El Suelo
pilar de la agroindustria en la pampa argentina
XXII Congreso Argentino de la Ciencia del Suelo Rosario, Argentina, 2010

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Nos resulta muy grato confirmarles la realización del **XXII Congreso Argentino de la Ciencia del Suelo**, que se realizará entre el 31 de Mayo y el 4 Junio de 2010, en la ciudad de Rosario.

Este evento será un singular ámbito para la integración de científicos, técnicos, estudiantes, productores y empresarios, y se verá jerarquizado con la presencia de destacados expertos nacionales e internacionales de reconocido prestigio.

En esta oportunidad, coincide con el 50º Aniversario de la creación de la Asociación Argentina de la Ciencia del Suelo y con el año del Bicentenario, especial ocasión histórica que galardonará el Congreso, tanto por los caros sentimientos que ello representa como por los innovadores actos previstos en su conmemoración.

Nuestro lema **"El suelo: pilar de la agroindustria en la pampa argentina"** pretende reflejar las características de nuestra región, productora de materias primas y agroindustrial. En tal sentido pretendemos conformar las diferentes disertaciones tanto en las conferencias como en las mesas redondas y en la gira edafológica que contemplará la observación de suelos característicos de nuestra región como así también la visita al cordón agroindustrial del Gran Rosario.

Es nuestra intención invitarlos a ser protagonistas de este encuentro y los esperamos en la Cuna de la Bandera, en las instalaciones de la Bolsa de Comercio.
Sin otro particular los saludo cordialmente.

Ing. Sebastián Gambaudo
Presidente del Congreso

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LOOKING FOR BIOLOGICAL INDICATORS OF SOIL USING HIERARCHICAL CLUSTERING

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ABSTRACT

Soil microbial activity (SMA) is related to the use and management of soil. We hypothesized that a single change in the sequence of crop rotation could be detected through changes in the biological and microbial activity of the soil. We analyzed SMA from an agricultural Typic Argiudoll soil under no-tillage (NT) with different crop rotations (corn-oat-soybean (COS), corn-soybean (C-S) and undisturbed soil as control (NC)). We measured dehydrogenase activity, β-glucosidase activity, community level physiological profiles, taxonomic microbial groups and the physiological group involved in the carbon cycle (cellulose- and amylose-decomposing micro-organisms) to detect changes in microbial activity. We also measured carbon from microbial biomass, total organic carbon, soil respiration, substrate induced respiration, biological quotient and metabolic quotient (qCO2) to detect changes in biological activity. Dependence on the variables analyzed by Bartlett's test allowed us to apply correspondence analysis and principal components analysis (PCA). PCA showed three different soil conditions and a negative correlation between qCO2 and the other variables. Hierarchical clustering analysis using Ward algorithm confirmed that qCO2 and BMC showed the three soil conditions. In fact, qCO2 and BMC explained the maximum sensitivity against contrasting management situations. Crop residues enhanced the metabolic quotient and reduced the microbial quotient. Increased enzymatic activities in rotation with the highest crop residues expedite mineralization and mobilization of available nutrients. We observed a quick response of the SMA to a single change in the crop rotation.

Keywords: crop rotations, enzyme activity, metabolic quotient, biological quotient, soil microbial biomass

INTRODUCTION

Soil is a natural non-renewable source. Soil degradation caused by intensive land use and inadequate production technologies involves one of the main environmental disarrangements (Hobbs *et al.*, 2008). The influence of soil micro-organisms in reducing soil degradation has been studied quite extensively. In fact, the soil microbiota is fundamental for the development and functionality of the soil (Jenkinson and Ladd, 1981). Among the management strategies to improve the possible solutions against soil degradation, alternative agricultural practices with crop residues are key factors in the environmental performance of crop production systems that alternate winter grains with summer leguminous plants in each sequence. In that respect, it has been found that soil management, which uses traditional plowing and disking to prepare the land, may reduce soil organic matter and microbial activity (Dick,1997), thus stimulating soil biodiversity and biological activity.

MATERIALS AND METHODS

Site Description

This research was carried out at an Agricultural Soil of Capitan Sarmiento (34 ° 10' S and 59° 49' W), an important agricultural region with economic significance of Buenos Aires, Argentina. The study sites were managed in the same way within each land-use category used since 1998. In brief, the cultivated sites presented a rotation of corn (Zea mays L.) - wheat (Triticum aestrivum L.) – soybean (Glycine max L.), except for the last years, when rotations were corn-oat-soybean (COS) and corn-soybean (C-S) for eight years, under NT. In the corn years, varying rates of supplemental N were applied to balance the cultivable N rates across cultures. No supplemental N was applied in the wheat year. Corn was grown in December and harvested in March. After harvest, corn stalks were shredded. In the wheat year, wheat was grown in June and harvested in December. Herbicides were used to control weeds.

Soil Sampling

Soil sampling was carried out from December 2006 to May 2008 to observe whether the experiments were sensitive to environmental interactions. Three experimental units from each site were randomly selected. At each sampling site, five composite samples, comprised of twenty subsamples from fourth depths (0-5, 5-10, 10-15 and 15-20 cm (2.54 cm in diameter), were obtained. Intact soil cores were cooled with ice packs in the field immediately after collection. The samples were sieved through a 5-mm mesh screen after removing any large plant material and stored at 4°C. Microbiological and biochemical analyses were performed within the same month of the sampling.

