



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(6): 533-536
Received: 20-03-2026
Accepted: 29-04-2026

Muhammad Ayesha Khanam
Department of Agronomy, School
of Agricultural Sciences, Malla
Reddy University, Hyderabad,
Telangana, India

Gudapati Ashoka Chakravarthy
Department of Agronomy, School
of Agricultural Sciences, Malla
Reddy University, Hyderabad,
Telangana, India

B Mahesh Naik
Department of Agronomy, School
of Agricultural Sciences, Malla
Reddy University, Hyderabad,
Telangana, India

M Sri Sai Charan Satya
Department of Soil Science, School
of Agricultural Sciences, Malla
Reddy University, Hyderabad,
Telangana, India

Corresponding Author:
Muhammad Ayesha Khanam
Department of Agronomy, School
of Agricultural Sciences, Malla
Reddy University, Hyderabad,
Telangana, India

Influence of tillage and nutrient management practices on chickpea (*Cicer arietinum* L.) productivity and soil health

Muhammad Ayesha Khanam, Gudapati Ashoka Chakravarthy, B Mahesh Naik and M Sri Sai Charan Satya

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i6g.5745>

Abstract

A field experiment was conducted during the *rabi* season 2025-26 at Research Farm, School of Agricultural Sciences, Malla Reddy University, Hyderabad, to study the influence of tillage and nutrient management practices on chickpea (*cicer arietinum* L.) productivity and soil health. The texture of soil at the experimental site was sandy loam, moderately alkaline in reaction, non-saline in electrical conductivity, low in organic carbon and available phosphorus medium in available nitrogen and potassium. The field experiment was laid out in a split plot design with three replications, comprising combinations with three tillage practices (permanent bed + residue management, zero tillage + residue management, and conventional tillage) in main plots and four nutrient treatments (100% RDF, biochar @ 2 t ha⁻¹, 100% RDF + biochar @ 2 t ha⁻¹, and 75% RDF + biochar @ 2 t ha⁻¹) in sub-plots. The results revealed that permanent bed with residue management combined with 100% RDF + biochar @ 2 t ha⁻¹ recorded superior soil properties, growth and yield of chickpea. A recommended fertilizer dose of 20:50:20 kg N:P₂O₅:K₂O ha was applied as basal and the chickpea variety JG-11 was sown in November at a spacing of 30 cm x 10 cm. Tillage practices carried out before sowing and nutrient scheduling for all treatments was done using the graduated bucket method. The data generated were analyzed using standard statistical procedures. The results revealed that T₁N₃ recorded the highest seed yield (1719.4 kg ha⁻¹) and T₃N₂: Conventional Tillage+Biochar 2 t ha⁻¹ recorded the lowest seed yield (1446 kg ha⁻¹). In terms of nutrient management practices 100% RDF + Biochar 2 t ha⁻¹ recorded the highest seed yield (1758 kg ha⁻¹) and lowest was Biochar 2 t ha⁻¹ (1395 kg ha⁻¹). Hence, integration of conservation tillage with biochar and balanced fertilization can be recommended as an efficient and sustainable strategy for improving productivity under semi-arid tropical conditions.

Keywords: Soil fertility, chickpea, grain yield, nutrient and different tillage practices, biochar

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops globally, ranking third among food legumes after beans and peas. Chickpea can meet up to 80% of its nitrogen (N) requirement via biological nitrogen fixation (BNF), thereby reducing dependence on synthetic nitrogen fertilizers and contributing to sustainable soil fertility management (Jukanti *et al.*, 2012) [6]. Conservation agriculture (CA) has emerged as a promising and sustainable soil and crop management system designed to mitigate the adverse effects of conventional tillage. CA is founded on three core principles: (i) minimal or zero soil disturbance, (ii) permanent soil cover through crop residues or cover crops, and (iii) diversified crop rotations (Corbeels *et al.*, 2020) [3]. Collectively, these practices promote ecological balance, resource use efficiency and long-term productivity. Additionally, diversified crop rotations disrupt pest and disease cycles, improve nutrient cycling, and reduce reliance on chemical inputs (Giller *et al.*, 2015) [5]. Biochar application has been shown to improve soil physical, chemical, and biological properties by enhancing water-holding capacity, cation exchange capacity, and microbial habitat (Lehmann and Joseph, 2015) [8]. Its high stability enables long term carbon sequestration, contributing to climate change mitigation. In addition, the pyrolysis process generates bioenergy co-products, making biochar a potentially sustainable tool in circular bioeconomy systems (Cely *et al.*, 2015)

