

Decoupling soil quality improvement from short-term crop productivity in tropical agroecosystems

Jean Luc Masabo Tuyisenge^{1*}, Georg Guggenberger², Clemens Wollny³, Siegmund Seidel⁴, Uwamariya Natalie⁵

¹Umwelt-Campus Birkenfeld, Trier University of Applied Sciences, Germany | ²Leibniz Universität Hannover, Germany

³Technische Hochschule Bingen, Germany | ⁴University of Koblenz, Germany | ⁵INES-Ruhengeri, Rwanda



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Towards multi-functional agro-ecosystems
promoting climate-resilient futures

1. BACKGROUND



Declining soil organic carbon threatens productivity in tropical agroecosystems.



Organic amendments can improve soil fertility and increase SOC.



Effects vary across sites; short-term responses remain unclear.

2. RESEARCH QUESTION



How do different organic amendments influence soil organic carbon (SOC) and soil fertility dynamics in contrasting agroecosystems?

3. OBJECTIVE

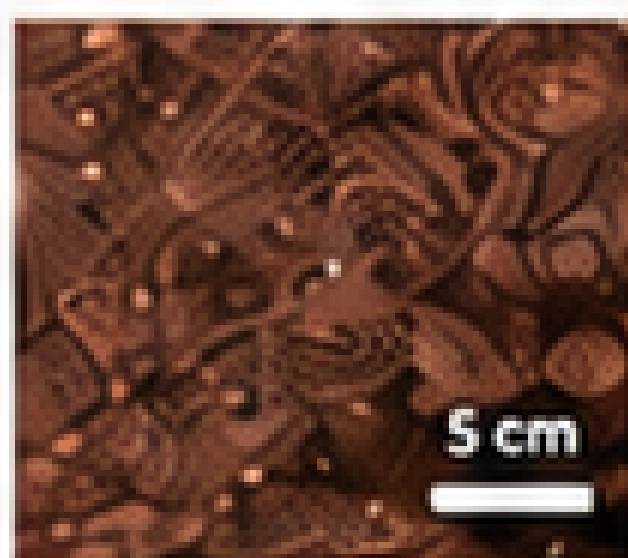


Compare short-term effects of organic amendments on SOC and soil fertility dynamics in contrasting agroecosystems.

4. STUDY DESIGN

Two sites in Rwanda

Highland 1,900 – 2,300 masl
Mid-altitude 1,600 – 1,700 masl



Andosols (volcanic origin)
Ferralsols (highly weathered)

