Biological Forum – An International Journal **15(11): 214-217(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Potential Effect of Integrated Nutrient Management on Growth Parameter and Yield of Chickpea (*Cicer arietinum* L.)

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(Received: 09 September 2023; Revised: 09 October 2023; Accepted: 19 October 2023; Published: 15 November 2023)
(Published by Research Trend)

ABSTRACT: A field experiment was conducted at the Department of Soil Science and Agriculture Chemistry, CoA, JNKVV, Jabalpur, during Rabi season 2021–22 to investigate the effect of Integrated Nutrient Management (INM) on chickpea production. The experiment involved three replications and three main treatments: 0% NPK at 20:60:20 kg ha^{-1}, 50% NPK at 20:60:20 kg ha^{-1}, and 100% NPK at 20:60:20 kg ha^{-1}. Six sub-treatments of vermicompost plus biofertilizer treatments were also tested: T_1vermicompost + (Rhizobium + PSB), T_2 vermicompost + (Rhizobium + KSB), and T_3 vermicompost + (Rhizobium + PSB + KSB), T_4 vermicompost + (Rhizobium + PSB + KSB + Trichoderma), T_5 vermicompost + (Rhizobium + PSB + KSB + Trichoderma + Pseudomonas), and T_6 (control) have the same effect on the productivity of chickpeas. The results showed that different variations in vermicompost and biofertilizer had different effects on chickpea plant height, nodules in plant^{-1}, chlorophyll content in leaves, and pod plant $^{-1}$ at harvest. The highest response was observed in 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + pseudomonas), with a maximum response of 28.51 pods plant^{-1}, 25% more than the control. The seed and straw yield of chickpea in 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + pseudomonas) was also significantly higher, with 18.41 qha^{-1}, 28% more than the control.

Keywords: Chlorophyll, *Pseudomonas*, *Rhizobium*, Vermicompost etc.

INTRODUCTION

The integrated nutrient management (INM) takes into consideration the nutrient cycle involving soils, crops and livestock, nutrient deficiencies, organic recycling, conjunctive use of organic manures and mineral fertilizers and biological nitrogen fixing potential (Kumar and Sreenivasulu 2004). Not only organic manures are bulky in nature and contain essential nutrients including micronutrients which are required for the growth and development of crops but also bio fertilizers are one of the renewable source of fertilizers those promising source of essential plant nutrients and growth promoting substance. Other substances those are using as INM i.e. Vermicompost, Phosphate solubilizing bacteria (PSB) and *Rhizobium.* This are important role play in productivity of crops as well as influences over the crop parameters. Chickpea is grown in an area of about 10.17 million hectare with an annual production of 11.35 million tones and average yield of 1116 kgha^{-1} (Directorate of Economics and Statistics, 2019-20) Madhya Pradesh produces 40% of India's chickpea production. Chickpea is a member of leguminosea family that is also Bengal gram. It is a good source of vitamins such as riboflavin, niacin, thiamin, folate, A precursor, β-carotene and the protein quality is considered to be better than other pulses. Integrated nutrient Management is an approach through which organic (Vermicompost), inorganic and bio inoculants are applied jointly to soil for superior crop production, soil deprivation prevention, and to meet future food supply requirements (Gruhn *et al.,* 2000).

MATERIALS AND METHODS

The field experiment was carried out at Research field of Department of Soil Science and Agriculture Chemistry, CoA, JNKVV, Jabalpur during *Rabi* season 2021-22. The experiment was consists of three main-plot treatments of NPK and six sub-plot treatments of vermicompost and biofetilizers which were replicated three times in a split plot design (SPD). The NPK fertilizers were supplied through urea, single super phosphate, muriate of potash were applied at recommended dose of 20:60:20 kg ha^{-1}. Healthy Seed sowing of chickpea var. 'JG-14' seeds were manually sowed at 3-4 cm depth in rows with spacing of 30 × 10 cm. The experimental data were tabulated and analyzed statistically by the method of analysis of variance as described by Gomez and Gomez (1984) in form of two way mean table. The significance of the treatments effect was tested with the help of 'F' (variance ratio) test. The difference between the significant treatments

means were tested against least significant difference at 0.05 probability level.

