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Effect of various levels of chickpea magic on growth and yield 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 growth and yield 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 were taken into study. The results of the study indicated that the growth and yield of chickpea were significantly influenced by the foliar nutrition with chickpea magic. The growth parameters *viz*., plant height (40.28 cm), number of primary and secondary branches $plant^{-1}$ (4.46 and 13.95 $plant^{-1}$, respectively), total dry matter accumulation $plant^{-1}$ (20.39 g $plant^{-1}$) at harvest and yield attributes like number of pods $plant^{-1}$ (47.03), pod yield $plant^{-1}$ (28.24 g), seed yield (18.53 q ha^{-1}) and haulm yield (26.96 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. The magnitude of increase in seed yield was up to 39.63% over farmers practice treatment without any chickpea magic application.

Keywords: Foliar application, chickpea magic, growth, yield, chickpea

Introduction
Chickpea (*Cicer arietinum* L.) is commonly known as gram or Bengal gram, 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) [10]. 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. 2020-21) [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) [8].

Foliar application is a technique of feeding nutrients to plants in the form of liquid directly to their leaves. The foliar application was 6 to 20 times more efficient than the soil treatment. The plant nutrients which are absorbed through roots can also be absorbed with equal efficiency through the foliage, 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. It has 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) [9].

Foliar feeding is often the most effective and economical way to improve plant nutrient deficiency (Dixit and Elamathi, 2007) [5].

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.

Material 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 dS m^{-1} and organic carbon (OC) 3.7 g kg^{-1}. 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 only. 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

The effect of various levels of chickpea magic on growth parameters of chickpea

Significantly higher growth parameters were recorded in the treatment received 100% RDF (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) + 1% chickpea magic at 60 DAS and at harvest except at 30 DAS. Plant height is an important growth parameter that reflects the vegetative growth behaviour of the crop to the applied nutrients. The plant height was progressively increased as the age of crop advanced up to harvest, significantly higher plant height (34.77 and 40.28 cm was recorded at 60 DAS and harvest, respectively) (Table 1). The increased plant height may be due to foliar spray of chickpea magic contained 12 per cent nitrogen, 16 per cent phosphorus, 06 per cent micronutrients and PGR 30 ppm at critical growth stages. So that crop can easily absorb nutrients directly through stomata and cuticle which results in increased photosynthetic activity in the leaves and in turn resulted in the rapid cell division and cell enlargement in the meristematic region and other cytological changes such as an increase in cell wall plasticity and permeability of cell membrane. These findings confirm with reports of Dixit and Elamathi (2007) [5] who concluded that the foliar application of 2 per cent DAP + 40 ppm NAA significantly increased the height of chickpea over control. The application of plant growth regulators through chickpea magic also plays a significant role in increasing plant height. Akter *et al.* (2007) [2] reported that spraying of GA_3 at 50 ppm resulted in maximum plant height over control on the growth of mustard.

Branching is the important growth parameter in pulse crops like chickpea, as tillering in cereals, number of branches per plant decides the number flowers and pods in the chickpea. A significantly maximum number of primary (4.06 at 60 DAS and 4.46 at harvest) and secondary branches $plant^{-1}$ (10.47 at 60 DAS and 13.95 at harvest) were noticed in the treatment with the application of 100 per cent RDF and FYM along with the foliar application of 1 per cent chickpea magic (Table 1). The higher number of branches might be due to hastening various metabolic processes *viz*., photosynthesis, symbiotic biological N_2 fixation process and higher nutrient availability at the initial stage of the crop because of the combined application of organic manures with inorganic fertilizers to the soil and foliar spray of chickpea magic increases the sprouting of auxiliary buds which reflected on the number of branches $plant^{-1}$. This increased photosynthetic activity might have caused more auxiliary buds and ultimately resulted in more number of branches (Banasode and Math, 2018) [3].

Accumulation of dry matter is a significant index representing the plant's growth and metabolic efficiency which ultimately influences crop yield. Dry matter acts as an indicator of availability of soil moisture and nutrients along with favourable climatic conditions. Significantly higher total dry matter production was recorded in the treatment received 100 per cent RDF and FYM along with 1 per cent chickpea magic (5.13 g and 14.6 g $plant^{-1}$ at 60 DAS and at harvest stage, respectively) (Table 1). This increase might be due to increased availability of nutrients through FYM and fertilizers along with a foliar spray of chickpea magic containing nutrients (macro and micro) and plant growth regulators at critical stages of the crop can full fill the high demand of nutrients led to higher assimilation of nutrients and good dry matter partitioning resulted in higher dry matter production. Foliar application of nitrogen through chickpea magic retarded loss of chlorophyll and enhanced the rate of photosynthesis. The application of potassium controlled the closing and opening of stomata and promoted better photosynthetic activities resulting in higher dry matter accumulation. Chavan *et al.* (2014) [4] noticed that balanced application of both organic and inorganic fertilizers and foliar spray of micronutrients reduced chlorophyll degradation and protease activity, which in turn facilitated soluble protein and photosynthetic enzyme synthesis resulting in a longer period of more assimilatory surface area and extended supply of photosynthates to the growing sinks in soybean. Karthikeyan *et al.* (2020) [6] showed that dry matter accumulation in black gram was significantly influenced by foliar application of 1% pulse wonder spray on 25 DAS followed by 0.5% 19:19:19 spray on 45 DAS.

