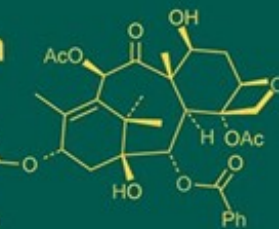
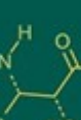
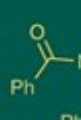
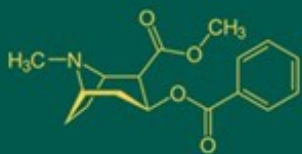


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Varietal response, integrated fertility management and in-situ moisture conservation effects on post-harvest soil fertility and physicochemical properties of rainfed pearl millet

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ABSTRACT

A two-year field experiment was conducted during the kharif seasons of 2024 and 2025 at the Soil Conservation and Water Management Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, to evaluate how pearl millet variety, integrated fertility management and in-situ moisture-conservation practices influence residual soil fertility and selected physico-chemical properties. Two varieties, TMBH 2652 and KH 302, three fertility levels and four moisture-conservation practices were evaluated in a factorial split-plot design with three replications. Post-harvest soils were analysed for available N, P and K, pH, electrical conductivity (EC), bulk density and organic carbon. Variety significantly influenced pooled available P and K: KH 302 recorded 24.97 kg P ha⁻¹ and 137.10 kg K ha⁻¹ compared with 24.00 and 133.36 kg ha⁻¹, respectively, under TMBH 2652, whereas available N did not differ significantly between varieties. Integrated fertility management produced a stronger residual nutrient response. Pooled available N increased from 202.31 kg ha⁻¹ under 100% RDF to 208.86 and 209.07 kg ha⁻¹ with RDF + FYM at 2.5 and 5 t ha⁻¹, respectively, while pooled available P increased from 22.32 to 25.03 and 26.10 kg ha⁻¹. Ridge and furrow combined with vegetative mulch recorded the highest pooled available P (26.41 kg ha⁻¹). Soil pH, EC, bulk density and organic carbon varied only within narrow ranges over the two seasons. The findings show that varietal choice, integrated fertility management and moisture conservation jointly shape the residual soil nutrient environment under rainfed pearl millet.

Keywords: Pearl Millet, Variety, Integrated Nutrient Management, FYM, Residual Soil Fertility, Available Nutrients, Bulk Density, Organic Carbon

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a climate-resilient cereal adapted to arid and semi-arid environments and remains important for food, fodder and livelihood security in rainfed regions. Its extensive root system and drought-adaptive physiology permit production under low and erratic rainfall, but poor soil fertility and progressive degradation of soil quality can still restrict sustained productivity. Maintaining nutrient reserves after harvest is therefore important both for pearl millet and for the productivity of subsequent crops in rainfed rotations (Satyavathi *et al.*, 2021; Shrestha *et al.*, 2023; Yadav *et al.*, 2023; Kumar *et al.*, 2023) [2, 3, 4, 1].

Variety is an important biological component of soil-plant nutrient relations. Pearl millet varieties may differ in root distribution, nutrient demand, biomass production and the amount of nutrients removed from the field. Consequently, two varieties grown under the same fertility and moisture regime may leave different quantities of plant-available nutrients in the soil after harvest (Singh *et al.*, 2023) [5]. Assessing varietal influence on residual soil fertility therefore complements conventional comparisons based only on crop yield. Increasing climatic variability and irregular rainfall patterns further complicate nutrient and soil-moisture management in rainfed farming systems, particularly in vulnerable production regions (Verma *et al.*, 2026) [6].

Rainfed soils commonly experience alternating wetting and drying cycles, low organic-matter inputs and limited nutrient-use efficiency. Under such conditions, repeated reliance on mineral fertilizer alone may not adequately address longer-term fertility constraints. Integration of organic sources such as farmyard manure (FYM) with recommended fertilizer doses can provide nutrients directly, improve nutrient buffering and support biological processes responsible for nutrient mineralization and retention. Residual benefits of FYM and mineral fertilizer on soil fertility and productivity have been reported in pearl millet (Kumawat *et al.*,

2018) [7], while more recent work has demonstrated improved post-harvest nutrient status under enhanced nutrient management (Guru *et al.*, 2024) [8].

