



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(8): 01-05
Received: 02-05-2026
Accepted: 08-06-2026

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Soil macronutrient status under different land use systems in Mahabubnagar district, Telangana

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8Sa.6176>

Abstract

Land use systems significantly influence soil nutrient availability by altering nutrient cycling and soil management practices. The present study evaluated the effect of different land use systems on available nitrogen, phosphorus and potassium in the soils of Mahabubnagar district, Telangana. Soil samples were collected from two depths (0–15 and 15–30 cm) under seven major land use systems, namely rice–rice, maize–groundnut, groundnut–fallow, cotton–fallow, mango orchard, fodder and forest. Available nitrogen, phosphorus and potassium were determined using standard analytical procedures, and the data were analysed by two-way analysis of variance. Significant differences in nutrient availability were observed among land use systems and soil depths. Forest soils recorded the highest mean available nitrogen (300.5 kg ha⁻¹), phosphorus (52.83 kg ha⁻¹) and potassium (350.88 kg ha⁻¹), whereas the cotton–fallow system recorded the lowest available nitrogen (196.3 kg ha⁻¹) and phosphorus (34.29 kg ha⁻¹), and the rice–rice system recorded the lowest potassium (252.46 kg ha⁻¹). All three nutrients showed a declining trend with increasing soil depth. The findings demonstrate that land use plays a vital role in regulating soil fertility and highlight the importance of adopting land use-specific nutrient management practices for sustainable agricultural production.

Keywords: Soil macronutrients, land use systems, Mahabubnagar, Telangana

1. Introduction

The productivity and long-term sustainability of cropping systems largely depend on soil fertility, which is strongly influenced by land use and management practices. Changes in land use, such as conversion of natural vegetation to cultivated land, intensive cropping, residue removal and continuous tillage, can significantly modify soil physical, chemical and biological properties, resulting in variations in soil nutrient availability and overall soil quality (Lal, 2004) [8]. Nitrogen (N), phosphorus (P) and potassium (K) are the primary macronutrients required for optimum crop growth and development. Nitrogen is an essential constituent of amino acids, proteins, nucleic acids and chlorophyll, and its availability is governed by biological processes such as mineralisation, immobilisation, nitrification and denitrification (Brady and Weil, 2017; Robertson, G.P. and Groffman, P.M., 2015) [1, 16]. Phosphorus plays a crucial role in energy transfer, root growth and reproductive development, but its availability is often limited because of fixation reactions in soil (Hinsinger, 2001) [14]. Potassium is involved in enzyme activation, photosynthesis, osmotic regulation and stress tolerance, and its availability gradually declines under intensive cultivation due to continuous nutrient removal and inadequate replenishment (Zörb *et al.*, 2014; Das *et al.*, 2019) [23, 2]. Differences in vegetation cover and management practices among land use systems substantially influence soil macronutrient status. Forest ecosystems generally retain higher nutrient availability, while cultivated lands are more prone to nutrient depletion due to continuous cropping and biomass removal (Liu *et al.*, 2010) [10]. Similar observations have been reported from Telangana, where land use systems significantly influenced the availability of nitrogen, phosphorus and potassium, emphasizing the need for location-specific nutrient management strategies (Poojitha *et al.*, 2024; Kiran Reddy and Goverdhan, 2012) [14, 17]. The present investigation was undertaken to evaluate the influence of different land use systems on the soil macronutrient status, with particular emphasis on the availability of nitrogen, phosphorus and potassium, in the soils of Mahabubnagar district,

Telangana. The findings of this study will contribute to a better understanding of nutrient dynamics and provide scientific information for developing land use-specific nutrient management strategies to sustain soil fertility and agricultural productivity.

2. Materials and Methods

The study was conducted during 2025 under 7 major land use systems (*i.e.*, rice-rice, maize-groundnut, groundnut-fallow, cotton-fallow, mango, fodder and forest, in Mahabubnagar district, Telangana which lies between 15°55' and 17°29' N latitude and 77°15'-79°15' E longitude and experiences a semi-arid climate with an average annual rainfall of 729 mm. The mean maximum and minimum temperatures are 40.9°C and 25.0°C, respectively, while the annual maximum and minimum relative humidity ranges from 75-82% and 45-47%. A total of 140 soil samples were collected from 70 representative sites (10 from each land use system) at two depths (0-15 and 15-30 cm). The GPS coordinates of each sampling location were recorded. Soil samples were shade-dried, gently crushed, passed through a 2-mm sieve and stored for laboratory analysis.

