The Pharma Innovation Journal 2023; 12(8): 1235-1237

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 1235-1237

www.thepharmajournal.com
Received: 02-05-2023
Accepted: 05-06-2023

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Effect of nutrient management on growth and yield of chickpea

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Abstract
A field study was carried out for two consecutive years (2019-20 and 2020-21) at the Rajendrapur Farm, NAU, Waghai, Gujarat to assess the impact of nutrient management practices on chickpea. A randomized block design was used to set up the experiment. Seven treatments, *viz*., T_1 (FYM 2.5 t/ha + 50% RDF), T_2 (FYM 2.5 t/ha + 75% RDF), T_3 (Bio compost 2.5 t/ha + 50% RDF), T_4 (Bio compost 2.5 t/ha + 75% RDF), T_5 (Vermicompost 2.5 t/ha + 50% RDF), T_6 (Vermicompost 2.5 t/ha + 75% RDF), T_7 (FYM 2.5 t/ha + 100% RDF) were applied to chickpea. The application of T_7 resulted in significantly higher growth, yield attributes and yield of chickpea, which remained at par with T_6 and T_4. Whereas the maximum net realization and BCR were observed under the application of T_4 followed by treatments T_7 and T_6.

Keywords: Chickpea, FYM, bio compost, vermicompost

1. Introduction
In India, pulses are an important crop group and they also generate significant financial benefits by accounting for a significant share of exports. Pulses are a vital part of the Indian diet, helping to meet the country's 25% protein and adding essential protein to the diet. Pulses are crucial in Indian agriculture because their nodules fix atmospheric nitrogen, restoring soil fertility. Pulses can be cultivated in various types of soils and climatic conditions and they are crucial for crop rotation, intercropping and mixed cropping because they contribute to maintaining soil fertility by fixing N from the atmosphere through symbiosis due to the presence of *Rhizobium* bacteria in their root nodules. Chickpea or gram (*Cicer arietinum* L.) is a prominent pulse crop that is cultivated and consumed worldwide. In India, it is cultivated in 10.91 m ha area with 13.75 million tons of production and 1063 kg per hectare of productivity. In Gujarat, it is cultivated in an 1.10 m ha area with 2.10 million tons of production and 1908 kg per hectare of productivity (Anon., 2022) [1]. It contains a large amount of protein and carbohydrates, with the protein content being superior to that of other pulses. Chickpea contain large amounts of all the required amino acids, which can be supplemented by the inclusion of cereals in the diet. The most critical issue affecting crop production, especially in pulses, is inadequate or insufficient nutrient application. It is becoming increasingly clear that no single nutrient source can completely fulfill the nutritional needs of crops. A balanced application of essential plant nutrients using organic manures and chemical fertilizers may aid in preventing the emergence of nutritional deficiencies other than NPK. It reduces fertilizer waste and has a positive impact on various soil properties.

2. Materials and Methods
The current investigation was undertaken by conducting a field trial at Rajendrapur Farm, NAU, Waghai on chickpea crop with various doses of fertilizers combined with organic manures (FYM, vermicompost and bio compost) for two years (2019–20 and 2020–21). The soil of the experimental site had a clayey texture, medium in organic carbon (0.63%), low in available N (215.00 kg/ha), medium in available P_2O_5 (35.00 kg/ha), high in available K_2O (310.15 kg/ha). This region has a warm, humid monsoon with heavy rainfall, a moderately hot summer and a fairly cool winter. The seeds of cultivar GG 5 (Gujarat Gram 5) were used in the present investigation. A randomized block design with three replications was used to set up the experiment. The experiment comprising seven nutrient management treatments *viz*., T_1 (FYM 2.5 t/ha + 50% RDF), T_2 (FYM 2.5 t/ha + 75% RDF), T_3 (Bio compost 2.5 t/ha + 50% RDF), T_4 (Bio compost 2.5 t/ha + 75% RDF), T_5 (Vermicompost 2.5 t/ha + 50% RDF), T_6 (Vermicompost 2.5 t/ha + 75% RDF), T_7 (FYM 2.5 t/ha + 100% RDF).

