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Combined effect of bio-fertilizer and micronutrients on fertility, growth and productivity of chickpea

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Abstract
This 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) to assess "the combined effect of fertility levels, bio-fertilizer and micronutrients on growth and productivity of chickpea". 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 (20:60:20 NPK 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). Chickpea variety *KWR-108* was grown with the recommended agronomic practices. The treatments effect was monitor in terms of crop growth and productivity of chickpea rabi season.

Keywords: Bio fertilizer, fertility level, growth, micronutrients

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) [20] and is the third most important pulse crop in the world, which is grown in almost all the continents except Antarctica. In India, it is premier pulse crop grown largely under rainfed conditions. 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). The Recommended dietary Allowances (RDA) for adult male and female is 60 g and 55 g per day respectively. The per capita availability of pulse is @ 52.9 g per day and per capita per year 19.3kg requirement. (Source: Press Information Bureau, Ministry of Agriculture & Farmers Welfare 2017-18). Chickpea crop since, fertilizer nutrients constitute a major costly production input, exploitation of yield potentiality of this crop depends on how efficiently and effectively this input in managed.

Inorganic fertilizer alone cannot sustain the soil productivity as well as the large scale use of only chemical fertilizers as a source of nutrient has, less efficient (Kumar *et al*. 2003). In recent years biofertilizers are ecofriendly and low cost inputs, have emerged as an important and integral component of integrated plant nutrients supply system for pulse crop production. Hence, to combat this problem and to sustain food production the present investigation was carried out to find out the appropriate integrated nutrient management including inorganic fertilizers, and biofertilizers for growth and productivity of chickpea.

Materials and Methods

The experiment was conducted in field number 8 at Students' Instructional Farm, Department of Agronomy of this University, which is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25º 26' to 26º58' North latitude and 79º 31' to 80º34'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 44-47ºC or beyond and during winter go down to 2-3 ºC. 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 (ºC), relative humidity (%), wind velocity (km/hr), evaporation rate (mm/day) and total rainfall (mm) recorded during the crop growth period (2017-18 and 2018-19). The experiment was laid out in split plot design with three replication saving fertility -3 levels (100% RDF (20:60:20 NPK Kg/ha), 50% RDF + Vermocompost @2.5 t/h and 50% RDF + FYM @5t/ha) in main plots and micronutrient management with seven levels (Control, Biofertilizers (PSB @ 6Kg/ha) as basal, Micronutrients (Zn @5 kg/ha) as basal, Boron (Bo @6 kg /ha) as basal, PSB + Zn, PSB + Bo and PSB + Zn +Bo) at the time of sowing. The twenty one treatment combinations were allotted in each experiment plots randomly. Chickpea cultivar KWR-108 was sown at 45x10 cm crop geometry with the seed rate of 100kg/ha apart during the third week of October. Fallow the standerd on growth of chickpea.

Result and Discussion

Different fertility level brought about significant improvement in growth parameters of chickpea i.e. plant height, No of nodules/plant, fresh weight of nodules/plant, dry weight of nodules/plant, Root fresh weight/plant, Root dry weight/plant, at successive growth stages (60DAS and at harvest) over fertility level during both the years At 60 days stage, the plant height was not significantly influenced by fertility levels however, maximum plant height was observed with 100%RDF (20:60:20NPK kg/ha) (F_1) followed by 50%RDF+Vermicompost@2.5t/ha (F_2) at fertility level during both the years. The chickpea plants were taller with more dry weight /plant when grown with fertility level during both the years. Chickpea fertility on an average attained maximum plant height of 53.88 cm, closely followed by fertility levels (51.83 cm) at harvest stage. These three fertility level had significantly taller chickpea plant over fertility of chickpea. This is probably due to adequate moisture supply during critical growth stages. Moisture during critical growth stages to the plant favourably influenced the metabolic activities in terms of higher rate of cell enlargement which directly reflected into better plant growth regarding plant height. Similar positive effect of fertility on growth of chickpea had been reported by Begum and agarwal (2011), Zaki *et al.* (2013) and Imdad et al. (2015).

Maximum number of root nodules per plant, fresh weight of nodules/plant and dry weight of root nodules/plant (Table 4.3) was observed under application of fertility levels 100% RDF (20:60:20 NPK kg/ha) (F_1) followed by fertility levels 50%RDF+Vermicompost@2.5t/ha (F_2). Chickpea adds micronutrients in soil through symbiotic process by *PSB* bacteria. The optimum supply of moisture as well as aeration enhanced the root development and nodulation. These findings are in agreement with those reported by Begum and agrawal (2011) and Meena *et al. (*2001) [17].

In general, Root fresh weight/plant, Root dry weight/plant and root length/plant was observed under application of fertility levels 100% RDF (20:60:20NPK kg/ha) (F_1) followed by fertility levels 50% RDF+Vermicompost@2.5t/ha (F_2). Chickpea adds micronutrients in soil through symbiotic process by PSB bacteria. The optimum supply of moisture as well as aeration enhanced the root fresh weight/plant, root dry weight/plant and root length/plant development. These findings are in agreement with those reported by Zaki *et al.* (2013) and Jat and Ahlawat. (2004).

