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Effect of different organic and inorganic fertilizers on nutrient content, uptake and quality of chickpea (*Cicer arietinum* L.)

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Abstract

A field experiment was conducted at Students' Instructional Farm, Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology Kanpur (U.P.) in *Rabi* season for two consecutive years (2017-18 and 2018-19). The soil of the experimental field was sandy loam in texture, poor in fertility in respect of available nitrogen and organic carbon and medium in respect of available phosphorus, available potassium, available Zinc and available Boron. Soil was slightly alkaline in reaction (pH 7.70). The experiment was conducted in Split Plot Design (SPD) with three replications and twenty one treatments combination. The main plot was consisting of three fertility levels (100%RDF (20:60:20NPK kg/ha), 50%RDF+Vermicompost@2.5t/ha and 50%RDF+FYM@5t/ha) and sub plot consisting of seven micronutrient management treatments (control, Biofertilizers (PSB@6kg/ha)as basal, Micronutrients (Zn@5kg/ha) as basal, Boron (Bo@6kg/ha) as basal, PSB+Zn, PSB+Bo and PSB+Zn+Bo). Chick pea variety KWR-108 was grown with the recommended agronomic practices. The treatments effect was monitor in terms of quality of grain, nutrients content, uptake and availability of micronutrients in soil.

Keywords: Nutrient content, Uptake, protein content, chickpea

1. Introduction

Chickpea (*Cicer arietinum* L.) is the member of family leguminaceae and sub-family papilionaceae is an ancient self-pollinated leguminous crop, diploid annual (2n=16 chromosomes) grown since 7000 BC, in different areas of the world but its cultivation is mainly concentrated in semi-arid environment. It is grown and consumed in large quantities from south East Asia to India and in the middle east and Mediterranean countries. It ranks second in area and third in production among the pluses worldwide. Chickpea or gram is one of the first grain legumes to be domesticated by humans (Singh *et al*. 2009) and is the third most important pulse crop in the world, which is grown in almost all the continents except Antarctica. Major production of chickpea comes from central and northern India, North African region, Eastern Africa and Latin America. In India it is the premier food legume crop covering about 29.36 million hectare areas with a production of 24.51 million tones and productivity of 835 kg ha^{-1} (DES, Ministry of Agri. &FW (DAC&FW), Govt. of India; 2017-18). India is contributing highest share in area (36.01%) and production (45.53%) in the world (DES, Ministry of Agri. &FW (DAC&FW), Govt. of India; 2017-18. In India import and export of pluses crops 8296.04 tonnes &135.42 crore in world. (DGCI & S, ministry of commerce 2017-18). In India total area under chickpea is 10.57 million hectare with production 11.16 million tones and productivity 1056 kg/ha^{-1} (DES, Ministry of Agri. &FW (DAC&FW), Govt. of India; 2017-18). Pulses are chief source of vegetable protein in the human diet. The deficiency of protein in human diet often leads to protein energy – malnutrition (PEM) causing various form of anemia. Besides, nutritive value of pulse in humen diet, food legumes tend to fix atmospheric nitrogen to N-compounds to the tune of 72 to 350 kg per hectare per year and provide soil cover that helps to sustain soil health (Dept. of Economics and Statisics 2017) Chickpea is a very nutritious crop and also has many medicinal properties. The daily per caput availability of 14 g chickpea is a source of approximately 2.3% (56 K cal) energy and 4.7% (2.7 g) protein to Indian population, besides being an important source (10-12%) of calcium and iron (Ali and Kumar, 2005). Germinated chickpea is reported to be effective in controlling cholesterol level in rats (Gearvani, 1991). Due to continuous use of high doses of synthetic chemical fertilizer without use of organic source and intensive system of cultivation practices, there is change in soil physio- chemical condition and nutritional deficiencies are common in general and specifically with micronutrients, which are very essential for plants.

