

## SOIL REACTION STATUS IN VARIOUS KINDS OF SOILS AS THE RESULT OF THEIR 15-YEAR LONG UTILIZATION IN SOUTH-EAST POLAND

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**Abstract.** In the present paper, the results of a 15-year long research pertaining to soil reaction in the level A<sub>1</sub> of six main kinds of soils, on which 32 exemplary farms were situated in south-eastern Poland. In those farms proper agrotechnics was carried out. It was combined with organic fertilization and liming, on the average, every 4 years and a yearly mineral fertilization. The level and form of the applied fertilizers was supervised by the specialists of the Regional Station of Agricultural Chemistry in Rzeszów. During the 15-year long period of the research a favourable effect of anthropogenic factor on soil reaction was noted.

**Key words:** soil reaction, organic and mineral fertilization

### INTRODUCTION

The Stations of Agricultural Chemistry played an important role in the research pertaining to the reaction and macro- and microelements availability of Polish soils.

Other authors also dealt with the problem of soil reaction [1-8]. The differentiation of soils in the respect of chemistry to a great extent depends on the kind of mother rock [2]. Soils formed from sand formations belong to the most acidified ones in Poland [2,8]. The soils formed from loess are much less acidified [2,8]. The application of mineral fertilization and, especially, nitrogen-potassium one causes the acidification of soils [1,4,5,7]. Humid climate also adds to the acidification of Polish soils, taking away the alkaline elements from soil together with plant crops. Large quantities of SO<sub>2</sub>

emitted to atmosphere and, connected with it, acid rainfalls also add to it [1]. The long-term application of the organic fertilizers has favourable effect on the reaction of soil [6]. Although, some researchers [5] indicate that farmyard manure lessens not only the acidifying effect of mineral fertilizers, but also the deacidifying properties of lime fertilizers. It results from the carried out research [1,3-8] that organic fertilization and sensible application of mineral fertilizers combined with soil liming can neutralize the unfavourable effect of soil acidification.

The aim of the research carried out by the Regional Station of Agricultural Chemistry in Rzeszów in the exemplary farms (private and state ones) was, among others, to determine the changes in soil reaction as the result of their 15-year long cultivation and fertilization.

### MATERIALS

The research was carried out in the years 1976-1990 in 32 exemplary farms selected by the Regional Station of Agricultural Chemistry in Rzeszów (Fig. 1). Careful agrotechnics with organic-mineral fertilization and liming was applied in these farms. Liming and farmyard manure was applied, on the average, every 4 years and mineral fertilization each year.

The kinds of soils occurring in south-eastern Poland were included in the research in



which the following numbers of permanent fields were taken into consideration:

- soils formed from weak loamy sands - 2,
- soils formed from light and medium loams - 2,
- soils formed from silt formations of water origin - 10,
- soils formed from loess formations - 11,
- soils formed from alluvial formations - 17,
- soils formed from not cemented sedimentary rock and Carpathian flysh - 22.

Soil samples were taken each year, starting with 1975/76 from A<sub>1</sub> level of the examined soils. The reaction of soil was determined in 1 mol/dm<sup>3</sup> KCl. The amounts of CaO kg/ha/year were calculated from the amounts of applied farm manure on the basis of its chemical composition determined through the analyses and from the amounts of fertilizing calcium utilized there. The results of soil reaction were statistically worked out by calculating LSD according to Tukey.

## RESULTS

Table 1 presents the use of CaO in kg/ha/year applied in the form of fertilizing lime and organic fertilization (including mainly farm manure) on the average per 1 field of the examined soils in the years 1976-90. The largest amounts of CaO both in organic fertilization and liming were applied in the farms situated on soils formed from light and medium loams. Slightly smaller amounts were applied in the farms situated on the soils formed from alluvial formations and loess formations, weak loamy sands, and the smallest amounts on

the soils formed from silty formations of water origin. The CaO introduced in all the forms came mainly from the applied liming and from organic fertilizers. The consumption of CaO during the 15-year long period of research did not fully cover the quantitative requirements of lime in soils and the frequency of the applied liming was not sufficient.

