Research Journal of Agricultural Sciences
An International Journal
www.rjas.org
Res. Jr. of Agril. Sci. **12**(1): 246–249
P- ISSN: 0976-1675 | **E-** ISSN: 2249-4538
Research Paper

Nutrient Recovery of Chickpea (*Cicer aeritinum* L) Cultivars as Influenced by Organic and Inorganic Sources of Plant Nutrients

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Received: 30 Nov 2020 | Revised accepted: 16 Jan 2021 | Published online: 01 Feb 2021

A B S T R A C T

The present investigation was conducted with the objective to know the Effect of integrated 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- Varmicompost @ 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, F_5- Vitormone @125ml ha^{-1} as foliar application, (d) 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- (Varmicompost @ 5 t ha^{-1}) found suitable for maximum yield and nutrient uptake of chickpea with variety V_3- Avrodhi. However, the higher IUE_{NPK} was associate with higher with F_3- Poultry manure @ 5 t ha^{-1} among the organic and inorganic sources of plant nutrients, however, the highest is with control. This, was statistically at par with F_2- and significantly higher than the other fertilizer modules. The maximum IUE_{NPK} found with V_1- Pragati (K-3256) which was significantly superior over V_2- Pusa- 256, and V_3- Avrodhi. It remained at par with V_4- Pant G-186. Thus, it may be concluded that V_3- Avrodhi fertilized with F_2- (Varmicompost @ 5 t ha^{-1}) may be sustainable chickpea production in Bundelkhand region of Uttar Pradesh.

Key words: *Cicer aeritinum*, Nutrient recovery, Plant nutrients, Organics

The world food availability is usually debated in terms of cereals, wheat, rice and maize are being the dominant, but pulses (legume grains) are second group of crops and makes major contribution to human diet in developing countries in tropical and subtropical areas. It has paramount importance as a large segment of the populations in these areas have limited access to food of animal origin. In general, pulse crops are energy rich plants but are cultivated largely under energy starvation conditions and more than 92 percent of the area under pulses is still under rainfed. The lower mean productivity of these crops is mainly due to cultivation with little or no monetary inputs in marginal drought prone lands [1].

Dry areas account for about 40% of the earth's surface land area. Whether arid or semiarid, these are fragile environmentally and are defined by the absence of rain or low rainfall, often with variable distribution. Low soil fertility is frequently a compounding constraint in dry lands. Much has been written about the significance of dry lands and their significance for society. How such dry regions are managed can have implications for society as a whole? Burgeoning world populations, especially in lesser- developed countries, have led to increased land use pressure around the globe, with implications for sustaining livelihoods and natural resources and maintenance of fragile, vulnerable and drought-stressed ecosystems [2]. With a crisis looming in world food production, the challenge of enabling countries dominated by dry areas to sustain their populations is enormous. In arid areas, crop production is not possible without irrigation, while in semiarid regions where irrigation is generally not an option, crop yields are dictated by low and erratic rainfall, typically with low yields and often complete crop failure. Variable rainfall limits the effectiveness of inputs such as fertilizers and increases the economic risk of fertilizer use [3].

Despite this dismal scenario, there is reason to believe that agriculture in arid and semiarid regions can, with improved management, be made more productive in a sustainable manner. Despite the crop production constraints associated with limited rainfall, crop yields in dry areas can be profitably increased and yield variation decreased with a combination of improved soil and crop management, such as using chemical fertilizers and adopting summer fallow, reduced tillage, and improved cultivars of drought-tolerant crops. These diverse agro-ecological conditions of the country are favorable for growing all the annual pulse crops. Among pulses, chickpea (*Cicer arietinum* L.) is the most important pulse crop in the country grown in more than 6.93 million hectares area which contributes 62% of the global production (5.6 million tonnes) and about 37% of total pulse production in the India.5 These have played a key role in the agricultural economy of India from time immemorial. Also, chickpea is used in various ways. It is one of the earliest cultivated pulses, having been grown for over seven millennia, and currently account for almost 40% of total pulse production. Chickpea is very nutritive and is used as a protein adjunct to starchy diets [4].

