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COMPARISON OF VARIABILITY OF SOIL ACIDITY OF AGRICULTURAL FARMS IN SLOVAKIA

Soil investigation oriented to soil reaction study took place in two agricultural farms in 2004 and it was repeated after four years again. The pH value change at total absence of liming was balanced. It was confirmed that liming absence resulted in soil reaction rapid decrease in natural way - by calcium and magnesium resorption with crops, their leaching into deeper soil horizons, their outflow with erosion but also physiologically acid fertilization. In the agricultural enterprise Nemsova neutral and alkaline soil acreage (pH value above 6.6) decreased from 1008 ha to 190 ha in period 2004-2008 (decrease 82 per cent) and contrary soil acreage with pH value below 5.5 increased from 274 ha to 569 ha in the same period. There is even more unbeneficial situation in the agricultural farm Osikov. Acreage with pH value above 6.6 was reduced in period 2004-2008 from 1548 ha to 178 ha (decrease 90 per cent), while acid and strong acid soils (pH lower than 5.5) increased from 138 ha to 838 ha in the same period.

Key words: pH value, liming, acid soils

Торма С., Лисняк А. СРАВНЕНИЕ ИЗМЕНЧИВОСТИ КИСЛОТНОСТИ ПОЧВ СЕЛЬСКИХ ХОЗЯЙСТВ СЛОВАКИИ

При почвенных исследованиях в 2004 году, и спустя четыре года, было проведено изучение реакции почвенной среды на почвах двух сельскохозяйственных ферм. Было подтверждено, что отсутствие известкования почвы приводит к быстрому снижению реакции среды за счёт уменьшения кальция и магния путём резорбции их сельскохозяйственными культурами, выщелачивания их в более глубокие горизонты почвы, оттока их с эрозией, а также за счёт внесения физиологически кислых удобрений. В сельскохозяйственном предприятии Немсова, за период 2004-2008 гг., площади нейтральных и щелочных почв (рН выше 6,6) снизились с 1008 га до 190 га (снижение на 82 %), а площади почв с рН ниже 5,5 увеличились с 274 га до 569 га за тот же период. Ещё более худшая ситуация на сельскохозяйственной ферме Осиков. Площади с рН выше 6,6 сократилась за период 2004-2008 гг. с 1548 га до 178 га (уменьшение на 90 %), в то время как площади сильнокислых почв (рН менее 5,5) увеличились с 138 га до 838 га за тот же период.

Ключевые слова: кислотность, известкование, кислые почвы

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Торма С., Лісняк А. ПОРІВНЯННЯ ЗМІНИ КИСЛОТНОСТІ ҐРУНТУ СІЛЬСЬКИХ ГОСПОДАРСТВ СЛОВАЧЧИНИ

При ґрунтових дослідженнях у 2004 році, і через чотири роки, було проведено вивчення реакції ґрунтового середовища на ґрунтах двох сільськогосподарських ферм. Було підтверджено, що відсутність вапнування ґрунту призводить до швидкого зниження реакції середовища за рахунок зменшення кальцію і магнію шляхом резорбції їх сільськогосподарськими культурами, вилуження їх у більш глибокі горизонти ґрунту, відтоку їх з ерозією, а також за рахунок внесення фізіологічно кислих добрив. У сільськогосподарському підприємстві Немсова, за період 2004-2008 рр., площі нейтральних і лужних ґрунтів (pH вище 6,6) знизилися з 1008 га до 190 га (зниження на 82 %), а площі ґрунтів із pH нижче 5,5 збільшилися з 274 га до 569 га за той же період. Ще більш гірша ситуація на сільськогосподарській фермі Осиков. Площі з pH вище 6,6 скоротилися за період 2004-2008 рр. з 1548 га до 178 га (зменшення на 90 %), у той час як площі сильнокислих ґрунтів (pH менш 5,5) збільшилися з 138 га до 838 га за той же період.

Ключові слова: pH, вапнування, кислі ґрунти

Introduction

Soil reaction, as one of basic agrochemical soil properties, reflects the properties of most active gentledispersed soil fractions, particularly their ratio of basic cations saturation to hydrogen. Formation of qualitative and quantitative ratios of soil saturation is result of interactive action of all factors in soil development process.

