Indian Journal of Agronomy **70** (2): 218–223 (June 2025)
DOI: 10.59797/ija.v70.i2.5606

Research Paper

Foliar application improves the productivity of the late sown chickpea (*Cicer arietinum*) in Bundelkhand region of Uttar Pradesh

AMIT MISHRA[1], DINESH SAH[2], G.S. PANWAR[2], MUKUL KUMAR[3] AND JAGANNATH PATHAK[4]

Banda University of Agriculture & Technology, Banda, Uttar Pradesh 210 001

Received: September 2024; Revised accepted: April 2025

ABSTRACT

A field experiment was carried out in the years 2019–20 and 2020–21 at Banda, Bundelkhand region to evaluate the performance of foliar nutrition on late sown chickpea crop during the *Rabi* season. The experiment was laid out in Randomized block design consisting of six treatments including the recommended dose of fertilizer (RDF) (T_1), RDF + foliar spray of 1% NPK at 30 days after seeding (DAS) (T_2), RDF + foliar spray of 1% NPK at 50% Flowering stage (T_3), RDF + foliar spray of 1% NPK at 30 DAS and 50% flowering stage (T_4), RDF + foliar spray of 2% NPK at 30 DAS (T_5), and RDF + foliar spray of 2% NPK at 30 DAS and flowering stage (T_6) and replicated 4 times. During both years, the chickpea crop was grown in 12 December. The mean increases in yield by foliar application at both the stages with RDF (T_4 and T_6) treatment was 32, 10, 11, and 12% than RDF alone (T_1) or foliar application at single stage i.e. T_2, T_3 and T_5, respectively. The economic efficiency was also better with T_4 (1.50) and T_6 treatments (1.42) than RDF alone application (1.04). Overall, our study concluded that, applying a 1% NPK mixture at 30 DAS and during the flowering stage to late sown chickpea crop generates a 3.1 q/ha greater yield compared to applying RDF alone, regardless of the year.

Key words: Foliar nutrient application, Late sown chickpea, NPK mixture, Soil properties, Yield

Chickpea (*Cicer arietinum* L.) is a substantial crop in the pulse category and holds the top position in terms of output, contributing to overall pulse production in India. In the 2023–24 season, cultivation area of chickpea in India was on approximately 94.6 lakh hectares, producing 115.76 lakh tonnes (UPAg, 2024) while it was get 1,224 kg/ha productivity. The Uttar Pradesh has almost similar productivity of the chickpea (1,236 kg/ha) crop (DPD, 2022). Known for its nutritional value, chickpea serves as an essential source of protein and energy, ensuring nutritional security for the vegetarian community. The chickpea cultivation predominantly occurs in the semi-arid to arid regions of India, particularly in the Bundelkhand region of India, which falls under agro-climatic zone VII and is renowned for its pulses and oilseeds. The chickpea is an important crop during the *Rabi* season, with timely planting of crops is crucial for achieving higher yields and is also recognized by farmers. Planting of chickpea crop in October and early November has been shown to result in better yields. However, delayed harvesting of Kharif crops often leads to delayed chickpea planting, and the unavailability of necessary inputs left the farmers with little alternative but to leave the land fallow. The significant decrease in yield or complete crop failure is attributed to the delayed seeding of the crop. According to Farooq *et al.* (2019) reported that delayed sowing adversely affects seed germination and the initial growth of the crops, leading to delayed emergence, poor nodulation, and slow plant growth, especially when sown in January due to cold temperatures. Additionally, high temperatures in March negatively impact the reproductive stage of crops.

The application of potassium and nitrogen can mitigate the adverse effects of unfavorable meteorological conditions, particularly in terms of drought resistance. Water-soluble fertilizers, primarily administered through foliar application, are more efficiently absorbed by plants compared to soil-applied nutrients to the soil (Suvarna and Singh, 2021). Although chickpea requires minimal nitrogen, its initial application aids in early growth. Bahr (2007) and Sridhara *et al.* (2022) found that foliar application of