Available nitrogen, phosphorus and potassium were determined using standard analytical procedures. Available nitrogen was estimated by the alkaline potassium permanganate method (Subbiah and Asija, 1956) ^[21]. Available phosphorus was extracted with 0.5 M sodium bicarbonate (Olsen's reagent) following Olsen *et al.* (1954) ^[13], and its concentration was determined by the ascorbic acid blue colour method using a spectrophotometer at 660 nm. Available potassium was extracted with 1 N neutral ammonium acetate and measured using a flame photometer as described by Jackson (1973) ^[5]. The nutrient contents were expressed in kg ha⁻¹. The data were

analysed using two-way analysis of variance (ANOVA) following Snedecor and Cochran (1967) ^[20] at the 5% level of significance, considering land use systems and soil depths as the main factors along with their interaction.

3. Results and Discussion

3.1 Available nitrogen

Available nitrogen under different land use systems ranged from 212.4 to 312.6 kg ha⁻¹ at 0–15 cm and 180.3 to 288.5 kg ha⁻¹ at 15–30 cm depth (Table 1 and Figure 1). The highest mean available nitrogen (300.5 kg ha⁻¹) was recorded under the forest land use system, whereas the lowest value (196.3 kg ha⁻¹) was observed under cotton–fallow. Available nitrogen decreased with increasing soil depth across all land use systems, and the interaction between land use systems and soil depths was non-significant. Across all land use systems, available nitrogen decreased with increasing soil depth, likely due to the higher organic matter content, greater root activity, and enhanced microbial processes in the surface soil compared to the subsoil (Ajeet Kumar *et al.*, 2025; Maqbool *et al.*, 2017) ^[7, 11]. The higher nitrogen status in forest soils may be attributed to continuous litter deposition, greater organic matter accumulation and enhanced microbial mineralisation, whereas intensive cultivation, repeated crop removal and lower organic residue inputs under cultivated lands contributed to nitrogen depletion (Liu *et al.*, 2010) ^[10]. Similar trends of higher available nitrogen under forest and perennial vegetation, together with a decline in nitrogen with soil depth, have been reported in Telangana by Ramprasad *et al.* (2014) ^[15], Gade KR *et al.* (2021) ^[18] and Devi Shravani *et al.* (2025) ^[19]. These findings indicate that land use systems play a significant role in regulating soil nitrogen dynamics and maintaining soil fertility.

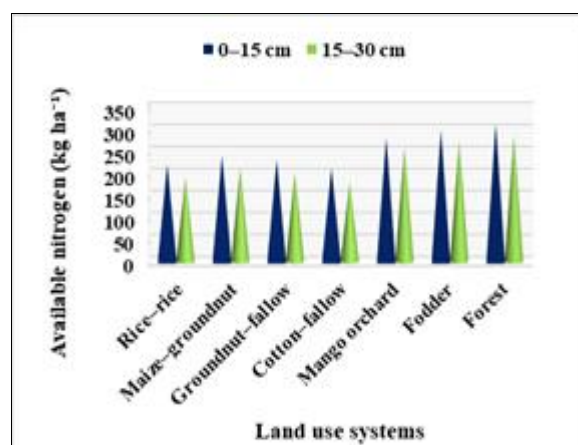


Fig 1: Available nitrogen (kg ha⁻¹) in soil under different land use systems

3.2 Available phosphorus

Available phosphorus under different land use systems ranged from 35.93 to 54.05 kg ha⁻¹ at 0–15 cm and 32.65 to 51.6 kg ha⁻¹ at 15–30 cm depth (Table 2 and Figure 2). The highest mean available phosphorus (52.83 kg ha⁻¹) was recorded under the forest land use system, whereas the lowest value (34.29 kg ha⁻¹) was observed under cotton–fallow. Available phosphorus declined with increasing soil depth and a significant interaction between land use systems and soil depths was observed. Hinsinger, P. (2001) ^[4] observed that available phosphorus was concentrated in surface soils because plant residues and microbial activity predominantly occur in the upper soil horizons. Negassa and Leinweber (2009) ^[12] concluded that

