*Original Research Article*

AUGMENTING THE AGRONOMIC TRAITS OF CHICKPEA (*Cicer arietinum* L.) THROUGH NIPPING AND FOLIAR NUTRITION PRACTICES

ABSTRACT

|  |
| --- |
| This study investigates the impact of integrating nipping treatments and foliar applications on chickpea growth and yield parameters. The study focused on various stages of nipping viz. N1 - no nipping, N2 - nipping at 30 days after sowing (DAS), N3 - nipping at 45 DAS, and N4 - nipping at 60 DAS), in —combination with the foliar nutrient application treatments, namely F1- no foliar application, F2- NAA @ 100 ppm + Nano urea @ 4 ml/lit applied at 30 and 45 DAS, and F3 - NAA @ 100 ppm + Nano DAP at 4 ml/L applied at 30 and 45 DAS (F3). Among these treatments, the combined application of NAA @ 100 ppm + Nano DAP @ 4 ml/L applied at 30 and 45 DAS, along with nipping at 45 DAS (N3F3), emerged as the most effective practice in enhancing the yield and growth parameters of chickpea. This treatment significantly impacted the plant height, enhanced the lateral branches, and increased the dry matter production, eventually resulting in superior pod formation and grain yield. The findings highlight the synergy between the traditional practice of nipping and modern practice of foliar nutrition with nano fertilizers, demonstrating a sustainable and resource-efficient approach in chickpea cultivation. |

*Keywords: Nipping, Chickpea, Naphthalene Acetic Acid (NAA), Nano Diammonium Phosphate (DAP), Nano Urea, Foliar Nutrition.*

**1. INTRODUCTION**

Pulses are one of the essential components of the human diet around the world as they provide a significant percentage of the required protein. Among the pulses, chickpeas, also known as Bengal gram or gram (*Cicer arietinum* L.), are regarded as the "king of pulses" due to their importance around the world, particularly in India. Chickpeas are highly nutritious, rich in protein, carbohydrates, and minerals, surpassing other legumes like pigeon peas, black gram, and green gram in protein quality [1]. Chickpea is a main rabi season crop cultivated widely in India and is highly valued for its high-quality protein. Chickpeas also serve as animal feed and contribute to agricultural sustainability by replacing fallow fields in cereal rotations. Through nitrogen fixation it reduces the need for nitrogen fertilizers and promotes sustainable production. Despite increased agricultural output, food and nutritional security face challenges from global climate change and population growth. Over 820 million people worldwide endure food insecurity, and around 2 billion experience nutritional insecurity. [1] Techniques like foliar fertilization show promise in improving productivity. The chickpea crop exhibits strong apical dominance, where auxins from the apical meristem inhibit axillary bud growth. Nipping, which removes this dominance, promotes lateral branching, leading to vigorous plants and potentially higher yields. It was reported that nipping practices show a significant effect on the growth and yield of chickpea [2].

The productivity of the chickpea is often affected by various nutrient deficiencies which results in flower dropping and poor pod setting, eventually affecting the yield of the crop. Under these circumstances, techniques like foliar fertilization or foliar nutrition shows promise in improving the productivity. It allows the plants to absorb nutrients quickly through their leaves, bypassing the soil and root system, which can be slow and inefficient particularly during the critical growth stages of the crop growth. Foliar application of plant growth substances like Naphthalene Acetic Acid (NAA) can accelerate crop growth at crucial stages. NAA, a synthetic auxin, enhances cell division, elongation, and differentiation, increases the grain yield and productivity. It does play a significant role in the efficient translocation of nutrients contributing to higher growth parameters and yields [2,3].

On the other hand, the advent of nano-fertilizers in agriculture offers precise nutrient delivery, improves crop growth and quality while ensuring the environmental safety. Foliar application of nano fertilizers, including nano urea and nano Di-Ammonium Phosphate (Nano-DAP), significantly improves chickpea growth metrics. Nano fertilizers are absorbed by the plant foliage through two primary routes: the cuticle pathway and the stomatal pathway [3]. Nanoparticles with a diameter of less than 4.8 nm are capable of directly penetrating the cuticle to enter the leaf. while nanoparticles with larger particle sizes are able to pass through the stomata [4]. Due to the high density of the stomata in leaves, the stomatal pathway is considered to be a more efficient way for the uptake of nano fertilizers [5] After nano fertilizers are taken up by the stomata, they get transferred to the rest of the plant via the phloem, while this mechanism is not so easy when conventional fertilizers are used for foliar nutrition. Thereby use of nano fertilizers for foliar nutrition provides quick access to nutrients for plants which impacts in increasing the chlorophyll production, photosynthetic rate, and eventually the crop growth and yield [6].