Table 1: Effect of fertility levels and micronutrient management practices on plant height of chickpea

Treatment	Crop growth stages					
	60DAS			At maturity		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility level						
F_1	23.65	23.80	23.72	53.75	54.01	53.88
F_2	23.12	23.35	23.24	51.78	51.88	51.83
F_3	23.02	23.22	23.14	49.86	50.11	49.98
S Em ±	0.24	0.26	0.18	0.50	0.54	0.37
CD at 5%	NS	NS	NS	1.97	2.13	1.21
Micronutrient management Practices						
M_1	20.95	21.14	21.05	47.68	46.91	47.29
M_2	22.40	22.58	22.49	48.29	49.83	49.06
M_3	23.17	23.34	23.26	51.43	53.02	52.18
M_4	23.52	23.66	23.59	52.11	52.25	52.22
M_5	24.04	24.21	24.13	52.61	52.82	52.72
M_6	24.21	24.46	24.34	53.66	53.73	53.69

M7	24.54	24.81	24.73	55.26	55.01	55.13
SEm ±	0.34	0.36	0.25	1.01	1.02	0.72
CD at 5%	0.98	1.05	0.70	2.92	2.94	2.02
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.

Table 2: Effect of fertility levels and micronutrient management practices on number of nodules/ plant of chickpea

Treatment	No of Nodules/plant			Fresh weight of Nodules/Plant (g)			Dry weight of Nodules/Plant (g)		
	60 DAS			60 DAS			60DAS		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	18-19	Pooled
Fertility levels									
F_1	25.77	25.94	25.86	1.80	1.81	1.81	0.71	0.72	0.72
F_2	25.12	25.81	25.47	1.75	1.80	1.78	0.67	0.71	0.69
F_3	25.16	25.40	25.28	1.76	1.77	1.76	0.67	0.69	0.68
SEm ±	0.29	0.18	0.17	0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Micronutrient Management									
M_1	23.93	24.50	24.42	1.70	1.71	1.70	0.59	0.63	0.62
M_2	24.34	25.18	24.56	1.67	1.76	1.72	0.61	0.67	0.63
M_3	25.43	25.61	25.52	1.78	1.79	1.78	0.69	0.70	0.69
M_4	25.61	25.84	25.72	1.79	1.81	1.80	0.70	0.72	0.71
M_5	25.86	26.06	25.96	1.81	1.82	1.81	0.72	0.73	0.72
M_6	26.03	26.25	26.14	1.82	1.83	1.82	0.73	0.74	0.73
M_7	26.26	26.59	26.42	1.83	1.86	1.84	0.74	0.77	0.75
SEm ±	0.49	0.30	0.29	0.02	0.02	0.01	0.26	0.02	0.01
CD at 5%	1.40	0.88	0.81	0.05	0.07	0.04	0.07	0.05	0.04
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 root fresh and dry weight/plant of chickpea

Treatment	Root fresh weight/plant (g)			Root fresh weight/plant (g)			Root dry weight/plant (g)			Root dry weight/plant (g)		
	60DAS			At harvest			60DAS			At harvest		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Fertility levels												
F_1	2.54	2.65	2.59	3.99	4.35	4.17	0.63	0.65	0.64	1.13	1.23	1.18
F_2	2.29	2.49	2.39	3.84	4.22	4.03	0.59	0.61	0.61	1.08	1.19	1.14
F_3	1.96	2.11	2.04	3.76	4.15	3.95	0.58	0.61	0.60	1.06	1.08	1.07
SEm ±	0.06	0.04	0.04	0.07	0.08	0.05	0.01	0.01	0.01	0.02	0.03	0.02
CD at 5%	0.25	0.18	0.13	NS	NS	NS	NS	NS	NS	NS	NS	NS
Micronutrient Management												
M_1	1.97	2.03	1.95	2.74	3.11	2.92	0.42	0.44	0.43	0.77	0.88	0.83
M_2	2.05	2.21	2.13	3.45	3.84	3.65	0.57	0.59	0.58	0.98	1.09	1.03
M_3	2.22	2.26	2.24	3.77	4.15	3..96	0.59	0.61	0.60	1.06	1.17	1.12
M_4	2.25	2.41	2.33	3.96	4.34	4.15	0.61	0.64	0.63	1.18	1.20	1.19
M_5	2.33	2.49	2.41	4.18	4.57	4.38	0.66	0.68	0.67	1.24	1.23	1.24
M_6	2.48	2.64	2.56	4.40	4.78	4.59	0.68	0.70	0.69	1.25	1.29	1.27
M_7	2.63	2.90	2.77	4.53	4.89	4.71	0.69	0.72	0.70	1.28	1.31	1.29
SEm ±	0.12	0.12	0.08	0.12	0.14	0.09	0.02	0.02	0.02	0.03	0.05	0.03
CD at 5%	0.35	0.35	0.24	0.36	0.40	0.26	0.07	0.07	0.05	0.11	0.14	0.09
F× M	NS	NS	NS	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

Significant differences in growth parameters *viz.*, plant height, Number of Nodules/plant, Fresh weight of Nodules/plant, Dry weight of Nodules/plant, Root Fresh weight/plant, Root dry weight/plant, growth stages of chickpea were observed due to micronutrient management practices during both the years On an average, these growth parameters were significantly higher due to the application PSB+Zn+Bo (M_7) soil application over rest of the micronutrient management practices. This is because of better synthesis of chlorophyll in leaves since biofertilizer contain appreciable quantities of magnesium apart from other nutrients, which might have helped in synthesis of chlorophyll. These findings corroborate the results of Arya *et al.* (2007) and Prasad *et al.* (2008).

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