in grain and stover

It is apparent from the data on nitrogen content in grain and stover that different organic manures and biofertilizers increase the nitrogen content in grain and stover. Maximum nitrogen was recorded in The T_7 treatment (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB). The inoculation of *Rhizobium* enhances the nitrogen availability and this available nitrogen absorbs by the plant roots which ultimately increased the nitrogen concentration in seed and stover. Nitrogen content in grain and stover is increased by the inoculation of *Rhizobium* and PSB as a seed treatment. The combination of biofertilizers enhances the nitrogen content. Almost similar results were also reported by Thenua and Sharma, Gangwar and Dubey

Phosphorus content in grain and stover

The data on phosphorus content in seed and stover with T_7 treatment (recommended dose of nitrogen through vermicompost + *Rhizobium* + PSB) revealed that the microbial inoculation had significant effect on the phosphorus content in grain and stover. The maximum phosphorus concentration with the treatment (recommended dose of nitrogen through vermicompost + *Rhizobium* + PSB) might be due to the availability of phosphorus in soil which ultimately increased the phosphorus concentration in plants. This might be due to the dilution effect of nutrient in biomass and thus consistent increase in dry matter accumulation. Almost similar results were also reported by Thenua and Sharma, Gangwar and Dubey.

Potassium content in grain and stover

It is apparent from the data on the potassium content in seed and stover with T_7treatment (recommended dose of nitrogen through vermicompost+ *Rhizobium* + PSB) had significant effect on the seed and stover in potassium. The maximum potassium was recorded in treatment T_7 with inoculation of biofirtilizers which might be due to the availability of potassium and its absorption by plant roots which ultimately increased the potassium concentration in seed and stover. Almost similar results were also reported by Thenua and Sharma, Gangwar and Dubey.

5.3.4 Protein content in grain and stover:

It may be seen from the data on protein content in seed and stover that recommended dose dose of nitrogen through vermicompost with *Rhizobium* and PSB. The *Rhizobium* and PSB enhances the nitrogen availability and due to the available nitrogen the protein content in grain and stover increased. The protein content in grain and stover depend on the nitrogen percentage. The protein content in grain and stover is estimated with the nitrogen percentage multiply with the conversion factor 6.25. Similar results were also reported by Thenua and Sharma, Gangwar and Dubey.

Soil properties

Available nitrogen showed positive response after harvesting of the crop (Chickpea). In general nitrogen content increased with increase in the doses of vermicompost with *Rhizobium* and PSB. The treatment T_7 (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB) had significant effect on the available N, P, K. This might be due to the application of different organic manures and biofertilzers which enhanced and established better root system. Nutrients possibly stimulate the nodulating bacteria for more fixation of atmospheric nitrogen resulting in increase of its content in soil. The PSB, *Rhizobium* and organic manures enhances the availability of the nitrogen through the fixation of nitrogen from the atmosphere. In the atmosphere the nitrogen is available in free form of elemental nitrogen and this nitrogen is available to the plants for their future growth and development. The vermicompost is a well decomposed material which encourages the availability of element. The PSB (phosphorus solubilizing bacteria) convert the insoluble phosphorus into the soluble form and the PSB support the phosphorus availability. Available phosphorus content of soil increased after harvesting of chickpea crop with increasing the *Rhizobium*, PSB and vermicompost. Higher available phosphorus might be due to the lower loss of nutrients due to slow available nutrients in soil. (Wagadre *et al*.(2010). The biofirtilizers like *Rhizobium* and PSB increases the phosphorus and nitrogen availability. Available potassium content of soil increased after harvesting of chickpea with the biofirtilizers inoculation might be due to the better establishment of crop which improved the availability of most of the nutrient including potassium. Similar results were reported by Singh and Mukherjee (2009). The biofirtilizers inoculation will also help in decreasing the pH and electrical conductivity. After decomposition of organic matter, it produces some organic acids which might have lowered down the pH of soil system. When we treated the seed with *Rhizobium* and PSB inoculation the PSB possess the ability to bring sparingly insoluble inorganic or organic phosphates into soluble form by secreting organic acids. These organic acids lower the soil's pH. (Silva *et al*.2012). The electrical conductivity also decreases with the help of PSB, *Rhizobium* and vermicompost. The inoculation of *Rhizobium* and PSB is very helpful for lowering the soil's pH. If there is a decrease in soil's pH, the electrical conductivity (EC) will also decreases because there is a direct relation between soil' pH and electrical conductivity. Organic manure in improving porosity and hydraulic conductivity which might have resulted in enhanced leaching of the salts thereby reducing the EC values. Similar results were reported by Khandelwal *et al*. (2012). A significant increase is shown in organic carbon because when we add the organic manure into the soil they increase the organic matter and hence the organic carbon is also increased. The inoculation of biofirtilizers is very helpful in increasing the organic matter and hence there is organic carbon also increases. Similar results were reported by Menon *et al*. (2010).

