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THE EFFECT OF PHOSPHORUS FERTILIZATION ON BOTANICAL COMPOSITION AND PRODUCTION IN TEMPERATE PASTURES IN ARGENTINA.

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Abstract

The objective of this paper is to evaluate floristic changes and above-ground primary production in native grasslands and old pastures dominated by tall fescue (*Festuca arundinacea)* that were fertilized with different levels of phosphorus. For this, aerial biomass was sequentially harvested from November 1998 to October 1999. Above-ground production of native grassland more than doubled (from 3000 to 7300 kg DM/ha) with the highest level of P through the increment of three naturalized species: the winter annual ryegrass (*Lolium multiflorum*) and two legumes: white clover (*Trifolium repens)* and lotus (*Lotus corniculatus*). In contrast, above-ground production of old fescue pastures remained unchanged while nutritive value improved as legumes and warm-season grasses increased where they were fertilized.

Keywords: native grasslands, *Festuca arundinacea*, phosphorus, floristic composition, productivity

Introduction

Native grasslands and cultivated tall fescue pastures are main forage resources in the Argentinian Flooding Pampa, region which beef production is limited due to the seasonality of forage growth and the absence of legumes species. Native grasslands show a severe winter shortage of forage due to the low density of cool-season grasses (Jacobo et al, 2000) while fescue pastures growth is interrupted during the warm period. Mineral deficiencies depress winter growth rate of both communities (Vazquez y Barberis, 1982). In spite of this, nitrogen fertilization is not a common agronomic practice in the region, although experiments show significant improvement in winter-spring productivity through nitrogen supply (Fernandez Greco et al, 1995; Fernandez Greco y Mazzanti, 1998; Fernandez Greco et al, 1998). Soil enrichment of N may be achieved increasing the density of legumes, capable of symbiotic fixation. For this it is necesary to overcome a severe phosphorus deficiency (Darwich, 1983), that limit legumes density in these communities. The objective of this work is to evaluate floristic changes and above-ground primary production (ANPP) in native grasslands and tall fescue pastures that were fertilized with different levels of phosphorus.

Material and Methods

The study site was located in a commercial farm where cow-calf operations were performed, in the Flooding Pampa region, 280 km southwest of Buenos Aires. Mean annual rainfall is 1008 mm distributed throughout the year. Monthly mean temperatures range from 6.8ºC in July to 21.8^{o}C in January.

Forage resources are native grasslands (dominated by *Paspalum dilatatum, Lolium multiflorum, Sporobolus piramidatus)* and pastures dominated by tall fescue. Rotational stocking was performed, moving the cow-calf herd through the paddocks with occupation and

rest periods that varied according to the growth rate of forage species (around thirty days in the spring and between sixty and ninety days in summer and winter).

Three paddocks of each community were selected and a different fertilization program applied on each one:

F2= 200 kg rock phosphate + 80 kg mono-ammonium phosphate in 1997;

80 kg mono-ammonium phosphate in September 1998 and

40 kg mono-ammonium phosphate in April 1999.

F1= 80 kg mono-ammonium phosphate in September 1998 and

40 kg mono-ammonium phosphate in April 1999.

F0= without nutrient supply.

Total aboveground biomass was harvested from November 1998 to October 1999 before and after each occupation period. On each paddock ten samples of 0.09 m^2 were randomly located and clipped to ground level on each date. Samples were separated by hand into five components (legumes, annual cold-season grasses, fescue, warm-season grasses and no forage dicots), oven dried at 70 ^oC and weighed.

A split-plot analysis was applied to test differences between aboveground net primary production for each floristic group, where within-experimental-unit variation was attributed to sampling dates and among-experimental-units variation was attributed to phosphorus fertilization. Tuckey test was performed to analyze differences between programs of phosphorus fertilization.

Results and Discussion

ANPP in native grasslands fertilized with the highest level of phosphorus supply (F2) more than doubled (7300 kg DM/ha/year) in relation to that registered without fertilization (F0) (3000 kg DM/ha/year) or doubled compared with the less intensive supply (F1) (3500

kg/ha/year), while in tall fescue pastures fertilization didn't modify aboveground primary production (around 7500 kgDM /ha/year).

