

Technosols from Iron Mining Tailings and Construction Waste: A Sustainable Approach for Solid Waste Management and plant growth

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Brazil faces significant environmental challenges due to the excessive waste generated by mining and construction activities [1,2], raising concerns about tailings dam failures [3] and landfill limitations. Technosols are soils significantly influenced, modified, or created by human activities [4]. They often contain artificial materials such as construction debris, industrial waste, or mining residues. This study assessed the potential of Technosols constructed from iron mining tailings (IMT) and construction and demolition waste (CDW) as a substrate for plant growth. The experiment followed a randomized block design with four replications and five treatments, totaling 20 plots. The treatments consisted of four different Technosols, created with varying proportions of IMT and CDW (60:40, 70:30, 80:20, and 100%). Natural soil (Haplic Ferralsol) was used as a control. *Urochloa brizantha* cv. Marandu was cultivated for 120 days, and both soil and plant attributes were analyzed at the end of the experiment. Technosols supported 3.3 times more dry biomass (825 ± 270 g; Fig. 1) than natural soil (251 ± 77 g, Fig. 1), with TEC 70:30 showing the best performance. This was attributed to favorable soil conditions, including neutral pH (~ 7.5), high cation exchange capacity (68.1 ± 12.4 mmol dm⁻³), and increased Ca and P availability (57.8 ± 0.8 and 28.2 ± 0.4 mmol dm⁻³, respectively). These findings highlight the potential of Technosols for sustainable land management, waste valorization, and environmental remediation, offering an alternative to mitigate the impacts of mining and construction waste while reducing the risks of future environmental disasters.

[1] Fernandes, G. W., F. F. Goulart, B. D. Ranieri, et al. 2016. "Deep into the Mud: Ecological and Socio-Economic Impacts of the Dam Breach in Mariana, Brazil." *Natureza & Conservação* 14, no. 2: 35–45.

[2] Brazilian National Mining Agency 2022. "IV Annual Mining Dam Safety Report." Brasília, DF. (Text in Portuguese)

[3] Brazilian National Mining Agency 2020. "Brazilian Mineral Yearbook—Main Metallic Substances." Brasília, DF. (Text in Portuguese)

[4] Fabbri, D., R. Pizzol, P. Calza, et al. 2021. "Constructed Technosols: A Strategy Toward a Circular Economy." *Applied Sciences* (Switzerland) 11: 3432.

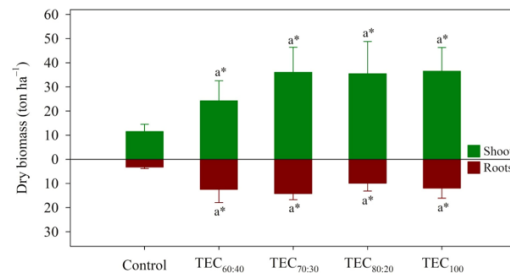


Figure 1. Total dry biomass (ton ha⁻¹) of shoot and root parts of *Urochloa brizantha* cv. Marandu grown in Control (natural soil) and Technosols (TEC60:40, TEC70:30, TEC80:20, and TEC100) after 120 days. Different letters indicate statistically significant differences between Technosols by Duncan test ($p < 0.05$) while * indicates statistically significant differences between each Technosol and control by Dunnett test ($p < 0.05$).