Microbial population

It may be seen from the data that there is a significant influences of different organic manures and biofirtilizers on microbial population. The T_7 treatment (recommended dose of vermicompost with *Rhizobium* and PSB) had significant effect on microbial population i.e. bacteria, fungi, Actinomycetes. When we treated the seed with biofirtilizers inoculants the microbial population will increases with the help of *Rhizobium* and PSB. The biofertlizers inoculant is much more beneficial for the microbial population because it increases the root nodule in the rhizosphere. In organic fertilizers, organic manure and biofirtilizers combined application had greatly influenced on the soil microbial population. Increased in both general and beneficial micro flora in soil can attributed to more availability of nutrients. It is also evidence from the T_7 treatment that the beneficial population of microbes were more wherever the organic manures and biofertlizers introduced than initial. This may be also understood with the treatment that when we add the vermicompost, the vermicompost due to the containing of higher amount of growth promoting substances, vitamins and enzymes, which in turn increased the microbial population and in addition to this azotobacter + phosphosolubilizing bacteria increased the root biomass production, which resulted in higher production of root exudates increasing the beneficial bacteria, fungi and Actinomycetes population in rhizosphere region. The bacterial, fungal and Actinomycetes population were significantly higher in those treatments receiving the organic manures and biofirtilizers. The bioinoculatns will help in increasing the root nodule and this increased root nodule favors the life of microbial population because there is a symbiotic association between root nodule and microbial population. Increase in bacteria population to a greater extent than Actinomycetes and fungi reported by Maheswarappa *et al*. (1999). Similar findings reported by Kannan *et al*. (2005).

Table 1: Effect of organic manures and bio-fertilizer on number of seed pod^{-1}and number of pod plant^{-1}

Treatment		No. of seed pod^{-1}	No. of pod plant^{-1}
T_1	Control	1.21	59.33
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	1.76	71.70
T_3	Recommended dose of Nitrogen through FYM	1.34	63.73
T_4	Recommended dose of Nitrogen through vermicompost	1.66	69.43
T_5	Recommended dose of Nitrogen through Poultry manure	1.46	67.40
T_6	T_3 + *Rhizobium* + PSB	1.81	74.30
T_7	T_4 + *Rhizobium* + PSB	2.13	80.00
T_8	T_5 + *Rhizobium* + PSB	1.90	75.43
S.Em±		0.06	0.62
CD at 5%		0.18	1.89

Table 2: Effect of organic manures and bio-fertilizer on seed yield, stover yield, test weight and harvest index

Treatment		Seed yield (qha^{-1})	Stover yield (qha^{-1})	Test weight (100 seed weight)	Harvest index (%)
T_1	Control	10.23	18.60	17.8	35.27
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	14.83	25.67	18.5	36.67
T_3	Recommended dose of Nitrogen through FYM	11.10	20.33	19.0	35.97
T_4	Recommended dose of Nitrogen through vermicompost	13.10	22.57	18.7	36.27

T_5	Recommended dose of Nitrogen through Poultry manure	11.73	21.77	19.3	35.27
T_6	T_3 + *Rhizobium* + PSB	15.57	28.77	19.1	37.17
T_7	T_4 + *Rhizobium* + PSB	18.53	35.57	18.8	37.90
T_8	T_5 + *Rhizobium* + PSB	14.53	31.10	19.5	37.33
S.Em±		0.30	0.45	0.52	-
CD at 5%		0.92	1.37	1.56	-

Table 3: Effect of organic manures and bio-fertilizers on nitrogen, phosphorus and potash content in grain and Stover of the crop

Treatment		Nutrient content (%)								
		Grain			Stover			Total		
		N	P	K	N	P	K	N	P	K
T_1	Control	2.74	0.270	1.30	0.68	0.150	1.95	3.42	0.42	3.25
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	2.85	0.294	1.47	0.73	0.166	2.16	3.58	0.46	3.63
T_3	Recommended dose of Nitrogen through FYM	2.77	0.274	1.38	0.70	0.156	1.98	3.47	0.43	3.36
T_4	Recommended dose of Nitrogen through vermicompost	2.82	0.288	1.45	0.72	0.161	2.15	3.54	0.449	3.6
T_5	Recommended dose of Nitrogen through Poultry manure	2.80	0.283	1.43	0.71	0.159	2.04	3.51	0.442	3.47
T_6	T_3 + *Rhizobium* + PSB	2.87	0.297	1.48	0.72	0.168	2.23	3.59	0.465	3.71
T_7	T_4 + *Rhizobium* + PSB	2.96	0.304	1.52	0.76	0.176	2.31	3.72	0.48	3.83
T_8	T_5 + *Rhizobium* + PSB	2.91	0.301	1.50	0.74	0.171	2.28	3.65	0.472	3.78
S.Em±		0.02	0.00	0.01	0.00	0.00	0.02	0.06	0.03	0.05
CD at 5%		0.05	0.01	0.02	0.01	0.00	0.05	0.19	0.03	0.02