Moisture-conservation practices can further modify the soil environment in which nutrient transformations occur. Ridge and furrow configurations can improve infiltration and reduce runoff, whereas vegetative mulch can reduce direct soil-water loss, moderate surface temperature and add organic residues during decomposition. These changes may influence nutrient mobility, root activity and the persistence of plant-available nutrient pools. In rainfed pearl millet, mulching and organic nutrient sources have been associated with improvement in soil properties (Meena *et al.*, 2017) [9], and long-term moisture-conservation and nutrient-management practices have improved soil-health indicators and resource-use efficiency in pearl millet-based systems (Meena *et al.*, 2025) [10].

Changes in soil pH, electrical conductivity, bulk density and organic carbon are generally slower than seasonal changes in available N, P and K. Nevertheless, these variables help determine whether management practices are altering the physical and chemical environment of the soil. Short-term stability of pH and EC together with maintenance or improvement of bulk density and organic carbon can be agronomically important because it indicates that nutrient management is not creating adverse soil reaction or salinity effects.

The present study was therefore undertaken to evaluate the individual influence of pearl millet variety, fertility level and in-situ moisture-conservation practice on post-harvest available N, P and K and selected soil physicochemical properties under rainfed conditions.

Materials and Methods

Experimental site and initial soil properties

The field experiment was conducted during the kharif seasons of 2024 and 2025 at the Soil Conservation and Water Management Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India. The experimental soil was sandy loam, containing 59.2% sand, 20.8% silt and 19.8% clay. Before experimentation, the soil had pH 7.3, EC 0.36 dS m⁻¹, bulk density 1.34 Mg m⁻³, field capacity 18.6%, organic carbon 0.32%, available N 179.21 kg ha⁻¹, available P 17.87 kg ha⁻¹ and available K 131.34 kg ha⁻¹.

Experimental design and treatment factors

The experiment comprised three factors: two pearl millet varieties, three fertility levels and four moisture-conservation practices, giving 24 treatment combinations. Treatments were evaluated with three replications in a factorial split-plot design. The factorial combinations of variety and fertility level constituted the main-plot treatment structure, while moisture-conservation practices were randomized to subplots within each main plot. Thus, six variety × fertility combinations formed the main plots in each replication, and each main plot was divided into four subplots.

The varieties were TMBH 2652 (V₁) and KH 302 (V₂). Fertility treatments were 100% recommended dose of fertilizer [RDF: 60 kg N, 40 kg P₂O₅ and 40 kg K₂O ha⁻¹ (F₁)], 100% RDF + FYM at 2.5 t ha⁻¹ (F₂), and 100% RDF + FYM at 5 t ha⁻¹ (F₃). Moisture-conservation practices were conventional line sowing (M₁, control), ridge and furrow at 30 days after sowing (DAS; M₂), vegetative mulch at 4 t ha⁻¹ at 30 DAS (M₃), and ridge and furrow at 30 DAS combined with vegetative mulch at 4 t ha⁻¹ at 30 DAS (M₄).

Post-harvest soil sampling and analysis

Post-harvest soil samples were analysed for soil fertility and physicochemical parameters. Bulk density was determined by the core-ring method following Blake (1965) [11]. Soil pH was measured in a 1:2.5 soil:water suspension using a glass-electrode pH meter, and EC was measured with a conductivity meter following Jackson (1973) [12]. Organic carbon was determined by the Walkley *et al.* (1934) [13] wet-oxidation method. Available N was estimated by the alkaline KMnO₄ method of Subbiah *et al.* (1956) [14], available P by the Olsen *et al.* (1954) [15] sodium bicarbonate extraction method, and available K by neutral ammonium acetate extraction followed by flame photometry.

