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Response of Chickpea (*Cicer arietinum* L.) Cultivars to Organic Sources of Plant Nutrients

Bharat Lal Kushwaha*, V. K. Singh, Kaptan Baboo, Satya Dev and Hari Prakash Namdev

Department of Agronomy, Brahmanand P.G.College, Rath, Hamirpur, Uttar Pradesh, India

**Corresponding author*

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A B S T R A C T

The present investigation was conducted with the objective to know the effect of nutrient management modules on nutrient uptake, quality and economics of high yielding varieties of chickpea (*Cicer arietinum* L.). The study comprised six treatments of nutrient management modules (a) F_1- FYM@10 t ha^{-1}, (b) F_2- Vermicompost @ 5 t ha^{-1}, (c) F_3- Poultry manure @ 5t ha^{-1}, (d) F_4- Chemical check 20+60+20+20 kg NPKS ha^{-1} as basal application, (e) F_5- Vitormone @125ml ha^{-1} as foliar application, (f) F_6- Control and four varieties (a) V_1- Pragati (K-3256), (b) V_2- Pusa- 256, (c) V_3- Avrodhi, (d) V_4- Pant G-186. The study revealed that the nutrient management modules F_2- Vermicompost @ 5 t ha^{-1}) found suitable for maximum biometric parameters, yield and quality of chickpea with variety V_3- Avrodhi. However, the higher B:C ratio was higher with F_5- Vitormone @125ml ha^{-1} as foliar application, which was statistically at par with F_2- Vermicompost @ 5 t ha^{-1} and significantly higher than the other fertilizer modules. The maximum B: C ratio found with V_3- Avrodhi which was significantly superior over V_1- Pragati (K-3256), and V_4- Pant G -186. It remained at par with V_2- Pusa- 256. Thus it may be concluded that V_3- Avrodhi fertilized with F_5- Vitormone @125ml ha^{-1} as foliar application may be found highest economic value of chickpea in Bundelkhand region of Uttar Pradesh.

Introduction

Chickpea (*Cicer arietinum* L.) is an important grain legume crop in the world which was globally, total production is approximately 14.2 million tons from an area of 14.8 million ha and a productivity of 0.96 t ha^{-1} FAOSTAT, (2014). South East Asia, led by India is leading producers, while in East Africa, Ethiopia, Tanzania, Malawi, and Kenya are leading chickpea producers. Worldwide chickpea is largely grown as a rain fed crop (> 90%) in the arid and semi-arid environments in Asia and Africa. Chickpea, almost in all regions, is grown on marginal soils and the good soils are used for growing other more favored crops. For obtaining high grain yields proper management of the crop is must and proper nutrient management is one of the important factors contributing towards high productivity. Though chickpea, being a grain legume, is capable of fixing atmospheric nitrogen, a starter dose of nitrogen is essential for proper growth and development of the plant. Chickpea grain yields are known to improve with the application of nitrogen Namvar *et al.,* (2011), Yagmur and Kaydan, (2011). Phosphorus plays an important role in nodulation, nitrogen fixation, growth and yield of chickpea Singh *et al.,* (2010).

Low soil fertility is one of the major factors responsible for low yield of crops including chickpea. Inadequate supply of nutrients aggravates nutrient depletion of soils. Higher chemical fertilizers price coupled with the low affordability by small farmers is the biggest obstacle for fertilizer use in the marginal lands. Furthermore, global warming is the major threat for the depletion of the soil organic carbon i.e. the main skeleton of soil fertility and productivity. Farmers of the region now realize the importance of soil organic carbon. This scenario drives the use of organic manures, which are environmentally friendly and at the same time improves and maintains soil fertility. However, sole application of farmyard manure is constrained by access to sufficient organic inputs, low nutrient content of manures, high labor demand for preparation and transportation. These constraints can be solved by the substitution of organic sources containing higher amount of plant nutrients, which can improve and sustain crop yields while improving soil fertility status. Though chickpea meets 80% of its nitrogen requirement from symbiotic nitrogen fixation, application of fertilizer is important as starter until the nodulation operates synchronously to fix the atmospheric N (Gaur *et al.,* 2010). The crop also requires balanced and optimum amounts of other nutrient elements such as phosphorus, potassium, sulfur and micro nutrients (Dhakal *et al.,* 2016). So, it is necessary to apply balanced nutrients from easily available sources of organic to sustainably improve the productivity of chickpea.

There was, therefore, a need to study the effect of nutrient application through various sources on the productivity of chickpea. The present study was undertaken to investigate the effect of application of farmyard manure, vermicompost and chemical fertilizers in chickpea.

