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SULPHUR CONCENTRATION IN THE AGRICULTURAL SOILS OF THE LUBLIN REGION AND POLAND

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A b s t r a c t. This paper characterises S-SO_4 concentration in the surface (0-20 cm) layers of the agricultural soils in Poland (45242 soil samples) and in the Lublin region (3648 soil samples).

Mir.eral soils in Poland contain, on average, 1.79 mg of S-SO_4/100 g of soil. In the Lublin region, it is 1.65 of S-SO_4/100 g of soil. In the whole of the country, 83.2% of the agricultural soils have natural (0^0 +1^0) levels of S-SO_4; this includes the areas with very low (0^0) concentrations (58.1% of the agricultural land) as well as elevated (I^0) concentrations (25.1% of the agricultural land).

Soils polluted with sulphur (2^0+3^0) make up 16.8% of the agricultural land. This includes weak (2^0) and heavy (3^0) pollution - 13.1 and 3.7%, respectively.

In the Lublin region, 88.5% of the agricultural soils have natural (0^0+1^0) levels of S-SO_4 . This includes the areas with low (0^0) concentration (64% of the agricultural land) as well as the areas with elevated (1^0) concentration (24.5% of the agricultural land). Soils polluted with sulphur (2^0+3^0) make up 11.5% of the agricultural land, including weakly (2^0) polluted soils (8.7%) and heavily polluted (3^0) soils (2.8%).

K e y w o r d s: sulphur, soil pollution, Poland, Lublin region.

INTRODUCTION

Intensive development of industry, especially power plants, chemical, and metallurgical industry, which produce a lot of dust and gas contaminants, including sulphur caused great soil pollution with that component in some regions of the country [1,6,8-10].

In 1992, research aiming at the estimation of the content of sulphate sulphur in the arable soils of Poland was started. This paper is a synthesis of the results of the investigations carried out in the Lublin region as related to the results obtained for the whole country.

MATERIAL AND METHODS

In 1992-1997, a commission of the Ministry of Agriculture and Food Technology carried out a research programme on the evaluation of the ecological state of the arable soils in Poland. Analysis of the soil samples, 45,000 in total, taken from the depth of 0-20 cm in the arable land of Poland, was carried out in the Regional Agrochemical Stations (OSCHR). The following properties were determined in the soil samples: granulometric composition, reaction (pH_{KCl}) and content of humus according to the methods commonly used in agrochemical laboratories, content of sulphate sulphur ($S\text{-}SO_4$) extracted with a mixture of ammonia acetate and acetic acid [2].

Evaluation of the degree of soil contamination with sulphur was made on the basis of the standards [4] which included the content of that element in the soil, granulometric composition and soil reaction, as well as the content of organic substance.

This paper was worked out on the basis of the results obtained from the analysis of 3648 average soil samples taken from the arable soils of the Lublin region in 1992-1997, and 45242 average soil samples taken all over Poland (an average sample consisted of 15-20 single samples taken from the area of 100 m^2 = 10x10 m). One soil sample represented the area of about 440 ha for the Lublin region or about 413 ha of arable land for the whole country.

RESULTS AND DISCUSSION

Beside nitrogen, phosphorus, potassium, and magnesium, sulphur is a necessary macroelement for plant nutrition. This element appears in soils in various amounts, depending on the content of organic matter, level of sulphur emission, intensity of organic and mineral fertilization, etc. High content of sulphur in the soil can be as harmful to plant growth and development as its shortage. Negative results of soil pollution with sulphur under the influence of anthropopressure are mainly related to their chemical degradation by acidification [5,8] and, in turn, to all the negative results of that phenomenon: greater wash out of basic cations; occurrence of toxic aluminum and manganese; growth of phytotoxicity of heavy metals; decrease in the fertilisation efficiency; an increase in the sulphur concentration also in the sulphate form [4,8]. Degradation of agro-ecosystems as a result of sulphur compound emission through the soil, shows that it is necessary to evaluate the sulphur content and degree of pollution with that element.

