ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LIX 8 Number 3, 2011

PROPORTION OF ROOT-DERIVED ACID PHOSPHOMONOESTERASE IN TOTAL SOIL ACID PHOSPHOMONOESTERASE IN DIFFERENT FORESTS

L. Holík, P. Dundek, P. Formánek, K. Rejšek, V. Vranová

Received: January 13, 2011

Abstract

HOLÍK, L., DUNDEK, P., FORMÁNEK, P., REJŠEK, K., VRANOVÁ, V.: *Proportion of root-derived acid phosphomonoesterase in total soil acid phosphomonoesterase in different forests.* Acta univ. agric. et silvic. Mendel. Brun., 2011, LIX, No. 3, pp. 55–58

Enzyme acid phosphomonoesterase (APM) plays an important role in phosphorus mineralization in different type of terrestrial ecosystems. This enzyme is of great agronomic significance because it hydrolyses organic phosphorus to different forms of inorganic phosphorus which are assimilable by plants. APM may also indicate changes in the quantity and quality of phosphorylated substrates in soil and is a good indicator of its biological state as well as presence of pollutants. APM may be produced by plant roots and soil microorganisms and both of these sources may play different role in phosphorus mineralization in different ecosystems. The aim of this work was determine acid phosphomonoesterase (APM) activity location in soil of different forest ecosystems. The APM activity location determination was performed on the basis of root-derived and soil-derived APM and expression of proportion of those root-derived in total soil APM up to 13 cm depth. The results of this preliminary study showed that root-derived APM formed 21–34% of total soil APM in pine and oak forest.

acid phosphomonoesterase, soil, forests, roots

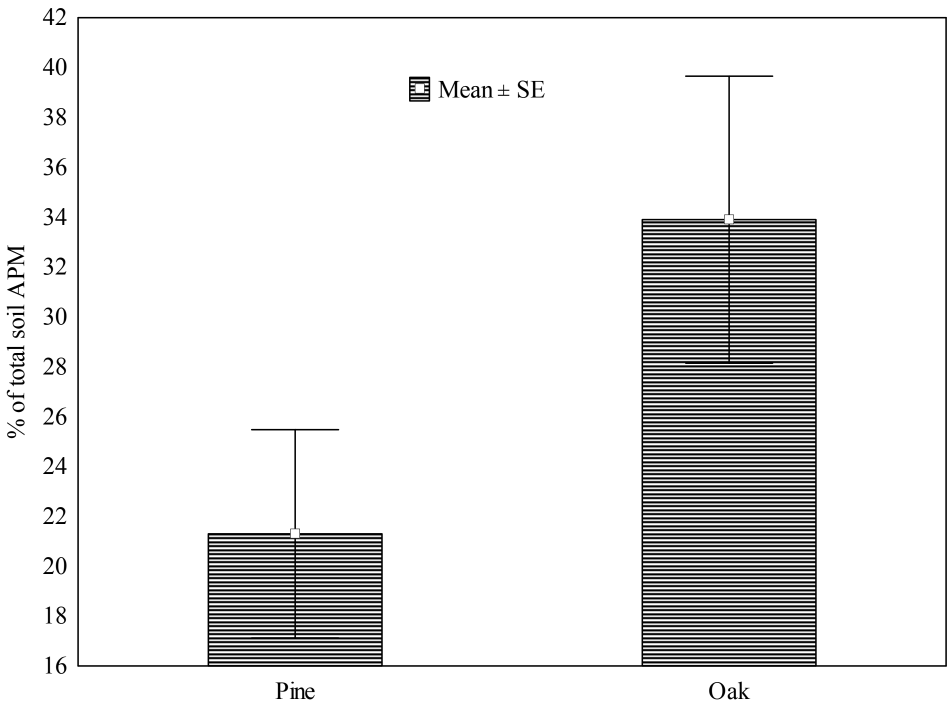
Extracellular phosphomonoesterases (orthophosphoric monoester phosphohydrolases) catalyze hydrolysis of a variety of organic phosphomonoesters and are therefore important in soil organic P mineralization and plant nutrition. Acid phosphomonoesterase (APM) in soil is located in different compartments. These include soil and its different fractions, plant roots and mycorrhizal fungi (Burns *et al.*, 1972; McElhinney and Mitchell, 1993; Asmar and Gissel-Nielsen, 1997; Tamás *et al.*, 2008). In these compartments, APM may occur intracellular or extracellular. As many studies were performed to determine localization of APM, still, the determination of proportion of root-derived APM in total soil environment of different terrestrial ecosystems is presently lacking. Due to this reason we have performed a pivotal experiment to determine proportion of root-derived APM in total soil APM of different forest ecosystems.

