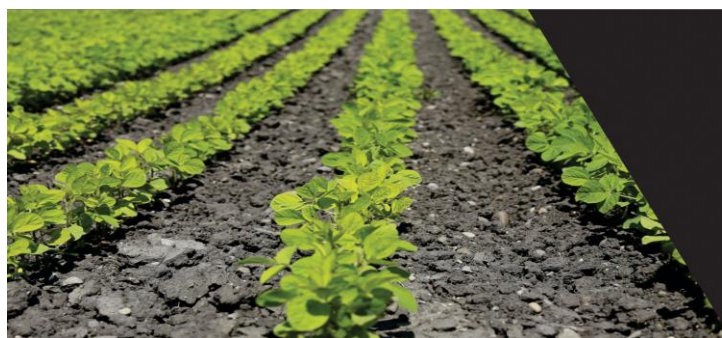




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Productivity enhancement through foliar nutrition in chickpea (*Cicer arietinum* L.)

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Abstract

A field experiment was conducted during the *rabi* 2025-26 at the Agricultural Research Station, Adilabad, Professor Jayashankar Telangana Agricultural University (PJTUA), Telangana, to evaluate Productivity enhancement through foliar nutrition in chickpea (*Cicer arietinum* L.) on the yield attributes and yield of chickpea (*Cicer arietinum* L.). The experiment was laid out in a Randomized Block Design with thirteen treatments and three replications, comprising different combinations of recommended dose of fertilizers (RDF), Acuspray Pulse (N:P:K:S) (10:8:34:2), Nano Urea Plus, Nano DAP, 2% urea and 2% DAP applied as foliar sprays at the pre-flowering and pod development stages. The results revealed that foliar nutrition significantly influenced the number of pods plant⁻¹, seed yield and haulm yield, whereas the number of seeds pod⁻¹, seed index and harvest index were not significantly affected. The treatment 100% RDF + two sprays of Acuspray Pulse (10:8:34:2) 4 g l⁻¹ (T₅) recorded the highest number of pods plant⁻¹ (35.0), seed index (26.7 g), seed yield (2520.7 kg ha⁻¹) and haulm yield (5199.4 kg ha⁻¹) and was statistically on par with 100% RDF + two sprays of 2% urea (T₁₁) and 100% RDF + two sprays of Nano Urea Plus 4 ml l⁻¹ (T₇) for seed yield. The lowest values for yield attributes and yield were observed under the absolute control (T₁). The higher productivity under T₅ was attributed to the balanced supply of nitrogen, phosphorus, potassium and sulphur during the reproductive stage, which improved pod formation, seed filling and efficient translocation of assimilates. The study concluded that foliar application of Acuspray Pulse (10:8:34:2) 4 g l⁻¹ in combination with 100% RDF at pre-flowering and pod development stages is an effective nutrient management strategy for enhancing chickpea productivity.

Keywords: Chickpea, foliar nutrition, Acuspray pulse, nano urea plus, nano DAP, yield attributes, seed yield

1. Introduction

Chickpea (*Cicer arietinum* L.) is an important cool-season grain legume belonging to the family Fabaceae and is believed to have originated in Southwest Asia. It is widely cultivated owing to its high nutritional value, adaptability and contribution to food and nutritional security (Singh *et al.*, 2018) [16]. Commonly known as gram, Bengal gram, garbanzo or chana, chickpea is an excellent source of dietary protein and improves soil fertility through biological nitrogen fixation, thereby contributing to sustainable cropping systems (Singh *et al.*, 2018) [16]. The seeds are consumed as whole grains, split dal and flour, while the haulm serves as nutritious livestock feed. Chickpea seeds contain 18-22% protein, 52-70% carbohydrates, 4-10% fat, about 1.37% crude fibre and are rich in essential amino acids, vitamins and minerals, making them an important component of a balanced human diet (Kumar *et al.*, 2018) [8]. Globally, chickpea is the second most important pulse crop after pigeon pea (Londhe *et al.*, 2022) [9]. India contributes nearly 65% of global chickpea production. During 2025-26, chickpea occupied 95.2 m ha with a production of 117.92 m t and an average productivity of 1238 kg ha⁻¹, while in Telangana it occupied 0.71 m ha with a production of 0.119 m t and productivity of 1673 kg ha⁻¹ (Indiastat, 2025-26) [5]. Despite its importance, chickpea productivity remains below its genetic potential, particularly under rainfed conditions, mainly due to inadequate nutrient availability during the critical reproductive stages. Foliar nutrition has emerged as an efficient nutrient management strategy for supplying nutrients directly to plant foliage during periods of peak nutrient demand. It facilitates rapid nutrient absorption, corrects temporary nutrient deficiencies, enhances photosynthetic activity, promotes assimilate translocation and improves nutrient use efficiency (Rauniyar, 2020) [13] while minimizing nutrient losses associated with soil application (Januszkiewicz *et al.*, 2023) [6].

