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Soil reaction (pH) and status of mobile phosphorus and potassium in Sava valley area of Bosnia and Herzegovina

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Abstract
Acid soils in Bosnia and Herzegovina occupy 2256272 ha or 44.12% of total soils area of the country and prevail distric cambisols (28.73%), luvisols (6.90%) and pseudogleys (4.64%). Soil pH and plant available phosphorus (P) and potassium (K) status were analysed in 478 soil samples covering 663 ha taken in five municipalities of Sava valley (Samac, Pelagicevo, Modrica, Srbac and Gradiska)**.** About 55% samples were with pH in KCl below 5, while adequate mobile P and K (AL-method) supplies were found in third part of samples only. Liming and the higher P and K fertilization of majority soils of the region could be useful for increases soil fertility.

INTRODUCTION

Excessive soil acidity on agricultural land of Bosnia and Herzegovina (BIH) as an agricultural limiting factor impacts crops production (Komljenovic et al., 2006, 2010, 2013; Markovic et al., 2006; Komljenovic and Markovic, 2008). Resulovic et al. (2008) estimated that acid soils in BIH occupying 2256272 ha or 44.12% of total soils area of the country and prevailing distric cambisols (28.73%, luvisols (6.90% and pseudogley (4.64%). Aim of the study was testing soil pH and plant available phosphorus (P) and potassium (K) status in part of Sava valley area in the entity Republic of Srpska (RS), BIH.

MATERIAL AND METHODS

General description of the area

The area covering five municipalities situated in the Bosnian part of Sava river valley in RS of BIH as follows: Samac (184 km^2), Pelagicevo (178 km^2), Modrica (363 km^2), Srbac (453 km^2) and Gradiska (762 km^2)**.** According the statistical data (SYB, 2013) this area covering 1 940 km^2 and participating with 7.8% in territory and 13.4% in arable lands contribution of RS. These municipalities contains 78427 ha of arable lands and gardens or 13.4% in level of RS. Main field crops are maize and winter wheat (SYB, 2013).

The analysed area is part of the Peri-Pannonian region of BIH. Climate of the region is characterised by moderately cold winters and warm summers (Saric et al., 1997). Excessive drought periods as result of recent climatic changes (Kovacevic et al., 2013) have considerable impact on nutrient mobilization to field crops.

Collection of the data and chemical analysis

Total 478 soil samples covering 663 ha were taken by the auger to 30 cm of depth during 2006 with aim of testing main agrochemical properties. Determination of plant available P was made by AL-method (Egner et al., 1960) at the Faculty of Agriculture, University of Banja Luka. Interpretation of the data was made according Vukadinovic and Loncaric (1998) by criterion as follows: for P (mg P_2O_5 100 g^{-1}) = very low (<5.0), low (5.1-12.0), good (12.1-20.0), high (20.1-30.0) and very high (>30.0); for K (mg K_2O 100 g^{-1}) = very low (<12.0), low (12.1-19.0), good (19.1-30.0), high (30.1-40.0) and very high (>40.0).

RESULTS AND DISCUSSION

About 55% samples were with pH in KCl below 5, while adequate mobile P and K supplies were found in third part of samples only (Table 1). Interaction of soil acidity and low supplies with P and K and unfavorable physical properties could be reasons of low yields of maize and wheat. The lowest yields of maize (3.6 t ha^{-1}) and wheat (2.7 t ha^{-1}) in Srbac municipality could be in connection with the something higher share of P and K deficient and acid soils (Table 1). Growth retardation and chlorosis of maize were found on acid hydromorphic soils of Gradiska municipality. Excessive aluminum and iron, as well as the lower P concentrations are in close connection with this type of disorders (Table 2). Liming and ameliorative fertilization, particularly with P fertilizers, could be recommended for improvement of soil properties. Markovic et al. (2008) applied dolomite up to 20 t ha^{-1} on the acid hydromorphic soil of Gradiska municipality. Maize was grown three years on the experiment and yield was increased average for 48%. Komljenovic et al. (2010) applied increasing rates of P fertilizers up to 1750 kg P_2O_5 ha^{-1} on soil of Gradiska municipality. Phosphorus fertilization resulted mainly by considerable yield increase of maize in level 17 %. Yield increases were achieved mainly by application of the P in the level of 750 kg P_2O_5 ha^{-1}.

Table 1. Ranges of soil pH and mobile (AL-method) phosphorus and potassium

Soil properties in the municipality Samac (a), Pelagicevo (b), Modrica (c), Srbac (d) and Gradiska (e): number of samples (N) and area covered by sampling (ha)															
	Municipality								Municipality						
	a	b	c	d	e	Σ	%		a	b	c	d	e	Σ	%
N	25	92	52	173	136	478		ha	40	142	82	221	178	663	
%	5.2	19.2	10.9	36.2	28.5		*100*	%	6.0	21.4	12.4	33.3	26.9		100
	Grain yields (t ha^{-1}) of maize (M) and winter wheat (W): 5-year averages 2008 – 2012 (SYB (2013)														
M	5.7	4.8	5.6	3.6	4.9			W	3.5	3.6	4.1	2.7	3.3		

pH H_2O	**Soil pH ranges (pH in H_2O)**							**pH KCl**	**Soil pH ranges (pH in 1n KCl)**						
	a	b	c	d	e	Total			a	b	c	d	e	Total	
	Number of soil samples (N)					Σ N	**%**		Number of soil samples (N)					Σ N	**%**
< 4.0	0	0	0	0	0	0	0	< 4.0	2	16	31	7	21	77	16.1
4 - 5	1	3	0	3	12	19	4.0	4 - 5	14	54	11	42	67	188	39.4
5 - 6	12	60	29	88	68	257	53.8	5 - 6	6	19	10	52	37	124	25.9
6 - 7	9	26	13	37	46	131	27.4	6 - 7	1	3	0	36	11	51	10.7
7 - 8	3	3	10	43	10	69	14.4	7 - 8	2	0	0	35	0	37	7.7
>8.0	0	0	0	2	0	2	0.4	> 8.0	0	0	0	1	0	1	0.2