The values of soils pH, which formed under the influence of the plant cultivation as well as of the 15-year long period of the research, are presented in Table 2.

CaO applied in the organic and lime fertilizers was accompanied by favourable changes of the reaction of the examined soils. The soils in the subsequent kinds were significantly differentiated in the respect of their pH both in the initial (1976) and final (1990) periods of the research as well as in some kinds of the average values of pH in the 15 years.

The greatest increase in pH value in 1990 in comparison to 1975 in the 15-year long period of the research was noted in soils formed from weak loamy sand. The favourable changes in the years 1975-90 were noted in soils formed from light and medium loams in which the value of pH increased on the average by 1.1 units.

In soil formed from light and medium loams the greatest use of CaO/ha was noted, on the average per 1 field during the 15 years. In soils formed from weak loamy sands, especially careful and frequent organic fertilization (farm manure) and liming was applied, which gave distinct

**Table 1.** Use of CaO in the exemplary farms in the 15-year long period of the utilization of soils in SE Poland (\*-mean values, \*\*-extreme values)

Kinds of soil	Amounts of CaO introduced in years 1975-90 kg/ha		
	In organic fertilizers	In fertilizing lime	Total
Soils formed from weak loamy sands	675*	4050	7725
Soils formed from light and medium loams	546-804**	3500-4600	4303-5146
Soils formed from loess and loess formations	1005	6250	7255
Soils formed from silt formations of water origin	777-1233	4000-8000	4777-9733
Soils formed from alluvial formations	990	4800	5790
Soils formed from Carpathian flysh	714-1583	2500-8500	3743-9133
	466	4210	4676
	281-943	2600-5500	3183-5769
	486	5141	5627
	230-833	2000-11000	3289-11230
	455	4810	5265
	233-602	2000-8000	3490-8600

**Table 2.** Changes of pH value formed in the subsequent kinds of soil in the 15-year long period of agricultural utilization in the exemplary farms from SE Poland (\*-mean values, \*\*-extreme values)

Soil kind	pH in 1mol/dm <sup>3</sup> KCl		
	1976	1990	average for 1976-90
Soils formed from weak loamy sands	4.30*	5.80	5.00
Soils formed from light and medium loams	4.30-4.40**	5.50-6.70	4.10-7.20
Soils formed from loess and loess formations	4.70	5.80	5.50
Soils formed from loess and loess formations	3.80-5.70	5.50-6.10	3.8-6.50
Soils formed from silt formations of water origin	5.30	5.94	5.59
Soils formed from alluvial formations	4.40-7.30	4.70-6.80	4.40-7.30
Soils formed from Carpathian flysh	4.80	5.43	5.10
	4.00-6.60	4.30-6.80	3.30-7.20
	4.88	5.28	5.16
	3.30-6.00	4.00-6.90	3.30-7.20
	5.08	5.63	5.47
	4.30-6.20	4.40-7.10	4.00-7.10
LSD $p=0.05$	0.32	0.41	0.38

favourable effect in their deacidification. In the remaining kinds of soils the average increase in pH value was from 0.4 in soils formed from alluvial formations to 0.64 in soils formed from loess formations. The greatest gap between the results of pH value occurred in 1975, especially in soils formed from alluvial formations and loess. In weak loamy soils after 15 years of the carried out research, simultaneously with the careful agrotechnics, a certain deacidification of soil proceeded. That is why pH values narrowed in the subsequent kinds. The values of pH during the 15 years were significantly differentiated in the subsequent kinds of soil.

