PHOSPHATASE ACTIVITY OF EUTRIC CAMBISOLS (UPPLAND, SWEDEN) IN RELATION TO SOIL PROPERTIES AND FARMING SYSTEMS

B. Šarapatka

Palacký University, Department of Ecology and Environmental Sciences, Olomouc, Czech Republic

The aim of the study was to assess the activity of soil phosphatases in agricultural soils in relation to some physical, chemical and biological properties. The trials were conducted at experimental locations and farms in Uppland (Sweden) with eutric cambisol soil type. The results demonstrate the correlation between acid and/or alkaline phosphatase and several soil characteristics (clay content, C_{org}, N_{tot}, pH, humic : fulvic acids ratio, P_{avail}, basal soil respiration). At the experimental plots the effect of different farming systems (conventional farming without animal husbandry /A/, organic farming with animal husbandry /B/, organic without animal husbandry with standard soil cultivation /C/, and organic agricultural system without animal husbandry with minimum soil management /D/) was also studied. The data show that the highest acid and alkaline phosphatase activity was found in system D followed by system B. The lowest means were recorded in systems A and C. The research suggests that soil phosphatase activity was directly dependent on the content of organic substances in the soils (C, N forms) which may be influenced by farming activities. Our research provides results which can help to optimize the agroecosystem with respect to both minimizing inputs and protecting the environment.

phosphatase activity; physical, chemical and biological soil characteristics; farming systems

INTRODUCTION

All biochemical reactions are dependent on, and/or related to enzymes present in the environment. The same applies to those processes which take place in soils. Based on their origin and development, soil types differ in organic matter content, soil organism composition and activity, and consequently, in the intensity of the biological processes and soil enzymes (Kuprevich, Scherbakova, 1971).

The activity of soil enzymes is important for nutrient availability for plants. Our research was focused on phosphorus – a major biogenic element that is made available through phosphatase.

Plants are able to take up and utilize inorganic phosphorus only, particularly the orthophosphate ion (anions $H_2PO_4^-$ and HPO_4^{2-}). In general, phosphorus occurs in soils in its inorganic form (both available and unavailable) as well as in organic bonds. Mineralization of such organic fractions, where a key role is played by phosphatases, is of great agricultural and economic importance. Enzyme reactions which take place in the cells of soil organisms, plant roots, and directly in the soil due to enzyme accumulation form the basis of soil metabolism (Chaziev, 1972; Kaprálek, 1986; Speir, Ross, 1978). A major step in organic matter conversion is its hydrolytic decomposition catalyzed by enzymes - hydrolases. A key role is played by esterase that cleaves ester bonds. Orthophosphates are released from the organic bonds by means of phosphoesterases that have their optimum pH in either acid or alkaline environments (acid and alkaline phosphatases, resp.).

In agricultural soils phosphatase activity is affected by physical, chemical, and biological soil properties, crop plants and cultural practices. As far as chemical characteristics are concerned, numerous studies have been focused on carbon content and its positive impact on phosphatase activity (e.g. Nannipieri et al., 1973; Bonmati et al., 1991; Nahas et al., 1994; Šarapatka, Kršková, 1997), relationships between organic matter content (C_{org}) and other elements in the organic bonds (e.g. N and P), pH, and available phosphorus content. The amount of microbes is generally rendered a significant biological property of the soil. Various studies have shown either positive or negative correlations between the above soil properties and enzyme activity; others have reported none.

The aim of our study was to assess the activity of soil phosphatases in agricultural soils as it relates to the physical, chemical, and biological properties of soils with the intention of further applying the results obtained to the optimization of nutrient supply, particularly phosphorus within the scope of low input farming systems (e.g. ecological farming, low input agriculture).

MATERIALS AND METHODS

The trials were conducted at the experimental locations of Ultuna and Säby, both run by the Swedish University of Agricultural Sciences and on private farms (latitude 59–60 degrees north) with eutric cambisol soil type. Soil samples were taken after sowing winter wheat (September), with the forecrop being either clover-grass, on animal husbandry farms, or winter rape on the others. Afterward, soil samples were removed from the same plots planted with winter wheat (June). In total the sampling was carried out at 29 locations. From all localities 2 samples were taken each term from the 0–20 cm horizon.