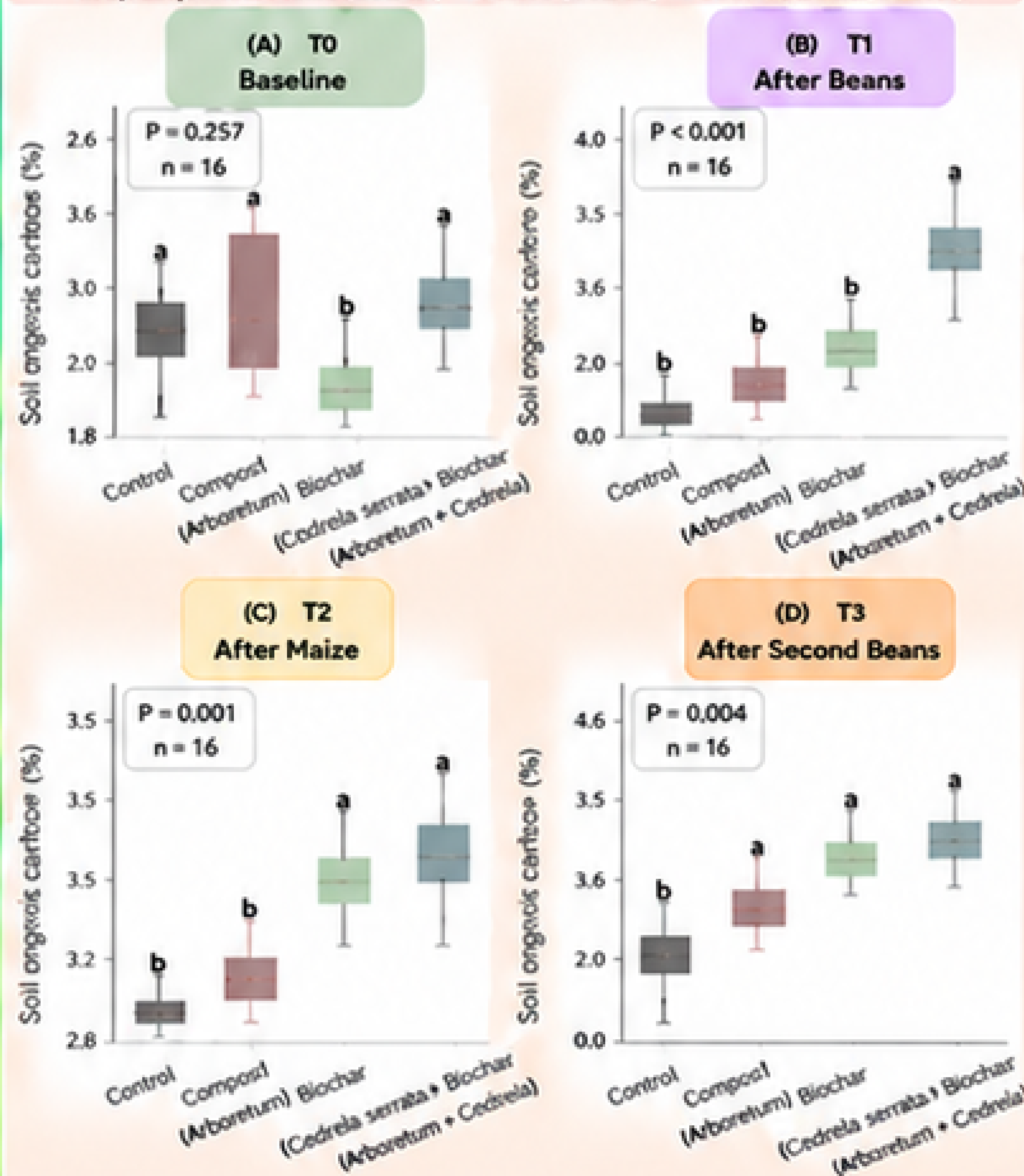
Site characteristics

	Highland	Mid-altitude
Altitude (masl)	1,900 – 2,300	1,600 – 1,700
Soil type	Andosols	Ferralsols
Main cropping system	Potato–Bean–Maize	Maize–Bean–Sweet potato
Sampling	Mar 2023, Sep 2023, Oct 2024, Feb 2025	Mar 2024, Aug 2024, Oct 2024, Feb 2025

5. SOIL ORGANIC CARBON (SOC) RESPONSE

Mid-altitude (Bean–Maize–Second Bean)

