J. Plantarum., 7(1): 09-22 ISSN PRINT 2710-4079
ISSN ONLINE 2710-4087

NUTRIENT MANAGEMENT STRATEGIES TO ENHANCE CHICKPEA PRODUCTION USING RESIDUAL RICE MOISTURE IN THE ARID CONDITIONS OF DERA ISMAIL KHAN

SALEEM NAWAZ MALIK[1], MUHAMMAD SADIQ[1], ABDUL AZIZ KHAKWANI[1], IQTIDAR HUSSAIN[1], AMJAD NADIM[1], EHTESHAM UL HAQ[2], MUHAMMAD JAWAD NAZIR[2], HADIA GUL[3], MONEEZA ABBAS[4]

1. Agronomy Department, Agriculture Faculty, Gomal University, Dera Ismail Khan, KP., Pakistan
2. Plant Genetic Resources Institute (PGRI), National Agri Research Centre, Islamabad, Pakistan.
3. Institute of Biological Sciences Gomal University D. I. Khan,
4. Environmental Science Department, Lahore College for Women University (LCWU) Jail Road, Lahore
**Corresponding Author's Email: Iqtidarhussain453@yahoo.com*

Received on: 02-12-23; Reviewed on: 18-08-24; Accepted on: 13-11-2024; Published on: 15-06-2025

Abstract

Application of macro and micronutrients is vital for raising the yield of crops and yield contributing parameters. The current research was led to applying macro and micronutrients on rice harvest residue moisture to enhance growth of chickpea and grain production. Throughout the course of the study, information was gathered on the following parameters crop growth rate, chlorophyll content, nodules count per plant, days to 50% flowering, plant height (cm), branches count per plant, pods count per plant, seed count per plant, pod weight, 100 seed weight, grain yield, biological yield, harvest index, and economic analysis. The means of the various treatments differed significantly from one another. Using all macro and micromanagement approaches, nipping management yielded the maximum grain production (2505 kg ha^{-1}), nutrients in relation to the reference (809.7 kg ha^{-1}). Therefore, applying macro and micronutrients (foliar application) is advised for rice harvest in arid places to increase seed yield and improve economic return per unit area from chickpea crop using pinching management approach.

Key Words: Macro & micro-nutrients, management, residual moisture, nipping, chickpea, arid climate.

INTRODUCTION

Grain legumes play a important part in cultivation together with cereal since they fix nitrogen in the diet. Following beans and soybeans in global cultivation, chickpeas (*Cicer arietinum* L.) are one of the greatest significant crops among pulses. In Pakistan, gram crops are grown on over 940,000 hectares, yielding 545 thousand tons of grain year (Govt. of Pakistan, 2019–20). 52–70% of its seed is made up of carbohydrates, 18–22% of protein, and 4–10% of fat.

One of the most extensively grown-up major legume crops in the world is the chickpea. Local grain is vital in the Islamic Republic of Pakistan, where it makes up 95% of the total grain, compared to 10% in Kabul. Gram can be characterized into five highly imperative periods in Pakistan: 1947–1965 (pre–Green Revolution period); before mineral fertilizer was widely available; 1966–1976 (Green Revolution period); genotypes and high-quality seed helped farmers achieve extreme yield on the major cultivated area (2/3) designated for chickpea; 1977–2000 (Post–Green Revolution period); new crop species; tunnel agriculture; drought and frost resistance stresses; technological advancements; and 2000–present (Modern period), when banks facilitate loans and the government carefully announces prices and various subsidies (Hafiz *et al*., 2021).

Problem Statement

Yield of chickpea is higher in other develop counties as compared to Pakistan. In Pakistan due to availability of macro and micronutrients and fertility of soil. Chickpea crop mostly survives in arid to semi-arid areas and in Pakistan chickpea crop is mostly grown under rainfed condition. But it requires proper moisture for germination and seedling establishment after harvest of rice. (Kagan and Kayan, 2014).

According to Borie *et al*. (2006), the main reason of the decline in yield of chickpea is a lack of macro and micronutrients. For the chickpea crop to grow and flourish properly, the macro and micronutrients NPK, iron (Fe) and zinc (Zn) essential to be present in adequate amounts. One of the main issues facing farmers currently is awareness of the quantity and use method of micronutrients like zinc and iron. The two most popular ways to apply nutrients are through soil and foliar applications. The crop obtains direct fertilization by the foliar spray of micronutrients (Fageria *et al*. 2009).

