Original Research Article

Effect of foliar nutrition and growth regulators on growth, quality and economics of greengram (*Vigna radiata* L.)

ABSTRACT

Aims: Foliar nutrition is aimed to eliminate the problems of fixation and immobilization of nutrients. Hence, foliar application of plant growth hormones is being recognized as a significant way of fertilizing modern agriculture, especially under rainfed conditions. Growth regulating substances or growth regulators are known to influence a wide array of physiological parameters like alteration of plant architecture, assimilate partitioning, promotion of photosynthesis, uptake of nutrients (mineral ions) and enhancing metabolism.

Study design: The experiment was laid out in Randomized complete block design with three replications.

Place and Duration of Study: A field experiment was conducted in medium black to deep black soil with clay loam texture at Agricultural Research Station, Bheemarayanagudi, Yadgir district during *kharif* season of 2022.

Methodology: The experiment was consist of eleven treatments *viz*., T_1: Control (water spray), T_2: Pulse magic @ 10 g l^{-1} at flower initiation, T_3: Nitrobenzene @ 500 ppm at flower initiation, T_4: Urea @ 2 % spray at flower initiation, T_5: DAP @ 2 % spray at flower initiation, T_6: N: P: K (19:19:19) @ 2 % spray at flower initiation, T_7: Boron @ 0.25 % spray at flower initiation, T_8: Urea @ 2 % + salicylic acid @ 75 ppm spray at flower initiation, T_9: DAP @ 2 % + salicylic acid @ 75 ppm spray at flower initiation, T_{10}: N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation and T_{11}: Boron @ 0.25 % + salicylic acid @ 75 ppm spray at flower initiation.

Results: Foliar application of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation was found beneficial for growth and yield of greengram along with higher net returns and BC ratio. Alternately, foliar application of N:P:K (19:19:19) @ 2 % + salicylic acid @ 75 ppm at flower initiation stage or foliar application of pulse magic @ 10 g l^{-1} at flower initiation stage can be recommended for achieving higher net returns from greengram cultivation.

Conclusion: Foliar application of nutrients and plant growth hormones would reduce the burden on soil application of fertilizers through urea and DAP for greengram cultivation. Thereby, cost incurred on fertilizers could be reduced and net returns could be increased. Foliar application of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation was found beneficial for growth and yield of greengram.

Comment [VA1]: Aim not aims

Keywords: *Greengram, Foliar nutrition, plant growth hormones*

1. INTRODUCTION

Greengram is originated from India and Central Asia. In India, greengram is grown in an area of about 45 lakh ha with an average production of 25 lakh t and productivity of 548 kg ha^{-1} in 2020-21. It is also considered as "Golden Bean" because of its nutritional values and suitability for increasing the soil fertility by fixing nitrogen. Greengram is mainly grown in Andhra Pradesh, Maharashtra, Orissa, Rajasthan, Gujarat, Madhya Pradesh, Punjab and Uttar Pradesh. Karnataka (3.97 lakh ha) stands third position in area after Rajasthan (17.19 lakh ha) and Maharashtra (4.53 lakh ha). Rajasthan (17.19 lakh ha) stands first position followed by Maharashtra (4.53 lakh ha). In Karnataka, the area under greengram cultivation is 3.97 lakh ha with a production of 0.96 lakh tones and productivity of 242 kg ha^{-1}.

Comment [VA2]: Write in detail

The productivity of Karnataka is less compared to national productivity due to physiological constraints *viz.*, slow rate of dry matter accumulation during the pre-flowering phase, poor pod setting and onset of leaf senescence during the period of pod development which leads to low partitioning efficiency of assimilates to grain. Foliar application of nutrients and growth regulators at particular stages may solve these physiological constraints.

To increase the nutrient use efficiency, foliar application is more beneficial than soil application as less quantity of fertilizer is required for foliar application as compared to soil application. The prices of fertilizers are increasing day by day hence, it is necessary to reduce the dosage of fertilizers by using foliar application of nutrients. In Karnataka, there was regularly dry spell of 15 to 35 days during *kharif* season which severely affect the growth and yield of greengram. It is evident from the literature that the foliar nutrition helps to increase drought resistance in plant and reduces the loss of water through transpiration.

Foliar feeding is a technique of feeding nutrients to plant in modern crop management method by applying liquid fertilizer (either in solution or suspension) directly to the crop canopy. It is used widely as it can be more efficient, economically feasible, environmental friendly, target oriented and supplement to soil fertilization. Foliar nutrition ensures higher or optimum crop performance by improving crop growth at certain growth stage, correcting the nutrient deficiency in crop and enhancing crop tolerance to adverse conditions.