Acid soil reaction has many negative phenomena with impact both on soil itself and crop grown. Some of them are mentioned bellow:

- very acid soil reaction brings about phosphorus chemical fixation and phosphorus is not available for plants
- potassium is less fixed with soil at low soil pH value and it is easier washed out of soil horizons. These two phenomena are resulting into lower nutrient uptake by plants.
- the microelement uptake with plants is various in dependence on soil pH value, e.g. iron, manganese and copper mobility increases in acid environment, but molybdenum, that positively influences on rhizobial bacteria development, is almost infunctional in environment with pH under 5.0.
- lower soil pH value supports heavy metals mobility that easier enter crops as well as food chain (Bruess et al., 1995)
- humus quality decreased at acid soil reaction due to low ratio of humic acids to fulvic acids
- acid soils have not stable structure and easily undergo erosion
- biological activity of acid soils is low, because all useful microflora and microfauna perishes. Therefore nitrification ability is low, cellulose decomposition is of small intensity and extent of breathing in soil is decreased.

Material and methods

As marked example of soil acidification at zero liming, two agricultural farms were chosen. They are Agricultural farm Osikov (county Bardejov, north-eastern Slovakia) and Agricultural farm Nemsova (county Trencin, western Slovakia).

Soil forming substratum in Osikov territory is Carpathian Flysch in typical development that is composed of sandstones alternated with slate and sandy mudstones. Quartenary is represented with deluviums and solifluction looms with majority of deluviums. All the groups of deluvial sediments have, as a rule, acid character and are mixed with the skeleton of flysch rocks. Holocene is located in drainage area of the Sekcov brook and in drainage area of other brooks. It is built of non calcareous to weak calcareous alluvial sediments of variable depth and texture. Main soil types are Dystric Planosols, Cambisols and Rankers.

In the Nemsova territory soil forming substrata in alluviums of the rivers Vah and Vlara are Holocene sediments most carbonate. There are loam of loess, Mesozoic slates and dolomitic limestone in hilly land part of the territory. Main soil representatives are here dystric Planosols, Luvisols and Cambisols.

This paper was elaborated based on the newest analytic data of soil solution pH (sampled in 2008), the values were compared with former pH value (2004). Noticeable is that in period of four years there was no application liming materials. So soil reaction change runs in normal way, under influence of paternal rocks, acid precipitation and calcium ions resorption with biomass.

Results and discussion

Factors affecting soil reaction

Soil reaction is under influence of inner and outer factors. *Inner (endogenous) factors* are including particularly rock chemism and texture (parental material).

Outer factors include:

atmospherical factors − precipitation that penetrate into soil and leach substances effecting soil puffering capacity, as well as soil reaction stability

biological factors − plant remainders and root secrets that are source of hydrogen ions. Here can be also included calcium and magnesium uptake by plants. Every crop needs these nutrient for its growth in smaller or larger extent as important constituent of its nutrition. Plants resorb mentioned nutrients in period of their active growth, whereby individual species have different demands (see Table 1, Czuba et al., 1994).

anthropic factors − soil acidification processes are considerably supported by acid atmospheric deposits with main compound sulphuric oxide. This is main contribution to calcium leaching after its natural dynamics in soil.

Fertilization belongs to other unneglegible factor of soil reaction decrease. Although recently was fertilizer use substantially reduced, particularly phosphorus and potassium ones, it is necessary to realize that most nitrogen fertilizers are physiologically acid (Table 2 - according to Sluismans), therefore their acidification impact should be neutralised. Farmyard manure reduced application contributes to soil acidification, too. As it is well known organic biomass has buffering effect on the processes of acidification by its increase soil buffering capacity.

