Zea mays and *Mucuna pruriens*, a management strategy to soil biological conservation

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Introduction

The soil is a very important ecosystem component that supplies a wide range of environmental services, in addition it hosts a great biodiversity, crucial for maintaining ecological functions; however, the land use change has resulted in a loss of biodiversity which put in danger the good operation of this complicated system.

Study area

The experimental plot was located in the Tropical Reserve Los Tuxtlas Veracruz Mexico, in Mpio. San Pedro Soteapan (N 18 º 10 '18.1''W 94 º 51' 47.6''), Veracruz (Fig. 1).

Fig. 1. Experimental-demonstrative plot

Objective

In this study, the aim was to evaluate the effect of crop rotation Maize (Poaceae) with *Mucuna* (Leguminosae) on the below ground biodiversity (macrofauna) and the maize productivity, as well as on the soil quality

Materials and methods

We used a randomized block design to evaluate the effect of four treatments: Mucuna + fertilizer (MF), fertilizer (F), Mucuna (M) and control (C) with 5 replicates (400 m2) for each. Month were determined: alkaline phosphatase activity and acid phosphatase (Tabatabai and Bremmer, 1969), fluorescein diacetate (total esterase); Alarcón-Gutiérrez et al., (2008), pH, respiration, diameter and height of the plant. At the end of the experiment was determined macrofauna (Anderson and Ingram, 1993) and the production of grain.

Results

The pH increased during the period of greatest plant growth (before flowering) to return later to the initial values from 6.221 to 6.428 (Fig. 2).

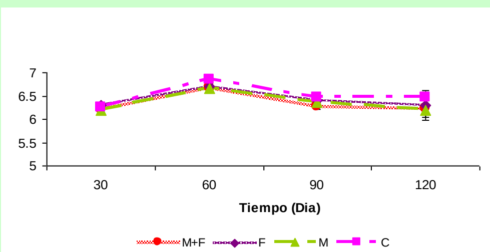

Fig. 2. soil pH. n = 3, bars indicate standard deviation

Regarding respiration, no significant difference between the treatments was observed, since all showed a higher value at second and third month (1.1 $mgCO_2.m^2.h^{-1}$), and then a drastic fall after the grain filling (0.1$mgCO_2.m^2.h^{-1}$). (Fig. 3).

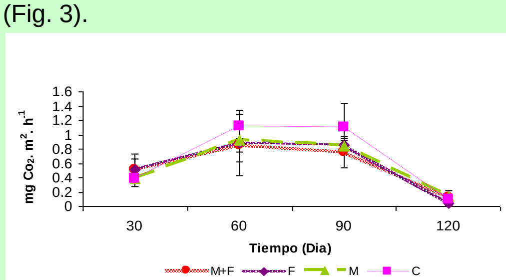

Fig. 3. Soil respiration rate. n = 3, bars indicate standard deviation

The alkaline phosphatase had a similar pattern: better treatments were M and F (0.03±0.009 nkat/gDM), (Fig. 4).

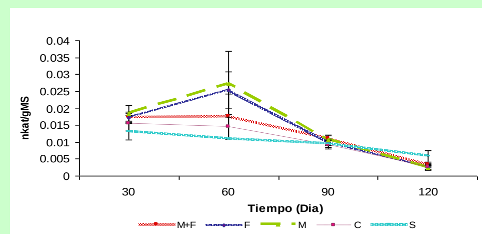

Fig. 4. Alkaline phosphatase activity. n =3, bars indicate standard deviation

The acid phosphatase activity was higher in the second month of the plant development, mainly in the M and MF treatments with the following respectively values: 0.007±0.005 nkat/gDM and 0.0055 nkat/gDM. (Fig. 5).

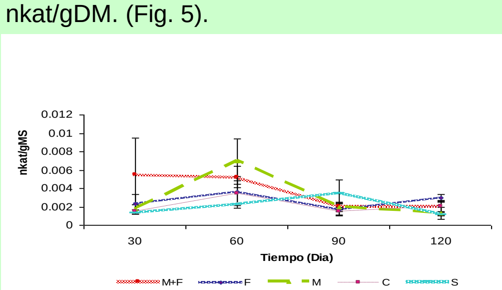

Fig. 5 Acid phosphatase activity. n = 3, bars indicate standard deviation

The macrofauna (individuals/m[2], according to the TSBF method; Anderson and Ingram 1993) showed that the treatment F had the biggest value, especially in the number of Isoptera (1792 individuals/m[2] (Fig. 6).