[1]**Corresponding author's Email:** amitkatayani@gmail.com
[1]Associate Professor, College of Post Graduate Studies in Agricultural Sciences, CAU-Imphal, Umiam, Meghalaya 793103; [2]Professor, Department of Agronomy, College of Agriculture, Banda University of Agriculture & Technology, Banda, U.P. 210 001; [3]Professor, Department of Genetics and Plant Breeding, College of Agriculture, Banda University of Agriculture & Technology, Banda, U.P. 210 001; [4]Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Banda University of Agriculture and Technology, Banda, U.P. 210 001

nitrogen enhances the economic yield of chickpea. According to Aliloo *et al.* (2012) also reported that foliar spraying of urea under rainfed conditions promotes growth and increases yield qualities. Similarly, Sharma and Thakral (2023) and Yadav *et al.* (2023) reported that foliar application of water soluble NPK mixture improved the yield of rabi season crop under rainfed condition. Effective nutrient management is crucial to preventing significant declines in chickpea output. The positive effects of foliar nutrient application on plant growth and yield, particularly with timely sowing, have been extensively studied. The present study was conducted to evaluate the performance of foliar spraying of an NPK mixture on a late-sown chickpea crop, considering the aforementioned facts.

MATERIALS AND METHODS

A field experiment was conducted to assess the impact of foliar application was carried out at the research farm of the College of Agriculture, Banda University of Agriculture Technology, Banda during *rabi* seasons of 2019–20 and 2020–21. The soil of the experimental area was silty clay loam with a neutral *p*H of 8.06, normal electrical conductivity (0.400 dS/m), and low organic carbon soil (0.34%). The available phosphorus and potassium content of the soil were 14.6 and 261 kg/ha, respectively. The area is located in semi-arid region of India, received almost negligible rainfall during both the years of crop growing seasons.

Throughout both research years, the crop endured extremely cold weather in December and January, with average maximum and minimum temperatures of 22 and 10 °C, respectively. Furthermore, the crop encountered terminal heat during the maturity phase, with an average maximum temperature exceeding 35°C and an average lowest temperature recording 20°C in both years (Fig. 1). The experiment was laid out in a randomized block design with four replications, including 6 fertilizer doses (Table 1). The water was sprayed in plots that did not receive nutrients through foliar application to ensure uniformity. A water-soluble fertilizer i.e. NPK mixture grade 19:19:19 ($N:P_2O_5:K_2O$) was used for the foliar application at 400 liters/hectare (Table 1).

The chickpea variety 'JG 14' is sown on December 12 during both the *Rabi* season with a seed rate was 80 kg/ha. Pre-sowing irrigation and two additional irrigations at 30 days after sowing and at the pod formation stage were applied. The weeds were manually removed from the field, and no insect pest incidences were observed during the crop-growing season. The crop was manually harvested the first year on March 28, 2020, and 2nd year on April 12, 2021, respectively. Periodic biomass measurements were recorded at 30, 60, 90 days and harvest. The plant was dried at 60 °C for 48 hours and biomass was expressed in

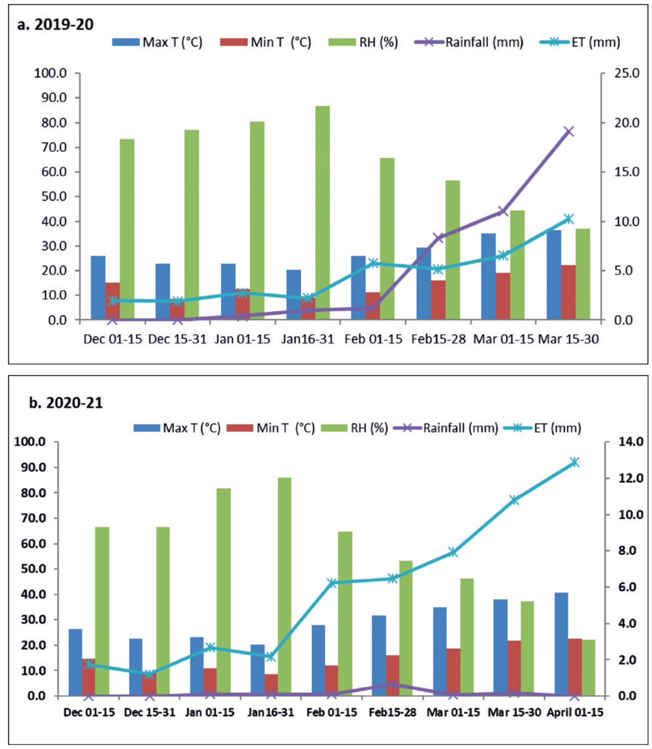

Fig. 1. Meteorological data during crop growing period of 2019-20 (a) and 2020-21 (b)

dry weight basis. Crop growth rate (CGR) was calculated by the following formula:

$$CGR = \frac{W2 - W1}{t2 - t1}$$

where, w_2 and w_1 are dry weights of plant at time t_2 and t_1, respectively.

