

# THE REACTION AND CONTENT OF MACRO AND MICROELEMENTS IN THE SURFACE LAYER OF SOILS IN LOWER SILESIA

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## Abstract

The reaction and content of phosphorus, potassium and magnesium, and microcomponents (Mn, Zn, Fe, Cu, B, Mo) were determined in the samples of soil from the surface layer in the area of former provinces of Jelenia Góra, Legnica, Wałbrzych and Wrocław. It was found that the soil of Lower Silesia has an acidic reaction (59% of area), medium content of available phosphorus (28% of area) and potassium (32% of area), and sufficient content of available magnesium (44% of area). The content of microelements in the soils of Lower Silesia is on a medium level as referred to the observed availability scale. In respect to some elements, the availability occurs on 98% of the area (Fe - Wałbrzych region) and 94% (Mn - Legnica region). Of the elements analysed, the largest areas of soils with high availability of copper were found in the Jelenia Góra region covering 55% of the area.

KEY WORDS: reaction, macrocomponents, microcomponents, soil

## INTRODUCTION

Poland is situated in the geographical zone whose climatic conditions favour an elution of nutrients from the soil and thus induce its systematic acidification. This is favoured also by other factors, such as chemicalization of the environment, the products of biochemical reactions in micro-organisms and acid rains. The acidification effect depends on the properties of the matrix formations of the soil and decreases with increasing density of soil. In Lower Silesia the fractions of the respective density categories are as follows: light and very light soils 40%, medium soils 20% and heavy soils 40% [2]. The soil reaction is largely decisive for the solubility and availability of macro and microcomponents, which derive from weathering of minerals, mineralisation of organic matter and fertilisation. The content of available forms of macro and microcomponents in soil depends not only on the kind and texture of the soil as well as fertilisation, but also on the course of atmospheric conditions and soil moisture content.

Each year together with yield the plants carry away considerable quantities of macro and microcomponents. The presently applied rates of mineral (about 74-85 kg NPK/ha) and organic fertilisation (76 kg NPK/ha/year) do not cover that depletion [1,3]. This is mostly true for microcomponents, which are delivered to the soil in organic fertilisers only. For many

years now the domestic animal stock is decreasing, and thus the amounts of farm manure. The optimum dose of that fertiliser is about 30 t/ha per 3 years. The actual production of manure is enough to apply such dose every 11 years [5].

Studies conducted at the beginning of 1990s showed that the soil negative valuation index for phosphorus, potassium and magnesium is 55% [4].

The aim of the study was to estimate the need for liming and how rich the soils of Lower Silesia are in available macro and microcomponents.

## METHODS AND SCOPE

The investigations were conducted in four former provinces: Jelenia Góra, Legnica, Wałbrzych and Wrocław. For the investigation were taken samples of soil from the surface layer according to Polish Standards BN-78/9180.02. A mean sample is composed of about 20 single samples (primary) mixed together. Primary samples were taken from places spread equally over the area investigated. The content of available forms of macrocomponents and reaction were determined in 67552 samples of soil that represented an area of about 125.000 ha. The numbers of samples in which macrocomponents were determined are given in Table 5

The following methods were employed in laboratory work:

- Egner-Riechm method for assay of P and K
- Schachtschalel method for assay magnesium
- potentiometric method for pH in 1 M KCl
- available microcomponents - boron and molybdenum by calorimetric method, and the remaining by atomic absorption spectrofotometry (AAS).

## RESULTS

The soils analysed of Lower Silesia exhibited, to a considerable degree, an acidic reaction.  $\text{pH} < 5.5$  occurred on 59% of the area, and only 13% area had neutral and alkaline reaction of  $\text{pH} > 6.6$  (Tab. 1). The parameter studied varies between the respective regions of the province. The largest amounts of acidic soils were found in the former Legnica and Wrocław provinces, 52 and 53% of area, respectively. The data for the Wałbrzych region are close to those for Lower Silesia. In the Wałbrzych region 63% of soils had  $\text{pH} < 5.5$ , and 10% were neutral and alkaline soils.

