10.7251/AGSY1303481P

TOTAL AND ORGANIC PHOSPHORUS STATUS IN SOILS OF EASTERN CROATIA

Brigita POPOVIC*, Zdenko LONCARIC, Krunoslav KARALIC, Vladimir IVEZIC

Univesity of Josip Juraj Strassmayer, Faculty of Agriculture in Osijek, Croatia
*(Corresponding author: brigita.popovic@pfos.hr)

Abstract

Far as is known there is no relevant information about the status of total and organic phosphorus in Croatian soils, so aim of this study was to determine the total and organic phosphorus in soils of the eastern Croatia. In total were collected 94 soil samples and the soil pH, organic matter as well as the total phosphorus content and organic phosphorus content were analyzed. All samples were grouped according to soil pH and organic matter in two groups (pH_{KCl} <6, pH_{KCl} > 6, organic matter< 2%, organic matter> 2%). Analyzed samples showed significant amounts of total phosphorus with minimal content of 329.84 mg P_2O_5 kg^{-1}, while the maximum value determined by the total phosphorus was 1732.19 mg P_2O_5 kg^{-1} with an average of 713.03 mg P_2O_5 kg^{-1}. The content of organic phosphorus in soils ranged from 3,44 mg P_2O_5 kg^{-1} to 292,55 mg P_2O_5 kg^{-1}, with the portion of organic phosphorus in total phosphorus from 0.54% to 78.29%.. Seen from the humus content in the soil, very low humic soil had an average of 12.0% of organic phosphorus, while fairly humic soil had an average of 7.1% organic phosphorus. Also, the results showed that the minimum (0.54%) and maximum (78.29%) portio of organic phosphorus in total phosphorus soils recorded within broad categories humic poor soils. Although it was expected, there was no significant differences between the amount of organic phosphorus in soil and organic matter content, but large influence of organic matter content to the correlation of certain fractions of phosphorus in the soil were determined (r = 0.89).

Key words: soil, total phosphorus, organic phosphorus, portion

Introduction

Total phosphorus are all fractions of phosphorus that exist in the soil and all organic and inorganic forms of phosphorus and oxidation of organic compounds and inorganic dissolution by acids necessary to determine the total amount of phosphorus in the soil. Many authors point out that there is an essential difference between the total and plant available phosphorus in the soil. Total phosphorus can be successfully predicted from the content of humus and common extraction methods such as Olsen or Bray (Bundy & Good, 2003) and few parameters are important for predicting the total phosphorus in the soil: the physical properties of the soil, the amount of water in soil chemical properties and organic matter (Ulen et al., 2000).

In most agricultural soils, organic P comprises 30-80 % of total P. The largest fraction of oragnic P over 50 % appears to be in form of phytin and its derivate (Tarafdar & Claassen, 1988). The significance of these organic P compounds for the P nutrition of plants is not clear. Generally, it is assumed that plants take up P as inorganic phosphate from the soil solution and than phosphatases, either from plant root or soil microorganisms, must first hydrolyze organic P compounds in soil (Hayes et al, 2000).

Materials and methods

In total were collected 94 soil samples from eastern Croatia and the soil pH (ISO 10390), organic matter (ISO 14235) as well as the total phosphorus content (ISO 11466) and organic phosphorus content (Kuo, 1996.) were analyzed. All samples were grouped according to soil pH and organic matter in two groups and several subgroups (pH_{KCl} <6, pH_{KCl} > 6, organic matter< 2%, organic matter> 2%). Total organic phosphorus determined by annealing samples. The method is based on the annealing process, which translates into an organic phosphorus inorganic form, and then determines the total amount of organic phosphorus by comparing the amount of phosphorus in the sample inorganic with or without prior annealing. Concentration of total phosphorus in both samples (with or without annealing) is calculated by the equation:
Total P (mg kg-1) = P conc (mg ml-1) x 50 / g
g = weighs soil
P = total organic P annealing - total P without annealing
Total phosphorus in the soil was determined destruction of soil samples with aqua regia (ISO 11466, 1995). Concentration of total phosphorus was determined by ICP-OES technique (induced coupled plasma-optical emission spectrometry) and expressed as mg P l^{-1}. The result then was converted into mg P_2O_5 kg^{-1}.