Five plants were randomly tagged in each plot to determine plant height and yield attributes. For nodule count, five plant roots were uprooted from the soil, and the nodules were oven-dried at 60 °C to estimate nodule dry weight. The yield of chickpea crop was determined by manual harvesting in a 4 m^2 undisturbed area.

Economic analysis was calculated by recording the actual cost of all the operations and input used in cultivation of chickpea crop. The minimum support price of chickpea was used for the calculation of net gain.

The pooled data from 2019-20 and 2020-21 for various characteristics were subjected to statistical analysis by the using SPSS. The means were compared by using the Critical Difference (CD) at $P<0.05$.

RESULTS AND DISCUSSION

Growth attributes

Initially, the growth of plants was quite sluggish, with all plants achieving comparable height by 30 days after sowing (DAS). Conspicuous effects of several treatments were observed at 60 days after sowing. The NPK mixture (T_2,

T_4, T_5, and T_6) applied through foliar application resulted in notably greater plant height compared to the treatment of RDF alone. T_4 had the tallest plants, showing a 36% higher plant height than T_1. A similar trend was recorded at 90 DAS, with T_4 to T_6 showing statistically significant parity and superior plant height compared to T_1 and T_2 (Table 2). The buildup of dry matter is a crucial feature of the mature crop, as it directly affects economic productivity of the crop, provided that the allocation of nutrients from the source to the sink is appropriate. At 30 days after sowing (DAS), all treatments exhibited comparable dry matter accumulation. By 60 DAS, treatments T_2, T_4, T_5, and T_6 showed superior dry matter accumulation compared to treatment T_1, with respective increases of 18, 24, 19, and 22%. Dry matter accumulation was higher at 90 days after sowing (DAS) for treatments T_2, T_4, and T_6 compared to treatment T_1. Based on statistical analysis, T_5 had comparable dry matter content to all other treatments except T_6. T_6 exhibited dry matter buildup of 31, 17, and 16% higher than T_1, T_3, and T_5, respectively. According to statistical analysis, treatments T_4 and T_6 (Foliar spray at 30 DAS and 50% flowering) had significantly more dry matter accumulation at harvest than the other treatments (Table 2). The crop growth rate (CGR) was found to be non-significant at 30 DAS. However, it was influenced statistically by the application of foliar nutrients at both the stages. The CGR data exhibited that T_4 and T_5 treatments were statistically similar and significantly superior to the alone application of recommended dose of the fertilizer alone at both 60 and 90 DAS intervals (Table 2).

Table 1. Treatment detail and an amount of fertilizer applied in different treatments

Description	Amount of nutrient added in different treatments (kg/ha)		
	N	P_2O_5	K_2O
T_1, Recommended dose of fertilizer (RDF)	20.0	60.0	40.0
T_2, RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P_2O_5:K_2O) at 30 DAS	20.8	60.8	40.8
T_3, RDF + foliar spray 1% NPK Mixture at flowering stage	20.8	60.8	40.8
T_4, RDF + 1% NPK Mixture at 30 DAS and flowering stage	21.5	61.5	41.5
T_5, RDF + 2% NPK Mixture at 30 DAS	23.8	63.8	43.8
T_6, RDF + 2% NPK Mixture at 30 DAS and flowering stage	27.6	67.6	47.6

T_1: Recommended dose of fertilizer (RDF); T_2: RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS; T_3: RDF + foliar spray 1% NPK Mixture at flowering stage; T_4: RDF + 1% NPK Mixture at 30 DAS and flowering stage; T_5: RDF + 2% NPK Mixture at 30 DAS and T_6: RDF + 2% NPK Mixture at 30 DAS and flowering stage

Table 2. Effect of foliar nutrition on plant height and biomass accumulation and crop growth rate of chickpea