Therefore, the present study is focused in demonstrating the effect of combining nipping, and foliar nutrition in the form of NAA, and nano fertilizers for achieving better growth and yield parameters of the chickpea crop.

**2. MATERIALS AND METHODS**

The field experiment was carried out in the Instructional Farm (South), Karunya Institute of Technology and Sciences, Coimbatore, India, it is located in the foothills of the Western Ghats of India at 10.934o N latitude, 76.75o E longitude, and at an altitude of 467 meters above mean sea level with a subtropical climatic condition. The field trial was taken up during 2024 rabi season, which span from October to January. The total precipitation received throughout the crop growing season was 91.64 mm, registering 7 rainy days, with a mean evaporation of 6.83 mm. During the cropping period, the maximum temperature ranged from 27.0°C to 32.7°C with a mean temperature of 32.3°C, whereas the minimum temperature ranged from 19.5°C to 22.5°C and the mean minimum temperature was 19.4°C. The soil in the experimental field was characterized as sandy clay loam, which exhibited an alkaline pH of 8.9 and moderate electrical conductivity of 0.24 ds/m. It contained low available nitrogen (80.06 kg ha⁻¹), medium levels of available phosphorus (0.143 kg ha⁻¹), and potassium (35.0 kg ha⁻¹). The Chickpea variety NBeG-49 with the duration of 80-85 days was used in this experiment. Chickpea was sown with the spacing of 30 x 10 cm The experiment was laid out in Factorial Randomized Block Design (FRBD) with 2 factors viz. nipping and foliar application consisting of 4 nipping treatments and 3 foliar nutrition treatments, which replicated thrice. The first factor nipping comprises of the treatments, N1 - no nipping, N2 - nipping at 30 days after sowing (DAS), N3 - nipping at 45 DAS, and N4 - nipping at 60 DAS. Similarly, the second factor of foliar applications includes the treatment, F1 - no foliar application, F2- NAA at 100 ppm + Nano urea at 4 ml/lit applied at 30 and 45 DAS, and F3 - NAA at 100 ppm + Nano DAP at 4 ml/L applied at 30 and 45 DAS. The crop was raised as per the recommended practices and was harvested manually using a sickle, wrapped into bundles with tags from each plot, and sun-dried. Growth attributes, viz., the plant height (cm), number of branches, dry matter production (kg ha-1), and yield parameters viz. grain yield (kg ha-1) and stover yield (kg ha-1) were recorded and statistically analyzed for Factorial Randomized Block Design (FRBD). The significance of the difference was tested by the “F” test at a 5 percent level.

3. results and discussion

**3.1 Effect of nipping and foliar nutrition on the growth attributes of chickpea**

The growth attribute of chickpea in response to the nipping and foliar nutrition are presented in the table 1.

**3.1.1. Effect of Nipping on growth parameters**

The results indicated that nipping significantly enhanced the growth-related traits in chickpea. The treatment N3 – nipping performed at 45 DAS recorded a lower plant height (29.09 cm), increased number of branches per plant (10.99), and maximum dry matter production (2847.54 kg ha-1), which was statistically comparable to the treatment N2 – nipping at 30 DAS. In contrast, the control treatment (N1), where no nipping was done, recorded a lower value of plant height (29.9 cm), number of branches per plant (8.78), and dry matter production (1848.77 kg ha-1). The observed decrease in plant height and increase in the number of lateral branches, due to nipping could be attributed to the stimulation of dormant lateral buds, leading to the development of more secondary branches. This practice disrupts the apical dominance, encouraging the lateral shoot growth, which contributes to more vigorous and robust plant development, which is evident from increased biomass [7].

**3.1.2 Effect of foliar nutrition on growth parameters**

The results of the foliar nutrition treatments indicated that applying NAA at 100 PPM combined with nano DAP at 4 ml/L at both 30 and 45 DAS under the treatment F3 has significantly enhanced the plant growth parameters. This treatment resulted in a higher plant height of 30.7 cm, more branches per plant of 10.24, and increased dry matter production of 2470.87 kg ha-1, and was statistically comparable to treatment F2, which involved the application of NAA at 100 PPM with nano urea at the same concentration and timing. Conversely, a lower value for plant height (30.2 cm), number of branches per plant (9.24), and dry matter production (2020.40 kg ha-1) were recorded in the control treatment (F1), which received no foliar nutrition. The increase in plant height observed with foliar nutrition may be attributed to the role of NAA, a synthetic auxin known to promote root development and overall plant growth. Additionally, the enhanced effect from nano DAP could be due to its high nutrient concentration and superior permeability, which allows for efficient absorption through the leaf surface, thus stimulating the crop growth [8].