At the experimental locations at Ultuna and Säby, soil samples were also taken for evaluation of different farming systems on soil phosphatase activity. The research was focused on the following farming systems:

A. conventional farming without animal husbandry (barley, oats, winter wheat, spring rape, winter wheat),
B. organic farming with animal husbandry (oats + peas, barley + undersown, clover-grass, clover-grass, winter wheat),
C. organic farming without animal husbandry and standard soil management (peas, winter wheat /potatoes/, oats + undersown, green manuring, winter wheat),
D. organic farming without animal husbandry and minimalized soil management (oats + peas, winter wheat + undersown, clover-grass, clover-grass, winter wheat).

Most of the analyses were conducted at the Department of Ecology and Environmental Sciences (Faculty of Science, Palacký University of Olomouc, Czech Republic) except for the biological soil activity – soil respiration which was determined at the Department of Microbiology (Swedish University of Agricultural Sciences in Uppsala, Sweden).

Methods:

The soil samples were subjected to granulometric analysis by means of a pipetting method, and to soil chemical analysis. The parameters obtained were used to determine organic carbon by oxidation with a chromium-sulphur mixture followed by back-titration with diammonium. Total nitrogen was assessed by means of Kjeldahl's method with nitrogen being mineralized by means of sulfuric acid. Dregs were determined by back titration with HCl. Moreover, available phosphorus was estimated after soil extraction with calcium lactate followed by spectrophotometric measurements of colour reaction, and exchangeable pH was determined in $CaCl_2$ extract (Králová, 1991; Javorský 1987). The soil organic phosphorus was estimated by a method which is based on a high efficiency of P_{org} extracted from soils by the solution's heat created by the addition of water to concentrated H_2SO_4. The acidic soil residue was then treated with NaOH to complete the extraction of P_{org} (Bowman, 1989).

The assessment of humic : fulvic acids ratio was made using the colour quotient Q 4/6 for humus substances. The visible part of the spectrum shows the highest and lowest absorbances of clear solutions of humus substances at 400 and 600 nm, respectively. This quotient, dependent on the content of humic and fulvic acids, was introduced as a tool for humus determination by Welte (Králová, 1991).

Out of the soil-biological parameters of alkaline and acid phosphatase activity were assessed. To determine the activity of the above enzymes, soil was incubated using p-nitrophenylphosphate solution, and the resulting p-nitrophenol was estimated spectrophotometrically (Tabatabai, Bremner, 1969).

The basal respiration (hourly respiration rate over forty hours before the substrate addition) and SIR (substrate induced respiration rate a few hours after addition of glucose/ammoniumsulphate/talcum mixture in 45/5/90 relation) were assessed. The CO_2 evolution, which is based on conductivity changes when CO_2 is trapped in KOH solution, was determined hourly at 20 ^{o}C with an improved version of the apparatus described by Nordgren (1988).

RESULTS

The results show the correlations among acid and/or alkaline phosphatase and numerous soil characteristics. The values of enzymatic activity and soil properties are presented in Table I. The tests revealed correlations at significance levels of 95 and 99%, resp. Afterward, a method of simple linear regression was used to determine interactions between the variables, and to assess the formula $Y = a + b.x$ (see Table II).

Analyses were carried out on the soils from experimental locations and from the farms. There was a positive correlation between acid phosphatase and organic matter content; and a negative correlation between acid phosphatase and pH. Our experiments demonstrated a positive correlation between alkaline phosphatase and basal soil respiration, organic matter content, and total nitrogen content, whilst the correlation between alkaline phosphatase and pH was negative.

Other interactions have been proved only in the soil samples from experimental locations, e.g. positive correlation between acid phosphatase and particles smaller than 0.01 mm, and total nitrogen content; and between alkaline phosphatase and a content of particles smaller than 0.01 mm and clay (smaller than 0.002 mm).

Controversial results were obtained in the study on the interaction between acid phosphatase and clay content (0.002 mm); in this case the soil samples from experimental locations showed a positive correlation contrary to the farm soils which were characterized by a negative correlation. Similar results were recorded for alkaline and acid phosphatase in relation to humus quality expressed by a humic acids : fulvic acids ratio.

As far as the content of various phosphorus forms is concerned, the negative correlation between alkaline phosphatase and available phosphorus was found only at the location of Ultuna (alkaline phosphatase = 7 835.52 – 20.74 P_{avail}). A positive correlation between alkaline phosphatase activity and SIR was observed at the same location (alkaline phosphatase = – 1 682.41 + 359.78 SIR).