Treatment	Plant height (cm)			Dry matter accumulation (q/ha)				Crop growth rate (g/dm/day)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS
T_1, Recommended dose of fertilizer (RDF)	5.87	20.8	41.8	2.22	10.33	19.1	23.9	0.07	0.27	0.29
T_2, RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS	6.17	27.3	45.3	2.32	12.2	22.2	28.3	0.08	0.33	0.34
T_3, RDF + foliar spray 1% NPK Mixture at flowering stage	5.95	22.5	47.2	2.32	10.8	21.4	28.4	0.08	0.28	0.35
T_4, RDF + 1% NPK Mixture at 30 DAS and flowering stage	5.92	28.3	50.7	2.30	12.8	24.3	31.1	0.08	0.35	0.38
T_5, RDF + 2% NPK Mixture at 30 DAS	6.42	25.3	47.8	2.29	12.3	21.6	28.4	0.08	0.33	0.31
T_6, RDF + 2% NPK Mixture at 30 DAS and flowering stage	6.30	27.0	52.2	2.36	12.7	25.0	31.8	0.08	0.34	0.41
SEm±	0.50	1.50	1.31	0.13	0.47	0.74	0.75	0.005	0.017	0.03
CD (P=0.05)	NS	5.20	4.56	NS	1.64	2.58	2.59	NS	0.06	0.09

T_1: Recommended dose of fertilizer (RDF); T_2: RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS; T_3: RDF + foliar spray 1% NPK Mixture at flowering stage; T_4: RDF + 1% NPK Mixture at 30 DAS and flowering stage; T_5: RDF + 2% NPK Mixture at 30 DAS and T_6: RDF + 2% NPK Mixture at 30 DAS and flowering stage

The 2-years pooled data showed poor nodulations in chickpea plants at 30 days after sowing (DAS). Nodulation increased with the age of the plant, and at 60 DAS, treatments T_3 to T_6 had a significantly higher number of nodules than the T_1 and T_2. However, at 90 DAS, T_6 was comparable to T_4 and had substantially higher nodulation than T_1 to T_3. Nevertheless, the dry weight of the nodules at 60 days after sowing (DAS) was almost the same across treatments, but at 90 DAS, notably greater nodule dry weight in the foliar application plots for both the concentrations (1 and 2% NPK combination) and the application stages (T_2 toT_6) compared to the control plot (Table 3).

The initial sluggish growth of the plants can be attributed to the cold temperature (around 10 °C) experienced from December 15 to January 15 during both years, which resulted in slow plant growth and inadequate nodulation at the early stage, resulting in poor accumulation of dry matter. As temperature began to rise, the application of nutrients through foliar sprays enhanced nodulation, resulting in improved nodule dry weight, plant height, and dry matter accumulation at 60 DAS in all treatments that received foliar application (T_2 toT_6). Additionally, the application of fertilizers during the flowering stage further enhanced nodulation, plant height, and accumulation of dry matter. Implementing foliar nutrient application at both stages of plant development can help mitigate the impact of cold stress and improve the plant's metabolic processes of the plant, as evidenced by growth characteristics (Ganga *et al.,* 2014, Takankhar *et al.,* 2017, Rahman *et al.,* 2017 and Khan *et al.,* 2018).

Yield attributes and yields

The application of foliar nutrients at both stages, and at concentrations of 1% and 2% resulted in a greater number of primary branches compared to the control treatment. However, the number of primary branches remained statistically equal in treatments T_2 to T_6. The quantity of pods per plant was notably higher when foliar nutrition was applied at both stages (T_4 and T_6). Specifically, the T_4 treatments exhibited a 29, 9, 16, and 8% increase in the number of pods per plant compared to the administration of merely the recommended dose of fertilizer (T_1) and RDF with foliar nutrient application at one stage i.e. T_2, T_3, and T_5 treatments, respectively. No significant effects were observed on the secondary branches, test weight, and harvest index when various treatments were applied. However, the grain yield of chickpea exhibited substantial variation across the different treatments, following a pattern similar to that of the growth characteristics and yield attributes (number of primary branches and number of pods per plant). Among the treatments, T_4 and T_6 treatments had notably higher grain yield rates compared to the other treatments. The mean increase in yield by T_4 and T_6 treatment was 32, 10, 11 and 12 % higher than RDF alone (T_1) or foliar application at single stage i.e. T_2, T_3 and T_5, respectively. The increase in yield characteristics and economic yield of chickpea can be attributed to the application of foliar nutrients, which promote plant growth and help the chickpea crop to mitigate the effects of heat and cold stress. This is achieved by enhancing the metabolic processes of the chickpea, as evidenced by the improved yield attributes and overall yield of the crop. In line with the findings of, Ganga *et al.* (2014), Pawar *et al.* (2016), Mudalagiriyappa *et al.* (2016), Rahman *et al.* (2017) and Ratnam *et al.* (2023), our study confirms that foliar nutrition enhances the production characteristics and yield of chickpea (Table 4).