Table 4: Effect of organic manures and bio-fertilizer on protein content in grain and Stover

Treatment		Protein content (%)	
		Grain	Stover
T_1	Control	17.72	4.56
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	18.38	4.70
T_3	Recommended dose of Nitrogen through FYM	17.97	4.60
T_4	Recommended dose of Nitrogen through vermicompost	18.24	4.67
T_5	Recommended dose of Nitrogen through Poultry manure	18.17	4.58
T_6	T_3 + *Rhizobium* + PSB	18.47	4.73
T_7	T_4 + *Rhizobium* + PSB	18.62	4.80
T_8	T_5 + *Rhizobium* + PSB	18.58	4.78
S.Em±		0.06	0.03
CD at 5%		0.19	0.09

Table 5: Effect of organic manures and bio-fertilizer on pH and organic carbon after harvest of the crop

Treatment		pH	Organic carbon (g kg^{-1})
T_1	Control	8.50	3.10
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	8.40	3.33
T_3	Recommended dose of Nitrogen through FYM	8.30	3.70
T_4	Recommended dose of Nitrogen through vermicompost	8.30	3.80
T_5	Recommended dose of Nitrogen through Poultry manure	8.20	4.0
T_6	T_3 + *Rhizobium* + PSB	8.20	4.13
T_7	T_4 + *Rhizobium* + PSB	8.20	4.33
T_8	T_5 + *Rhizobium* + PSB	8.30	4.20
S.Em±		0.06	0.13
CD at 5%		0.19	0.39

Table 6: Effect of organic manures and bio-fertilizer on available N, P and K in soil

Treatment		Available nutrient (kg ha^{-1})		
		45 DAS	60 DAS	75 DAS
T_1	Control	144.07	14.57	244.87
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	146.07	14.93	251.33
T_3	Recommended dose of Nitrogen through FYM	144.93	14.73	247.70
T_4	Recommended dose of Nitrogen through vermicompost	145.73	14.77	250.90
T_5	Recommended dose of Nitrogen through Poultry manure	145.13	14.60	248.47
T_6	T_3 + *Rhizobium* + PSB	146.60	15.10	251.90
T_7	T_4 + *Rhizobium* + PSB	148.70	15.76	253.63
T_8	T_5 + *Rhizobium* + PSB	147.43	15.40	252.10
S.Em±		0.30	0.08	0.63
CD at 5%		0.90	0.25	1.90

Table 7: Effect of organic manures and bio-fertilizer on bacteria, fungi and Actinomycetes after harvest of the crop

Treatment		Microbial count(CFU/gm)		
		Bacteria	Fungi	Actinomycetes
T_1	Control	9.20	6.10	8.32
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	9.40	6.21	9.20
T_3	Recommended dose of Nitrogen through FYM	9.50	6.40	8.50
T_4	Recommended dose of Nitrogen through vermicompost	9.60	6.56	8.97
T_5	Recommended dose of Nitrogen through Poultry manure	9.70	6.64	8.87
T_6	T_3 + *Rhizobium* + PSB	10.16	6.72	9.26
T_7	T_4 + *Rhizobium* + PSB	10.29	6.90	9.34
T_8	T_5 + *Rhizobium* + PSB	10.26	6.80	9.29
S.Em±		0.09	0.03	0.04
CD at 5%		0.28	0.10	0.13

Table 8: Economics of various treatments

Treatment		Total yield (Seed+ Straw)	Gross return	Cost of Cultivation	Net return	Benefit: cost ratio
T_1	Control	28.83	58422.60	28540	29882.6	1.04
T_2	RDF 100% (20kg N2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	40.5	83916.60	32628.2	51288.4	1.57
T_3	Recommended dose of Nitrogen through FYM	31.43	63480	30940	32540	1.05
T_4	Recommended dose of Nitrogen through vermicompost	35.67	74064	35480	38584	1.08
T_5	Recommended dose of Nitrogen through Poultry manure	33.5	67254.6	30540	36714.6	1.20
T_6	T_3 + *Rhizobium* + PSB	44.34	89195.4	31030	58165.4	1.87
T_7	T_4 + *Rhizobium* + PSB	54.1	107070.6	35570	71500.6	2.01
T_8	T_5 + *Rhizobium* + PSB	45.63	85788.6	30630	55158.6	1.80

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