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Foliar Nutrition as Influence on Growth and Yield of *Kharif* Cowpea

B. J. Chaudhary[1*], P. P. Chaudhari[2], R. M. Parikh[3], N. M. Chaudhary[4] and D. M. Patel[1]
[1]Ph.D. Scholar, Department of Agronomy, N. M. College of Agriculture,
Navsari Agricultural University, Navsari (Gujarat), India.
[2]Associate Professor (Agronomy), Directorate of Research,
Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat), India.
[3]M.Sc. Agronomy, C. P. College of Agriculture,
Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat (Gujarat), India.
[4]Ph.D. Scholar, Department of Soil Science, N. M. College of Agriculture,
Navsari Agricultural University, Navsari (Gujarat), India.

(Corresponding author: B. J. Chaudhary)*
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ABSTRACT: A field experiment was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, to study the "Foliar nutrition as influence on growth and yield of *kharif* cowpea" during *kharif* season of 2020 with eight treatment combinations in RBD with four replications. Cowpea variety Gujarat cowpea 5 was sown at a distance of 45 cm × 10 cm. Elucidating the specific effects of foliar nutrient applications on growth and yield, the study provides valuable insights for optimizing farming practices and enhancing crop productivity. Various growth parameters of cowpea like plant height, number of branches/plant, dry matter accumulation and yield attributing characters *viz*., number of pods/plant, pod length, number of seeds/pod and seed yield (1422 kg/ha), stover yield (2553 kg/ha), net realization of Rs.71,373/ha and benefit: cost Ratio 3.15 of cowpea recorded significantly maximum with the application of 75% of RDF + 2% spray of each urea and urea phosphate at 15 and 30 DAS as compared to other treatments except application of 75% of RDF + 2% spray of NPK 19:19:19 at 15 and 30 DAS. Significantly lower value of said growth and yield attributes are recorded with control.

Keywords: Foliar spray, Cowpea, Growth attributes, Yield and Economics.

INTRODUCTION

Cowpea, a crucial legume crop for food production in semi-arid regions across Asia, Africa, Southern Europe, and Central America, originates from Central Africa. This warm-weather crop thrives in the humid tropics and subtropical climates, displaying impressive drought tolerance. However, it cannot withstand frost or waterlogged conditions (Singh, 2003). Cowpea also contributes significantly to soil health by fixing nitrogen at a rate of 30-60 kg per hectare (Danielnyoki and Patrick 2014).

In India, the cultivation of pulses covers an extensive area, spanning approximately 287.8 lakh hectares, resulting in an annual harvest of 254.6 lakh metric tons, and boasting an average yield of 885 kilograms per hectare, according to data from 2021 (DES, 2021). In 2021, the per capita per year availability of pulses was measured at 16.3 kg. Shifting our focus to Gujarat, the state dedicates a combined area of 1.758 lakh hectares for total pulses, yielding a substantial production of 2.69 million metric tons in the 2021-22 season, (DAG, 2022).

Foliar fertilization has emerged as a well-established technique for increasing crop yields and enhancing the quality of agricultural products. It offers the added benefits of improved nutrient utilization and reduced environmental pollution by reducing the quantity of fertilizers required in the soil. Notably, foliar fertilization demonstrates superior effectiveness compared to soil-based fertilizer application, particularly in situations characterized by drought and salinity. This superiority arises from several factors, including the direct supply of essential nutrients to the leaves, their rapid absorption, and the reduced dependence on root activity and soil moisture availability. When commercial fertilizers are applied during periods of low soil moisture, they are swiftly taken up by the plant through the foliage, resulting in heightened crop yields and improved product quality. It's worth noting that when fertilizers are administered foliarly, the plant utilizes more than 90% of the supplied nutrients.

Foliar nutrient application surpasses soil-based methods in effectiveness due to the plant's efficient utilization of nutrients and its cost-effectiveness on a per-unit area basis. Therefore, it is essential to employ both soil application and foliar spraying for fertilizer delivery. When water-soluble fertilizers are foliar applied to mature crops, they swiftly address nutrient deficiencies and prevent nutrient fixation in the soil, offering a rapid and effective solution.