Statistical analysis

Available N, P and K were interpreted using the year-wise and pooled standard errors and critical differences reported for the experiment, with comparisons made at *P* = 0.05. The effects of variety, fertility level and moisture-conservation practice were interpreted separately from the relevant treatment means and CD values. The supplied physicochemical-property table did not report SE or CD values for pH, EC, bulk density or organic carbon; consequently, these variables are presented descriptively and no statistical significance is assigned to their numerical differences.

Results

Varietal influence on residual soil fertility

Variety influenced the residual nutrient status of the soil, particularly for pooled available P and K. Available N did not differ significantly between TMBH 2652 and KH 302 in either year or in the pooled analysis. In contrast, KH 302 recorded greater pooled available P (24.97 kg ha⁻¹) than TMBH 2652 (24.00 kg ha⁻¹); the difference exceeded the pooled CD of 0.62 kg ha⁻¹. Pooled available K was also greater under KH 302 (137.10 kg ha⁻¹) than under TMBH 2652 (133.36 kg ha⁻¹), with a pooled CD of 3.20 kg ha⁻¹. Thus, the two varieties differed in the amount of residual P and K remaining after crop harvest.

Influence of fertility management on residual N, P and K

Fertility management produced the strongest residual response for available N and P. Pooled available N increased from 202.31 kg ha⁻¹ under 100% RDF to 208.86 and 209.07 kg ha⁻¹ under 100% RDF + FYM at 2.5 and 5 t ha⁻¹, respectively. With a pooled CD of 5.93 kg ha⁻¹, both FYM-supplemented treatments were superior to RDF alone, whereas the two FYM rates were statistically similar. Available P increased successively from 22.32 kg ha⁻¹ under F₁ to 25.03 kg ha⁻¹ under F₂ and 26.10 kg ha⁻¹ under F₃. The pooled CD for P was 0.75 kg ha⁻¹, indicating significant separation among all three fertility levels. Available K increased numerically with FYM addition, but the pooled fertility effect remained non-significant.

Influence of moisture-conservation practice on residual N, P and K

Moisture-conservation practice significantly influenced pooled available P but not pooled available N or K. Conventional line sowing recorded 22.30 kg P ha⁻¹, compared with 24.10, 25.11 and 26.41 kg ha⁻¹ under ridge and furrow, vegetative mulch, and ridge and furrow + vegetative mulch, respectively. With a pooled CD of 0.642 kg ha⁻¹, the four moisture-conservation means were distinctly separated. Available N and K followed increasing numerical trends from conventional line sowing toward the combined ridge-and-furrow + mulch treatment, although the differences were non-significant.

Table 1. Post-harvest available N, P and K as influenced by variety, fertility level and moisture-conservation practice

Treatment	N			P			K		
	2024	2025	Pooled	2024	2025	Pooled	2024	2025	Pooled
Variety									
V ₁	201.83	209.94	205.11	23.34	24.65	24	132.14	135.22	133.36
V ₂	202.93	212.28	208.39	24.09	25.85	24.97	134.05	137.09	137.1
SE(d)	7.856	16.82	2.175	1.851	1.69	0.27	8.46	8.47	1.44
CD (P = 0.05)	NS	NS	NS	NS	NS	0.62	NS	NS	3.2
Fertility level									
F ₁	192.98	200.92	202.31	21.61	23.03	22.32	129.63	132.56	133.32
F ₂	205.67	215.21	208.86	24.22	25.84	25.03	133.2	136.72	135.63
F ₃	208.49	217.21	209.07	25.32	26.88	26.1	136.46	139.19	136.75
SE(d)	9.622	20.6	2.664	2.26	2.07	0.341	10.36	10.37	1.76
CD (P = 0.05)	NS	NS	5.93	NS	NS	0.75	NS	NS	NS
Moisture-conservation practice									
M ₁	199.83	208.24	206.02	21.54	23.06	22.3	131.53	133.71	133.25
M ₂	201.934	210.42	206.22	23.34	24.86	24.1	132.7	135.49	133.25
M ₃	202.727	211.94	206.89	24.37	25.85	25.11	133.92	136.7	135.82
M ₄	205.04	213.85	207.85	25.6	27.23	26.41	134.24	138.71	137
SE(d)	13.05	23.73	2.71	2.508	2.37	0.31	11.91	11.92	1.777
CD (P = 0.05)	NS	NS	NS	NS	NS	0.642	NS	NS	NS

