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Effect of various levels of chickpea magic on yield, nutrient uptake and economics of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during *Rabi* season of 2021-22 at Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur, Chitradurga, to study the effect of various levels of chickpea magic on of chickpea (*Cicer arietinum* L.). The experiment was laid out in randomized complete block design with nine treatments replicated thrice. The recommended dose of fertilizer (13:25:25 kg N: P_2O_5: K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) in combination with foliar spray of varied levels of chickpea magic and DAP were taken into study. The results of the field study indicated that, the quality, nutrient uptake and economics of chickpea were significantly influenced by foliar nutrition with chickpea magic. The yield attributes like number of pods $plant^{-1}$ (47.03), pod yield $plant^{-1}$ (28.24 g) and seed yield (18.53 q ha^{-1}) were significantly higher in the treatment which received 100% RDF along with the foliar application of 1% chickpea magic at 45 DAS over the farmers practice. Similarly, higher nitrogen, phosphorus and potassium uptake by chickpea crop (95.25, 14.98 and 82.01 kg ha^{-1} respectively) also noticed in the above said treatment. Further, the highest net returns (₹ 58,045 ha^{-1}) and benefit cost ratio B: C ratio (2.61) were realized in the same treatment which received 100 per cent RDF (13:25:25 kg NPK + FYM @ 7.5 t/ha) along with foliar spray of 1 per cent chickpea magic at 45 DAS.

Keywords: Chickpea, foliar application, chickpea magic, yield, nutrient uptake, economics

Introduction
Chickpea (*Cicer arietinum* L.) is commonly known as gram or Bengal gram which belongs to the family Fabaceae. Next to groundnut and soybean, it is the highest protein-yielding grain legume with 21.1 per cent protein, 61.5 per cent carbohydrates and 4.5 per cent fat and is also a good source of vitamins (especially vitamin B) and minerals like phosphorus, potassium, calcium, iron and niacin. Hence it is also called the "King of Pulses". Chickpea can fix atmospheric nitrogen through its symbiotic association with *Rhizobium* sp., thus helping in enhancing the soil quality. Chickpea is a hardy, deep rooted dry land crop sown on marginal lands, which can grow to full maturity on conserved moisture that would be unsuitable for most crops (Singh and Reddy, 2010) [7]. It is cultivated in nearly 50 countries around the world and accounts for more than 20 per cent of the world pulse production and much of the world chickpea supply (80-90%) comes from India. India ranks first in area and production in the world, with an area of 9.99 m ha, production of 11.91 mt and productivity of 1192 kg ha^{-1}. Karnataka is one of the major chickpea producing states in the country and ranks fourth in area and is grown over an area of 7.13 lakh ha with an annual production of 4.45 lakh tons and the average productivity is 625 kg ha^{-1} (Anon., 2022-23) [1].
The productivity of chickpea is often constrained due to imbalanced and insufficient supply of nutrients to plants in critical growth stages especially under reducing soil moisture conditions without any irrigation. The maximum yield potential can be achieved by the balanced application of nutrients which includes four basic principles *i.e.* right time, right rate, right source and right method that would ensure higher economic returns with environmental balance (Majumdar *et al.*, 2012) [4].

Foliar application is a technique of feeding nutrients to plants in the form of liquid directly to their leaves. Foliar application of nutrients was more advantageous than soil application, as well as avoiding the depletion of these nutrients in leaves, resulting in a higher photosynthetic rate, better nutrient translocation from the leaves to the developing seeds. many advantages such as quick and efficient utilization of nutrients, increased rate of photosynthesis, better nutrient absorption and translocation of these nutrients from the leaves to the developing seeds, elimination of losses through leaching, fixation and regulating the uptake of nutrients by the plant (Manonmani and Srimathi, 2009) [5]. Foliar feeding is often the most effective and economical way to improve plant nutrient deficiency (Dixit and Elamathi, 2007) [2].

The chickpea magic contains a mixture of 12 per cent nitrogen, 16 per cent phosphorus, 4 per cent potassium, 6 per cent micro nutrients and 300 ppm PGR. It was developed in the year 2014 from KVK, Kalburgi, University of Agricultural Sciences, Raichur, Karnataka. Foliar spray of chickpea magic will helps to reduce flower drop, induces drought and heat tolerance in the crop and help to get a higher yield.