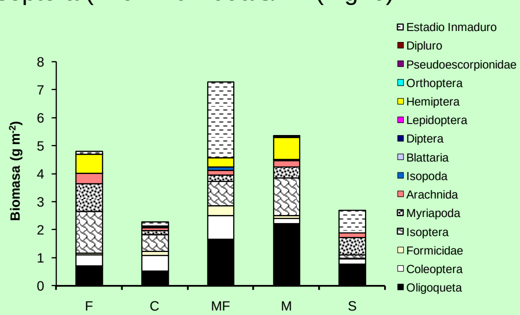

Fig. 6 Soil macrofauna (biomass)

Finally, the MF treatment showed the highest corn production (1738 kg/ha) in contrast to the M treatment that was the lowest (1519.2 kg/ha).(Fig. 7).

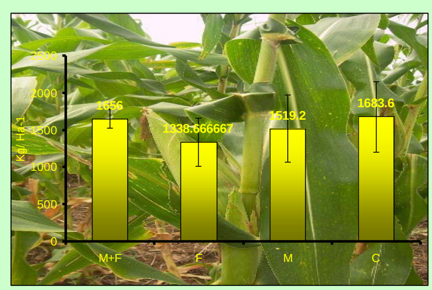

Fig. 7. Corn Yield (Summer 2008) n = 3, bars indicate standard deviation.

Conclusion: The rotation *Mucuna*-maize improves some soil quality parameters, conserves the below ground biodiversity and could reduce the cost of the production (inputs) in tropical areas, obtaining a benefit similar to the conventional crop method, but making the rotation *Mucuna*-maize an environmentally friendly system is applied.

References

Alarcón-Guitiérrez, E., Floch, C., Raudel, F., Criquet, S. (2008) Non-enzimatic hidrolysis of fluorescein diacetate (FDA) in Mediterranean oak (*Quercus ilex* L.) litter. European Journal of soil Sciencie. 59,139-146.
Anderson J.M., J.S.I. Ingram. (1993(. Tropical soil biology and fertility: A handbook of methods, 2ª edicion. CAB International, Wallingford. 221pp.
Tabatabai, M.A., Bremmer, J.M., (1969). Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. Soil Biology and Biochemistry 1,301-307.

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Pontoscolex corethururus and *Mucuna pruriens* effect over maize production

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Introduction

The current research focuses on obtaining a friendly environmental farm production, with cheap techniques, and varying the degrees of effectiveness; some of those techniques are the culture with earthworms (Brown *et al.,* 2007) and the addition of cover crops, particularly legumes. Indeed, the attention has been attracted on the effect of glomalin – a glycoprotein produced by mycorrhizal fungi- over the soil quality and, in consequence, over the crop productivity. Some studies reported that glomalin is a source of nitrogen for the soil, promotes a good soil structure, improves water capture and a good aeration, and it also promotes the good development of the plant roots and gives the ability to endure the erosion (Rilling *et al*., 2002).

Objective

This work aims to assess the productivity of maize in response to the presence of earthworm *Pontoscolex corethrurus* and the legume *Mucuna pruriens* var. *utilis*, as well as to quantify the production of glomalin, all under greenhouse conditions.

Materials and methods

The treatments used were: (1) *Mucuna*-Maize-*Pontoscolex*; (2) *Mucuna*-Maize; (3) *Pontoscolex*-Maize; (4) Maize and (5) Control. To extract and quantify the glomalin, the Wright and Upadhyaya (1996) method was used. The hyphae length was estimated according to Bloem *et al*. (1995). Earthworm, cocoons and maize biomass were determined at the end of the experiment.

Results

The results showed that the treatment (MPZ) *Mucuna-Pontoscolex-Maize* produced the highest corn biomass (40.2 g/plant vs. 9.74 g/plant) and cocoons (0.6 g FM vs. 0.18 g FM) (Figs. 1 and 2); however, no significant differences (P>0.05) were found between treatment with earthworms (MPZ) and *Pontoscolex*-Maize (PZ); at the end, *Pontoscolex* biomass was the same. Regarding the glomalin content, the treatment (MZ) *Mucuna*-Maize showed the highest values; however, the hyphae length did not change significantly between the treatments, as Spearman correlations (hyphae length versus glomalin content) showed the following results: 0.5 (1), 0.43 (2), 0.31 (3), 0.88 (4) and 0.74 (5).