Significance of the study

Since masses of people depend on chickpea seeds for their nourishment, they are usually referred to as the poor man's meat. When compared to other pulse crops, chickpeas have higher levels of protein, carbs and minerals. Nutrient deficiencies can result in disorders related to plant development since micronutrients are often needed in very small amounts by crops for growth and development. Efficiency is increased when micronutrients are added to fertilizers (Nadi *et al*., 2013).

The development and productivity of chickpeas are encouraged by urea applied topically. Zinc both significantly raises the zinc content and plant seed output. Nipping significantly affects the growth and chickpea yield.

However, it is normal practice to plant chickpeas without fertilizer in rice-based cropping systems. As a result, the current study was supported out to assess the influence of applying macro and micronutrients on productivity of chickpea when pinching management measures were used against those that were not. This study also clarified how nutrition interacts with both nipping and non-nipping behaviors.

MATERIAL AND METHODS

During the Rabi season of 2021–2022, a field study was led at the Research Area Agronomy Department, Agriculture Faculty, Gomal University, D.I. Khan. The seedbed was fine-tuned through plowing to help seed germination and conservation of moisture. To plant the seeds, a physical sowing drill was employed. After harvesting the rice, seeds were sowed on the remaining moisture.

In an experimental field, the certified chickpea variety Karak-1 seed was sown. The experiment was set up using a Randomized Complete Block Design (RCBD) with three replications using a split-plot layout. Main plots with and without nipping factors were retained, but

NPK and micronutrients were allocated to subplots. In the sub, a 45 cm row and a 30 cm plant-plant separation were maintained. plots totaling 12.15 square meters.

Prior to seeding, the NPK was added, and the soil was well stirred to ensure uniformity. On the other hand, twice during the crop's life, foliar sprays of 1% urea, 0.5% Fe, and 0.5% Zn solutions in water were sprayed (before and after flowering).

Treatments to be studied

Main plot

S_1: Nipping, **S_2**: Non- nipping

Sub-plot (Control, NPK and foliar application of macro and micronutrients levels)

T_1 = Control (without fertilizer)

T_2 = NPK (20:40:20 kg ha^{-1})

T_3 = NPK + Foliar (urea 1%)

T_4 = NPK + Foliar (urea 1% + Zn 0.5%)

T_5 = NPK + Foliar (urea 1% + Fe 0.5%)

T_6 = NPK + Foliar (urea 1% + Zn 0.5% + Fe 0.5%)

RESULTS AND DISCUSSION

Crop growth rate (CGR) (g $m^{-2}$$day^{-1}$)

The increase in dry matter output per unit area over a specific time period of the crop is referred to as its crop growth rate. The results in Table 1 indicated a notable difference in CGR across the treatments; however, there was no variation in CGR between nipping and non-nipping, nor in their interaction with foliar fertilizer application. T6 (NPK + foliar application of urea 1% + Zn 0.5% + Fe 0.5%) exhibited the highest CGR of 4.71 g m^{-2} day^{-1}. T5 (NPK + foliar (urea 1% + Fe 0.5%)) and T4 (NPK + foliar (urea 1% + Zn 0.5%)) yielded a CGR of 3.61 and 3.14 g m^{-2} day^{-1}, respectively.

Control treatment T1 exhibited the lowest CGR of 1.79 g m^{-2} day^{-1}, while treatment T2 (NPK 20:40:20 kg ha^{-1}) had a CGR of 2.50 g m^{-2} day^{-1}. The T6 treatment likely achieves the highest crop growth rate due to the chickpea crop's utilization of balanced micronutrient treatments and timely nitrogen supplementation. Enhanced growth transpired throughout the vegetative phase consequently.

The findings align with Patel and Hanki (2020), who established that nipping management strategies exhibited the highest CGR compared to non-nipping treatments.

Number of nodules plant^{-1}

The quantity of nodules per plant indicates the increased nitrogen supply from crops and soil nitrogen fixation for subsequent crops. Table 2 demonstrated significant changes in the number of nodules per plant across several treatments involving micronutrient delivery and the interaction of micronutrients with management strategies.

The nipping treatment with T6 (NPK + foliar-urea 1% + Zn 0.5% + Fe 0.5%) yielded the highest number of nodules (47.40 per plant), comparable to the non-nipping treatment with T6, the nipping treatment with T5 (NPK + foliar-urea 1% + Fe 0.5%), and the non-nipping treatment with

T5, which produced averages of 42.44, 38.85, and 39.34 nodules per plant, respectively.