Table 1

Calcium and magnesium output by some plants

Crop	Ca and Mg output with 1 ton of main product with by-product (kg)			
	CaO	Ca	MgO	Mg
Winter wheat	4 - 6	2.8 - 4.3	4 - 6	2.4 - 3.6
Spring barley	8 - 10	5.7 - 7.1	4 - 6	2.4 - 3.6
Oats	9 - 11	6.4 - 7.9	6 - 8	3.6 - 4.8
Triticale	6 - 9	4.3 - 6.4	5 - 7	3.0 - 4.2
Winter rape	50 - 70	35.7 - 50.0	8 - 11	4.8 - 6.6
Legumes	25 - 40	18 - 28.5	5 - 10	3.0 - 6.0
Sugar beet	3 - 5	2.1 - 3.6	2 - 3.5	1.2 - 2.1
Potatoes	1.1 - 1.5	0.8 - 1.1	0.4 - 1	0.25 - 0.6
Silage maize	4 - 6	2.8 - 4.3	0.3 -0.6	0.2 - 0.6
Corn maize	7 - 9	5.0 - 6.4	8 - 10	4.8 - 6.0
Alfalfa	4 - 6	2.8 - 4.3	0.5 - 1	0.3 - 0.6
Red clover	4 - 6	2.8 - 4.3	0.5 - 1	0.3 - 0.6

Table 2

Calcium equivalent at some fertilizer application

Fertlizers	CaO loss or gain	
	per 100 kg of fertilizer	per 100 kg N
Ammonium sulphate	- 63	- 299
Ammonium nitrate with limestone	- 16	- 58
Urea	- 46	- 100
Kalkamid	+ 35	+ 81
Waterless ammonium	- 82	- 100
Superphosphate (18 %)	0	0
Potassium salts and kieserit	0	0

So soil reaction is linked with Ca^{2+} and Mg^{2+} compounds presence in soil forming substrata (particularly carbonates). In conditions of their surplus soils have alkaline reaction and contrary soil acidity is linked with mentioned compounds absence.

Primary acid soil originated of acid rocks that are minerally poor (no or less basic compounds), are not able to neutralise quickly enough hydrogen ions of organic, mineral, biotic or abiotic origin.

Acidification could be happen also in secondary way, including substrata containing basic compounds, particularly when located in climatic regions with higher precipitation and soluble acid compounds (CO_2, fertilizers, acid pollutants etc.) Under these influences calcium and magnesium compounds are released and are leached into lower soil horizons.

<u>*Soil reaction status in observed farms*</u>

At generally well known soil categorisation by soil reaction in period 2003-2004 was in Osikov registered only 6.8 per cent soil with pH value under 5.5, almost one half of arable land was neutral and more than one fourth was alkaline (pH 6.6 - 7.2). After the „planned economy“ retreat and market mechanism assembling, when crop production inputs (primarily liming materials) were markedly limited, pH value shift toward acid reaction takes place. Liming materials application was totally absented in Osikov. This was reflected in new distribution of arable land according to pH values (Table 3, Figure 1).

There was almost 55 per cent of arable land in the category extreme acid, strong acid and acid with pH value lower than 5.5 in 2008.

Table 3

The soil pH value in farm Osikov

Agrochemical Soil Testing year	Share of soils	Soil pH value pH/KCl in arable land					
		< 4.5	4.6 – 5.0	5.1 – 5.5	5.6 – 6.5	6.6 – 7.2	> 7,2
2004	ha	27	34	77	408	963	585
	per cent	1.4	1.7	3.7	19.5	46.0	27.9
2008	ha	60	150	628	532	178	0
	per cent	3.9	9.7	40.8	34.0	11.6	0