[2]. Biochar, a carbon rich material produced through pyrolysis of organic biomass under limited oxygen conditions, has gained considerable attention as a soil amendment with multiple agronomic and environmental benefits. Improper application can lead to challenges such as temporary nitrogen immobilization, changes in soil pH and electrical conductivity, release of heavy metals, or phytotoxic effects (Singh *et al.*, 2010; Kookana *et al.*, 2011; Rogovska *et al.*, 2012) [13, 7, 12]. However, the effectiveness of biochar in agricultural systems depends on feedstock type, pyrolysis temperature, application rate, and soil characteristics. Furthermore, large-scale adoption of biochar remains constrained by economic and logistical challenges related to production, transport, and uniform field application (Spokas *et al.*, 2012 and Lehmann *et al.*, 2011) [14, 9]. The aim to evaluate the influence of different tillage regimes conventional tillage (CT), permanent bed (PB), and zero tillage (ZT) and nutrient input strategies recommended fertilizer dose (RDF), biochar, and their combinations on soil fertility, nutrient uptake, productivity, and environmental sustainability indicators in chickpea cultivation.

Materials and Methods

The Field experiment was carried out during *Rabi* 2025-26 in a Field No. A-2 of the Experimental Farm, Department of Agronomy, School of Agricultural Sciences (SoAS), Malla Reddy University, Maisammaguda, Hyderabad, Telangana. The experimental site is situated at 17°33' N latitude and 78°27' E longitude at an altitude of 583 meters above mean sea level. The weather of Maisammaguda is moderately warm with cool and dry winter. The mean maximum temperature is 31.3°C while the mean minimum temperature is 17.9°C, and the mean relative humidity is 60%. The soil of the experimental field is alkaline in nature with a pH of 8.03.

The field experiment was laid out adopting a split plot with 12 treatments and 3 replications the gross plot size is 5.4×4.0m and net plot size is 4.2×3.6m. The treatments are (T₁N₁) Permanent bed + crop residue + 100% RDF, (T₁N₂) Permanent bed + crop residue + Biochar (2.0 t ha⁻¹), (T₁N₃) Permanent bed + crop residue + 100% RDF + Biochar (2 t ha⁻¹), (T₁N₄) Permanent bed + crop residue + 75% RDF + Biochar (2.0 t ha⁻¹), (T₂N₁) Zero tillage + crop residue + 100% RDF, (T₂N₂) Zero tillage + crop residue + Biochar (2.0 t ha⁻¹), (T₂N₃) Zero tillage + crop residue + 100% RDF + Biochar (2.0 t ha⁻¹), (T₂N₄) Zero tillage + crop residue + 75% RDF + Biochar (2.0 t ha⁻¹), (T₃N₁) Conventional tillage + 100% RDF, (T₃N₂) Conventional tillage + Biochar (2.0 t ha⁻¹), (T₃N₃) Conventional tillage + 100% RDF + Biochar (2.0 t ha⁻¹), (T₃N₄) Conventional tillage + 75% RDF + Biochar (2.0 t ha⁻¹).

The chickpea JG-11 is employed as a test crop and experimented

with using a recommended seed rate of 80 kg ha⁻¹ and a row spacing of 30 × 10 cm. N, P₂O₅ and K₂O were distributed evenly among all treatment plots, the recommended dose of fertilizers (RDF) comprising 20 kg N, 50 kg P₂O₅, and 20 kg K₂O ha⁻¹ was applied through urea (46% N), diammonium phosphate (DAP; 18% N and 46% P₂O₅), and muriate of potash (MOP; 60% K₂O), respectively. The effect of biochar on biomass was expected due to its ability to retain nutrients and improve water holding capacity of sandy textured soils (Biederman and Harpole 2013) [1]. Measurements related to growth, yield, and yield attributes were recorded from five randomly chosen plants, and the mean values for each treatment were computed and recorded. Following the harvest and threshing of the crop, the yield was measured for each net plot and converted to kg ha⁻¹.

The experimental data collected on plant growth parameters, yield components, and yield were subjected to Fisher's method of "Analysis of Variance" (ANOVA) as outlined by Panse and Sukhatme (1954) [10]. Wherever F- test was significant, for comparison between the treatment means, an appropriate value of critical difference (C.D.) was worked out. All the data were analysed and the results are presented and discussed at a probability level of 5%

Results and Discussion

Effect of tillage and nutrient management on growth parameters of *rabi* chickpea