long-term cultivation without adequate phosphorus replenishment gradually depletes available phosphorus through continuous crop removal and transformation into less available phosphorus fractions. Likewise, under Telangana conditions, Poojitha *et al.* (2024) ^[14] reported that contrasting land use systems significantly altered available phosphorus status, with natural vegetation maintaining comparatively higher phosphorus than cultivated fields. Similarly, Reddy *et al.* (2021) ^[6] observed a decline in available phosphorus with increasing soil depth in Telangana soils, attributing it to phosphorus fixation and lower organic matter in subsurface horizons. These findings confirm that land use and soil depth jointly influence phosphorus availability and overall soil fertility.

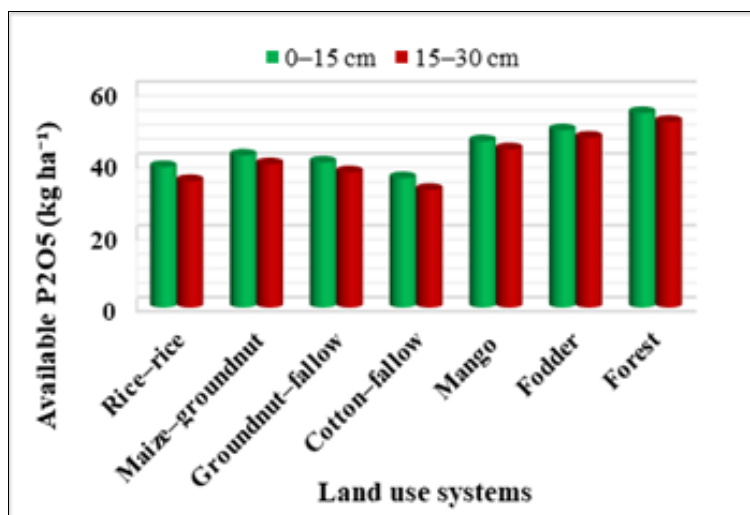


Fig 2: Available phosphorus (kg ha^{-1}) in soil under different land use systems

Table 1: Effect of different land use systems on available N (kg ha^{-1}) in soil at different depths

Land use system	Depth	1	2	3	4	5	6	7	8	9	10	Average
Rice-rice	0-15 cm	203.2	280.3	211.5	195.4	280.1	207.6	214.3	200.8	213.9	205.7	221.3
	15-30 cm	190.2	235.0	189.8	153.0	234.0	190.5	188.7	152.9	195.0	185.3	191.4
Maize-groundnut	0-15 cm	237.3	230.6	223.4	280.7	234.5	226.2	280.6	232.8	235.9	221.3	240.3
	15-30 cm	212.5	213.2	187.5	240.0	211.8	214.0	239.0	210.3	214.1	187.3	213.0
Groundnut-fallow	0-15 cm	224.4	218.2	280.5	213.6	222.8	227.3	216.5	221.7	280.1	210.9	231.6
	15-30 cm	210.3	209.8	230.0	154.8	211.0	208.9	210.7	208.4	229.0	154.6	202.8
Cotton-fallow	0-15 cm	197.4	190.3	280.6	194.2	200.9	188.8	280.1	196.5	192.4	202.3	212.4
	15-30 cm	182.2	126.6	230.0	181.5	182.9	126.4	229.0	180.8	183.1	180.5	180.3
Mango orchard	0-15 cm	283.6	274.4	348.6	277.7	286.5	212.4	281.9	289.1	275.3	284.8	281.4
	15-30 cm	282.9	166.0	291.0	276.4	285.3	165.8	281.5	288.9	275.0	284.7	259.8
Fodder	0-15 cm	301.0	292.2	304.3	297.7	294.9	358.6	237.4	302.8	296.1	299.7	298.5
	15-30 cm	299.8	185.2	299.9	297.6	294.5	300.2	184.9	299.9	296.0	298.2	275.6
Forest	0-15 cm	314.8	307.2	320.0	311.3	275.7	317.9	308.7	350.3	306.1	313.9	312.6
	15-30 cm	299.5	298.3	319.1	299.0	226.0	299.2	298.6	319.9	226.4	298.8	288.5