The required amount of organic manures (FYM, bio compost and vermicompost) was calculated and they were applied to the chickpea crop in accordance with the treatments and evenly distributed and incorporated in individual plots. Before applying organic manures, they were tested for N, P_2O_5 and K_2O content. The fertilizers were applied in chickpea as per treatment. Nitrogen was applied in the form of urea, while phosphorus was applied in the form of SSP. Chickpea was sown using a 60 kg/ha seed rate with 30 cm × 10 cm spacing.

3. Results and Discussion

The results summarized in Table 1 revealed that treatment T_7 resulted in significantly taller plants at harvest and was found statistically at par with treatments T_6, T_4 and T_2 during individual years, whereas, in pooled results, only T_6 and T_4 remained at par with T_7. Similarly, treatment T_7 produced a significantly higher number of branches/plant at harvest and was found at par with treatments T_6, T_4 and T_2 during individual years, whereas, in the pooled study, it remained at par with treatments T_6 and T_4 only. Significantly higher dry matter accumulation/ plant was recorded under the application of T_7, which was found at par with T_6 and T_4 during the first year as well as in pooled findings, whereas, in the second year, it was found at par with T_6, T_4 and T_2. The increase in growth attributes may be a result of application of nitrogen and phosphorus through chemical fertilizer, which increased their availability and led to an increase in photosynthetic activity and the movement of photosynthates from sources to sinks, both of which contributed to the higher growth. Similar outcomes have also been noticed by Mansuri (2016) [3], Sodavadiya *et al.* (2021) [8], Patel and Thanki (2022) [6] and Parmar *et al*. (2023) [4] in chickpea.

Table 1: Growth attributes of chickpea affected by nutrient management treatments

Treatment	Plant height (cm) at harvest			No. of branches/plant at harvest			Dry matter accumulation at harvest (g/plant)		
	Year I	Year II	Pooled	Year I	Year II	Pooled	Year I	Year II	Pooled
T_1	46.27	41.23	43.75	7.87	6.95	7.41	25.72	26.84	26.28
T_2	47.97	45.44	46.71	8.66	7.80	8.23	30.59	30.93	30.76
T_3	45.24	42.55	43.89	8.25	7.45	7.85	28.86	27.17	28.01
T_4	50.00	46.24	48.12	9.15	8.57	8.86	31.77	31.48	31.62
T_5	45.26	43.56	44.41	7.94	7.68	7.81	28.71	28.52	28.61
T_6	50.60	47.50	49.05	9.26	8.74	9.00	33.23	31.55	32.39
T_7	52.34	49.51	50.92	9.41	8.93	9.17	34.65	33.88	34.26
S.Em+	1.47	1.57	1.08	0.31	0.36	0.24	1.29	1.47	0.98
CD (P=0.05)	4.53	4.84	3.14	0.96	1.12	0.70	3.98	4.52	2.85
CV (%)	5.28	6.03	5.65	6.28	7.88	7.07	7.34	8.46	7.91
Interaction (Y x T)									
S.Em±	1.52			0.34			0.52		
CD (P=0.05)	NS			NS			NS		