Results and discussion

Total phosphorus in soil consists of organic and inorganic forms of phosphorus, and considering that the method for determination of total phosphorus in the soil complicated analyzes were made on 94 samples, primarily to study the relationship between the total, organic and inorganic phosphorus in the soil. Criteria for samples distributions was pH_{KCl}, (Figure 1).
Highly acidic soil (pH_{KCl} <4) were presented with the lowest number of samples (13), and most of the samples were from a group of slightly acidic soils (23).

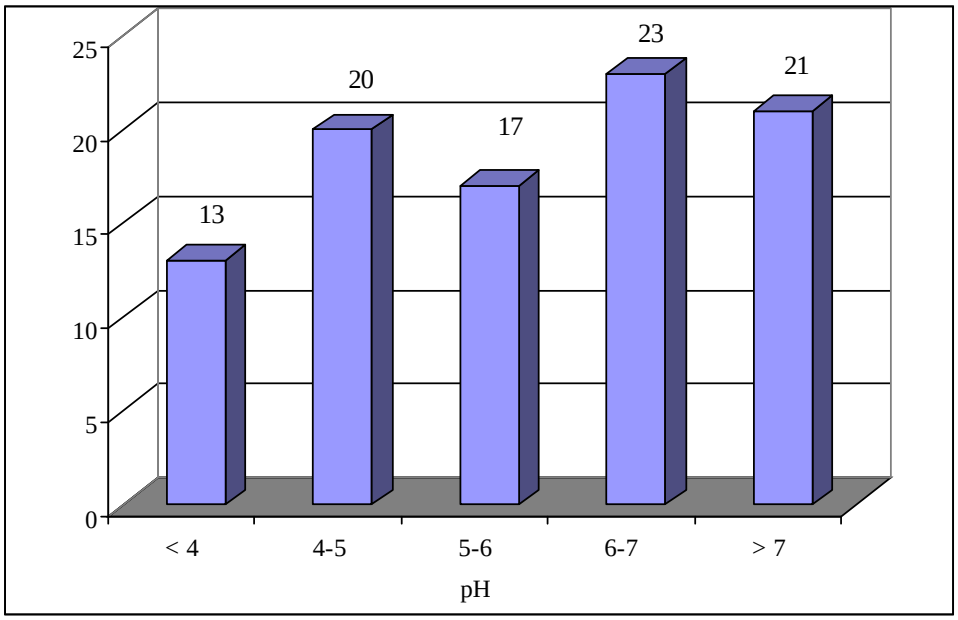

Figure 1. Soil samples distribution according to pH_{KCl}

In the analyzed samples showed significant amounts of total phosphorus from 329.84 mg P2O5 kg-1, to 1732.19 mg P2O5 kg-1 with an average value of 713.03 mg P2O5 kg-1 (Table 1).

Table 1. Minimum, maximum and average of total and organic P

Total P_2O_5 mgkg^{-1}		Organic P_2O_5 mgkg^{-1}	
Min	329,84	Min	3,44
Max	1732,19	Max	292,55
Average	713,03	Average	56,9

There was no significant differences between the minimum, maximum and average values of total phosphorus in soils according to different acidity (Table 2). However, the lowest total phosphorus was determined in slightly alkaline soils and followed by a total phosphorus in highly acidic soils.

Table 2. Minimum, maximum and average of total and organic P in different range od soil pH

Total P_2O_5 mgkg^{-1}				Organic -P_2O_5 mgkg^{-1}			
pH_{KCl}	min	max	average	pH_{KCl}	min	max	average
<4	373,69	1211,23	669,45	<4	6,3	292,55	81,69
4-5	457,06	1254,95	742,38	4-5	4,58	188,93	45,86
5-6	429,26	1175,39	724,21	5-6	3,44	201,52	62,77
6-7	408,09	1264,93	723,06	6-7	4,58	156,87	54,09
>7	329,84	1732,19	692,03	>7	11,45	237,59	50,38

Many authors point out that there is an essential difference between the total and plant available phosphorus in the soil (Al-Jaloud et al. 1998; Kuo, 1996). As proved by Bundy and Good (2003) total phosphorus can be successfully predicted from the organic matter content and common extraction methods such as Olsen or Bray. Four parameters are important for predicting the total phosphorus in the soil: the physical properties of the soil, the amount of water in soil, chemical properties and organic matter content (Ulen et al., 2000.).

As wall as total phosphorus, in the same number of samples organic phosphorus in the soil were determined and the criteria for selecting samples were organic matter content (<2% and> 2%) and soil pH.