Growth Parameters the growth characteristics of chickpea, such as plant height (cm), number of branches plants, number of nodules and dry matter accumulation (g plant⁻¹), were significantly affected by the various treatments, as shown in Table 1. The treatment T₁N₃ led to greater plant height (41.44 cm), no.of branches(7.12), nodule count (22.39) and dry matter production (12.21 g plant⁻¹) followed by (Permanent bed + crop residue 2.0 Mg ha⁻¹ + 100% RDF + Biochar 2 t ha⁻¹ and the lowest plant height (36.82 cm), no. of branches(5.48), nodule count (15.60) and dry matter production (9.93 g plant⁻¹) was observed under conventional tillage without residue and biochar (2.0 t ha⁻¹) T₃N₂. The increased plant height under T₁N₃ may be attributed to improved soil structure, better moisture retention and enhanced nutrient availability due to residue retention and biochar application. Biochar improves soil aeration, microbial activity and nutrient holding capacity, which ultimately enhances crop growth. Permanent bed planting further contributes by reducing soil disturbance and improving root proliferation. These findings are in accordance with Shadman *et al.*, (2020) [15] who reported higher number of nodules, fresh weight in chickpea under biochar application treatments. Similar results were also reported by Elamin *et al.*, (2015) [4] with highest number of plant height and number of pods⁻¹.

Table 1: Effect of tillage and nutrient management practices on plant height, no. of branches, Nodule count and dry matter production of *kharif* maize

Treatments	Plant height at harvest (cm)	No. of branches	Nodule count	Dry matter production (gplant ⁻¹)
Main plots- Tillage practices				
PB+ Crop residue	41.44	7.12	22.39	12.21
ZT+ Crop residue	40.44	6.78	20.16	11.47
CT	36.82	5.48	15.60	9.93
SEd±	1.25	0.16	1.074	0.49
LSD (p=0.05)	3.47	0.44	2.982	1.36
Sub Plot- Nutrient management				
100% RDF	38.76	6.28	17.66	10.73
Biochar @ 2 t ha ⁻¹	34.53	4.94	14.43	9.46
100% RDF + Biochar @ 2 t ha ⁻¹	43.39	7.76	24.30	13.13
75% RDF + Biochar @ 2 t ha ⁻¹	41.59	6.85	21.15	11.49

SEd±	1.68	0.31	2.562	0.56
LSD ($p=0.05$)	3.53	0.66	5.382	1.18
Interaction				
SEd±	2.91	0.54	4.437	0.97
LSD ($p=0.05$)	NS	NS	NS	NS

Effect of tillage and nutrient management on grain and haulm yield of rabi chickpea.

The yield characteristics of chickpea, including seed and haulm yield are presented in Table 2. Different tillage practices had a significant impact that T₃: Conventional Tillage+ Biochar 2 t ha⁻¹, exhibited the lowest values for the seed yield (1446 kg ha⁻¹) and haulm yield (2856 kg ha⁻¹). Conversely, the highest values for these attributes were observed under T₁N₃ (Permanent bed + crop residue 2 t ha⁻¹ + 100% RDF + Biochar 2 t ha⁻¹) with seed yield (1719 kg ha⁻¹) and haulm yield (3230 kg ha⁻¹). These findings are in accordance with pradhan *et al.*, (2022) ^[11] that the growth of chickpeas in biochar amended soil was faster than the control and even early on showed a slightly greater number of germinated plants.

For the yield of chickpea seed were significantly influenced by the different treatments. Nutrient management treatments also exerted a significant influence on yield among the treatments,

the highest seed yield (1758 kg ha⁻¹) and haulm yield (3314 kg ha⁻¹) were recorded under 100% RDF + Biochar 2 t ha⁻¹ as the next most productive 75% RDF + biochar @ 2 t ha⁻¹ (1669 and 3129 kg ha⁻¹ respectively). The Biochar 2 t ha⁻¹ yielded the lowest seed yield (1395 kg ha⁻¹) and haulm yield (2711 kg ha⁻¹) while biochar alone resulted in the lowest yields and 100% RDF alone showed intermediate performance that seed and haulm yield (1589 and 3058 kg ha⁻¹). One possible explanation for this is the combined effect of permanent bed planting, residue retention, and biochar application resulted in enhanced soil fertility and nutrient use efficiency, leading to higher yield. The increased seed yield under T₁N₃ may be attributed to improved growth parameters, efficient nutrient utilization, and better soil moisture availability. The combined effect of permanent bed planting, residue retention, and biochar application resulted in enhanced soil fertility and nutrient use efficiency, leading to higher yield.

