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Microbial consortia and organic fertilization enhance growth and water status of *Astronium fraxinifolium* seedlings

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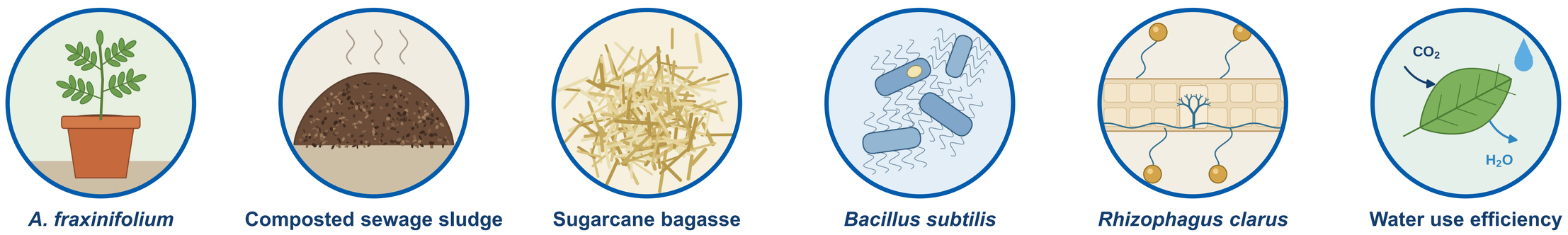
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Introduction

Vigorous native seedlings are key to forest restoration. *Astronium fraxinifolium* (gonçalo-alves) is a valuable Brazilian native tree. **Composted sewage sludge (CSS)** recycles organic matter and nutrients into nursery substrates, while *Bacillus subtilis* and the mycorrhizal fungus *Rhizophagus clarus* can improve nutrient and water uptake.

Objective

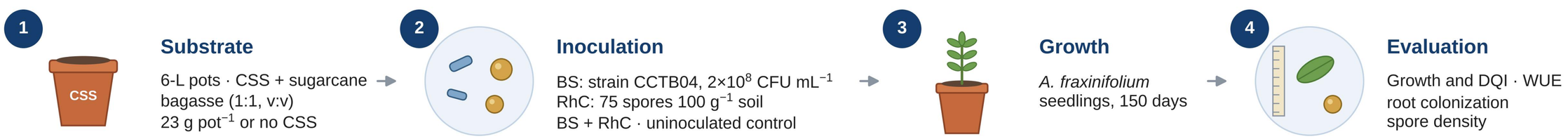
To evaluate CSS mixed with sugarcane bagasse (1:1, v:v) and microbial consortia on fungal root colonization, water use efficiency (WUE) and initial development of *A. fraxinifolium* seedlings.



A. fraxinifolium · Composted sewage sludge · Sugarcane bagasse · *Bacillus subtilis* · *Rhizophagus clarus* · Water use efficiency

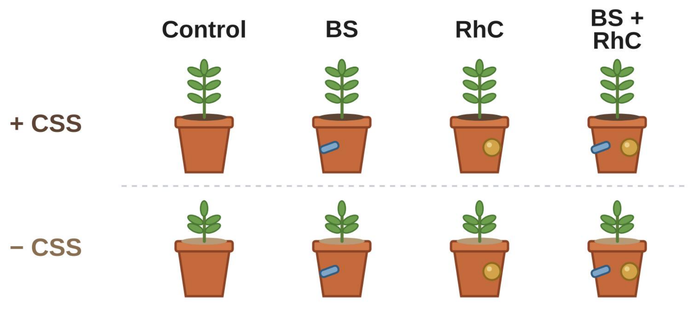
Materials and methods

A Experimental workflow



Randomized blocks · 2 × 4 factorial · n = 5 per treatment · Shapiro–Wilk · ANOVA · Tukey ($p \leq 0.05$)

B Treatment design and variables



Growth (150 days)
Shoot/root dry mass (SDM, RDM) · collar diameter (CD) · height (H)

Seedling quality
Dickson index: DQI = TDM / (H/CD + SDM/RDM); TDM = SDM + RDM

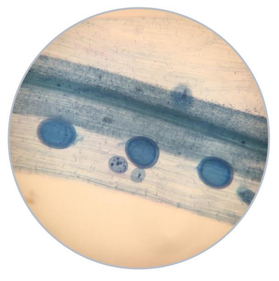
Water use efficiency
WUE = A / E (net photosynthesis / transpiration)

Mycorrhiza
Colonization (AMF, 100 fine-root segments) · spores (NSP, 100 g soil)

C Representative images



− CSS · Control + CSS · RhC



AMF in stained root

Results

0.6 vs 0.1
DQI with vs without CSS

+51%
WUE with CSS (5.65 vs 3.74)

44.2%
Root colonization · RhC (control 18.0%)

19.6 spores
per 100 g soil · BS+RhC (control 11.5)

