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

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Abstract

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.

acidity phosphomonoesterase, soil, forests, roots

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°37'29.177°). Soil samples were taken at the beginning of December 2009 using PVC cylinders (height 15cm x inner diameter 5.9cm) 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. 1). 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 (Tarfadar 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.

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.

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