



ESTIMATION OF DEHYDROGENASE ACTIVITY IN MAIZE CULTIVATED SOILS, SUBJECTED TO VARIOUS AGROTECHNICAL WORKS

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SYNOPSIS

The chemical reactions involved in soil bio-transformation are especially conducted by enzymes produced by the micro-flora. Dehydrogenase activity are often used as a soil activity indicator, because it provides correlative information regarding the soil microbial populations, and also represent a marker for the destruction caused by pesticides, humidity excess, faulty management, etc.

In this paper, results from apparent and potential dehydrogenases activity research are presented for both fertilized and unfertilized soils that sustained different agricultural activities, with harvesting depths of 7-10 cm and 15-25 cm. Our results suggest that different tillage, treatments and harvesting depth have an obvious indirect influence on dehydrogenises activity by the modifications it brings on the airy status of the soil.

INTRODUCTION

Like an dynamical living organism, the soil functions in a manner depending on proper state. The biological component of soil health is dependent on the number, diversity and good health of specific macro-, mezo- and microflora. The number of soil species assuring an adequate functioning of soil processes is inferior to that naturally occuring in the most soils (Wardle et Giller, 1996).

The plants furnish organic substrata (carbohydrates, amino acids etc.) to microorganisms which realize their microbiological degradation, by production and excretion of proper oxidoreduction enzymes with active role in biodegradation (in the case of contaminants, the degradation prevents their penetration in soil profile) (Cunningham et Ow, 1996; Radwan et al., 2000).

Because dehydrogenase activity is implied in initial splitting of organic substances, the dehydrogenases are frequently used as indicators of soil biological activity (Garcia et al., 1997, 1998, 2000). These enzymes are important endocellular enzymes catalyzing ATP – producing metabolic reactions; they exist in intact cells and have not soil extracellular accumulation. Also, this biochemical indicator is often used as a measure unit of pesticide caused destructions (Pandely et Singh, 2006), humidity excess (Brzezinska et al., 1998), defective management etc.

In this paper, we studied the actual and potential dehydrogenase activities in two depth levels of fertilized and non fertilized maize cultivated soils, which supported different agrotechnical works.

MATERIAL AND METHODS

The biological material consisted in maize cultivated soil, collected in the middle of May 2008 and subjected to basic agrotechnical works in autumn of 2007. Soybean was the precursory crop. The investigated experimental variants, the used notations, the effected chemical treatments, the applied agrotechnical works as well the depth levels from which the samples were collected are included in Table I.

After 24 h of room temperature maintenance, the soil was ground and sift. The samples were weighted and processed in view of determination of enzyme activities.

Actual and potential dehydrogenase activities were performed by colourimetric method based on the capacity of dehydrogenases to transfer the hydrogen from various organic substrata preexisting in analysed biological material or, respectively, from glucose to 2,3,5-triphenyltetrazolium chloride, which is reduced to triphenylformazan, red-coloured. The intensity of triphenylformazan acetone extract colour is proportional with dehydrogenase activity Kiss et al., 1965).

Actual dehydrogenase activity was expressed in micrograms formazan resulted by the action of enzyme on 2,3,5-triphenyltetrazolium chloride, reported to the analysed material weight. The standard curve, constructed with known formazan concentrations, present the dependence between sample extinction and formazan concentration.

Table I. Experimental variants

Crt. no.	Conventional notation	Treatment	Agrotechnical works	Depth (cm)
1.	DF1	Fertilized (N80P80)	Disk harrow	7 – 10
2.	DF2		Disk harrow	15 – 25
3.	PPF1		Plug paraplow – paraplow system	7 – 10
4.	PPF2		Plug paraplow – paraplow system	15 – 25
5.	CF1		Chisel and disk harrow	7 – 10
6.	CF2		Chisel and disk harrow	15 – 25
7.	AF1		20 cm ploughing	7 – 10
8.	AF2		20 cm ploughing	15 – 25
9.	AF3		20 cm ploughing	7 – 10
10.	AF4		20 cm ploughing	15 – 25
11.	DN1	Non fertilized	Disk harrow	7 – 10
12.	DN2		Disk harrow	15 – 25
13.	PPN1		Plug paraplow – paraplow system	7 – 10
14.	PPN2		Plug paraplow – paraplow system	15 – 25
15.	CN1		Chisel and disk harrow	7 – 10
16.	CN2		Chisel and disk harrow	15 – 25
17.	AN1		20 cm ploughing	7 – 10
18.	AN2		20 cm ploughing	15 – 25
19.	AN3		20 cm ploughing	7 – 10
20.	AN4		20 cm ploughing	15 – 25