The mineral soils of Poland (up to 10% of organic substance) from the typically agricultural areas usually contain less than 100 mg of S/100 g [11]. In the organic soils (over 10% of organic substance), the total content of S can reach several hundred mg/100 g of soil [7]. In our soil-climate conditions, the content of sulphur usually decreases along with the depth of the soil profile.

Sulphate sulphur ($S\text{-}SO_4$) constitutes a small percentage of the total S. Most often it is about several per cent of the total S content in the soil. This form of sulphur is of the greatest agricultural and ecological importance. It provides plants with this component and is a signal of hazard conditions for the soil environment in terms of excessive sulphur emission as a result of anthropopressure [9].

Sulphate sulphur content in the Polish soils that were investigated in 1992-1996 [14] ranged from 0.01 to 50.0 mg of $S\text{-}SO_4$/100 g. Extending the research range to a general representation of 45242 trials, allowed to determine that this range is 0.01-77.50 mg of $S\text{-}SO_4$/100 g (Table 1). The average values for Poland and for the Lublin region, observed during the investigations were at a similar levels equal to, respectively: 1.79 and 1.65 mg of $S\text{-}SO_4$/100 g of soil. Most of the soils with a low content of sulphate sulphur are situated in the northern and north-eastern districts of Poland [12-14], while the soils with higher sulphur content are situated in the southern districts, especially in the Katowice voivodeship.

Data presented in Table1 indicate that 58.1% of the arable area in Poland has a low natural (0^o) content of sulphate sulphur (Lublin region - 64.0%), while 25.1% has higher content of that component (1^o) (Lublin region - 24.5%). The soils polluted with sulphur to the 2nd and 3rd degree take up a relatively greater area in Poland than in the Lublin region. A significant amount of soils with a low content of sulphate sulphur - up to 2.5 mg S/100 g (0^o and 1^o) in the soils of the Lublin region showed a clearly decreasing emission of that element to the atmosphere in the

Table 1. Cencentration and degree of pollution with sulphate sulphur ($S\text{-}SO_4$) of surface layer (0-20 cm) of mineral soils in Poland and the Lublin region

Area	mg $S\text{-}SO_4$/100 g of soil		% of agricultural soils with a given classes of $S\text{-}SO_4$ contents (mg/100 g of soil)			
	ranges	arithmetical mean	≤1.5 (0^o)	1.6-2.5 (1^o)	2.6-5.0 (2^o)	>5.0 (3^o)
			soil with natural content of $S\text{-}SO_4$		soil polluted with $S\text{-}SO_4$	
			low	elevated	weakly	strongly
Poland	0.01-77.5	1.79	58.1	25.1	13.1	3.7
Lublin region	0.05-32.2	1.65	64.0	24.5	8.7	2.8

recent years. It means that a lot of soils of that region will need fertilization with sulphur. In the near future, shortage of sulphur in the soils could be a limiting factor for the fertilisation efficiency especially with nitrogen.

CONCLUSIONS

The research allows to draw the following conclusions:

1. Mineral soils from the arable land of Poland and the Lublin region contain similar average amounts of sulphate sulphur in the arable-humic leyer. They are respectively: 1.79 and 1.65 mg S/100 g.

2. About 64% of the arable soils of the Lublin region have a low natural content of sulphur (0^{o}), while 24.5% have higher content of that element (1^{o}).

3. The amount of soils polluted with sulphur in the Lublin region is 11.5% of the arable land, including: low pollution (2^{o}) - 8.7%, and high pollution (3^{o}) - 2.8%. Those values for the arable soils in Poland are, respectively: 58.1% (0^{o}); 25.1% (1^{o}); 13.1% (2^{o}); and 3.7 % (3^{o}).

4. Low content of sulphate sulphur in the soils, especially in the light soils and the soils with low humus content, at a significant wash-out and decreasing emission of that element from anthropogenic sources could, in the near future, create a need for soil fertilization with sulphur.

5. Opinions on the high pollution of the Polish soils with sulphur have not been confirmed with the present results. Small areas of the arable land polluted with that component are situated in the southern and south-western part of the country (districts: Katowice, Bielsko-Biała, Częstochowa, and Wałbrzych), which is a highly industrialised area.

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