The determined value of organic phosphorus in soils ranged from 3.44 to 292.55 mg kg-1 with an average of 56.9 mg kg^{-1} (Table 1). Distribution of samples at pH values showed that, on average, the highest concentration of organic phosphorus were represented in the group of highly acidic soils (81.69 mg kg^{-1}) while in other groups were occurred approximately the same value of organic phosphorus (Table 2).

Considering the organic matter content samples were divided into six groups: <1% organic matter, 1.0-1.5% organic matter, 1.5-2.0% organic matter 2.0-2.5% organic matter, 2,5 - 3.0% organic matter and> 3% organic matter. According to Gračanin these groups can be categorized into three: very low humic soil (<1%), low humic soil (from 4 categories by previous division: 1-3%), and plenty of humic soil (> 3%) (Figure 2).

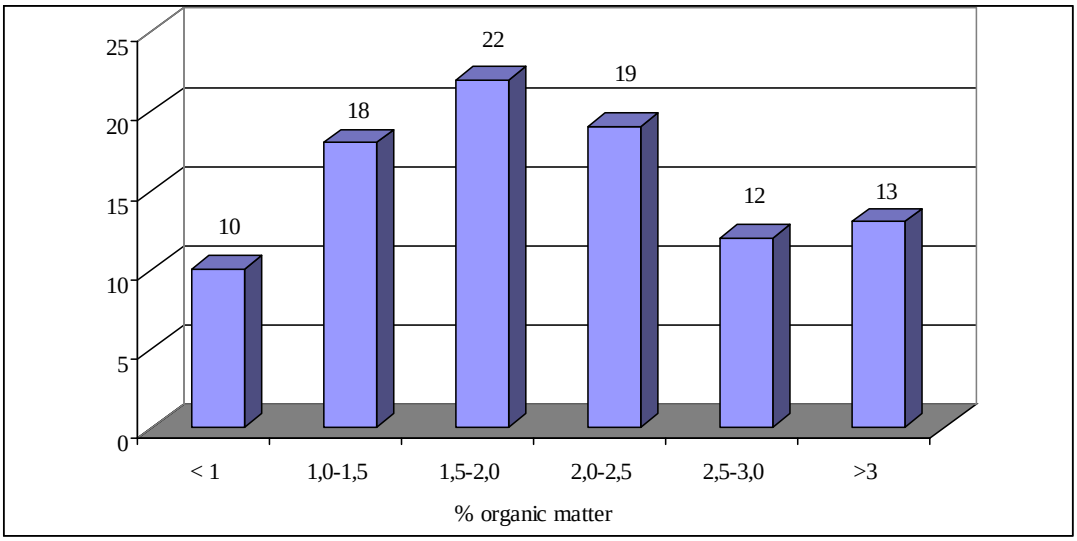

Figure 2. Soil samples distribution according to organic matter content

The share of organic phosphorus in total phosphorus were ranged from 0.54% to 78.29%. The minimum proportion of organic phosphorus in total phosphorus was recorded in the sample from the group moderately acidic soils (pH_{KCl} 5-6), while the maximum share recorded in samples from a group of highly acidic soils (pH_{KCl} <4). The soils of extremely acidic reaction was recorded the highest (14.32%) average share of organic phosphorus in total phosphorus (Figure 3). Generally, the minimum registered share of organic phosphorus in total phosphorus was in slightly humic moderately acidic soils (0,54 %), while the maximum share was recorded in extremely low humic acid soils (78,29%).