Global Biological analyses

The microbial biomass carbon (BMC) was determined by the Chloroform-fumigation-extraction method (Vance et al.,1987). In brief, organic C from the fumigated (24 h) and non-fumigated (control) soils were quantified by the NaOH titration method (Alef and Nannipieri, 1995). The metabolic rate ($qCO2$) was calculated by the Anderson and Domsch (1993) method. The biological quotient was calculated as BMC:orgC.

Microbiological analyses

The dilution plate count method (by Brock and Madigan, 1993) in PYS agar medium (Alef and Nannipieri, 1995) was applied for cultural heterotrophic aerobic bacteria, in PDRB agar medium with Streptomycin for culturable yeast and fungi group and RBME agar medium with 0.067% of Rose Bengal (Alef and Nannipieri, 1995) for culturable actinomycetes. Culturable cellulose-decomposing micro-organisms were measured with more probable number MPN (Alef and Nannipieri, 1995) in medium with cellulose (filter paper strip) as the only source of carbon in a mineral salt broth (Sato et al., 1984). Culturable amylose-decomposing micro-organisms were estimated using MPN with amylose as the only source of carbon (Alef and Nannipieri, 1995).

Biochemical analyses

The activity of β-Glu was assessed as previously described (Tabatabai, 1982). We measured DH as previously (Camiña *et al.*, 1998).

Data Analyses

The homogeneity of variances was analyzed using Bartlett's test of the null that the variances in each of the groups (samples) are the same (Bartlett,1937). Principal components analysis was performed for all samples continuous variables. Hierarchical clustering was carried out using Ward's distance (Anderberg, 1973). Statistical analyses of data were performed with the R program (R project, 2010).

RESULTS

We found a positive correlation ($p<0.05$) between global biological activities and the chemical properties of the soil. Pearson correlation coefficients (r2) and significance (p) of Basal_res, SIR, qCO2, BMC, orgC, BMC:orgC, DH, b-Glu and pH from COS, C-S, NC soils. Only qCO2 showed a negative correlation against the other chemical and biological variables. Figure 1 shows the plot of analysis of the principal components of the variables studied in the COS, C-S and NC soils, we observed that the first and second components explained 86% of the total variance. The metabolic quotients qCO2 and BMC are the two parameters that differed in the rotations studied. The metabolic quotient was enhanced by crop residues, while the microbial quotient was reduced. This score plot indicated that the samples can be divided into three groups: COS, C-S and NC, which suggests that the different management conditions had a strong effect on soil properties.

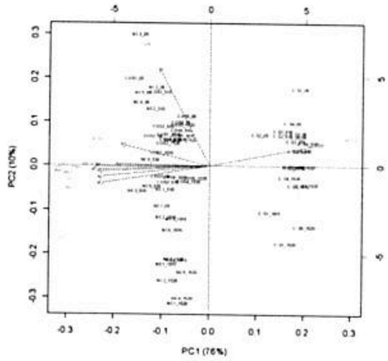
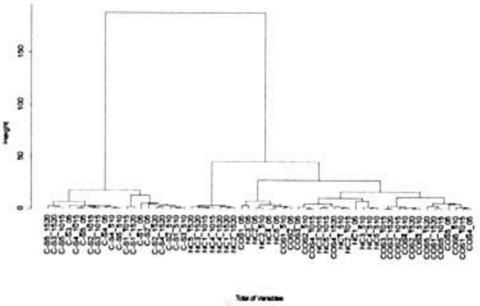


Figure 1. Biplot of chemical and microbiological properties under rotation including oat and excluding oat as management strategy. PC1and PC 2, principal component 1 y 2; BMC, total organic carbon; qCO2, metabolic quotient; BMC:orgC, biological quotient; b-glu, β-glucosidase activity, DH, Dehydrogenase activity, pH.

The parameters studied showed the same variability within COS as within C-S and NC (Fig. 2A). Once we reduced the size of the original global dimensions to two variables, we assayed the classification of these variables (qCO2 and BMC) in response to changes in the soil environment under different crop rotations as management strategies using a hierarchical cluster analysis on a set of dissimilarities and Ward's minimum variance method (Fig. 2B).

A



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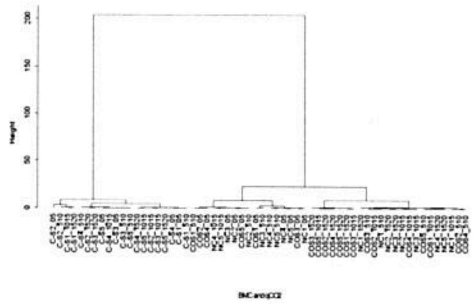

Figure 2. Dendrogram of variables measured using Ward algorithm to construct hierarchical clustering of total variables (A) and BMC and qCO2 variables (B).

DISCUSSION

Although a single cycle included oat in the rotation, meaning that there was a short time to generate a imprinting on the field, it was possible to find a response in the biological and microbial properties of the soil. We observed that qCO2 and BMC explained the maximum sensitivity against different conditions of management and those two variables synthesized all variability of this soil system (Fig. 2B). Hierarchical cluster analysis on a set of dissimilarities (Anderberg, 1973) and Ward's minimum variance method helped us find compact spherical clusters. As regards the statistical methodologies, we applied the non-parametric Wilcox's test because the rank sum test may be more applicable than the t-test on farm studies, where scientific rigour and control over inputs are more difficult to obtain than in plot studies, because it is less likely to have false positive conclusions.

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