In this endeavor proper blend of organic and inorganic fertilizer is important not only for increasing yield but also for sustaining soil health (Weber *et al*., 2007 and Pullicinoa *et al*. (2009). The potential of rural and urban compost in India is estimated to be 600 and 16 million tones, respectively. Thus the average consumption has been about 2 ton/ha/year similarly less than 50% of FYM is utilized in crop production and a large production is lost as fuel and dropping in non agricultural land. The biofertilizers of microbial organic are much cheaper, pollution free and renewable (Mukherjee and Rai, 2000).

2. Material and Methods

The experiment was conducted in field number 8 at Students' Instructional Farm, Department of Agronomy of this University (2017-18 and 2018-19). Which is situated in the alluvial tract of Indo -Gangetic plains in central part of Uttar Pradesh between 25^o 26' to 26^o 58' North latitude and 79^o 31' to 80^{o}34'East longitude at an elevation of 125.9 meters from the sea level. This region falls under agro-climatic zone V (Central Plain Zone) of Uttar Pradesh. The irrigation facilities are adequately available on this farm. This zone has semi-arid climatic conditions having alluvial fertile soil. The normal rainfall of the area is about 890 mm per annum. Most of the rains are received from mid-June to the end of the September. The winter months are cooler with occasional rain and frost during last week of December to mid-January. The temperature in the month of May and June may go up to 44-47^{o}C or beyond and during winter go down to 2-3^{o}C. Mean relative humidity (7AM) remains nearly constant at about 80-90% from July to end of the March and after March slowly decline to about 40-50% by the end of April and remains 80% up to May. The weekly distribution of maximum and minimum temperature (^{o}C), relative humidity (%), wind velocity (km/hr), evaporation rate (mm/day) and total rainfall (mm) recorded during the crop growth period are presented. Soil samples from 0 to 15 cm depth were collected through core sampler of 8-cm diameter. Composite soil samples were collected for determination of available N, P, K, Bo, Inorganic carbon, EC and pH before conducting the experiment. Treatment-wise soil samples were collected for determination of available N, P, K, Zn, organic carbon, EC and pH after harvesting of the chickpea crop. Soil samples Mechanical analysis of soil: It was determined by International pipette method. (Piper, 1950). *pH:* pH was measured in 1:2.5 soil water suspension by Elicodegetal pH meter *Electrical Conductivity:* Electrical conductivity was determined by conductivity meter in the same soil-water suspension in which pH was measured as described by Jackson (1967) [20]. *Organic Carbon:* Organic carbon was determined by Walkley and Black's rapid titration method as described by Jackson (1967) [20]. Available Nitrogen: It was estimated by alkaline potassium permanganate method as described by Subbiah and Asija (1956). Available Phosphorus: Available phosphorus was determined calorimetrically extracting by 0.5 M $NaHCO_3$ (pH 8.3) extractant as given by Olsen *et al*. (1954). Available Potassium: Available potassium was extracted by 1 N NH_4OAC (pH 7.0) Morgan's solution and estimated by flame photometer as described by Jackson (1967) [20]. Available Zinc: Zinc was present in soil depends on the parent materials of that soil. .zinc ions (Zn^{++}) are held on the surface of clay and organic matter particles .soil organic matter holds zinc in a chelated form. Zinc determined by spectrophotometric method Kiran, (2012).

