RESEARCH ARTICLE

EFFECT OF NUTRIENT MANAGEMENT PRACTICES ON GROWTH, YIELD AND NUTRIENTS UPTAKE BY CHICKPEA (*CICER ARIETINUM* L.) UNDER ORGANIC FARMING

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Abstract: A field experiment was carried out during the winter season of 2019-20 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of nutrient management practices on growth, yield and nutrients content and uptake by chickpea (*Cicer arietinum* L.) under organic farming. Total nine treatment combinations *viz.*, T_1 : FYM 5 t/ha + *panchagavya* spray 3% at branching and flowering, T_2 : FYM 5 t/ha + cow urine spray 5% at branching and flowering, T_3 : FYM 5 t/ha + vermiwash spray 10% at branching and flowering, T_4 : FYM 2.5 t/ha + seed inoculation with *rhizobium* and PSB + *panchagavya* spray 3% at branching and flowering, T_5 : FYM @ 2.5 t/ha + seed inoculation with *rhizobium* and PSB + cow urine spray @ 5% at branching and flowering, T_6 : FYM @ 2.5 t/ha + seed inoculation with *rhizobium* and PSB + vermiwash spray @ 10% at branching and flowering, T_7 : Castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering, T_8 : Castor cake @ 0.5 t/ha + cow urine spray @ 5% at branching and flowering and T_9 : Castor cake @ 0.5 t/ha + vermiwash spray @ 10% at branching and flowering were laid out in randomized block design replicated 3 times. Application of 5.0 t FYM/ha along with two foliar sprays of 3% *panchagavya* at branching and flowering recorded the maximum value of all growth parameters *viz*., plant height, number of branches per plant, dry matter accumulation per plant, number of root nodules per plant and dry weight of root nodules per plant and yield attributes *viz*., number of pods per plant, seed index as well as seed and stover yield of chickpea besides improving quality parameter (protein content). However, it was found at par with 0.5 t castor cake/ha along with two foliar spray of *panchagavya* at branching and flowering, 5.0 t FYM/ha along with either two foliar spray of 5% cow urine or 10% vermiwash at branching and flowering stages. It also uptake maximum total N and P_2O_5 by chickpea, net returns and benefit cost ratio.

Keywords: Chickpea, Farm yard manure, Castor cake, *Panchagavya*, Cow urine, Vermiwash, Branching, Flowering, Uptake

INTRODUCTION

Pulses are one of the most nutritious crops on the planet for overall health. Pulses have emerged as a viable option to improve soil health, conserve the natural resources and sustain the agricultural productivity. Among the pulses, chickpea is a good source of energy, protein, minerals (especially potassium, phosphorus, calcium, magnesium, copper, iron and zinc), vitamins (especially vitamin B), fiber and also contains potentially health beneficial phytochemicals. Leaves consist of mallic and oxalic acids are very useful for stomach ailments and blood purification. It is beneficial for the prevention of coronary and cardiovascular diseases in human and hence, considered as healthy food (Yadav *et. al*., 2007).

Indiscriminate and continuous use of inorganic fertilizers had adverse effect on soil physical, chemical and biological properties, there by affecting the sustainability of crop yield besides causing environmental pollution (Virmani, 1994). Therefore, it is necessary to improve the productivity and quality of the pulses by enhancing the soil fertility and it's productivity through increasing soil organic carbon, soil moisture storage capacity by adopting nutrient management practices through different organic sources. The crop productivity under organic farming system can be possible with integration of organic manures and foliar application of bio enhancers which have different nutrient release pattern and efficiency. Combined application of nutrient through organic sources mainly farm yard manure, castor cake and vermicompost produced higher yield apart from improving soil health. Regular addition of organic materials, particularly the composted ones, increased soil physical fertility, mainly by improving aggregate stability and decreasing soil bulk density (Diacono and Montemurro, 2010). *Panchagavya* has capability to play the function of promoting boom and improve immunity of plant system thereby confers resistance against pest and sicknesses (Ram, 2017). Bio-chemical properties of *panchagavya* revealed that it possesses almost all the major nutrients like N, P, K and micro nutrients essential for plant and growth hormones like IAA and GA required for crop growth (Selvaraj *et al*., 2007). Cow urine could be a potent source to improve soil fertility, crop productivity and quality besides a potential alternative for fertigation which is becoming common in most of the crops (Pathak and Ram, 2013). Vermiwash is considered as storehouse of nutrients and microorganisms, used as foliar spray for crops and had significant effect on crop growth and productivity. Keeping this in view, the present investigation was undertaken to study the

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effect of different nutrient management practices on growth, yield and nutrient uptake by chickpea grown in converted organic plot.