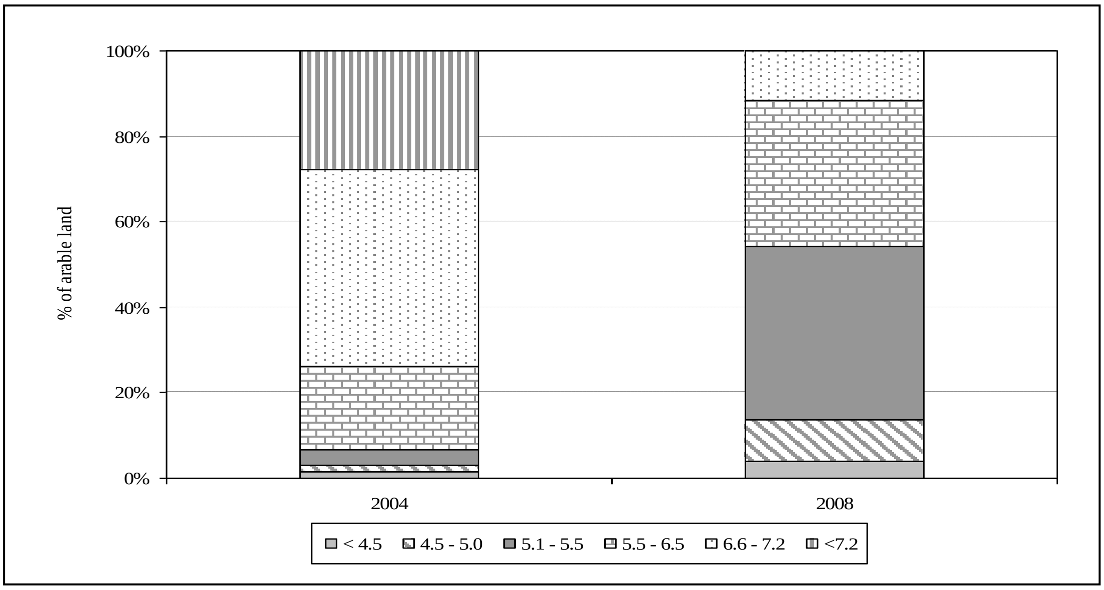

Fig. 1 − The change of soil pH value during three years in farm Osikov

Minimum pH value within the whole farm is 3.6. From Figure 1 is visible that soils with pH above 5.6 (in 2004 belonged here almost all arable land) cover only 45.6 per cent.

The farm Nemsova showed similar trend in soil reaction evolution in recent 5 years - non beneficial. Liming materials limited application in recent three-four years resulted in substantial decrease of soil area with alkaline and neutral reaction and vice versa increase of acid soil area, strong acid and extreme acid soils.

Table 4

The soil pH value in farm Nemsova

Agrochemical Soil Testing year	Share of soils	Soil pH value pH/KCl in arable land					
		< 4.5	4.6 - 5.0	5.1 - 5.5	5.6 - 6.5	6.6 - 7.2	> 7.2
2004	ha	43	76	155	365	557	451
	%	2.6	4.6	9.4	22.1	33.8	37.5
2008	ha	217	165	187	208	80	110
	%	22.4	17.1	19.3	21.5	8.3	11.4