MATERIALS AND METHODS

The study took place at the Agronomy Instructional Farm, situated within the Department of Agronomy at Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University. This location is positioned at 24° 19' North latitude and 72° 19' East longitude, with an elevation of 154.52 meters above sea level. It is situated within the North Gujarat Agro-climatic region. The climate in this region follows a sub-tropical monsoon pattern and falls within the semi-arid category. The soil of the experimental field was characterized as loamy sand in texture, with relatively low levels of organic carbon (0.27%) and available nitrogen (158 kg/ha). It exhibited medium levels of available phosphorus (38.9 kg/ha) and high levels of available potash (295.2 kg/ha), with a pH value of 7.58.

A total of eight treatment combinations were employed in a randomized block design, each with four replications. Here are the details of the treatments: T_1: Control, T_2: Recommended dose of fertilizer (RDF), T_3: 75% of RDF + 1% spray of each urea and urea phosphate at 15 and 30 days after sowing (DAS), T_4: 75% of RDF + 1% spray of NPK 19:19:19 at 15 and 30 DAS, T_5: 75% of RDF + 2% spray of each urea and urea phosphate at 30 DAS, T_6: 75% of RDF + 2% spray of NPK 19:19:19 at 30 DAS, T_7: 75% of RDF + 2% spray of each urea and urea phosphate at 15 and 30 DAS and T_8: 75% of RDF + 2% spray of NPK 19:19:19 at 15 and 30 DAS. For this experiment, the cowpea variety used was Gujarat cowpea 5, and it was sown with a spacing of 45 cm × 10 cm on July 7th. The recommended fertilizer dose was 20:40 kg per hectare of N: P_2O_5. The crop was harvested when it reached physiological maturity on October 1st, 2020.

RESULTS AND DISCUSSION

A. Effect on growth parameters

The perusal mean data as influenced by various treatments *viz.*, Inorganic fertilizers and foliar spray are presented in Table 1.

Plant height due to various levels of inorganic fertilizers and foliar spray were found significant. Treatment T_7 recorded higher plant height (32.96 cm) and it was statistically at par with treatments T_8, T_2, T_3, T_4, T_5 and T_6. Plant height at 60 DAS (57.77 cm) and at harvest (68.17 cm) were recorded significantly higher with treatment T_7 (75% of RDF+2% spray of each urea and urea phosphate at 15 and 30 DAS) and remained at par with treatment T_8 (75% of RDF + 2% spray of NPK 19:19:19 at 15 and 30 DAS), treatment T_3 (75% of RDF + 1% spray of each urea and urea phosphate at 15 and 30 DAS), treatment T_4 (75% of RDF + 1% spray of NPK 19:19:19 at 15 and 30 DAS), treatment T_5 (75% of RDF+2% spray of each urea and urea phosphate at 30 DAS). Treatment T_1 (control) recorded lower plant height at 30 DAS (25.14 cm), 60 DAS (41.24 cm) and at harvest (48.66 cm). Nitrogen is one of the major elements, which influences the metabolic activities of the plants. The increase in plant height can be explained on the basis of more available nitrogen and phosphorus being an essential part of nucleic acid and protein, which are very important in promoting quick growth. This may be due to optimum level of nitrogen in the soil and also abundance of nitrogenous and phosphatic fertilizers as a foliar for photosynthesis activity increase in plant height. These results related with Kavitha *et al.* (2019) and Choudhary and Yadav (2011).

Data revealed that the application of 75% of RDF + 2% spray of each urea and urea phosphate at 15 and 30 DAS (T_7) recorded significantly higher number of branches/plant (7.15) over all the treatments except treatment T_8 (application of 75% of RDF + 2% spray of NPK 19:19:19 at 15 and 30 DAS). The number of branches per plant recorded with T_7 which was 22.53 and 45.91 per cent higher than T_2 (Recommended dose of fertilizer) and T_1 (control), respectively. Higher levels of nitrogen and phosphorus supplied through foliar spray at early crop growth have increased the photosynthetic activity and the photosynthates might have been utilized for the production of more number of auxiliary buds and ultimately resulted in more number of branches. The results are in close agreement with the findings of Choudhary and Yadav (2011) in cowpea and Narayan *et al.* (2011).

