The Acidifying Effect of $(NH_4)_2SO_4$ Fertilizer in a Pot Experiment

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Excessive soil acidity is increasingly becoming a yield-limiting factor.

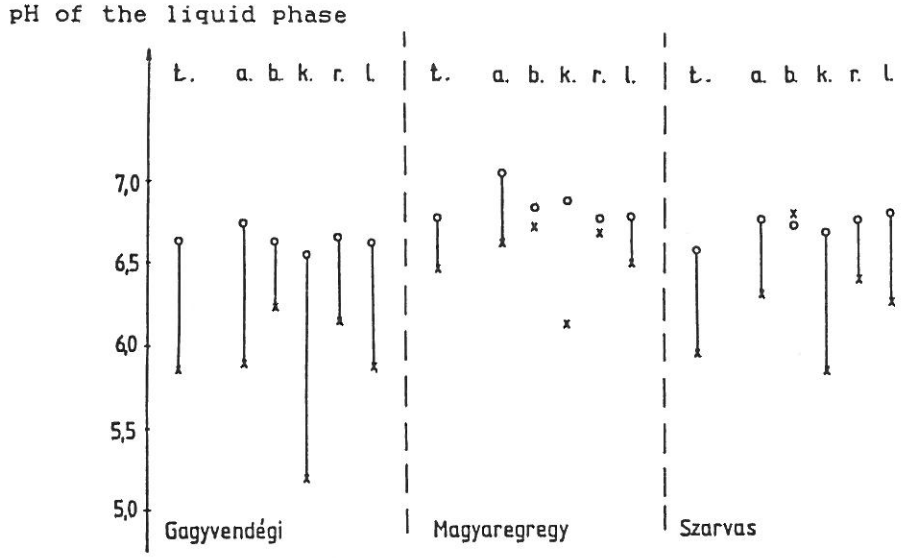
The pH-decrease of soils in Hungary is also significant and the regular soil analyses show that this unfavourable trend can be detected in large areas.

The process of soil acidification - caused by natural, as well as anthropogenic processes - is extremely complex, it is influenced by several factors and most of its consequences are dangerous.

Materials and methods

The role of biotic factors in soil acidification cannot be neglected. For that very reason a pot experimental method was elaborated to measure the soil chemical effects induced by biotic factors. The real pH-decreasing effect of the strongly acidifying $(NH_4)_2SO_4$ fertilizer /indirect acid treatment/ was studied in the experiment, in case of different soil - plant combinations. The pH-decrease of the soil liquid phase was used as the indicator of acidification.

Five non-calcareous mineral soils /t./ were selected from the soil bank of our Institute: two acidic sandy soils /one from Nyirlugos, and another from Hamokszentgyörgy/ and three clay-loam soils /two slightly acidic soils from Gagyvendégi and Szarvas, and a neutral soil from Magyaregregy/. Five test plants were applied: a.: ryegrass /Lolium perenne/, b.: winter wheat, k.: maize, r.: winter oilseed rape, l.: alfalfa. The pots were irrigated and the air temperature followed the field conditions. After six weeks the plants were harvested. The pH /pH_{H_2O}/ and the HCO_3 - content of the soil liquid phase, the NO_3^--N and NH_4^+-N content of the soil, root weight /air-dry/ and plant production were determined.



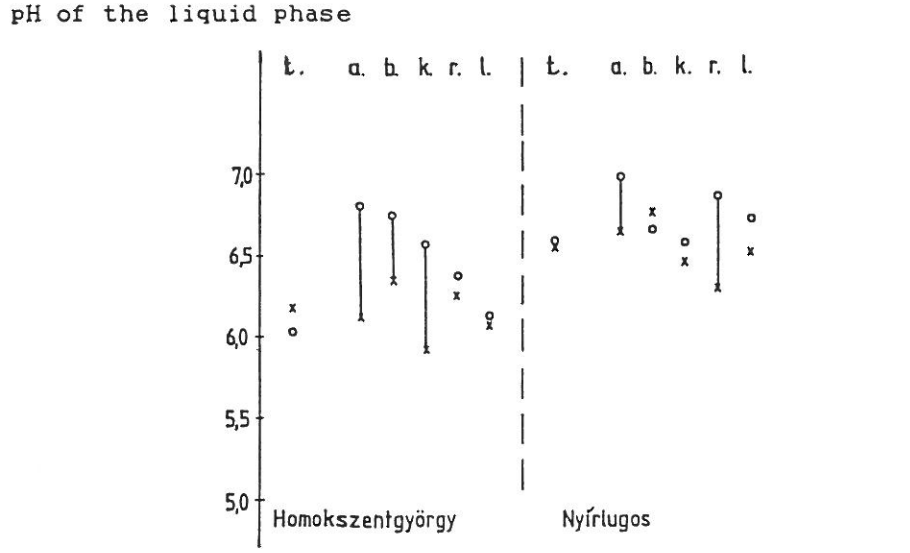


Fig. 1

The pH value of soil liquid phase in case of different soil-plant combinations. Treatments: Control – without N addition: o; $(NH_4)_2SO_4$ application: x. Abbreviations: t: soil; a: ryegrass /Lolium perenne/, b: winter wheat; k: maize; r: winter oilseed rape; l: alfalfa

Results

The acidifying effect of $(NH_4)_2SO_4$

Soils without plants - The measured changes in the soils incubated without plants /t./ proved that the acidifying effect /that is the pH-decrease of the soil liquid phase/ caused by the $(NH_4)_2SO_4$ treatment was closely related to the microbial processes as well as to the fate of the nitrogen fertilizer in soils. The microorganisms can influence the pH-value of the soil liquid phase in a great extent both in the control treatments and in the N-treatments. For instance, the original soil pH value of the two sandy soils was 5.3 resp., while the pH values of their soil liquid phase were 6.0 and 6.6 after the experiment.

Not only the chemical and physical characteristics but also the microbial properties of soils have to be taken into consideration in the case of soil acidification processes.

Soil - plant combinations - The soil chemical changes in the pots without plants were induced by microorganisms, by the soil biological processes. These reference changes could be compared with those changes which were measured in the presence of plants.

The pH-values measured in the 5 soils x 5 plants combinations were compared with the reference pH-values of the 5 soils incubated without plants, respectively /Fig. 1/. The results demonstrated that during the pot experiment:

- without N-addition: the applied plants in themselves did not decrease the pH-value of the soil liquid phase, in other words the pH-values of the incubated soils /t./ were never lower than the ones with plants /a., b., k., r., l./; the pH-values of the soils' liquid phase were in the range of 6.0-7.1;
- applying $(NH_4)_2SO_4$: in case of several soil - plant combinations the plants were able to reduce the acidifying effect of the N-fertilizer.

When the pH-decrease of the soil liquid phase was significant /indicated by continuous lines/ after $(NH_4)_2SO_4$ application the calculated CO_2-content of soil air increased, with the exception of a single case. This was found in soils without plants as well as in soils with plants.

On clay-loam soils $(NH_4)_2SO_4$ application resulted in an increase in the green weight and the root weight of plants, while on sandy soils the root weight decreased in most cases. The most extreme situation occurred in the Nyírlugos soil - winter oilseed rape combination when the green weight production was 1/3rd and the root weight was 1/10th of the values obtained without N-addition.

As a consequence of these results it can be concluded that the role of biotic factors in soil acidification deserves more attention in future research, it should be studied in more details.