Materials and Methods

The experiment was conducted at Research Farm, Brahmanand P.G. College, Rath, Hamirpur situated in the vicinity of Kanpur city. Geographically experimental site situated in the longitude and latitude range of 79.7^{o} East and 25.2^{o} North, respectively. The altitude of Rath is 165 m above mean sea level. The climate of Rath is semi-arid and subtropical type. Among the 15 broad agro-climatic zones identified by Indian Planning Commission of India, Rath (Hamirpur) falls in Central Plateau and Hill region. This, region receives an average annual rainfall of about 1000 mm. The rainfall is erratically distributed.

Major rains are received from mid-June to end of September. Summer is hot and dry. Westerly hot winds start from the month of March and continue up to onset of monsoon. Winter months are cold and occasional frost occurs during this period. And during the crop season, the minimum and maximum temperature varied from 6.4 to 23.6 °C and 19.7 to 42.8 °C, respectively. Total rainfall received during the crop period was 45.7 mm.

Relative humidity was the maximum in the month of February during the crop period. The sunshine ranged from 0.5-10.2 hours. The soil is sandy to sandy loam with a pH of 7.8 and 0.52% organic C. Soil low in available N (218.03 kg ha^{-1}), medium in available P (21.59 kg ha^{-1}) and medium in available K (205.57 kg ha^{-1}). The treatment was carried out with 24 treatment combination formed with six nutrient management levels and four varieties of chickpea which were allocated in RBD with three replications. The six nutrient management modules (a) F_1- FYM@10 t ha^{-1}, (b) F_2- Vermicompost @ 5 t ha^{-1}, (c) F_3- Poultry manure @ 5t ha^{-1}, (d) F_4- Chemical check 20+60+20+20 kg NPKS ha^{-1} as basal application, (e) F_5- Vitormone @125ml ha^{-1} as foliar application, (f) F_6- Control and four varieties (a) V_1- Pragati (K-3256), (b) V_2- Pusa- 256, (c) V_3- Avrodhi, (d) V_4- Pant G - 186.

The crop sowing was done @ 80Kg seed ha^{-1}. The crop was shown on 18th Nov. 2015 and 25th Oct. 2016. The seeds were sown by hand hoe at the depth of 6-8 cm. The distance between two rows was maintained 45 cm. Irrigations was scheduled on the basis of critical stages i.e. pre-flowering stage. The crop was harvested 140 days after sowing.

The biometric observations such as plant height (cm), branches $plant^{-1}$ and number of pods $plant^{-1}$ were measured at maturity, were recorded from five randomly selected plants. From the total produce of each plot, 1000 seeds were counted to record data as test weight (g). Whereas, the yield were recorded on net plot basis and converted to q ha^{-1}. However, protein content in grain was calculated by multiplying nitrogen content in grain with the factor of 6.25. Micro-Kjeldahl's method was followed for determination of nitrogen content in grain. The statistical analysis was done by using Randomized Block Design suggested by Gomez and Gomez (1984).

Results and Discussion

The plant height, number of branches $plant^{-1}$ and dry matter accumulation were significantly higher with the application of vermicompost 5 t ha^{-1}**,** followed by Vitormone 125 ml ha^{-1} which might be due to the increase in plant growth which attributed to the increase in the availability of nutrients with application of inorganic fertilizer, continuous supply of macro and micro nutrients from vermicompost, which helped in acceleration of various metabolic processes viz., photosynthesis, might have energy transfer reaction and symbiotic biological N–fixation process, which resulted in better growth attributes.

Whereas, vitormone is combination of plant growth hormones in combination of micro organisms absorbed through stomata openings. Which is directly enters into the plant physiological process and made other nutrient available for plant growth (Singh *et al.,* 2010).

Plant height increased progressively with the progression of plant growth. Avrodhi variety produced the taller plant at harvest stage, year, and pooled in which varieties showed significant differences. Karasu *et al.,* (2009) showed maximum plant height was recorded on popular local genotype of chickpea named Yearly, Canıtez-87 cultivar and ILC-114 line had shorter plant height.

Application of micronutrients, plant growth hormones, organic and inorganic sources of nutrients on nutrient uptake, yield and quality of chickpea, showed significant effect on yield attributing characters i.e. pods $plant^{-1}$, seeds $plant^{-1}$, test weight etc. Application of vermicompost 5 t ha^{-1} produced significantly higher value of this parameter over other treatments. But, it was noticed at par with vitormone 125 ml ha^{-1}. Enhancement in yield attributes may be because of ideal conditions for soil microflora with the application of vermicompost, vitormone and maintenance of good tilth, resulted in better response. Results are also in close agreement with the findings of Amiri *et al.,* (2017) (Table 1 and 2).

