Plant species identity and traits drive ecosystem functioning in experimental grassland monocultures

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Résumé

Grassland systems are facing unprecedented disturbances due to global changes and human-induced pressures, significantly affecting baseline ecosystem functioning and the associated services provided to humans. Out of the multiple biotic drivers of ecosystem functioning, plants are key organisms that steer a range of properties and processes above- and belowground.
However, we are only starting to understand the range of traits that show the strongest link to multiple aspects of functioning. To explore these linkages, 16 temperate grassland plant species with contrasting traits were grown in monocultures in a standard soil and in controlled conditions. Functional identity of each plant species was thoroughly characterized by measuring above- and belowground traits and eight ecosystem functions were quantified after 14 months of growth. We here provide evidence that plants, over relatively short time scales, substantially modify a diversity of key ecosystem functions – such as primary production, fodder quality, soil fertility, resistance to leaching and soil carbon stabilization.

Species-specific effects were observed for some functions, with above-ground net primary production varying up to 5-fold among species, whereas others, such as resistance to nitrogen leaching, were essentially (positively) affected by the presence of plants. While trade-offs in species-mediated effects were observed between functions, legumes expressed versatile effects on functioning, such as concomitantly achieving high level of productivity and enhancing soil fertility.

We further demonstrate that changes in functioning are related to a range of carefully selected effect traits, including leaf (dry matter content, vegetative height) and root (root tissue density, nitrogen concentration) economics traits, but also mycorrhizal and rhizobial traits (mycorrhizal colonization intensity, active nodule mass). The proportion of ecosystem function variance explained by species traits ranged from 51% to 94%. Our results suggest that a literature-based selection of plant traits, integrative of the whole organism, allows the inference of mechanisms that link organisms to ecosystem properties and processes.

Overall, these results indicate that in human-managed simplified ecosystems, plant identity and functional traits mediate ecosystem multifunctionality and open promising perspectives for finding versatile species most able to provide high levels of multiple functions.

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Mots-Clés: ecosystem functioning, trait, grassland, primary production, soil fertility, nutrient cycling