THE TILLAGE EFFECT ON THE SOIL ACID AND ALKALINE PHOSPHATASE ACTIVITY

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Abstract: Phosphatases (acid and alkaline) are important in soils because these extracellular enzymes catalyze the hydrolysis of organic phosphate esters to orthophosphate; thus they form an important link between biologically unavailable and mineral phosphorous. Phosphatase activity is sensitive to environmental perturbations such as organic amendments, tillage, waterlogging, compaction, fertilizer additions and thus it is often used as an environmental indicator of soil quality in riparian ecosystems. The aim of the study was to assess the effect of tillage systems on phosphatases activity in a field experiment carried out in Ezăreni farm. The phosphatase activitiy were determined at two depths (7-10 cm and 15-25cm layers) of a chernozem soil submitted to conventional tillage (CT) in a fertilised and unfertilised experiment. Monitoring soil alkaline phosphatase activity showed, generally, the same in fertilized soil profiles collected from both depths; the values being extremely close. In unfertilized soils, alkaline phosphatase activity is different only in soils that were exposed to unconventional work using disc harrows and 30cm tillage. Both works type (no tillage and conventional tillage) cause an intense alkaline phosphatase activity in 7-10 cm soil profile. Acid phosphatase activity is highly fluctuating in both fertilized as well unfertilized soil, this enzyme being influenced by the performed works.

INTRODUCTION

Soil management influences microbial activity, microbial biomass and enzyme activity through changes in nutrient inputs and in the quality and quantity of plant residues entering the soil (Ekenler and Tabatabai, 2002). The soil properties are significantly alters by the different tillage, especially the spatial distribution within the soil profile of the various enzyme activities (Bergstrom et al. 1998, Oprica et al. 2008, Olteanu et al., 2008). The enzymes activities of the surface layer of no till soil are higher than those of the same layer of tilled soils, whereas the opposite occurs for the deepest soil layer (Angers et al. 1993, Roscoe et al., 2000, Dumontet et al., 2001). The response of enzyme activity can be annually and seasonally different (Curci, 1997). Conventional tillage accelerates the microbial oxidation of organism matter thus stimulating greater microbial activity. Both tillage and management system can indirectly affect enzyme activities through changes in the structure of microbial communities. Changes in activity of some enzymes (acid and alkaline phosphatase, dehydrogenase, β-glucosidase and urease) induced by tillage of arable soil were related to the main physiological groups of bacteria and fungi and to water-filled pore space, organic C and total N contents, too (Aon and Colaneri, 2001; Aon et al. 2001).

The phosphorus cycle in soil is a system which involves soils, land and microorganisms. Major processes include the uptake of soil phosphorus by plants, recycling (the return of plant and animal residues), biological turnover (mineralization and immobilization), fixation to clay, solubilization (Stevenson, 1986). Phosphorus is not supplied through biochemical fixation but, must come from other sources (commercial fertilizers, animal manures, plant residues) to meet plant requirement. These sources include wastes and native compounds of phosphorus, both inorganic and organic already present in the soil. Of many biological properties that have potential as sensitive indicators of soil quality, enzyme activities often provide a unique integrative biological assessment of soil function, especially those catalyzing a wide range of soil biological processes, such as dehydrogenase, urease, phosphatase, etc (Nannipieri et al., 2002). The phosphomonoesterases (acid and alkaline) differ in their substrate specificity and their pH optimum. They are excreted by plant roots and by microorganisms. In the soil microbial phosphatases is dominate (Balota et al. 2003; Canarutto et al., 1995). Soil phosphatases the enzymes that transforms organic P to inorganic P are mostly of plant and microbial origin. Phosphatase is an enzyme that release inorganic phosphate from organic moiety, and is known to play a key role in phosphorus cycle in soil ecosystems (Speir and Ross, 1975).

This study was conducted to assess the effect of tillage systems on acid and alkaline phosphatases activity in a field experiment carried out in Iezăreni farm, during July 2008.

MATERIAL AND METHODS

The chernozem soil sample originated from the Experimental Ezăreni Farm of Agricultural Sciences and Veterinary Medicine ”Ion Ionescu de la Brad” University of Iasi during July 2008. Soils used for biochemical analysis

were fertilized and unfertilized beeing collected from two depths (7-10 cm, 15-25 cm). Works applied to these soils were unconventional (paraplow plug, polish or disc harrow) or classical (ploughing) (Table I).