RESULTS AND DISCUSSION

A. Growth attributes of chickpea at different growth stages

Plant height. The Table 1 showed that Plant height of chickpea at 30 DAS ranged from 15.50 to 21.50 cm. 100% NPK + VC + (*Rhizobium +PSB+ KSB+ Trichoderma+ pseudomonas)* exhibited maximum response with 21.50 cm which was 42% more over that of control without additive (15.50cm). This was followed by the response of 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma*) which were 20.70 cm. Similarly, the plant height of chickpea at 60 DAS ranged from 31 to 35.50 cm. 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma + pseudomonas*) exhibited maximum response with 35.50 cm which was 9% more over that of control without additive (31.00cm). This was followed by the response of 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma)* which were 35.40 cm.

The same pattern on plant height of chickpea at 90 DAS ranged from 34.27 to 41.17 cm. 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma + pseudomonas)* exhibited maximum response with 41.17 cm which was 16% more over that of control without additive (34.27cm). This was followed by the response of 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma*) which were 40.20 cm. Similar result have also been reported by Netwal (2003); Mathur *et al.* (2007); Verma *et al.* (2017); Kumar *et al.* (2017); Jakhar *et al.* (2020).

Nodule enumeration of chickpea at different growth stages. The number of nodules per plant in chickpea was determined at 30 and 60 DAS. The following data are presented in Table 2. The number of nodules plant^{-1} of chickpea at 30 DAS ranged from 10.10 to 18.00 plant^{-1} 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + Pseudomonas) exhibited maximum response with 18.00 plant^{-1}, which was 43% moreover that of the control without the additive (10.10 plant^{-1}). This was followed by the response of 100% NPK + VC (Rhizobium + PSB + KSB + Trichoderma), which was 17.90 plant^{-1}.

Similarly, the number of nodules plant^{-1} of chickpea at 60 DAS ranged from 16.67 to 22.67 plant^{-1}. 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + Pseudomonas) exhibited maximum response with 22.67 plant^{-1} cm, which was 27% moreover that of control without additive (16.67 plant^{-1}). This was followed by the response of 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + Pseudomonas) which was 22.47 plant^{-1}. Similar results have also been reported by Das *et al.* (2002); Kausale *et al.* (2007); Singh (2011); Ahamd *et al.* (2017).

Chlorophyll content in leaves of chickpea at different growth stages. Chlorophyll content in chickpea leaves was determined at 30 and 60 DAS. The following data are presented in Table 3. The chlorophyll content in chickpea leaves at 30 DAS ranged from 1.09 to 3.89%. 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma + pseudomonas)* exhibited maximum response with 3.89% which was 71% more over that of control without additive (1.09%). This was followed by the response of 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma)* which were 3.43%.

Similarly, the chlorophyll content in chickpea leaves at 60 DAS varied from 3.25 to 5.72, respectively, over that of the control. 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + Pseudomonas) exhibited the maximum response with 5.72%, which was 46% more than that of the control without the additive (3.25%). This was followed by a response of 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma), which was 5.70%. Similar results have also been reported by Das *et al.* (2002); Choudhary and Yadav (2011).

Yield attributes of chickpea

Number of pod/plant of chickpea at harvest. The number of pod plant^{-1} in chickpea was determined at harvest. The following data are presented in Table 4. The number of pod plant^{-1} in chickpea at harvest ranged from 21.35 to 28.51, with an average of 25.07 pod plant^{-1}. 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + pseudomonas) exhibited the maximum response with 28.51 pod plant^{-1} which was 25% more than that of control (21.35 pod plant^{-1}). This was followed by the response of 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma) with 28.45 pod plant^{-1}. Similar results have also been reported by Devi *et al.* (2005); Singh *et al.* (2017). The chlorophyll content in chickpea leaves at 60 DAS varied from 3.25 to 5.72, respectively, over that of the control. 100% NPK + VC + (Rhizobium + PSB + KSB + Trichoderma + Pseudomonas) exhibited the maximum response with 5.72%, which was 46% more than that of the control without the additive (3.25%). This was followed by a response of 100% NPK + VC + Rhizobium + PSB + KSB + Trichoderma, which was 5.70%. Similar results have also been reported by Das *et al.* (2002); Choudhary and Yadav (2011).

