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CONTENT OF MACROELEMENTS AND MICROELEMENTS IN SIX DIFFERENT SOILS AFTER 15 YEARS OF APPROPRIATE FERTILISATION

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A b s t r a c t. Systematic examinations of the soil in the static experiments carried out from 1974 by IHAR, Jadwisin Division, with respect to such parameters as pH, the content of available forms of phosphorus, potassium and magnesium, as well as some microelements (boron, zinc, manganese, copper), showed that common potato soils require systematic organic and mineral fertilisation as well as liming in order to maintain high productivity. The results obtained in 1997, after 15 years (from the time of last examinations in 1982) constitute the evidence supporting the above conclusion. For example pH in KCl increased from 5.61 to 5.94, the content of phosphorus, respectively, from 15.67 to 23.63 mg, potassium from 14.46 to 17.36 mg and magnesium from 3.66 to 7.25 mg/100 g of the soil and the content of microelements increased as follows: boron from 0.23 to 0.46 ppm, zinc from 4.86 to 5.63 ppm, manganese from 274.40 to 137.53 ppm in the soil.

K e y w o r d s: static experiments, mineral fertilisation, microelements, macroelements, soils.

INTRODUCTION

Alterations of macroelements and microelements in soils most commonly applied in potatoes cultivation is of interest for both agricultural science and practice [1,4,5]. Taking into account soil and climate conditions of Poland, where light soils prevail, high potato yield is achieved when the soil pH is 5.5 to 6.5 and the layer of humus is deep with high and medium content of phosphorus, potassium, magnesium and zinc.

Observations of that type became possible when static experiments on microplots with 6 types of soils most common for the cultivation of potato were initiated in the Potato Institute (currently "IHAR", i.e. the Institute for Plant Breeding and Acclimatisation).

Initial analyses of the soil in the individual micro-plots concerning different parameters of soil (mechanical composition, organic C, pH, P, K, Mg, B, Zn, Mn, Cu) were made in 1974, and then repeated in 1982 and 1997, however, only with respect to the content of macroelements and microelements and pH in KCl [2,3].

MATERIALS AND METHODS

Observations and measurements were carried out in the micro-plots with 6 soil types of the following mechanical composition to the depth of 150 cm in the soil profile:

Profile I - slightly loamy sand, lying on light carbonate-free loam at a depth of 120 cm;

Profile II - slightly loamy sand, lying on light carbonate-free loam at a depth of 50 cm;

Profile III - deep loamy light sand;

Profile IV - loamy light sand, lying on light carbonate-free medium loam at a depth of 50 cm, and on light loam at a depth of 120 cm;

Profile V - strong loamy sand, lying on light carbonate-free loam at a depth of 45 cm, and at a depth of 100 cm on light carbonate loam;

Profile VI - medium loam, lying on heavy loam at a depth of 25 cm.

Crop rotation composed of 3 plants was introduced to the micro-plots with: potatoes, rye, seradella (cultivated up to 1983), and subsequently field pea (up to 1988) and phacelia (from 1989).

In the autumn of each experimental year, cattle farm-yard manure was used for potato in the dose of 25 t/ha. The level of mineral fertilisation was constant from 1974 and only diversified for individual plants (potatoes - 90 kg N and P_2O_5, and 135 kg K_2O; rye - 50 kg N, 80 kg P_2O_5, and 120 kg K_2O; and other plants - 60 kg P_2O_5 and 120 kg K_2O, per 1 ha).

In the years 1979 to 1981, in all the micro-plots (after rye harvest) dolomite carbonate lime at a dose of 1 Hh was applied. That treatment was repeated in the period 1996 to 1998.

The results of the examined soil parameters were statistically worked out. Some parts of the analysis of variation were presented in Table 1.

The following factors were taken into account in the scheme of experiments:

1. soil kind (6 profiles);
2. experimental years (1982 to 1997);
3. plant species (potatoes, rye, phacelia).

Table 1. Significane of the examined factors for the chemical soil properties (Jadwisin 1982 to 1997)

Specification	Examined fators and their interaction					
	soil (1)	experimental year (2)	plant (3)	interaction of factors 1 x 2	1 x 3	2 x 3
pH in KCl	++	++		+		
Phosphorus	++	++		+		
Potassium						++
Magnesium	++	++		++		
Boron		++				
Zinc		++	+	+		+
Manganese	++	++	++	++		++
Copper	++		++	++		

Explanations: significance level: + -0.95; ++ - 0.99; examined factors: 1 - soil profile; 2 - experimental year; 3 - cultivated plant.

Both in 1982 and 1997, the soil samples were taken from 4 repetitions only from surface soil by means of the Egners sampling stick. All the chemical analyses were carried out in the Regional Agrochemical Station in Wesoła near Warsaw.

RESULTS

The analysis of variances showed that after 15 years (1982-1997) from the moment of determining various chemical properties of the soil, significant changes in pH and content of both macroelements and microelements (with exception of K and Cu) in the individual soil formations occurred.

The soil kind differentiated the pH values and the content of phosphorus, magnesium, manganese and cooper (Tables 2 and 3) to the highest degree. The soils of slightly loamy texture and loamy texture had a lower pH value than the medium loam (profile VI). Systematic liming of those loams with dolomite carbonate lime considerably improved pH as opposed to the medium loam profile where a slight decrease of the pH value was recorded. Analogous interrelations were also observed with respect to the content of Mg in the soil (Table 2).

