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Neha Kulkarni
PG Scholar, VNMKV, Parbhani, Maharashtra, India

Dr. BV Asewar
Head, Department of Agronomy, VNMKV, Parbhani, Maharashtra, India

Bhagyalaxmi
PG Scholar, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Neha Kulkarni
PG Scholar, VNMKV, Parbhani, Maharashtra, India

Effect of nutrient sprays and plant growth regulator on growth, yield attributes and yield of chickpea (*Cicer arietinum* L.)

Neha Kulkarni, Dr. BV Asewar and Bhagyalaxmi

Abstract
The present investigation was aimed that, "Effect of nutrient sprays and plant growth regulator on growth, yield attributes and yield of chickpea (*Cicer arietinum* L.)" was conducted during *Rabi* 2020-21 at Experimental Farm (Block-B), Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The soil of experimental plot was clayey in texture and it is low in available nitrogen, medium in phosphorus and organic carbon, rich in available potassium and slightly alkaline in reaction. The experiment was laid out in randomized block design with eight treatments and three replications. Treatments consisted of foliar application of nutrient sprays xiii *viz.*, T_1 - (Control), T_2 - (2% Urea spray at flower initiation and pod development), T_3 - (2% DAP spray at flower initiation and pod development), T_4 - (1% Urea + 1% DAP spray at flower initiation and pod development), T_5 - (2% KNO_3 spray at flower initiation and pod development), T_6 - (Organic plant extract @ 1% spray at flower initiation and pod development), T_7 - (Seaweed extract @ 0.2% spray at flower initiation and pod development), T_8 - (Grade II foliar spray of nutrient @ 2% at flower initiation and pod development). The gross and net plot size were 5.4 m x 4.5 m and 4.5 m x 4.2 m respectively. Among all the treatments Grade II foliar spray nutrient @ 2% (T_8) were significantly recorded the highest growth attributes, yield attributes, yield and economics of chickpea. Organic plant extract @ 1% (T_6) and 2% KNO_3 (T_5) which are at par with Grade II foliar spray nutrient at flower initiation and pod development stage.

Keywords: Chickpea, foliar spray, growth and yield attributes, seed yield and economics

Introduction
Chickpea (*Cicer arietinum* L.) also known as Bengal gram and commonly gram in English and is popularly known as Chana dal in India. Chickpea is a pulse crop that belongs to the family Fabaceae, sub-family Faboideae. It is the third most important food legume crop of India, contributing about 65% of the world's production and pulse crop in the world after a dry bean and dry peels. And an important source of protein particularly in South Asia, who are largely vegetarian either by choice or because of some economic reasons.

Seed is the main edible part of the plant and is rich in protein content (20.47 g 100 g^{-1}), carbohydrate (62.95 g 100 g^{-1}), fiber (12.2 g 100 g^{-1}), phosphorous (252 mg l00 g^{-1}) and five high amounts of minerals such as calcium (57 mg 100 g^{-1}), magnesium (79 mg 100 g^{-1}), iron (4.31 mg l00 g^{-1}) and zinc (15 mg 100 g^{-1}) these are low in fat content and most of it is polyunsaturated (Wallace *et al*. 2016) [19]. According to International Crops Research Institute for Semi-Arid Tropics (ICRISAT) chickpea seeds contains about 23% protein, 64% total carbohydrates, 5% fat, 6% crude fiber and 3% ash. It supplies about four times as much protein and eight times as riboflavin and the caloric value of it is equal to rice (Anonymous, 1966) [1]. Moreover, it is known as poor man's meat. It is a versatile source of nutrients for man, animals and soil (Maih, 1976) [11].

Area under chickpea cultivation during 2017-18 in Maharashtra is 18.48 L ha. With a production of 18.41 L tons and productivity of 962 kg ha^{-1} (Anonymous, 2017-18a) [2] and in Marathwada, chickpea is grown on an area of 8.70 L ha. With a production of 9.18 L tons, with a productivity of 1055 kg ha^{-1} (Anonymous, 2017-18b) [3].

Agronomic practices of the crop are required to be standardized for better yield potential. Application of nutrients through foliar sprays along with soil application has several advantages in supplementing the nutritional requirements and these are designed to eliminate the problems like fixation and immobilization of nutrients. The extent of flower drop determines the yield and yield attributing characters in pulses and retention of flowers by the plant gives yield more than expected.