3. Result and discussion

3.1 Nitrogen content and uptake

The significantly higher value of nitrogen content in grain and stover was noticed with the application of fertility at 100%RDF (20:60:20 NPK Kg/ha) (F_1) which was at par with 50%RDF+ Vermicompost@2.5t/ha (F_2) but significantly higher than 50%RDF+FYM (@5t/ha (F_3) during both the years and on pooled basis. The lowest values of nitrogen content in grain and stover were observed in plots where 50%RDF+FYM (@5t/ha (F_3) was given to chickpea crop during both the years and on pooled basis. Among the micronutrient management practices, application of PSB+Zn+Bo (M_7) soil application gave significantly higher values of nitrogen content in grain and stover than rest of the treatments during both the years and on pooled basis. Application of Biofertilizers (PSB @6 kg/ha) as basal (M_2), micronutrients (Zn@5 kg/ha) as basal (M_3) Boron (Bo@6 kg/ha) as basal (M_4), PSB+Zn (M_5) and PSB+Bo (M_6) remained statistically at par among each other in nitrogen content in grain and stover during both the years and on pooled basis. The lowest values of nitrogen content in grain and stover was observed with the application of control (M_1) during both the years and on pooled basis. The significantly higher nitrogen uptake by grain, straw and total nitrogen uptake was noticed with the application of fertility 100%RDF (20:60:20NPK kg/ha) (F_1) than remaining fertility levels during both the years and on pooled basis. Where the application of 50%RDF+Vermicompost@2.5t/ha (F_2) was remained statistically at par with 50%RDF+FYM@5t/ha) (F_3). The lowest values of nitrogen uptake by grain, straw and total nitrogen uptake were observed in plots where 50%RDF+FYM@5t/ha (F_3) was given to chickpea crop during both the years and on pooled basis.As regards the micronutrient management practices, application of PSB+Zn+Bo (M_7) soil application gave significantly higher values of nitrogen uptake by grain, straw and total nitrogen uptake than rest of the treatments during both the years and on pooled basis. Application of Biofertilizers (PSB@6kg/ha) as basal (M_2), Micronutrients (Zn@5kg/ha) as basal (M_3), Boron (Bo@6kg/ha) as basal (M_4), PSB+Zn (M_5) and PSB+Bo (M_6) remained statistically at par in nitrogen uptake by grain during both the years and on mean basis. The lowest values of nitrogen uptake by grain, straw and total nitrogen uptake was observed with the application of control (M_1) during both the years and on pooled basis. Kalipadand Singh (2003), Gangwar and Dubey (2005) [14] and Valenciano *et al*. (2010)

Interaction effect between fertility levels and micronutrient management practices did not vary significantly in respect of nitrogen content, uptake by grain, straw and total nitrogen uptake during both the years and on pooled basis.

3.2 Phosphorus content and uptake

phosphorus content in grain and stover was noticed with the application of fertility levels at 100%RDF (20:60:20 NPK kg/ha) (F_1) than 50%RDF+ Vermicompost@2.5t/ha (F_2) and 50%RDF+FYM@5t/ha (M_3) at par with fertility levels fertility levels during both the years and on pooled basis. The lowest values of phosphorus content in grain and stover were observed in plots where 50%RDF+FYM@5t/ha (M_3) was given to chickpea crop during both the years and on pooled basis. Among the micronutrient management practices, application of PSB+Zn+Bo (M_7) soil application gave significantly higher values of phosphorus content in grain and stover than rest of the treatments during both the years and on pooled basis. Application of Biofertilizers (PSB @6 kg/ha) as basal (M_2), micronutrients (Zn@5 kg/ha) as basal (M_3) Boron (Bo@6 kg/ha) as basal (M_4), PSB+Zn (M_5) and PSB+Bo (M_6) remained statistically at par in phosphorus content in grain and stover during both the years and on pooled basis. The lowest values of phosphorus content in grain and stover was observed with the application of control (M_1) during both the years and on pooled basis. higher phosphorus uptake by grain, straw and total phosphorus uptake was noticed with the application of fertility at 100%RDF (20:60:20NPK kg/ha) (F_1) than remaining fertility levels during both the years and on pooled basis except phosphorus uptake by Stover during 2018 Where the application of 50% RDF+ Vermicompost@2.5t/ha (F_2) was remained statistically at par with 50%RDF+FYM@5t/ha) (F_3). The lowest values of phosphorus uptake by grain, straw and total phosphorus uptake were observed in plots where 50%RDF+FYM@5t/ha (F_3) was given to chickpea crop during both the years and on pooled basis. Among the micronutrient management practices, application of PSB+Zn+Bo (M_7) soil application gave significantly higher values of phosphorus uptake by grain, straw and total phosphorus uptake than rest of the treatments during both the years and on pooled basis. Application of PSB+Bo (M_6) and PSB+Zn (M_5) remained statistically at par in phosphorus uptake by grain and total phosphorus uptake by crop during both the years and on pooled basis. Application of Biofertilizers (PSB@6kg/ha) as basal (M_2), Micronutrients (Zn@5kg/ha) as basal (M_3) and Boron (Bo@6kg/ha) as basal (M_4) also remained statistically at par in phosphorus uptake by grain and total phosphorus uptake by crop during both the years and on mean basis. The lowest values of phosphorus uptake by grain, straw and total phosphorus uptake was observed with the application of control (M_1) during both the years and on pooled basis. Das S. K (2016), Das Shayam (2013) [10] and Elkoca, E (2008).