Seed and straw yields of chickpea at harvest. Seed yield and straw yield of chickpea in q ha^{-1} were determined at harvest. The following data are presented in Table 5. The seed yield of chickpea in q ha^{-1} at harvest ranged from 13.00 to 18.41 q ha^{-1} with an average of 16.43 q ha^{-1}. 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma + pseudomonas)* exhibited maximum response with 18.41 q ha^{-1}, which was 28% more than that of control (13.00 q ha^{-1}). This was followed by the response of 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma)* with 18.17 q ha^{-1}. The straw yield of chickpea in q ha^{-1} at harvest ranged from 21.67 to 28.37 q ha^{-1} with an average of 25.74 q ha^{-1}. 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma + pseudomonas)* exhibited maximum response with 28.37 q ha^{-1}, which was 24% more than that of control (21.67 q ha^{-1}). This was followed by the response of 100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma)* with 27.38 q ha^{-1}. Similar results have also been reported by Sohu *et al.* (2015); Kemal *et al.*

(2018); Lakum *et al.* (2020); Sodavadiya *et al.* (2021). Chlorophyll content in chickpea leaves is also found in treatment T5:100% NPK + VC + (*Rhizobium + PSB + KSB + Trichoderma + pseudomonas)* these are directly involved in the production of chickpea.

Table 1: Effect of Integrated Nutrient Management on plant height of chickpea.

Main treatments / Sub treatments	30 DAS				60 DAS				90 DAS			
	0% NPK	50% NPK	100% NPK	Mean	0% NPK	50% NPK	100% NPK	Mean	0% NPK	50% NPK	100% NPK	Mean
vermicompost+Rhizobium+PSB	16.5	18	19.33	**17.94**	32.73	33.2	33.33	**33.09**	36	38	38.83	**37.61**
vermicompost+Rhizobium+KSB	17	18.33	19.83	**18.39**	32.67	33.33	33.67	**33.22**	36.8	38.3	39.17	**38.09**
vermicompost+Rhizobium+PSB+KSB	17.5	19.33	20.2	**19.01**	33.17	34.5	34.5	**34.06**	37.6	38.43	39.83	**38.62**
vermicompost+Rhizobium+PSB+KSB+Trichoderma	18.5	20	20.7	**19.73**	33.77	35.3	35.4	**34.82**	38.33	39	40.2	**39.18**
vermicompost+Rhizobium+Trichoderma+Pseudomonas	19	20	21.5	**20.17**	34	35	35.5	**34.83**	40	39.67	41.17	**40.28**
control	15.5	17.33	19	**17.28**	31	32	34	**32.33**	34.27	37.67	39.17	**37.03**
Mean	**17.33**	**18.83**	**20.09**		**32.89**	**33.89**	**34.4**		**37.17**	**38.51**	**39.73**	
	NPK	VC+BF	interaction		NPK	VC+BF	interaction		NPK	VC+BF	interaction	
SEm±	0.42	0.62	1.07		0.6	0.55	0.96		0.59	0.58	1	
CD(0.05)	1.66	1.78	3.09		2.23	1.59	2.76		2.3	1.67	2.9	

Table 2: Effect of Integrated Nutrient Management on nodulation attributes of chickpea at different growth stages.

Root nodules	30 DAS				60 DAS			
Main treatments / Sub treatments	0% NPK	50% NPK	100% NPK	Mean	0% NPK	50% NPK	100% NPK	Mean
Varmicompost +Rhizobium+PSB	10.5	13.8	16.37	**13.56**	18.73	20.07	21.57	**20.12**
Varmicompost +Rhizobium+KSB	11.21	14.1	16.93	**14.08**	18.77	20	21.73	**20.17**
Varmicompost +Rhizobium+PSB+KSB	11.8	14.83	17.3	**14.64**	19	20.67	22.07	**20.58**
Vermicompost+Rhizobium+PSB+KSB+Trichoderma	12.2	15.27	17.9	**15.42**	20.9	20.8	22.47	**21.71**
Vermicompost+Rhizobium+Trichoderma+Pseudomonas	12.7	15.76	18	**17.47**	20.67	22	22.67	**19**
Control	10.1	16.13	17.47	**14.23**	16.67	19.33	19	**18.33**
Mean	**11.42**	**14.98**	**17.83**		**19.12**	**20.48**	**21.58**	
	NPK	VC+BF	interaction		NPK	VC+BF	interaction	
SEm±	0.8	1.65	2.86		0.16	0.57	0.99	
CD(0.05)	3.13	4.76	8.25		0.64	1.65	2.86	

Table 3: Effect of Integrated Nutrient Management on total chlorophyll content (mgg^{-1}) in leaves of chickpea at different growth stages.