Recent advances in nanotechnology have led to the development of nano fertilizers, which offer controlled nutrient release, higher nutrient absorption efficiency and reduced environmental losses, thereby improving crop productivity and nutrient use efficiency (Al-Juthery and Al-Maamouri, 2020) ^[2]. Among these, Nano Urea and Nano DAP developed by the Indian Farmers Fertiliser Cooperative Limited (IFFCO) have emerged as promising alternatives to conventional fertilizers for sustainable crop production (Rameshaiah *et al.*, 2015) ^[12]. Nano Urea contains 4% nitrogen in nanoparticles (30-50 nm), enhancing nitrogen absorption while reducing nutrient losses through volatilization, leaching and runoff (Suthar *et al.*, 2023) ^[17]. Similarly, Nano DAP contains 8% nitrogen and 16% phosphorus, improving phosphorus use efficiency and reducing dependence on conventional diammonium phosphate fertilizers (Khemshetty *et al.*, 2024) ^[7]. Therefore, integrating foliar nutrition with nano fertilizers offers considerable potential for improving nutrient use efficiency, productivity and sustainability in chickpea cultivation.

2. Materials and Methods

A field experiment was conducted during *rabi* 2025-26 at the Agricultural Research Station (ARS), Adilabad, Professor Jayashankar Telangana Agricultural University (PJTUAU), Telangana, India, to evaluate the effect of different foliar nutrition treatments on the productivity of chickpea (*Cicer arietinum* L.). The experimental site is located in the Northern Telangana Agro-climatic Zone at 19°40' N latitude and 78°32' E longitude, with an altitude of about 264 m above mean sea level. During the crop growth period the maximum temperature ranged from 28.6 to 37.8 °C, while the minimum temperature ranged from 11.4 to 22.8 °C. The crop received only scanty rainfall during the experimental period and the prevailing weather conditions were generally favourable for normal growth and development of chickpea.

The soil of the experimental field was well-drained clay in texture. Before sowing, composite soil samples were collected from the 0-15 cm soil depth and analysed using standard laboratory procedures. The experimental soil was neutral in reaction (pH 7.53), non-saline (EC 0.52 dS m⁻¹) and low in organic carbon (0.43%). It was low in available nitrogen (220.5 kg ha⁻¹), medium in available phosphorus (39.17 kg P₂O₅ ha⁻¹) and medium in available potassium (267.05 kg K₂O ha⁻¹).

The experiment was laid out in a Randomized Block Design (RBD) with thirteen treatments and three replications. The treatments consisted of T₁: Absolute control; T₂: 80% RDF; T₃: 100% RDF; T₄: 80% RDF + Acuspray Pulse (N:P:K:S 10:8:34:2) 4 g l⁻¹; T₅: 100% RDF + Acuspray Pulse (N:P:K:S 10:8:34:2) 4 g l⁻¹; T₆: 80% RDF + Nano Urea Plus 4 ml l⁻¹; T₇: 100% RDF + Nano Urea Plus 4 ml l⁻¹; T₈: 80% RDF + Nano DAP 2.5 ml l⁻¹; T₉: 100% RDF + Nano DAP 2.5 ml l⁻¹; T₁₀: 80% RDF + two sprays of 2% urea; T₁₁: 100% RDF + 2% urea; T₁₂: 80% RDF 2% DAP; and T₁₃: 100% RDF + 2% DAP. The recommended dose of fertilizers (20:50:20 kg N P₂O₅ K₂O ha⁻¹) was applied through urea, single superphosphate and muriate of potash according to the treatment schedule. Foliar sprays were imposed twice, at the pre-flowering and pod development stages.

