Long-term phosphorus fertilization and perennial legumes addition impacts on temperate natural grassland: II. Total and particulate soil organic carbon.

Conference Paper · July 2008

CITATION
1

READS
55

7 authors, including:

Lucía Salvo
Facultad de Agronomía,
10 PUBLICATIONS **187** CITATIONS
SEE PROFILE

Jose Terra
National Institute of Agricultural Research of Uruguay
103 PUBLICATIONS **357** CITATIONS
SEE PROFILE

Walter Ayala
National Institute of Agricultural Research of Uruguay
44 PUBLICATIONS **84** CITATIONS
SEE PROFILE

Hernández Jorge
Faculty of Agronomy, Uruguay
19 PUBLICATIONS **199** CITATIONS
SEE PROFILE

Long-term phosphorus fertilization and perennial legumes addition impacts on a temperate natural grassland: II. Total and particulate soil organic carbon.

Lucía Salvo[1], *José A. Terra*[2], *Walter Ayala*[2], *Raul Bermudez*[2], *Jose Correa*[2], *Paola Avila*[2], *and Jorge Hernández*[1]
[1] *Departamento de Suelos y Aguas, Fac. de Agronomia, Universidad de la Republica. Garzón 780, Montevideo, Uruguay, E-mail: lsalvo@fagro. du. uy,* [2] *Instituto Nacional de Investigación Agropecuaria (INIA), Ruta 8 Km. 281, Treinta y Tres, Uruguay.*

Key words: Natural grassland, improved pastures, P fertilization, legumes, soil organic carbon.

Introduction Soil organic carbon (SOC) is a critical soil quality indicator and its pools have different functional roles in agroecosystems. Natural grassland improved with perennial legumes and P fertilizers is a rare production system in the world. We evaluated long-term P fertilization and perennial legumes inclusion effects on SOC and particulate organic C (C-POM; 53-2000 μm) in a natural grassland of Uruguay.

Materials and methods We analyzed a 30 ha experiment in a Typic Argiudol of Uruguay (33° 14′ 58″ S, 54° 29′ 24″ W). A randomized complete block design with five replications was used. Treatments were: natural grassland (NG), and natural grassland overseeded with *Trifolium repens* L. and *Lotus corniculatus* L. fertilized with 30 (IP_{30}), or with 60 kg ha^{-1} yr^{-1} of P_2O_5 (IP_{60}) during 9 yrs. After the 9th year, soil samples were collected to a depth of 0-5 and 5-15-cm, dried, dispersed and passed through sieves of 2000, 200 and 53 μm (Cambardella and Elliot, 1992). Soil remaining on the 200 and the 53 m sieves (coarse and fine C-POM, respectively) and the one passing all sieves (mineral-associated organic matter, C-MAOM) was analyzed for total C using the Mebius method (Nelson and Sommers, 1982). Orthogonal contrasts were used to make comparisons among treatments, NG vs. IP_{30} and IP_{60} average (IP), and IP_{30} vs. IP_{60}. The level of significance for the statistical test was 0.1.

Results and discussions Overall, there were no treatments effects on SOC at 0-15-cm depth after 9 yrs (mean: 21.2 g C kg^{-1}). However, treatments affected SOC by depth and C pools (Table 1). On average, IP had 8% higher and 11% lower SOC compared to NG at 0-5-cm and 5-15-cm depth, respectively. On the other hand, IP had 40% higher C-POM ($p<0.01$) and surprisingly 15% lower C-MAOM ($p<0.01$) than NG at 0-15-cm. As expected, a significant C-POM increase of 40% in the 0-5-cm depth was observed in IP relative to NG. In this layer, C-POM represented 46% of total SOC in IP but only 35% of total SOC in NG. Similarly, C-POM, that represented 21% of the total SOC in IP and only 13% in NG at 5-15-cm, was 40% higher in IP than in NG. Unexpected, IP had 9% and 19% lower C-MAOM than NG at 0-5-cm and 5-15-cm depths, respectively. Finally, no significant differences either on SOC or C pools were found between IP_{30} and IP_{60} at any depth. The SOC stratification, C-POM increase and C-MAOM drop in IP relative to NG, were probably related with the greater biomass production, lower biomass C-N ratio and the changes in the root system distribution observed in IP. These results are in agreement with Palm et al. (2001) and Metherell (2003) that shown that increased availability of nutrients results in increased quality of the litter input and reduces the recalcitrant pool of SOC.

Table 1 Perennial legumes addition and long-term P fertilization (30 and 60 kg P_2O_5 ha^{-1} yr^{-1}) impacts on soil organic carbon (SOC) and particulate organic C fractions (C-POM) in a temperate natural grassland of Uruguay after 9 years.

Soil Depth	(0-5-cm)			(5-15-cm)		
Treatment	SOC	C-POM (2000-200 μm)	C-POM (200-53 μm)	SOC	C-POM (2000-200 μm)	C-POM (200-53 μm)
	g C kg^{-1}					
Natural Grassland	32.67b†	7.68b	3.83b	15.80a	1.41b	0.70b
Improved Pasture 30 kg P_2O_5	36.02a	11.44a	5.15a	13.96b	1.75a	1.33a
Improved Pasture 60 kg P_2O_5	34.73a	10.81a	4.87a	14.11b	1.73a	1.12a

†Means followed by the same letter within a column are not significantly different at $P \leq 0.1$ level.

Conclusion The aggregate of data suggest that for temperate NG on undegraded soils, improved pastures with overseeded legumes and P fertilizers may sustain SOC in the long term. However, excessive SOC stratification, basically due to C-POM rise, and C-MAOM drop on IP are issues that may need further attention in the future.

References

Cambardella, C. A. and Elliot, E. T. (1992). Particulate soil organic matter changes across a grassland cultivation sequence. *Soil Sci.* Soc. Am. J. 56:777-783.

Nelson, D. W, Sommers, L. E., (1982). Total carbon, organic, and organic matter. *In*: A. L. Page (Ed), Methods of Soil Analysis, Part 2, *Agronomy* No. 9, Am. Soc. Agron., Madison, WI, pp. 539-579.

Metherell, A. K., (2003). Management effects on soil organic C in New Zealand pastures. *In*: Proc. *New Zealand Grassland Asoc.* 65:253-257.

Palm, C. A, Giller, K. E, Mafongoya, P. L., Swift, M. J. (2001). Management of organic matter in the tropics: translating theory into practice. *Nutrient Cycling in Agroecosystem*. 61:63-75.