Chlorophyll content(mgg^{-1})	30 DAS				60 DAS			
Main treatments / Sub treatments	0% NPK	50% NPK	100% NPK	Mean	0% NPK	50% NPK	100% NPK	Mean
vermicompost+Rhizobium+PSB	1.13	2.24	3.18	**2.18**	3.25	4.5	5.63	**4.46**
vermicompost+Rhizobium+KSB	1.15	2.42	3.09	**2.22**	3.31	4.52	5.65	**4.49**
vermicompost+Rhizobium+PSB+KSB	1.19	2.57	3.22	**2.43**	3.37	4.55	5.68	**4.53**
Vermicompost+Rhizobium+PSB+KSB+Trichoderma	1.24	2.71	3.43	**2.69**	3.4	4.57	5.7	**4.6**
Vermicompost+Rhizobium+Trichoderma+Pseudomonas	1.27	2.9	3.89	**1.92**	3.47	4.61	5.72	**5.6**
control	1.09	1.33	1.92	**1.45**	3.09	4.45	5.6	**4.38**
Mean	**1.18**	**2.36**	**3.18**		**3.31**	**4.53**	**5.66**	
	NPK	VC+BF	interaction		NPK	VC+BF	interaction	
SEm±	0.002	0.01	0.01		0.01	0.02	0.04	
CD(0.05)	0.01	0.02	0.03		0.04	0.07	0.11	

Table 4: Effect of Integrated Nutrient Management onNumber of pod/plant of chickpea at harvest.

Number of pod/plant	At harvest			
Main treatments / Sub treatments	0% NPK	50% NPK	100% NPK	Mean
vermicompost+Rhizobium+PSB	22.94	25.94	27.84	**25.57**
vermicompost+Rhizobium+KSB	23.8	25.62	21.95	**23.79**
vermicompost+Rhizobium+PSB+KSB	24.95	26.28	21.62	**26.56**
vermicompost+Rhizobium+PSB+KSB+Trichoderma	24.57	26.94	28.45	**26.41**
vermicompost+Rhizobium+Trichoderma+Pseudomonas	23.86	26.86	28.51	**27.25**
control	21.35	22.47	27.25	**23.69**
Mean	**23.58**	**25.69**	**25.94**	
	NPK	VC+BF	interaction	
SEm±	0.43	1.68	2.91	
CD(0.05)	1.69	4.86	8.41	

Table 5: Effect of Integrated Nutrient Management on Seed yield and Straw yield.

Main treatments / Sub treatments	Seed yield q ha^{-1}				Straw q ha^{-1}			
	0% NPK	50% NPK	100% NPK	Mean	0% NPK	50% NPK	100% NPK	Mean
vermicompost+Rhizobium+PSB	14.41	15.85	17.67	**15.97**	22.6	25.73	27.5	**25.28**
vermicompost+Rhizobium+KSB	14.39	15.92	17.33	**15.88**	22.67	26.43	27.04	**25.38**
vermicompost+Rhizobium+PSB+KSB	15.67	16.72	18.08	**16.86**	23.67	27	28.37	**26.35**
vermicompost+Rhizobium+PSB+KSB+Trichoderma	16.4	17.83	18.17	**17.33**	25.33	26.67	26.83	**26.85**
vermicompost+Rhizobium+Trichoderma+Pseudomonas	16.17	17.74	18.41	**16.83**	25.83	27.33	27.38	**26.67**
control	13	15.17	16.83	**15**	21.67	24.53	26.67	**24.29**
Mean	**15.01**	**16.54**	**17.75**		**23.63**	**26.28**	**27.3**	
	NPK	VC+BF	interaction		NPK	VC+BF	interaction	
SEm±	0.45	0.44	0.75		0.39	0.7	1.21	
CD(0.05)	1.77	1.26	2.18		1.55	2.02	3.5	

CONCLUSIONS

The treatments of NPK 100+ VC+ Rhizobium +PSB+ KSB+ Trichoderma+ pseudomonas influence almost every parameter under study. This seemed to indicate that co-inoculation with different microbial cultures performed better than that of individual ones; application of the microbial consortia positively influenced parameters like plant height, nodulation, chlorophyll content, number of pods, seed yield, and straw yield.

Acknowledgements. I would like to express my sincere gratitude to the Department of Soil Science and agricultural chemistry CoA, JNKVV, Jabalpur for providing valuable resources for this experiment and to express my humility to the Department of Statistics, CoAE, JNKVV Jabalpur providing a tool for data analysis.

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How to cite this article: Kalyani Meravi, Kamal Kishor Patel, Ajay Kumar Shah, Shekhar Singh Baghel, Kailash Kumar and Alpana Kumhare (2023). Potential Effect of Integrated Nutrient Management on Growth Parameter and Yield of Chickpea (*Cicer arietinum* L.). *Biological Forum – An International Journal, 15*(11): 214-217.