Nonetheless, the non-nipping treatment with T1 (control) resulted in the fewest nodules per plant, followed by the non-nipping treatment with T2 (NPK (20:40:20 kg ha^{-1})) and the nipping treatment with T1 (control), producing 14.33, 18.67, and 21.33 nodules per plant, respectively. The application of micronutrients during the later stages of vegetative growth, which enhances the symbiotic relationship between rhizobium bacteria and atmospheric nitrogen, may have contributed to the increased number of nodules per plant. This may have occurred because of the initial application of NPK.

Patel and Hanki (2020) found that the combination of micronutrients and precise nutrition control results in an increased number of nodules per plant.

Days to 50% flowering (days)

Table 3 demonstrated a considerable difference in the number of days to 50% blooming in chickpea crops based on the application of foliar micronutrients and the interrelationships among these factors. Management approaches yielded variable effects regarding the duration to 50% flowering.

Nipping combined with the foliar application of micronutrients (T6) (NPK + foliar (urea 1% + Zn 0.5% + Fe 0.5%) results in the maximum duration until 50% flowering (119 days). This is followed by pinching treatment (T5) (NPK + foliar application of 1% urea and 0.5% Fe), resulting in 113.33 days to 50% bloom. T1 (control) under non-nipping treatment required a minimum of 103 days to achieve 50% flowering, whereas T1 (control) following nipping treatment took 106 days.

The plant exhibited new growth following the nipping treatments. Conversely, non-nipping treatments involving foliar application of micronutrients induce earlier flowering, as they remain untrimmed, thereby initiating vegetative growth sooner and completing the vegetative stage in a shorter timeframe, resulting in fewer days to achieve 50% flowering compared to nipped treatments. It required a lengthier duration to attain its vegetative maximum peak before thereafter producing flowers.

Moreover, the foliar application enhances the vegetative growth phase, so affecting the treatment including all three micronutrients, which need the greatest number of days to achieve 50% blooming. To enhance chickpea yield, Singh *et al*. (2020) focused on integrated nutrition management. They indicated that the greatest duration to reach 50% flowering was attained by nutrient balancing methods.

Plant height (cm)

Table 4 indicates a significant variation in chickpea plant height based on the presence or absence of nipping, as well as the foliar management of micronutrients and their interactions. The highest plant height of 36.83 cm was observed in the non-nipping treatment T6 (NPK + foliar (urea 1% + Zn 0.5% + Fe 0.5%)), followed by T5 (NPK + foliar (urea 1% + Fe 0.5%)) at 34.46 cm, and T4 (NPK + foliar (urea 1% + Zn 0.5%)) at 30.26 cm.

Conversely, the control treatment T1, which omitted soil fertilizer and foliar micronutrient application in the nipping and non-nipping treatments, respectively, exhibited the lowest plant heights of 19.50 cm and 23.07 cm. The plant was unable to grow branches in non-nipping plots, resulting in the tallest plants being produced. After 60 days, the plants subjected to nipping treatments were nipped, and these plants subsequently exhibited more frequent growth and branching compared to those in the non-nipping treatments.

Consequently, the plants subjected to the pinching treatments could not achieve greater height, although their canopy expanded in relation to their stature. Consequently, as comparison to non-nipping treatments, the height of the nipping treatment with foliar application of micronutrients was superior. The excision of primary branches through nipping may have led to the possible reduction in height.

Auxin, or hormones, present in the excised branches facilitated canopy expansion by translocating to lateral branches rather than the apical meristem, which lengthened vertically to increase plant height. The findings of Malik *et al*. (2016) corroborated our results, confirming that the removal of the apical meristem led to enhanced canopy formation. Our results align with those of Patel and Hanki (2020), who identified significant variations in plant height due to different fertilizer levels and the application of nipping versus non-nipping procedures.

Number of branches plant^{-1}

The number of branches influences the quantity of pods produced by an individual plant and contributes to the overall biomass of chickpeas, both of which enhance crop production.

Data in Table 5 indicate significant variations in the number of branches per plant in chickpeas, contingent upon the application of foliar micronutrient sprays and their interaction with other factors. The pinching treatment with T6 (NPK + foliar (urea 1% + Zn 0.5% + Fe 0.5%)) and T5 (NPK + foliar (urea 1% + Fe 0.5%)) resulted in the maximum number of secondary branches, with 11.43 and 10.96 branches per plant, respectively, and both treatments were statistically significant. The pinching treatment with T4 (NPK + foliar (urea 1% + Zn 0.5%)) resulted in 9.63 branches per plant.