Growth regulating substances or growth regulators are known to influence a wide array of physiological parameters like alteration of plant architecture, assimilate partitioning, promotion of photosynthesis, uptake of nutrients (mineral ions), enhancing nitrogen metabolism, promotion of flowering, uniform pod formation, increased mobilization of assimilates to defined sinks, improved seed quality, induction of synchrony in flowering and delayed senescence of leaves (Sharma *et al.*, 2013). These growth regulators, when applied as foliar spray at proper crop growth stage in optimum concentration could play a significant role in increasing crop yield and

quality of produce in different field crops (Nagasubramaniam *et al.,* 2007). These plant growth regulators have been considered as software for plant development and improvement in crop productivity. Nutrient availability to plant is very low in soil application. In this circumstance application of nutrients and growth regulators through foliar spray may be beneficial to greengram to enhance the productivity.

2. MATERIAL AND METHODS

A field experiment was conducted during *kharif*, 2022 at Agricultural Research Station, Bheemarayanagudi, University of Agricultural Sciences, Raichur on *vertisols* having pH 8.3 and EC 0.21 ds m^{-1}. The soil was medium in organic carbon content (0.5 %) and available P_2O_5 (21.04 kg ha^{-1}) and low in available N (241 kg ha^{-1}) with high available K_2O content (280 kg ha^{-1}). The experimental site was located at a latitude of 16^0 43' North and 76^0 51' East longitude and an altitude of 411.75 meters above mean sea level in North Eastern Dry Zone of Karnataka (Zone 2).

The meteorological monthly data were recorded at meteorological observatory, Agricultural Research Station, Bheemarayanagudi, for the year 2022 and the mean data of climatic parameters *viz.*, rainfall (mm), maximum and minimum temperatures (^oC) and relative humidity (%) are presented in Fig. 1. The highest temperature was observed in the month of May (38.9 °C) and lowest was found in January (14.6 °C). The total amount of rainfall received throughout the year was 905.8 mm and average relative humidity of the year 2022 was 64.48 per cent.

The experiment was laid out in randomized complete block design along with three replications. There were 11 treatment combinations, consisting of T_1: Control (water spray); T_2: Pulse magic @ 10 g l^{-1} at flower initiation; T_3: Nitrobenzene @ 500 ppm at flower initiation; T_4: Urea @ 2 % spray at flower initiation; T_5: DAP @ 2 % spray at flower initiation; T_6: N: P: K (19:19:19) @ 2 % spray at flower initiation; T_7: Boron @ 0.25 % spray at flower initiation; T_8: Urea @ 2 % + salicylic acid @ 75 ppm spray at flower initiation; T_9: DAP @ 2 % + salicylic acid @ 75 ppm spray at flower initiation; T_{10}: N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation and T_{11}: Boron @ 0.25 % + salicylic acid @ 75 ppm spray at flower initiation. The land was ploughed once after the harvest of the previous crop followed by two harrowings. At the time of sowing, the land was prepared to a fine seedbed and the plots were laid out. The variety BGS-9 was used and application of FYM was done 15 days before sowing of seeds. The crop was sown on 13^{th} June 2022 with a spacing of 30 × 10 cm. Harvesting was done at physiological maturity of the crop. The net plot area as per the treatments was harvested by cutting the plants to the ground level. After harvesting, the plants were bundled and allowed for sun drying. After complete sun drying, the crop was threshed by beating with wooden sticks. The separated seeds were winnowed, cleaned and grain and haulm yield were expressed in

kilogram per hectare. The harvest index was calculated by using the formula suggested by (Donald, 1962).

The yield attributes and yield observations were recorded from the net plots and seed yield was converted to hectare basis in kilograms. The economics of each treatment was computed with prevailing market prices of the corresponding year. The yield was further computed for gross and net returns as well BC ratio to assess the profitability. The benefit-cost ratio was worked out by dividing the gross returns by the total cost of cultivation of respective treatments.

2.1 Statistical analysis

The data collected from the experiment at different growth stages and at harvest were subjected to statistical analysis as described by Panse and Sukhatme (1967). The level of significance used for 'F' test was P=0.05. Critical Difference (CD) values were calculated at 5 per cent probability level if the F test will find to be significant.

