

Impacts of long-term phosphorus fertilization and addition of perennial legumes on a temperate natural grassland: I. Changes in species biodiversity and stability

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Introduction Grassland improvement with legumes and phosphate fertilizers enhances livestock productivity in Uruguay compared with performance achieved in natural grasslands. The objective of this work was to evaluate long-term impacts of legume introduction and phosphorus fertilization on botanical composition and structure of a temperate grassland.

Materials and methods The experiment was established in 1996, in a Tipic Argiudol of Uruguay (33°14'58"S, 54° 29'24"W), in a randomized complete block design with five replicates (2 ha each). Three treatments were evaluated: a) Natural grassland without legume introduction and fertilization (NG₀₋₀), improved oversown pasture (IP) with 4 kg ha⁻¹ of *Trifolium repens* and 8 kg ha⁻¹ of *Lotus corniculatus* and fertilized initially and annually with b) 45 and 30 kg ha⁻¹ of P₂O₅, respectively (IP₄₅₋₃₀), or fertilized with c) 90 and 60 kg ha⁻¹ of P₂O₅, respectively (IP₉₀₋₆₀). In 2006, botanical composition was evaluated by species presence and canopy cover in 11 quadrats (50×50 cm) randomly distributed in each plot, adapting the botanical method (Tothill *et al.*, 1992). The census information richness and Shannon Weaver diversity index (SW Index) were calculated. An F statistic with P ≤ 0.05 (Tukey test) was used to determine the significance of all analyses.

Results and discussion After 10 years, IP showed significantly lower species richness than NG₀₋₀ (Table 1). The SW index was significantly lower in IP₆₀ than in NG₀₋₀. Species frequency was significantly affected by legume introduction and fertilization. In IP, the perennial C₄ species were replaced by annual grasses in winter and by *Cynodon dactylon* in summer. A high frequency and ground cover biomass of exotic species (*Lolium multiflorum* and *Gaudinia fragilis*), the native (*Vulpia australis*) and perennial invasive weeds (*Cynodon dactylon*) were found in IP compared with NG₀₋₀. There were no significant effects of fertility levels within IP in any of the tested parameters. The new community is similar to Mediterranean grasslands with high vulnerability in conditions of drought stress. Changes are in agreement with the "fluctuating resources" theory (Davies *et al.*, 2000), sustaining that community susceptibility to invasion increases when pulses of a limiting resource occur (e. g. nitrogen and water).

Table 1 Species richness (SR/plot), SW Index and frequency of exotic (FE) and winter annual species (FW) in natural grasslands and improved pastures after 10 years of establishment.

Treatment	SR/plot	SW Index	FE (%)	FW (%)
NG ₀₋₀	60 a	1.68 a	5.8 b	3.2 b
IP ₄₅₋₃₀	35 b	1.51 ab	26.5 a	21.8 a
IP ₉₀₋₆₀	29 b	1.36 b	30.5 a	24.4 a
P _{value}	0.001	0.012	0.004	0.001

Means followed by the same letter within a column are not significantly different (P ≤ 0.05).

Conclusions The results indicate the importance of developing strategies for managing IP to enhance production and maintain the diversity of natural grasslands.

References

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