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PROPERTIES OF SOILS SURROUNDED TRZUSKAWICA LIME PLANT INDUSTRY S.A., DEPARTMENT OF KUJAWY

WŁAŚCIWOŚCI GLEB W OTOCZENIU ZAKŁADÓW PRZEMYSŁU WAPIENNICZEGO TRZUSKAWICA S.A., ZAKŁAD KUJAWY

Abstrakt: Effect of pollutants emitted by plants Trzuskawica Lime Industry S.A., Department of Kujawy and Lafarge "Cement" on the physicochemical properties of soils in this region, mainly pH and the state of exchangeable complex was studied.

Soil samples were collected in late August and September 2007, during post-harvest. There were 16 soil samples selected from arable-humus horizon, from the area of about 4000 m^2. In the samples taken for analysis active and exchangeable acidity, hydrolytic acidity, calcium carbonate, total exchangeable cations, and organic C content were determined. Statistical analysis was performed using STATISTICA 8.0 PL programme.

As a result of the studies there were found a high degree of soils alkalization, due to high accumulation of lime pollutants emitted in the past, and high natural content of calcium carbonate in soils in the vincinity of plants. The highest share of Ca^{2+} ions in the cation exchangeable capacity of soil complex there was found. The degree of cation saturation of analyzed soils and their cation exchange capacity was significantly related to the content of alkaline cations. Comparison of results from the years 1992–2007 indicates a continuing high pH values and the nature of saturation of soil exchangeable complex due to the presence of exchangeable calcium in the soils surrounding Trzuskawica Lime Plant Industry S.A., Department of Kujawy and Lafarge "Cement".

Based on the studies can not be determine the impact of each individual, the two largest plants, emitting limestone pollutants, on the environment in their surroundings.

Keywords: dusts, exchangeable complex, lime, soil

Anthropogenic emissions of various compounds into the atmosphere are one of the factors causing its pollution. It should be highlighted that the most emerging contaminants enters the environment mainly through the atmosphere, which makes it

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possible to spread them over considerable distances, and point sources of pollution takes the territorial nature. Atmospheric pollutions also cause changes in the soil environment. As a result of human activities the atmosphere is entered by hundreds of thousands of different pollutants. These include carbon, sulfur and nitrogen oxides and also dusts, which formation is associated with all production and combustion processes [1].

Cement and lime industry, considered the most dust-producing, constitutes a major part in the contamination of soils. Emission occurs at each stage of production from extraction by crushing the raw material to transport [2]. Literature reports about the danger of dusts and gas pollutions, which cause lowered yields of crops in the vincinity of the cement plants [3].

The aim of this study was to assess the impact of pollutants emitted by Trzuskawica S.A. Lime Plant Industry, Department of Kujawy and Lafarge "Cement" on the physicochemical properties of soils in surrounding area. The comparison of results from years 1992–2007 was also made [4].

Material and methods

As a research material 16 soil samples from arable-humus horizon of an area surrounded by Trzuskawica Lime Plant Industry S.A., Department of Kujawy, were collected. Sampling sites corresponded to the location of soil sampling in 1992 for the impact assessment of KCW Kujawy on soil pH [4].

In dried and sieved (with a 1 mm diameter mesh sieve) samples the following physicochemical soil properties were determined: pH in H_2O and in 1 mol · dm^{-3} KCl solution, hydrolytic acidity (Hh) using Kappen's method, the total content of organic carbon using Turin's method, the content of $CaCO_3$ by Scheibler and the content of exchangeable bases were determined by Pallmann, the contents of Ca^{2+}, K^+ and Na^+ were determined by emission and Mg^{2+} by absorption atomic spectrometry, using a PU 9100X Philips spectrometer.

The statistical analysis of the results was evaluated with STATISTICA 8.0 PL computer programme.

Results and discussion

The properties of soils are presented in Tables 1 and 2. Emission of dusts is an important factor affecting the natural environment. Often, the effects of the impact of dust on plants can be manifested through changes in the properties of soil [5]. Compared the active acidity with the results obtained in 1992 it was reported a slight decrease of pH value, only one sample (No. 13) had the same value, and samples 5 and 15 showed an increase of pH. Similar results were obtained in the case of exchangeable acidity: samples 2, 13, 15 and 16 had similar value, samples 5 and 6 showed a slight increase, and the remaining samples had a slightly lower pH than in 1992. Such a high soil pH can be closely linked with the presence of dust in the studied area [2]. Changes in soil pH, observed in previous studies, are accompanied by far-reaching changes in the exchangeable complex.

