International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(2): 191-195

Received: 08-01-2021
Accepted: 16-02-2021

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Effect of organic manures and biofirtilizers on growth parameters of chickpea (*Cicer ariteinum* L.) and their effect on soil health

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DOI: https://doi.org/10.22271/chemi.2021.v9.i2c.11805

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. On the basis of present investigation, it may be concluded that application of different organic manures (FYM, vermicompost, poultry manure) and biofirtilizers (Rhizobium, PSB) significantly increased the growth, yield and soil health parameters *viz*. Plant height, number of branches plant^{-1},dry matter accumulation plant^{-1}.

Keywords: Conducted, biofertilizers, design

Introduction
Chickpea (*Cicer aritienum*) belongs to family 'fabaceae'. It is a cool season legume crop and is grown worldwide as food source. Chickpea commonly known as Bengal gram has been known in this country for a long time. In India chickpea grows on about 106 lakh ha area producing 111.58 lakh tone with an average yield of 1056 kg ha^{-1}. 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. The use of more and more agrochemicals for higher agricultural production, not only deteriorating the quality of products but also reducing the production thus reducing the per capita income of farmers. Now a days excessive use of agrochemicals are polluting our soil and water which resulting hazardous for present and future human and animal population. There is urgent need to minimize the use of agrochemicals substitute by combined application of organic manures mainly FYM, Vermicompost produced higher yield apart from improving soil health (Babalad *et al*., 2009) [3]. Vermicompost besides being a rich source of micro nutrients also act as chelating agent and regulates the availability of metallic micro-nutrient to the plants and increase the plant growth and yield by providing nutrients in the available form and based on crop demand. Application of organic *viz*., FYM @ 10t ha^{-1} resulted in higher grain yield and uptake of nutrients like NPK, Ca, S and Fe over RDF alone (Kattimani, 2004). Bio fertilizers are some non-symbiotic and symbiotic microbes like *Azospirrillum*, *Bacillus polymyxa*, *Pseudomonas striata* and *Azotobacter*, in the soil (Saxena, 1993) that stimulate plant growth and contribute to the improvement of ecosystem. They also play an active role in biological control of pathogen (Tilk *et al*., 2005). *Azotobacter* and *Azospirillum* also release gibberellins, biotin and auxin. These substances are effective in promotion in plant growth as biofirtilizers (Vessey, 2003). *Azotobacter* for example, produces antifungal compounds and increases speed of seed germination and seeding establishment (Tilk *et al*., 2005). Water and nitrogen availability to plant influence their potential growth and yield (Rajala *et al*., 2009).

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

Growth parameters

Plant population

It is apparent from the data that plant population increased under organic manures application in combination with *Rhizobium* and PSB but there is not a significant effect on the plant population because the plant population is depend on the seed vigourness and seed viability. The application of recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB increased the plant population in comparison to control but there were not any significant influences on plant population. The application of treatment T_7 (recommended dose of nitrogen through vermiocompost and biofertilizers (*Rhizobium* + PSB) improved the plant population because vermicompost increases the enzymatic activity, increases the microbial population and activity, accelerating the population and activity of earthworm and easy availability of macro and micro nutrients by application of vermicompost. These results are in conformity with those reported by Mascolo *et al*., (1999); Albiach *et al*., (2000); Arancon *et al*., (2006).

Plant height

The application of different organic manures and biofertilizers produced significantly higher plant height over control. The application of vermicompost with *Rhizobium* and PSB increases the plant height. The doses of vermicompost and inoculation with *Rhizobium* and PSB enhance the availability of nutrients, thereby given positive impact on growth parameters as plant height. One of the unique features of vermicompost is that during the process of conversion of various organic wastes by earthworms, many of the nutrients are changed to their available forms in order to make them easily utilizable by plants. biofertilizer is a natural product carrying living microorganism enhances the atmospheric nitrogen fixation and increase the nitrogen and phosphorus availability. Due to this nature of vermicompost and biofertilizers, the plant height increased with the application of vermicompost and *Rhizobium* + PSB. Similar findings were reported by Asewar *et al*. (2003) [2], Singh and Yadav (2004).

Dry matter accumulation

The data regarding dry matter accumulation as influenced by recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB revealed that the vermicompost increases the availability of nitrogen. The *Rhizobium* and PSB increases the availability of nitrogen and phosphorus because the PSB convert the insoluble form to soluble form and enhances the availability of essential nutrients for fixation of the atmospheric nitrogen. The enhanced nitrogen will help in increasing the plant height, which ultimately results in increased dry matter accumulation. The plants having higher plant height have more dry matter accumulation. Similar findings were reported by Namwar *et al*, (2013); Uddin *et al*, (2014).