The chickpea variety ADBeG-2 was sown using a seed rate of 62.5 kg ha⁻¹ with the recommended agronomic practices of PJTUAU. Observations on yield attributes, seed yield, haulm yield, harvest index, were recorded following standard procedures. Statistical analysis of chickpea observations was carried out using the analysis of variance technique suitable for a randomized block design in accordance with Panse and Sukhatme (1978) ^[11]. The F-test at 5% probability was used to determine significance and treatment means were compared using CD values.

3. Results and Discussion

3.1 Yield attributes

3.1.1 Number of pods plant⁻¹

The number of pods plant⁻¹ was significantly influenced by different foliar nutrition treatments (Table 1). Among them T₅ (100% RDF + two sprays of Acuspray Pulse (N:P:K:S 10:8:34:2) 4 g l⁻¹ at pre flowering and pod development stages) recorded the highest number of pods plant⁻¹ (35.0) and T₇ (32.9), T₁₁ (32.7), T₁₃ (30.6). are on par with T₅. This was followed by T₉ (28.8), T₃ (25.6), T₄ (23.8), T₁₀ (22.1), T₆ (20.5), T₁₂ (18.9) and T₈ (17.2). The lowest number of pods plant⁻¹ (14.1) was recorded under the absolute control (T₁), which was comparable with T₂ (15.8). The increase in pod number under T₅ may be attributed to the balanced supply of nitrogen, phosphorus, potassium and sulphur during the reproductive phase, which increased photosynthetic efficiency, flower retention and translocation of assimilates towards developing reproductive organs, thereby improving pod setting. Similar trends were observed by Aggarwal *et al.* (2015) ^[1], who observed a significant increase in pods plant⁻¹ with foliar application of balanced nutrient sources in chickpea.

3.1.2 Number of seeds pod⁻¹

The number of seeds pod⁻¹ was not considerably responded to different foliar feeding (Table 1). Numerically, the highest number of seeds pod⁻¹ (1.3) was registered in T₅ and T₉, while T₃, T₆, T₇, T₈, T₁₁, T₁₂ and T₁₃ showed 1.2 seeds pod⁻¹. Treatments T₂, T₄ and T₁₀ recorded 1.1 seeds pod⁻¹, whereas the lowest value (1.0) was observed in the absolute control (T₁). non-significant response indicates that seeds pod⁻¹ is largely governed by the genetic makeup of the variety and is comparatively less impacted by external nutrient supply. Nevertheless, a slight numerical improvement under Adequate foliar nutrient supply may be Associated with better fertilization and seed development resulting from improved nutrient availability during flowering. Corresponding observations were documented by Dewangan *et al.* (2017) ^[3].

3.1.3 Seed index

Seed index was also not significantly affected by different foliar nutrition treatments (Table 1). However, numerical variation was exhibited among the treatments, with values ranging from 21.1 to 26.7 g. The highest seed index (26.7 g) was achieved with T₅, followed by T₁₁ (26.0 g), T₇ (25.9 g), T₁₃ (25.6 g) and T₉ (25.5 g). The lowest seed index (21.1 g) was obtained in the absolute control (T₁). The relatively higher seed index under T₅ might be due to improved nutrient availability during the seed filling stage, resulting in greater accumulation and translocation of photosynthates to developing seeds. However, the absence of significant differences suggests that seed size is predominantly controlled by varietal characteristics and therefore shows limited response to foliar nutrition. The current results are in conformity with those of Manjhi *et al.* (2020) ^[10].

3.2 Yield

3.2.1 Seed yield

Seed yield differed significantly among the foliar nutrient regimes (Table 2). The highest seed yield (2520.7 kg ha⁻¹) was reflected in T₅ (100% RDF + two sprays of Acuspray Pulse 4 g l⁻¹), T₁₁ (2437.3 kg ha⁻¹), T₇ (2408.3 kg ha⁻¹) was statistically on par with T₅. These treatments were followed by T₁₃ (2383.3 kg ha⁻¹), T₉ (2335.7 kg ha⁻¹), T₃ (2253.7 kg ha⁻¹), T₄ (2166.7 kg ha⁻¹), T₁₀ (2123.0 kg ha⁻¹), T₆ (2117.3 kg ha⁻¹), T₁₂ (2074.7 kg ha⁻¹), T₈ (2045.5 kg ha⁻¹) and T₂ (2003.4 kg ha⁻¹). The lowest seed yield (1864.0 kg ha⁻¹) was documented under absolute control (T₁).