The results furnished in Table 2 showed that the number of pods per plant at harvest in chickpea was significantly influenced by various nutrient management treatments. Treatment T_7 produced a significantly higher number of pods per plant (71.00, 65.62 and 68.61) during first year, second year and in pooled findings, respectively, which were found at par with treatments T_6 and T_4 during individual years and in pooled analysis. The treatment T_7 produced significantly higher seed yields (2750, 2715 and 2733 kg/ha) during individual years and in a pooled results and it was at par with T_6 and T_4. These could be attributed to the better nutrient absorption, translocation and assimilation that came about as a result of the integrated usage of organics and inorganics, which increased nutrient availability. Increased assimilation of dry matter into the reproductive parts improved yield attributing characteristics and yield. In case of stover yield, the treatment T_7 produced significantly higher stover yield (4062, 4172 and 4117 kg/ha, respectively) during first year, second year and in pooled findings, respectively. In first and second year, T_7 was found at par with the treatments T_6, T_4 and T_2, whereas, in the pooled results, it was found at par with T_6 and T_4 only. Improved vegetative growth as in terms of plant height and dry matter accumulation may be responsible for the higher stover yield under the aforementioned treatments. It may also be because the integration of organic and inorganic sources of nutrients enhanced the production of suitable biomass, which led to a higher stover yield. These observations corroborate the conclusions of Patel *et al*. (2007) [5], Singh *et al*. (2012) [7], Mansuri *et al*. (2016) [3], Yadav *et al*. (2017) [9], Kumar *et al*. (2018) [2], Sodavadiya *et al.* (2021) [8], Patel and Thanki (2022) [6] and Parmar *et al.* (2023) [4] in chickpea crop.

The economics, consisting of the cost of cultivation, gross and net returns, as well as the B:C ratio affected by various treatments, are furnished in Table 3. The results showed that the highest net return of ₹ 122689 with a BCR of 2.45 was observed under treatment T_4, followed by T_7 with net returns of ₹ 118495/ha and a BCR of 2.05. However, the lowest net realization of 129953/ha and lowest B:C ratio of 1.29 were observed under the application of treatment T_1. The same outcomes were also reported by Mansuri (2016) [3], Sodavadiya *et al.* (2021) [8] and Parmar *et al.* (2023) [4] in chickpea.

Table 2: Yield attributes and yield of chickpea affected by nutrient management treatments

Treatment	No. of pods per plant			Seed yield (kg/ha)			Stover yield (kg/ha)		
	Year I	Year II	Pooled	Year I	Year II	Pooled	Year I	Year II	Pooled
T_1	55.00	51.00	53.00	2040	1978	2009	3193	3082	3138
T_2	61.00	56.45	58.72	2339	2323	2331	3519	3658	3588
T_3	59.33	56.00	57.67	2124	2277	2201	3245	3471	3358
T_4	65.65	60.50	63.08	2698	2680	2689	3850	3798	3824
T_5	60.63	52.89	56.76	2300	2265	2282	3415	3454	3435
T_6	67.83	62.00	64.92	2743	2692	2718	3870	3824	3847
T_7	71.00	65.62	68.31	2750	2715	2733	4062	4172	4117
S.Em±	2.47	2.73	1.842	131.59	125.97	91.08	187.53	183.20	131.08
CD (P=0.05)	7.62	8.41	5.37	405	388	265	577	564	382
CV (%)	6.81	8.18	7.48	9.39	9.02	9.21	9.04	8.72	8.88
Interaction (Y x T)									
S.Em±	1.52			0.34			0.52		
CD (P=0.05)	NS			NS			NS		

Table 3: Economics of chickpea as influenced by nutrient management treatments (Average of two years)

Treatment	Yield (kg/ha)		Cost of cultivation (₹/ha)			Gross returns (₹/ha)	Net returns (₹/ha)	BCR
	Seed	Stover	Fixed	Variable	Total			
T_1	2009	3138	46836	9865	56701	129953	73253	1.29
T_2	2331	3588	46836	10422	57258	150615	93357	1.63
T_3	2201	3358	46836	2740	49576	142107	92531	1.87
T_4	2689	3824	46836	3297	50133	172822	122689	2.45
T_5	2282	3435	46836	16115	62951	147250	84299	1.34
T_6	2718	3847	46836	16672	63508	174591	111083	1.75
T_7	2733	4117	46836	10980	57815	176310	118495	2.05

4. Conclusion
Two years of research have led to the conclusion that chickpea should be fertilized with biocompost 2.5 t/ha along with 75% RDF (15:30:00 N:P_2O_5:K_2O kg/ha) in order to increase yield and net returns.

5. Conflict of Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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