Table 1

Physical and chemical properties of soil (1992)

No.	$CaCO_3$	$C_{org.}$	Acidity			Exchangeable cations				TEB	CEC	Base saturation [%]
			pH		Hh	Ca	Mg	K	Na			
	[g · kg^{-1}]		H_2O	KCl	[mmol · kg^{-1}]							
1	15.3	7.0	7.97	7.92	0.2	122.4	4.1	4.4	1.3	132.2	132.4	99.9
2	n.d*	6.0	7.93	7.56	1.2	48.0	2.3	1.4	1.0	52.7	53.9	97.8
3	n.d.	6.2	7.61	7.40	2.2	47.3	2.3	1.7	1.5	52.8	55.0	96.0
4	n.d.	7.0	7.34	7.03	4.1	40.4	2.5	1.8	0.9	45.6	49.7	91.8
5	n.d.	9.4	6.94	6.28	10.2	33.4	3.3	2.0	1.0	39.7	49.9	79.6
6	9.8	6.8	7.99	6.85	0.9	121.1	3.5	1.0	0.9	126.5	127.4	99.3
7	11.0	8.6	7.84	7.64	0.8	119.3	3.7	2.9	1.1	127.0	127.8	99.4
8	4.2	5.8	8.03	7.57	1.1	109.1	3.9	4.1	1.1	118.2	119.3	99.1
9	13.6	7.3	8.19	7.79	1.3	108.8	3.3	2.4	0.8	115.3	116.6	98.9
10	14.8	5.2	8.19	7.93	1.2	95.0	3.0	1.5	0.8	100.3	101.5	98.8
11	n.d.	5.8	7.73	7.54	2.3	59.2	2.8	0.8	1.0	63.8	66.1	96.5
12	22.1	9.6	7.50	7.39	2.6	117.2	4.4	3.5	1.3	126.4	129.0	98.0
13	2.5	7.7	7.56	7.50	2.1	61.3	2.4	4.8	0.9	69.4	71.5	97.1
14	n.d.	7.6	7.12	6.93	3.7	48.0	2.5	3.5	2.2	56.2	59.9	93.8
15	n.d.	9.1	6.23	6.06	12.4	36.3	4.9	2.2	2.2	45.6	58.0	78.6
16	1.7	6.7	7.53	7.28	2.1	48.8	1.7	3.5	2.3	56.3	58.4	96.4

* – not detected.

Table 2

Physical and chemical properties of soil (2007)

No.	$CaCO_3$	$C_{org.}$	Acidity			Exchangeable cations				TEB	CEC	Base saturation [%]
			pH		Hh	Ca	Mg	K	Na			
	[g · kg^{-1}]		H_2O	KCl	[mmol · kg^{-1}]							
1	67.9	2.7	7.61	7.53	2.0	100.9	2.5	8.1	1.1	112.6	114.6	98.3
2	22.9	1.9	7.58	7.51	2.1	96.5	1.4	2.7	0.2	100.9	103.0	98.0
3	11.9	4.4	7.26	7.16	2.5	52.1	2.5	3.2	0.2	58.0	60.5	95.9
4	n.d.*	1.5	6.63	6.50	8.3	35.9	1.5	1.0	0.1	38.5	46.8	82.3
5	57.3	1.5	7.48	7.42	1.9	116.2	4.7	2.5	0.3	123.7	125.6	98.5
6	20.4	2.7	7.62	7.45	2.0	98.7	2.0	3.0	0.2	103.9	105.9	98.1
7	21.2	4.0	7.47	7.35	2.2	96.2	1.4	3.4	0.2	101.2	103.4	97.9
8	18.7	5.2	7.36	7.27	2.4	94.4	2.2	6.9	0.2	103.7	106.1	97.7
9	40.3	2.0	7.48	7.44	2.2	96.6	2.9	3.3	0.1	102.8	105.0	97.9
10	12.7	1.5	7.24	7.20	2.9	68.4	1.5	2.5	0.2	72.6	75.5	96.2
11	18.7	1.9	7.50	7.42	1.8	107.3	1.5	3.4	0.1	112.3	114.1	98.4
12	13.6	2.3	7.28	7.24	2.4	81.3	1.2	5.1	0.2	87.8	90.2	97.3
13	40.3	4.2	7.57	7.49	2.1	100.5	1.6	3.4	0.2	105.7	107.8	98.1
14	12.7	0.3	7.38	7.20	2.2	69.5	1.5	3.5	0.2	74.6	76.8	97.1
15	n.d.	3.9	6.56	6.12	9.8	61.2	3.6	5.6	0.4	70.8	80.6	87.8
16	36.1	3.0	7.33	7.21	2.3	86.0	3.2	4.7	0.2	94.1	96.4	97.6

* – not detected.

Determination of hydrolytic acidity is needed mainly to precise needs of soil liming. Both in 1992 and 2007 the value of Hh was very low. In 1992, ranged between 0.2 and 12.4 mmol · kg^{-1}, and in 2007 from 1.8 to 9.8 mmol · kg^{-1}, no significant differences were noticed.

The percentage base saturation during the analyzed period ranged from 82.3 to 98.5 %. Statistical analysis showed almost complete negative correlation (r = –0.937) between the hydrolytic acidity and the degree of cation saturation of exchangeable complex.