Table 1

Reaction in 1M KCl in the surface layer of soils in Lower Silesia  
(on average for 1993-1998)

Region	Number of samples	Tested area in ha	Area of soils in %				
			pH				
			<4,5 very acidic	4,6-5,5 acidic	5,6-6,5 slightly acidic	6,6-7,2 neutral	>7,2 alkaline
Legnica	68399	130679	17	35	32	12	4
Wrocław	67552	124895	18	35	30	14	3
Wałbrzych	41406	84838	23	39	28	8	2
Jelenia Góra	39915	76924	45	34	16	4	1
Lower Silesia	223272	434996	24	35	28	10	3

The content of available phosphorus in soils of Lower Silesia in the period studied was relatively low. For 68% of the area the content was 15 mg P<sub>2</sub>O<sub>5</sub>/100 g soil, which according to the valid classification places it in the medium, low and very low category (Tab.2). In the province 32% area had soils of high and very high phosphorus content, i.e. more than 15 mg P<sub>2</sub>O<sub>5</sub>/100 g.

Table 2

The content of available phosphorus in the surface layer of soils of Lower Silesia  
(on average for 1993-1998)

Region	Area of soils on %				
	mg P <sub>2</sub> O <sub>5</sub> /100g				
	< 5 very low	5,1-10,0 low	10,1-15,0 mean	15,1-20,0 high	>20,0 very high
Legnica	8	26	32	16	18
Wrocław	7	30	30	18	23
Wałbrzych	14	27	27	14	16
Jelenia Góra	31	36	19	7	7
Lower Silesia	13	27	28	15	17

Like in the case of pH, the percentage of the soils with respect to phosphorus content was differential. The greatest area with soils of phosphorus content over the mean (> 15 mg P<sub>2</sub>O<sub>5</sub>/100 g) was found in the Wrocław (71% of area) and Legnica (66% of area) regions. Soils most poor with phosphorus are in the Jelenia Góra region. Barely 33% of the soil area has more than 15 mg P<sub>2</sub>O<sub>5</sub>/100 g. The data on phosphorus in soils in the Wałbrzych region are on the medium level, since 57% of area has soils with more than 15 mg P<sub>2</sub>O<sub>5</sub>/100 g. The percent participation in the specified classes of available phosphorus content is connected

with granulometric distribution of soils. The available phosphorus content was greater for the more compact soils (Legnica and Wrocław regions) and markedly lower for the light soils (Jelenia Góra region).

Table 3

The content of available potassium in the surface layer of soils in Lower Silesia  
(on average for 1993-1998)

Region	Area of soil in %				
	mg K <sub>2</sub> O/100g				
	< 7,5 very low	7,6-12,5 low	12,6-20,0 mean	20,1-25,0 high	>25,0 very high
Legnica	9	16	33	16	26
Wrocław	11	20	30	15	24
Wałbrzych	13	21	33	16	26
Jelenia Góra	18	20	31	12	19
Lower Silesia	12	20	32	14	22

Table 4

The content of available magnesium in the surface layer of soils in Lower Silesia  
(on average for 1993-1998)

Region	Area of soils in %				
	mg Mg/100g				
	< 3,0 very low	3,1-5,0 low	5,1-7,0 mean	7,1-9,0 high	>9,0 very high
Legnica	3	12	24	20	41
Wrocław	12	17	25	19	27
Wałbrzych	15	19	25	15	26
Jelenia Góra	17	23	26	15	19
Lower Silesia	12	19	25	17	27

The content of available potassium in the soils studied of Lower Silesia with respect to the scale of availability observed in Poland is on medium level. The soil area of low and very low potassium content (< 12.5 mg K<sub>2</sub>O/100g) is 32%, of medium content also 32% and of high and very high content (>20.1 mg K<sub>2</sub>O/100g) - 34% (Tab. 3). Differential is, however, the content of that element in the respective regions. Most rich in available potassium proved to be soils around Wałbrzych, as 40% of the area has high and very high potassium content (>20.1 mg K<sub>2</sub>O/100g). Soils of low and very low content were found on 25% of soil area.

Most poor

Table 5

The content of microcomponents (on average for 1993-1998)

Region	Number of samples	Area of soils in %			Number of samples	Area of soils in %			Number of samples	Area of soils in %		
		mg Mn/kg				mg Zn/kg				mg Fe/kg		
		<50,0				<4,6	4,6-20,5	>20,5		<700	701-3800	>3800
		low	mean	high		low	mean	high		low	mean	high
Wałbrzych	853	-	90	10	1083	21	76	3	707	2	98	-
Legnica	2321	1	94	5	2738	22	69	9	1669	29	69	2
Wrocław	2003	3	90	7	2861	30	54	16	1512	27	71	2
Jelenia Góra	1613	1	75	24	1869	24	59	17	1370	8	90	2
		mg Cu/kg				mg B/kg				mg Mo/kg		
		<2,3	2,4-6,7	>6,7		<1,0	1,1-3,2	>3,2		<0,004	0,05-0,22	>0,22
		low	mean	high		low	mean	high		low	mean	high
Wałbrzych	1053	17	74	9	649	37	61	2	275	21	35	44
Legnica	2888	23	65	12	2112	38	60	2	328	16	65	19
Wrocław	1869	20	59	21	718	46	53	1	51	61	35	4
Jelenia Góra	2726	5	40	55	1405	42	56	2	148	17	74	9