Varietal and management trends in soil pH and electrical conductivity

Soil pH and EC varied within narrow ranges among varieties and management treatments. TMBH 2652 recorded pH values of 7.49 in both seasons, while KH 302 recorded 7.47 and 7.46. Corresponding

EC values were 0.27 and 0.26 dS m⁻¹ under TMBH 2652 and 0.28 and 0.27 dS m⁻¹ under KH 302. Across fertility levels and moisture-conservation practices, pH remained between 7.45 and 7.51 and EC between 0.25 and 0.29 dS m⁻¹. Because the source table did not provide SE or CD values for these variables, the numerical differences are described without assigning statistical significance.

Table 2. Soil pH and electrical conductivity after pearl millet as influenced by variety, fertility level and moisture-conservation practice

Treatment	pH	pH	EC (dS m ⁻¹)	EC (dS m ⁻¹)
	2024	2025	2024	2025
Variety				
V ₁	7.49	7.49	0.27	0.26
V ₂	7.47	7.46	0.28	0.27
Fertility level				
F ₁	7.50	7.50	0.29	0.27
F ₂	7.49	7.48	0.28	0.28
F ₃	7.47	7.48	0.27	0.25
Moisture-conservation practice				
M ₁	7.50	7.51	0.29	0.28
M ₂	7.49	7.48	0.28	0.27
M ₃	7.47	7.48	0.27	0.28
M ₄	7.45	7.46	0.26	0.25

Varietal and management trends in bulk density and organic carbon

Varietal means for bulk density were 1.27 Mg m⁻³ for TMBH 2652 and 1.29 Mg m⁻³ for KH 302 in both seasons, while organic carbon was 0.35 and 0.34%, respectively. Across fertility treatments, bulk

density declined numerically from 1.29 Mg m⁻³ under 100% RDF to 1.26 Mg m⁻³ under 100% RDF + FYM at 5 t ha⁻¹. Among moisture-conservation practices, the combined ridge-and-furrow + mulch treatment recorded the lowest year-wise bulk density (1.25 Mg m⁻³). Organic carbon remained between 0.34 and 0.35% across all treatment means.

Table 3. Bulk density and organic carbon after pearl millet as influenced by variety, fertility level and moisture-conservation practice

Treatment	Bulk density (Mg m ⁻³)		Organic carbon (%)	
	2024	2025	2024	2025
Variety				
V ₁	1.27	1.27	0.35	0.35
V ₂	1.29	1.29	0.34	0.34
Fertility level				
F ₁	1.29	1.29	0.35	0.35
F ₂	1.27	1.27	0.34	0.34
F ₃	1.26	1.26	0.35	0.35
Moisture-conservation practice				
M ₁	1.29	1.29	0.35	0.35
M ₂	1.28	1.28	0.34	0.34
M ₃	1.26	1.26	0.35	0.35
M ₄	1.25	1.25	0.34	0.34

Discussion

Varietal influence on residual nutrient status

The significant pooled differences in available P and K demonstrate that variety was not merely a crop-production factor but also influenced the post-harvest soil nutrient environment. KH 302 left greater pooled available P and K than TMBH 2652, whereas residual N remained statistically similar between the two varieties. Varietal differences in root distribution, nutrient uptake efficiency, biomass formation and nutrient removal can alter the quantity of nutrients remaining in the soil after harvest. Because root traits and nutrient uptake were not measured directly in this experiment, these mechanisms should be treated as plausible explanations rather than confirmed causes. The result nevertheless supports inclusion of variety alongside fertility and moisture management when interpreting residual soil fertility.

