The change in biological activity is a good indicator of soil organic matter change

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INTRODUCTION

Soil's variable organic matter supply, quality and quantity determine not only the physical and chemical properties of soils, but also their biological properties. Organic matter (SOM) forms the C and N reserves of soil, is involved in pH regulation, cation exchange, structure formation, and is a key substrate for soil microorganisms.
Microbial enzymes in the soil play an essential role in catalysing processes required for organic matter decomposition and nutrient turnover. Soil enzyme activities are “sensors” of soil organic matter decomposition since they integrate information about microbial status and soil physicochemical conditions. Most organic C and N compounds are too large to be absorbed by microbes or plants, so bacteria and fungi produce enzymes extracellularly to break down organic matter into useful forms. Therefore, soil enzymes are good indicators of microbial activity and soil fertility. There is currently great interest in the use of extracellular enzyme activities as biological indicators of soil quality, because they are relatively simple to measure, are sensitive to environmental stress and respond rapidly to changes in land management. Extracellular enzyme activities can also be directly affected by factors such as temperature, moisture, pH, nutrient availability and chemical properties of the litter. Phosphatases, β-glucosidase and phenoloxidase play important role in organic matter mineralization in soil. Phosphatase enzymes can be a good indicator of the organic phosphorus mineralization potential and biological activity of soils. Phosphatase activity is related to soil and vegetation conditions, responds to changes in management, and can be related to seasonal changes in soil temperature and. β-Glucosidase is active in the first phases of degradation of organic compounds that reduce the molecular size of organic structures, thus facilitating future microbe enzyme activity. β-Glucosidase is produced by many diverse fungi, including the wood-rotting basidiomycetes (both white- and brown-rot). Some organisms use extracellular phenoloxidases to degrade lignin and humus to gain carbon and other nutrients. More generally, extracellular phenol oxidases are deployed by both fungi and bacteria to mitigate the toxicity of phenolic molecules and metal ions, and aid in antimicrobial defence.

Our objective was to examine seasonal dynamics of soil phosphatase, phenoloxidase and β-glucosidase activities and to determine the effects of detrital manipulations on these dynamics.

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MATERIALS AND METHODS

Síkfőkút DIRT Project (SIK) was established in 2000 as the part of US ILTER DIRT (Detritus Input and Removal Treatments) network. The study area comprises 21ha in the south part of the Bükk Mountains in Hungary (N 47°55' E 20°46'), 325 m altitude. The mean annual temperature is 10°C, and means annual precipitation is 553 mm. Six treatments were established according to ILTER DIRT (Table 1; Fig. 1)

Table 1: The applied DIRT treatments in SIK

Treatment	Method
Control (C)	Normal litter inputs are allowed.
No Litter (NL)	Aboveground inputs are excluded from plots.
Double Litter (DL)	Aboveground leaf inputs are doubled by adding litter removed from No Litter plots.
Double Wood (DW)	Aboveground wood inputs are doubled based on measured input rates of woody debris fall.
No Roots (NR)	Roots are excluded with impenetrable barriers extending from the soil surface to the top of the C horizon.
No Inputs (NI)	Aboveground inputs are prevented as in No Litter plots, belowground inputs are prevented as in No Roots plots.

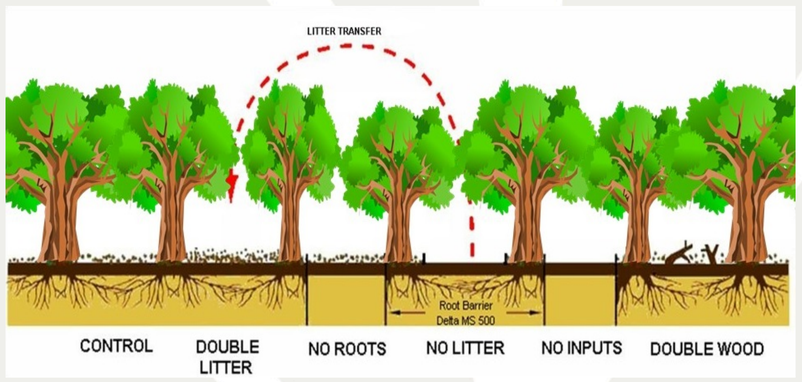

Fig. 1: The litter manipulation treatments in SIK

The soil samples were taken randomly, from the top 15 cm layer. The phosphatase, phenoloxidase and β-glucosidase activity was measured for one year in each season according to Sinsabaugh et al. 1999.

