THE EFFECT OF PLANTS ON THE COPPER CONCENTRATION IN THE SOIL SOLUTION

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SUMMARY

Changes in the copper concentration and the content of organic complexing agents in soil solutions were followed in a pot experiment with increasing copper addition to a calcareous peat soil with and without barley plants. Samples of soil solution were collected from the soil in situ at various times during the period of plant growth. During the period 1–34 days after germination copper concentrations decreased in the solution from soils treated with copper. During the latter part of the growth period (34–100 days), copper concentration in soil solution from soil without plant-cover remained almost constant, whereas in soil solution from soils with plants the copper concentration increased to maximum values due to simultaneous increases in the content of organic complexing agents. The correlation coefficient between the content of organic complexing agents and copper concentration was 0.96 during this period.

These variations in the concentration of copper and in content of complexing agents may considerably alter the copper flux by mass-flow and diffusion to roots.

INTRODUCTION

The dynamics of copper in the soil-water-plant system may be illustrated by the following scheme:

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\begin{align*}
\text{non-labile-Cu} & \quad \text{Cu-complexes} \\
\downarrow & \quad \uparrow & \iff \\
\text{labile Cu} & \iff \text{Cu-ions} & \iff \text{Cu plant roots}
\end{align*}
\]

The rate of reaction between labile Cu(diffusible Cu)non-labile Cu(non-diffusible Cu) shown above can be assumed to be slow as compared with that between labile Cu and Cu-ions in the soil solution.

The total concentration of copper in the soil solution, which is the
main object of this study, depends on a number of factors. The most important factors are 1) the amount of labile copper in the soil, 2) the size of the adsorbing capacity for copper by the soil, and 3) the proportion of the total copper present as soluble copper complexes in the soil solution. Concerning the latter factor, Hodgson et al.² have shown that more than 98% of the copper in the soil solution of a neutral soil may be present in complexes of soluble organic matter. From this it follows that the copper concentration in the soil solution must be strongly influenced by the content of copper complexing agents. The concentrations of these agents may be assumed to be influenced by the presence of growing plants. Based on this assumption the variation in copper concentration of solutions collected from the soil on which barley was growing was measured during the growing period. Soils without a crop served as a control.

MATERIAL AND METHODS

A calcareous peat soil with a known history of copper deficiency was used. Details of this soil were given in a previous publication of this series. In a 2 × 4 factorial greenhouse experiment including pots with and without plants, copper additions, 0, 10, 40 and 200 ppm and a basal dressing at 6.1 g NaNO₃, 2.8 g K₂SO₄, 2.7 g (NH₄)₂HPO₄ and 0.24 g MnSO₄·H₂O were used per 1 kg dry soil. All salts were p.a.

The basal dressing was mixed with the soil. Each copper addition was dissolved in water and sprayed on the soil by means of a hydraulic nozzle sprayer. The copper solution was applied in 7 or 8 portions. After each application the soil was re-mixed.

3.18 kg dry soil were placed in PVC pots with a volume of 20 litres, surface area of 500 cm². All pots had an upper layer consisting of 0.5 kg un-fertilized soil, covered by 0.5 kg H₂O-washed quartz sand.

Samples of the soil solution were obtained by means of suction filters, placed in the soil as previously described. The moisture level was kept at about 60 per cent of the total waterholding capacity of the soil, corresponding to a volume percentage of water-air and soil of 41, 45 and 14, respectively. During the experiment the water content of the soil was checked at frequent intervals, and if necessary adjusted.

The pots were kept in a green-house for three weeks before the half number of them were sown with barley.

On 30 April 1968, 35 barley seeds (Hordeum vulgare var. Emir) were placed per pot. The germination was completed within one week. Seedlings were removed 15 and 29 days after germination, to give 30 and 24 plants per pot.