PCA analysis (Ter Braak, 1993) was used to estimate the group of pedological characteristics and the results show similar correlations as those above (see Figs. 1 and 2).

I. The values of phosphatase activity and soil properties

	Research fields			
	average	medium	mode	standard errors
Acid phosphatase ($\mu mol.kg^{-1}.hour^{-1}$)	5 072.90	4 730.00	4 840.00	225.82
Alkaline phosphatase ($\mu mol.kg^{-1}.hour^{-1}$)	4 458.79	3 740.00	5 940.00	258.08
Particles < 0.01 mm (%)	54.34	60.40	60.10	2.83
Clay < 0.002 mm (%)	33.19	37.80	41.60	1.86
C_{org} (%)	1.87	1.87	1.60	0.06
N_{tot} ($mg.kg^{-1}$)	1 943.39	1 802.2	1 744.3	110.24
pH	5.80	5.75	5.48	0.06
Humic : fulvic acids (ratio)	0.60	0.64	0.64	0.04
Basal respiration ($mg\ CO_2.kg^{-1}.hour^{-1}$)	1.43	1.40	0.90	0.09
SIR ($mg\ CO_2.kg^{-1}.hour^{-1}$)	16.25	15.24	14.73	1.27
P_{avail} ($mg.kg^{-1}$)	99.43	102.00	59.00	6.43
P_{tot} ($mg.kg^{-1}$)	1 068.00	1 020.00	966.00	41.83
P_{org} ($mg.kg^{-1}$)	182.33	155.00	205.00	22.55
	Uppland farms			
	average	medium	mode	standard errors
Acid phosphatase ($\mu mol.kg^{-1}.hour^{-1}$)	4 855.44	4 741.00	5 610.00	290.04
Alkaline phosphatase ($\mu mol.kg^{-1}.hour^{-1}$)	4 768.11	4 647.50	3 740.00	255.04
Particles < 0.01 mm (%)	55.46	55.25	52.10	2.36
Clay < 0.002 mm (%)	32.89	32.50	31.10	1.74
C_{org} (%)	1.78	1.62	1.35	0.08
N_{tot} ($mg.kg^{-1}$)	1 855.26	1 760.25	1 696.6	99.51
pH	5.90	5.80	5.28	0.10
P_{avail} ($mg.kg^{-1}$)	118.75	102.5	84.00	8.65
Humic : fulvic acids (ratio)	0.615	0.64	0.64	0.03
Basal respiration ($mg\ CO_2.kg^{-1}.hour^{-1}$)	1.43	1.28	1.05	0.10
SIR ($mg\ CO_2.kg^{-1}.hour^{-1}$)	17.84	16.52	16.17	0.96

Based on the data from research fields in Ultuna and Säby, mean values of acid and alkaline phosphatase activity were calculated in relation to the different farming systems under study (Table III). The data clearly show that the highest acid and alkaline phosphatase activity was found in system D (organic farming without animal husbandry with minimalized soil management), followed by system B (organic farming with animal husbandry). The lowest means were recorded in the systems A and C (conventional farming without animal husbandry, and organic farming without animal husbandry with standard soil management, respectively).

DISCUSSION AND CONCLUSIONS

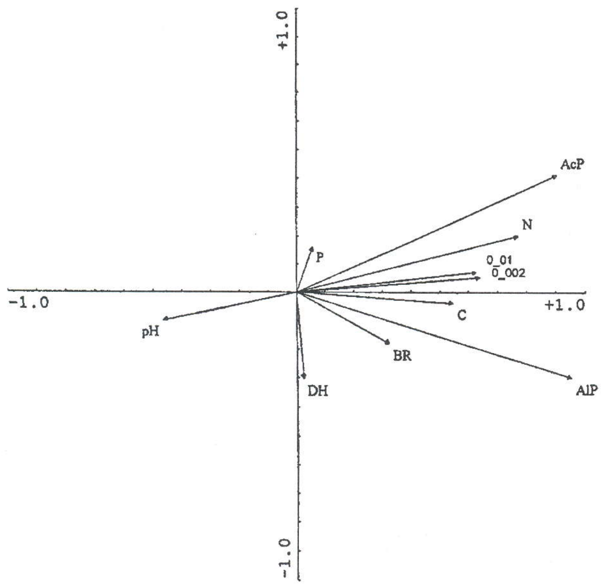
The aim of the present paper was to undertake a comprehensive study on phosphatase activity in a widespread Swedish soil type, namely eutric cambisol dependent on soil properties. The results obtained can be successfully applied for farming system optimization, particularly within the scope of low input agriculture and ecological farming.