Foliar application is regarded as a preferred solution when a quick supply of nutrients is hindered or the soil conditions are not conducive for the absorption of nutrients (Salisbury and Ross, 1985) [16]. It is one of the most important methods of fertilizer application practices in agriculture because foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching, fixation and regulating the uptake of nutrients by the plant (Manonmani and Srimathi, 2009) [12].

Material and Methods

A field experiment was carried out during *Rabi* 2020-21 using chickpea (cv. Akash) at the Experimental farm (Block-B), Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in randomized block design with three replications. The treatment details are comprised of T_1 - Control, T_2 - 2% Urea at flower initiation and pod development, T_3 - 2% DAP at flower initiation and pod development, T_4 - 1% Urea + 1% DAP at flower initiation and pod development, T5 - 2% KNO_3 at flower initiation and pod development, T6 - Organic plant extract @ 1% at flower initiation and pod development, T_7 - Seaweed extract @ 0.2% at flower initiation and pod development and T_8 - Grade II foliar spray nutrient @ 2% at flower initiation and pod development. The soil of experimental field was low in nitrogen, medium in phosphorus and high in potash while medium in organic carbon and slightly alkaline. Growth and yield attributing characters were recorded at different growth stages. In each plot, five random plants were selected to be record biometric observations on growth and yield attributes. Five plants were uprooted from the observation unit for recording the dry matter studies and after removing the roots, plant samples were kept in well labelled brown paper bag. First the samples are dried in shade and after that kept in oven at 65 °C ± 2 °C, and then weight of dry matter was taken and expressed on per plant basis. All the data were subjected to analysis of variance.

Result and Discussion

Effect of nutrients on growth and yield attributes Plant height (cm)

Data revealed in Table 1. That the plant height at harvesting stage was varied from 41.35 to 52.52 cm. The maximum height was significantly observed in (T_8) Grade II foliar spray nutrient @ 2% at flower initiation and pod development stage. (T_6) Organic plant extract @ 1% and (T_5) 2% KNO_3 which are at par with Grade II foliar spray at flower initiation and pod development stage and minimum height was recorded in treatment (T_1) Control. Application of nutrients would have resulted in better vegetative growth as observed by taller plants and thus, favourable influence of foliar application of nutrients could be ascribed to more and quick access to nutrients by plants at seedling and early development stage. Results is in conformity with the findings of Shinde and Vasudevan (2017) [18], Maheswari and Karthik (2017) [10], Rathod *et al.* (2020) [15], Doddamani *et al.* (2020) [5].

Number of branches plant^{-1}

The presented data in Table 1. Revealed that number of branches plant^{-1} at 75 DAS were 13.05 to 21.42. The maximum number of branches were observed in the treatment (T_8) Grade II foliar spray nutrient @ 2% at flower initiation and pod development stage. (T_6) Organic plant extract @ 1% and (T_5) 2% KNO_3 which are at par with Grade II foliar spray at flower initiation and pod development stage and minimum was recorded in treatment (T_1) Control. Due to increase in the rate of metabolic processes and quick absorption of nutrients applied to plants. Similar results are in finding of Janmohammadi *et al.* (2012) [7], Nishane and Shashikant (2016) [13], Rathod *et al.* (2020) [15], Doddamani *et al.* (2020) [5].

Plant spread (cm)

Data revealed that plant spread at harvesting stage was varied from 40.96 to 52.36 cm. The highest plant spread was observed in the treatment (T_8) Grade II foliar spray nutrient @ 2% at flower initiation and pod development stage. (T_6) Organic plant extract @ 1% and (T_5) 2% KNO_3 which are at par with Grade II foliar spray at flower initiation and pod development stage and minimum height was recorded in treatment (T_1) Control.