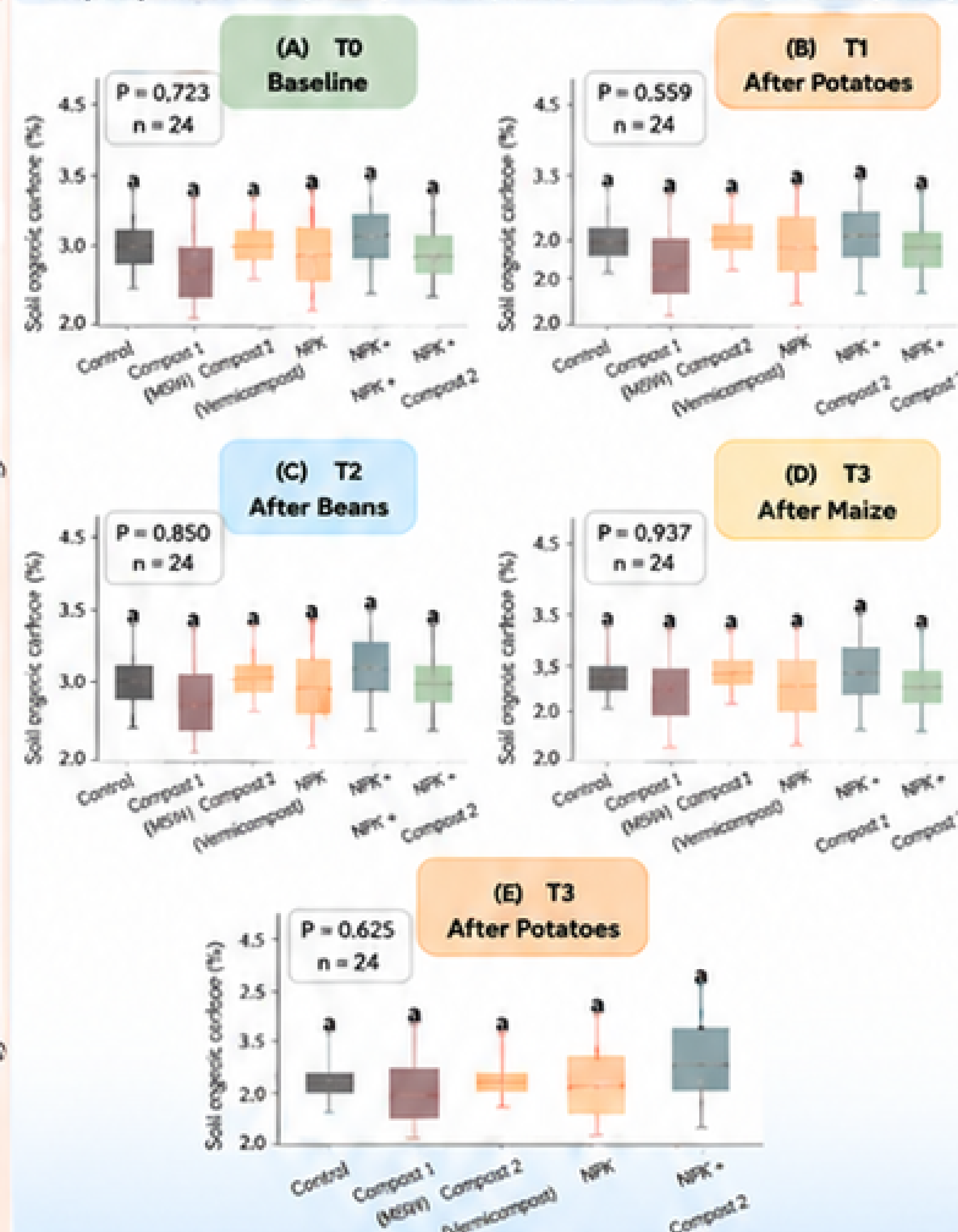
Crop sequence: Maize (2024A) → Maize (2024B) → Second Bean (2025A)



SOC increased significantly after amendment application (T1, T2 and T3), while no significant differences were observed at baseline (T0).

