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STUDY OF AVAILABLE FUNGI AND BACTERIA POPULATIONS IN EROSION PLOTS ONE YEAR AFTER THE APPLICATION OF DIFFERENT TREATMENTS

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ABSTRACT

A long-term experiment was designed to study the relationship between soil losses and soil quality conditions analyzing different physical, chemical and biological soil properties. Different treatments were carried out in an agricultural terrace in “El Teularet experimental station” in the Sierra of Enguera (Valencia, southeast Spain), getting 13 different plots. In this paper we show the results of the state of available fungi and bacteria populations one year after the application of the treatments, due to the close relationship of structural stability and the resistance of the soil to erosive processes. The major growth for both populations was observed in the plots with the addition of rest of vegetal material. Less growth was observed in the plots with some type of herbicide and the plot with geo-text.

Résumé

Une expérience à long terme a été établie en vue d´étudier le rapport entre les pertes du sol et les conditions de qualité du sol, en analysant les différentes propriétés physiques, chimiques et biologiques du sol. Différents traitements ont été réalisés sur une terrasse agricole dans "la station expérimentale EL Teularet" dans la montagne d'Enguera (Valence, sud-est de l'Espagne) obtenant 13 parcelles de terrain différentes. Dans cet article nous montrons les résultats de l'état des populations de champignons et de bactéries disponibles après un an d'application des traitements, due à la relation étroitement entre la stabilité structurale et la résistance du sol aux processus érosifs. La croissance principale pour les deux populations a été observée dans les parcelles de terrain avec addition de reste de matériel végétal. La plus faible croissance a été observée dans les parcelles de terrain avec ajout d´un certain type d'herbicide ainsi que la parcelle avec le geo-texte.

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INTRODUCTION

The loss of soil due to erosion in agricultural transformed areas is a major environmental problem in the Mediterranean region, because the soils are submitted to arid conditions and torrential rainfalls. The aggregate stability of soil is closely related to the resistance of soil to erosion processes. It is known that the formation and stabilization of the aggregates in soil is mainly due to its biotic components. The majority of microorganisms in the soil can synthesize different substances from the degradation of organic matter (Martens and Frankenberger, 1992) that can act as cementing compounds of particles of soil forming stable aggregates. It has been postulated that fungi are involved in binding together larger soil particles. (Oades and Waters, 1991), whereas bacterias mainly influence stabilization of clay and silt-sized particles (Tisdall 1994). Fungi initiate aggregate formation by enmeshing fine particles into macroaggregates (Oades, 1993; Tisdall et al., 1997) and producing organic substrates that bind soil particles together into micro- and macroaggregates. It has been reported that the addition of readily available substrate causes a rapid stimulation of the soil microflora and this is accompanied by an increase in aggregate stability (Roldán et al., 1994; Lax et al., 1997). Other treatment to improve degraded soil produce different responses in soil microbial populations (Biederbeck et al.; 2005). The objective of this work is to study the influence of different treatments applied to soil, on the growing of microbial populations.

MATERIAL AND METHODS

Experimental site and sampling

Data reported in this study were collected from “El Teularet experimental station” in the Sierra of Enguera (Valencia, southeast Spain). The station consists of 11 plots placed on an abandoned field and 2 plots placed on nearby forest soil. Each one of the plots includes closed erosion plots and a destructive plot to take the soil samples for laboratory analyses. Different treatments were applied on abandoned field plots during autumn, 2004, that is shown in table 1. Three samples per plot were collected from 0-10cm surface soil layer in July 2005. The samples were sieved (<2mm) and stored at 4ºC before analysis.

Table1. Description of treatments in the different plots.

Plot	Treatment	Description
1	Contact herbicide	3 applications
2	Sistemic herbicide	3 applications
3	Plough	4 times/year (tractor)
4	Oats	Sown 60% oats-40% *Veza* sp. (ground and added to soil in Spring)
5	Oats+Plough	Plough: 4 times/year (tractor) Sown 100% Oats (ground and added to soil in Spring)
6	Legume	*Medicago sativa* L. sowing
7	Control	Abandoned field with natural colonization
8	Oats Straw	Amount: 0.250 kg m^2 $year^{-1}$
9	Rest of pruning	Amount: 0.05 kg $m^2 year^{-1}$
10	Residual herbicide	3 applications
11	Geotextil cover	100% cover recycled cotton plot
12	Natural cover	on marls
13	Natural cover	on limestone

The densities of cultivable bacteria and fungi were estimated using a standard dilution-plating procedure. Bacteria were quantified on Tryptic Soy Agar (TSA/ Eur. Phar.