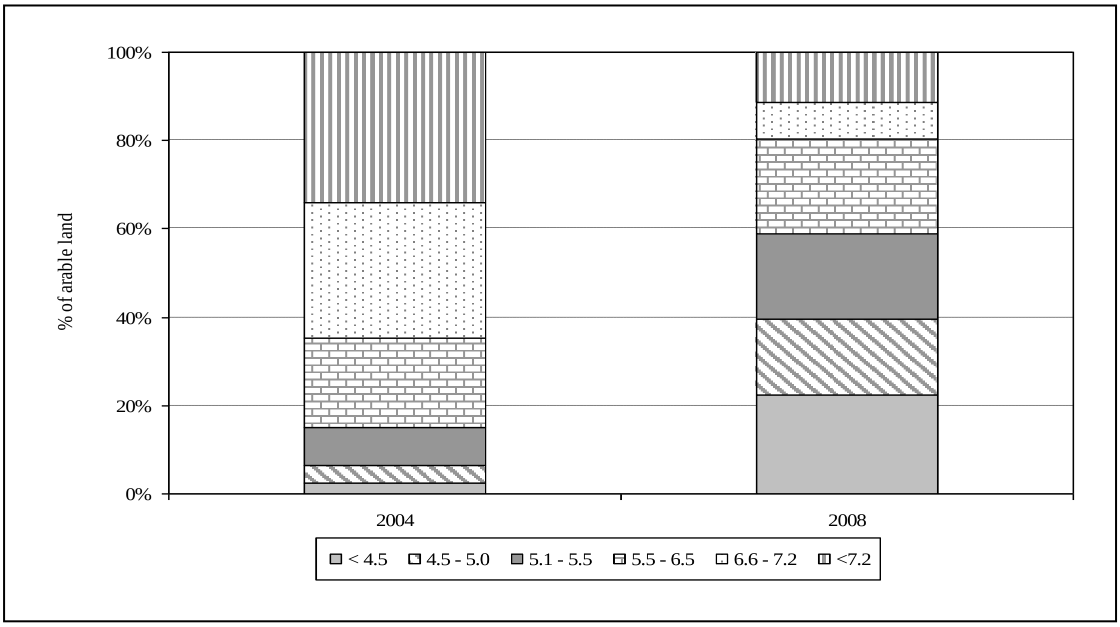

Fig. 2 − The change of soil pH value during three years in farm Nemsova

From table 4 and Figure 2 is visible that soil share with pH under 4.5 (extreme acid) increased from 2.6 per cent even to 22.4 per cent.

Share of soils with strong acid and acid reaction was increased within recent Agrochemical Soil Testing similarly in Nemsova and in 2008 was almost 60 per cent soil with pH value lower than 5.5. Share of neutral soils decreased from 33.8 per cent to present 8.3 per cent of total area. From this trend is possible to form a picture, what could happen when liming material application remains neglected.

Conclusion

There is a shocking situation from the point of view of soil reaction on both mentioned farms. Areas of soil categories with alkaline and neutral soil reaction were reduced markedly and proportion of acid, strong acid and extreme acid soil reaction (soils with pH value lower than 5.5) increased. This process runs in natural way - leaching and washing out calcium cations, acid character of plant remainders, and calcium natural resorption by crops.

The share of alkaline and neutral soils (pH above 6.6) was reduced in the agricultural farm Nemsova from 1008 ha in 2004 to 190 ha in 2008 and contrary the acidity category with pH value lower than 5.5 increased from 274 ha in 2004 to 596 ha in 2008.

Similar situation is also in agricultural enterprise Osikov. Soil acreage with pH value above 6.6 decreased in period three years from 1548 ha to 178 ha, vice versa acid and strong acid soils acreage (pH value lower than 5.5) increased from 138 ha in 2004 to 838 ha in 2008.

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ОЦІНКА ПОЛІЕЛЕМЕНТНОГО ЗАБРУДНЕННЯ ГРУНТІВ ТЕРИТОРІЙ РІЗНОГО РІВНЯ АНТРОПОГЕННОГО НАВАНТАЖЕННЯ

Надана оцінка поліелементного забруднення ґрунтів на прикладі територій з різним рівнем антропогенного навантаження м. Харкова та області за сумарним показником забруднення Z_{cj}, показником ступеня поліелементного забруднення Сз, за цинковим еквівалентом $Zn_{екв}$., а також за показником інтенсивності забруднення природного компонента Pj.

Ключові слова: поліелементне забруднення, сумарний показник забруднення, цинковий еквівалент, показник інтенсивності забруднення природного компоненту

Гололобова Е. А. ОЦЕНКА ПОЛИЭЛЕМЕНТНОГО ЗАГРЯЗНЕНИЯ ПОЧВ ТЕРРИТОРИЙ З РАЗНЫМ УРОВНЕМ АНТРОПОГЕННОЙ НАГРУЗКИ

Представлена оценка полиэлементного загрязнения почв на примере территорий с разным уровнем антропогенной нагрузки г. Харькова и области за суммарным показателем загрязнения Z_{cj}, показателем степени полиэлементного загрязнения Сз, за цинковым эквивалентом $Zn_{экв}$, а так же за показателем интенсивности загрязнения природного компонента.

Ключевые слова: полиэлементное загрязнение, суммарный показатель загрязнения, цинковый эквивалент, показатель интенсивности загрязнения природного компонента

Gololobova E. ASSESSMENT OF SOIL CONTAMINATION POLYELEMENT AREAS OF DIFFERENT LEVELS ANTHROPOGENIC LOAD

Provides an assessment of soil contamination on polyelement sample areas with different levels of anthropogenic load of Kharkov and region for the summary measure of pollution Zcj, exponent polyelement Cs contamination for zinc equivalent Znekv, as well as an indicator for the pollution intensity of the natural component.

Keywords: polyelement pollution, total pollution index, a zinc equivalent indicator of the intensity of pollution of natural component

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