The superior seed yield expressed with T₅ could be ascribed to the synchronized supply of both primary and secondary nutrients during the reproductive phase, which ensured continuous assimilate production, reduced flower and pod abscission and promoted efficient partitioning of photosynthates towards developing seeds. The subsequent high-performing treatment, T₁₁ (100% RDF + two sprays of 2% urea at pre-flowering and pod development stages). The current findings reinforce the observations of Singh *et al.* (2023) ^[14] who observed that foliar application of 2% urea at flowering and pod formation stages significantly enhanced seed yield.

3.2.2 Haulm yield

Haulm yield was considerably regulated by the foliar nutrition treatments (Table 2). The highest haulm yield (5199.4 kg ha⁻¹) was presented in T₅, followed by T₁₁ (4873.6 kg ha⁻¹), T₇ (4869.8 kg ha⁻¹), T₁₃ (4590.0 kg ha⁻¹) and T₉ (4512.4 kg ha⁻¹). Lowest haulm yield (3215.6 kg ha⁻¹) was exhibited in the absolute control

(T₁). The increased haulm yield under T₅ could be due to enhanced vegetative growth, increased dry matter accumulation and efficient utilization of nutrients supplied through integrated foliar nutrition during critical growth stages. The findings are in line with Singh *et al.* (2021) ^[15].

3.2.3 Harvest index

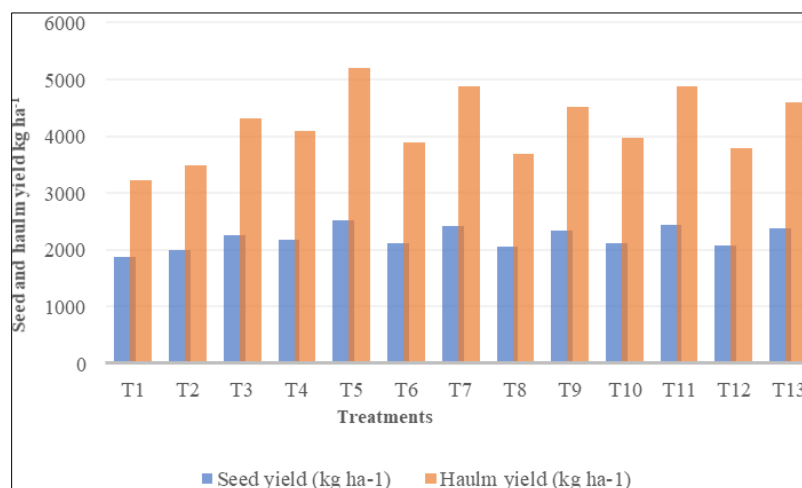
Harvest index was not significantly Determined by different foliar nutrition treatments (Table 2). Although numerical differences were observed. Harvest index ranged from 32.6% in T₅ to 36.7% in the absolute control (T₁). The non-significant variation in harvest index indicates that foliar nutrition proportionally increased both seed yield and haulm yield without markedly altering biomass partitioning between economic and biological yield. Comparable responses were reported by Eliş *et al.* (2020) ^[4] who also found that harvest index remained statistically unaffected under different foliar nutrition treatments in chickpea.

Table 1: Number of pods plant⁻¹, Number of seeds pod⁻¹ and Seed index (g) influenced by different foliar nutrition in chickpea