Table I. Experimental variants from Ezăreni farm in July 2008

Crt. nr.	Treatment	Agrotechnical works	Conventional notation	Depth
1.	Fertilized (N80P80)	Disc harrow	DF1	7-10 cm
2.		Disc harrow	DF2	15-25 cm
3.		Plug paraplow	PPF 1	7-10 cm
4.		Plug paraplow	PPF 2	15-25 cm
5.		Chisel + disk harrow	CF 1	7-10 cm
6.		Chisel + disk harrow	CF 2	15-25 cm
7.		20 cm ploughing	AF1	7-10 cm
8.		20 cm ploughing	AF2	15-25 cm
9.		30 cm ploughing	AF3	7-10 cm
10.		30 cm ploughing	AF4	15-25 cm
11.	Nefertilizat	Disk harrow	DN1	7-10 cm
12.		Disk harrow	DN2	15-25 cm
13.		Plug Paraplow	PPN 1	7-10 cm
14.		Plug Paraplow	PPN2	15-25 cm
15.		Chisel + disk harrow	CN 1	7-10 cm
16.		Chisel + disk harrow	CN 2	15-25 cm
17.		20 cm ploughing	AN1	7-10 cm
18.		20 cm ploughing	AN2	15-25 cm
19.		30 cm ploughing	AN3	7-10 cm
20.		30 cm ploughing	AN4	15-25 cm

After 24 hour of room temperature maintenance, the samples soils where ground and passed through a 2 mm and, finally, used for phosphatase activity determination. The phosphatase (EC 3.1.3.2) activity was measured in reaction mixtures whith citric acid, citrate, disodic p-nitrophenil phosphate buffer (pH 4.8) while alkaline phosphatase (EC 3.1.3.1) activity in reaction mixtures with β-glyceophosphate and natrium diethyl barbiturate buffer (pH 8.6). Both, phosphatases activities are expressed in mg phosphorous at 100 g soil (Artenie et al. 2008).

RESULTS AND DISCUSSIONS

Phosphatase are a broad group of enzymes that are capable of catalyzing hydrolysis of esters and anhydrides of phosphoric acid. Apart from being good indicators of fertility, phosphatase enzymes play key role in the soil system (Dick et al. 2000). Acid and alkaline phosphatases are the two forms of active phosphatase. Alkaline phosphatase, occurs in roots mainly after mycorrhizal colonization and has been proposed as a marker for the analyzing the symbiotic efficiency of root colonization (Tisserant et al., 1993). In soil these enzymes are belived to play critical roles in P cycles as evidence shows that they are correlated to P stress and plant growth.

Generraly, enzymes respond to soil management changes long before other soil quality indicator changes are detectable. Soil enzymes play an important role in organic matter decomposition and nutrient cycling. While some enzymes only facilitate the breakdown of organic matter (e.g., hydrolase, glucosidase), others are involved in nutrient mineralization (e.g., amidase, urease, phosphatase, sulfates). With the exception of phosphatase activity, there is no strong evidence that directly relates enzyme activity to nutrient availability or crop production. The relationship may be indirect considering nutrient mineralization to plant available forms is accomplished with the contribution of enzyme activity (Bandick and Dick, 1999, Dick, 1997).

In both fertilized soil profiles chosen for study (7-10 cm and 15-25 cm) the alkaline phosphatase activity, shows the same variation and the values are very close (Fig. 1). However, enzymatic activity is slightly higher in the soil profile collected from the surface in the case of ploughing at 30 cm (AF 30), using the plug paraplow (PPF), chisel and disk harrow (CF), where they encountered a greater number of microorganisms.

In unfertilized soil alkaline phosphatase activity in soil profiles collected from 7-10 cm and 15-25 cm, have values very close to the use of plow (PPN), polished (CN) and plowing at 20 cm (AN 20 cm) (Fig. 2.). By plowing to a depth of 30 cm and use the disc (DN), soil profile taken from 7-10 cm have relatively higher values of this enzymes compared with the profile collected from 15-25 cm.

Comparative study of alkaline phosphatase activity in soils fertilized and unfertilized collected from two depths, which were conducted on various agricultural works reveals that enzymatic activity is increased, with different amplitudes, if unfertilized soil was used Disk harrow (D), Plug paraplow (PP) and chisel + disk harrow (C) (Fig. 3. and Fig. 4). Enzymatic activity is reversed by tillage at both depths (20 cm and 30 cm), which is higher in fertilized soils compared to the infertile soil profiles in both samples. An explanation of this behavior would be that agricultural works have an influence on soil enzymatic activity due to different physical conditions causing them.