Traditionally, the development approach for arid and

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semiarid regions for crop production has focused on single elements of the farming system such as fertilizer use, soil and water management. Substantial impact on crop yields has often failed to emerge following this fragmented approach. Successful strategies to increase dryland crop output are likely to involve an integrated approach involving genotypes with balanced nutrient inputs. 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° East and 25.2° 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 Randomized Block Design with three replications. The six nutrient management modules (a) F_1- FYM @ 10 t ha^{-1}, (b) F_2- Varmicompost @ 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, F_5- Vitormone @125ml ha^{-1} as foliar application, (d) 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 was recorded on net plot basis and converted to q ha^{-1}. Each sample was washed with distilled water, dried in an oven at 70°C, and ground to fine size for analysis. The total nitrogen of shoot was determined by micro Kjheldahl's method [5] and the total P and K was determined [6]. However, the nutrients uptake was used for calculating N, P and K uptake using following formulae: N- uptake (kg ha^{-1}) = yield (kg ha^{-1}) × plant N (%)/100, P-uptake (kg ha^{-1}) = yield (kg ha^{-1}) × plant P (%)/100 and K-uptake (kg ha^{-1}) = Yield (kg ha^{-1}) × plant K (%) plant K (%)/100). Internal utilization efficiency (IUEP) was calculated by dividing grain yield (q) by total N, P and K uptake (kg). The statistical analysis was done by using Randomized Block Design suggested by [7].

RESULTS AND DISCUSSION

The seed yield of chickpea genotypes varies significantly with each other. The seed yield produced by different variety in the order of V_3 (Avrodhi), V_2 (Pusa-256), V_4 (Pant G-186) and V_1 (Pragati K-3256). Avrodhi variety (V_3) produced significantly higher seed yields over rest of the varieties. However, variety Pusa-256 and Pant G-186 were statistically at par with each other. It is attributed due to the increased the number of primary and secondary branches per plant, increased number of pods per plant, number of seeds per pod and test weight, which ultimately increased grain yield of chickpea. The BARI Chola-4 produced the highest seed yield per it was followed by BARI Chola-6 [8].

Plant growth hormone, organic and inorganic sources of nutrients significantly influenced the grain yield of chickpea. Application of vermicompost 5 t ha^{-1} was significantly superior then the other nutrient plant nutrient sources it may be ascribed due to better plant growth and yields such as seed yield. 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 [9].

The different variety treatments showed significant difference in respect of total N, P and K uptake. The significantly higher N, P and K uptake was found in V_3 (Avrodhi), however, V_2 (Pusa-256), and V_4 (Pant G-186) were statistically at par with each other and significantly superior over Variety V_1 Pragati (K-3256) during both years of experimentation and pooled data. It is attributed due to the chickpea varieties supplemented with different organic and inorganic sources of plant nutrients increased macro and micro nutrient status of soil enhances the nutrient accumulation in the dry matter as well as translocation from source to sink hence augment the total N, P and K uptake of the crop. Further, the genetic makeup of the varieties differs for the accumulation pattern of nutrients might be another reason for nutrient uptake variations [10].

The data revealed that total N P and K uptake increased significantly with the application of organic and inorganic sources in addition with plant growth regulators. The uptake was significantly higher with application of F_2 (vermicompost) 5 t ha^{-1}. The different treatments showed significant difference in respect of total N, P and K uptake. The beneficial effect of vermicompost might be due to its role in adequate nutrient supply, enhanced mobilization of nutrients, and activation of beneficial soil microbes, biological N-fixation and improved physical condition of soil which lead to good nutrient availability for growth and development of the plant. The increase in uptake of nitrogen could be the results of enhanced physiological processes within the plant system which resulted in the increased absorption of nitrogen by plant chickpea and thereby, translocation of nitrogen. Supplementation of vermicompost with inorganic fertilizer improves the crop growth and thereby, uptake of nitrogen.

The increase in uptake of phosphorus could be the results of enhanced physiological processes within the plant system which resulted in the increased absorption of phosphorus by chickpea plant and hence the translocation of phosphorus, might occurs and get accumulated in seed resulted higher uptake. Likewise, K uptake was also improved significantly with different treatments of organic and inorganic sources of nutrients and application of F_2 (vermicompost) 5 t ha^{-1} leads to accumulation of significantly higher total K in plants. Application of F_2 (vermicompost) 5 t ha^{-1} ultimately enhanced the status in the soil consequently due to fair availability absorption of potassium is increased hence increased uptake by plants [11-12].

Table 1 Effect of varieties and fertility sources on grain yield t ha^{-1} and nutrients uptake by chickpea