Interaction effect between fertility levels and micronutrient management practices did not vary significantly in respect of phosphorus uptake by grain, straw and total phosphorus uptake during both the years and on pooled basis.

3.3 Potassium content and uptake

Application of fertility at pod development stage 100%RDF (20:60:20 NPK kg/ha) (F_1) resulted in significantly higher value of potassium content in grain and stover but 50%RDF+ Vermicompost@2.5t/ha (F_2) and 50%RDF+FYM (@5t/ha) (F_3) at par during both the years and on pooled basis. The lowest values of potassium content in grain and stover were observed in plots 50%RDF+FYM (@5t/ha) (F_3) was given to chickpea crop during both the years and on pooled basis.Among the micronutrient management practices, application of PSB+Zn+Bo (M_7) soil application gave significantly higher values of potassium content in grain and stover than rest of the treatments during both the years and on pooled basis. Application of Biofertilizers (PSB@6kg/ha) as basal (M_2), Micronutrients (Zn@5 kg/ha) as basal (M_3), Boron (Bo@6 kg/ha)as basal(M_4), PSB+Zn (M_5) and PSB+Bo (M_6) remained statistically at par in potassium content in grain and stover during both the years and on pooled basis. The lowest values of potassium content in grain and stover was observed with the application of control (M_1) during both the years and on pooled basis. The significantly higher potassium uptake by grain, straw and total potassium uptake was noticed with the application of 100%RDF (20:60:20NPK kg/ha) (F_1) than remaining fertility levels during both the years and on pooled basis. Where the application of 50%RDF+Vermicompost@2.5t/ha (F_2) was remained statistically at par with 50%RDF+FYM@5t/ha) (F_3). The lowest values of potassium uptake by grain, straw and total potassium uptake were observed in plots where 50%RDF+FYM@5t/ha) (F_3) was given to chickpea crop during both the years and on pooled basis. As regards the micronutrient management practices, application of PSB+Zn+Bo (M_7) soil application gave significantly higher values of potassium uptake by grain, straw and total potassium uptake than rest of the treatments during both the years and on pooled basis. Application of Biofertilizers (PSB@6kg/ha) as basal (M_2), Micronutrients (Zn@5kg/ha) as basal (M_3), Boron (Bo@6kg/ha) as basal (M_4), PSB+Zn (M_5) and PSB+Bo (M_6) remained statistically at par in potassium uptake by grain during both the years and on pooled basis. The lowest values of potassium uptake by grain, straw and total potassium uptake was observed with the application of control (M_1) during both the years and on pooled basis. Ganga, N (2014) [13], Interaction effect between fertility levels and micronutrient management practices did not vary significantly in respect of potassium uptake by grain, straw and total potassium uptake during both the years and on pooled basis.

3.4 Protein content

The protein content and yield was significantly affected by fertility levels and micronutrient management during both the– years of the fertility levels, chickpea grown with 100%RDF (20:60:20 NPK Kg/ha) (F_1) (474.45 kg/ha) recorded significantly higher protein content and yield in grains than rest of the fertility levels during both the years and on pooled basis. The significantly lowest protein content and yield in grains of chickpea was recorded with 50%RDF+FYM (@5t/ha) (F_3) during both the years and on pooled basis.Protein content in grains was significantly influenced by integrated micronutrient management practices during both the years. Significantly higher protein content and yield in grains was observed with the application of micronutrients PSB+Zn+Bo (M_7) than rest of the treatments during both the years and on pooled basis. Application of Biofertilizers (PSB @6 kg/ha) as basal (M_2), Micronutrients (Zn@5 kg/ha) as basal (M_3), Boron (Bo@6 kg/ha) as basal (M_4), PSB+Zn (M_5), PSB+Bo (M_6) and remained statistically at par in protein content and yield in grains during both the years and on pooled basis. The lowest protein yield was observed with the application of control (M_1) during both the years and on pooled basis. Shinde *et al*. (2019).