	SEm $\pm$	CD (5%)
LUS	7.201	20.177
Depth	3.849	10.785
LUS $\times$ Depth	10.183	NS

Table 2: Effect of different land use systems on available P (kg ha^{-1}) in soil at different depths

Land use systems	Depth	1	2	3	4	5	6	7	8	9	10	Average
Rice-rice	0-15 cm	39.0	38.4	45.9	32.5	39.2	45.8	38.6	39.4	32.6	38.8	39.0
	15-30 cm	35.2	34.5	38.3	32.0	35.4	39.2	34.8	35.9	31.1	35.0	35.1
Maize-groundnut	0-15 cm	42.1	39.6	44.9	42.7	41.8	45.0	39.5	42.4	42.7	41.5	42.2
	15-30 cm	39.6	37.1	43.8	40.0	39.4	42.9	36.0	39.8	40.3	39.2	39.8
Groundnut-fallow	0-15 cm	42.8	40.0	40.6	37.0	41.2	40.4	42.9	37.1	40.8	40.2	40.3
	15-30 cm	40.5	37.2	37.8	33.0	38.3	37.6	41.6	34.2	38.0	37.4	37.6
Cotton-fallow	0-15 cm	36.3	34.1	38.5	35.6	35.2	38.4	34.0	36.0	35.4	35.8	35.9
	15-30 cm	33.3	30.2	35.5	32.9	32.5	34.3	29.1	33.1	32.7	33.0	32.7
Mango orchard	0-15 cm	47.1	40.6	49.0	46.7	40.5	48.1	49.1	46.5	46.9	47.3	46.2
	15-30 cm	43.9	40.1	48.5	43.7	38.0	44.7	48.6	43.5	43.8	45.0	44.0
Fodder	0-15 cm	50.4	42.5	51.7	50.0	52.0	50.8	42.6	51.9	50.2	50.6	49.3
	15-30 cm	47.4	41.0	48.1	47.0	51.4	47.8	42.2	51.4	47.2	48.5	47.2
Forest	0-15 cm	54.7	57.5	47.6	55.3	47.5	55.1	57.6	54.5	55.8	54.9	54.1
	15-30 cm	51	57.0	47.1	52.6	45.1	52.1	57.3	49.4	52.7	51.8	51.6

	SEm $\pm$	CD (5%)
LUS	0.659	1.848
Depth	0.352	0.988
LUS $\times$ Depth	0.932	NS

Table 3: Effect of different land use systems on available K (kg ha⁻¹) in soil at different depths

