

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
Pvalue	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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