Number of branches plant^{-1}

The application of different organic manures and biofertilizers produced more number of branches plant^{-1} over control. The T_7 treatment (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB) increases the number of branch plant^{-1} compare to the control. The PSB (phosphorus solubilizing bacteria) possess the ability to transform insoluble forms. PSB possess the ability to bring sparingly insoluble inorganic or organic phosphates into soluble form and thus, the PSB enhances the P availability in the soil. Phosphorus is essential constituent of plant cell and is also helpful in increasing the different growth characters. The increases in the number of branches plant^{-1} were highest with the vermicompost *Rhizobium* and PSB. This might be because of more solubility of phosphorus which increased the availability of phosphorus resulted in sufficient formation of photosynthates which promotes the metabolic activities, accelerates cell division and formation of meristemetic tissues, due to this reason there might be enhancement in the number of branches plant^{-1}. Similar findings were reported by Rudresh *et al* (2005).

Number of nodules plant^{-1}

It is apparent from the data that number of nodules increased under the T_7 treatment (recommended dose of nitrogen through vermicompost+ *Rhizobium* + PSB) significantly over control. Number of nodules plant^{-1} increased with the different organic manures and biofirtilizers. The application of biofertilizer like *Rhizobium* and PSB also increased the number of nodules considerably in comparison to control. PSB (phosphorus solubilizing bacteria) enhances the number of nodules. PSB supply the phosphorus to the plant roots at vigorous stages especially at the time of nodule formation and the microbial association with legumes plant increases the number of nodules. The activity of microorganisms increased in legumes crop due to the biofirtilizers application and this increased activity of microorganism improve the number of nodules plant^{-1}. The increase in nodulation was highest with the T_7 treatment. These results are in conformity with those reported by Rudresh *et al.*

Fresh and dry weight of root nodules plant^{-1}

Fresh and dry weight of root nodules improved with the application of different organic manures and biofertilizers. The application of T_7 (recommended dose of nitrogen through vermicompost with *Rhizobium* and PSB) increases the fresh and dry weight of root nodules plant^{-1} compare to control. Vermicompost enriches the soil and act as a soil conditioner which enhances the nutrient availability and it contains nitrogen in abundant amount which will help in increasing the nitrogen fixation rate and this fixed nitrogen form the nodule in leguminous crop. Vermicompost is much beneficial for soil microorganism and it increases its activity, thus the increased soil microorganism will help in nodule formation. The PSB also helps in nodule formation because PSB increases the

phosphorus availability and this available phosphorus has direct role in biological nitrogen fixation in legumes which ultimately increases the weight of nodules. Sufficient amount of *Rhizobium* also increases the activity of microorganism and this increased microorganism will help in nodule formation. Sufficient amount of phosphorus produced by PSB enhanced the activities of rhizobia and increase the formation of nodule. Due to higher nodule formation, the fresh and dry weight of root nodules increases in leguminous crops. The increase in fresh and dry weight of root nodules was highest in treatment T_7.

Table 1: Effect of organic manures and bio-fertilizers on plant population m^{-2}

Treatment		Plant population m^{-2} (45DAS)
T_1	Control	28.60
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	28.63
T_3	Recommended dose of Nitrogen through FYM	28.65
T_4	Recommended dose of Nitrogen through vermicompost	28.70
T_5	Recommended dose of Nitrogen through Poultry manure	28.00
T_6	T_3 + *Rhizobium* + PSB	28.80
T_7	T_4 + *Rhizobium* + PSB	28.85
T_8	T_5 + *Rhizobium* + PSB	28.75
S.Em±		1.06
CD at 5%		(NS)

Table 2: Effect of organic manures and bio-fertilizers on plant height

Treatment		Plant height (cm)		
		45 DAS	60 DAS	75 DAS
T_1	Control	18.73	31.33	35.6
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	24.16	38.6	43.6
T_3	Recommended dose of Nitrogen through FYM	22.66	35.9	40.5
T_4	Recommended dose of Nitrogen through vermicompost	23.96	37.73	41.46
T_5	Recommended dose of Nitrogen through Poultry manure	23.5	36.53	40.83
T_6	T_3 + *Rhizobium* + PSB	24.26	39.9	44.5
T_7	T_4 + *Rhizobium* + PSB	25	41.2	46.2
T_8	T_5 + *Rhizobium* + PSB	24.56	40.03	45.53
S.Em±		0.51	0.33	0.47
CD at 5%		1.56	1.02	1.43

Table 3: Effect of organic manures and bio-fertilizers on dry matter accumulation (gm m^{-2})