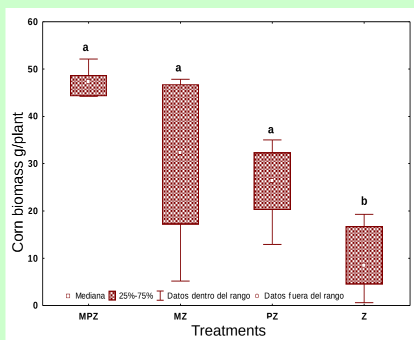

Fig. 1 Corn biomass of the treatments. n =6, bars indicate standard deviation.

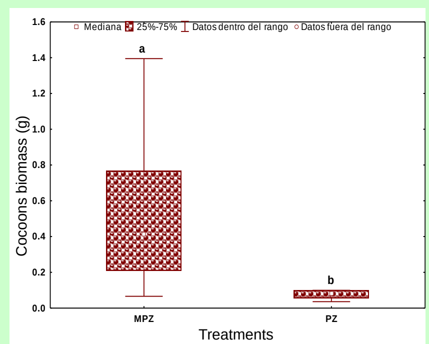

Fig. 2. Cocoons biomass of the treatments. n =6, bars indicate standard deviation.

Experimental units under greenhouse conditions

Conclusion: The simultaneous use of *Pontoscolex* and *Mucuna* positively impact the corn production, favoring the cocoons biomass and enhancing the production of glomalin.

References

Brown G. G., Senapati B. H, Pashanasi B., Villenave C., Patrón J.C., Lavelle P., Barois I., Blakemore J. (2007) Earthworms stimulate plant production. In Minhocas na América Latina: Biodiversidade e Ecologia. Brown G. G. and Fragoso C.(Ed.). Embrapa Soja Londrina Brasil.

Bloem, J., Bolhuis, P.R., Veninga, M.R., Wieringa, J. (1995) Microscopic methods for counting bacteria and fungi in soil. En: Methods in Applied Soil Microbiology & Biochemistry. K. Alef, P. Nannipieri (Eds.) Academic Press, London, 162-173.

Ortiz Ceballos AI (1995) Evaluación de cultivares de picapica mansa *Mucuna* ssp. como cultivos de cobertura. Tesis de Maestría en Ciencias. Colegio de Postgraduados, México.

Buckles D., Triomphe, B., Sain, G. (1999). Los cultivos de cobertura en la agricultura en laderas. Innovación de los agricultores con mucuna. Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), México DF. México.

Rilling M.C; Wright S.F; Eviner V.T. (2002). The role of arbscular mycorrhizal fungi and glomalin in soil aggregation: comparing effects of five plant species. Plant and soil, 238:325-333.

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Effects of the earthworm *Pontoscolex corethrurus* on aggregate formation, infiltration and enzyme activity over a maize-mucuna crop

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Introduction

The *Pontoscolex corethrurus* is an earthworm that has invaded most of the cultivated land, in the humid tropics, through its ability to live in a wide variety of soils and is widespread in agroecosystems, because of its ability to thrive easily in diverse habitats, still common in maize crops

Objective

The aim of this study was to evaluate the effects of *P. corethrurus* on the enzyme activity (acid and alkaline phosphatases) of the leachate, soil water infiltration, pH and soil macroagregation.

Material and methods

Experimental design

The experiment was designed using three main factors: *P. corethrurus* (P), *Mucuna pruriens* -300g dried and crushed- (M), and plant *Zea mays* (Z) and their respectively combinations: PZM, ZM, PM, M, PZ, Z and C (control), with six replicates.

Materials

The soil was sieved in a mesh of 0.5 cm and then placed in plastic containers of 20 L (15 kg per container) equipped with a hose and a bottle at the bottom in order to collect the leachate, experiment was performed under greenhouse conditions.

Methods

Sampling and measurements were made every 30 days through 150 days as follow: the determination of enzyme activity was performed following the Tabatabai and Bremmer (1969) method, the pH was determined using a potentiometer, infiltration was measured with a portable infiltrometer, the leached volume was measured using a graduated cylinder and macroaggregates were determined according to Velasquez *et al*. (2007).

