ELSEVIER

Journal of Arid Environments 65 (2006) 142–155

Journal of Arid Environments

www.elsevier.com/locate/jnlabr/yjare

Soil quality in three range soils of the semi-arid Pampa of Argentina

E. Noellemeyer*, A.R. Quiroga, D. Estelrich

Facultad de Agronomía, Universidad Nacional de La Pampa, CC 300, 6300 Santa Rosa, L.P., Argentina

Received 14 December 2004; received in revised form 12 July 2005; accepted 13 July 2005
Available online 22 August 2005

Abstract

Degradation of semi-arid rangelands in the Argentinean Pampa due to increasing grazing intensity has been a growing concern among ecologist. Many studies document the impact of grazing on vegetation structure but little information is available on soil properties in these environments. The present study aims to establish some terms of reference for these range soils. Field studies were carried out to test the validity of selected soil chemical, physical and biological parameters for their capacity to discriminate soils according to quality under rangeland use. The selected data set includes total soil organic carbon (SOC), particulate organic carbon (POC), total N and P contents, dry aggregate size distribution, water stable aggregates and proctor maximum bulk density. Three soils (sand, sandy loam and loam) corresponding to different topographical situations and natural vegetation structure were sampled in 6 cm depth intervals up to 18 cm in bulk density cylinders, with six replicates in each site. Sun and shade vegetation communities were sampled separately. Standing biomass was determined and dry matter was analysed for N, P, Ca and Mg content. A positive significant relation between clay + silt content and SOC was found ($R^2 = 0.53$) in the 0–6 cm depth. Topsoil SOC was related to standing biomass ($R^2 = 0.21$), and POC showed a strong correlation with SOC ($R^2 = 0.94$). The highest values of SOC and POC were found in the sandy loam, while the loam had the highest POC/SOC ratio. Aggregate size distribution especially of >8 and <1 mm fractions reflected textural differences. Vegetation communities differed in their POC contents and POC/SOC ratios, with higher values found in the soils under shade community. It was concluded that SOC, POC, POC/SOC ratio and aggregate

*Corresponding author. Tel.: +54 2954 433092.
E-mail addresses: noellemeyer@agro.unlpam.edu.ar, noellemeyer@cpenet.com.ar (E. Noellemeyer).

0140-1963/$ - see front matter
doi:10.1016/j.jaridenv.2005.07.007

fractions >8 and <1 mm are sensitive soil quality parameters that reflect differences of soil texture and vegetation community structure in range soils of this region.

Keywords: Texture; Soil organic carbon; Particulate organic carbon; Aggregate size distribution; Vegetation community

1. Introduction

Savannahs and grasslands are important resources for cattle grazing. As agriculture spreads into marginal semi-arid regions, grazing is displaced and becomes more intensive in the drier belts of natural semi-arid to arid savannahs. Degradation of vegetation quality of these natural grasslands caused by grazing has been extensively documented (Cano, 1969; Cano et al., 1988a, 1990; Estelrich et al., 1997). The principal indicators used are modifications caused by grazing on vegetation structure and cover due to the selective removal of palatable species (Cano et al., 1988b), as for instance percentage of palatable species, or INTECO, which takes into account the proportion of palatable species and their relative cover (Frank et al., 1998). The effect of overgrazing generally is recognized as the loss of forage species, the increasing dominance of non-forage herbaceous plants, and wood encroachment (Peinetti et al., 1993). The productive potential of land is often defined according to the relative abundance of fodder, and the sustainability of the grazing management is evaluated by its capacity to maintain this forage production (Frank et al., 1998).

In contrast, degradation of any other kind of agricultural system is commonly described based on soil conditions (Stengel et al., 1984; Quiroga, 1994). Sustainability is related to soil carbon and nutrient balance and the capability to maintain adequate soil conditions for water availability and root development (Quiroga et al., 1998, 1999; Franzluebbers, 2002). Few studies assess such changes in soil quality caused by (over-)grazing of grasslands (Milchunas and Lauenroth, 1993; Villamil et al., 2001). Grazing not only modifies the amount of residues which are returned to the soil, but also changes the composition of vegetation which in turn affects carbon and nutrient balance. The effects of grazing are continuous and irregular, and no clear event of disturbance marks the difference between one and another situation of landuse or management. Field experiments are difficult to set up unless long-term enclosures have been maintained. Most terms of reference for soil quality parameters are derived from agricultural fields or from comparisons of cultivated with grass- or woodlands, which have not been used for grazing.

Soil organic carbon (SOC) plays an important role in improving soil physical, chemical and biological properties for sustained plant growth. Soil quality is reflected in the soil carbon balance and the physical and structural conditions of range soils.

The soil C balance is maintained by plant litter inputs which enter the soil as particulate organic carbon (POC). Under relatively regular inputs not subject to