Table 2: Effect of tillage and nutrient management practices on seed yield and haulm yield of rabi chickpea (kg ha⁻¹)

Treatments	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)
Main plots- Tillage practices		
PB+ Crop residue	1719.4	3230.75
ZT+ Crop residue	1644.4	3073.3
CT	1446.5	2856.43
SEd±	62.5	313.41
LSD ($p=0.05$)	173.5	NS
Sub Plot- Nutrient management		
100% RDF	1589.4	3058.42
Biochar @ 2 t ha ⁻¹	1395.8	2711.83
100% RDF + Biochar @ 2 t ha ⁻¹	1758.6	3314.11
75% RDF + Biochar @ 2 t ha ⁻¹	1669.9	3129.23
SEd±	82.5	145.97
LSD ($p=0.05$)	173.4	306.68
Interaction		
SEd±	143	252.83
LSD ($p=0.05$)	NS	NS

Conclusion

The findings of the present investigation revealed that both tillage and nutrient management practices had a significant effect on the growth and productivity of chickpea under semi-arid conditions. Among the different tillage methods, permanent bed planting resulted in superior growth parameters, seed yield, and haulm yield compared to zero tillage and conventional tillage. Likewise, nutrient management treatments involving the combined use of fertilizers and biochar proved more effective, with the application of 100% RDF along with biochar @ 2 t ha⁻¹ recording the highest growth and yield performance. The treatment receiving 75% RDF + biochar also performed on par with 100% RDF, suggesting the possibility of reducing fertilizer application without causing a substantial reduction in yield. Overall, the study indicates that the adoption of conservation tillage practices, especially permanent bed planting, together with biochar-based nutrient management, can be considered a sustainable and efficient strategy for enhancing chickpea productivity under semi-arid agro-climatic conditions.

References

1. Biederman LA, Harpole S. Biochar and its effects on plant

- productivity and nutrient cycling: A meta-analysis. *GCB Bioenergy*. 2013;5:202-214.
- Cely P, Tarquis AM, Paz-Ferreiro J, Mendez A, Gasco G. Factors driving the biochar stability and its effect on carbon mineralization in soils. *Soil and Tillage Research*. 2015;155:67-75.
- Corbeels M, de Graaff J, Ndah HT, Penot E, Baudron F, Naudin K, *et al.* Understanding the impact and adoption of conservation agriculture in Africa: A multi-scale analysis. *Agriculture, Ecosystems and Environment*. 2014;187:155-170.
- Elamin AY, Madhavi K. Residual effect of integrated nutrient management on growth and yield parameters of rabi chickpea (*Cicer arietinum* L.) under cropping system. *American Journal of Scientific and Industrial Research*. 2015;6(5):103-109.
- Giller KE, Andersson JA, Corbeels M, Kirkegaard J, Mortensen D, Erenstein O, *et al.* Beyond conservation agriculture. *Frontiers in Plant Science*. 2015;6:870.
- Jukanti AK, Gaur PM, Gowda CLL, Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): A review. *British Journal of Nutrition*.

- 2012;108(S1):S11-S26.
7. Kookana RS, Sarmah AK, Van Zwieten L, Krull E, Singh B. Biochar application to soil: Agronomic and environmental benefits and unintended consequences. *Advances in Agronomy*. 2011;112:103-143.
 8. Lehmann J, Joseph S. Biochar for environmental management: Science, technology and implementation. 2nd ed. London: Routledge; 2015.
 9. Lehmann J, Gaunt J, Rondon M. Bio-char sequestration in terrestrial ecosystems. *Mitigation and Adaptation Strategies for Global Change*. 2006;11(2):403-427.
 10. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. 1st ed. New Delhi: ICAR Publication; 1954. p. 359.
 11. Pradhan S, Mackey HR, Al-Ansari TA, McKay G. Biochar from food waste: A sustainable amendment to reduce water stress and improve the growth of chickpea plants. *Biomass Conversion and Biorefinery*. 2022;12:4549-4562.
 12. Rogovska N, Laird DA, Cruse RM, Fleming P, Parkin T, Meek D. Impact of biochar on manure carbon stabilization and greenhouse gas emissions. *Soil Science Society of America Journal*. 2011;75(3):871-879.
 13. Singh B, Singh BP, Cowie AL. Characterisation and evaluation of biochars for their application as a soil amendment. *Australian Journal of Soil Research*. 2010;48(7):516-525.
 14. Spokas KA, Cantrell KB, Novak JM, Archer DW, Ippolito JA, Collins HP, *et al*. Biochar: A synthesis of its agronomic impact beyond carbon sequestration. *Journal of Environmental Quality*. 2012;41(4):973-989.
 15. Shadman Khan Z, Shah Z, Mian IA, Dawar K, Tariq M, Khan B, *et al*. Soil fertility, N₂ fixation and yield of chickpea as influenced by long-term biochar application under a mung-chickpea cropping system. *Sustainability*. 2020;12(21):9008.
 16. Thierfelder C, Chivenge P, Mupangwa W, Rosenstock TS, Lamanna C, Eyre JX. How climate-smart is conservation agriculture? Its potential to deliver on adaptation, mitigation and productivity on smallholder farms in southern Africa. *Food Security*. 2017;9:537-560.