Several correlations found in our experiments correspond with the results of others. However, they were confined to few interrelationships occurring in the soil environment. The positive correlation between phosphatases and C and N is in good agreement with the results of Bonmati et al., (1991), Chhonkar, Tarafdar (1984) and Šarapatka, Kršková (1997), the correlation between acid phosphatase and pH is similar to the observations of Gehlen, Schroder (1990), Herbien, Neal (1990) and Chhonkar, Tarafdar (1984), and the relation to the microbial activity (referred to as respiration in our study) at some locations (i.e. farms, Ultuna + Säby) corresponds with the positive correlation demonstrated by Nannipieri et al. (1983) and Chhonkar, Tarafdar (1984). It should be stressed that a negative correlation for the latter soil biological property was recorded at Säby where the phosphatase activity could have been affected by plant enzymes (Speir, 1976).

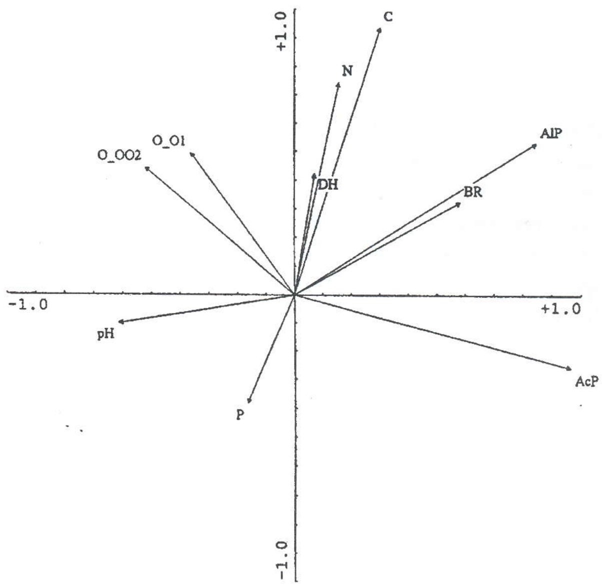
Increasing phosphatase activity with reduced mineral phosphorus content as recorded on the experimental plots of Ultuna resembles the results of Hedley et al. (1983) or Kandeler (1988). Nevertheless, our trials

II. Interactions between the activity of phosphatases and soil properties

	Research fields	Farms
Acid phosphatase x particles < 0.01 mm	AC.P = 2 622.1 + 45.50 x particles 0.01 mm R^2 = 33.96%	–
Acid phosphatase x clay < 0.002 mm	AC.P = 2 745.61 + 70.65 x clay < 0.002 mm R^2 = 35.54%	AC.P = 7 565 – 82.56 x clay < 0.002 mm R^2 = 26.474%
Acid phosphatase x C_{org}	AC.P = 2 415.97 + 1 437.25 x C_{org} R^2 = 16.19%	AC.P = 2 300.41 + 1 447.76 x C_{org} R^2 = 16.35%
Acid phosphatase x N_{tot}	AC.P = 2 182.81 + 1.50 x N_{tot} R^2 = 55.56%	–
Acid phosphatase x humic : fulvic acids	AC.P = 3 459.37 + 2 712.60 x HA : FA R^2 = 28.93%	AC.P = 7 200.24 – 3 793.25 x HA : FA R^2 = 16.43%
Acid phosphatase x pH	AC.P = 14 903 – 1 692.13 x pH R^2 = 21.47%	AC.P = 16 944.9 – 2 041.89 x pH R^2 = 54.15%
	Research fields	Farms
Alkaline phosphatase x particles < 0.01 mm	AL.P = 952.26 + 64.87 x particles < 0.01 mm R^2 = 53.85%	–
Alkaline phosphatase x clay < 0.002 mm	AL.P = 1 150.52 + 100.18 x clay < 0.002 mm R^2 = 55.25%	–
Alkaline phosphatase x C_{org}	AL.P = 1 962.85 + 1 580.11 x C_{org} R^2 = 23.82%	AL.P = 677.30 + 2 011.07 x C_{org} R^2 = 25.03%
Alkaline phosphatase x N_{tot}	AL.P = 1 031.98 + 1.76 x N_{tot} R^2 = 60.81%	AL.P = 2 385.18 + 1.28 x N_{tot} R^2 = 25.12%
Alkaline phosphatase x humic : fulvic acids	AL.P = 2 090.96 + 4 029.77 x HA : FA R^2 = 46.06%	AL.P = 7 051.83 – 3 713.37 x HA : FA R^2 = 19.12%
Alkaline phosphatase x pH	AL.P = 11 615.2 – 1 160.94 x pH R^2 = 22.11%	AL.P = 15 735.7 – 1 945.1 x pH R^2 = 22.35%
Alkaline phosphatase x basal respiration	AL.P = 3 058.12 + 1 192.52 x BR R^2 = 23.64%	AL.P = 2 793.2 + 1 163.07 x BR R^2 = 16.64%