Fig. 1. Experimental unit

Results

Infiltration

Infiltration showed a significant difference at 30 days (0,03 cm^3/s), and it reached its highest value in the control treatment (C) after 60 days (0.053 cm^3/s) (Fig. 2).

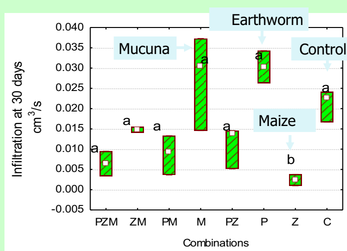

Fig. 2 Infiltration

Alkaline phosphatase

Alkaline phosphatase showed a significant difference (P<0.05) at 90 and 120 days, the PZ treatment showed the highest value of activity (0.2 nkat/mL), but after 120 days the highest activity was showed by the P treatment (0.68 nkat/mL) (Fig. 3).

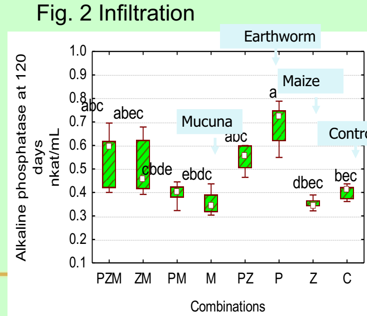

Fig. 3 Alkaline phosphatase

Acid phosphatase

The acid phosphatase activity showed significant differences after 60 days in the ZM treatment (0.52 nkat/mL); after 90 days the PZM treatment (1.33 nkat/mL) was higher; after 120 days the P treatment (4.6 nkat/mL) and finally; after 150 days the ZM treatment (0.82 nkat/mL) acquired the highest value. The pH only showed a significant difference in the M treatment after 60 days, acquiring a pH of 7.74.(Fig. 4)

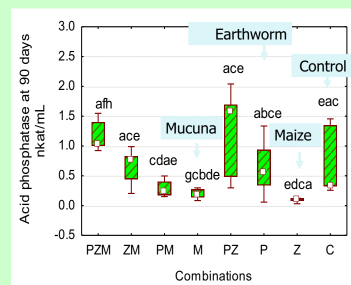

Fig. 4 Acid Phosphatase

Macroaggregates

Macroaggregates (0.5 cm < x < 1cm) were higher in the PZM treatment (108.61 cm^2)(Fig. 5).

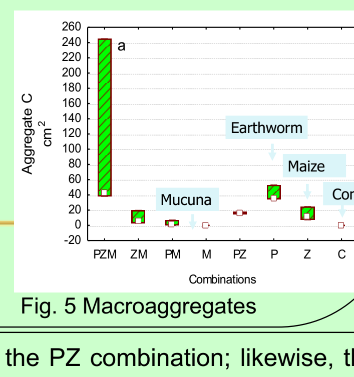

Fig. 5 Macroaggregates

Conclusión:

Phosphatase activity was enhanced by the presence of the *P. corenthurus* and also in the PZ combination; likewise, the activity of acid phosphatase appears to be favored by combining P and PZ and it kept constant in the ZM treatment. The greater infiltration into the P treatment may be due to the effect of earthworm on soil structure. The largest aggregate formation in PZM treatment may be due to the structuring of fine roots. The variables taken into account in this study were measured in a short time, and it is possible that some sources of variation require more time to cause significant effects *e.g.* degradation time of mucuna and its integration into the soil.

References

Tabatabai, M.A., Bremner, J.M., (1969). Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. Soil and Biochemistry 1,301-307.

Velasquez E., Pelosi C., Brunet D., Grimaldi M., Martins M., Rendeiro., A. C., Barrios E., Lavelle, P. (2007). This ped is my ped: Visual separation and near infrared spectra allow determination of the origins of soil macroaggregates. Pedobiologia - International Journal of Soil Biology, (51): 75-87.

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Soil acid and alkaline phosphatase activities in a greenhouse experiment

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Introduction

The expansion of agriculture in areas with a certain degree of fragility makes necessary to evaluate the state of soil system by means of indicators (Cantu *et al*., 2007). Soil activity is affected by many biological variables; the most important biological activities are those related to the organic matter (MO) and nutrient cycling. One of them, the mineralization of organic phosphorus (Po) into soluble inorganic phosphorous (Pi) is catalyzed by the phosphatase enzymes: acid and alkaline.