Table 3. Effect of foliar nutrient application on nodule number and nodule weight of chickpea

Treatment	Nodule number			Nodule dry weight (mg/plant)	
	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS
T_1, Recommended dose of fertilizer (RDF)	1.40	13.9	17.1	224.3	269.2
T_2, RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS	1.44	14.1	21.0	233.6	313.3
T_3, RDF + foliar spray 1% NPK Mixture at flowering stage	1.58	15.7	19.8	232.9	320.2
T_4, RDF + 1% NPK Mixture at 30 DAS and flowering stage	1.50	15.2	22.3	253.9	331.2
T_5, RDF + 2% NPK Mixture at 30 DAS	1.78	16.2	21.0	266.6	316.2
T_6, RDF + 2% NPK Mixture at 30 DAS and flowering stage	1.71	15.9	23.4	248.4	329.7
SEm±	0.18	0.28	0.60	12.5	14.5
CD (P=0.05)	NS	0.97	2.08	NS	50.5

T_1: Recommended dose of fertilizer (RDF); T_2: RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS; T_3: RDF + foliar spray 1% NPK Mixture at flowering stage; T_4: RDF + 1% NPK Mixture at 30 DAS and flowering stage; T_5: RDF + 2% NPK Mixture at 30 DAS and T_6: RDF + 2% NPK Mixture at 30 DAS and flowering stage

Table 4. Effect of foliar nutrition on yield attributes

Treatment	Number of primary branches	Number of secondary branches	Number of pods/ plant	Test weight (g)	Grain yield (kg/ha)	Harvest index (%)
T_1, Recommended dose of fertilizer (RDF)	3.83	7.33	24.3	132.7	970	40.6
T_2, RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS	4.33	8.50	28.7	132.7	1160	40.8
T_3, RDF + foliar spray 1% NPK Mixture at flowering stage	5.00	8.33	27.0	134.6	1150	40.7
T_4, RDF + 1% NPK Mixture at 30 DAS and flowering stage	5.83	9.50	31.4	133.7	1280	41.1
T_5, RDF + 2% NPK Mixture at 30 DAS	5.00	7.83	29.1	133.4	1140	40.2
T_6, RDF + 2% NPK Mixture at 30 DAS and flowering stage	5.50	9.50	32.5	134.6	1290	40.7
SEm±	0.48	0.63	0.83	1.30	29.70	0.47
CD (P=0.05)	1.66	NS	2.87	NS	104	NS

Table 5. Effect of foliar nutrition on soil physic-chemical properties

Treatment	*p*H	Electrical conductivity (dS/m)	Soil organic carbon (%)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
Initial	8.20	0.351	0.31	14.6	259.5
T_1, Recommended dose of fertilizer (RDF)	8.13	0.405	0.32	14.1	261.3
T_2, RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS	8.10	0.405	0.32	15.4	257.2
T_3, RDF + foliar spray 1% NPK Mixture at flowering stage	8.13	0.388	0.34	14.4	261.3
T_4, RDF + 1% NPK Mixture at 30 DAS and flowering stage	8.10	0.376	0.35	14.5	268.8
T_5, RDF + 2% NPK Mixture at 30 DAS	7.92	0.371	0.35	13.5	253.9
T_6, RDF + 2% NPK Mixture at 30 DAS and flowering stage	7.98	0.459	0.35	16.0	267.6
Mean	8.06	0.400	0.34	14.6	261.7
SEm±	0.10	0.09	0.02	1.51	16.4
CD (P=0.05)	NS	NS	NS	NS	NS

Soil Properties

After the 2-years of study, the analysis of soil samples revealed that the application of nutrients through foliar sprays did not influenced the soil properties. There was a slight change in pH, electrical conductivity, and soil organic carbon compared to initial values, irrespective of the treatments. However, no notable change in available phosphorus and available potassium was observed after the two years of experimentation. These slight changes can be attributed to the continuous cultivation of pulse crops in the soil (Table 5).