1. Correlations among soil properties in research fields (PCA analysis)



2. Correlations among soil properties in Uppland farms (PCA analysis)

Legend:
AcP – acid phosphatase activity
AlP – alkaline phosphatase activity
DH – dehydrogenase activity
BR – basal respiration
0-01 – particles smaller than 0.01 mm
0-002 – clay smaller than 0.002 mm
C, N, P – symbols for C_{org}, N_{tot}, P_{avail}

III. Mean values of acid and alkaline phosphatase activity in research fields at Ultuna and Säby (in %)

System	Acid phosphatase	Alkaline phosphatase
A. Conventional without animals	95.3	96.8
B. Organic with animals	101.8	101.8
C. Organic without animals, normal tillage	96.1	95.5
D. Organic without animals, minimal tillage	106.8	105.9

showed no positive correlation between phosphatases and organic phosphorus content as reported by e.g. Speir and Ross (1978) or Nahas et al. (1994). In addition, there was some correlation with the content of clay particles at the experimental locations.

Quality is considered an important parameter of organic matter. In our trials it was expressed as a humic acids : fulvic acids ratio. This parameter was characterized by a positive correlation in the experimental plots (Ultuna + Säby), whilst the correlation was negative on the farms. Having compared the experimental locations, the above ratio was higher at the Säby location and was accompanied by higher values of phosphatase activity. The situation on the farms was different due to the diversity of the respective locations. The increasing humic : fulvic acids ratio brought about a decrease in the activity of the enzymes which may be due to the fact that those substances with a lower molecular weight decompose more easily (Schulten et al., 1995; Šarapatka, Kršková, 1997). However, these findings contradict the results obtained from the sites at Ultuna and Säby, where there was a positive correlation between these variables. This is probably due to differences in organic matter and clay content.

At the Swedish farms the phosphatase activity decreases with increasing clay content. This is related to the fact that soil enzymes are associated with clays and have lower activity (Boyd, Mortland, 1990).

Aditionally, differences between conventional and organic farming, as well as among different agricultural practices, were studied during the evaluation of phosphatases activity.

Organic farming system B was the only one to comprise animal husbandry, where the farmyard manure was applied (25 t/hectare). Another crop was clover grass which leaves large amount of postharvest residue. The organic farming system with minimum soil cultivation (B), was similar to that with animal husbandry. On the one hand, the crop rotation involved biennial grass, and on the other hand no farmyard manure was applied. Moreover, the organic matter supply was supplemented with cut straw scattered over the soil surface. These farming systems show a higher activity of phosphatases than systems A and C.

Conventional farming system (A) and organic farming system with standard soil management (C) were characterized by similar organic matter supplies as well as comparable soil phosphatase activities. Conventional system A did not comprise any animal husbandry and organic matter supply was quaranteed by straw incorporation. Organic farming system C was given organic matter through straw and green manure incorporation.

The above results are in close agreement with the fact that enzyme activities can be increased after the addition of energy sources (Nannipieri et al., 1983). The results of the effects of organic farming systems on higher enzyme activity are in agreement with the data published by e.g. Oberson et al. (1993) and Mäder et al. (1993). The enzyme activity could also be higher in the systems with minimum or no-tillage because of higher amounts of organic matter in the topsoil layer (e.g. Angers et al., 1993). Increasing the carbon, total nitrogen and phosphorus content could serve as a basis for increasing both biological and enzymatic soil activities.

In conclusion, the results indicate that enzyme activities are directly dependent on the content of organic substances in the soil (C, N forms) which may be influenced by farming activities (e.g., integrated and ecological agriculture). Our research provides results which can help to optimize inputs to the agroecosystem with respect to the protection of the environment.