Interaction effect between fertility levels and micronutrient management practices vary significantly in respect of protein content in grains of chickpea during both the years and on pooled basis.

3.5 Physico-chemical properties of the experimental field

The soil of the experimental field was originated farm alluvial deposits. The soil type and fertility status was determined by the mechanical and chemical analysis of the soil. In order to ascertain physio-chemical properties of the experimental soil, primary soil samples were drawn randomly up to 15cm depth from different spots of the entire experimental area. A representative soil sample was drawn from these samples, which was subjected to mechanical and chemical analysis to ascertain its physio-chemical properties. Methods used for the determination of physical and chemical properties of soil and their outcomes are presented.

Table 1: Procedure followed in mechanical and chemical analysis of experimental soil and their results

Sr. No.	Soil properties	Values (%)		Method of determination	Reference	Remarks
		2017-18	2018-19			
1.	**Mechanical analysis**					
a.	Coarse sand	0.84	0.82	International pipette method	Piper (1966)	-
b.	Fine sand	48.20	48.30	International pipette method	Piper (1966)	-
c.	Silt	24.31	24.42	International pipette method	Piper (1966)	-
d.	Clay	26.65	26.46	International pipette method	Piper (1966)	-
e.	Textural class	Sandyloam		Triangular method	-	-
2.	**Chemical analysis**					
a.	Organic carbon (%)	0.42	0.41	Walkley and Black's rapid titration method	Jackson (1967)	Medium
b.	Available N (kg/ha)	228.20	228.75	Alkaline potassium permanganate method	Subbaiha and Asija (1956)	Low
c.	Available P (kg/ha)	13.07	13.12	Olsen's calorimetrically method	Olsen *et al.* (1954)	Medium
d.	Available K (kg/ha)	173.76	173.75	Flame photometer method	Jackson (1967)	Medium
e.	Available Zn (mg-ha-^{1})	1.2	1.3	Spectrophoto metric method	Kiran (2012)	Low
f.	Soil pH	7.72	7.70	Electrometric glass electrode method	Piper (1966)	Slightly alkaline
g.	EC (ds/m)	0.131	0.129	Electrometric glass electrode method	Jackson (1967)	-

Table 2: Effect of fertility levels and micronutrient management practices on NPK content in grain of chickpea

Treatment	NPK content in grain								
	N Content (%)			P Content (%)			K Content (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels									
F_1	3.19	3.22	3.20	1.33	1.38	1.35	0.65	0.66	0.65
F_2	3.15	3.19	3.17	1.32	1.35	1.34	0.64	0.65	0.64
F_3	3.12	3.16	3.14	1.31	1.34	1.32	0.63	0.64	0.63
S Em ±	0.01	0.01	0.01	0.004	0.005	0.003	0.002	0.002	0.002
CD at 5%	0.04	0.04	0.03	0.02	0.04	0.02	0.02	0.02	0.02
Nutrient management practice									
M_1	3.01	3.04	3.03	1.26	1.28	1.27	0.60	0.61	0.61
M_2	3.16	3.19	3.17	1.32	1.35	1.34	0.63	0.64	0.64
M_3	3.17	3.20	3.18	1.33	1.36	1.35	0.64	0.65	0.65
M_4	3.18	3.21	3.19	1.33	1.37	1.35	0.65	0.66	0.66
M_5	3.18	3.21	3.20	1.34	1.38	1.36	0.65	0.66	0.66
M_6	3.19	3.23	3.21	1.35	1.39	1.37	0.65	0.66	0.65
M_7	3.20	3.24	3.22	1.36	1.42	1.39	0.66	0.67	0.67
SEm ±	0.02	0.02	0.01	0.006	0.07	0.005	0.003	0.003	0.003
CD at 5%	0.04	0.05	0.03	0.02	0.02	0.01	0.01	0.01	0.01
F× M	NS	NS	NS	NS	NS	NS	NS	NS	NS