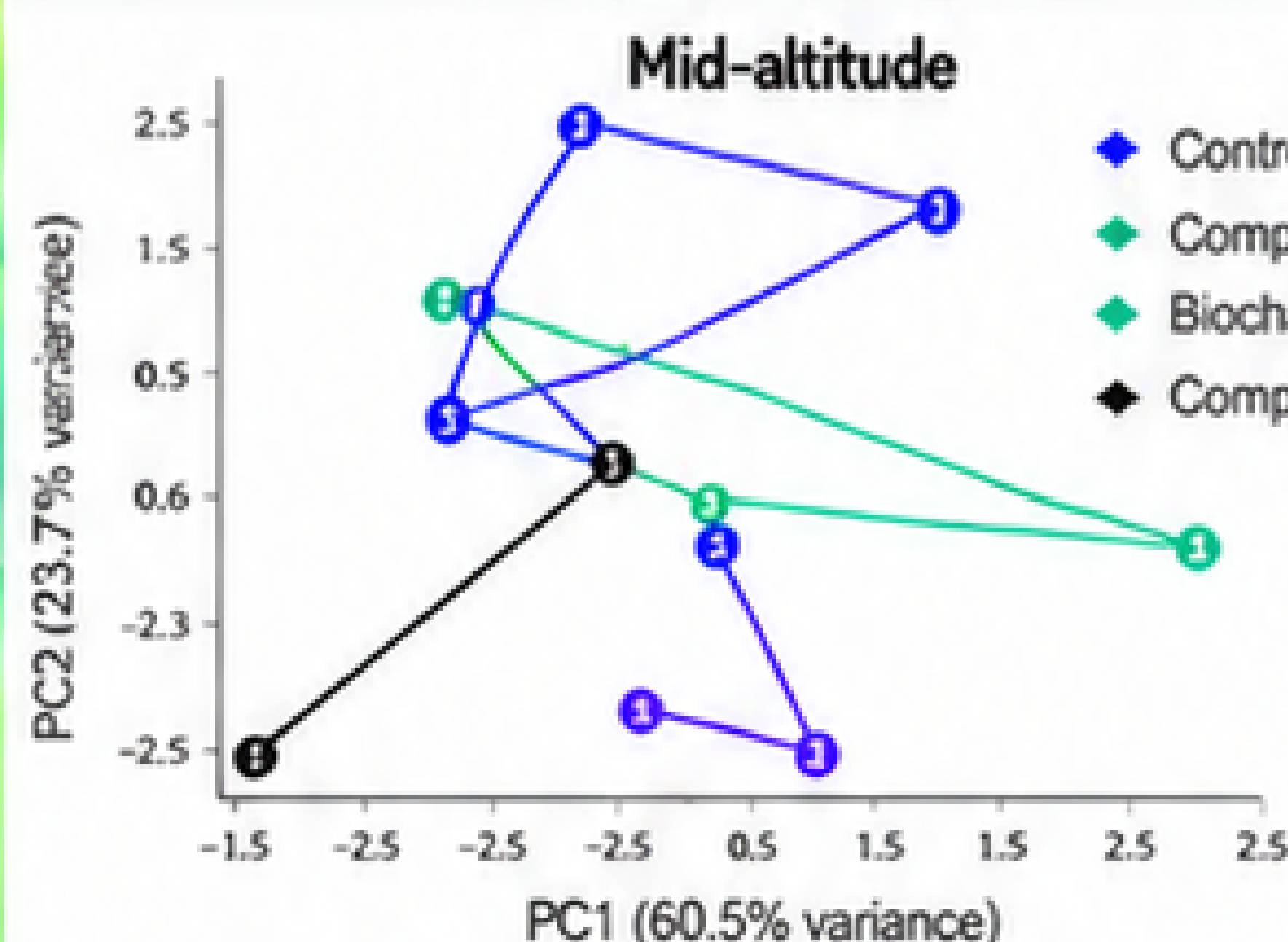
Highland (Potato–Bean–Maize–Bean)

Crop sequence: Potato (2023A) → Bean (2023B) → Maize (2024A) → Bean (2024B)