Dry matter accumulation at 30, 60 DAS and at harvest were significantly higher with the application of 75% of RDF + 2% spray of each urea and urea phosphate at 15 and 30 DAS (T_7). The corresponding value of dry matter accumulation was 14.66, 29.33, 38.84 g/plant, respectively. Treatment T_7 was remained at par with T_8, T_2, T_3 and T_4 at 30 DAS and T_8, T_3, T_4 and T_5 at 60 DAS as well as T_8, T_3, T_4, T_5 and T_6 at harvest. Significantly lower dry matter accumulation recorded at 30 DAS (9.35 g/plant), 60 DAS (18.21 g/plant) and at harvest (24.76 g/plant) were noted with treatment T_1 (control). The observed phenomenon can likely be attributed to improved nutrient absorption facilitated by both soil and foliar applications. This, in turn, results in the promotion of optimal root and shoot growth, an augmentation in leaf area, increased dry matter production, and enhanced nutrient uptake. Consequently, these processes culminate in a notable increment in the overall dry weight of the plant. The application of nutrients via foliar spraying is particularly noteworthy, as it ensures a higher nutrient supply precisely during flower initiation. This, in turn, may be responsible for the efficient translocation of photosynthates from source to sink, ultimately leading to a higher number of pod formations and an increased dry weight per plant. These observations align with prior studies conducted by Narayan *et al.* (2011) and Dey *et al.* (2017).

Table 1: Effect of inorganic fertilizers and foliar spray on growth and yield of *kharif* cowpea.

Treatments	Plant height (cm)			Number of branches/plant	Dry matter accumulation (g/plant)			Number of pods/plant	Pod length	Number of seeds/pod	Seed yield (g/plant)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
	30 DAS	60 DAS	At harvest		30 DAS	60 DAS	At harvest							
T_1	25.14	41.24	48.66	4.90	9.35	18.21	24.76	7.02	9.14	7.72	5.52	880	1553	35.90
T_2	31.85	48.45	57.17	5.84	13.75	23.80	30.24	9.66	10.55	9.88	6.75	1186	1937	37.97
T_3	31.46	53.48	63.11	6.43	13.36	27.63	37.14	9.91	12.68	9.99	7.17	1214	2083	36.94
T_4	31.42	52.36	61.78	6.32	13.21	25.21	36.32	9.78	12.40	9.72	6.98	1194	2002	37.29
T_5	29.23	50.05	59.05	5.79	10.06	24.32	34.85	8.95	11.51	8.91	6.66	1098	1892	36.74
T_6	29.45	48.56	57.80	5.76	10.29	24.00	34.74	7.96	11.16	8.94	6.33	1079	1937	35.76
T_7	32.96	57.77	68.17	7.15	14.66	29.33	38.84	12.28	13.14	10.46	8.51	1422	2553	35.76
T_8	32.57	56.19	66.30	6.68	14.09	28.90	37.65	11.05	12.85	10.01	8.17	1349	2260	37.48
S.Em. ±	1.59	2.86	3.05	0.21	0.67	1.54	2.09	0.45	0.50	0.32	0.29	59	106	1.00
C.D. at 5 %	4.66	8.40	8.98	0.63	1.96	4.53	6.16	1.32	1.46	0.95	0.87	173	313	NS
C.V. %	10.40	11.20	10.13	7.00	10.79	12.22	12.21	9.39	8.50	6.84	8.40	10.01	10.50	5.46