Due to systematic mineral fertilisation of all the plants in crop rotation throughout the period of 23 years, a very significant increase of the content of phosphorus especially in the profile VI and a slight increase of the content of potassium was recorded (Table 2).

The content of boron and zinc in the individual soil formations was diversified, however, the differences were not significant. Nevertheless, a significant increase was recorded in the period of soil examination in 1982 (Table 3).

Table 2. Effect of soil type and years on the changes in pH and content of available phosphorus, potassium, magnesium in the period 1982 to 1997 (Jadwisin 1998)

Soil property	Experimental year	Soil profile						Mean value for profile	$LSD_{0.05}$
		I	II	III	IV	V	VI		
pH in KCl	1982	5.26	5.60	5.10	5.33	5.56	6.80	5.61	0.17
	1997	5.66	5.83	5.66	5.96	6.16	6.36	5.94	
Profile mean value		5.46	5.71	5.38	5.65	5.86	6.58		
$LSD_{0.05}$ for profile - 0.31; for interaction* 1 x 2 - 0.43									
P_2O_5 (mg/100 g soil)	1982	14.93	13.36	13.93	14.03	16.50	18.86	15.27	1.50
	1997	21.33	21.20	19.93	21.40	23.23	34.70	23.63	
Profile mean value		18.13	17.28	16.93	17.71	19.86	26.78		
$LSD_{0.05}$ for profile - 2.60; for interaction 1 x 2 - 3.68									
K_2O (mg/100 g soil)	1982	13.60	14.93	14.73	12.93	13.23	17.36	14.46	1.50
	1997	16.33	16.70	15.36	17.56	20.03	18.20	17.36	
Profile mean value		14.96	15.81	15.05	15.25	16.63	17.78		
$LSD_{0.05}$ for profile - not significant; for interaction 1 x 2 - not significant									
MgO (mg/100 g soil)	1982	2.13	2.50	2.33	2.06	2.63	10.30	3.66	0.25
	1997	6.66	7.26	5.80	7.36	7.90	8.50	7.25	
Profile mean value		4.40	4.88	4.06	4.71	5.26	9.40		
$LSD_{0.05}$ for profile - 0.44; for interaction 1 x 2 - 0.62									

*Explanation for examined factors: 1 - soil profile; 2 - experimental year.

Table 3. Effect of soil type and experimental years on changes in the content of some microelements in the period 1982 to 1997 (Jadwisin 1998)

Soil property	Experimental year	Soil profile						Mean value for profile	$LSD_{0.05}$
		I	II	III	IV	V	VI		
Boron (mg/kg soil)	1982	0.19	0.22	0.21	0.17	0.23	0.34	0.23	0.05
	1997	0.38	0.40	0.50	0.50	0.76	0.55	0.46	
Profile mean value		0.29	0.31	0.35	0.34	0.34	0.45		
$LSD_{0.05}$ for profile - n.s. for interaction 1 x 2 - n.s.									
Zinc (mg/kg soil)	1982	5.56	4.95	4.79	3.86	4.11	5.90	4.86	0.52
	1997	5.43	5.30	4.53	5.16	6.44	6.47	5.63	
Profile mean value		5.50	5.13	4.66	4.74	5.28	6.18		
$LSD_{0.05}$ for profile - 2.60; for interaction 1 x 2 - 1.29									
Manganese (mg/kg soil)	1982	180.80	171.03	274.33	144.20	435.40	274.40	246.69	17.22
	1997	134.13	144.16	114.40	138.00	144.96	137.53	135.53	
Profile mean value		157.46	157.60	194.36	141.10	290.18	205.96		
$LSD_{0.05}$ for profile - 29.83 for interaction 1 x 2 - 42.19									
Copper (mg/kg soil)	1982	2.07	1.05	0.69	0.80	1.05	2.05	1.29	n.s.
	1997	1.45	1.43	1.14	1.20	1.47	1.43	1.37	
Profile mean value		1.76	1.24	0.92	1.04	1.26	1.74		
$LSD_{0.05}$ for profile - 0.27; for interaction 1 x 2 - 0.39									

n.s. - not significant. for other explanations see Table 2.

The content of manganese and copper in the soil underwent significant changes both in particular soil formations and experimental years. The content of manganese in the soil after 15 years decreased in each soil formation, however the highest decrease was recorded in the soil profile No. III, V, and VI, and the lowest in the profile I, II, and IV (Table 3).

The content of copper in the individual soil profiles undergoes various fluctuations. Significant increase in its content was recorded in some of them (profile II, III, IV and V), while in others (profile I and VI) a significant decrease was observed (Table 3).

CONCLUSIONS

Static micro-plot experiments during which various examinations on potato plants were carried out for 23 years (starting in 1974), while a constant level of organic and mineral fertilisation of all plants in crop rotation was preserved together with an appropriate protection of those plants against pests, weeds and diseases showed the following:

1. By using a simplified crop rotation and a preserving balanced mineral fertilisation as well as systematic liming of the soils, most commonly used for potato cultivation, chemical properties of the soil with respect to pH and the content of microelements and microelements can be improved.

2. Organic and mineral fertilisation, as well as dolomite lime and necessary protective treatments in the form of various pesticides, applied in the experiments, contributed to the improvement of soil fertility. They also help to maintain a good state of its cultivation properties.

3. With respect to all the examined properties (pH in KCl and the content of macroelements and microelements), the soil of the profile III (deep loamy light sand) showed the worst parameters, while the soil of the profile VI (medium loam) the best parameters.

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