Integrated fertility management and nutrient carry-over

The residual soil-fertility response was most pronounced under integrated fertility management. The pooled available-N data showed that supplementing RDF with FYM maintained a larger post-harvest N pool than RDF alone. The similarity between the two FYM rates for pooled N indicates that the lower manure rate was already sufficient to create a measurable residual-N advantage under the conditions of this study. FYM can contribute through direct nutrient addition, gradual mineralization and improved retention of mineral N. Residual benefits of FYM and fertilizer integration have previously been reported in pearl millet by Kumawat *et al.* (2018) [7], while Guru *et al.* (2024) [8] also reported improved available nutrient status under enhanced nutrient management.

Available P showed an even clearer response. The progressive increase from F₁ to F₂ and F₃ suggests that organic supplementation improved the residual P pool beyond the effect of RDF alone. Organic acids produced during manure decomposition may reduce P fixation and improve desorption of less-available P forms, while FYM also contributes P directly. Comparable improvements in soil fertility through integration of organics and mineral nutrient sources have been reported in rainfed millet systems (Prabhakar *et al.*, 2023) [16].

Moisture-conservation practice and residual fertility

Moisture-conservation practice exerted its clearest effect on pooled available P. Ridge and furrow combined with vegetative mulch recorded the highest value, followed by mulch alone and ridge-and-furrow alone. Although usable soil-moisture measurements were not available for publication, the residual-P pattern is agronomically compatible with a more buffered soil environment under improved land configuration and surface cover. Reduced surface drying, improved infiltration and the gradual decomposition of vegetative residues can favour biological activity and nutrient cycling. Long-term work in

pearl millet-based systems has similarly shown that moisture conservation combined with nutrient management can improve soil-health indicators and resource-use efficiency (Meena *et al.*, 2025) [10].

Physicochemical stability under variety and management treatments

Soil pH and EC remained within narrow ranges under both varieties and across the fertility and moisture-conservation treatments. This stability indicates that none of the treatments produced evidence of short-term soil acidification or salinity build-up. Bulk density showed a consistent numerical decline with increasing FYM and with mulch-based moisture conservation, which is compatible with the effects of organic inputs and surface residues on aggregation, pore continuity and soil packing. Varietal differences in bulk density and organic carbon were small and were not subjected to inferential comparison because the source table did not provide SE or CD values for these variables.

Organic carbon remained between 0.34 and 0.35% across the treatment means. Detectable changes in soil organic carbon commonly require a longer period of repeated organic input than the two-season duration of the experiment. Accordingly, the principal short-term soil response in this study was expressed through the plant-available nutrient pool rather than through large shifts in slowly changing physico-chemical properties.

Conclusion

Variety, integrated fertility management and moisture-conservation practice all contributed to the post-harvest soil response of rainfed pearl millet, although their effects differed among soil variables. KH 302 maintained significantly greater pooled available P and K than TMBH 2652, while available N was similar between varieties. Integrated fertility management had the strongest effect on residual N and P: RDF + FYM at 2.5 and 5 t ha⁻¹ significantly increased pooled available N over RDF alone, and available P increased progressively with FYM level. Ridge and furrow combined with vegetative mulch produced the highest pooled available P among moisture-conservation practices. Soil pH and EC remained stable, while bulk density showed only modest numerical improvement and organic carbon changed little over two seasons. These findings indicate that varietal choice should be considered together with fertility and moisture management when evaluating residual soil fertility in rainfed pearl millet systems.

References

1. Kumar S, Sridhar R, Monika S, Kumar A, Bhayankar, Raghavan M, Tiwari H, Kumar A, Singh S, Yadav R. A comprehensive review on millets: A potential source of energy and nutrients for health. *International Journal of Environment and Climate Change*. 2023;13(9):2531–2538.