The non-nipping treatment with T1 (control) resulted in the fewest branches per plant, at 3.77, whereas the nipping treatment with T1 (control) yielded 5.40 branches per plant of the chickpea crop. The hormone auxin, naturally present in the apical meristem of branches, may be responsible for the tallest branches observed in pinching treatments involving foliar administration of micronutrients.

The nipping process facilitated the delivery of this hormone into the lateral branches, which subsequently exhibited increased lateral growth and produced more branches compared to the non-nipping treatment. The epicormic branches were not pruned in non-nipping treatments, permitting auxin to accumulate in the top sections of the branches, resulting in their growth surpassing that of the lateral branches and the plant's canopy foliage.

Patel and Hanki (2020) reported that, compared to control treatments, nipping management techniques combined with NPK and zinc application resulted in the highest number of branches.

Number of pods plant^{-1}

Table 6 indicates that the number of pods per plant in the nipping versus non-nipping treatment, the foliar management of micronutrients, and their interactions exhibited substantial variation. After the nipping treatment with T5 (NPK + foliar (urea 1% + Fe 0.5%)), which yielded 44.11 and 38.05 pods per plant, the nipping treatment with T6 (NPK + foliar (urea 1% + Zn 0.5% + Fe 0.5%)) produced the largest number of pods per plant.

The non-nipping treatment exhibited the lowest minimum number of pods per plant, succeeded by the nipping treatment with control, yielding 20.36 and 26.30 pods per plant, respectively, in the absence of micronutrient supplementation. The administration of nutrients alongside nipping treatments enhanced the number of branches and pods per plant, subsequently augmenting the total pod count per plant.

This improvement may result from balanced nutrient management and crop management through nipping, which increased both the number of branches and the plant's canopy, ultimately elevating the pod count per plant. Shah *et al*. (2016) shown that the primary application of NPK fertilizers results in the highest number of pods per plant.

Grain yield (kg ha^{-1})

The ultimate objective of every research study is to optimize grain yield, while farmers aim to enhance yield and economic returns on their investments. Table 7 demonstrates that the mean yield of several treatments considerably differs based on management strategies, foliar micronutrient delivery, and their interactions. The application of T6 (NPK + foliar urea 1% + Zn 0.5% + Fe 0.5%) resulted in the highest grain yield of 2505 kg ha^{-1}.

The non-nipping treatment with T6 (NPK + foliar urea 1% + Zn 0.5% + Fe 0.5%) and the nipping treatment with T5 (NPK + foliar urea 1% + Fe 0.5%) had grain outputs of 2159.3 and 2112.7 kg ha^{-1}, respectively. Conversely, the non-nipping management strategy with T1 (control) resulted in the lowest grain yield at harvest.

The subsequent management strategy employing T1 (control) resulted in grain yields of 809.7 and 982.7 kg ha^{-1}, respectively. The density of plants per unit area, the number of pods per plant, the number of seeds per plant, and the weight of 100 seeds collectively contribute to the total grain yield of chickpeas.

In conjunction with the control treatment in both management practices, the micronutrient and management strategies enhanced the grain yield of chickpea with NPK. To enhance field nipping procedures and ultimately boost chickpea output, the balanced administration of NPK and foliar application of micronutrients augmented the total number of branches per plant and the number of pods per plant. The Valenciano group (2011) reported that, in comparison to the control treatment, the highest grain yield was observed with the administration of NPK in conjunction with Zinc and Boron.

Biological yield (kg ha^{-1})

The biological yield encompasses the total above-ground biomass. It is the total amount of dry matter harvested by a crop per unit area. A higher biological production enhances a plant's photosynthetic efficiency. The data on biological yield indicated a significant variation across the treatments, influenced by management strategies, foliar micronutrient application, and their interaction (Table 8).

The pinching treatment with T6 (NPK + 1% foliar urea + 0.5% Zn + 0.5% Fe) resulted in the highest biological yield of 4510.3 kg ha^{-1}, as measured. The non-nipping treatment with T6 (NPK + foliar urea 1% + Zn 0.5% + Fe 0.5%) and the nipping treatment with T5 (NPK + foliar urea 1% + Fe 0.5%) produced yields of 4244 and 4129.7 kg ha^{-1}, respectively, although the lowest biological yield recorded was 1536 kg ha^{-1}.