Economic indices

All expenses related to crop cultivation were recorded in real time to calculate the total cultivation cost. Economic factors play a crucial role in assessing the recommendation analysis. Only the cost of fertilizer inputs varied among the treatments, while all other costs remained the same. By

Table 6. Effect of foliar nutrition on cost of cultivation, net return and B:C ratio of chickpea crop

Treatment	Cost of cultivation (₹/ha)	Net returns (₹/ha)	Benefit: cost ratio
T_1, Recommended dose of fertilizer (RDF)	24,419	25,292	1.04
T_2, RDF + foliar spray of 1% NPK Mixture (19:19:19 (N:P2O5:K2O) at 30 DAS	25,579	33,359	1.30
T_3, RDF + foliar spray 1% NPK Mixture at flowering stage	25,579	33,160	1.30
T_4, RDF + 1% NPK Mixture at 30 DAS and flowering stage	26,339	39,526	1.50
T_5, RDF + 2% NPK Mixture at 30 DAS	26,339	32,614	1.24
T_6, RDF + 2% NPK Mixture at 30 DAS and flowering stage	27,859	39,471	1.42

applying a 1% NPK mixture at 30 days after sowing and at the 50% flowering stage, the highest net return and benefit-cost (B:C) ratio were achieved, with results nearly identical to the T_6treatment. In general, all the treatments involving foliar sprays showed a greater B:C ratio compared to applying the prescribed dosage of fertilizer. The increased return can be attributed to the enhanced economic productivity of the chickpea crop as compared to the control field. The results of our study are consistent with the findings reported by Pawar *et al.* (2016), Mudalagiriyappa *et al.* (2016), Pal *et al.,* 2020 and Ratnam *et al.* (2023) (Table 6).

Our study revealed that the economic yield of chickpea ranged from approximately 970–1290 kg/ha across all treatments, which is comparable to the productivity of chickpea in the Bundelkhand region. The application of foliar nutrients helped to alleviate the effects of cold stress and terminal heat caused by delayed sowing. Therefore, if farmers in the semi-arid region are unable to sow the crop promptly, delaying the sowing may require the provision of three essential nutrients to the crop at a concentration of 1% at both the 30-day post-sowing and 50% flowering phases to achieve a satisfactory crop yield. Furthermore, the study demonstrated that the application of foliar treatment had no impact on the soil characteristics. In summary, the study found that applying a 1% NPK mixture at 30 days after sowing and during the flowering stage generates a yield increase of 3.23 q/ha compared to applying RDF alone, regardless of the year.

REFERENCES

Bhowmick M.K. 2006. Foliar nutrition and basal fertilization in chickpea under rainfed condition. *Environment and Ecology* **24**: 1028–1030.

Bozorgi, H.A., Azarpour, E. and Moradi, M. 2011. Effects of bio, mineral nitrogen fertilization and foliar zinc spraying on yield and yield components of faba bean. *World Applied Science Journal* **13**(6): 1,409–1,414.

Ismael, H.S. 2000. Response of three chickpea cultivars to late foliar spraying with urea as a supplement for early soil applied nitrogen in sandy soils. *Annals of Agriculture Sciences* **38**: 31–46.

Manivannan, V.K., Thanunathan, Imayavaramban V. and Ramanathan, N. 2002. Effect of foliar application of NPK and chelated micronutrients on rice-fallow urd bean. *Legume Research* **25** (4): 270–272.

Aliloo, A.A., Khorsandy, H. and Mustafavi, S.H. 2012. Response of Chickpea (*Cicer arietinum* L.) cultivars to nitrogen applications at vegetative and reproductive growth stages. *Moldova Journal of Agric.ulture* **45**: 152–158.

Bahr, A.A. 2007. Effect of plant density and urea foliar application on yield and yield components of chickpea (*Cicer arietinum* L.). *Research journal of Agriculture and Biological Sciences* **3**: 220–223.