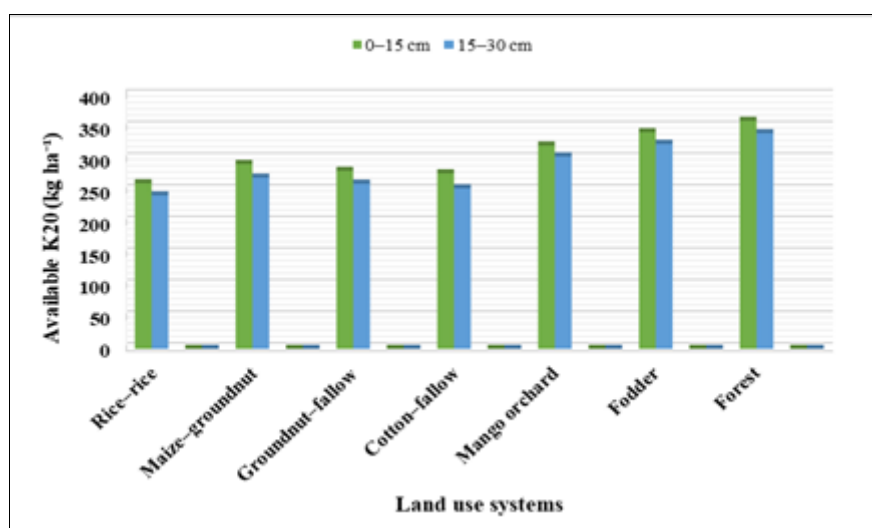
Land use systems	Depth	1	2	3	4	5	6	7	8	9	10	Average
Rice–rice	0–15 cm	322.9	320.2	269.4	266.8	264.7	264.2	261.5	258.3	197.5	195.0	262.1
	15–30 cm	300.9	298.0	248.0	246.6	246.3	244.8	242.5	239.1	182.3	180.2	242.9
Maize–groundnut	0–15 cm	344.5	342.0	291.3	289.9	289.6	287.8	285.2	282.7	257.1	255.0	292.5
	15–30 cm	312.8	309.5	274.1	272.5	272.0	270.7	268.3	265.5	232.2	230.4	270.8
Groundnut–fallow	0–15 cm	326.9	324.0	285.1	282.8	281.6	280.5	278.4	274.7	242.3	240.0	281.6
	15–30 cm	308.7	306.0	267.4	265.3	262.5	262.7	260.2	257.1	212.5	210.3	261.3
Cotton–fallow	0–15 cm	332.8	330.0	287.3	284.9	284.6	281.7	278.2	275.5	212.6	210.1	277.8
	15–30 cm	318.2	315.1	258.4	257.1	255.7	253.2	250.5	248.3	192.3	189.8	253.9
Mango orchard	0–15 cm	346.0	343.5	324.6	323.5	322.1	320.8	318.5	315.3	302.0	300.0	321.6
	15–30 cm	341.9	339.3	310.4	308.2	307.6	306.7	304.5	301.2	262.5	260.5	304.3
Fodder	0–15 cm	373.0	370.0	346.7	344.4	342.6	342.1	339.7	336.5	317.5	315.0	342.8
	15–30 cm	365.6	362.0	329.1	328.8	327.3	325.0	322.8	319.3	282.7	280.0	324.3
Forest	0–15 cm	399.0	396.0	366.5	364.0	363.2	361.8	358.6	355.2	322.5	320.0	360.7
	15–30 cm	384.0	381.0	346.3	344.0	343.4	342.7	340.2	336.5	297.6	295.1	341.1

	SEm ±	CD (5%)
LUS	6.996	19.603
Depth	3.739	10.478
LUS × Depth	9.894	NS

3.3 Available potassium

Available potassium content under different land use systems ranged from 262.05 to 360.68 kg ha⁻¹ at 0–15 cm and 242.87 to 341.08 kg ha⁻¹ at 15–30 cm depth (Table 3 and Figure 3). The highest mean available potassium (350.88 kg ha⁻¹) was recorded under the forest land use system, whereas the lowest value (252.46 kg ha⁻¹) was observed under the rice–rice system. Available potassium decreased with increasing soil depth across all land use systems, while the interaction between land use systems and soil depth was non-significant. Wakeel and Ishfaq (2022) [22] reported that continuous return of plant residues enhances potassium recycling and helps maintain available potassium under perennial vegetation and minimally disturbed

ecosystems. In contrast, intensive cultivation and continuous nutrient removal under agricultural systems may have reduced the available potassium content due to inadequate replenishment (Das *et al.*, 2022) [3]. Similar findings were reported by Poojitha *et al.* (2024) in Telangana, where forest soils maintained higher available potassium than cultivated lands. Lalitha and Dhakshinamoorthy (2019) [9] further explained that higher potassium availability in surface soils is maintained through the equilibrium among different soil potassium fractions and continuous residue recycling. These findings demonstrate that both land use and soil depth play an important role in governing potassium availability and overall soil fertility.

**Fig 3:** Available potassium (kg ha⁻¹) in soil under different land use systems

4. Conclusion

The present study confirmed that land use systems are a major determinant of soil macronutrient status in Mahabubnagar district, Telangana. Forest ecosystems maintained superior nitrogen, phosphorus and potassium availability, whereas cultivated lands showed comparatively lower nutrient status, with all macronutrients decreasing with soil depth. These findings underscore the need for land use-specific nutrient management and conservation practices to sustain soil health and agricultural productivity.

