

Optimizing mineral fertilizer rates with biochar and compost: a slow-release fertilizer for nutrient use efficiency and cotton yield improvement in northern Benin

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INTRODUCTION & AIM



In Benin, sustainable cotton production is threatened by dependence on mineral fertilizers

Although mineral fertilizers (MF) are effective in increasing cotton yields, they are often misused by farmers, leading to soil degradation and detrimental environmental impacts

- Is enriched biochar a promising strategy for improving cotton production?
- Can Nutrient Use Efficiency in cotton be optimized by enriching biochar with two nutrient sources : mineral fertilizers (NPKSB + urea) and compost?

METHOD

EXPERIMENTAL APPROACH

VARIABLES MEASURED

STATISTICAL ANALYSIS

- **Place:** Baka research station, Parakou, Benin https://maps.app.goo.gl/7hz2bDh88SYRDVFNA?g_st=ac
- **Experimental design:** Randomized complete block, 4 replicates
- **Factors:** Percentage of biochar (3 levels) and Type of enrichment nutrient (4 levels)
- **Year of experiment:** 2024

- **Seed-cotton yield** (YLD-180 days after sowing-DAS)
- **Plant height** (HT-45, 60, 90, and 120-DAS)
- **Number of fruiting branches per plant** (NFP-120 DAS)
- **Number of bolls per plant** (NBP-120 DAS)

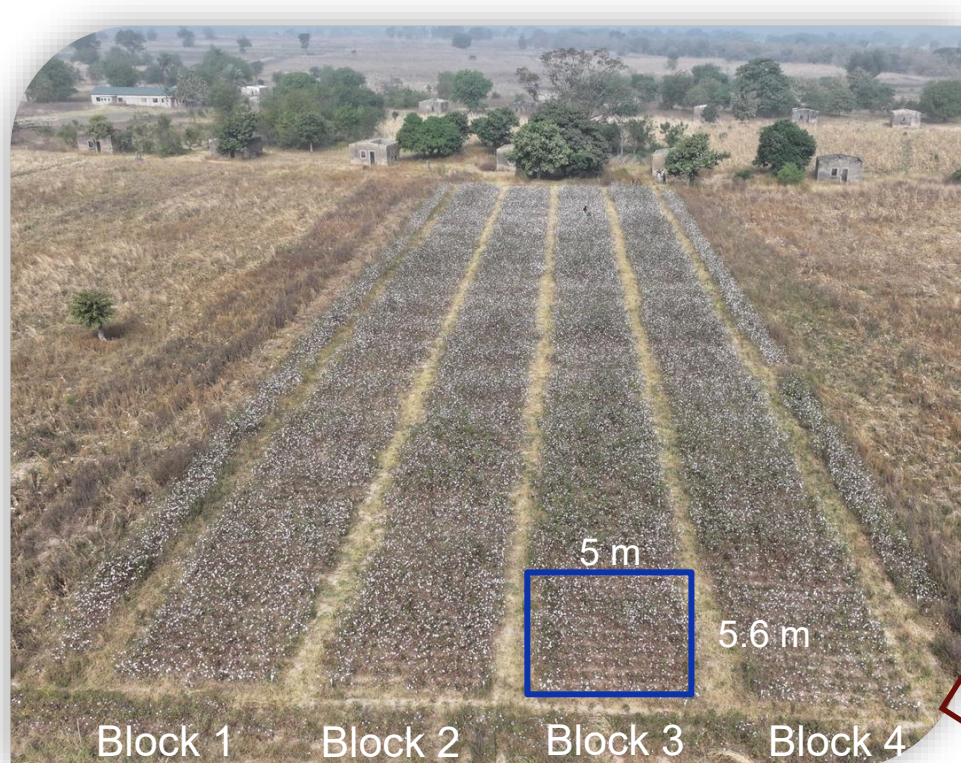


Figure 1. Overview of the experimental design implemented on the study plot in Benin.



4.4.2

ANOVA & CONTRAST ANALYSIS



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RESULTS & DISCUSSION

- MF has significant effect on all response variables
- Biochar alone has limited effect but impact becomes notably beneficial when combined with fertilizer and nitrogen (Tao *et al.*, 2024)
- Synergistic effects observed in early growth stages with combined treatments.
- **Strong Correlations:** HT ↔ NBF ↔ NCF = more fruiting branches & bolls.
- Compost partially replaces MF but high MF remains essential (Cissé *et al.*, 2021; Rubel *et al.*, 2024)