3. RESULTS AND DISCUSSION

3.1 Growth attributes

Foliar application of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation has produced significantly taller plants (66.53 cm), number of branches per plant (6.68), leaf area per plant (576.63 cm^2), LAI (1.92), SPAD value (28.49) at harvest and it was found *on par* with N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation (64.76 cm, 6.14, 539.19 cm^2, 1.80 and 27.41, respectively) and pulse magic @ 10 g l^{-1} at flower initiation (64.29 cm, 5.98, 527.73 cm^2, 1.76 and 26.87, respectively). However, control treatment recorded significantly lower values (49.58 cm, 3.41, 319.20 cm^2, 1.07 and 19.20, respectively) (Table 1). The significant increase in growth characters of crop might be due to combination of nutrient and foliar spray of growth regulators which play a major role in growth, development and metabolism of the crop. The reason for a greater number of branches per plant, leaf area, LAI and SPAD values might be due to the balanced metabolism maintained continuously inside the plant to subsequent phases of growth (Marimuttu and Surendran, 2015).

Foliar spray of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation has recorded significantly higher dry matter accumulation in leaf, stem and pod (6.31, 10.53 and 12.94 g $plant^{-1}$, respectively) followed by foliar application of N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation (5.96, 9.91 and 11.75 g $plant^{-1}$, respectively) and pulse magic @ 10 g l^{-1} at flower initiation (5.72, 9.59 and 11.63 g $plant^{-1}$, respectively). Significantly lower dry matter accumulation in leaf, stem and pod was recorded in control (2.79, 4.95 and 7.91 g $plant^{-1}$, respectively) (Table 2).

Foliar application of nutrients and plant growth regulators produced non-significant effect on protein content in seed and it varied from 21.13% to 23.04%. Numerically higher protein

content (23.04 %) was recorded with foliar spray of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation and lower protein content was recorded in control (water spray) treatment (21.13 %) (Table 2).

3.2 Economics

Significantly higher gross returns, net returns and BC ratio were recorded with foliar application of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation (Rs. 90,000 ha^{-1}, Rs. 58,527 ha^{-1} and 2.86, respectively) as compared to other treatments and it was found on par with N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation (Rs. 86,000 ha^{-1}, Rs. 53,297 ha^{-1} and 2.63, respectively) and pulse magic @ 10 g l^{-1} at flower initiation (Rs. 83,200 ha^{-1}, Rs. 51,055 ha^{-1} and 2.59, respectively). Significantly lower gross returns, net returns and BC ratio were recorded in control (Rs. 49,920 ha^{-1}, Rs. 18,750 ha^{-1} and 1.60, respectively) (Fig 2.).

Basal application of conventional and foliar application of fertilizers and plant growth regulators supplied the required amount of nutrients adequately and resulted in producing higher yields which in turn helped to get higher gross returns, net returns and BC ratio. The net returns was lower in control as the nutrient requirement of plant was not met, as a result of this the plant produced lower yields and fetched lower returns. Similar results were also obtained by Muthal *et al.* (2016), Sruthi *et al.* (2020) and Thadaboina *et al.* (2022) in greengram.

4. CONCLUSION

Foliar application of DAP @ 2 % + salicylic acid @ 75 ppm at flower initiation was found beneficial for growth and yield of greengram along with higher growth attributes, net returns and BC ratio. Alternately, foliar application of N:P:K (19:19:19) @ 2 % + salicylic acid @ 75 ppm at flower initiation or foliar application of pulse magic @ 10 g l^{-1} at flower initiation can be recommended for achieving higher net returns from greengram cultivation. In addition to this, foliar application of nutrients and plant growth hormones would reduce the burden on soil application of fertilizers through urea and DAP for greengram cultivation. Thereby, cost incurred on fertilizers could be reduced and net returns could be increased.

REFERENCES

Donald, C. N., 1962, In search of yield. *J. Australian Inst. Agric. Sci.,* 28: 1971-1978.

Marimuthu, S. and Surendran, U., 2015, Effect of nutrients and plant growth regulators on growth and yield of blackgram in sandy loam soils of Cauvery new delta zone, India. *Cogent Food Agric.*, 1(1): 1-9.

Muthal, Y. C., Deshmukh, S. L., Sagvekar, V. V. and Shinde, J. B., 2016, Response of foliar application of macro and micronutrients on growth, yield and quality of *kharif* greengram (*Vigna radiata* L.). *Int. J. Tropical Agric.*, 34(7): 2137-2141.