Materials and Methods

The experiment was conducted during *Rabi season of* 2021 at Zonal Agricultural and Horticultural Research Station (ZAHRS), Babbur Farm, Hiriyur. It falls under region X and agro-climatic zone IV (Central dry zone) of Karnataka. Geographically an experimental site was located at 13º 94' 38" North latitude and 76º 61' 61" East longitude, with an altitude of 630 meters above mean sea level. The soil of the experimental site was clayey in texture with pH 7.5, Electrical conductivity (EC) 1.12 dSm^{-1} and organic carbon (OC) 3.7 g kg^{-1} content. The available nitrogen (250.9 kg ha^{-1}) was low, phosphorus (41.1 kg P_2O_5 ha^{-1}) and potassium (329.5 kg K_2O ha^{-1}) were medium. The actual rainfall of the station during the cropping period was 166.6 mm. Field experiment was laid out in Randomized Complete Block Design with nine treatments and three replications. Treatments consisting of foliar application of various levels of chickpea magic at 45 days after sowing along with recommended dose of fertilizers *viz.*, T_1: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}), T_2: Farmers practice (25 kg ha^{-1} DAP), T_3: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} only) + 2% DAP, T_4: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} only) + 0.75% chickpea magic, T_5: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} only) + 1% chickpea magic, T_6: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) + 2% DAP, T_7: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) + 0.75 per cent chickpea magic, T_8: 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) + 1 per cent chickpea magic, T_9: 1% chickpea magic. Variety used is JAKI-9218, it is medium tall, semi-spreading type with profuse branching. It is early maturing (95-112 days) and high yielding variety with the average yield of about 18-20 q ha^{-1}. All the biometric observations are recorded were subjected to analysis.

Results and Discussion

Yield attributes

Seed yield governed by number of factors which have direct or indirect impacts. The improvement in seed yield is achieved through improvement in yield attributing characters *viz.*, number of pods per plant, test weight and pod yield $plant^{-1}$. In the present investigation, application of foliar spray of chickpea magic during 50 per cent flowering stage along with the recommended dose of fertilizers and FYM increased the yield attributing characters and it may be due to the greater assimilatory leaf area as it is a major source for supplying assimilates to developing organs and seeds in crops. Significantly higher number of pods $plant^{-1}$ (47.03), test weight (22.18 g) and pod yield $plant^{-1}$ (28.24 g) were observed in treatment T_8. Foliar applied macro and micronutrients at critical stages of the crop were effectively absorbed and translocated to the developing pods, producing more number of pods and better filling of seeds (Jayabal *et al*., 1999) [3]. Similarly, higher seed yield due to the application of growth regulators in various pulses was related to increased vegetative growth, the number of branches, flowers and number of pods $plant^{-1}$ (Dixit and Elamathi, 2007) [2]. It was also found that an increase in the number of pods $plant^{-1}$ and improved pod yield $plant^{-1}$ under foliar treatments might be due to the supply of nutrients (macro and micro) and plant growth regulators enhanced the enzymatic activity and effectively increased the photosynthesis and translocation of assimilates to developing pods resulting in sound mature seeds. Foliar application of micronutrients at flowering stage would have helped for reducing flower drop and contributed more for reproductive parts resulting in an increased number of pods $plant^{-1}$.

Better plant performance in these treatments in turn increased the seed yield (18.53 q ha^{-1}) and haulm yield (26. 96 q ha^{-1}) (Table 1).

Nutrient uptake

Nutrient uptake is the mechanism by which plants absorbs mineral nutrients essential for the normal growth and development of crop either through roots or through foliar application. The higher uptake of nutrients was mainly attributed to higher concentration of these nutrients in different plant parts and ultimately higher total biomass produced due to higher availability of nutrients through the combined application of RDF and FYM along with the chickpea magic spray.

Significantly higher nitrogen uptake was noticed with (Table 2) application of 100 per cent RDF (13:25:25 kg N:P2O5:K2O ha^{-1} + FYM @ 7.5 t ha^{-1}) + 1 per cent chickpea magic (seed: 70.04 kg ha^{-1}, haulm: 38.01 kg ha^{-1}, total: 108.05 kg ha^{-1}) over farmers practice. Nitrogen absorption increased with crop growth advancing due to higher biomass production. The increased nitrogen absorption by the crop can be accounted for synergistic effect between N and P which helped to enhance the root growth, which helped in better absorption of nitrogen through the symbiotic nitrogen fixation process.

Application of 1 per cent chickpea magic along with 100 per cent RDF and FYM increased the phosphorus uptake (seed: 8.34 kg ha^{-1}, haulm: 6.20 kg ha^{-1}, total: 14.54 kg ha^{-1}) compared over farmers practice (Table 2). The increase in uptake of P mainly attributed to increased absorption and dry matter production due to foliar application of chickpea magic containing 16 per cent phosphorus at the high nutrient demand stage. Assimilated phosphorus, along with nitrogen, enhances cell division and cell elongation leads to increased dry matter production. The increase in P absorption may be due enhanced phosphorus solubilization process in the active root zone by increase in the root length and growth led to higher uptake of phosphorus by the plants.