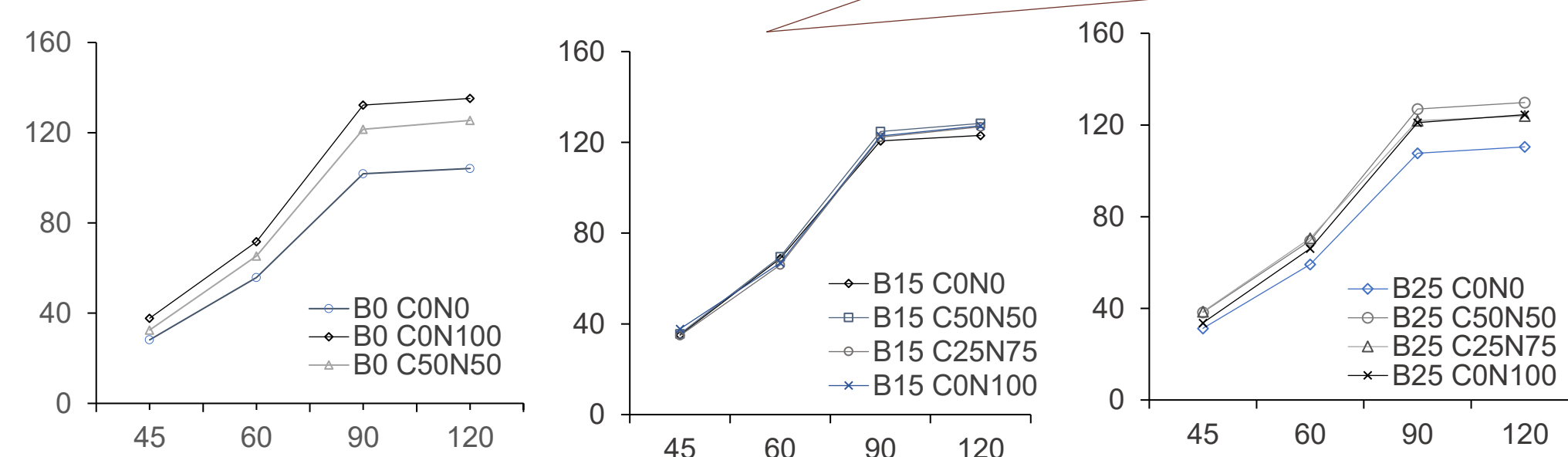


Figure 2. Response of plant height over time to varying Fertilizer formulations on the study plot in Benin.

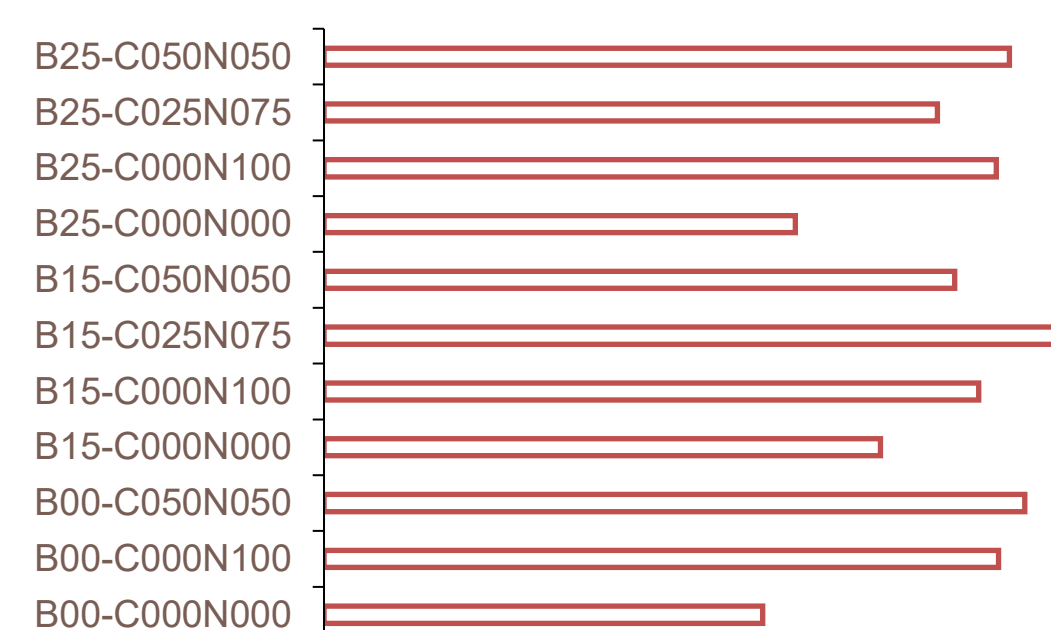


Figure 3. Effect of Fertilizer formulations under experimental conditions on seed-cotton yield (180-DAS).