RESULTS AND DISCUSSIONS

Analysis of results on actual dehydrogenase activity, determined in two depth levels of fertilized soils, generally evidences smaller amplitudes of enzyme values in the samples from 15-25 cm level comparatively to those originating from 7-10 cm level (fig. 1). Exception is the variant in which the soil was subjected to an agrotechnics realized at 20-25 cm in depth, without furrow overturning. In this case, for both depth provenances of samples, the graphic representation reveals a minimum value of actual dehydrogenase in disk harrow worked soil and maximum in 30 cm ploughed soil.

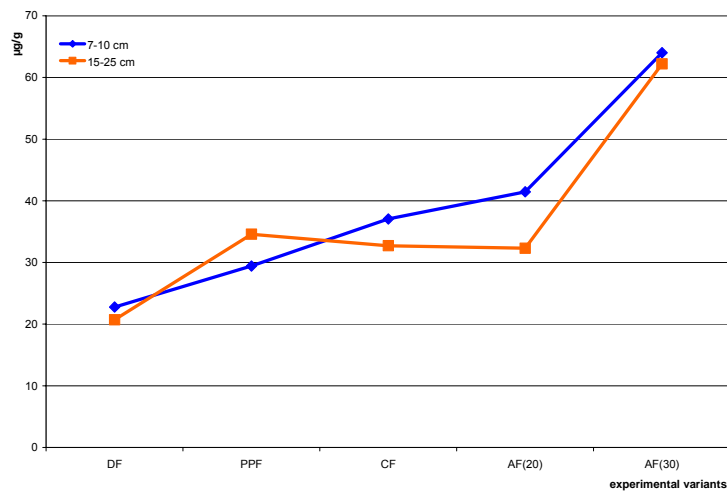


Figure 1. Variation of actual dehydrogenase activity in two depth levels of fertilized soils subjected to different types of agrotechnical works

According to our results, the most efficient soil aeration was realized – in precursory autumnal agrotechnical works – by ploughing at 30 cm and the smaller by disk harrow. The soil physical conditions have a strong influence on dehydrogenase activity by the modifications of aeration state of soil. We sustain this fact because in literature some data on dehydrogenase activity are in inverse relation with air penetration in pores, oxygen diffusion rate and redox potential. Therefore, the enzyme activity increases together with aerobiosis increasing because anaerobic or facultatively aerobic members of microbial association become more important in total respiratory process of the soil.

Relative to the actual dehydrogenase activity in non fertilized soils - also harvested from the two depth levels - the maximum and minimum amplitudes are registered in the same experimental variants like in fertilized soils (fig. 2).

A study effected on dehydrogenase activity of chernozem soils revealed a significant influence of soil aggregates diameter on enzyme activity (Drazkiewicz, 1995). We consider that by agrotechnical works, the smaller soil aggregates are obtained in experimental variant „chisel and disk harrow” at which the dehydrogenase activities registered medium values both for fertilized and non fertilized soils, comparatively to the activities of the soils subjected to other types of agrotechnics.

Comparative analysis between variants of fertilized soils and non fertilized soils shows that, excepting plug paraplow variant, the values of actual dehydrogenase activities in non fertilized soil are superior to those of fertilized soil (fig. 3).