Table.1 Effect of varieties and organic sources of nutrient on plant height (cm) and yield attributes of chickpea

	Plant height (cm)			Branches plant^{-1}			Number of pods plant^{-1}			Test weight (g)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Varieties												
Pragati (K-3256)	53.46	52.61	53.03	5.78	5.80	5.79	101.22	100.53	100.87	193.67	194.50	194.08
Pusa-256	55.00	55.90	55.45	5.95	5.95	5.95	103.11	105.68	104.40	195.00	195.83	195.42
Avrodhi	55.67	58.67	57.17	6.00	5.88	5.94	106.72	109.81	108.26	196.50	195.50	196.00
Pant G -186	54.17	55.12	54.65	5.86	5.92	5.89	103.79	105.00	104.40	194.89	195.50	195.19
S. E(m)±	0.15	0.66	0.59	0.03	0.09	0.08	1.40	0.75	1.37	0.25	0.23	0.29
C.D. (p=0.05)	0.41	1.85	1.68	0.09	0.24	0.23	3.91	2.10	3.92	0.71	0.64	0.84
Nutrient Management												
Control	50.43	45.43	47.93	5.45	5.50	5.48	94.60	94.34	94.47	188.50	186.75	187.63
FYM 10 t ha^{-1}	55.00	57.58	56.29	5.98	6.00	5.99	105.17	109.04	107.10	196.00	196.75	196.38
Vermicompost 5 t ha^{-1}	57.25	61.73	59.49	6.10	6.15	6.13	111.36	113.68	112.52	200.50	201.50	201.00
Poultry Manure 5 t ha^{-1}	55.00	55.50	55.25	5.95	5.98	5.96	102.08	103.36	102.72	194.58	195.00	194.79
20, 60, 20 kg NPK ha^{-1}	53.50	53.32	53.41	5.89	5.90	5.90	100.01	99.76	99.89	192.00	192.50	192.25
Vitormone 125 ml ha^{-1} (Foliar)	56.25	59.91	58.08	6.03	5.80	5.91	109.04	111.36	110.20	198.50	199.50	199.00
S. E(m)±	0.18	0.81	0.52	0.04	0.11	0.07	1.71	0.92	1.23	0.31	0.28	0.26
C.D. (p=0.05)	0.51	2.26	1.50	0.11	0.30	0.21	4.78	2.57	3.51	0.87	0.78	0.75

Table.2 Effect of varieties and organic sources of nutrient on yield, quality B: C ratio of chickpea

	Seed yield q ha^{-1}			**Stover yield q ha^{-1}**			**Protein content (%)**			**B:C ratio**		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Varieties												
Pragati (K-3256)	18.28	18.77	18.52	21.02	22.46	21.74	17.42	16.66	17.04	1.70	1.75	1.72
Pusa-256	19.67	20.39	20.03	21.59	23.06	22.32	18.13	19.07	18.60	1.82	1.89	1.86
Avrodhi	20.68	21.67	21.17	22.31	23.82	23.07	18.38	19.87	19.12	1.91	2.01	1.96
Pant G -186	19.40	20.20	19.80	21.76	23.16	22.46	17.83	18.38	18.11	1.80	1.87	1.84
S. E(m)±	0.13	0.03	0.12	0.04	0.03	0.04	0.05	0.35	0.30	0.01	0.003	0.010
C.D. (p=0.05)	0.36	0.08	0.33	0.10	0.09	0.12	0.13	0.97	0.87	0.03	0.007	0.029
Nutrient Management												
Control	16.77	17.92	17.34	19.77	21.17	20.47	15.94	13.16	14.55	1.75	1.87	1.81
FYM 10 t ha^{-1}	20.09	20.66	20.37	22.17	23.67	22.92	18.25	18.83	18.54	1.68	1.73	1.71
Vermicompost 5 t ha^{-1}	20.43	21.31	20.87	22.73	24.20	23.47	19.21	22.46	20.83	1.79	1.87	1.83
Poultry Manure 5 t ha^{-1}	19.86	20.62	20.24	21.42	22.93	22.18	17.71	18.20	17.95	1.76	1.83	1.79
20, 60, 20 kg NPK ha^{-1}	20.09	19.86	21.21	22.72	21.96	17.44	16.79	17.11	1.84	1.89	1.86	192.25
Vitormone 125 ml ha^{-1} (Foliar)	20.93	20.61	22.71	24.05	23.38	19.08	21.54	20.31	2.02	2.09	2.06	199.00
S. E(m)±	0.04	0.10	0.04	0.04	0.04	0.06	0.43	0.27	0.01	0.003	0.009	0.26
C.D. (p=0.05)	0.10	0.30	0.13	0.11	0.11	0.16	1.19	0.78	0.04	0.009	0.026	0.75

There was significant variation among gram cultivars regarding the parameters of number of pods plant^{-1}, seed weight plant^{-1} and test weight. Among cultivars, Avrodhi produced significantly highest all the parameters than other cultivars. Ali *et al.,* (2010) showed that among the performance of six brown chickpea (*Cicer arietinum* L.) genotypes viz. 90261, 93127, 97086, 98004, 98154, genotype 98004 expressed comparatively more pods plant^{-1} (77.58). Kabir *et al.,* (2009) said the highest number of seeds within individual pod was found in BARI Chhola-4 and it was closely followed by BARI Chhola-2. The lowest number of seeds pod^{-1} was found in BARI Chhola-6. BINA (2012) showed in Magura, highest 1000 seed weight produced form BINA Chhola-6 (148.05 g). Karasu *et al.,* (2009) showed that the effects of cultivars were statistically significant at 1% probability level on the 1000 seed weight. While maximum 1000 seed weight was obtained from Canıtez- 87 cultivar (498.2 g) and popular local genotype Yerli (497.9 g), ILC-114 line had fewer 1000 seed weight (446.8 g).