Nagasubramaniam, A., Pathmanabhan, G. and Mallika, V., 2007, Studies on improving production potential of baby corn with foliar spray of plant growth regulators. *Ann. Rev. Plant Physiol. Plant Mol. Biol.*, 21: 154-157.

Panse, V. G. and Sukhatme, P. V., 1978, Statistical methods for agriculture workers, ICAR Publication, New Delhi.

Sharma, P., Sardana, V. and Singh, K. S., 2013, Dry matter partitioning and source-sink relationship as influenced by foliar sprays in groundnut. *Bioscan*, 8(4): 1171-1176.

Sruthi, D. S. V. S., Singh, S., Tiwari, D. and Kavya, P., 2020, Effect of foliar spray of nutrient and plant growth regulators on growth and yield of greengram (*Vigna radiata* L.). *Int. J. Life Sci.*, 15(2): 253-256.

Thadaboina, S., Debbarma, V. and Kumar, G. A., 2022, Performance of foliar application of nutrients and growth regulators on growth and yield of greengram (*Vigna radiata* L.). *J. Pharma. Innov.*, 11(7): 3460-3464.

Table 1. Growth attributes of greengram at different growth stages as influenced by foliar application of nutrients and growth regulators

Treatment	At harvest				
	Plant height (cm)	**Number of branches**	**Leaf area (dm^2 plant)**	**LAI**	**SPAD value**
T_1: Control (Water spray)	49.58	3.41	319.20	1.07	19.20
T_2: Pulse magic @ 10 g l^{-1} at flower initiation	64.29	5.98	527.73	1.76	26.87
T_3: Nitrobenzene @ 500 ppm at flower initiation	53.34	4.20	390.05	1.30	21.71
T_4: Urea @ 2 % spray at flower initiation	55.24	4.39	400.31	1.34	22.27
T_5: DAP @ 2 % spray at flower initiation	57.36	4.54	421.82	1.41	23.38
T_6: N: P: K (19:19:19) @ 2 % spray at flower initiation	57.28	4.79	448.31	1.49	24.84
T_7: Boron @ 0.25 % spray at flower initiation	52.37	4.16	382.26	1.27	21.52
T_8: Urea @ 2 % + salicylic acid @ 75 ppm spray at flower initiation	60.39	5.06	486.79	1.62	26.28

Comment [VA3]: Check the unit (cm^2/dm^2)

T_9: DAP @ 2 % + salicylic acid @ 75 ppm spray at flower initiation	66.53	6.68	576.63	1.92	28.49
T_{10}: N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation	64.76	6.14	539.19	1.80	27.41
T_{11}: Boron @ 0.25 % + salicylic acid @ 75 ppm spray at flower initiation	59.88	5.02	475.38	1.58	25.15
S.Em.±	**2.01**	**0.25**	**18.38**	**0.06**	**0.72**
C.D. at 5 %	**5.94**	**0.73**	**54.24**	**0.18**	**2.12**

Table 2. Growth attributes of greengram at different growth stages as influenced by foliar application of nutrients and growth regulators

Treatment	At harvest			
	Leaf dry matter (g)	**Stem dry matter (g)**	**Pod dry matter (g)**	**Protein content (%)**
T_1: Control (Water spray)	2.79	4.95	7.91	21.13
T_2: Pulse magic @ 10 g l^{-1} at flower initiation	5.72	9.59	11.63	21.19
T_3: Nitrobenzene @ 500 ppm at flower initiation	3.30	6.23	8.41	21.26
T_4: Urea @ 2 % spray at flower initiation	3.37	6.62	8.87	22.32
T_5: DAP @ 2 % spray at flower initiation	3.72	7.11	9.46	21.49
T_6: N: P: K (19:19:19) @ 2 % spray at flower initiation	4.15	7.51	9.80	22.21
T_7: Boron @ 0.25 % spray at flower initiation	3.23	5.57	8.18	21.18
T_8: Urea @ 2 % + salicylic acid @ 75 ppm spray at flower initiation	4.90	8.65	10.89	23.04

T_9: DAP @ 2 % + salicylic acid @ 75 ppm spray at flower initiation	6.31	10.53	12.94	22.82
T_{10}: N: P: K (19:19:19) @ 2 % + salicylic acid @ 75 ppm spray at flower initiation	5.96	9.91	11.75	22.70
T_{11}: Boron @ 0.25 % + salicylic acid @ 75 ppm spray at flower initiation	4.61	8.11	10.35	21.23
S.Em.±	**0.21**	**0.33**	**0.48**	**1.16**
C.D. at 5 %	**0.61**	**0.96**	**1.41**	**NS**