**3.1.3 Interaction effect of nipping and foliar nutrition**

The combined influence of nipping and foliar nutrition revealed that the treatment (N3F3) involving NAA @ 100 PPM with nano DAP @ 4 ml/L applied at 30 and 45 DAS, along with nipping at 45 DAS, was the most effective. This combination resulted in a lower plant height (30.01 cm), higher number of branches per plant (11.56), and increased dry matter production (3167.34 kg ha-1), which was statistically comparable to the treatment (N2F2) involving NAA @ 100 PPM with nano urea @ 4 ml/L and nipping at 30 DAS. The synergistic effect of NAA and nano DAP with nipping likely contributed to enhanced plant growth parameters by improving the nutrient availability, boosting photosynthetic efficiency, facilitating better mobilization of photosynthates, and increasing membrane permeability. These physiological improvements were visibly reflected in optimum plant height and enhanced lateral branching. The sustained nutrient release from nano DAP throughout the growth cycle, coupled with its high permeability nano-sized particles, likely enabled more effective absorption through the leaf surfaces, thereby enhancing the development of growth and yield attributes. These results are in close alignment with the findings [9] in chickpea studies. The notable increase in branch numbers per plant may have promoted the production of more leaves, which in turn contributed to greater total dry matter accumulation due to nipping [10].

**3.2 EFFECT OF NIPPING AND FOLIAR NUTRITION ON THE YIELD PARAMETERS OF CHICKPEA**

The yield of chickpea response to the nipping and foliar nutrition are presented in the table 2 and figure 1.

**3.2.1. Effect of Nipping on yield parameters**

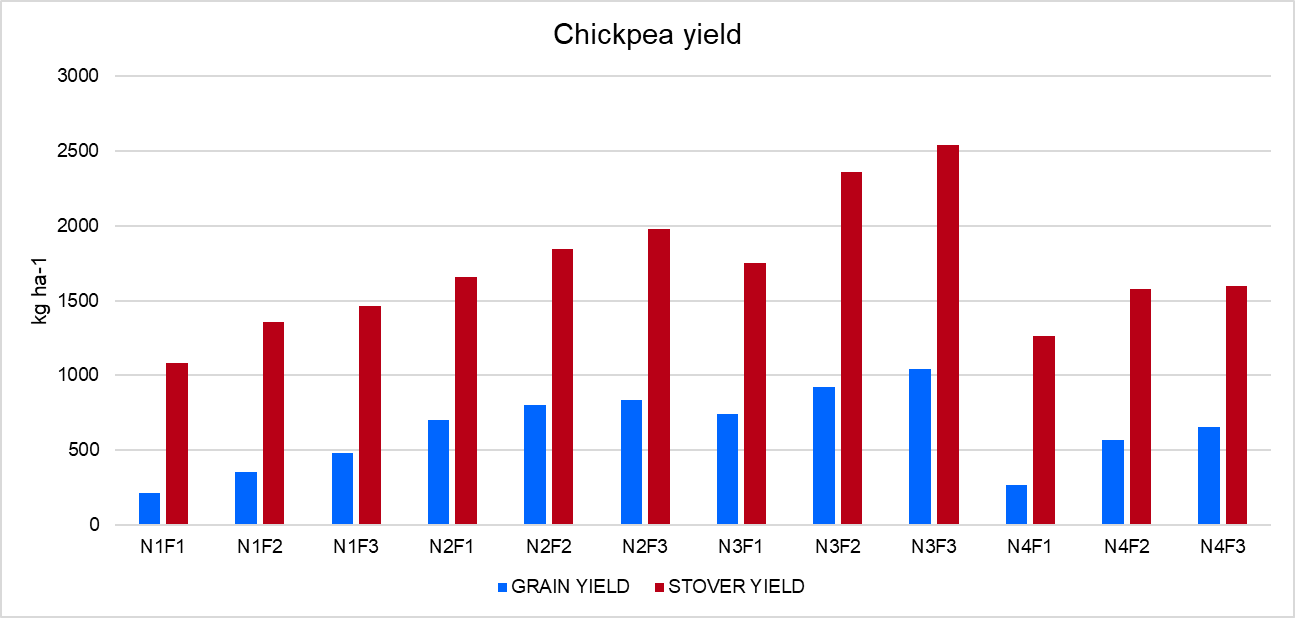
The results revealed that nipping had a positive impact on yield-related traits. A higher grain yield (903.19 kg ha-1) and stover yield (2219.32 kg ha-1) were recorded under the treatment N3 – nipping at 45 DAS, which was statistically on par with the treatment N2 – nipping at 30 DAS during the field trial. In contrast, the control treatment (N1), where no nipping was performed, recorded a lower grain yield (348.06 kg ha-1) and stover yield (2219.32 kg ha-1). The superior grain yield observed in the nipped treatments may be attributed to the stimulation of lateral branching, which likely led to an increased number of pods per plant, ultimately resulting in higher grain production. The increased number of branches and leaves might have led to a greater photosynthetic surface area, allowing the plants to capture more sunlight and produce more energy, ultimately boosting the overall yield. Furthermore, nipping has been found to enhance stover yield by encouraging vigorous vegetative growth by increasing overall plant biomass. The improved source-sink relationship brought about by nipping also contributes to more efficient nutrient distribution within the plant, thereby supporting greater seed and stover production [11].