Acknowledgements

I am much indebted to the Swedish Institute and Ministry of Agriculture and Ministry of Education, Youth and Sports of the Czech Republic for their support of the research whose partial results are presented in this paper. My personal thanks to Dr. T. Sjöqvist, Dr. B. Stenberg and Dr. J. Dlouhý from SLU Uppsala for their help. Last but not least, I wish to express my thanks to my colleagues from Palacký University, Olomouc, namely Dr. M. Kršková and Mrs. S. Šlezarová for their assistance.

REFERENCES

ANGERS, D.A. – BISSONNETTE, N. – LEGERE, A. – SAMSON, N.: Microbial and biochemical changes induced by rotation and tillage in a soil under barley production. Can. J. Soil Sci., *73*, 1993: 39–50.

BONMATI, M. – CECCANTI, B. – NANNIPIERI, P.: Spatial variability of phosphatase, urease, protease, organic carbon and total nitrogen in soil. Soil Biol. & Biochem., *23*, 1991: 391–396.

BOWMAN, R. A.: A sequential extraction procedure with concentrated sulfuric acid and dilute base for soil organic phosphorus. Soil Sci. Soc. Amer. J., *53*, 1989: 362–366.

BOYD, S. A. – MORTLAND, M. M.: Enzyme interaction with clay and clay-organic matter complexes. In: BOL-

LAG, J. M. – STOTZKY, G. (eds.): Soil Biochemistry, Vol. 6, 1990: 1–28.
CHAZIEV, F. CH.: Systemo/ekologičeskij analiz fermentativnoj aktivnosti počv. (Ecological analysis of soil fermentative activity). Moskva, Nauka 1972. 202 pp.
CHHONKAR, P. K. – TARAFDAR, J. C.: Accumulation of phosphatases in soils. J. Indian Soc. Soil Sci., *32*, 1984: 266–272.
GEHLEN, P. – SCHRODER, D.: Bedeutung von pH-Wert, $C_{org.}$ Gehalt, Kultur, Substrat und Jahreseinfluss für bodenmikrobiologische Eigenschaften in einheitlich genutzten. Ackerboden. Verband Dtsch. Landwirtsch. Untersuchungs und Forschungsanstalten Bayreuth, *30*, 1990: 467–472.
HEDLEY, M. J. – NYE, P. H. – WHITE, R. E.: Plant-induces changes in the rhizosphere of rape seedling. IV. The effect of rhizosphere phosphorus status on the pH, phosphatase activity and depletion of soil phosphorus fractions in the rhizosphere and on the cation/anion balance in the plants. New Phytologist, *95*, 1983: 69–82.
HERBIEN, S. A. – NEAL, J. L.: Soil pH and phosphatase activity. Communications in Soil Sci. and Plant Anal., *21*, 1990: 439–456.
JAVORSKÝ, P. (ed.): Chemické rozbory v zemědělských laboratořích (Chemical analyses in agricultural laboratories). Ministry of Agriculture Prague, 1987: 190–276.
KANDELER, E.: Kinetische Eigenschaften von Proteasen und Phosphatasen in unterschiedlich bewirtschaften Boden. Bodenkultur, *39*, 1988: 201–206.
KAPRÁLEK, F.: Fyziologie baktérií (Physiology of bacteria). Praha, SPN 1986: 603 pp.
KRÁLOVÁ, M. (ed.): Vybrané metody chemické analýzy půd a rostlin (Methods of chemical analysis of soils and plants). Praha, Academia 1991: 17–68.
KUPREVICH, V. F. – SCHERBAKOVA, T. A.: Comparative Enzymatic Activity in Diverse Types of Soil. In: McLAREN, A. D. – SKUJINS, J. (eds.): Soil Biochemistry, Vol. 2. New York, Dekker 1971: 167–201.
MÄDER, P. – PFIFFNER, L. – JÄGGI, W. – WIEMKEN, A. – NIGGLI, U. – BESSON, J. M.: DOK – Versuch: Vergleichende Langzeituntersuchungen in den drei Anbausystemen Biologisch-dynamisch, Organisch-biologisch und Konventionell. III. Boden: Mikrobiologische Untersuchungen. Schweiz. Landw. Fo., *32*, 1993: 509–545.
NAHAS, E. – CENTURION, J. F. – ASSIS, L. C.: Efeito das caracteristicas quimicas dos solos sobre os microorganismos solubilizatores de fosfato e produtores de fosfatases. Revista Brasileira de Ciencia do Solo, *18*, 1994: 49–54.
NANNIPIERI, P. – CERVELLI, S. – PERNA, A.: Enzyme activities in some Italian soils. Agric. Ital. Pisa, *73*, 1973: 367–376.
NANNIPIERI, P. – MUCCINI, L. – CIARDI, C.: Microbial biomass and enzyme activities: production and persistence. Soil Biol. & Biochem., *15*, 1983: 679–685.
NORDGREN, A.: Apparatus for the continuous long-term monitoring of soil respiration rate in large numbers of samples. Soil Biol. & Biochem., *20*, 1988: 955–958.
OBERSON, A. – FARDEAU, J.C. – BESSON, J.M. – STICHER, H.: Soil phosphorus dynamics in cropping systems managed according to conventional and biological agricultural methods. Biol. Fertil. Soils, *16*, 1993: 111–117.
SCHULTEN, H. R. – MONREAL, C. M. – SCHNITZER, M.: Effect of long–term cultivation on the chemical structure of soil organic matter. Naturwissenschaften, *82*, 1995: 42–44.
SPEIR, T. W.: Studies on a climosequence of soils in tussock grasslands 8. Urease, phosphatase and sulphatase activities of tussock plant matterials and of soils. N. Z. Jl. Sci., *19*, 1976: 383–387.
SPEIR, T. W. – ROSS, D. J.: Soil phosphatase and sulphatase. In: BURNS, R. G. (ed.): Soil Enzymes. London, Academic Press 1978: 198–250.
ŠARAPATKA, B. – KRŠKOVÁ, M.: Interactions between phosphatase activity and soil characteristics from some locations in the Czech Republic. Rostl. Výr. *43*, 1997: 415–419.
TABATABAI, M. A. – BREMNER, J. M.: Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. Soil Biol. & Biochem., *1*, 1969: 301–307.
TER BRAAK, C. J. F.: Canoco 3.1. Agric. Math. Group Wageningen, 1993. 88 pp. + appendix.