Where, F1- 100%RDF (20:60:20 NPK Kg/ha), F2-50% RDF+Vermicompost@2.5 t/ha, F3-50% RDF+FYM@5 t/ha, M1- Control, M2- Biofertilizers (PSB@6 Kg/ha) as basal, M3- Micronutrients (Zn@5kg/ha) as basal,M4-Boron (Bo @6 kg/ha) as basal,M5-- PSB + Zn, M6-PSB+Bo,M7-PSB+Zn+BO

Table 3: Effect of fertility levels and micronutrient management practices on NPK content in stover of chickpea

Treatment	NPK content in stover								
	N Content (%)			P Content (%)			K Content (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels									
F_1	2.90	2.93	2.92	0.53	0.54	0.54	1.68	1.70	1.69
F_2	2.88	2.90	2.89	0.52	0.53	0.53	1.67	1.69	1.68
F_3	2.85	2.87	2.86	0.52	0.53	0.52	1.65	1.68	1.66
S Em ±	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.03	0.04	0.02	0.03	0.02	0.02	0.03	0.02	0.03
Nutrient management practice									
M_1	2.74	2.76	2.75	0.50	0.51	0.51	1.59	1.61	1.60
M_2	2.88	2.90	2.89	0.53	0.53	0.53	1.67	1.69	1.68
M_3	2.89	2.91	2.90	0.53	0.54	0.54	1.67	1.70	1.69
M_4	2.89	2.92	2.91	0.54	0.54	0.54	1.68	1.71	1.70
M_5	2.90	2.93	2.92	0.54	0.55	0.55	1.68	1.71	1.70
M_6	2.91	2.94	2.93	0.55	0.56	0.56	1.69	1.72	1.71
M_7	2.92	2.94	2.93	0.56	0.58	0.57	1.70	1.72	1.71
SEm ±	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
CD at 5%	0.03	0.04	0.02	0.02	0.03	0.02	0.05	0.06	0.05
F× M	NS	NS	NS	NS	NS	NS	NS	NS	NS

Where, F1- 100%RDF (20:60:20 NPK Kg/ha),F2-50% RDF+Vermicompost@2.5 t/ha, F3-50% RDF+FYM@5 t/ha, M1- Control, M2- Biofertilizers (PSB@6 Kg/ha) as basal,M3- Micronutrients(Zn@5kg/ha) as basal,M4-Boron (Bo @6 kg/ha) as basal,M5-- PSB + Zn, M6-PS B+Bo, M7-PSB+Zn+BO

Table 4: Effect of fertility levels and micronutrient management practices on nitrogen uptake (kg ha^{-1}) by chickpea crop

Treatment	Grain			Stover			Total		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels									
F_1	69.20	70.90	70.05	80.66	85.11	82.89	149.86	156.01	152.94
F_2	62.91	64.65	63.78	75.90	80.24	78.07	138.81	144.89	141.85
F_3	62.25	64.00	63.12	72.16	76.48	74.32	134.41	140.48	137.44
SEm ±	0.75	0.87	0.57	0.96	1.23	0.78	1.71	2.10	1.35
CD at 5%	2.95	3.41	1.88	3.76	4.82	2.55	6.71	8.23	4.43
Microutrient management practices									
M_1	42.41	43.86	43.14	54.67	58.42	56.55	97.08	102.28	99.69
M_2	62.41	63.91	63.16	73.90	78.00	75.95	136.31	141.91	139.11
M_3	64.26	65.91	65.08	77.62	81.44	79.53	141.88	147.35	144.61
M_4	67.05	68.53	67.79	78.25	83.44	80.85	145.30	151.97	148.64
M_5	68.96	71.11	70.03	81.31	85.60	83.45	150.27	156.71	153.48
M_6	73.15	74.93	74.04	83.54	88.59	86.07	156.69	163.52	160.11
M_7	75.27	77.38	76.33	84.41	88.79	86.60	159.68	166.17	162.93
SEm ±	0.86	1.05	0.68	1.10	1.40	0.89	1.96	2.45	1.57
CD at 5%	2.49	3.01	1.90	3.18	4.02	2.50	5.67	7.03	4.40
F× M	NS	NS	NS	NS	NS	NS	NS	NS	NS