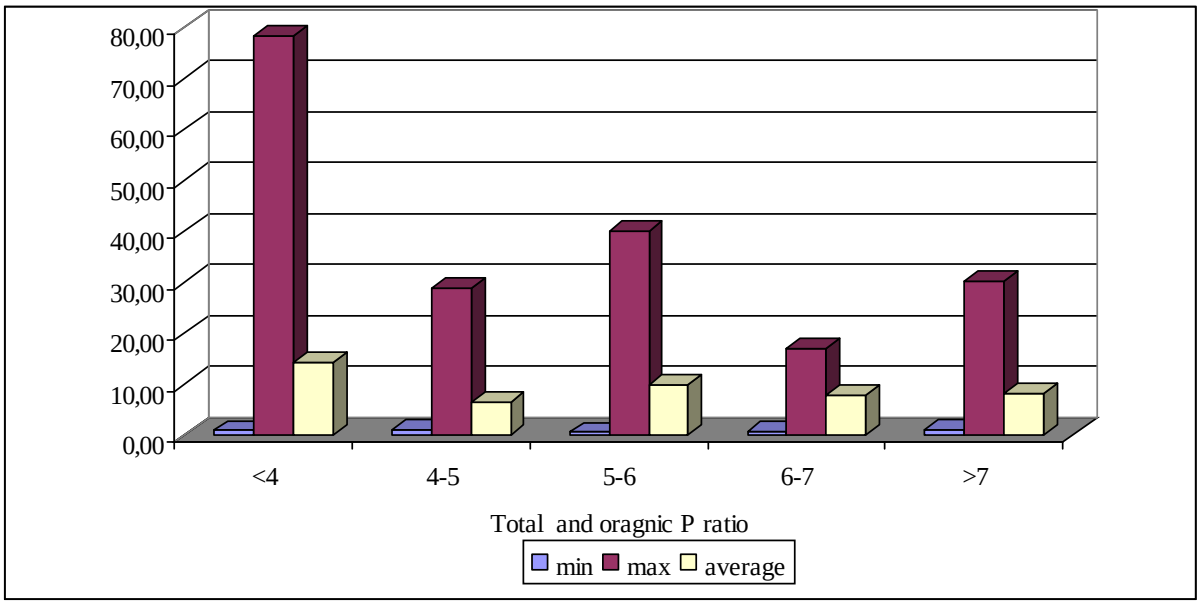

Figure 3. Total and organic P share

In most soils, organic phosphorus is more than 50% of total phosphorus, mostly in the form of inositol phosphate penta and hexa-related iron and aluminum (Borie & Rubio, 2003). Since most plants can intake phosphorus exclusively in inorganic form enzyme phosphatase activity in the soil are crucial.

Conclusion

pH reaction had no effect on the concentration of total and organic phosphorus in the eastern Croatia soils. Also, although the amount of organic phosphorus in soil is closely related to the amount of organic matter, expected results of their correlation were absent, but the organic matter content significantly influenced the simplified fraction of phosphorus in the soil (r=0,89). Seen from the organic matter content in the soil, very low humic soil had an average of 12.0% of organic phosphorus, while fairly humic soil had an average of 7.1% organic phosphorus. Different proportion of organic phosphorus in very low humic soils in relation to humic soil, probably due to varying intensity of mineralization, C / P, N / P ratio, and different enzyme phosphatase activities. Also, the increase in organic matter content of the soil can be binding free inorganic phosphorus (Humate effect) affected by the decreased in the share of organic phosphorus in the soil.

References

Al-Jaloud, A. A., Hussain, G., Bashour, I. I.(1998): Analitical methos: Evaluation and status of phosphorus fractionation in calcareous soils of Saudi Arabia. Commun. Soil Sci. Plant anal. 33: 15-18.

Borie, F., Rubio, R. (2003): Total and Orgaic Phosphorus in Chilean Volcanic Soils. Gayana Bot. 60(1):69-78.

Bundy, L. G. and Good A. M. (2003): Phosphorus source effects on soil test phosphorus and forms of phosphorus in soil. Commun. Soil Sci. Plant. Anal. 34(13&14):1897-1917.

Hayes, J. E., Richardson, A. E., Simplson, R. J. (2000): Components of organic phosphorus in soi extracts that are hydrolysed by phytase and acid phosphatase. Biol. Fertil. Soils. 32:279-286.

International Standard Organisation, [ISO 10390: 1994 (E)] (1994.c): Soil quality – determination of pH.

International Standard Organisation, [ISO 11466: 1995 (E)] (1994.b): Soil quality – determination of total phosporus in aqua regia.

International Standard Organisation, [ISO 14235: 1998 (E)] (1998.): Soil quality – determination of organic carbon by sulfochromic oxidation.

Kuo, S. (1996): Methods of soil analysis. Part 3 chemical methods. 32: 874-876.

Tarafdar, J. C. and Claassen, N. (1988): Organic phosphorus compounds as a phosphorus source for higher plants trough the activity of phosphatases produced by plant roots and microorganisams. Biol. Fertil. Soils. 5:308-312.

Ulen, B., Johansson, G., Kyllmar, K. (2001): Model predictions and long-term trends in phosphorus transport from arable lands in Sweden,Department of Soil Sciences, Division of Water Quality Management,Swedish University of Agricultural Sciences, 197-210.