MATERIALS AND METHODS

A field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* season of the year 2019-20. The soil of the experimental field was loamy sand having neutral pH (7.6), low in organic carbon (0.30%) and available nitrogen (148.8 kg/ha) and medium in available phosphorus (45.1 kg/ha) and potash (254.7 kg/ha). The present experiment comprising of nine treatment combinations *viz.*, T_1 : FYM 5 t/ha + *panchagavya* spray 3% at branching and flowering, T_2 : FYM 5 t/ha + cow urine spray 5% at branching and flowering, T_3 : FYM 5 t/ha + vermiwash spray 10% at branching and flowering, T_4 : FYM 2.5 t/ha + seed inoculation with *rhizobium* and PSB + *panchagavya* spray 3% at branching and flowering, T_5 : FYM @ 2.5 t/ha + seed inoculation with *rhizobium* and PSB + cow urine spray @ 5% at branching and flowering, T_6 : FYM @ 2.5 t/ha + seed inoculation with *rhizobium* and PSB + vermiwash spray @ 10% at branching and flowering, T_7 : Castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering, T_8 : Castor cake @ 0.5 t/ha + cow urine spray @ 5% at branching and flowering and T_9 : Castor cake @ 0.5 t/ha + vermiwash spray @ 10% at branching and flowering. The experiment was laid out in randomized block design with three replications. The FYM and castor cake were applied as per treatments manually 15 days prior to sowing of chickpea in the previously opened furrows and properly covered with soil. The FYM contain 0.57% N, 0.31% P_2O_5 and 0.45% K_2O and castor cake contain 4.68% N, 1.80% P_2O_5 and 1.40% K_2O. Foliar spray of *panchagavya* (3%), cow urine (5%) and vermiwash (10%) were done at branching and flowering stages as per treatments. The seed treatment with *Trichoderma viride* @ 4 g/kg seed were applied to all treatments and liquid formulation of *rhizobium* and phosphate solubilizing bacteria (PSB) were inoculated to seeds at 5 ml/kg seed just before sowing as per the treatments and dried in the shed. Chickpea variety "Gujarat Gram 5" was sown on 16th November, 2019 using 60 kg/ha seed rate by maintaining intra row spacing of 45 cm. Observations on plant growth and yield attributes and yield were recorded as per standard procedure. Economics was worked out on the basis of prevailing market price of various inputs used and output obtained from each treatment. The plant samples were analyzed for N and P content as per the standard methods. The concentration of nutrients in seed and stover were used to calculate the uptake of nutrients by chickpea crop. Protein content in seed was calculated by multiplying nitrogen content of seed (%) with 6.25. The soil samples were collected from each net plot after harvest of chickpea crop at 0-15 cm depth. Organic carbon, available N and P_2O_5 status of soil after harvest of crop were estimated by Walkley and Black method, alkaline permanganate and olsen's method, respectively. The data were statistically analyzed for various characters as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth attributes

Growth attributes, *viz*. Plant height, number of branches per plant and dry matter accumulation per plant indicated that application of FYM @ 5 t/ha + *panchagavya* spray @ 3% at branching and flowering was found significantly superior to rest of the treatments being at par with castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering and FYM @ 5 t/ha + cow urine spray @ 5% at branching and flowering. Significantly higher plant height in these treatments ascribed due to increase in availability of cytokinine with foliar application of *panchagavya* and application of FYM/castor cake contain favorable macro and micro nutrients and hormones which play a vital role in cell elongation process either through cell division and cell enlargement ultimately resulted in faster growth in term of taller plant. These results are in accordance with the findings of Panchal *et al*. (2017). Improvement in number of branches and dry matter accumulation might be due to optimum supply and slow release of nutrients for longer duration from FYM/castor cake which help in better uptake of nutrients resulted in more synthesis of amino acid and nucleic acid, amide substances in growing region and meristematic tissue ultimately enhanced plant growth and foliar application of *panchagavya* has resulted in greater absorption, assimilation and translocation of metabolizing nutrients which enhance the photosynthetic rate are responsible for producing more number of branches per plant and dry matter accumulation. These results are in close vicinity with the findings of Upendranaik *et al*. (2018).

Significantly higher number of root nodules per plant at 45 DAS (20.7) and dry weight of root nodules (55.6 mg) (Table 1) was found with application of FYM @ 5 t/ha + *panchagavya* spray @ 3% at branching and flowering followed by castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering, FYM @ 5 t/ha + cow urine spray @ 5% at branching and flowering as well as FYM @ 5 t/ha + vermiwash spray @ 10% at branching and flowering. Combined application of FYM along with *panchagavya* might have enhanced the population of desired microbes in the rhizosphere during the early stage of infection by improving the physical, chemical and biological properties of soil. Higher

population of the desired microorganisms will always have greater possibilities of infection and consequently formation of more healthy and effective root nodules having higher amount of dry weight. It might also be due to foliar spray of *panchagavya* increased plant growth and translocation of carbohydrate to developing nodules. These findings are in agreement with those reported by Panchal *et al*. (2017) and Yadav *et al*. (2017).