Where, F1- 100%RDF (20:60:20 NPK Kg/ha),F2-50% RDF+Vermicompost@2.5 t/ha, F3-50% RDF+FYM@5 t/ha, M1- Control, M2-Biofertilizers (PSB@6 Kg/ha) as basal,M3- Micronutrients(Zn@5kg/ha) as basal,M4-Boron (Bo @6 kg/ha) as basal,M5-- PSB + Zn, M6-PSB+Bo,M7-PSB+Zn+BO

Table 5: Effect of fertility levels and micronutrient management practices on phosphorus uptake (kg ha^{-1}) by chickpea crop

Treatment	Grain			Stover			Total		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels									
F_1	29.00	29.81	29.40	14.82	15.64	15.23	43.82	45.45	44.63
F_2	26.40	27.38	26.89	13.95	14.71	14.33	40.35	42.09	41.22
F_3	26.12	27.26	26.69	13.27	14.12	13.69	39.39	41.38	40.38
SEm ±	0.33	0.40	0.26	0.27	0.24	0.18	0.60	0.64	0.44
CD at 5%	1.29	1.58	0.85	1.06	0.95	0.59	2.35	2.53	1.44
Microutrient management practices									
M_1	17.78	18.47	18.12	10.05	10.71	10.38	27.83	29.18	28.51
M_2	26.08	27.05	26.57	13.58	14.33	13.96	39.66	41.38	40.53
M_3	26.95	27.99	27.47	14.29	15.00	14.64	41.24	42.99	42.11
M_4	28.15	29.14	28.65	14.39	15.29	14.84	42.54	44.43	43.49
M_5	28.98	29.94	29.46	14.94	15.73	15.34	43.92	45.67	44.80
M_6	30.73	31.70	31.22	15.35	16.28	15.81	46.08	47.98	47.03
M_7	31.55	32.76	32.15	15.52	16.42	15.97	47.07	49.18	48.12
SEm ±	0.39	0.48	0.31	0.33	0.29	0.22	0.72	0.77	0.53
CD at 5%	1.12	1.39	0.88	0.96	0.83	0.62	2.08	2.22	1.50
F× M	NS	NS	NS	NS	NS	NS	NS	NS	NS

Where, F1- 100%RDF (20:60:20 NPK Kg/ha),F2-50% RDF+Vermicompost@2.5 t/ha, F3-50% RDF+FYM@5 t/ha, M1- Control, M2-Biofertilizers (PSB@6 Kg/ha) as basal,M3- Micronutrients(Zn@5kg/ha) as basal,M4-Boron (Bo @6 kg/ha) as basal,M5-- PSB + Zn, M6-PSB+Bo,M7-PSB+Zn+BO

Table 6: Effect of fertility levels and micronutrient management practices on potassium uptake (kg ha^{-1}) by chickpea crop