Directorate of Pulses Development (DPD). 2022. Government of India, Ministry of Agriculture & Farmers Welfare, Annual Progress Report, 2021–22. *Directorate of Pulses Development, Bhopal.* Pp. 50.

Farooq, M., Hussain, M., Imran, M., Ahmad, I., Atif, M. and Alghamdi, S.S. 2019. Improving the Productivity and Profitability of Late Sown Chickpea by Seed Priming. *International Journal of Plant Production* **13**: 129–139 (2019). https://doi.org/10.1007/s42106-019-00041-z

Ganga, N., Singh, R.K., Singh, R.P., Choudhury, S.K. and Upadhyay, P.K. 2014. Effect of potassium level and foliar application of nutrient on growth and yield of late sown chickpea (*Cicer arietinum* L.). *Environment and Ecology* **32** (1A): 273–275.

Khan, E.A., Hussain, I., Sheryar, Ahmad, H.A. and Hussain, I. 2023. Influence of nipping and foliar application of nutrients on growth and yield of chickpea in rain-fed condition. *Legume Research* **41**(5): 740–744.

Mudalagiriyappa, Sameer Ali M., Ramachandrappa B.K., Nagaraju and Shankara lingappa B.C. 2016. Effect of foliar application of water solublewater-soluble fertilizers on growth, yield and economics of chickpea (*Cicer arietinum* L.). *Legume Research* **39**(4): 610–613.

Pal, V., Singh, G. and Dhaliwal, S.S. 2020. Symbiotic Parameters, Growth, Productivity and Profitability of Chickpea as Influenced by Zinc Sulphate and Urea Application. *Journal of Soil Science and Plant Nutrition* **20**: 738–750 https://doi.org/10.1007/s42729-019-00161-5

Pawar S.B. 2016. Effect of Foliar Application of Plant Nutrients on Productivity of Rainfed Chickpea. *Advances in Life Sciences* **5**(17): 7,036–7,038.

Rahman, I. U., Farhana, I., Aftab, A. and Zafar, I. 2017. Effect of foliar application of plant mineral nutrients on the growth and yield attributes of chickpea (*Cicer arietinum* L.) under Nutrient deficient soil conditions. *Bangladesh Journal of Botany* **46**(1): 111–118.

Ratham, M., Sowmya, D. and Babu, G. K. 2023. Enhancing the productivity of chickpea through foliar nutrition under rainfed conditions. *Journal of Research ANGRAU* **51**(4): 23–29.

Sharma, S.K., Thakral, S.K. 2023. Assessment of yield and profitability of Indian mustard (Brassica juncea) with foliar fertilization under rainfed condition. *Indian Journal of Agronomy* **68**(3): 300–304 https://doi.org/10.59797/ija.v68i3.2811

Sridhara M.R., Nandagavi, R.A., Nooli, S.S. and Biradar, A.H. 2022. Effect of Foliar Nutrition in Chickpea (*Cicer arietinum* L.) through Organics under Rainfed Condition. *Environment and Ecology* **40**(3A): 1,355–1,360.

Suvarna M. and Singh G.K. 2021. Water Soluble Fertilizers in Indian Agriculture. *Indian Journal of Fertilisers* **17**(4) : 290–0300.

Takankhar, V.G., Karanjikar, P.N. and Bhoye, S.R. 2017. Effect of foliar nutrition on growth, yield and quality of chickpea (*Cicer arietinum* L.). *Asian Journal of Soil Science* **12**(2): 296–299. DOI : 10.15740/HAS/AJSS/12.2/296–299.

UPAg (Unified Portal for Agriculture Statistics, Department of Agriculture & and Farmers Welfare, 2024. Available online: https://upag.gov.in/(accessed 02/09/2024).

Yadav, S.L., Ram, Baldev, Yadav, G.N., Samota, S.D., Yadav, Rajendra Kumar, Yadav, R.K., Yadav, Devideen, Kumar, Ajay, Singh, Khajan, Dhakad, Uditi, 2023. Effect of fertility levels and foliar nutrition in fieldpea (*Pisum sativum*) under south - eastern Rajasthan. *Indian Journal of Agronomy* **68**(2): 188–193: https://doi.org/10.59797/ija.v68i2.353