The application of nipping treatment with T1 (control) after T1 (control) resulted in a biological yield of 1814 kg ha^{-1} The regulation of critical and micronutrients may have enhanced photosynthetic productivity, subsequently improving dry matter production and ultimately leading to optimal biological yield. Drostkar *et al*. (2014) discovered that a balanced nutrient application yielded the highest biological output compared to the absence of fertilizer.

Harvest index (%)

The harvest index is defined as the ratio of grain yield to crop biological yield. A higher harvest index, relative to straw output, indicates greater allocation of dry matter to grain production. Table 9 indicates that while the management approaches and their interaction with micronutrients were found to be non-significant, the foliar application of micronutrients resulted in a substantial alteration in the harvest index across the different treatments.

T6 (NPK + foliar urea 1% + Zn 0.5% + Fe 0.5%), T1 (control), and T2 (NPK (20:40:20 kg ha^{-1}) exhibited the highest harvest indices, measuring 53.21%, 53.44%, and 53.31%, respectively. T4 (NPK + foliar urea 1% + Zn 0.5%) and T5 (NPK + foliar urea 1% + Fe 0.5%) had the lowest crop indices, measuring 49.35% and 49.58%, respectively.

An effective and balanced nutrient treatment may enhance photosynthetic efficiency and optimize dry matter allocation, resulting in an increased harvest index. Our findings aligned with those of Usman *et al*. (2014), who indicated that zinc and NPK produced a maximum harvest index.

Benefit cost ratio (BCR)

The economic feasibility of applying urea, zinc, and iron through foliar application, alongside appropriate management practices and effective macro- and micronutrient strategies in chickpea crops utilizing residual moisture from rice crops, as evidenced by the BCR analysis and the economics of primary nutrients.

Table 10 presents the computed benefit-cost ratio data. The minimum benefit-cost ratio was observed in the non-nipping treatment T1 (control) at 2.01, followed by the nipping treatment T1 (control) at 2.13. Conversely, the maximum benefit-cost ratio was recorded in the nipping treatment T6 (NPK + foliar urea 1% + Zn 0.5% + Fe 0.5%) and the non-nipping treatment T5 (NPK + foliar urea 1% + Fe 0.5%), yielding ratios of 3.66 and 3.55, respectively, which were statistically comparable.

Rehman and associates (2021) also indicated that, relative to the control, NPK and micronutrients resulted in an elevated BCR.

CONCLUSION

Current research concludes that the application of macro nutrients NPK in soil and the foliar application of micro-nutrients (urea, Zn, and Fe) resulted in superior grain and biological yields compared to the control treatment. Comparing nipping and non-nipping management approaches, it was determined that nipping treatment resulted in a greater number of branches per plant, pods per plant, and seeds per plant compared to non-nipping treatment. The combined effect of macro and micronutrients, along with the pinching management strategy, resulted in the maximum grain output (2505 kg ha^{-1}) and benefit-cost ratio (3.95), while also enhancing the number of nodules per plant.

FUNDING STATEMENT

This study was supported by all authors.

AUTHOR’S CONTRIBUTION

All authors contributed equally.

DATA AVAILABILITY STATEMENT

All the data is primary.

ACKNOWLEDGMENTS

We acknowledge the Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, for providing the laboratory, research field, and labor for this research

CONFLICT OF INTEREST

The authors declared that the present study was performed in absence of any conflict of interest.

REFERENCES

Baloch, M. S. and M. Zubair. 2010. Effect of nipping on growth and yield of chickpea. *The Journal of Animal and Plant Sciences*, 20(3): 208-210.

Borie, F., R. Rubio, J. L. Rouanet, A. Morales, G. Borie and C. Rojas. 2006. Effects of tillage systems on soil characteristics, glomalin and mycorrhizal propagules in a Chilean Ultisol. *Soil Tillage Research,* 88: 253–261.

Drostkar, E., R. Talebi, H. Kanouni. 2016. Foliar application of Fe, Zn and NPK nano-fertilizers on seed yield and morphological traits in chickpea under rainfed conditions. *Journal of Research in Ecology,* 4 (2): 221-228.

FAO (Food and Agriculture Organization of the United Nations) (2017) Soil fertility atlas of Pakistan, p: 115.

Fageria, N. K., M. B. P. Filho, A. Moreira, C. M. Guimaraes. 2009. Foliar fertilization of crop plants. *Journal of Plant Nutrition*, 32: 1044–1064.

