



ORIGINAL RESEARCH ARTICLE

Biochar–Compost Blends Improve Water Retention and Early Maize Growth in a Simulated Tropical Dryland Soil

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ENGLISH

ABSTRACT

Soil amendments are increasingly used to reduce drought sensitivity in tropical cropping systems, yet their combined effects are context dependent. This demonstration study tested four amendment regimes in a controlled greenhouse experiment using a synthetic sandy loam: no amendment, compost, biochar, and a biochar–compost blend. Forty-eight pots were observed for eight weeks under a standardised irrigation schedule. The blended treatment produced the highest gravimetric water retention, shoot biomass, and leaf chlorophyll index. Compost alone improved early growth, whereas biochar alone primarily affected water retention. The results illustrate how a factorial experimental article can report methods, uncertainty, tables, and figures. All locations, participants, measurements, and results in this article are fictional and were generated solely to demonstrate the ZATARA manuscript format.

Keywords: biochar; compost; soil moisture; maize; tropical drylands

中文

摘要

土壤改良剂常用于降低热带农业系统对干旱的敏感性，但其组合效果取决于具体环境。本示范研究在受控温室试验中比较四种处理：无改良剂、堆肥、生物炭以及生物炭—堆肥混合物。研究采用四十八个盆栽，在统一灌溉条件下观察八周。混合处理在重量含水率、地上部生物量和叶片叶绿素指数方面表现最高。堆肥主要促进早期生长，而生物炭主要改善保水能力。本文所有地点、测量和结果均为虚构，仅用于展示 ZATARA 稿件格式。

关键词: 生物炭；堆肥；土壤水分；玉米；热带旱地

BAHASA INDONESIA

ABSTRAK

Bahan pembenah tanah semakin banyak digunakan untuk mengurangi kerentanan tanaman terhadap kekeringan, tetapi pengaruh kombinasinya bergantung pada konteks. Studi demonstrasi ini membandingkan empat perlakuan dalam percobaan rumah kaca: tanpa pembenah, kompos, biochar, dan campuran biochar–kompos. Empat puluh delapan pot diamati selama delapan minggu dengan jadwal irigasi yang seragam. Perlakuan campuran menghasilkan retensi air gravimetrik, biomassa tajuk, dan indeks klorofil tertinggi. Kompos terutama meningkatkan pertumbuhan awal, sedangkan biochar terutama memengaruhi retensi air. Seluruh lokasi, pengukuran, dan hasil dalam artikel ini bersifat fiktif dan dibuat hanya untuk mendemonstrasikan format naskah ZATARA.

Kata kunci: biochar; kompos; kelembapan tanah; jagung; lahan kering tropis

1. Introduction

Seasonal water stress constrains crop establishment in many tropical dryland systems. Coarse-textured soils drain rapidly, organic matter is often low, and short interruptions to rainfall can reduce seedling survival. Organic amendments are therefore used to improve soil structure while recycling locally available residues [1,2].

Biochar has a porous structure that may increase water storage, whereas mature compost can supply nutrients and stimulate biological activity. Their combination may produce complementary effects, but performance varies with feedstock, application rate, soil texture, and crop. This study asked whether a biochar–compost blend would outperform either amendment used alone during early maize growth.

We hypothesised that (H1) biochar-containing treatments would retain more water than the unamended control, and (H2) the blended treatment would produce the greatest biomass because it combined physical and nutrient benefits.

2. Materials and Methods

A randomised greenhouse experiment was constructed for demonstration purposes. Forty-eight 5-L pots were filled with 4.5 kg of a synthetic sandy loam and randomly assigned to four treatments with 12 replicates each. Treatment C0 received no amendment; C1 received compost at 3% dry mass; B1 received biochar at 3%; and BC received 1.5% compost plus 1.5% biochar.

Two maize seeds were sown per pot and thinned to one seedling after emergence. Pots were maintained at $28 \pm 3^{\circ}\text{C}$ and irrigated to 70% of estimated field capacity every second day. Gravimetric water retention was measured at week 4 after a 48-hour drainage period. Plant height and SPAD chlorophyll index were recorded weekly. Shoots were harvested at week 8 and dried at 65°C to constant mass.

Treatment means were compared using one-way analysis of variance followed by Tukey-adjusted pairwise comparisons. Residual plots were inspected for approximate normality and homoscedasticity. Effect sizes are reported with standard errors. Because all data are synthetic, the analysis demonstrates reporting practice rather than scientific inference.

3. Results

All 48 plants survived to harvest. Amendment regime was associated with water retention, chlorophyll index, and shoot biomass. The blended treatment retained 29% water by mass, compared with 18% in the control. Mean dry shoot biomass increased from 18.4 g in C0 to 27.1 g in BC.

Biochar alone produced a stronger moisture response than compost alone but a smaller biomass gain. Compost alone increased chlorophyll values, consistent with greater nutrient availability. The blended treatment showed the most balanced response across all three outcome domains.

Table 1

Treatment composition and week-8 outcomes (synthetic data).