From this researches follows that, apart from minor fluctuations, the sum of alkaline cations remains unchanged in studied years. Our results showed small reduction of cation exchangeable capacity in relation to the year 1992.

High share of Ca^{2+} in the soil exchangeable cations of soil complex is reflected in the degree of soil base saturation. This observation was confirmed in the statistical analysis which showed very high value of correlation coefficient amounting 0.787 between these variables. Accordingly, a significant correlation between the hydrolytic acidity and Ca^{2+} content was also registered. In this case the correlation coefficient was negative and is equal –0.680.

Exchangeable cations in the soil exchangeable complex should be present in appropriate proportions. According to different authors, the average percentage of each cation should be 65 % of Ca, 10 % Mg, 5 % K and 20 % H, which gives the ratio of Ca:Mg:K:H equals 14:2:1:4 [8, 9]. In the studied soil samples Nos. 3, 12 and 16 the content of K^+ and in soil sample No. 4 the content of H^+ are very similar to the contents of the most common. In other soil samples, these values deviate far from the standards.

Almost all samples showed an increase of $CaCO_3$ content in relation to 1992. It is a component of anthropogenic origin and may come from the alkaline dusts emitted by plants [6, 7]. Significant emissions from fugitive sources of dusts, method of extraction and transport of raw material could be a reason of such situation. With the increase of calcium carbonate content hydrolytic acidity decreased, as was indicated by high correlation coefficient (r = –0.546), and simultaneously the degree of base saturation inreased (r = 0.568).

Registered organic carbon content was significantly lower than in 1992. Impact on such a low value could be the fact that the samples were collected during post-harvest. Reduction of humus content can also be caused by limited use of manure in the study area. It is also known that under alkaline conditions follows a rapid mineralization of humus.

Conclusions

1. In connection with the structural changes of the Cement and Lime Plant into two separate companies, ZPW Trzuskawica S.A., Department of Kujawy and “Lafarge” Cement, it is difficult to assess the impact of each of them separately on the state of the soil environment.

2. In 2007 compared with 1992 the decrease in organic carbon content in the studied soils was observed. This is due probably to the limited organic fertilization of soils and accelerated mineralization of humus under alkaline conditions.

3. Based on the study there was found a high degree of alkaline soils due to high accumulation of pollutants emitted from limestone in the past. The results of studies from year 1992 and 2007 indicate that there are still high pH values, and soil exchangeable complex is largely saturated by exchangeable forms of calcium.

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WŁAŚCIWOŚCI GLEB W OTOCZENIU ZAKŁADÓW PRZEMYSŁU WAPIENNICZEGO TRZUSKAWICA S.A., ZAKŁAD KUJAWY

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Abstrakt: Przedmiotem badań był wpływ zanieczyszczeń emitowanych przez Zakłady Przemysłu Wapienniczego Trzuskawica S.A., Zakład Kujawy i Lafarge „Cement", na fizykochemiczne właściwości gleb uprawnych w tym rejonie, przede wszystkim odczyn i stan kompleksu sorpcyjnego.

Próbki gleb do badań zostały pobrane na przełomie sierpnia i września 2007 r., w okresie pożniwnym. Do badań wytypowano 16 próbek glebowych z poziomu ornopróchnicznego, z obszaru o powierzchni około 4000 m^2. W pobranych do analizy próbkach oznaczono kwasowość czynną i wymienną, kwasowość hydrolityczną oraz zawartość węglanu wapnia, zasadowych kationów wymiennych i C-organicznego. Obliczenia statystyczne wykonano z wykorzystaniem programu komputerowego STATISTICA 8.0 PL.

Na podstawie przeprowadzonych badań stwierdzono wysoki stopień alkalizacji gleb, wynikający z dużej akumulacji zanieczyszczeń wapiennych emitowanych w przeszłości oraz dużej naturalnej zawartości węglanu wapnia w glebach w otoczeniu zakładów. Największy udział w kationowej pojemności wymiennej kompleksu sorpcyjnego miały jony Ca^{2+}. Stopień wysycenia analizowanych gleb zasadami oraz ich pojemność sorpcyjna były istotnie związane z zawartością kationów o charakterze zasadowym. Porównanie wyników badań z lat 1992–2007 wskazuje na utrzymujące się duże wartości pH i stopnia wysycenia zasadami glebowego kompleksu sorpcyjnego, spowodowany obecnością wymiennych form wapnia w glebach w otoczeniu Zakładów Przemysłu Wapienniczego Trzuskawica S.A., Zakład Kujawy i Lafarge „Cement".

Na podstawie przeprowadzonych badań nie można określić wpływu każdego z osobna, dwóch największych zakładów, emitujących zanieczyszczenia wapienne, na stan gleby w ich otoczeniu.

Słowa kluczowe: pyły wapienne, kompleks sorpcyjny, gleba