Received for publication on February 14, 2001
Accepted for publication on November 5, 2001

ŠARAPATKA, B. (Přírodovědecká fakulta Univerzity Palackého, katedra ekologie a životního prostředí, Olomouc, Česká republika):

Aktivita fosfatáz v kambizemích eutrofních (Uppland, Švédsko) ve vztahu k půdním vlastnostem a systému hospodaření.

Scientia Agric. Bohem., *33*, 2002: 18–24.

Cílem práce bylo stanovení aktivity fosfatáz v zemědělských půdách v závislosti na jejich fyzikálních, chemických a biologických vlastnostech. Výzkum byl prováděn na experimentálních lokalitách a farmách v Upplandu (Švédsko) s půdním typem kambizem eutrofní. Výsledky demonstrují korelace mezi aktivitou kyselé a/nebo alkalické fosfatázy a řadou půdních charakteristik (obsah jílu, C_{org}, N_{tot}, pH, poměr huminových kyselin a fulvokyselin, P, bazální respirace).

Na experimentálních lokalitách byl rovněž studován vliv zemědělských systémů (konvenční systém bez živočišné produkce /A/, ekologický zemědělský systém s živočišnou produkcí /B/, ekologický bez živočišné produkce s klasickým zpracováním půdy /C/ a ekologický systém bez živočišné produkce s minimalizovaným zpracováním půdy /D/). Získané výsledky ukazují nejvyšší aktivitu kyselé a alkalické fosfatázy u systému D, následovaného systémem B. Nejnižší hodnoty byly zaznamenávány ve variantách A a C.

Výzkum potvrdil přímou závislost aktivity fosfatáz na obsahu organických látek v půdě s možným vlivem zvoleného způsobu hospodaření. Výsledky výzkumu jsou využitelné při optimalizaci agroekosystémů včetně minimalizace vstupů a tím i pro ochranu životního prostředí.

aktivita fosfatáz; fyzikální, chemické a biologické charakteristiky půdy; zemědělský systém

Contact Address:

Doc. Ing. Bořivoj Šarapatka, CSc., Přírodovědecká fakulta Univerzity Palackého v Olomouci, katedra ekologie a životního prostředí, tř. Svobody 26, 771 46 Olomouc, Česká republika, tel.: +420-68/563 45 60, fax: +420-68/522 57 37, e-mail: sar@risc.upol.cz