P_2O_5	**Soil P ranges* (mg P_2O_5 100 g^{-1})**							**K_2O**	**Soil K ranges** (mg K_2O 100 g^{-1})**						
	a	b	c	d	e	Total			a	b	c	d	e	Total	
	Number of soil samples (N)					Σ N	**%**		Number of soil samples (N)					Σ N	%
< 5.0	4	11	35	74	43	167	34.9	< 12	4	26	24	87	30	171	35.8
5.1-12	11	39	13	54	36	153	32.1	12.1-19	10	29	22	48	31	140	29.3
12.1-20	6	23	3	20	28	80	16.7	19.1-30	9	25	5	27	35	101	21.1
20.1-30	2	15	0	12	13	42	8.8	30.1-40	2	8	1	7	24	42	8.8
> 30	2	4	1	13	16	36	7.5	> 40	0	4	0	4	16	24	5.0

***** very low (<5.0), low (5.1-12), good (12.1-20), high (20.1-30) and very high (>30)

****** very low (<12), low (12.1-19), good (19.1-30), high (30.1-40) and very high (>40).

Table 2. Properties of maize at early growth stage on P-deficient soils (Kovacevic et al., 1988)

Top of maize at 6-9 leaves stage on PIK «Mladen Stojanovic» Nova Topola (municipality Gradiska): dry matter yield (DMY), plant height (PH) and P, Fe and Al status (on DM basis) – averages of four samples										
Sample	Chlorotic (majority of plants) maize					Normal (oasis at the same plot) maize				
	g $plant^{-1}$	cm	%	mg kg^{-1}		g $plant^{-1}$	cm	%	mg kg^{-1}	
	DMY	PH	P	Fe	Al	DMY	PH	P	Fe	Al
1-4	2.78	23	0.29	3470	3817	18.84	72	0.46	410	470

REFERENCES

Egner, H., Riehm, H., Domingo, W.R. (1960): Untersuchungen uber die chemische Bodenanalyse als Grundlage fur die Beurteilung des Nahrstoffzustandes der Boden II. Chemische Extractionsmethoden zu Phosphor- und Kaliumbestimmung. K. Lantbr. Hogsk. Annlr. W.R., 26, p.199-215.

Komljenovic, I., Markovic, M., D. (2008): Residual influences of phosphorus fertilization on maize status in Potkozarje area. Cereal Res. Commun. 36 (Supplement): 699-702.

Komljenovic, I., Markovic, M., Djurasinovic, G., Kovacevic, V. (2013): Response of maize to liming and ameliorative phoshorus fertilization. Advanced Crop Science 13(3): 225-232.

Komljenovic, I., Markovic, M., Kondic, D., Kovacevic, V. (2010): Response of maize to phosphorus fertilization on hydromorphic soil of Bosnian Posavina area. Poljoprivreda , Vol 16, No 2: 9-13.

Komljenovic, I. Markovic, M. Todorovic, J., Cvijovic, M. (2006): Influences of fertilization by phosphorus on yield and nutritional status of maize in Potkozarje area. Cereal Res. Commun. 34(1 Part 2):549-552.

Kovacevic, V., Kovacevic, D., Pepo, P., Markovic, M. (2013): Climate change in Croatia, Serbia, Hungary and Bosnia and Herzegovina: comparison the 2010 and 2012 maize growing seasons. Poljoprivreda / Agriculture 19 (2): 16-22.

Kovacevic, V., Vukadinovic, V., Bertic, B. (1988): Excess in iron and aluminum uptake and nutritional stress in corn (Zea mays L.) plants. Journal of Plant Nutrition 11 (6-11): 1263-1272.

Markovic, M., Komljenovic, I., Delalic, Z., Kovacevic, V. (2006): Phosphorus as a limiting factor of the field crops yield unde conditions of the northern Bosnia. Lucrari Stiintifice. Seria Agronomie. Universitatea de Stiinte Agricole si Medicina Vetrinara Iasi (1454-7414) 49 (2006), 1; 218-222.

Markovic, M., Todorovic, J., Biberdzic, M., Delalic, Z. (2008): Response of maize to liming in northern Bosnia. Cereal Res. Commun 36: 2079-2082.

Resulovic, H., Custovic, H., Cengic, I. (2008): Classification of soils, systematic, development, properties and fertility. University in Sarajevo.

Saric, T., Djikic, M., Gadzo, D. (1997): Two harvest in year. Biblioteka Savremena poljoprivreda, NIP Zadrugar Sarajevo and EDIS Sarajevo.

SYB (2013): Statistical Yearbook of Republic of Srpska, Institute of Statistics Banja Luka.

Vukadinovic, V., Loncaric, Z. (1998): Plant nutrition. Faculty of Agriculture in Osijek.