Govt. of Pakistan, 2019-2020. Economic Survey of Pakistan, Economic adviser’s Wing, Finance Division, Government of Pakistan, Islamabad. pp 121.

Hafiz, S. M., I. Hussain, M. Z. Al-Faisal, H. B. Ahmad, M. N. Khan, J. Salim, A. H. Shah, A. Afzal, M. Rashid, A. Wakeel, A. Nawaz, M. Zulfqar, R. Khursheed, M. Altaf, I. Ahmad. 2021. Quantitative evaluation of chickpea (*Cicer arietinum* L.) cultivars in dry land agro-climatic conditions. *Plant Cell Biotechnology and Molecular Biology*, 22(71&72):658-667.

Kagan, S., N. Kayan. 2014. The influence of inoculation and nitrogen treatments on yield and yield components in chickpea (*Cicer arietinum* L.) cultivars. *Legume Research,* 37: 363–371.

Nadi, E., A. Aynehband, M. Mojaddam. 2013. Effect of nano-iron chelate fertilizer on grain yield, protein percent and chlorophyll content of Faba bean (*Vicia faba* L.).

International Journal of Bioscience, 3 (9): 267-272.

Patel, H. A., D. J. Hanki. 2020. Effect of integrated nutrient management on growth, yield, soil nutrient status and economics of chickpea (*Cicer arietinum L.)* under south Gujarat conditions. *Journal of Pharmacognosy and Phytochemistry*, 9(6): 623-626.

Rehman, A. U., X. Wang, A. Hussain, R. Qamar, A. Khalofah, M. Hussain. 2021. Boron application in Yermosols improves grain yield and quality of chickpea (*Cicer arietinum* L.). *Journal of King Saud University – Science*, 34: 101768.

Shah, T., A. Fareed, M. Nauman. 2016. Yield and quality response of chickpea cultivars to different NPK levels. *Austin Food Sciences* 1(4): 1018.

Singh, L., A. D. Arun, S. Narendra, T. Tarence. 2020. Assessment of integrated nutrient management on soil properties and yield attribute of chickpea (*Cicer arietinum* L.*)* Var. Samrat. *International Journal of Current Microbiology and Applied Sciences*, 9(8): 3432-3439.

Usman, M., M. Tahir, M. A. Majeed. 2014. Effect of zinc sulphate as soil application and seed treatment on green gram (*Vigna radiata L.*). *Pakistan Journal of Life and Social Sciences*, 12(2): 87-91.

Valenciano, J. B., J. A. Boto, V. Marcelo. 2011. Chickpea (*Cicer arietinum* L.*)* response to zinc, boron and molybdenum application under field conditions. *New Zealand Journal of Crop and Horticultural Science*, 39(4): 217-229.

Table 1. Influence of nipping and foliar micronutrient application on chickpea crop growth rate (g m-^{2}day^{-1}) under residual rice moisture

Management Practices	Foliar application of micro-nutrients						Means
	T_1 Control	T_2 NPK (20:40:20 Kg ha^{-1})	T_3 NPK + Foliar (Urea 1%)	T_4 NPK + Foliar (Urea 1% + Zn 0.5%)	T_5 NPK + Foliar (Urea 1% + Fe 0.5%)	T_6 NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)	
Nipping	1.86 ^{NS}	2.70	2.91	3.37	3.91	4.80	**3.26 ^{NS}**
Non- Nipping	1.73	2.31	2.71	2.92	3.32	4.62	**2.94**
Means	**1.79 f**	**2.50 e**	**2.81 d**	**3.14 c**	**3.61 b**	**4.71 a**	

Mean sharing common letters do not different significantly at 5% level of probability.
$LSD_{0.05}$ for nipping vs. non-nipping = NS
$LSD_{0.05}$ for foliar application of micro-nutrients = 0.18
$LSD_{0.05}$ for interaction = NS

Table 2. Influence of nipping and foliar micronutrient application on number of nodules plant^{-1} of chickpea under residual rice moisture