in available potassium proved to be the region of Jelenia Góra, where low and very low content ( $< 12.5 \text{ mg K}_2\text{O}/100\text{g}$ ) occurs on 38% of the area. In the Wrocław and Legnica area the soils in principle have similar and good content of available potassium. The soil area of high and very high content of the element ( $>20.1 \text{ mg K}_2\text{O}/100\text{g}$ ) near those towns is over 39%, and 34% of low and very low potassium content.

Magnesium content in soils of Lower Silesia is predominantly good. On average for the whole province the soil area of high and very high magnesium content ( $>7.1 \text{ mg Mg}/100\text{g}$ ) is 44% (Tab. 4). Soils of low and very low content ( $<5 \text{ mg Mg}/100\text{g}$ ) in Lower Silesia occupy 31% of the province. Most rich in available magnesium ( $>7.1 \text{ mg Mg}/100\text{g}$ ) are soils in the Wałbrzych region, occupying 60% of the region. However, the lowest magnesium content occurred around Legnica, where soil area of low and very low content ( $<5.0 \text{ mg Mg}/100\text{g}$ ) is 40%. Soils in the Wrocław and Jelenia Góra regions exhibit good magnesium content. In both of these regions soils of high and very high magnesium content prevail, compared with those of low and very low content of the element.

The content of the microelements assayed in soils of Lower Silesia with respect to the observed soil nutrient availability scale was on a medium level. Though it differed depending on the place of sample taking, the percent fraction of soil area of medium content was largest in the four regions and referred to all the microelements studied.

In the case of magnesium and iron the soil area of medium content varied from 69 to 98% depending on region. Only in three regions the area was within the limits 35-74% and referred to copper and molybdenum. Soils with high content of a given element occurred only scarcely in the province discussed. Practically it refers only to copper in the Jelenia Góra region, where the area of high content of the element was 55%. Of the microelements discussed soils of Lower Silesia are most poor in boron. The soil area of low boron content ( $<1 \text{ mg B}/\text{kg}$ ) depending on region amounts from 37% (Wałbrzych) to 46% (Jelenia Góra). Soils of Lower Silesia are most rich in manganese. In the neighbourhood of Wałbrzych soils of low content of the element ( $<50 \text{ mg Mn}/\text{kg}$ ) do not occur at all, while in the case of the three remaining regions they occupy an area within the limits 1-3%.

## CONCLUSIONS

1. Soils of Lower Silesia on a considerable area are of acidic reaction (59% of area), have medium content of available phosphorus (28% of area) and available potassium (32% of area), and good content of available magnesium (44% of area). The percentage of soil area in the respective pH categories and nutrient availability is fairly differential depending on the parameter studied and locality of sample taking.
2. The content of microelements in soils of Lower Silesia is on a medium level as referred to the observed availability scale. In respect to some elements the availability occurs on 98% of the area (Fe - Wałbrzych region) and 94% (Mn - Legnica region). Of the elements analysed the largest amounts of soils with high availability of copper were found in the Jelenia Góra region, i.e. 55% of the area.

## SUMMARY

Soil samples taken from the surface layer (0-20 cm) in the area of the former provinces of Jelenia Góra, Legnica, Wałbrzych and Wrocław were assayed for pH and the available forms of P, K, Mg, Mn, Zn, Fe, Cu and B. The investigation was carried out in the years 1993-98. It was found that soils of Lower Silesia are predominantly acidic (59% of area), have medium content of available phosphorus (28% of area) and potassium (32% of area), and good content of available magnesium (44% of area).

The content of microelements in soils of Lower Silesia is on a medium level, referred to the observed scale of soil nutrient availability. Some microelements (Mn, Fe) in the medium class of nutrient availability occupy over 90% of region's area.

The element that occupies the largest area of soils classified as having high nutrient availability is copper, which in the Jelenia Góra region occupies 55% of the area. The soils of Lower Silesia are most poor in boron, since the area of low content of the element (<1 mg B/kg) constitutes from 37% (Wałbrzych) to 46% (Jelenia Góra), and most rich in magnesium, as low Mg-content area constitutes 1-3%.

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