The Influence of Acidity on Soil Fertility

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The acidification of soils leads to a considerable reduction in crop yields.

Acidification takes place particularly rapidly on sandy soils with a light mechanical composition and low adsorption capacity.

The critical pH value for soil acidity is around 5. In mediums more acidic than this, Al and Mn, which are toxic to plant roots in the ionic state, become mobile. According to BLACK /1968/, however, the effect of acidity reduces soil fertility

- due to the effect of toxic ions /Al, Mn/,
- due to changes in the availability of mineral nutrients,
- due to changes in the microbiological activity of the soil.

The aim of the present paper was to determine how toxic ions affect soil fertility and how this effect can be eliminated by liming. In order to clarify the causes of soil fertility reduction, field experiments were set up in Somogy County on sandy brown forest soil with the cooperation of Prof. J. NYÉKI.

Material and methods

The experiment was begun in 1972 with four replications, the test plant being maize, MvSC. 580.

The treatments used in the field experiment are as follows:

A. 1. Control; 2. 3 t $CaCO_3$/ha.

B. 1. Control; 2. $N_{65}K_{104}$; 3. $N_{130}K_{208}$; 4. $N_{260}K_{416}$.

C. 1. Control; 2. P_{130} in years 1, 2, 3, 4, 5 and 6; 3. P_{260} in years 1, 2 and 3; 4. P_{390} in years 1 and 4; 5. P_{780} in year 1.

In the adsorption complex of the soil, the exchangeable Ca, Mg and K were determined in 1 mol/l ammonium acetate exchanging solution /pH = 7.0/. The determination of K was carried out using a flame photometer and that of Ca and Mg in EDTA measuring solution.

The exchangeable Al content was extracted from the soil with 1 mol/l KCl solution. The Al was then transformed into a complex compound with oxine and extracted with chloroform, after which the extinction of the complex was measured at 340 nm.

The Al saturation of the soil was calculated in the following manner:

$$Al_{sat.} = \frac{Al}{Ca + Mg + K + Al} \cdot 100$$

where the ion concentrations are given as meq/100 g.

Results, discussion and conclusions

It can be seen from Fig. 1 that the relative maize yield increases as the result of liming due to the reduction in Al saturation. Artificial fertilizers /NK/ raise soil Al saturation and reduce the relative maize yield.

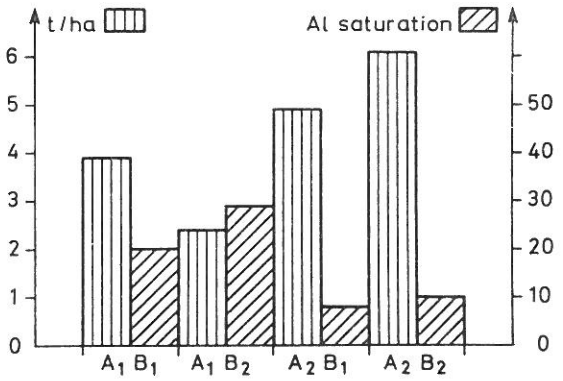

Fig. 1

The influence of Al saturation on the relative maize yield

These results are in agreement with those of FOX /1979/, who proved that the reduction in maize yields on acidic soils is more closely correlated to the Al saturation than with soil pH. His data show that at an Al saturation of 0-5% the relative maize yield is 100%, while only 76-80% of the maximum yield can be achieved at 45-50% Al saturation.

There is a sudden reduction in relative maize yield at Al saturation of over 50%.

The current investigations indicate that there is a 20% reduction in yield even at 20% Al saturation and a 50% reduction at 30% Al saturation. The difference can be explained by the differing circumstances under which the experiments were conducted. The low adsorption capacity of brown forest soil /T value = 5 meq/100 g/ and the low buffering capacity of the soil lead to yield depression even at lower values of Al saturation.

The results for all the treatments in the field experiment are presented in Fig. 2; the unlimed, fertilized treatments are to be found in Fig. 2 A., and the limed, fertilized treatments in Fig. 2 B.

The experimental data /Fig. 2 A./ show that on the brown forest soil examined, the soil became acidified to a significant extent between 1972 and 1976 if liming was omitted. This led to a sudden decrease in maize yields.

NK fertilization has a more intense acidifying effect than P fertilization.

The greatest maize yield was obtained in the control treatment /B_1/, where phosphorus fertilization led to an increase. NK fertilization caused a considerable reduction in these yields, however. The B_2 treatment decreased the yield only slightly, while treatments B_3 and B_4 caused substantial reductions. In the absence of phosphorus fertilization large doses of NK fertilization reduced the yield to zero /B_4/.

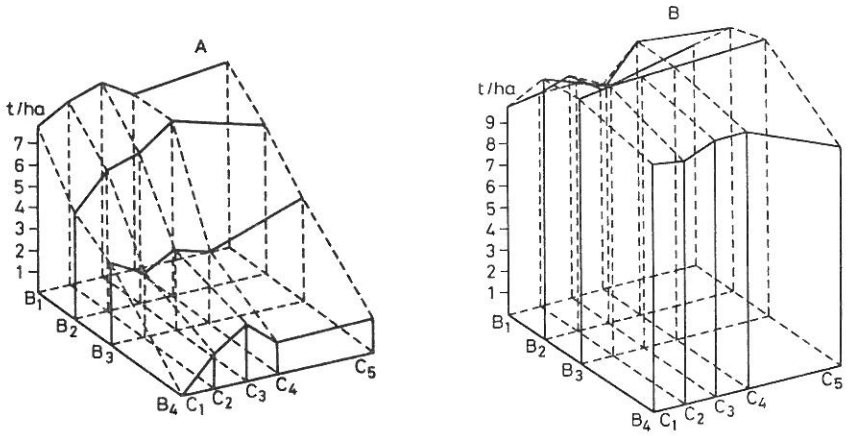

Fig. 2

The effect of NPK fertilizers on the relative maize yield in the unlimed /A/ and limed /B/ treatments /1976/

It can be seen in Fig 2 B. that as the result of liming /3 t/ha/year/ and fertilization, maize yields were considerably more stable and uniform than in the unlimed treatments. The highest NK rate, however, reduced maize yields in all the P treatments.

On the basis of the results obtained, the following conclusions can be drawn:

- Liming has a positive effect on maize yields on acidic brown forest soil.
- On the soil examined, the maximum maize yield in limed treatments was obtained with fertilizer rates of $N_{65}K_{104}P_{390}$ or P_{720}.
- Without liming the desired yield level cannot be achieved, since soil acidity substantially reduces soil fertility. This can be attributed to an increase in Al saturation in the cation exchange complex of the soil, which has a toxic effect on maize roots, since it hinders cell division. According to FOY /1974/, Al toxicity is responsible in large part for maize yield reductions on such soils.
- NK fertilization increases the Al saturation of the soil, thus reducing maize grain yields. On the soil examined a similar effect was observed in the case of winter wheat.

References

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