Abstract

Background and Aims Multiple biotic and abiotic stressors increasingly threaten tropical grasslands, yet restoration efforts predominantly prioritise aboveground traits, neglecting critical belowground traits essential for ecosystem resilience and recovery. We proposed that these neglected traits shape ecosystem biodiversity, productivity, and stress tolerance. This study assessed biomass yield, root and rhizosphere traits, resource acquisition strategies, and soil microbial communities in selected perennial grasses used for forage and seed-based restoration. We also evaluated enzymatic activity and microbial functional potential related to carbon, nitrogen, and phosphorus cycling.

Methods In a long-term restoration project in a tropical semi-arid grassland, we measured plant biomass, root morphology, mycorrhization, extracellular enzyme activities, and rhizosphere microbial community composition and function. Results Eragrostis superba had the highest shoot biomass, while Cenchrus ciliaris showed the highest root biomass and mycorrhization. The root trait– microbiome associations revealed distinct resource acquisition strategies: Chloris roxburghiana and Enteropogon macrostachyus displayed a ‘do-it-yourself’ strategy supported by copiotrophic rhizomicrobiome, while C. ciliaris displayed an ‘outsourcing’ strategy. Conversely, E. superba displayed high intraspecific root trait variation, exhibiting partially ‘do-it-yourself’ and ‘outsourcing’ traits. Grass species significantly influenced fungal, but not bacterial, community composition and favoured nutrient recycling over direct nutrient acquisition, with recycling strategies varying among species.

Conclusion Root traits and belowground plant– microbe interactions shape ecosystem function in tropical grassland restoration. Selected species occupied distinct successional niches, from early colonisation (C. ciliaris) to late-stage productivity (E. superba). Integrating these traits into restoration frameworks is essential for enhancing ecosystem resilience, productivity, and successful long-term ecological restoration outcomes.