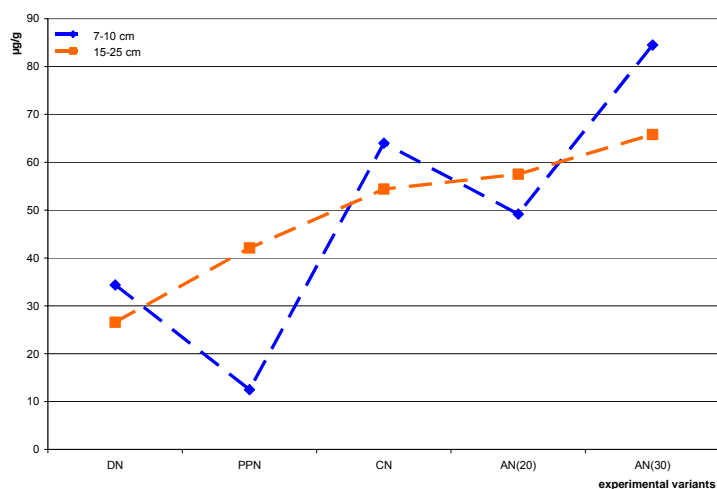


Figure 2. Variation of actual dehydrogenase activity in two depth levels of non fertilized soils subjected to different types of agrotechnical works

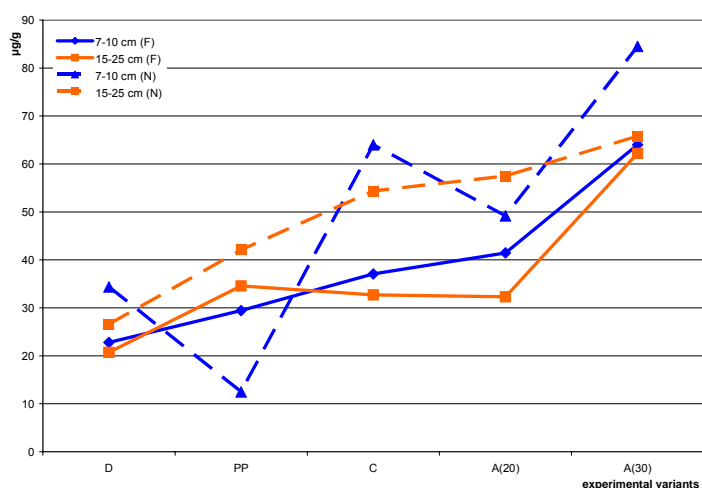


Figure 3. Variation of actual dehydrogenase activity in two depth levels of fertilized and non fertilized soils subjected to different types of agrotechnical works

This behaviour can be explained by the inhibitory effect of used fertilizer on dehydrogenase activity. The most studies with pesticides evidenced a temporary inhibition exerted by these substances on soil enzymes (Pandely et Singh, 2006).

Potential dehydrogenase has superior activities for experimental variants in which the soil was prelevated from 7-10 cm depth (fig. 4). We argue this behaviour by previous comments as well as by the fact that the fertilization treatments introduce in soil nitrogen, phosphorus and other elements with some influence on enzyme activity. Especially in those situations in which the agrotechnics not lead to the soil furrow overturning – like plug paraplow variant – the potential dehydrogenase is evidently higher in soil sample prelevated from surface level.

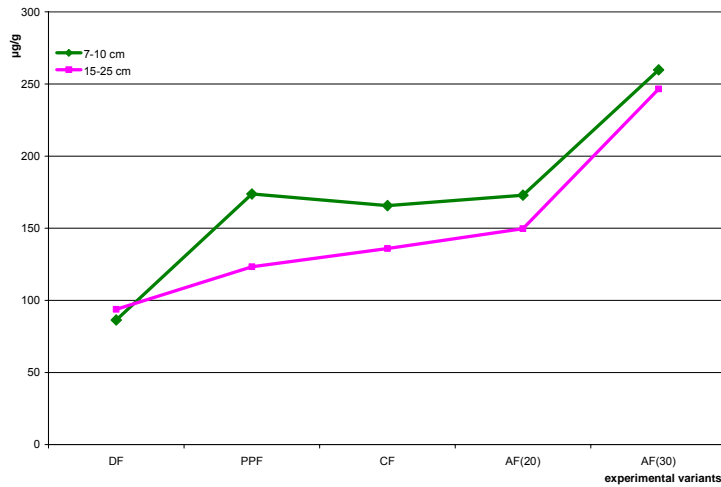


Figure 4. Variation of potential dehydrogenase activity in two depth levels of fertilized soils subjected to different types of agrotechnical works

The minimum and maximum values of enzyme activity are registered for the same work types, both for the soils prelevated from 7-10 cm depth and 15-25 cm depth. For experimental variants noted PPF1, CF1, AF1, respectively PPF2, CF2, AF2, the values are comparable, but the amplitudes are different for each prelevation depth.