Table 1. Growth parameters of chickpea as influenced by different nutrient management practices

Treatments	Plant height (cm)	Number of branches/ plant	Dry matter accumulation /plant at harvest (g)	Number of root nodules /plant at 45 DAS	Weight of dry root nodules/ plant (mg)
T_1: 5 t/ha FYM + 3% P at BF	51.3	8.5	30.67	20.7	55.6
T_2: 5 t/ha FYM + 5% CU at BF	45.5	7.7	28.03	18.4	51.4
T_3: 5 t/ha FYM + 10% VW at BF	43.7	7.5	26.94	18.1	50.5
T_4: 2.5 t/ha FYM + RP + 3% P at BF	42.5	7.1	26.30	17.5	48.6
T_5: 2.5 t/ha FYM + RP + 5% CU at BF	39.2	6.8	24.27	16.5	45.7
T_6: 2.5 t/ha FYM + RP + 10% VW at BF	38.8	6.7	23.57	15.9	44.5
T_7: 0.5 t/ha CC + 3% P at BF	48.4	8.0	29.23	19.4	52.9
T_8: 0.5 t/ha CC + 5% CU at BF	41.6	6.9	25.56	17.3	47.3
T_9: 0.5 t/ha CC + 10% VW at BF	41.3	6.9	25.02	16.9	46.1
S.Em.±	2.38	0.36	1.45	0.92	2.28
C.D. (P=0.05)	7.1	1.1	4.35	2.8	6.8
C.V.%	9.45	8.35	9.45	8.90	8.02

FYM: Farm yard manure, CC: Castor cake, P: *Panchagavya*, CU: Cow urine, VW: Vermiwash
RP: *Rhizobium* and Phosphate solubilizing bacteria, BF: Branching and flowering.

Yield and yield attributes

An application of FYM @ 5 t/ha + *panchagavya* spray @ 3% at branching and flowering registered significantly higher values of number of pods per plant (54.6) and seed index (21.35 g) over rest of the treatments (Table 2). However, it did not differ significantly over application of castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering, FYM @ 5 t/ha + cow urine spray @ 5% at branching and flowering and FYM @ 5 t/ha + vermiwash spray @ 10% at branching and flowering. Increase in number of pods per plant might be due supply of essential nutrients in balanced proportion from combined application of FYM along with foliar spray of *panchagavya* to plants favorably influenced the flowering and seed formation which ultimately increased the pods per plant. It also increased rate of photosynthesis coupled with efficient translocation of photosynthates from source (leaf and stem) to sink (pods) attributed to significant improvement in the sink size have helped to increase number of seeds per pod and to produce healthy and bold seeds. Similar observations were also been made by Shariff *et al*. (2017) and Sutar *et al*. (2019). Numerically higher number of seeds per pod (1.44) was noticed with FYM @ 5 t/ha + *panchagavya* spray @ 3% at branching and flowering, but failed to show any significant differences over rest of the treatments.

Table 2. Yield attributes and yield of chickpea as influenced by different nutrient management practices

Treatments	Number of pods/plant	Number of seeds/pod	Seed index (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
T_1: 5 t/ha FYM + 3% P at BF	54.6	1.44	21.35	2872	3271
T_2: 5 t/ha FYM + 5% CU at BF	50.4	1.41	19.62	2468	2864
T_3: 5 t/ha FYM + 10% VW at BF	48.1	1.40	19.09	2379	2806
T_4: 2.5 t/ha FYM + RP + 3% P at BF	46.8	1.40	18.70	2231	2613
T_5: 2.5 t/ha FYM + RP + 5% CU at BF	44.4	1.37	17.74	2017	2418
T_6: 2.5 t/ha FYM + RP + 10% VW at BF	43.8	1.36	17.59	1969	2399
T_7: 0.5 t/ha CC + 3% P at BF	52.7	1.42	20.62	2642	3142
T_8: 0.5 t/ha CC + 5% CU at BF	45.6	1.39	18.33	2160	2568

T_9: 0.5 t/ha CC + 10% VW at BF	44.8	1.38	18.00	2087	2499
S.Em.±	2.39	0.07	0.81	175.0	180.4
C.D. (P=0.05)	7.2	NS	2.43	525	541
C.V.%	8.65	8.52	7.37	13.10	11.44

FYM: Farm yard manure, CC: Castor cake, P: *Panchagavya*, CU: Cow urine, VW: Vermiwash
RP: *Rhizobium* and Phosphate solubilizing bacteria, BF: Branching and flowering,

The seed and stover yield of chickpea were significantly higher with application of 5.0 t FYM/ha along with foliar spray of 3% *panchagavya* at branching and flowering closely followed by castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering. As most of the yield parameters are greately influenced by the availability of N as well as micronutrients, they could get sufficient amount of all major and micro nutrients from FYM/ castor cake due to balance nutrition and supply of nutrients for longer duration as per demand of the crop leading to improvement in yield attributes The cow dung in *panchagavya* act as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth upon fermentation with other ingredients in *panchagavya* has beneficial effect on growth and yield. Moreover, *panchagavya* increased synthesis of growth promoting substances which in turn helped in improvement of growth and yield attributes and finally on seed and stover yield. These findings are in line with those reported by Yadav *et al*. (2016) and Panchal *et al*. (2017).