- **Seed cotton yield:** +69.5% increase, reaching 3.41 t/ha (B15-C25-N75) with moderate biochar application combined with high mineral fertilization and compost substitution (Yin *et al.*, 2022)
- Strongly affected by fertilizer type, mineral fertilizer, and nitrogen rate (Cissé *et al.*, 2021; Abiola *et al.*, 2023)
- **Synergy:** Biochar × Fertilizer → boosts early development and yield.

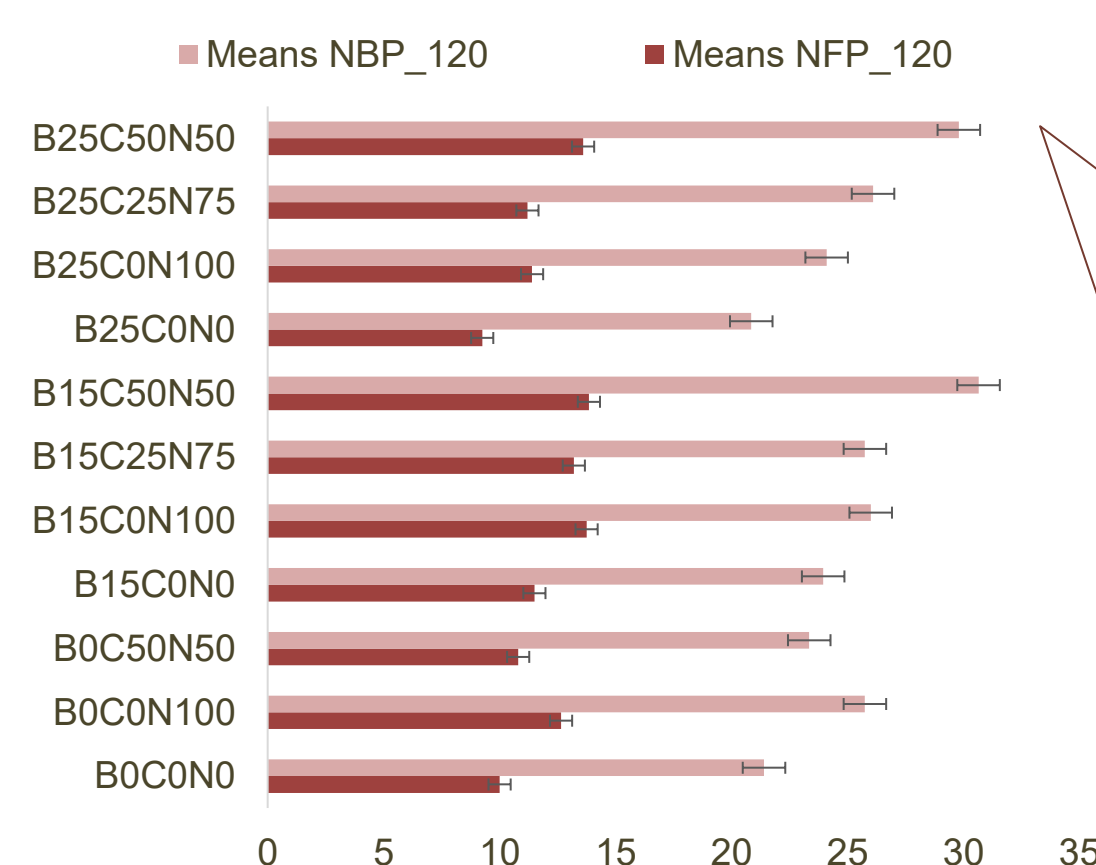


Figure 4. Effect of Fertilizer formulations on fruiting branches and boll production in cotton.

- **Top Treatments:** B25C50N50: 29.0 NBP, 13.6 NFP; B15C50N50: 30.6 NBP, 13.8 NFP
- **NBP (#Bolls/Plant):** Enhanced by biochar + fertilizer → promotes boll formation and overall reproduction
- **NFP (#Fruiting branches/Plant):** Significantly influenced by nitrogen rate and fertilizer → key for reproductive structures
- **Balanced nutrient combinations,** particularly those integrating biochar with compost and MF, foster optimal reproductive development in cotton (Upadhyay *et al.*, 2024)

CONCLUSION

- **Strong potential of enriched biochar as a promising strategy to improve** nutrient use efficiency, plant architecture and reproductive success in cotton cultivation
- **MF + Compost + Biochar:** Maximizes cotton performance yield simultaneously minimizes environmental impact and contributes to more sustainable cotton production systems in Benin
- **Viable solution** to the environmental and agronomic challenges faced by cotton farmers.

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