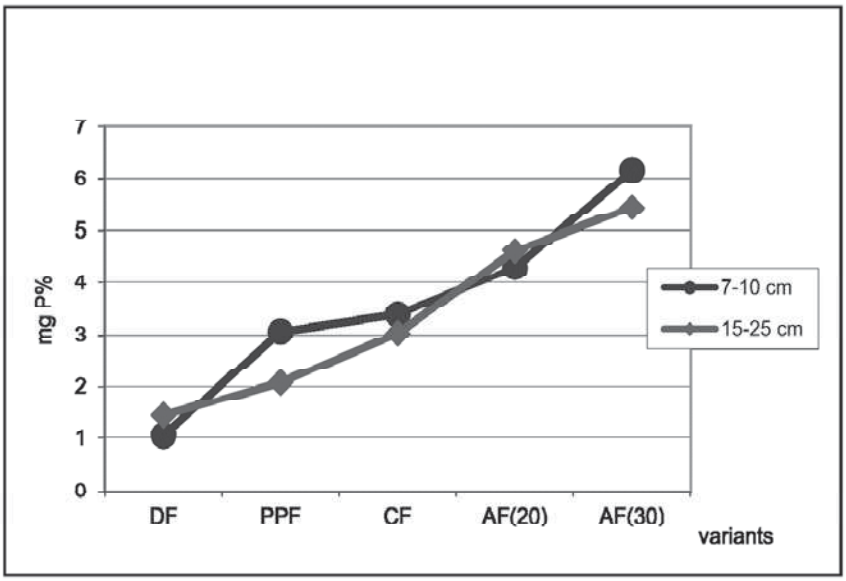

Figure 1. Variation of alkaline phosphatase activity at fertilized soil from different depth, subjected to different types of agrotechnical works

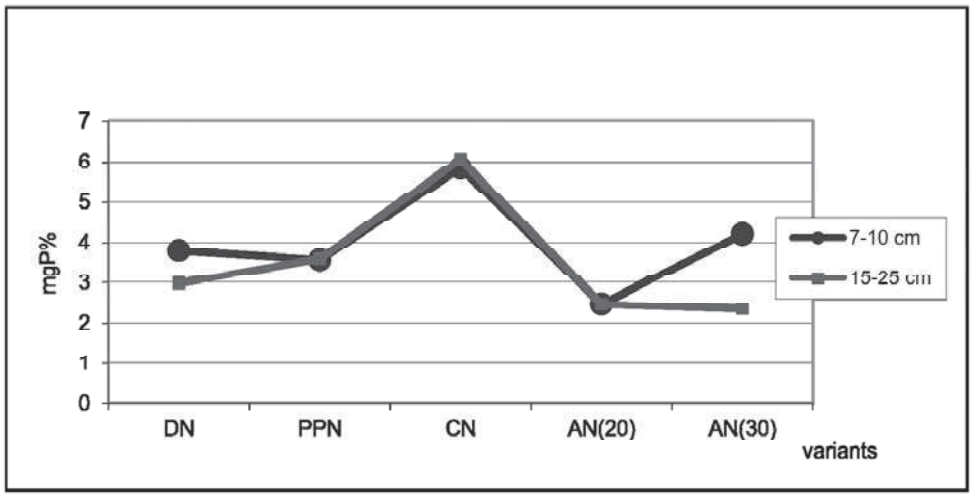

Figure 2. Variation of alkaline phosphatase activity at unfertilized soil from different depth, subjected to different types of agrotechnical works

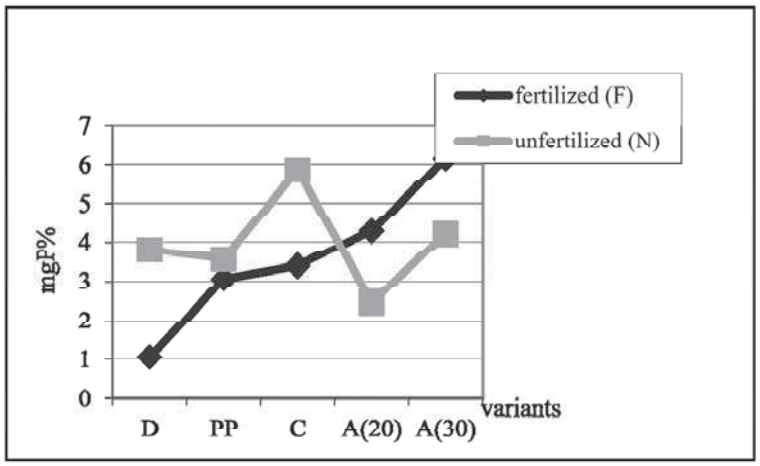

Figure 3. Variation of alkaline phosphatase activity at soil colected from 10-15 cm depth, subjected to different agrotechnical works