**3.2.2 Effect of foliar nutrition on yield parameter**s

The application of foliar nutrition has significantly influenced the yield-related traits. The treatment (N3) involving application of NAA @ 100 PPM combined with the application of nano DAP @ 4 ml/L at 30 and 45 DAS resulted in a higher grain yield (753.78 kg ha-1) and stover yield (1895.53 kg ha-1). This was statistically comparable to the treatment F2, which involved the application of NAA @ 100 PPM with nano urea at the same concentration and application schedule. In contrast, the control treatment (F1), which received no foliar nutrition, recorded a lower grain yield (479.81 kg ha-1) and stover yield (1438.27 kg ha-1). The improved grain yield with nano fertilizer treatments may be attributed to the enhanced levels of plant growth hormones, stimulated metabolic activities, and improved photosynthesis, all of which contribute to better crop productivity [12].

**3.2.3 Interaction** **effect of nipping and foliar nutrition on yield parameters**

The combined influence of nipping and foliar nutrition demonstrated that the treatment (N3F3) involving the application of NAA @ 100 PPM with nano DAP @ 4 ml/L at 30 and 45 DAS, along with nipping at 45 DAS, was the more effective. This combination resulted in a higher grain yield (1042.4 kg ha-1) and stover yield (2541.78 kg ha-1), which was statistically similar to the treatment involving NAA @ 100 PPM with nano urea @ 4 ml/L applied during the same period, combined with nipping at 30 DAS (N2F2). The enhanced performance under these treatments can be attributed to the improved source-sink relationship facilitated by nipping, which promotes more efficient nutrient distribution within the plant, hereby contributing to increased grain and stover yields. These findings are in strong agreement with the observations reported by [13 and 14]



***Fig. 1 The yield of chickpea response to the nipping and foliar nutrition***

**4. CONCLUSION**

The study highlights that combining nipping with the foliar application of NAA and Nano-DAP significantly improved chickpea’s growth and productivity. This combination notably impacts the growth parameters such as plant height, number of branches, and dry matter production. The treatment of NAA @ 100 ppm and nano-DAP @ 4ml/L, applied at 30 and 45 days after sowing (DAS), in conjunction with nipping at 45 days, proves very effective for chickpea. By integrating these practices, plant architecture gets optimized, resulting in better pod formation and improved grain quality. This fusion of traditional practice like nipping with modern agro chemicals such as nano-DAP and NAA offers a sustainable and resource-efficient approach to chickpea cultivation, increasing productivity while aligning with environmental conservation goals.