The effect of various levels of chickpea magic on yield and yield parameters of chickpea

The economic yield is a function of various independent factors like dry matter production, efficiency to translocate photosynthates from the assimilatory area of the sink and its accumulation in different parts of the plant and ultimately on yield attributing traits *viz*., number of pods plant^{-1} (47.03), pod yield plant^{-1} (17.51 g plant^{-1}) and seed index (22.18 g) (Table 2). In the present investigation, application of foliar spray of chickpea magic during 45 days after sowing along with the recommended dose of fertilizers (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) was increased the yield attributing characters. The higher yield parameters in this treatment might be due to better plant performance in these treatments due to the balanced application of organic and inorganic fertilizer along with the foliar spray of chickpea magic containing nutrients (macro and micro) and plant growth regulators resulting in more productive branches plant^{-1}, efficient partitioning of metabolites, appropriate translocation and accumulation of photosynthates, vitamins, amino acids to developing reproductive structures. Due to increase in yield attributing characters, which ultimately increased the seed yield (18.53 q ha^{-1}) and haulm yield (26.96 q ha^{-1}). Foliar spray maintains the leaf area for longer duration which extends period of photosynthates translocation to developing pods resulting in bolder and well-shaped seeds.

Foliar application of nutrients and growth regulators at flowering stage was seen on reduction in flower drop percentage in green gram. The number of flowers plant^{-1} was more significant with the foliar application of 50 ppm salicylic acid at 24 DAS (Kumar *et al*. 1999) [12]. Similar results of reduction in flower drop due to a foliar spray of pulse magic have been reported by Teggelli *et al*. (2016) [11] in pigeon pea.

The complementary use of FYM, fertilizers and chickpea magic complemented each other and produced higher yield and yield parameters. Whereas, significantly lower seed yield was noticed in the treatment which received 1 per cent chickpea magic alone and it might be due to insufficiency in nutrient availability at critical growth stages because there was no application of a recommended dose of fertilizer.

Table 1: The effect of various levels of chickpea magic on growth parameters of chickpea

Treatment details	Plant height (cm)			No. of primary branches			No. of secondary branches			Dry matter production (g plant^{-1})		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1	18.98	31.67	36.46	3.33	3.59	4.03	2.66	9.47	12.52	0.77	5.82	18.62
T_2	17.15	28.23	32.92	3.08	3.25	3.72	2.50	8.56	10.65	0.75	5.06	16.02
T_3	17.19	29.36	35.47	3.11	3.27	3.96	2.51	8.89	11.48	0.68	5.53	17.62
T_4	17.56	30.52	35.75	3.16	3.48	3.98	2.54	9.03	11.90	0.70	5.74	18.09
T_5	17.73	30.88	36.26	3.20	3.57	4.00	2.48	9.29	12.30	0.71	5.75	18.61
T_6	18.34	32.70	37.50	3.29	3.72	4.29	2.64	9.94	12.97	0.73	5.98	18.65
T_7	18.69	33.29	38.83	3.31	3.89	4.34	2.64	10.20	13.42	0.74	6.11	19.72
T_8	18.86	34.77	40.28	3.32	4.06	4.46	2.65	10.47	13.95	0.74	6.94	20.39
T_9	16.75	26.27	29.74	2.78	2.82	3.15	2.23	8.47	10.00	0.56	5.13	14.60
S.Em. ±	0.54	0.91	1.30	0.19	0.14	0.14	0.19	0.32	0.42	0.06	0.26	0.58
C.D. @ 5%	NS	2.72	3.91	NS	0.43	0.42	NS	0.96	1.27	NS	0.78	1.73

Note: DAS - Days after sowing; RDF - Recommended dose of fertilizer; FYM – farm yard manure; DAP - Di-ammonium phosphate; NS - Non significant

Table 2: The effect various levels of chickpea magic on yield and yield parameters 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})	Harvest index (%)
T_1	42.36	14.65	21.49	16.60	23.36	41.54
T_2	40.20	11.71	20.32	13.27	19.72	40.22
T_3	41.69	14.18	21.02	14.44	21.76	39.88
T_4	41.98	14.23	21.16	14.96	23.04	39.37
T_5	42.22	14.36	21.44	16.54	23.17	41.65
T_6	44.15	16.44	21.73	17.06	25.25	40.32
T_7	45.71	16.50	22.00	17.95	25.89	40.94
T_8	47.03	17.51	22.18	18.53	26.96	40.73
T_9	39.53	10.01	19.89	12.75	17.57	42.05
S.Em. ±	1.24	0.58	0.61	0.52	0.71	1.27
C.D. @ 5%	3.72	1.75	**NS**	1.57	2.13	**NS**

Note: DAS - Days after sowing; RDF - Recommended dose of fertilizer; FYM – farm yard manure; DAP - Di-ammonium phosphate; NS - Non significant

Conclusion

The application recommended dose of fertilizers (13:25:25 kg N:P_2O_5:K_2O ha^{-1} + FYM @ 7.5 t ha^{-1}) along with the foliar spray of chickpea magic @ 1 per cent during 45 DAS is more beneficial and economically advantageous to improve grain yield and haulm yield (18.53 q ha^{-1} and 26.96 q ha^{-1}, respectively) of the chickpea especially under rainfed conditions.

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