Similarly, potassium uptake was also significantly influenced by the foliar application of 1 per cent chickpea magic along with 100 per cent RDF and FYM (seed: 15.76 kg ha^{-1}, haulm: 7.07 kg ha^{-1}, total: 22.83 kg ha^{-1}) over farmers practice (Table 2). Balanced application of nutrients helped to increase the total dry matter which in turn results in higher uptake of potassium by the plant. The findings also suggest that the application of micronutrients that is present in the chickpea magic improved potassium uptake.

Economics

Economics is the ultimate criteria for acceptance and wider adoption of any technology and will not be embraced by the farming community unless it is economically viable. Net returns and benefit to cost ratio is the wage to evaluate the economic viability of any crop production system. In the present study, significantly higher gross returns (₹ 93,998 ha^{-1}), net returns (₹ 58,045 ha^{-1}) and benefit to cost ratio of 2.61 were noticed in the treatment with the application of 1 per cent chickpea magic along with 100 per cent RDF and FYM (Table 3). The higher economics in this treatment might be due to higher economic yield of chickpea as a result of better utilization of nutrients through foliage and higher market price of the produce. These results are in conformity with findings of Ramesh *et al.* (2016) [6] in blackgram and Vighnesh *et al.* (2021) [8] in cowpea.

Table 1: Effect of various levels of chickpea magic on yield attributes of chickpea

Treatment details	No of pods plant^{-1}	Pod yield plant^{-1} (g)	100 seed weight (g)	Seed yield (q ha^{-1})	Haulm yield (q ha^{-1})
T_1	42.36	14.65	21.49	16.60	23.36
T_2	40.20	11.71	20.32	13.27	19.72
T_3	41.69	14.18	21.02	14.44	21.76
T_4	41.98	14.23	21.16	14.96	23.04
T_5	42.22	14.36	21.44	16.54	23.17
T_6	44.15	16.44	21.73	17.06	25.25
T_7	45.71	16.50	22.00	17.95	25.89
T_8	47.03	17.51	22.18	18.53	26.96
T_9	39.53	10.01	19.89	12.75	17.57
S.Em. ±	1.24	0.58	0.61	0.52	0.71
C. D. @5%	3.72	1.75	NS	1.57	2.13

Table 2: Effect of various levels of chickpea magic on nutrient content and nutrient uptake by chickpea after harvest.

Treatment details	N uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	Seed	Haulm	Total	Seed	Haulm	Total	Seed	Haulm	Total
T_1	48.97	23.82	72.79	5.81	6.07	11.88	31.04	35.97	67.01
T_2	36.62	18.14	54.76	3.84	4.73	8.58	23.48	28.79	52.27
T_3	41.29	20.88	62.17	4.47	5.44	9.91	26.28	32.64	58.92
T_4	43.68	22.57	66.25	4.78	5.76	10.54	27.67	35.02	62.69
T_5	48.62	23.17	71.79	5.54	6.02	11.56	30.92	35.45	66.37
T_6	53.56	27.52	81.08	5.88	7.07	12.95	32.75	39.89	72.64
T_7	58.15	30.03	88.08	6.46	7.50	13.97	35.18	41.68	76.86
T_8	62.63	32.62	95.25	6.89	8.08	14.97	37.80	44.21	82.01
T_9	33.40	15.81	49.21	3.18	3.51	6.7	21.80	24.77	46.57
S.Em. ±	1.52	0.88	2.81	0.20	0.25	0.48	1.24	1.02	2.03
C. D. @5%	4.58	2.66	8.44	0.60	0.74	1.45	3.72	3.07	6.09

Table 3: Effect of various levels of chickpea magic on economics of chickpea.

Treatment details	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
T_1	35,228	84,168	48,940	2.38
T_2	32,978	67,336	34,358	2.04
T_3	33,435	73,288	39,853	2.19
T_4	33,597	75,952	42,355	2.26
T_5	33,703	83,859	50,156	2.48
T_6	35,685	86,563	50,878	2.42
T_7	35,847	91,045	55,198	2.53
T_8	35,953	93,998	58,045	2.61
T_9	32,075	64,629	32,554	2.01

Conclusion

The application of 100 per cent RDF (13:25:25 kg N:P2O5:K2O ha^{-1} + 7.5 t ha^{-1}FYM) along with foliar spraying of 1 per cent chickpea magic at 45 DAS was found effective in enhancing nutrient uptake yield and profitability of chickpea under rainfed conditions in Central Dry Zone of Karnataka.

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