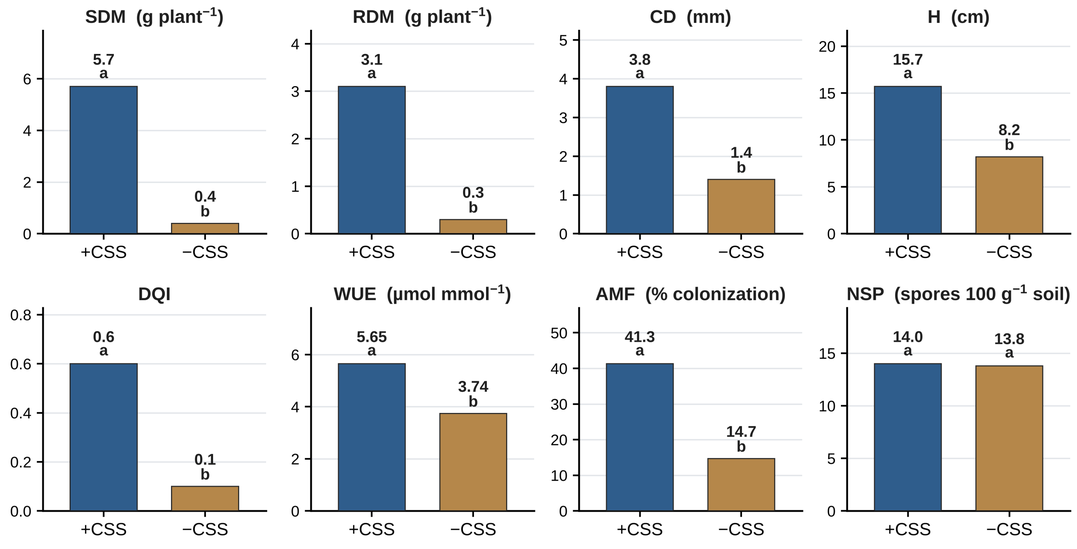


Figure 1. Main effect of composted sewage sludge (CSS) after 150 days (means across inoculations). Different letters differ by Tukey's test ($p \leq 0.05$).

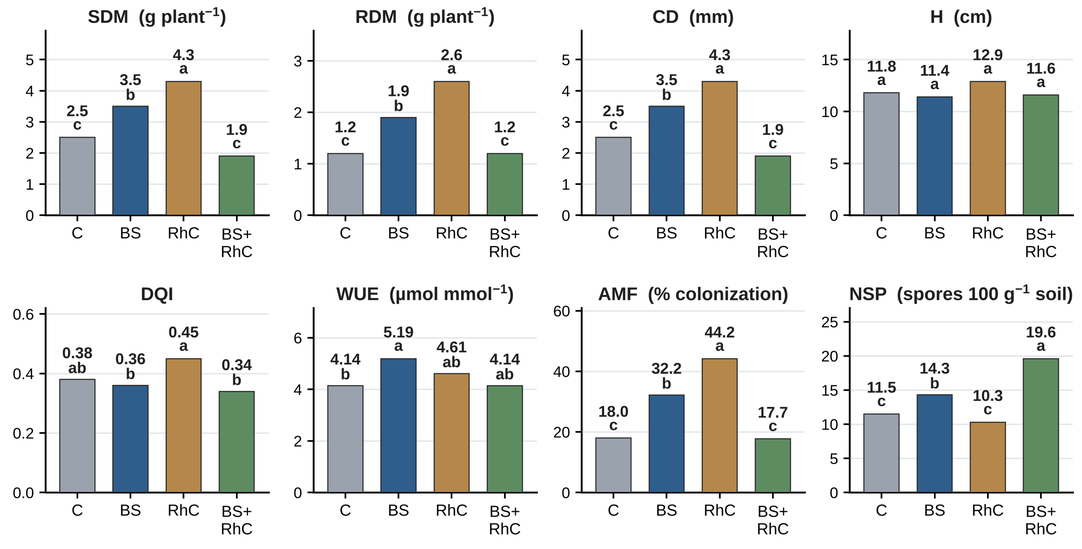


Figure 2. Main effect of inoculation (C: uninoculated; BS: *B. subtilis*; RhC: *R. clarus*), means across CSS levels. Different letters differ by Tukey's test ($p \leq 0.05$).

Conclusion

CSS was the main driver of seedling growth and quality, and the highest DQI occurred with CSS+BS and CSS+RhC. CSS and *B. subtilis* improved WUE; BS and RhC increased root colonization, and the BS+RhC consortium gave the highest spore density. Combining CSS with microbial consortia is a sustainable biotechnological strategy to produce high-quality *A. fraxinifolium* seedlings.

References: DICKSON, A.; LEAF, A. L.; HOSNER, J. F. Quality appraisal of white spruce and white pine seedling stock in nurseries. *The Forestry Chronicle*, v. 36, p. 10–13, 1960.

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