#### DISCUSSION

The application of liming combined with the organic and mineral fertilization in the permanent fields of the exemplary farms in south-eastern Poland contributed to the drop of acidification of all the kinds of soils. The changes occurred especially distinctly in the soils formed from weak loamy sand and light and medium loams, which was the result of quite large use of CaO kg/ha coming from liming and from the application of organic fertilization. Boguszewski [1] and Nowosielski *et al.* [6] stress the positive effect of liming and organic fertilization on the pH values of soil. Rabikowska *et al.* [7] also noted favourable effect of fertilizing with farm manure on the soil pH. The result of the testing

of soil reaction indicate that the soils of the examined area preserved many primary properties resulting from the natural soil-formation processes in spite of comparatively long period of utilization, as it results from the geodetic documentation. It is characteristic that in the initial period of the research, the majority of soils formed from the alluvial formations had very acid and acid reaction. It probably testifies to the fact that the sedimentary material and waters transporting it, were of acid reaction [8]. It suggests that in this and preceding periods the processes of denudation and erosion in the catchment areas were quiet and did not disturb the soil cover to the extent that would uncover the deeper, naturally richer in alkaline elements, horizons of soil, especially of soils formed from loess. The low pH of soils formed from alluvial formations testifies to the fact that even all amounts of Ca<sup>2+</sup> introduced from the soils of catchment areas did not deposit in the alluvia [8]. In the effect the 15-year long cultivation, fertilization and liming, the favourable effect of soil anthropogenization was visible in the respect of pH in all the kinds of soils, which resulted from the high farming culture of the exemplary farms. Definitely higher amounts of lime, farm manure and mineral fertilizers in comparison to other farms in this area were used in these farms.

From the research of Turski *et al.* [8], carried out for all the private farms in the central part of

(Subcarpathian Lowland) results that during the 16-year long period of the research, favourable directions of changes of the pH of soil occurred in soils formed from loess and alluvial formations. However, soils formed from sands and light and medium loams underwent further acidification, which resulted from the small use of lime in these farms. It was from 0 to 68.8 kg CaO/ha in the years 1958-1973.

From the research of some authors [1,3-8] results that liming combined with organic and mineral fertilization contributes to the deacidification of soil. The noted favourable changes in the direction of the increase of pH value of the tested kinds of soils, testify to the great abilities of man in forming the pH of soil with the help of high level of agrotechnics including liming, organic and rational mineral fertilization.

#### CONCLUSIONS

1. The application of CaO in the organic fertilizers and fertilizing lime during the 15-year long period of the utilization of soil was differentiated in the exemplary farms in the subsequent kinds of soil:

a) the highest average use of CaO/ha in a farm during the 15 years was noted on soils formed from light and medium loams;

b) the lowest average use of CaO kg/ha in a farm during the 15 years was noted in soils formed from silt formations of water origin. The remaining kinds of soils had medium position in the respect of the average use of CaO.

2. During the 15-year long period of plant cultivation and mineral-organic fertilization and liming, favourable changes of the reaction of all the kinds of soils were noted. The highest increase in pH occurred in the exemplary farms in soils formed from weak loamy sand and light and medium loams, which was connected with the highest average use of CaO kg/ha applied both with liming and in organic fertilizers, especially in soils formed from light and medium loams.

3. Favourable changes of soil reaction under the influence of 15-year long plant cultivation and fertilization testify to the high agricultural culture of the exemplary farms and, thus, to the great abilities of the anthropogenic factor

in the formation of the subsequent elements of soil fertility.

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#### KSZTAŁTOWANIE SIĘ ODCZYNU W NIEKTÓRYCH RODZAJACH GLEB W WYNIKU 15-LETNIEGO ICH UŻYTKOWANIA W POŁUDNIOWO-WSCHODNIEJ POLSCE

W pracy przedstawiono 15-letnie wyniki badań odczynu gleb w poziomie A<sub>1</sub> 6 głównych rodzajów gleb, na których były prowadzone 32 gospodarstwa przykładowe w południowo-wschodniej Polsce.

W gospodarstwach przykładowych była prowadzona staranna agrotechnika, połączona z nawożeniem organicznym i wapnowaniem przeciętnie co 4 lata oraz nawożeniem mineralnym w każdym roku. Poziom i rodzaj stosowanych nawozów w gospodarstwach był nadzorowany przez pracowników Okręgowej Stacji Chemiczno-Rolniczej w Rzeszowie. W okresie 15-letniego okresu badań stwierdzono korzystny wpływ czynnika antropogenicznego na odczyn badanych gleb.

Sł o w a k l u c z o w e: odczyn gleb, nawożenie organiczne i mineralne.