CONCLUSIONS

According to our result in soils of DL and DW treatments had significantly higher β-Glucosidase and Phosphatase activity than in the detritus withdrawal treatment condition.
In DL and DW treatments the presence of hot spots of microbial activity was amplified with increasing amount of plant debris, including litter and deadwood; so naturally the microbial activity of soils was enlarged.
We have also found that the quality of organic matter in the soils has a significant effect on the biological activity of the soil and thus on its ability to provide nutrients.

MAIN RESULTS

The soil phosphatase and β-glucosidase enzymes measured showed similar seasonal dynamics.

Both enzymes showed the highest activities in spring coincident with high soil moisture and, presumably, high root activity. In soil enzyme activity, there was a significant difference between glucosidase and phosphatase enzymes activity between treatments. In case of phenoloxidase enzyme we found a significant difference between treatments and DW treatment. There was no significant difference between glucosidase enzyme in June and September (Fig. 2). In contrast, there were significant differences between treatments in the early spring (March). The highest activity was observed in this period in the case of doubling treatments (DL, DW) and in the soils of C plots. Withdrawal treatments (NL, NR, and NI) showed lower activity than the Control.

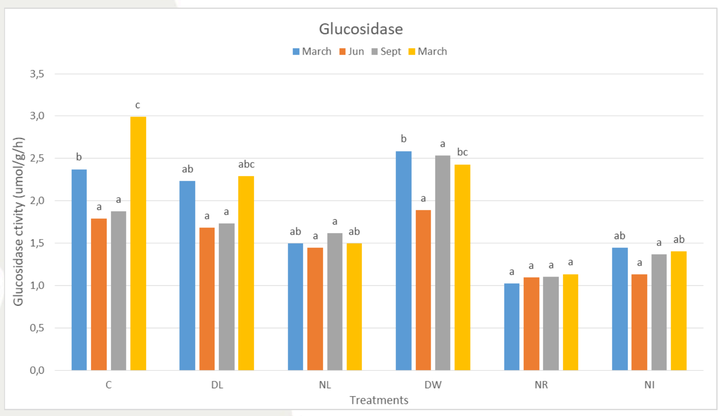

Fig. 2: The litter manipulation treatments in SIK

A similar trend was observed for the phosphatase enzyme (Fig 3). For this enzyme, of the withdrawal treatments, the NL treatment showed higher activity than the NR and NI treatments, but did not reach the values measured for the doubling treatments. In the case of the phenoloxidase enzyme, the activity values measured with the DW treatment were outstanding (Fig 4).

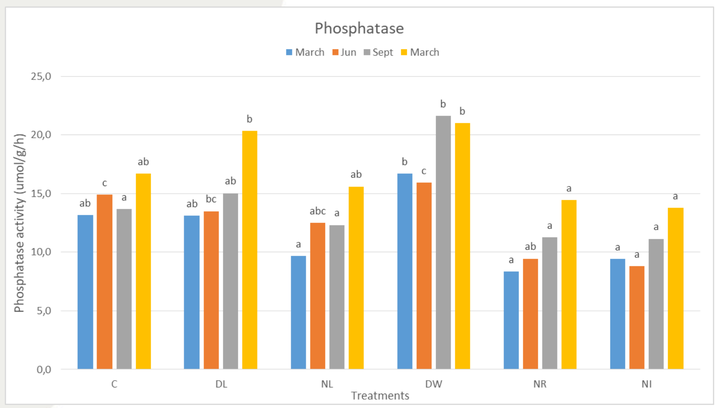

Fig. 2.1: The litter manipulation treatments in SIK

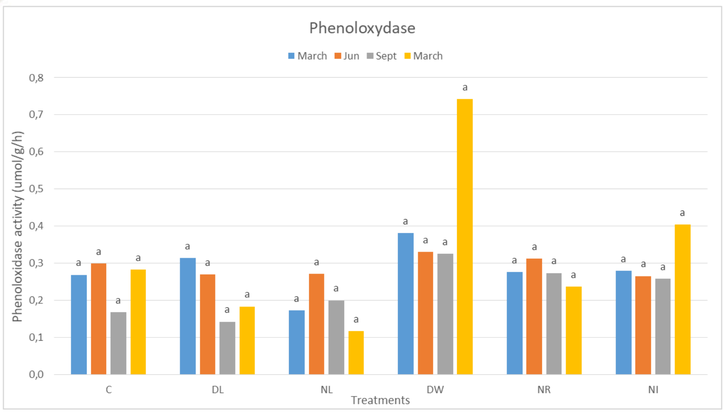

Fig. 2.2: The litter manipulation treatments in SIK

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