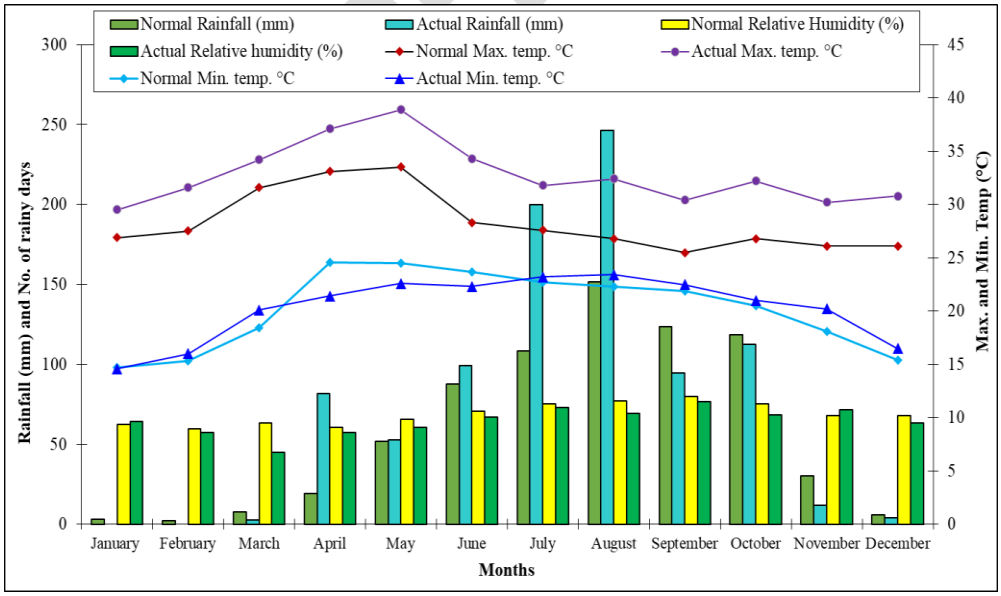

Fig. 1. Mean monthly meteorological data for the year 2022 and mean of the last 30 years (1992-2021) at ARS, Bheemarayanagudi, UAS, Raichur

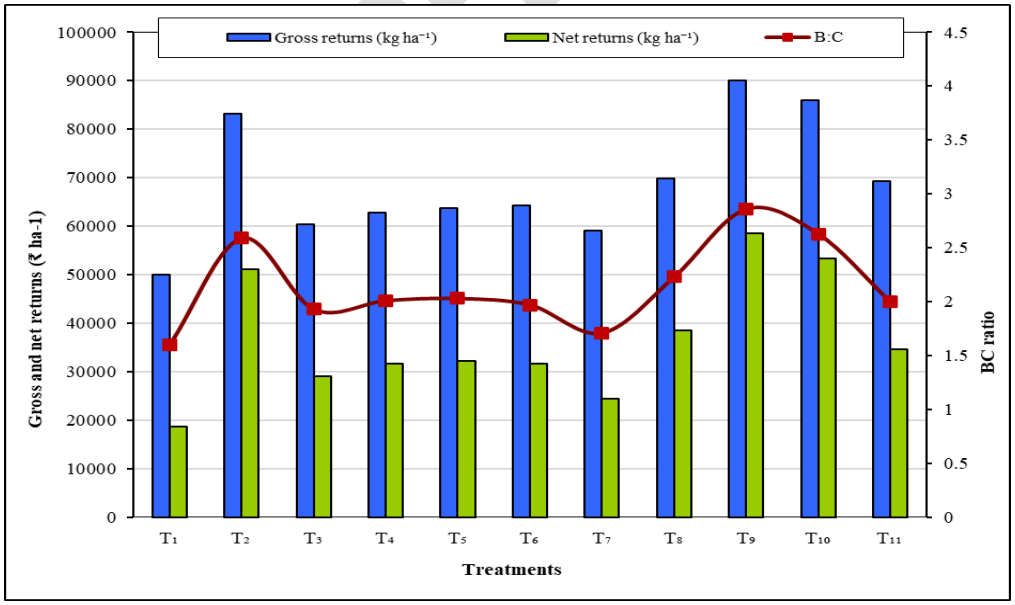

Fig. 2. Gross returns, net returns and BC ratio of greengram as influenced by foliar application of nutrients and growth regulators