

## ACIDIFICATION OF A MEADOW CHERNOZEM (LUVIC PHEOZEM) SOIL IN THE TRANS-TISZA REGION

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### Introduction

Soil acidity is common in all regions where the soils developed on parent materials with low base content and/or the amount of precipitation is high enough to leach appreciable amounts of bases from the surface layers. Since the 1970s more and more data indicated that soil acidification is not confined only to the soils on wet areas which were developed on acidic parent material (Sipos-Patócs, 1975; Debreczeni, 1994). After leaching the  $\text{CaCO}_3$  the acid load of soil is buffered by the exchangeable cations. The neutral, slightly acidic soils are especially sensitive to acidification. On slightly acid soil the same acid load caused much bigger pH decrease than on a strongly acid one (Zsigrai, 1995).

### Material and methods

The acidification process was measured in a long term fertilization experiment at Karcag, which belongs to the National Fertilization Experimental Network. In Hungary the fertilizer rate experimental network was established by G. Láng in 1967. The experimental sites of the network represent the most important soil types of Hungary. The Karcag Experiment lies on a meadow-chnozem (Luvic Phaeosem) soil. The effects of different rates of N, P and K fertilization on soil properties were investigated. The split-plot experimental design included two rotations:

A: winter wheat-maize-maize-peas,

B: winter wheat-maize-maize winter wheat.

Each rotation was subjected to five N ( $\text{N}_0$ ,  $\text{N}_1=1765$  kg/32 year,  $\text{N}_2=3155$  kg/32 year,  $\text{N}_3=4545$  kg/32 year,  $\text{N}_4=5840$  kg/32 year), four  $\text{P}_2\text{O}_5$  ( $\text{P}_0$ ,  $\text{P}_1=1660$  kg/32 year,  $\text{P}_2=3320$  kg/32 year  $\text{P}_3=4945$  kg/32 year) and three  $\text{K}_2\text{O}$  ( $\text{K}_0$ ,  $\text{K}_1=3610$  kg/32 year  $\text{K}_2=4500$  kg/32 year) levels. Originally each fertilizer treatment had 4 replications. In 1987 10 t/ha lime ( $\text{CaCO}_3$ ) was applied to the plots of replication I and III. Soil samples from the topsoil are taken every 4 years. In order to determine the long term acidification process, those soil samples are evaluated in this paper, that have been taken between 1979 and 1999. The detailed data can be found in a book edited by Blaskó and Zsigrai (2003).

The following soil properties were measured at two depth intervals (0-20 and 20-40 cm): humus content,  $\text{pH}_{(\text{KCl})}$ , exchangeable Ca-, Mg. The results were evaluated using one way ANOVA and multiple regression analysis by means of ORIGIN PRO7.

### Results

The time tendency of soil acidification was similar in both crop rotations: between 1979 and 1983 acidification of considerable degree (0.5 - 1  $\text{pH}_{(\text{KCl})}$ ) occurred, then reaching a lower threshold the decrease of pH-value was much smaller, or even could not be detected. Acidification could be observed in the non fertilized variant ( $\text{N}_0$ ) as well (Fig. 1).

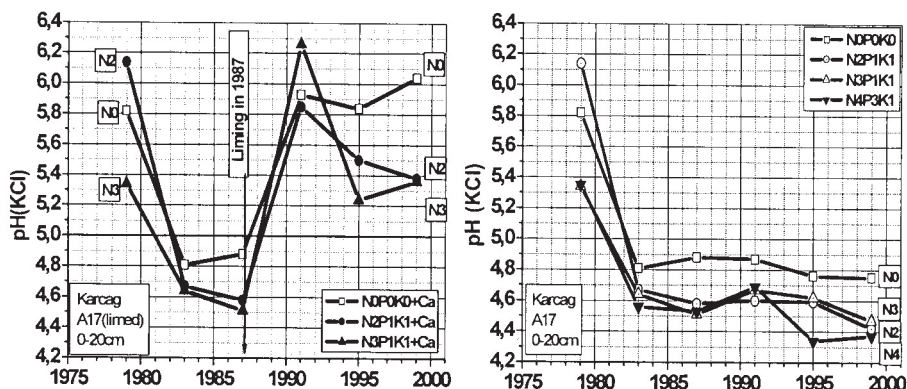


Fig.1. Temporal change of  $pH_{(KCl)}$  under the influence of fertilization and liming between 1979 and 1999

Within the fertilization treatments, mainly the effect of nitrogen supply can be pointed out. N-fertilization significantly lowered the soil pH in all rotations. The pH decreasing effect of nitrogen fertilizer was significant in the 0-20 and 20-40cm layers (Table 1).