Total dry matter accumulation plant^{-1} (g)

The presented data revealed that total dry matter accumulation plant^{-1} at harvesting stage was varied from 15.31 to 23.65g. Significantly highest dry matter was observed by foliar application of treatment (T_8) Grade II foliar spray nutrient @ 2% at flower initiation and pod development stage. (T_6) Organic plant extract @ 1% and (T_5) 2% KNO3 which are at par with Grade II foliar spray at flower initiation and pod development stage and minimum height was recorded in treatment (T_1) Control. Due to foliar application of nutrients leads to increase uptake of nutrients which in turn helped in increased plant height, number of branches, plant spread. These results were conformity with the findings of Dixit and Elamathi (2007) [4], Maheswari and Karthik (2017) [10], Kachave *et al.* (2018) [8] who reported that highest total dry matter production had resulted from inefficient translocation of assimilates.

Yield and yield attributing characters

Among all the treatments, foliar application by Grade II foliar spray nutrient @ 2% (T_8) were statistically recorded highest number of pods plant^{-1} (60.84), weight of pods plant^{-1} (18.27 g), number of seeds plant^{-1} (39.63), weight of seeds plant^{-1} (8.55g) and seed index (18.71 g) at flower initiation and pod development stage. Organic plant extract @ 1% (T_6) and 2% KNO_3 (T_5) which are at par with Grade II foliar spray nutrient at flower initiation and pod development. It might be due to better translocation of photosynthesis towards reproductive parts with the particular application of nutrients. Similar results were observed by Maheswari and Karthik (2017) [10], Doddamani *et al.* (2020) [5].

Seed yield (kg ha^{-1})

Among all the treatments**,** Grade II foliar spray nutrient @ 2% (T_8) were statistically recorded higher seed yield (1702 kg ha^{-1}), straw yield (3484 kg ha^{-1}) and biological yield (5186 kg ha-1) which are found to be at par with Organic plant extract @ 1% (T_6) and 2% KNO_3 (T_5) at flower initiation and pod development stage. The impact of the foliar nutrients to meet the nutrient demand of the crop at the critical stage on-site, where they are needed without stress, would have resulted in better growth and development of the crop and ultimately the yield attributing characters and yield. The balanced growth

habit, which induced more flower and fruiting body production with timely supply of nutrients through foliar spray might have reduced shedding of flowers and fruits, which led to a positive source-sink gradient of photosynthates translocation due to growth regulator. Similar, results were reported by Dixit and Elamathi (2007) [4], Gowthami *et al.* (2018) [6], Pal *et al.* (2021) [14], Sarbandi and Madani (2014) [17], Nishane and Shashikant (2016) [13], Maheswari and Karthik (2017) [10], Kachave *et al.* (2018) [8], Rathod *et al.* (2020) [15], Doddamani *et al.* (2020) [5].

Harvest index (%)

The highest harvest index was statistically recorded by foliar application of Grade II foliar spray nutrient @ 2% (T_8) (32.81%) compared to all treatments at flower initiation and pod development stage. Crop need to have enough microelement nutrient to produce maximum yield, thus increasing of seed yield and biological yield could improve harvest index. Similar result was in accordance by Sarbandi and Madani (2014) [17].

Table 1: Growth attributes of chickpea as influenced by various treatments

T. No	Treatment Details	Plant height (cm)	Number of branches plant^{-1}	Plant spread (cm)	Total dry matter accumulation plant^{-1} (g)
T_1	Control	41.35	13.05	40.96	15.31
T_2	2% Urea at flower initiation and pod development	45.44	17.24	44.57	19.61
T_3	2% DAP at flower initiation and pod development	46.20	17.36	45.41	19.79
T_4	1% Urea + 1% DAP at flower initiation and pod development	47.27	17.52	45.86	19.86
T_5	2% KNO3 at flower initiation and pod development	50.60	20.14	48.49	22.53
T_6	Organic plant extract @ 1% at flower initiation and pod development	50.64	20.84	48.53	23.33
T_7	Seaweed extract @ 0.2% at flower initiation and pod development	44.72	17.08	44.21	19.40
T_8	Grade II foliar spray nutrient @ 2% at flower initiation and pod development	52.52	21.42	52.36	23.65
	S.E +	2.21	1.08	2.13	1.02
	C.D. (5%)	6.69	3.26	6.45	3.08
	General Mean	47.34	18.08	46.29	20.43