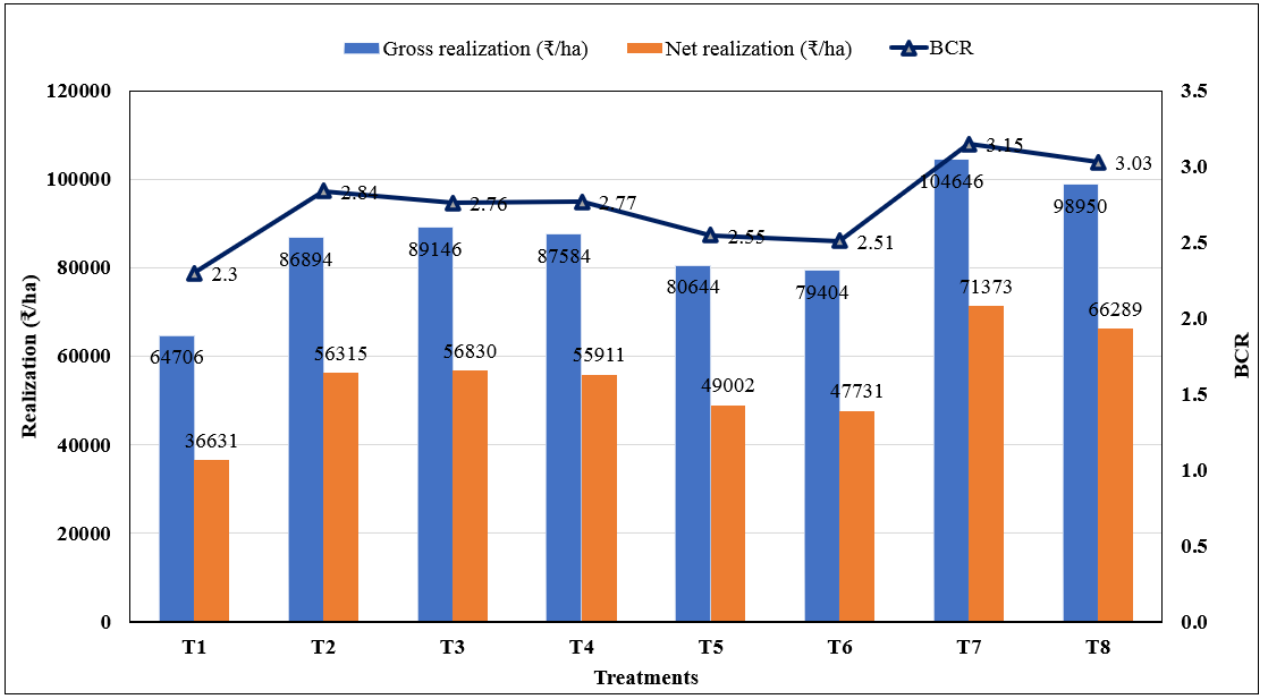

Fig. 1. Effect of inorganic fertilizers and foliar spray on gross and net realization as well as BCR of *kharif* cowpea.

B. Effect on yield parameters

An assessment of data (Table 1) indicated that number of pods/plant, Pod length, number of seeds/pod, seed yield (g/plant), seed yield and stover yield were significantly higher with the treatment T_7 (75% of RDF + 2% spray of each urea and urea phosphate at 15 and 30 DAS) and it was at par with the treatment T_8 (75% of RDF + 2% spray of NPK 19:19:19 at 15 and 30 DAS). The treatment T_7 accounted an increase number of pods/plant 27.12 and 74.92 per cent over T_2 (Recommended dose of fertilizer) and T_1 (Control), respectively. An increment of 24.54 and 43.76 per cent was observed under T_7 over T_2 (Recommended dose of fertilizer) and T_1 (control), respectively. The magnitude of increase in seeds/pod due to T_7 over T_1, T_2, was to the extent of 35.49 and 5.87 per cent, respectively. The increase in seed yield per plant under T_7 over T_1 and T_2 was 54.16 and 26.07 per cent, respectively. The increase in seed yield (kg/ha) under T_7 and T_8 over T_2 (RDF) was 19.92 and 13.70 per cent and over T_1 (control) was 61.59 and 53.29 per cent, respectively. stover yield due to T_7 over T_1 (control) and T_2 (Recommended dose of fertilizer) was to the extent of 64.39 and 31.79 per cent and T_8 over T_1 and T_2 was to the tune of 29.10 and 16.66 per cent, respectively. Whereas Treatment T_1 (control) produced significantly lowest number of pods/plant, number of seeds/pod, seed yield/plant, seed yield and stover yield. Harvest index unchanged due to different treatments combination which is remain non-significant.