While the pH has decreased significantly under the influence of ammonium-nitrate fertilization, the exchangeable calcium content has not changed significantly, except for a few cases (Table 2.). The possible cause is that rainfall is generally not high enough to leach calcium compounds of low solubility away from the soil. The comparatively high exchangeable and water soluble calcium content, even in case of acidic pH range, is a distinctive feature of this soil.

The exchangeable magnesium content was much more affected by the mineral fertilization than the calcium content. The magnesium content was decreased in a few cases by nitrogen- and in more cases by potassium application (Table 3.).

Table 1.: Statistical values of multiple regression analysis of NPK effect on pH(KCl)

| Crop rotation | Liming | Layer cm | pH (KCl) | N-effect | P-effect | K-effect |
|---------------|--------|----------|----------|----------|----------|----------|
| A1732         | L+     | 0-20     | 6,01     | -        | 0        | 0        |
|               |        | 20-40    | 5,88     | -        | 0        | 0        |
|               | L0     | 0-20     | 4,64     | -        | 0        | (+)      |
|               |        | 20-40    | 4,77     | -        | 0        | 0        |
| B1732         | L+     | 0-20     | 5,90     | -        | 0        | 0        |
|               |        | 20-40    | 5,91     | -        | 0        | 0        |
|               | L0     | 0-20     | 4,80     | -        | 0        | 0        |
|               |        | 20-40    | 4,82     | -        | 0        | 0        |

Signs and abbreviations: L+: limed. L0: not limed Statistical evaluation ( T-test): 0: no effect +: P=5% proved increase - P=5% proved decrease (+): P=10% proved increase (-): P=10% proved decrease

Table 2.: Statistical values of multiple regression analysis of NPK effect on exchangeable Ca content

| Crop rotation | Liming | Layer cm | Exch. Ca meq/100g | N-effect | P-effect | K-effect |
|---------------|--------|----------|-------------------|----------|----------|----------|
| A1732         | L+     | 0-20     | 24.04             | 0        | 0        | 0        |
|               |        | 20-40    | 23.54             | 0        | 0        | 0        |
|               | L0     | 0-20     | 21.03             | -        | +        | -        |
|               |        | 20-40    | 18.57             | 0        | (+)      | 0        |
| B1732         | L+     | 0-20     | 24.6              | 0        | 0        | 0        |
|               |        | 20-40    | 21.63             | (-)      | 0        | 0        |
|               | L0     | 0-20     | 20.44             | 0        | 0        | 0        |
|               |        | 20-40    | 18.84             | 0        | 0        | 0        |

Signs and abbreviations: see table 1.

Table 3.: Statistical values of multiple regression analysis of NPK effect on exchangeable Mg content of soils

| Crop rotation | Liming | Layer cm | Exch. Mg meq/100g | N-effect | P-effect | K-effect |
|---------------|--------|----------|-------------------|----------|----------|----------|
| A1732         | L+     | 0-20     | 4.16              | 0        | 0        | 0        |
|               |        | 20-40    | 4.10              | 0        | 0        | -        |
|               | L0     | 0-20     | 4.57              | -        | 0        | -        |
|               |        | 20-40    | 4.21              | 0        | 0        | -        |
| B1732         | L+     | 0-20     | 3.88              | 0        | 0        | 0        |
|               |        | 20-40    | 4.24              | -        | 0        | 0        |
|               | L0     | 0-20     | 4.48              | -        | 0        | -        |
|               |        | 20-40    | 3.77              | 0        | 0        | 0        |

Signs and abbreviations: see table 1.

### Conclusions

On the non-calcareous soils, which were neutral or slightly acidic at the beginning of the experiment, there is a strong acidification process in the whole carbonate-free top layer. In the neutral, slightly acidic soil considerable acidification occurred, and then reaching a lower threshold the decrease of pH-value is much smaller, or even can not be detected. The acidification goes not only on the fertilized plots, but also on the control plots. This fact proves that fertilization is not the only reason of acidification, but other factors like acid environmental loads, uptake of basis forming elements by the crops have important role in it.

### References

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