**DISCLAIMER**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**ACKNOWLEDGEMENT**

The authors are grateful to the Division of Agronomy, School of Agricultural Sciences (SAS), Karunya Institute of Technology and Sciences (KITS), Coimbatore, Tamil Nadu – 641114.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

**REFERENCES**

1. Rintu Jha, Kaixuan Zhang, Yuqi He, Nora Mendler-Drienyovszki, Katalin Magyar-Tabori, Muriel Quinet, Mateja Germ, Ivan Kreft, Vladimir Megli, Kiyokazu Ikeda, Mark A. Chapman, Dagmar Janovska, Grazyna Podolska, Sun-Hee Woo, Studer Bruno, Milen I. Georgiev, Nikhil Chrungoo, Alexander Betekhtin, Meiliang Zhou*.* (2024). Global Nutritional Challenges and Opportunities: Buckwheat, A Potential Bridge Between Nutrient Deficiency and Food Security. *Trends Food Science Technology*. 145, 104365.
2. Choudhary A, Shekhawat PS, Kumar S, Pareek B. Performance of Chickpea (*Cicer arietinum* L.) Varieties to Seed Rate and Nipping in Arid Irrigated Western Plain Zone. 2020. *International Journal Microbiology of Current and Applied Science*. 9(8):3895-3903.
3. Zulfiqar, F., Navarro, M., Ashraf, M., Akram, N. A., & Munne-Bosch, S. 2019. Nano fertilizer Use for Sustainable Agriculture: Advantages and Limitations. *Plant Science*, *289*, 110270.
4. Jitao Lv, Peter Christie and Shuzhen Zhang. 2019. Uptake, translocation, and transformation of metal-based nanoparticles in plants: Recent advances and methodological challenges. *Environmental Science Nano*, 6, 41–59.
5. Yiming Su, Vanessa Ashworth, Caroline Kim, Adeyemi S. Adeleye, Philippe Rolshausen, Caroline Roper, Jason White, David Jassby. 2019. Delivery, uptake, fate, and transport of engineered nanoparticles in plants: A critical review and data analysis. *Environmental Science Nano*, 6, 2311–2331.
6. Subhash Babu, Raghavendra Singh, Devideen Yadav, SanjaySingh Rathore, Rishi Raj, Ravikant Avasthe, S.K. Yadav, Anup Das, Vivek Yadav, Brijesh Yadav, Kapila Shekhawat, P.K. Upadhyay, Dinesh Kumar Yadav, Vinod K. Singh. 2022. Nano fertilizers for agricultural and environmental sustainability. *Chemosphere*, 292, 133451.
7. Mounika, S., & Singh, S. 2022. Effect of nipping and plant growth regulator on growth and yield of chickpea (*Cicer arietinum L*). *International Journal of Environment and Climate Change*, 1088–1094.
8. Kushwaha, A., Tyagi, A., & Patel, D. 2023. Effect of Nipping and Varieties On Growth, Yield Attributes and Yield of Chickpea. *International Journal of Agriculture and Innovations*, 15(3), 45-50.
9. Khemshetty, A., Patil, D. H., Rathod, P. S., Patil, A. S. P., & Basavaraj, K. 2024. Studies On Nano Dap On Growth, Yield and Quality of Chickpeas Under Rainfed Conditions of Northeastern Dry Zone of Karnataka. *Journal of Experimental Agriculture International*, *46*(3), 139–145.
10. Panda, P. K., Mohapatra, P. M., Bal, S. S., Mishra, I. O. P., Senapati, N., Panigrahi, R. K., & Prusti, A. M. 2020. Effect of Nipping and Row Spacing On Crop Growth and Productivity of Medium Duration Pigeon pea. *International Journal of Current Microbiology and Applied Sciences*, *9*(8), 1832–1837.
11. Joshi, N. 2020. Effect of land configuration, irrigation levels and nipping on growth, yield and economics of chickpea (*Cicer arietinum* L.) Under mild winter of south Gujarat. *Indian Journal of Pure & Applied Biosciences, 8,* 82-87
12. Thakur, M., Bochalya, R. S., Choudhary, K., Sharma, D., Himanshu, & Sharma, A. 2024. Effect of plant growth regulators and spacing on growth and yield of chickpea (*Cicer arietinum* L.). *International Journal of Research in Agronomy*, 7(9S), 12–16
13. Shukla, U., Singh, S., & Tripathi, R. S. 2018. Weed Dynamics and Yield of Chickpea (Cicer Arietinum L.) As Influenced by Pre and Post-Emergence Herbicides. *International Journal of Current Microbiology and Applied Sciences*, 7(7), 2150-2156.
14. Meena, D. S., Gautam, C., Patidar, O., Meena, P. H. M., Prakasha, G. And Vishwa, J. 2017. Nano Fertilizers Are a New Way to Increase Nutrients Use Efficiency in Crop Production. *International Journal of Agriculture Sciences*, 9(7): -67-75