Management Practices	Foliar application of micro-nutrients						Means
	T_1 Control	T_2 NPK (20:40:20 Kg ha^{-1})	T_3 NPK + Foliar (Urea 1%)	T_4 NPK + Foliar (Urea 1% + Zn 0.5%)	T_5 NPK + Foliar (Urea 1% + Fe 0.5%)	T_6 NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)	
Nipping	21.33 ^{fg}	23.67 ^{ef}	25.83 ^{e}	29.87 ^{d}	38.85 ^{c}	47.40 ^{a}	**31.15 ^{NS}**
Non- Nipping	14.33 ^{i}	18.67 ^{h}	23.33 $^{e-g}$	27.34 ^{de}	39.34 ^{c}	42.44 ^{b}	**27.57**
Means	**17.83 f**	**21.16 e**	**24.58 d**	**28.60 c**	**39.09 b**	**44.92 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = NS
$LSD_{0.05}$ for foliar application of micro-nutrients = 1.79
$LSD_{0.05}$ for interaction = 2.54

Table 3: Influence of nipping and foliar micronutrient application on days to 50% flowering of chickpea under residual rice moisture

Management Practices	Foliar application of micro-nutrients						Means
	T_1 Control	T_2 NPK (20:40:20 Kg ha^{-1})	T_3 NPK + Foliar (Urea 1%)	T_4 NPK + Foliar (Urea 1% + Zn 0.5%)	T_5 NPK + Foliar (Urea 1% + Fe 0.5%)	T_6 NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)	
Nipping	106 fg	108 ef	109 de	111 cd	113.33 b	119 a	**111.06 a**
Non- Nipping	103 h	104.33 gh	108.33 e	110 c-e	110.67 cd	111.67 bc	**108 b**
Means	**104.50 e**	**106.17 d**	**108.67 c**	**110.50 b**	**112 b**	**115.33 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = 1.26
$LSD_{0.05}$ for foliar application of micro-nutrients = 1.51
$LSD_{0.05}$ for interaction = 2.13

Table 4. Influence of nipping and foliar micronutrient application on plant height (cm) of chickpea under residual rice moisture

Management Practices	Foliar application of micro-nutrients						Means
	T_1 Control	T_2 NPK (20:40:20 Kg ha^{-1})	T_3 NPK + Foliar (Urea 1%)	T_4 NPK + Foliar (Urea 1% + Zn 0.5%)	T_5 NPK + Foliar (Urea 1% + Fe 0.5%)	T_6 NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)	
Nipping	19.50 i	22.13 h	24.30 fg	25.80 e	27.86 d	30 c	**24.93 b**
Non- Nipping	23.07 g	25.06 ef	27.46 d	30.26 c	34.46 b	36.83 a	**29.52 a**
Means	**21.28 f**	**23.60 e**	**25.88**	**28.03 c**	**31.16 b**	**33.41 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = 0.80
$LSD_{0.05}$ for foliar application of micro-nutrients = 1.00
$LSD_{0.05}$ for interaction = 1.4

Table 5. Influence of nipping and foliar micronutrient application on number of branches plant^{-1} of chickpea under residual rice moisture

Management Practices	*Foliar application of micro-nutrients*						*Means*
	T_1 Control	**T_2 NPK (20:40:20 Kg ha^{-1})**	**T_3 NPK + Foliar (Urea 1%)**	**T_4 NPK + Foliar (Urea 1% + Zn 0.5%)**	**T_5 NPK + Foliar (Urea 1% + Fe 0.5%)**	**T_6 NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)**	
Nipping	5.40 e	5.30 e	7.50 c	9.63 b	10.96 a	11.43 a	**8.37 a**
Non- Nipping	3.77 f	5.16 e	5.20 e	5.60 e	6.56 d	6.80 cd	**5.51 b**
Means	**4.58 e**	**5.23 d**	**6.35 c**	**7.61 b**	**8.77 a**	**9.12 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = 0.74
$LSD_{0.05}$ for foliar application of micro-nutrients = 0.48
$LSD_{0.05}$ for interaction = 0.68

Table 6. Influence of nipping and foliar micronutrient application on number of pods plant^{-1} of chickpea under residual rice moisture

Management Practices	*Foliar application of micro-nutrients*						*Means*
	T_1 Control	**T_2 NPK (20:40:20 Kg ha^{-1})**	**T_3 NPK + Foliar (Urea 1%)**	**T_4 NPK + Foliar (Urea 1% + Zn 0.5%)**	**T_5 NPK + Foliar (Urea 1% + Fe 0.5%)**	**T_6 NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)**	
Nipping	26.30 g	28.38 f	31.37 e	35.90 c	38.05 b	44.11 a	**34.02 a**
Non- Nipping	20.36 j	23.30 i	25.05 h	27.03 g	31.15 e	32.86 d	**26.63 b**
Means	**23.34 f**	**25.84 e**	**28.21 d**	**31.46 c**	**34.60 b**	**38.48 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = 0.71
$LSD_{0.05}$ for foliar application of micro-nutrients = 0.79
$LSD_{0.05}$ for interaction = 1.13