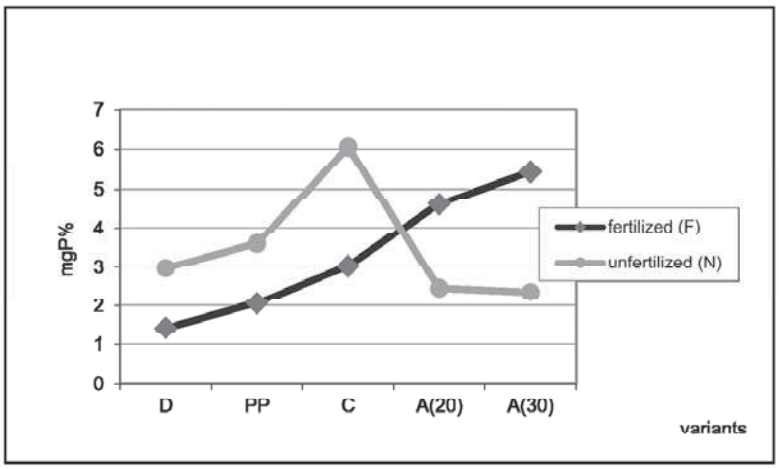

Figure 4. Variation of alkaline phosphatase activity at soil colected from 15-25 cm depth, subjected to different agrotechnical works

The amount of acid phosphatase exuded by plant roots has been show to differ between crop species and varieties as well as crop management practices (Ndakidemi, 2006, Wright and Reddy, 2001). Thus, research has show that legume secrete more phosphatase enzymes than cereals. The soil pH is another factor that influenced the rate of this enzyme synthesis, release and stability.

Acid phosphatase activity from fertilized soils taken from different depths is showing fluctuating larger or smaller amplitudes depending on the type of work performed (Fig. 5.). Thus, the soil enzymatic activity is increased in the profile collected from 7-10 cm while from the 15-25 cm is low and reciprocally. This variation is dependent on the response of existing microbial populations as a consequence of carrying out agricultural works.

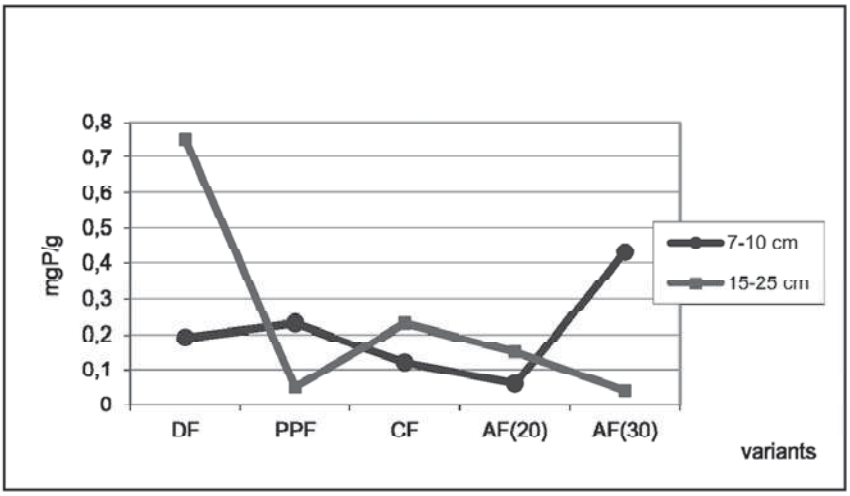

Figure 5. Variation of acide phosphatase activity at fertilized soil from different depth, subjected to different types of agrotechnical works

In unfertilized soils taken from 7-10 cm the acid phosphatase activity values are close by applying tillage using disc harrow (DN) and chisel + disk harrow (CN), like plug paraplow (PPN) and plowing at 20 cm or 30 cm (Fig. 6.). Generally, enzymes activities decrease with soil depth (Deng and Tabatabai, 1997) as it does microbial biomass and organic C content. A number of studies have compared the phosphatase activity with soil depth finding that it decreases with soil depth and corresponds to a distribution of microorganisms in soil profiles (Khazirev, Burangulova, 1965) and organic matter content (Arutyunyan, Galstyan, 1975).