Chickpea is one of the most important pulses crops of India. The production of any crop can be increase and optimum production can only be obtained by judicious use of suitable genotype with environment and agronomic management practices. Physiological phenomenon and plant growth pattern form an important basis in crop management and productivity maintenance by proper soil moisture, reduction of crop weed competition and supply of adequate amount of required nutrients through organic and inorganic plant nutrient approaches in the soil is essential for obtaining high yield of crop.

Plant growth hormone, organic and inorganic sources of nutrients significantly influenced the grain yield of chickpea. Application vermicompost 5 t ha^{-1} was significantly superior; it may be ascribed due to better plant growth and yields such as grain, stover and biological. The increment in supply of essential elements through organic and inorganic sources, their availability, mobilization and influx into the plant tissues increased and thus, improved growth and yield components and finally the grain yield of chickpea. The results are also corroborated the findings of Amiri *et al.,* (2017).

Seed and stover yields varied significantly among the four varieties V_1 Pragati (K-3256), V_2 (Pusa-256), V_3 (Avrodhi) and V_4 (Pant G-186). The highest seed and stover yields were found in Avrodhi, which was significantly superior over rest of the varieties. It is attributed due to the increased the number of primary and secondary branches per plant, increased number of pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight, the grain and biological yield ultimately increased of chickpea yields. Kabir *et al.,* (2009) observed seed yield per hectare BARI Chhola-4 produced the highest seed yield. The second highest yield was recorded in BARI Chhola-6.

Micronutrients, biofertilizers, organic and inorganic sources of nutrients on protein content in seeds was noticed significantly higher in vermicompost 5 t ha^{-1} in seed (19.21, 22.46 and 20.83% during 2015-16, 2016-17 and pooled, respectively) statistically at par with vitormone 125 ml ha^{-1} (19.08, 21.54 and 20.31% during 2015-16, 2016-17 and pooled, respectively, and both were significantly superior over the rest of the treatments. This might be due to increased in biological nitrogen fixation under these treatments due to supplementation of Mo which favored nitrogenase activity thereby increased N fixation and uptake by plants which resulted in higher N and crude protein in compared to the other treatments**.** N content because protein content was computed by multiplying the N content in seeds with 6.25.The results of similar kind were also reported by Quddus *et al.*, (2018).

Protein content varied significantly among the varieties V_1 Pragati (K-3256), V_2 (Pusa-256), V_3 (Avrodhi) and V_4 (Pant G-186). The highest protein content was found in V_3 (Avrodhi), which was statistically similar with V_3 (Avrodhi), it was significantly superior over rest of the varieties. The results are also corroborated with the findings of Quddus *et al.*, (2018).

B:C ratio is the ratio of gross return and cost of cultivation. The maximum net return and B:C ratios was obtained with vitormone 125 ml ha^{-1} and was significantly higher over rest of the treatment. Vitormone is growth enhancer which contains combinations of growth hormones and beneficial microorganisms with cheaper price. The treatment has ability to produce at par yield of the vermicompost 5 t ha^{-1} and higher yield over other treatments. The combination of cheaper price and higher yields might be the reason for maximum return with higher B:C ratios and proving the beneficial response of these inputs for Bundelkhand soils.

Chickpea variety Avrodhi (V_3) showed maximum B:C ratio which was significantly superior over rest of the varieties. It was followed by V_2 (Pusa-256) and was significantly superior over rest of the two varieties V_1 Pragati (K-3256) and V_4 (Pant G-186). It was attributed due to the yield potential of the tested varieties were differ significantly and thus the cost of produce varies significantly. Whereas, the cost of cultivation for all the tested varieties was same might be the basic reason for variation in economics of varietal treatments. The results are also in support of findings of Nagarajaiah *et al.*, (2005).

On the basis of overall results obtained from the present investigation it is concluded that organic and inorganic fertilizers played an important role on growth, yield, quality and its benefit cost ratio of chickpea production. Variety Avrodhi produce higher yields with when it is fertilized with vermicompost @ 5 t ha^{-1}. However, it's B:C ratio may be augmented by the application of vitormone @ 125 ml ha^{-1}.

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