Objective

In this study, the aim was to compared the acid and alkaline Phosphatases of eight treatments in a greenhouse, in order to detect early biochemical changes, whit reflected of biological activities originated by the impacts of the treatments.

Materials and methods

Phosphatase enzymes were measured in soil from an experimental (2^3) crop of *Zea mays*, with the following variants: the presence or absence of the earthworm *Pontoscolex corethrurus* (P), the presence or absence of *Zea mays* (Z) and the presence or absence of the plant *Mucuna pruriens* var. *utilis* (M). The experiment was realized under a greenhouse conditions, with a total of eight treatments (PZM, ZM, PM, PZ, Z, P, M y T) with six replicates of each one; we evaluated, quantified and compared the biological activity of the soil using the phosphatase enzymes as indicators. The enzymes were extracted from the soil and measured using the method described by Tabatabai and Bremner (1969).

Results

The figure 1 and 2 shows the trend of the results obtained for the phosphatase enzyme activity, showing that during the two initial samples (30 and 60 days), values were relatively low (less than 1.0002 U / g DM for acid phosphatase and 0.012 U / g DM for alkaline phosphatase), which after 90 days increased tendency persists up to 120 days, but in the final sampling at 150 days was a drop of enzyme activity

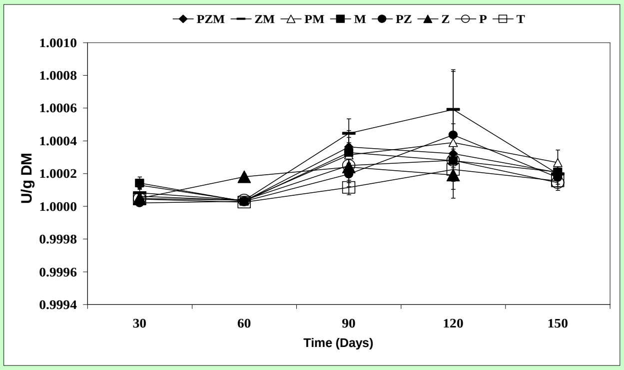

Figure 1.– Acid Phosphatase

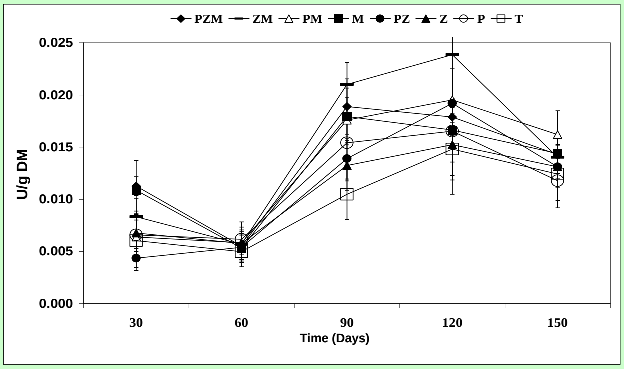

Figure 2 .– Alkaline phosphatase

The results showed a wide variation, control treatment usually maintains a low-level activity throughout the experiment. However, acid phosphatase activity was higher than alkaline activity. Mean activity of acid phosphatase was 1.0002 U / g DM while mean activity of alkaline phosphatase was 0.0122 U / g dry soil.

Conclusion: The results also suggest that acid phosphatase is more active than alkaline phosphatase in the soil samples evaluated. This may indicate that there is greater availability of inorganic phosphorus as according to Nannipieri *et al*. (1979) these enzymes are activated when there is low availability of this element in soil.

References

- Cantú, M.P., Becker. A., Bendano, J.C. Achiavo, H.F. (2008). Soil quality Evaluation using indicators and indices. C.I. suelo (Argentina) 25 (2): 173.178
- Tabatabai, M.A., Bremner, J.M., (1969). Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. Soil and Biochemistry 1, 301-307.
- Nannipieri P., Pechozzini F., Arcada P.G., Pioranelli C. (1979) Changes in amino acids, enzyme activities and biomass during soil microbial growth. Soil Sci. 127, 26-34.

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