Table 2: Yield attributing characters as influenced by various treatments

T. No	Treatment Details	No. of seeds plant^{-1}	Wt. of seeds plant^{-1} (g)	No. of pods plant^{-1}	Wt. of pods plant^{-1} (g)	Seed index (g)
T_1	Control	30.63	6.47	54.49	15.32	18.15
T_2	2% Urea at flower initiation and pod development	37.91	7.97	59.12	17.91	18.44
T_3	2% DAP at flower initiation and pod development	38.93	8.21	60.67	18.32	18.51
T_4	1% Urea + 1% DAP at flower initiation and pod development	39.70	8.55	61.39	18.67	18.59
T_5	2% KNO3 at flower initiation and pod development	43.42	9.23	62.03	19.23	18.92
T_6	Organic plant extract @1% at flower initiation and pod development	43.63	9.29	64.63	19.27	18.93
T_7	Seaweed extract @0.2% at flower initiation and pod development	34.35	7.33	57.45	16.18	18.21
T_8	Grade II foliar spray nutrient @ 2% at flower initiation and pod development	48.50	11.32	67.24	21.26	19.3
	S.E +	2.08	0.56	2.46	1.02	1.12
	C.D. (5%)	6.30	1.71	7.42	3.08	NS
	General Mean	39.63	8.55	60.84	18.27	18.71

Table 3: Seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index as influenced by various treatments

T. No	Treatment Details	Seed yield kg ha^{-1}	Straw yield kg ha^{-1}	Biological yield kg ha^{-1}	Harvest Index (%)
T1	Control	1173	2668	3841	30.53
T2	2% Urea at flower initiation and pod development	1326	2903	4229	31.35
T3	2% DAP at flower initiation and pod development	1398	3028	4426	31.58
T4	1% Urea + 1% DAP at flower initiation and pod development	1437	3325	4762	30.17
T5	2% KNO3 at flower initiation and pod development	1486	3168	4654	31.92
T6	Organic plant extract @ 1% at flower initiation and pod development	1569	3326	4895	32.05
T7	Seaweed extract @ 0.2% at flower initiation and pod development	1242	2652	3894	31.89
T8	Grade II foliar spray nutrient @ 2% at flower initiation and pod development	1702	3484	5186	32.81
	S.E +	87.39	179.58	280.6	2.11
	C.D. (5%)	263.87	542.19	847.2	NS
	General Mean	1416.62	3069.46	4485.88	31.54

Economics

From economic analysis it is observed that among all treatments, Grade II foliar spray nutrient @ 2% (T_8) were statistically recorded the higher GMR, NMR and B:C ratio which are found to be at par with Organic plant extract @ 1% (T_6) and 2% KNO_3 (T_5) at flower initiation and pod development stage. Increased in net monetary return, gross monetary return and B: C ratio due to foliar application at various growth stages may be due to the enhanced grain yield. Similar results were observed with findings of Nishane and Shashikant (2016) [13], Kachave and Kausadikar (2018) [8].

Table 4: Economics of chickpea as influenced by various treatments

T. No	Treatment Details	Cost of cultivation (₹ ha^{-1})	Gross monetary returns (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	Benefit: Cost ratio
T1	Control	27550	63342	35792	2.2
T2	2% Urea at flower initiation and pod development	27714	71604	43890	2.5
T3	2% DAP at flower initiation and pod development	28126	75492	47366	2.6
T4	1% Urea + 1% DAP at flower initiation and pod development	28750	77598	49678	2.6
T5	2% KNO3 at flower initiation and pod development	29850	80244	50555	2.6
T6	Organic plant extract @ 1% at flower initiation and pod development	31750	84726	51827	2.6
T7	Seaweed extract @ 0.2% at flower initiation and pod development	28784	67068	38284	2.3
T8	Grade II foliar spray nutrient @ 2% at flower initiation and pod development	33750	91908	54482	2.7
	S.E +	-	3675	3674	-
	C.D. (5%)	-	11095	11095	-
	General Mean	29534	76497	46484	2.51

Conclusion

The findings of present investigation revealed that among all foliar application of different nutrients sprays Grade II foliar spray nutrient @ 2% (T_8) recorded significantly the higher growth attributes, yield attributes and yield which are at par with Organic plant extract @ 1% (T_6) and 2% KNO_3 (T_5) at flower initiation and pod development stage.

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