Treatment		Dry matter accumulation (gm m^{-2})		
		45 DAS	60 DAS	75 DAS
T_1	Control	181.80	264.57	315.70
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	205.90	294.20	361.77
T_3	Recommended dose of Nitrogen through FYM	192.10	271.30	332.80
T_4	Recommended dose of Nitrogen through vermicompost	202.13	287.87	352.33
T_5	Recommended dose of Nitrogen through Poultry manure	196.67	280.67	343.87
T_6	T_3 + *Rhizobium* + PSB	209.57	301.67	373.10
T_7	T_4 + *Rhizobium* + PSB	218.37	312.40	391.23
T_8	T_5 + *Rhizobium* + PSB	212.70	306.53	382.20
S.Em±		1.11	0.99	1.01
CD at 5%		3.37	3.00	3.05

Table 4: Effect of organic manures and bio-fertilizers on Number of branches $plant^{-1}$

Treatment		No. of branches $plant^{-1}$		
		45 DAS	60 DAS	75 DAS
T_1	Control	4.20	5.60	6.20
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	5.53	6.87	7.67
T_3	Recommended dose of Nitrogen through FYM	4.80	6.30	7.10
T_4	Recommended dose of Nitrogen through vermicompost	5.60	7.00	7.63
T_5	Recommended dose of Nitrogen through Poultry manure	5.20	6.67	7.33
T_6	T_3 + *Rhizobium* + PSB	6.00	7.30	7.53
T_7	T_4 + *Rhizobium* + PSB	6.40	7.80	8.60
T_8	T_5 + *Rhizobium* + PSB	6.20	7.50	8.27
S.Em±		0.16	0.17	0.17
CD at 5%		0.48	0.51	0.52

Table 5: Effect of organic manures and bio-fertilizers on Number of nodule plant^{-1}

Treatment		No. of nodules		
		45 DAS	60 DAS	75 DAS
T_1	Control	7.40	8.53	6.37
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	8.80	9.93	7.60
T_3	Recommended dose of Nitrogen through FYM	7.73	8.90	6.57
T_4	Recommended dose of Nitrogen through vermicompost	8.50	9.70	7.00
T_5	Recommended dose of Nitrogen through Poultry manure	8.07	9.27	6.83
T_6	T_3 + *Rhizobium* + PSB	9.10	10.30	7.90
T_7	T_4 + *Rhizobium* + PSB	9.63	10.87	8.43
T_8	T_5 + *Rhizobium* + PSB	9.37	10.53	8.17
S.Em±		0.07	0.08	0.09
CD at 5%		0.21	0.25	0.27

Table 6: Effect of organic manures and bio-fertilizers on fresh weight of nodule plant^{-1}

Treatment		Fresh weight of nodule		
		45 DAS	60 DAS	75 DAS
T_1	Control	491.60	554.87	460.17
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	570.60	650.57	547.47
T_3	Recommended dose of Nitrogen through FYM	524.70	604.23	496.30
T_4	Recommended dose of Nitrogen through vermicompost	560.33	642.33	528.93
T_5	Recommended dose of Nitrogen through Poultry manure	542.30	627.50	514.67
T_6	T_3 + *Rhizobium* + PSB	576.53	657.17	553.20
T_7	T_4 + *Rhizobium* + PSB	604.30	689.43	571.23
T_8	T_5 + *Rhizobium* + PSB	586.73	668.87	549.10
S.Em±		1.18	0.17	4.53
CD at 5%		3.57	0.52	13.73

Table 7: Effect of organic manures and bio-fertilizers on dry weight of nodule plant^{-1}

Treatment		Dry weight of nodule		
		45 DAS	60 DAS	75 DAS
T_1	Control	91.87	105.53	83.20
T_2	RDF 100% (20kg N_2 /ha + 60kg P_2O_5/ha + 20kg K_2O/ha)	106.43	125.43	97.27
T_3	Recommended dose of Nitrogen through FYM	96.10	113.3	88.20
T_4	Recommended dose of Nitrogen through vermicompost	103.90	117.13	95.10
T_5	Recommended dose of Nitrogen through Poultry manure	101.83	117.03	92.93
T_6	T_3 + *Rhizobium* + PSB	110.17	125.43	103.40
T_7	T_4 + *Rhizobium* + PSB	122.23	135.46	115.40
T_8	T_5 + *Rhizobium* + PSB	116.87	132.66	108.13
S.Em±		1.75	0.68	0.95
CD at 5%		5.30	2.07	2.87

Conclusion

Application of T_7 (Recommended dose of nitrogen through vermicompost with the inoculation of biofirtilizers (Rhizobium+PSB) produced highest seed, stover yield and protein, nitrogen, phosphorus and potassium content among the treatments. 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.

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