For non fertilized soil, the maximum amplitudes of potential dehydrogenase activity maintain in the same experimental variants, but the minimum activities of dehydrogenase are modified (fig. 5). Particular behaviours are registered for the soil samples originating in both depth levels; we suppose that these behaviours are in relation to the different agrotechnical works applied to respective lots.

Comparative analysis of potential dehydrogenase activities in variants of fertilized soils and non fertilized soils shows a similar profile with that of actual dehydrogenase, some difference existing in values amplitude (fig. 6). Fertilization represents a disturbing factor of oxidoreduction reactions implied in the metabolism of microorganism populations in that time when the dehydrogenase activity is inhibited by the presence of treatment products.

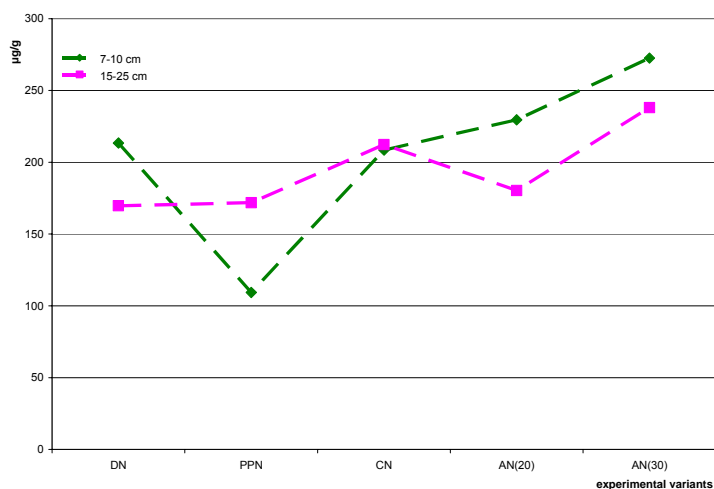


Figure 5. Variation of potential dehydrogenase activity in two depth levels of non fertilized soils subjected to different types of agrotechnical works

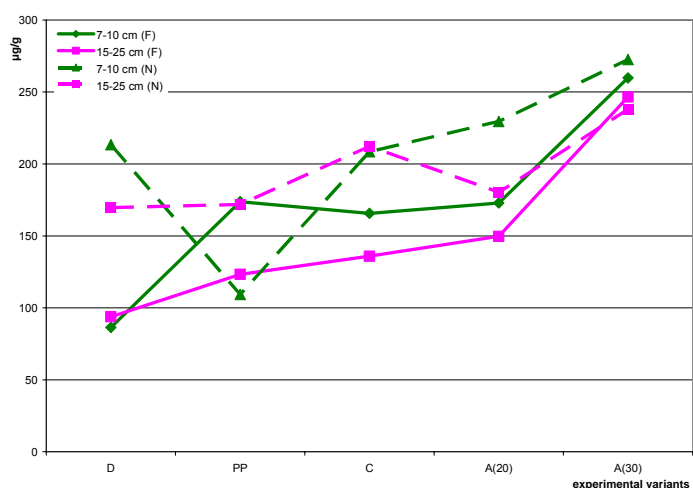


Figure 6. Variation of potential dehydrogenase activity in two depth levels of fertilized and non fertilized soils subjected to different types of agrotechnical works

CONCLUSIONS

We estimate that actual and potential dehydrogenase activities are good indicators for soil biological activity. The enzymes are active in all investigated experimental variants, and the particular aspects are dependent on chemical treatments applied to soils, variants of agrotechnical works and depth levels from which the soil samples were collected.

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