Agar Medium B) and fungi were quantified in Rose Bengal Chloramphenicol (0.1 g l^{-1}) Agar (Atlas and Parks, 1993). Bacterial and fungal plates were incubated at 25ºC for 72 and 92 hours, respectively, prior to counting colony forming units (CFU).

RESULTS AND DISCUSSION

We have found three growing levels for fungal populations in different treatments compared with the control plot (figure 1). The treatments corresponding to plots 4, 8 and 9 show significantly higher fungi values with regard to the control; treatments with similar values to the control corresponding to plots 1, 2, 3, 5, 6, 10, 12 and 13 and treatments with significant lower fungi abundance (plot 11) than control treatments. Residual herbicide and geotextil cover present lower fungi CFU. The higher fungi account was shown in oats straw and the rest of the pruning plots ($6 \cdot 10^5$ and $4 \cdot 10^5$ CFU g^{-1} dry soil, respectively). The growth of aerobic bacteria (figure 1) can be divided in two presence levels for the different treatments: the treatments that present lower values than the control treatment (10, 11, 12 and 13) and the similar-control values treatments (the remaining ones). Natural cover treatment on marls shows the lowest values ($3 \cdot 10^6$ CFU g^{-1} dry soil). The treatments 1, 4 and 8 present higher bacteria abundance ($1.3 \cdot 10^7$ CFU g^{-1} dry soil) regarding the similar-control values treatments group.

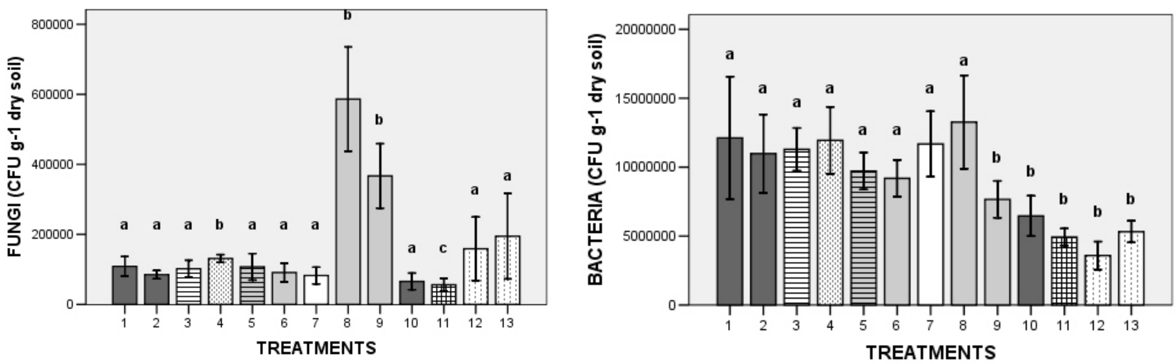

Figure 1. Mean values of fungal and bacterial populations. The different groups have been established with regard to the control treatment. "a, b and c" letters represent statistically significant differences.

The higher values in the fungal population analysis belong to treatments 8 and 9. If common factors between these treatments are analyzed we can observe that main characteristics are great vegetal rest abundance and low values of previous vegetal cover. This characteristic could suppose an advantage with regards to other treatments, mainly if sampling conditions are taken into account. The samples were taken in dry summer season with punctual rainfall events. Under these circumstances soils can present heterogeneous water and moisture distribution because abundant vegetal cover can retain water both in the aerial part as well as through the root. The low values in forest soil can be due to poor water availability in the soil. Low values in the geotextil treatment may be due to the hydrophobic nature of this material that may be influencing microbial proliferation. With respect to the bacterial population we can say that the treatment effects are not as pronounced as on fungal population. In fact it has been seen that agricultural management can promote bacterial population whereas it can have a negative influence on fungal population (Moore, 1994). Spedding et al. (2004) indicate that there is a clear dominance of the season of the year when it is sampled. On the other hand we have to take in account the Biederbeck et al. (2005) remarks about the prokaryotic flora towards greater dominance by zimogenous-type organism proliferation in soils fertilized with green manure. In this sense we can suppose that zymogenous-type organism abundance may be increasing in both green manured plots (4, 5, 8 and 9) and plots in successional colonization stage (1, 2, 3, 7 and 10). Nevertheless autochthonous-type organisms may be more abundant in natural cover plots.

Conclusions

- The addition of vegetal rest seems to promote microbial populations, mainly fungal.
- Treatments seem to influence bacterial populations in lower rank than fungi due to beneficial effects of agricultural management.

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