Code	Treatment	Water retention (%)	SPAD index	Shoot biomass (g)
C0	Unamended control	18.0 ± 0.8	31.4 ± 1.2	18.4 ± 1.1
C1	Compost 3%	22.1 ± 0.9	38.7 ± 1.4	23.8 ± 1.3
B1	Biochar 3%	25.8 ± 1.0	34.9 ± 1.1	22.6 ± 1.2
BC	Biochar 1.5% + compost 1.5%	29.0 ± 1.1	41.6 ± 1.3	27.1 ± 1.4

Note. Values are synthetic and should not be cited as empirical evidence.

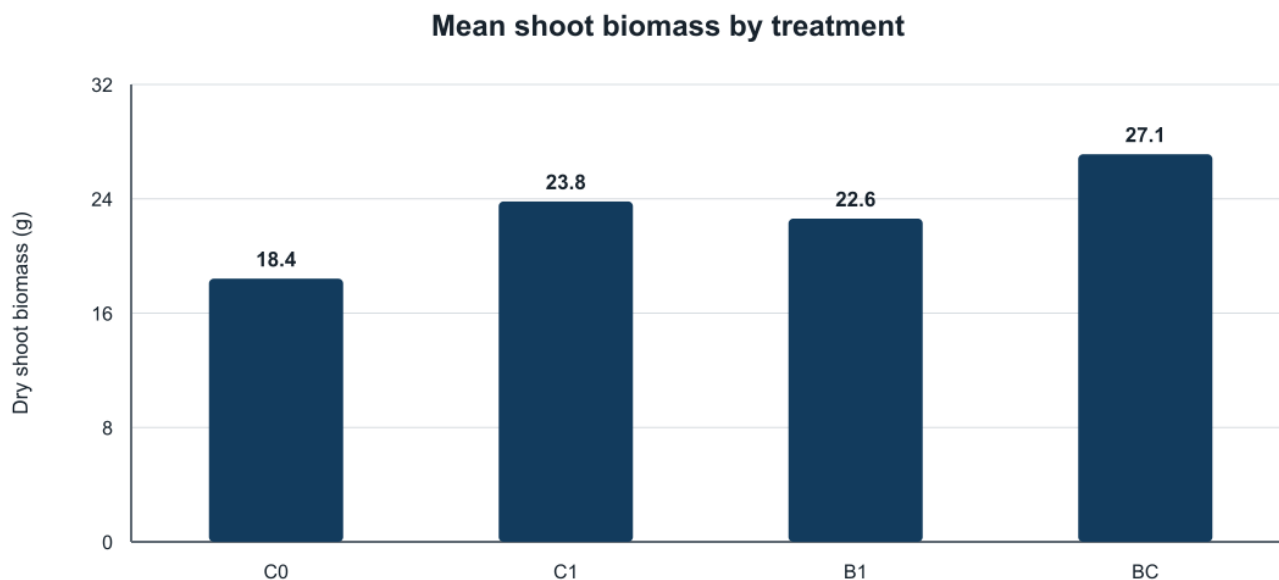


Figure 1. Mean dry shoot biomass at week 8. Values are synthetic; error bars are omitted in this layout demonstration.

4. Discussion

The synthetic pattern supports both study hypotheses. The stronger water-retention response in biochar-containing treatments is consistent with the expected influence of pore space and surface area. The larger biomass response under the blend suggests that water storage and nutrient supply can operate jointly during crop establishment.

The study design also illustrates important cautions. Pot experiments restrict rooting volume and cannot reproduce field heterogeneity. Amendment quality was held constant, although real compost and biochar vary substantially. Field trials across soil types and rainfall regimes would be required before recommending an application rate.

5. Conclusion

In this fictional experiment, a biochar–compost blend generated the strongest combined improvement in water retention and early maize growth. The example demonstrates transparent treatment descriptions, statistical reporting, and alignment between research questions, tables, figures, and conclusions.

Practice and Policy Implications

- Test amendment blends under field conditions before operational use.
- Report feedstock, production temperature, maturity, and application rate.
- Pair agronomic outcomes with cost, labour, and lifecycle assessment.

Declarations

Data Availability Statement

The synthetic dataset used to populate the tables and figure is fully reproduced in this article. No external dataset or real participant record exists.

Ethics Approval

Not applicable. This is a fictional demonstration article and no human participant, animal, biological specimen, or identifiable record was involved.

Consent to Participate and Publish

Not applicable. All author names and affiliations are pseudonymous and all content was created for layout demonstration.

Author Contributions

J.A.D.: Conceptualisation, methodology, writing—original draft. M.S.R./S.K.R./D.N.R.: analysis, visualisation, writing—review and editing. L.M.T./M.C.L./A.P.V.: validation, interpretation, writing—review and editing.

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Conflict of Interest

The pseudonymous authors declare no competing interests.

Use of Artificial Intelligence

Generative AI was used to create synthetic demonstration prose, pseudonymous names, fictitious data, and layout content. No claim in this article should be interpreted as reporting a real study.

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