The substantial augmentation in the total seed and stover yield can be primarily attributed to an enhanced nutrient supply and the concurrent reduction in nutrient losses. The application of either 2% urea and urea phosphate or 2% NPK (19:19:19) through foliar spraying proves instrumental in facilitating the expeditious absorption of both nitrogen and phosphorus precisely during the critical periods of nutrient demand at 15 days after sowing (DAS) and 30 DAS in the crop's growth cycle. This strategic nutrient management effectively mitigates flower drop occurrences, increased leaf area and dry matter thereby promoting enhanced pod formation and ultimately resulting in elevated seed and stover yields. These findings substantiate the research of Choudhary and Yadav (2011) on cowpea, which demonstrated that the foliar application of 2% DAP (Diammonium Phosphate) at the branching and flowering stages significantly improved various growth parameters and overall yield when compared to alternative treatments. Similarly, congruent outcomes were observed in cowpea crop by Gupta *et al.* (2011), Kumar *et al.* (2013), Gupta *et al.* (2014), Singhal *et al.* (2015), Pradeepa *et al.* (2017) and Kavitha *et al.* (2019).

Harvesting index was not significantly affected due to different fertilizer treatments on *kharif* cowpea.

C. Effect on Economics

Economics assumes a pivotal role in the decision-making process for farmers when it comes to adopting specific treatments. Consequently, an evaluation of gross realization, net realization, and the benefit-to-cost ratio (BCR) was conducted, as outlined in Fig. 1.

Data revealed that higher gross, net realization and benefit: cost Ratio (BCR) of Rs. 104646/ha, Rs. 71,373/ha and 3.15 respectively were registered by fertilizing the crop with 75% of RDF + 2% spray of each urea and urea phosphate at 15 and 30 DAS (T_7) followed by treatment of 75% of RDF + 2% spray of NPK 19:19:19 at 15 and 30 DAS (T_8) with a value of Rs. 98950/ha, Rs. 66289/ha and 3.03. The lowest gross (Rs. 64706/ ha) net realization (Rs. 36,631/ha) and benefit: cost Ratio (BCR) 2.30 were fetched under control (T_1).

The higher benefit: cost ratio (BCR) due to higher seed and stover yield received in these treatments These findings corroborate with those of Gupta *et al.* (2014), Gowda *et al.* (2015) and Pradeepa *et al.* (2017).

CONCLUSIONS

Based on the results obtained from the present investigation, it is concluded that *kharif* cowpea crop should be fertilized with 75% of RDF (15:30 kg N: P_2O_5/ha) and 2% spray of either urea and urea phosphate or NPK 19:19:19 at 15 and 30 DAS to obtain higher growth, yield and monetary returns in loamy sand. The findings could guide farmers in adopting more efficient and sustainable nutrient management strategies, ultimately contributing to food security and agricultural sustainability in *Kharif* cowpea cultivation.

FUTURE SCOPE

The study opens avenues for future research by prompting investigations into the long-term effects of foliar nutrition on Kharif cowpea, including its impact on soil health, resistance to pests and diseases, and overall sustainability. Further exploration into the molecular mechanisms underlying nutrient uptake and utilization by the crop could provide a deeper understanding of the observed growth and yield outcomes. Additionally, considering the dynamic nature of agricultural systems, assessing the adaptability of foliar nutrition strategies under varying climate scenarios and different geographical regions could be an important direction for future studies.

Conflict of Interest. The authors declare no conflicts of interest that could potentially influence the interpretation or presentation of the research findings. Transparency regarding any affiliations, financial interests, or personal relationships that might bias the study's objectivity is essential for maintaining the credibility and integrity of the research.

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