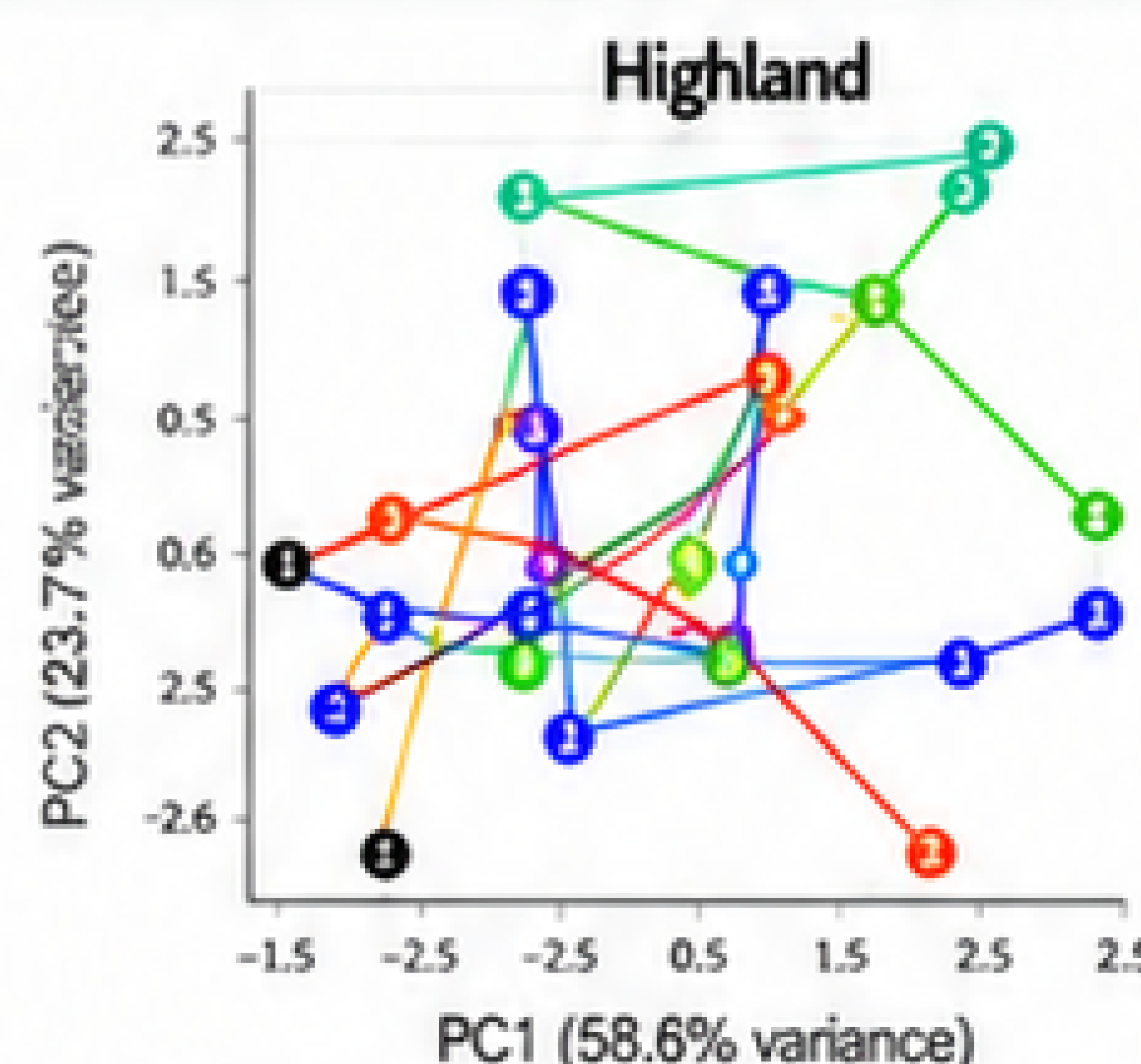


SOC remained stable across all sampling periods, with no significant treatment effects (T0–T4).

6. TEMPORAL DYNAMICS OF SOIL MACRONUTRIENT FERTILITY (PCA)



1 = Mar 2024 | 2 = Aug 2024 | 3 = Mar 2025 | 4 = Oct 2025



1 = Mar 2023 | 2 = Sep 2023 | 3 = Feb 2024 | 4 = Oct 2024 | 5 = Feb 2025

Abbreviations (graphs)

n = number of replicates
p = p-value (ANOVA)
PCA = Principal Component Analysis

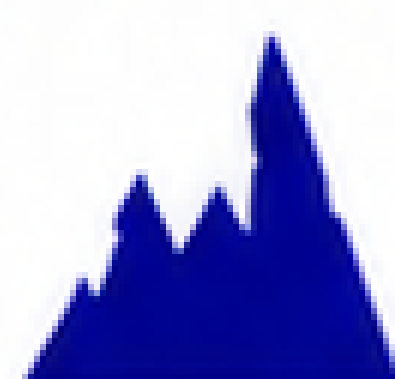
7. WHY SITES RESPOND DIFFERENTLY?

Mid-altitude – Strong SOC increase

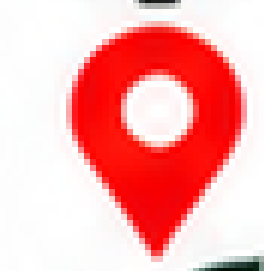


- Low initial SOC
- Amendments added carbon and nutrients
- Favourable moisture and decomposition conditions

Highland – Stable SOC



- High initial SOC (Andosols)
- No significant treatment effects
- Site conditions likely buffered short-term changes



Organic amendments can increase SOC in mid-altitude systems.

SOC response depends on site conditions.

No clear SOC increase in high-altitude Andosols in the short term.

Strong amendment sustain rather than increase SOC.

Management should be site-specific and long term.

Arboretum Compost

Cedrela serrata Biochar

Bean

Sweet potato