In native grasslands, ANPP increases as a consequence of the increment of growth rate of annual cool-season grasses (77 % of this group is *Lolium multiflorum*) and legumes (*Lotus tenuis* in December and *Trifolium repens* from February to October) (Table 1). These results show that phosphorus fertilization may contribute to overcome the severe winter shortage of forage, together with a protein supply of high strategic value caused by the increment of legumes. The last effect is not observed when high levels of nitrogen are supplied (Fernandez Greco et al, 1998; Fernandez Greco y Mazzanti, 1998). Simultaneously to the increment of cool-season grasses and legumes growth rates it was observed a reduction of warm-season grasses growth rates (Table 1). This reduction may be attributed to the higher competitive capacity of annual cool-season grasses during spring, when the biomass increases exponentially because of the reproductive growth (Jacobo et al, 2000).

A different result was observed in fescue pasture, where ANPP was not modified by phosphorus fertilization (Table 2). Nevertheless, pastures fertilized at the highest level were colonized by *Trifolium repens* (Table 2). This change in floristic diversity may improve the nutritive value and reduce the toxic effect of fescue pastures. In addition, in the short term, the higher proportion of legumes may improve progressively the supply of N by symbiotic fixation and, consequently, the ANPP of the community.

In conclusion, high levels of phosphorus supply have shown an important effect on the colonization and productivity of cool-season grasses and legumes of native grasslands, and on the colonization by legumes in old fescue pastures, consistent with the higher phosphorus requirement of these species during establishment.

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Table 1 - Aboveground net primary productivity (kg/ha/day) and annual production (kg/ha/year) of different floristic groups of natural grasslands under different phosphorous fertilization programes

Floristic group	**Fertilization**	**Aboveground net primary productivity**										**Annual**	
		Nov'98		Dec'98		Jan'99	Feb-Jun'99		Jul-Oct'99			**Production**	
Annual	F0	0,00	#	0,00	#	0,00	0,00		0,74	#		86,66	#
cool-season	F1	0,00	#	0,00	#	0,00	0,00		0,82	#		146,66	#
grasses	F2	39,60	*	26,90	*	0,00	0,00		11,74	*		4735,51	*
Legumes	FO	0,00		0,00	#	0,00	0,10	#	0,11	#		24,44	+
	F1	0,00		0,00	#	0,00	0,18	#	0,89	*		120,00	#
	F2	0,00		10,72	*	0,00	0,24	*	0,69	*		502,22	*
Warm-season	FO	21,10	*	9,50		12,60	0,60		0,00	#		1618,99	*
grasses	F1	24,00	*	12,30		11,90	0,60		0,70	*		1787,27	*
	F2	8,12	#	11,90		12,50	1,10		0,00	#		1260,35	#
No forage	FO	9,40		4,20		9,30	2,02		1,68			1289,99	
dicots	F1	14,00		4,40		3,90	2,95		2,97			1466,64	
	F2	12,00		8,80		2,00	0,62		0,21			877,76	

*#+The means of fertilization treatments for each functional group with different symbols are significantly different (P< 0.05)

Table 2 - Aboveground net primary productivity (kg/ha/day) and annual production (kg/ha/year) of different floristic groups of fescue pastures under different phosphorous fertilization programes.

Floristic group	Fertilization	Aboveground net primary productivity										Annual Production	
		Nov'98		Dec'98		Jan'99		Feb-Jun'99		Jul-Oct'99			
Fescue	F0	40,04	#	45,03	*#	8,59		21,04	*	10,75	*ǂ	7145,47	*
	F1	67,56	*	56,02	*	2,12		10,67	+	7,15	#	6397,72	#
	F2	66,96	*	39,06	#	3,69		18,57	*	12,47	*	7397,71	*
Legumes (white clover)	FO	0,00	#	0,00		0,00		0,00	#	0,00	#	0,00	+
	F1	0,00	#	0,00		0,00		0,07	#	0,02	#	11,11	#
	F2	8,74	*	0,00		0,00		0,25	*	1,50	*	464,44	*
Warm-season grasses	FO	7,78	*	0,58		1,26	+	0,00		0,00		311,10	#
	F1	0,01	#	0,00		23,64	*	0,06		0,00		1047,53	*
	F2	1,11	#	0,00		4,92	#	0,08		0,00		260,39	#
Cool-season grasses	FO	0,00		0,00		0,00		0,00		0,00	#	0,00	#
	F1	0,00		0,00		0,00		0,00		1,33	*	151,00	*
	F2	0,00		0,00		0,00		0,00		0,00	#	0,00	#
No forage dicots	FO	0,00		0,00		0,00		0,00		0,00		0,00	+
	F1	0,74		0,00		1,19		0,00		0,58		139,99	*
	F2	0,00		0,58		0,45		0,00		0,00		41,89	#

*#+The means of fertilization treatments for each functional group with different symbols are significantly different (P< 0.05)