Tr. No.	Treatment details	Number of pods plant ⁻¹	Number of seeds pod ⁻¹	Seed index (g)
T ₁	Absolute Control	14.1	1.0	21.1
T ₂	80% RDF	15.8	1.1	22.3
T ₃	100% RDF	25.6	1.2	25.0
T ₄	80% RDF + 2 Sprays of Acuspray pulse (N:P:K:S) (10:8:34:2) 4g l ⁻¹ at pre flowering and pod development stage	23.8	1.1	24.7
T ₅	100% RDF + 2 Sprays of Acuspray pulse (N:P:K:S) (10:8:34:2) 4g l ⁻¹ at pre flowering and pod development stage	35.0	1.3	26.7
T ₆	80% RDF + 2 Sprays of Nano urea plus 4 ml l ⁻¹ at pre flowering and pod development stage	20.5	1.2	23.9
T ₇	100% RDF + 2 Sprays of Nano urea plus 4 ml l ⁻¹ at pre flowering and pod development stage	32.9	1.2	25.9
T ₈	80% RDF + 2 Sprays of Nano DAP 2.5 ml l ⁻¹ at pre flowering and pod development stage	17.2	1.2	22.5
T ₉	100% RDF + 2 Sprays of Nano DAP 2.5 ml l ⁻¹ at pre flowering and pod development stage	28.8	1.3	25.5
T ₁₀	80% RDF + 2 Sprays of 2% urea at pre flowering and pod development stage	22.1	1.1	24.3
T ₁₁	100% RDF + 2 Sprays of 2% urea at pre flowering and pod development stage	32.7	1.2	26.0
T ₁₂	80% RDF + 2 Sprays of 2% DAP at pre flowering and pod development stage	18.9	1.2	23.8
T ₁₃	100% RDF + 2 Sprays of 2% DAP at pre flowering and pod development stage	30.6	1.2	25.6
	SEm±	1.3	0.1	1.2
	CD(p=0.05)	3.7	NS	NS
	CV (%)	8.9	8.7	8.5

Table 2: Seed yield (kg ha⁻¹), Haulm yield (kg ha⁻¹) and Harvest index (%) influenced by different foliar nutrition in chickpea

Tr. No.	Treatment details	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Harvest index (%)
T ₁	Absolute Control	1864.0	3215.6	36.7
T ₂	80% RDF	2003.4	3488.4	36.5
T ₃	100% RDF	2253.7	4315.7	34.3
T ₄	80% RDF + 2 Sprays of Acuspray pulse (N:P:K:S) (10:8:34:2) 4g l ⁻¹ at pre flowering and pod development stage	2166.7	4086.9	34.7
T ₅	100% RDF + 2 Sprays of Acuspray pulse (N:P:K:S) (10:8:34:2) 4g l ⁻¹ at pre flowering and pod development stage	2520.7	5199.4	32.6
T ₆	80% RDF + 2 Sprays of Nano urea plus 4 ml l ⁻¹ at pre flowering and pod development stage	2117.3	3882.8	35.3
T ₇	100% RDF + 2 Sprays of Nano urea plus 4 ml l ⁻¹ at pre flowering and pod development stage	2408.3	4869.8	33.1
T ₈	80% RDF + 2 Sprays of Nano DAP 2.5 ml l ⁻¹ at pre flowering and pod development stage	2045.5	3685.5	35.7
T ₉	100% RDF + 2 Sprays of Nano DAP 2.5 ml l ⁻¹ at pre flowering and pod development stage	2335.7	4512.4	34.1
T ₁₀	80% RDF + 2 Sprays of 2% urea at pre flowering and pod development stage	2123.0	3975.3	34.8
T ₁₁	100% RDF + 2 Sprays of 2% urea at pre flowering and pod development stage	2437.3	4873.6	33.3
T ₁₂	80% RDF + 2 Sprays of 2% DAP at pre flowering and pod development stage	2074.7	3788.9	35.4
T ₁₃	100% RDF + 2 Sprays of 2% DAP at pre flowering and pod development stage	2383.3	4590.0	34.2
	SEm±	89.7	197.2	1.7
	CD(p=0.05)	261.9	575.6	NS
	CV (%)	7.0	8.2	8.6



Seed and Haulm yield (kg ha⁻¹) as influenced by the different foliar nutrition in chickpea

4. Conclusion

Among the different foliar nutrition treatments, T₅ (100% RDF + two sprays of Acuspray Pulse (N:P:K:S 10:8:34:2) 4 g l⁻¹ at pre-flowering and pod development stages) recorded superior yield attributes, including the highest number of pods plant⁻¹ and seed index and produced the highest seed yield and haulm yield. It was followed by T₁₁ (100% RDF + two sprays of 2% urea) and T₇ (100% RDF + two sprays of Nano urea plus 4 ml l⁻¹). The number of seeds pod⁻¹, seed index and harvest index were not significantly raised by the foliar application schedules. Based on the results of the present investigation, foliar application of T₅ proved to be the most effective nutrient management for enhancing productivity and profitability of chickpea.

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