MATERIAL AND METHODS

The research was conducted in two forest plots. Oak forest and pine forest located at Training Forest Enterprise Masaryk Forest (TFE) Křtiny (oak forest N 49°16’51.656”, E 16°37’55.646”, pine forest N49°15’40.661”, E 16°37’29.17”). Soil samples were taken at the beginning of December 2009 using PVC cylinders (height 15 cm x inner diameter 5.9 cm) which were inserted in pairs to a depth of 13 cm at five selected points of each of the localities (totally 10 samples per locality). After transportation to the laboratory in plastic bags, one of the pair of cylinders was carefully separated to organic and mineral layers whereas the other was used for separation of roots. The study supposed equivalence of each of cylinders in the pair. APM of soil as well as roots was determined using modified method of Rejšek (1991), and recalculated per total amount of soil and roots.

RESULTS AND DISCUSSION

The results of this primary study showed that APM derived from roots, representing root-associated or released as a part of root exudates formed 21.3% in pine forest and 33.9% in oak forest of total soil APM up to depth of 13 cm (Fig. I). No statistically significant (P > 0.05) differences were found between the studied forests. These data were obtained at the beginning of December and no comparable study was performed so far on any type of ecosystems. APM in root exudates of different plants was found to form smaller fraction of root – derived APM ranging from 1.5 to less than 10% (Gaume *et al.*, 2001; Asmar and Gissel-Nielsen, 1997; George *et al.*, 2008). Phosphatase location seems to be uneven within root systems. Fine roots of Norway spruce were found to have significantly higher APM than medium or coarse roots (Firsching and Claassen, 1996). This aspect was not evaluated in our study. Asmar and Gissel-Nielsen (1997) reported that in barley, most of the extracellular root APM activity to be associated with roots, that is 89.5–97.5%, while 1–5% was associated with rhizoplane microorganisms. Concerning soil APM, the highest activity was reported in the upper humus layer decreasing with soil depth (Taylor *et al.*, 2002; Wittmann *et al.*, 2004; Niemi *et al.*, 2005.). APM in soil may also be influenced by plant coverage and its density due to support of microbial activity via plant roots (Dinesh *et al.*, 2004). Higher APM activity was reported in rhizosphere compared to bulk soil (Tarafdar and Claassen, 1988; George *et al.*, 2002; Hernesmaa *et al.*, 2005; Zhao *et al.*, 2007 etc.). As no comparable data related to this study are available for any type of ecosystem further more detailed study is necessary to evaluate the role of root derived APM in total soil AMP of different terrestrial ecosystems.



1: *Proportion of root-serived APM on total soil APM in different type of forests*

CONCLUSION

This opening study on location of acid phosphomonoesterase in soil showed dominance of soil-derived acid phosphomonoesterase activity up to 13 cm in pine and oak forests. The proportion of actually root-derived acid phosphomonoesterase was only 21–34%. In terms of aiming the future investigations, evaluating the role of roots in phosphorus transformation in different terrestrial ecosystems appears to be particularly challenging.

The study was supported by the Grant MSM6215648902/Forest and Wood: the support of functionally integrated forest management and use of wood as a renewable raw material phase 4/2/2, part II "The management strategy of nature conservation areas", and by project "Extension of current knowledge on bioavailable amino acids in soil and their utilization by soil microorganisms and plant roots"(IGA FFWT MENDELU No. 47/2010–2012).

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Address

Bc. Ladislav Holík, Ing. Peter Dundek, doc. RNDr. Pavel Formánek, Ph.D., doc. Ing. Klement Rejšek, CSc., Ing. Valerie Vranová, Ph.D., Ústav geologie a pedologie, Mendelova univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika, e-mail: ladisholik@seznam.cz, xdundek@node.mendelu.cz, formanek@mendelu.cz., kr@mendelu.cz, vranova@mendelu.cz