Table 7. Influence of nipping and foliar micronutrient application on grain yield (Kg ha^{-1}) of chickpea under residual rice moisture

Management Practices	*Foliar application of micro-nutrients*						*Means*
	T_1 Control	**T_2** NPK (20:40:20 Kg ha^{-1})	**T_3** NPK + Foliar (Urea 1%)	**T_4** NPK + Foliar (Urea 1% + Zn 0.5%)	**T_5** NPK + Foliar (Urea 1% + Fe 0.5%)	**T_6** NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)	
Nipping	982.7 g	1890.7 de	1900 d	1999.7 c	2112.7 b	2505 a	**1898.4 a**
Non- Nipping	809.7 h	1598.3 f	1784 e	1864.3 de	1920.7 cd	2159.3 b	**1689.4 b**
Means	**896.2 f**	**1744.5 e**	**1842 d**	**1932 c**	**2016.7 b**	**2332.2 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = 101.95
$LSD_{0.05}$ for foliar application of micro-nutrients = 40.07
$LSD_{0.05}$ for interaction = 56.66

Table 8. Influence of nipping and foliar micronutrient application on biological yield (kg ha^{-1}) of chickpea under residual rice moisture

Management Practices	*Foliar application of micro-nutrients*						*Means*
	T_1 Control	**T_2** NPK (20:40:20 Kg ha^{-1})	**T_3** NPK + Foliar (Urea 1%)	**T_4** NPK + Foliar (Urea 1% + Zn 0.5%)	**T_5** NPK + Foliar (Urea 1% + Fe 0.5%)	**T_6** NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)	
Nipping	1814 i	3519.7 g	3644.3 f	3990.7 d	4129.7 c	4510.3 a	**3601.4 a**
Non- Nipping	1536 j	3022.7 h	3481.7 g	3838.3 e	4003 d	4244 b	**3354.3 b**
Means	**1675 f**	**3271.2 e**	**3563 d**	**3914.5 c**	**4066.3 b**	**4377.2 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = 58.15
$LSD_{0.05}$ for foliar application of micro-nutrients = 73.93
$LSD_{0.05}$ for interaction = 104

Table 9. Influence of nipping and foliar micronutrient application on harvest index (%) of chickpea under residual rice moisture

Management Practices	***Foliar application of micro-nutrients***						***Means***
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	
	Control	**NPK (20:40:20 Kg ha^{-1})**	**NPK + Foliar (Urea 1%)**	**NPK + Foliar (Urea 1% + Zn 0.5%)**	**NPK + Foliar (Urea 1% + Fe 0.5%)**	**NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)**	
Nipping	54.17 ^{NS}	53.73	52.16	50.11	51.19	55.55	**52.82 ^{NS}**
Non- Nipping	52.71	52.88	51.24	48.59	47.98	50.87	**50.71**
Means	**53.44 a**	**53.31 a**	**51.70 b**	**49.35 c**	**49.58 c**	**53.21 a**	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = NS
$LSD_{0.05}$ for foliar application of micro-nutrients = 1.41
$LSD_{0.05}$ for interaction = NS

Table 10. Influence of nipping and foliar micronutrient application on BCR of chickpea under residual rice moisture

Management Practices	***Foliar application of micro-nutrients***						***Means***
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	
	Control	**NPK (20:40:20 Kg ha^{-1})**	**NPK + Foliar (Urea 1%)**	**NPK + Foliar (Urea 1% + Zn 0.5%)**	**NPK + Foliar (Urea 1% + Fe 0.5%)**	**NPK + Foliar (Urea 1% + Zn 0.5% + Fe 0.5%)**	
Nipping	2.13 f	2.85 de	2.95 cd	3.05 c	3.19 b	3.66 a	2.97 ^{NS}
Non- Nipping	2.01 g	2.72 e	2.89 d	2.99 cd	3.11 bc	3.55 ab	2.88
Means	2.07 e	2.79 d	2.90 cd	3.02 c	3.15 b	3.60 a	

Mean sharing common letters do not different significantly at 5% level of probability
$LSD_{0.05}$ for nipping vs. non-nipping = NS
$LSD_{0.05}$ for foliar application of micro-nutrients = 0.11
$LSD_{0.05}$ for interaction = 0.16