References

1. Brady NC, Weil RR. The nature and properties of soils. 15th ed. Harlow (UK): Pearson Education Limited; 2017.
2. Das A, Biswas DR, Das D, Sharma VK, Das R, Ray P, *et al.* Assessment of potassium status in soils under different land use systems of Assam. Indian J Agric Sci. 2019;89:1077-1081.
3. Das A, Srinivasarao C, Ravisankar N, Babu MVS, Venkateswarlu B, *et al.* Ongoing soil potassium depletion under intensive cropping in India and probable mitigation

- strategies. *Agron Sustain Dev.* 2022;42:14.
4. Hinsinger P. Bioavailability of soil inorganic phosphorus in the rhizosphere as affected by root-induced chemical changes: A review. *Plant Soil.* 2001;237:173-195.
 5. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; 1973.
 6. Kiran Reddy G, Sharma SHK, Jayasree G, Hussain SA, Triveni S, Neelima TL. Assessment of spatial variability of soil fertility status of Nagarjuna Sagar Left Bank Command area in Nalgonda district, Telangana using GIS-GPS. *The Pharma Innovation Journal.* 2021;10(7):481-489.
 7. Kumar A, Bairwa M, Meena SK, Singh SK, Sinha SK, Rana L, *et al.* Comparative analysis of macronutrient, soil sulphur availability and micronutrient dynamics across diverse land use types of Indo-Gangetic plains of India. *AATCC Review.* 2025;13(1):467-472.
 8. Lal R. Soil carbon sequestration impacts on global climate change and food security. *Science.* 2004;304:1623-1627.
 9. Lalitha M, Dhakshinamoorthy M. Forms of soil potassium: A review. *Agricultural Reviews.* 2014;35(1).
 10. Liu XL, He YQ, Zhang HL, Schroder JK, Li CL, Zhou J, *et al.* Impact of land use and soil fertility on distributions of soil aggregate fractions and nutrients. *Pedosphere.* 2010;20(5):666-673.
 11. Maqbool M, Rehman NZ, Rasool R, Akhtar F. Available macronutrient status of soils under different land use systems of Ganderbal district, Jammu and Kashmir. *J Indian Soc Soil Sci.* 2017;65(3):263-270.
 12. Negassa W, Leinweber P. How does the Hedley sequential phosphorus fractionation reflect impacts of land use and management on soil phosphorus: A review. *J Plant Nutr Soil Sci.* 2009;172(3):305-325.
 13. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular No. 939. Washington (DC): United States Department of Agriculture; 1954.
 14. Poojitha K, Reddy GK, Ramprasad M, *et al.* Impact of land use systems on soil phosphorus and potassium in Khammam district, Telangana State. *Int J Plant Soil Sci.* 2024;36(5):1-12.
 15. Ramprasad M, Govardhan V, Reddy GK. Characterization and classification of rice growing soils of Southern Telangana region of Andhra Pradesh. *Green Farming.* 2013;4(3):276-281.
 16. Robertson GP, Groffman PM. Nitrogen transformations. In: Paul EA, editor. *Soil microbiology, ecology and biochemistry.* 4th ed. Amsterdam: Elsevier; 2015. p. 421-446.
 17. Reddy GK, Goverdhan V. Characterization and classification of soil and land resource environs of Nagarjuna Sagar Left Bank Command areas of Nalgonda district.
 18. Reddy GK, Sharma SHK, Jayasree G, Hussain SA, Triveni S, Neelima TL. Soil fertility mapping of Patancheru area, Sanga Reddy district Telangana by using GPS-GIS.
 19. Shravani PD, Reddy GK, Ramprasad M, Reddy KI. Assessment of physico-chemical and chemical properties of soils under turmeric growing sites of Nizamabad District, Telangana.
 20. Snedecor GW, Cochran WG. *Statistical methods.* 6th ed. New Delhi: Oxford and IBH Publishing Co.; 1967.
 21. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. *Current Science.* 1956;25:259-260.
 22. Wakeel A, Ishfaq M. Potash use and dynamics in agriculture. 2022.
 23. Zörb C, Senbayram M, Peiter E. Potassium in agriculture: Status and perspectives. *J Plant Physiol.* 2014;171:656-669.