Quality trait

Protein content in seed was significantly influenced due to different nutrient management practices. Higher protein content (24.31%) in seed was registered with application of FYM @ 5 t/ha + *panchagavya* spray @ 3% at branching and flowering followed by castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering. As N is the integral part of protein synthesis and better nutrient status in soil resulted in higher uptake and translocation of nitrate from mother plant due to application of FYM and *panchagavya* ultimately enhanced protein content in seed. These results are in alike with the findings of Das *et al*. (2015).

Table 3. Protein content, N and P uptake and economics as influenced by different treatments

Treatments	Protein content (%)	Total uptake of N (kg/ha)	Total uptake of P (kg/ha)	Total cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
T_1: 5 t/ha FYM + 3% P at BF	24.31	166.0	28.3	45924	75498	2.64
T_2: 5 t/ha FYM + 5% CU at BF	22.88	135.3	23.3	44368	60080	2.35
T_3: 5 t/ha FYM + 10% VW at BF	22.25	127.1	22.0	45978	54794	2.19
T_4: 2.5 t/ha FYM + RP + 3% P at BF	21.75	116.8	19.9	41473	52993	2.28
T_5: 2.5 t/ha FYM + RP + 5% CU at BF	20.88	102.7	16.8	39917	45599	2.14
T_6: 2.5 t/ha FYM + RP + 10% VW at BF	20.63	99.8	16.3	41527	42031	2.01
T_7: 0.5 t/ha CC + 3% P at BF	23.44	149.7	25.8	40257	71707	2.78
T_8: 0.5 t/ha CC + 5% CU at BF	21.31	112.0	18.9	38701	52835	2.37
T_9: 0.5 t/ha CC + 10% VW at BF	21.19	107.4	18.0	40311	48167	2.19
S.Em.±	0.77	6.63	0.99			
C.D. (P=0.05)	2.32	19.9	3.0			
C.V.%	6.06	9.26	8.19			

FYM: Farm yard manure, CC: Castor cake, P: *Panchagavya*, CU: Cow urine, VW: Vermiwash RP: *Rhizobium* and Phosphate solubilizing bacteria, BF: Branching and flowering,

Nutrient uptake

Total N and P uptake by chickpea (Table 3) was influenced significantly due to different nutrient management practices. An application of FYM @ 5 t/ha + *panchagavya* spray @ 3% at branching and flowering recorded significantly higher uptake of N (166.0 kg/ha) and P (28.3 kg/ha) over rest of the treatments except castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering. Increase in N and P uptake might be due to application of FYM/ castor cake improve nutrient availability and soil environment that which encouraged proliferous root-system, resulting in better absorption of nutrients leading to increase the concentration of N and P in vegetative and reproductive parts and transport towards pod by metabolic activity. Better availability of phosphorus in crop root zone may be due to organic acid released during microbial decomposition of FYM. *Panchagavya* contain uric acid, a source of nitrogen which is readily available to plants and directly influencing the nitrogen content of leaves. Similar findings have been reported by Gowthamchand *et al*. (2019).

Economics

The economics of chickpea were calculated and presented in Table 3. The highest net returns 75498 ₹/ha was obtained with manuring of 5 t FYM/ha along with two foliar spray of 3% *panchagavya* at branching and flowering but maximum BCR (2.78)

was observed with castor cake @ 0.5 t/ha + *panchagavya* spray @ 3% at branching and flowering. Use of organic manure (5.0 t FYM/0.5 t castor cake/ ha) along with 3% *panchagavya* spray at branching and flowering stages was found more remunerative with respect to net return and BCR as compared to rest of the treatments. This might be attributed to higher seed and stover yield of chickpea received in these treatments. Similar results were obtained by Singh *et al*. (2014), and Panchal *et al*. (2017).

CONCLUSION

Chickpea grown under organic farming should be manured with 5.0 t FYM/ha along with foliar spray of either 3.0% *panchagavya* or 5.0% cow urine or 10.0% vermiwash at branching and flowering stages or application of 0.5 t castor cake/ha along with foliar spray of 3.0% *panchagavya* at branching and flowering stages to obtain higher seed yield, improved quality of seed and net return under North Gujarat condition.

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