Unfertilized soil colected from 15-25 cm have a more pronounced enzyme activity, relatively similar to the use of disc harrows (DN) and plowing at 30 cm. Fertilization is one of the soil and crop management practices, which exert a great influence on soil quality. Generally, soils fertilized with organic manure increased significantly phosphatase activity (Guan, 1989). Collected soil samples from two fertilized and unfertilized soil depth (7-10 cm and 15-25 cm) soil presents the different activities of acid phosphatase and treatment amplitudes are dependent on agricultural work carried out on soil (Fig. 7., Fig. 8.).

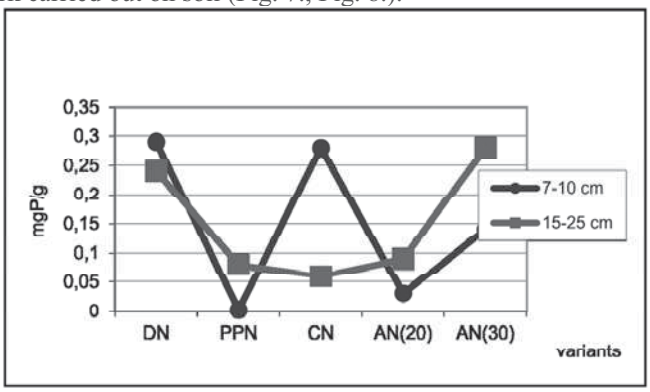

Figure 6. Variation of acide phosphatase activity at unfertilized soil from different depth, subjected to different types of agrotechnical works

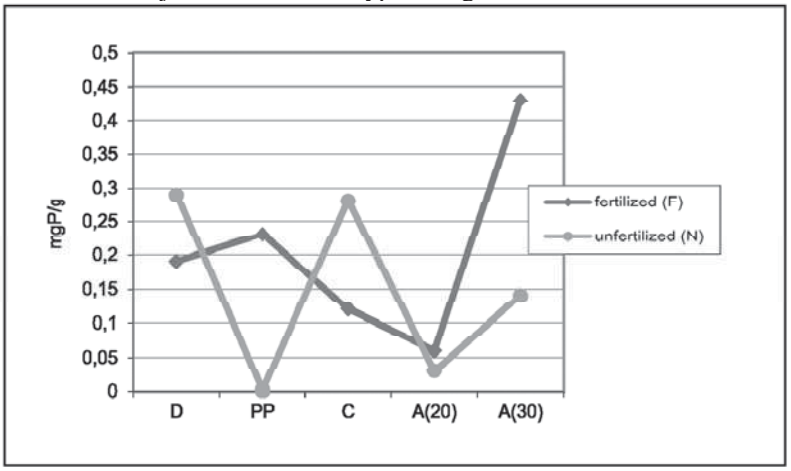

Figure 7. Variation of acide phosphatase activity at soil colected from 7-10 cm depth, subjected to different agrotechnical works

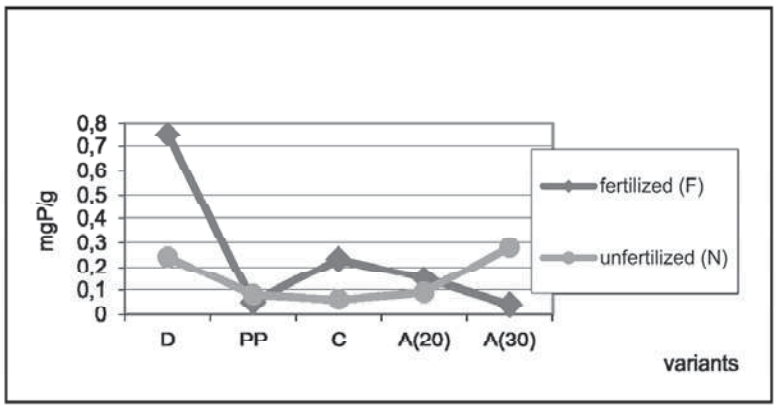

Figure 8. Variation of acide phosphatase activity at soil colected from 15-25 cm cm depth, subjected to different agrotechnical works

CONCLUSIONS

Biological parameters have great value as early and sensitive indicators of changes in soil properties induced by different management strategies. Monitoring soil alkaline phosphatase activity showed, generally, the same in fertilized soil profiles collected from both depths; the values being extremely close. In unfertilized soils, alkaline phosphatase activity is different only in soils that were exposed to unconventional work using disc harrows and 30cm tillage. All utilised works type cause an intense alkaline phosphatase activity in 7-10 cm soil profile. Acid phosphatase activity is highly fluctuating in both fertilized as well unfertilized soil, this enzyme being influenced by the performed works.

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