2. Satyavathi CT, Ambawat S, Khandelwal V, Srivastava RK. Pearl Millet: A climate-resilient nutraceutical for mitigating hidden hunger and providing nutritional security. *Frontiers in Plant Science*. 2021;12:659938.
3. Shrestha N, Hu H, Shrestha K, Doust AN. Pearl millet response to drought: A review. *Frontiers in Plant Science*. 2023;14:1059574.
4. Yadav R, Singh LB, Patel A, Kumar M, Kumar M, Pandey MK, Yadav S, Kumar S, Singh S. A review on yield gap analysis of millets in India. *International Journal of Plant & Soil Science*. 2023;35(18):1800–1804.
5. Singh S, Yadav RN, Tripathi AK, Kumar M, Kumar M, Yadav S, Kumar D, Kumar S, Yadav R. Current status and promotional strategies of millets: A review. *International Journal of Environment and Climate Change*. 2023;13(9):3088–3095.
6. Verma AP, Gupta BK, Mishra BP, Shukla G, Chandra U, Ojha PK, Mishra D, Patel D, Katiyar D, Yadav R, Verma T, Pathak VK. Knowledge and perception on climatic variability among farming communities: An assessment in Bundelkhand region, India. *Plant Science Today*. 2026;13(Special Issue 2):1–10.
7. Kumawat A, Yadav RS, Pareek NK. Residual effect of FYM and fertilizers on soil fertility, productivity and economics of pearl millet (*Pennisetum glaucum* L.). *Journal of Soil and Water Conservation*. 2018;17(11):102-106.
8. Guru G, Saliha BB, Suresh G, Marimuthu M, Ravichandran V. Evaluation of nutrient levels and growth regulators on growth, productivity and available nutrient status in pearl millet (*Pennisetum glaucum*). *The Indian Journal of Agricultural Sciences*. 2024;94(9):1024-1027.
9. Meena R, Maurya S, Meena R. Productivity, soil properties and economics of rainfed pearl millet as influenced by mulching and organic sources of nutrients. *International Journal of Current Microbiology and Applied Sciences*. 2017;6:566-574.
10. Meena SL, Bana RS, Kaur R, Nirmal R, Singh D, Godara S, *et al*. Long-term moisture conservation and nutrient management improves yield stability and resource use efficiency in pearl millet (*Pennisetum glaucum*)-mustard (*Brassica juncea*) system under rainfed ecosystem. *Frontiers in Sustainable Food Systems*. 2025;9:1597025.
11. Blake GR. Bulk density. In C A Black (Ed.), *Methods of Soil Analysis, Part 1*. American Society of Agronomy, Madison, Wisconsin; 1965.
12. Jackson ML. *Soil Chemical Analysis*. Prentice Hall of India, New Delhi; 1973.
13. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*. 1934;37:29-38.
14. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. *Current Science*. 1956;25:259-260.
15. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *USDA Circular 939*. 1954.
16. Prabhakar M, Gopinath KA, Sai Sravan U, Srasvan Kumar G, Thirupathi M, Samba Siva G, *et al*. Potential for yield and soil fertility improvement with integration of organics in nutrient management for finger millet under rainfed Alfisols of Southern India. *Frontiers in Nutrition*. 2023;10:1095449.
17. Kumar A, Rana KS, Bana RS, Dass A, Meena MC, Kumar S, Shankar K. Response of pearl millet (*Pennisetum glaucum*) to crop residue application and potassium management options under rainfed condition. *The Indian Journal of Agricultural Sciences*. 2024;94(10):1106-1110.
18. Yadav SK, Dudwal BL, Yadav VL, Yadav KC, Yadav JK. Effect of moisture conservation practices and zinc fertilization on nutrient status and quality of pearl millet under rainfed condition. *Indian Journal of Agricultural Research*. 2021;55(5):629-633.

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