Treatments	Grain yield t ha^{-1}			Total N uptake kg ha^{-1}			Total P uptake kg ha^{-1}			Total K uptake kg ha^{-1}		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Varieties												
Pragati (K-3256)	1.828	1.877	1.852	73.72	73.76	73.74	9.06	9.23	9.14	38.38	38.63	38.5
Pusa-256	1.967	2.039	2.003	81.69	90.64	86.16	10.31	11.07	10.69	41.45	42.71	42.08
Avrodhi	2.068	2.167	2.117	86.91	99.56	93.24	11.08	12.49	11.78	44.88	46.68	45.78
Pant G -186	1.940	2.020	1.980	79.74	86.87	83.31	9.94	10.65	10.3	41.48	42.11	41.8
S. E(m)±	0.013	0.003	0.012	0.45	1.71	1.53	0.06	0.14	0.47	0.56	0.54	0.67
C.D. (p=0.05)	0.036	0.008	0.033	1.25	4.79	4.38	0.17	0.38	1.34	1.56	1.51	1.92
Nutrient management												
Control	2.009	2.066	2.037	61.71	54.96	58.34	7.21	6.59	6.90	32.68	31.80	32.24
FYM 10 t ha^{-1}	2.043	2.131	2.087	83.97	90.25	87.11	10.67	11.60	11.13	43.33	44.39	43.86
Varmicompost 5 t ha^{-1}	1.986	2.062	2.024	90.80	111.58	101.19	11.91	13.68	12.79	47.53	49.82	48.68
Poultry manure 5 t ha^{-1}	1.962	2.009	1.986	79.79	86.23	83.01	9.80	10.55	10.17	40.76	42.06	41.41
20, 60, 20 kg NPK ha^{-1}	2.029	2.093	2.061	77.38	77.85	77.61	9.41	9.76	9.58	38.80	39.66	39.23
Vitormone 125 ml ha^{-1} (Foliar)	1.677	1.792	1.734	89.45	105.38	97.42	11.59	12.99	12.29	46.16	47.45	46.80
S. E(m)±	0.016	0.004	0.010	0.55	2.10	1.37	0.08	0.17	0.42	0.68	0.66	0.60
C.D. (p=0.05)	0.044	0.010	0.030	1.53	5.87	3.92	0.21	0.47	1.20	1.91	1.84	1.72

Table 2 Effect of varieties and fertility on (IUE_{NPK}) of chickpea

Treatments	Internal N utilization efficiency (IUE_N)			Internal P utilization efficiency (IUE_P)			Internal K utilization efficiency (IUE_K)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Varieties									
Pragati (K-3256)	0.25	0.26	0.26	2.04	2.12	2.08	0.48	0.50	0.49
Pusa-256	0.24	0.23	0.24	1.94	1.92	1.93	0.48	0.48	0.48
Avrodhi	0.24	0.23	0.24	1.91	1.83	1.87	0.46	0.47	0.47
Pant G -186	0.25	0.24	0.24	1.98	1.99	1.98	0.47	0.49	0.48
S. E(m)±	0.001	0.005	0.005	0.009	0.029	0.010	0.006	0.007	0.008
C.D. (p=0.05)	0.002	0.015	0.014	0.026	0.081	0.029	0.018	0.019	0.023
Nutrient management									
Control	0.27	0.33	0.30	2.33	2.74	2.53	0.52	0.57	0.54
FYM 10 t ha^{-1}	0.24	0.23	0.24	1.89	1.82	1.85	0.46	0.47	0.47
Varmicompost 5 t ha^{-1}	0.23	0.20	0.21	1.72	1.57	1.65	0.43	0.43	0.43
Poultry Manure 5 t ha^{-1}	0.25	0.24	0.24	2.03	1.96	1.99	0.49	0.49	0.49
20, 60, 20 kg NPK ha^{-1}	0.25	0.26	0.26	2.09	2.06	2.07	0.51	0.51	0.51
Vitormone 125 ml ha^{-1} (Foliar)	0.23	0.20	0.21	1.76	1.63	1.70	0.44	0.44	0.44
S. E(m)±	0.001	0.007	0.004	0.012	0.036	0.009	0.008	0.008	0.007
C.D. (p=0.05)	0.003	0.019	0.012	0.032	0.100	0.026	0.022	0.023	0.021

The internal use efficiency of nitrogen, phosphorus and potassium (IUE_{NPK}) in different varieties varies significantly. Its higher value was associated with V_1 Pragati (K-3256) and was statistically at par with V_4 (Pant G-186), whereas, it was higher over V_3 (Avrodhi) and V_2 (Pusa-256).

Internal utilization efficiency (IUE_{NPK}) data showed that either application of organic and inorganic sources of plant nutrients reduced IUE_{NPK}. Among the nutrient sources treatments, the higher values of IUE_{NPK} was observed with vitormone 125 ml ha^{-1} and was statistically at par with Poultry manure @ 5 t ha^{-1}. However, highest value was associated with control. Soil moisture has an important role in the accessibility of N, P and K to plant because nutrient diffusion in soil is a moisture dependent process [13]. Plant nutrient acquisition by chickpea is influenced by soil properties such as pH, soil moisture, nutrient availability and functional traits of chickpea like root volume, root exudates and rhizospheric environment [14].

CONCLUSIONS

In this study, it was concluded that application of vermicompos @ 5 t ha^{-1} in Avrodhi variety of chickpea produced higher yields with in increasing total N, P and K uptakes. However, application of poultry manure @ 5 t ha^{-1}remarkably improved nutrient internal use efficiency by 20-30%.

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