**Table.1 The effect of nipping and foliar the nutrition on the plant growth parameters of chickpea at harvest stage**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Plant Height (cm)** | **No. of branches plant-1** | **Dry matter production (kg ha-1)** |
| **NIPPING (N)** |  |  |  |
| ***N1 – No Nipping*** | 31.01 | 8.78 | 1848.77 |
| ***N2 – Nipping at 30 DAS*** | 30.09 | 10.3 | 2399.99 |
| ***N3 - Nipping at 45 DAS*** | 29.09 | 10.99 | 2847.54 |
| ***N4 - Nipping at 60 DAS*** | 30.03 | 9.51 | 2004.46 |
| **SEd** | 0.04 | 0.04 | 62.86 |
| **CD (p=0.05)** | 0.08 | 0.09 | 130.38 |
| **FOLIAR NUTRITION (F)** |  |  |  |
| ***F1 - No Foliar application*** | 30.02 | 9.24 | 2020.41 |
| ***F2 - NAA @ 100 ppm + Nano urea @ 4ml/lit at 30 and 45 DAS*** | 30.07 | 10.21 | 2334.30 |
| ***F3 - NAA @ 100 ppm + Nano DAP @ 4ml /lit at 30 and 45 DAS*** | 30.09 | 10.24 | 2470.87 |
| **SEd** | 0.03 | 0.03 | 54.44 |
| **CD (p=0.05)** | 0.07 | 0.08 | 112.91 |
| **INTERACTION (N×F)** |  |  |  |
| **N1F1** | 31.38 | 8.27 | 1695.33 |
| **N1F2** | 31.09 | 9.01 | 1874.44 |
| **N1F3** | 31.07 | 9.06 | 1976.55 |
| **N2F1** | 30.46 | 9.84 | 2241.39 |
| **N2F2** | 30.05 | 10.52 | 2417.36 |
| **N2F3** | 30.03 | 10.55 | 2541.23 |
| **N3F1** | 30.44 | 9.87 | 2379.64 |
| **N3F2** | 30.01 | 11.53 | 2995.63 |
| **N3F3** | 29.63 | 11.56 | 3167.34 |
| **N4F1** | 31.35 | 8.98 | 1765.24 |
| **N4F2** | 30.52 | 9.76 | 2049.78 |
| **N4F3** | 30.48 | 9.82 | 2198.36 |
| **SEd** | 0.06 | 0.07 | 108.89 |
| **CD (p=0.05)** | 0.19 | 0.16 | 225.82 |

**Table.2 The effect of nipping and foliar the nutrition on the yield of chickpea**

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Grain yield (kg ha-1)** | **Stover yield (kg ha-1)** |
| **NIPPING (N)** |  |  |
| ***N1 – No Nipping*** | 348.06 | 1299.45 |
| ***N2 – Nipping at 30 DAS*** | 779.29 | 1825.41 |
| ***N3 - Nipping at 45 DAS*** | 903.19 | 2219.32 |
| ***N4 - Nipping at 60 DAS*** | 497.04 | 1479.32 |
| **SEd** | 28.38 | 60.54 |
| **CD (p=0.05)** | 58.87 | 125.55 |
| **FOLIAR NUTRITION (F)** |  |  |
| ***F1 - No Foliar application*** | 479.81 | 1438.27 |
| ***F2 - NAA @ 100 ppm + Nano urea @ 4ml/lit at 30 and 45 DAS*** | 662.10 | 1784.12 |
| ***F3 - NAA @ 100 ppm + Nano DAP @ 4ml /lit at 30 and 45 DAS*** | 753.78 | 1895.53 |
| **SEd** | 24.58 | 52.43 |
| **CD (p=0.05)** | 50.98 | 108.73 |
| **INTERACTION (N×F)** |  |  |
| **N1F1** | 211.43 | 1080.13 |
| **N1F2** | 354.28 | 1354.99 |
| **N1F3** | 478.65 | 1463.25 |
| **N2F1** | 700.74 | 1654.28 |
| **N2F2** | 800.79 | 1845.32 |
| **N2F3** | 836.57 | 1976.62 |
| **N3F1** | 741.31 | 1754.36 |
| **N3F2** | 925.81 | 2361.81 |
| **N3F3** | 1042.43 | 2541.78 |
| **N4F1** | 265.92 | 1264.33 |
| **N4F2** | 567.60 | 1574.36 |
| **N4F3** | 657.64 | 1600.45 |
| **SEd** | 49.17 | 104.86 |
| **CD (p=0.05)** | 101.97 | 217.47 |