Treatment	Grain			Stover			Total		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels									
F_1	13.80	14.17	13.98	46.69	49.64	48.17	60.49	63.81	62.15
F_2	12.91	13.32	13.11	44.01	46.82	45.42	56.92	60.14	58.53
F_3	12.78	13.22	13.00	41.90	44.76	43.33	54.68	57.98	56.33
SEm ±	0.16	0.19	0.12	0.64	0.67	0.46	0.80	0.86	0.58
CD at 5%	0.64	0.75	0.41	2.50	2.61	1.51	3.14	3.36	1.72
Microutrient management practices									
M_1	8.49	8.77	8.63	31.71	34.10	32.91	40.20	42.87	41.54
M_2	12.51	12.85	12.68	42.80	45.49	44.14	55.31	58.34	56.82
M_3	13.03	13.45	13.24	44.99	47.55	46.27	58.02	61.00	59.51
M_4	13.68	14.10	13.89	45.37	48.67	47.02	59.05	62.77	60.91
M_5	14.08	14.52	14.30	47.06	49.92	48.49	61.14	64.44	62.79
M_6	14.94	15.38	15.16	48.46	51.83	50.14	63.40	67.21	65.30
M_7	15.40	15.93	15.66	49.01	51.99	50.50	64.41	67.92	66.16
SEm ±	0.23	0.26	0.17	0.70	0.74	0.51	0.93	1.00	0.68
CD at 5%	0.67	0.76	0.50	2.02	2.14	1.44	2.69	2.95	1.94
F× M	NS	NS	NS	NS	NS	NS	NS	NS	NS

Where, F1- 100%RDF (20:60:20 NPK Kg/ha),F2-50% RDF+Vermicompost@2.5 t/ha, F3-50% RDF+FYM@5 t/ha, M1- Control, M2-Biofertilizers (PSB@6 Kg/ha) as basal,M3- Micronutrients(Zn@5kg/ha) as basal,M4-Boron (Bo @6 kg/ha) as basal,M5-- PSB + Zn, M6-PSB+Bo,M7-PSB+Zn+BO

Table 7: Effect of fertility levels and micronutrient management practices on protein content and protein yield of chickpea

Treatment	Protein content (%)			Protein yield (kg/ha)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels						
F_1	22.84	22.88	22.86	470.54	478..35	474.45
F_2	21.58	21.70	21.64	454.46	463.84	459.15
F_3	21.20	21.23	21.21	422.17	429.57	425.87
SEm ±	0.06	0.07	0.05	3.05	4.04	2.70
CD at 5%	0.24	0.30	0.16	13.96	15.79	8.80
Micronutrient Management Practices						
M_1	20.94	20.96	20.95	294.47	301.63	298.05
M_2	21.60	21.91	21.75	431.42	439.18	435.30
M_3	21.89	21.96	21.92	454.15	461.91	458.03
M_4	21.98	22.02	22.00	458.47	466.11	462.29
M_5	22.10	22.13	22.11	478.80	486.81	482.80
M_6	22.10	22.13	22.11	505.41	513.32	509.36
M_7	22.53	22.44	22.48	520.70	531.82	526.26
SEm ±	0.09	0.12	0.07	3.81	4.74	3.04
CD at 5%	0.27	0.35	0.21	10.94	13.60	8.51
F× M	NS	NS	NS	NS	NS	NS

Where, F1- 100%RDF (20:60:20 NPK Kg/ha),F2-50% RDF+Vermicompost@2.5 t/ha, F3-50% RDF+FYM@5 t/ha, M1- Control, M2-Biofertilizers (PSB@6 Kg/ha) as basal,M3- Micronutrients(Zn@5kg/ha) as basal,M4-Boron (Bo @6 kg/ha) as basal,M5-- PSB + Zn, M6-PSB+Bo,M7-PSB+Zn+BO

4. Conclusion

application of 100%RDF (20:60:20NPK kg/ha) fertility levels and PSB+Zn+Bo soil application showed beneficial effect on the performance of chickpea followed by 50%RDF+Vermicompost@2.5t/ha and PSB+Zn+Bo was found at par Application of PSB+Bo, PSB+Zn, Boron (Bo@6kg/ha) as basal, Micronutrients (Zn@5kg/ha)as basal and Biofertilizers (PSB@6kg/ha) as basal inoculation were soil application remained at par in nutrient content, uptake,protein content and protein yield of chickpea. The physico-chemical properties of soil after harvest of crop were improved by the application of inorganic fertilizers along with bio-fertilizers. Thus it may be concluded that application of PSB+Zn+Bo or PSB+Bo along with bio-fertilizers is good option for achieving higher content uptake and quality of chickpea crop and improving the physico-chemical properties of soil.

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