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Exploring the productivity of underutilised grassland forage C3 species under temperate and sub-tropical climatic conditions

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Abstract

Temporary grasslands are not only a source of forage but also play a role in soil health, environmental protection, and sustainable agriculture. However, climate change is threatening the productivity and resilience of grasslands. Increasing interspecific and intraspecific diversity is suggested to counteract this development. In order to achieve this, the yield potential of species and accessions, including so far underutilized ones, under different climatic conditions has to be explored in order to find locally adapted functioning species. A field experiment was conducted in Germany and Brazil using a randomized block design, evaluating six forage species grown in pure stands differing in intraspecific diversity, i. e., one vs. two to three accessions. The selected species – two grasses (*Dactylis glomerata* and *Festuca arundinacea*), two legumes (*Onobrychis viciifolia* and *Lotus corniculatus*), and two non-leguminous dicotyledonous forage herbs (*Achillea millefolium* and *Plantago lanceolata*) – are representative of multispecies grasslands. Mineral fertiliser (CAN, 27% N) was applied at a rate of 120 kg N ha⁻¹ yr⁻¹ to non-legume plots in Germany and across all plots in Brazil. For Germany, the mean yield across two main production years, whereas for Brazil annual yield was derived from one experimental year. The data was analysed using linear mixed-effects models, with Tukey's HSD tests employed for pairwise comparisons of means.

Species significantly affected productivity, with responses varying between sites ($p \leq 0.001$). In Brazil, *O. viciifolia* showed significantly lower productivity than all other species likely due to poor establishment. In contrast, in Germany, *O. viciifolia* showed the highest production and *P. lanceolata* the lowest. While accessions had no main effect, its influence depended on the specific species-site combination, as indicated by the significant three-way interaction ($p < 0.05$). More accessions significantly increased productivity of *Festuca arundinacea* at both sites and of *L. corniculatus* and *P. lanceolata* in Germany. In contrast, there was no significant difference among accessions in Brazil. This pattern may reflect local adaptation and environmental filtering, with less-adapted accessions diluting the performance of an otherwise superior accession and reducing productivity in mixtures with more accessions. These findings show accession diversity benefits depend on context, emphasizing region-specific selection and breeding for sustainable grasslands.

Keywords: Accessions, grasses, herbs, legumes, productivity

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