EFFECT OF AMMONIUM ON UPTAKE OF PHOSPHORUS, POTASSIUM, CALCIUM AND MAGNESIUM BY INTACT SOYBEAN PLANTS

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SUMMARY

The effect of a wide range of ammonium concentrations (1.78 × 10⁻⁵ to 3.57 × 10⁻³ M) on the uptake and tissue content of P, K, Ca and Mg in intact soybean (Glycine max (L.) Merr. Cv. Amsoy) plants at different growth stages was studied. A stimulatory effect of ammonium on the uptake and content of P was observed over the entire concentration range, whereas this effect was observed only up to 500 μM of ammonium with respect to K. At higher levels (>500 μM), ammonium suppressed the uptake and content of K. Inhibition by high levels (>357 μM) of ammonium was also found for the uptake and content of Ca and Mg. Inhibition of uptake of K, Ca and Mg by high levels of ammonium may be an important factor in the mineral nutrition of soybean plants.

INTRODUCTION

It has been found by many workers that the rate of ion uptake is influenced by the nature and level of counter ions present in the nutrient or soil solution. Uptake for prolonged periods necessarily involves the use of complete nutrient solutions and this brings into play ion interactions and growth effects on ion accumulation. Cation-anion interactions need to be considered separately for entry into roots and intact plants. Cations, at least in certain concentration ranges, are generally more readily absorbed by plants when nitrate

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rather than other anions is the counter ion\textsuperscript{19,21}. Ammonium on the other hand tends to compete with K and other alkali cations for absorption\textsuperscript{19,21}. In the presence of nitrate, more $^{42}\text{K}$ was taken up and a higher percentage translocated to the shoot than in the presence of ammonium\textsuperscript{22}.

Experiments with a number of plant species have shown that the forms of nitrogen supply exerts a pronounced effect on both growth and chemical composition of plants\textsuperscript{4,14}. The present investigation was aimed to extend this information to soybeans by studying the effect of a wide range of ammonium concentrations ($1.78 \times 10^{-5}$ to $3.57 \times 10^{-3}$ M) on the uptake and content of P, K, Ca and Mg at different growth stages of plants.

MATERIALS AND METHODS

Seeds of soybean (\textit{Glycine max} (L.) Merr. cv. Amsoy) were germinated between paper towels. After 3 days of germination, 5 uniform and healthy seedlings were placed in plant support discs which were positioned in black 3-liter lucite vessels. The nutrient solution (Table 1) was renewed every day in order to keep the ammonium level as constant as possible. Ammonium, in concentrations from 17.8 to 3571 $\mu$M, was added as (NH$_4$)$_2$SO$_4$. The pH of the solution was maintained at 5.5 $\pm$ 0.2.

Growing of plants and the uptake experiments were done in a controlled environment chamber under the following conditions: Day temperature 26 $\pm$ 1°C, night temperature 20 $\pm$ 1°C, relative humidity 75%. Thirteen hours day light was provided with phototubes at an intensity of 16,000 lux at 20 cm above the bench level\textsuperscript{19}.

\begin{table}[h]
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\caption{Composition of the nutrient solution}
\begin{tabular}{ll}
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Salt & Molarity 10\textsuperscript{-6} \\
\hline
KH$_2$PO$_4$ & 32 \\
KCl & 510 \\
CaCl$_2$.4H$_2$O & 500 \\
MgSO$_4$.7H$_2$O & 82 \\
Fe(EDTA).Na & 0.9 \\
H$_3$BO$_3$ & 5.0 \\
MnCl$_2$.4H$_2$O & 0.9 \\
ZnSO$_4$.7H$_2$O & 0.8 \\
CuSO$_4$.5H$_2$O & 0.03 \\
H$_2$MoO$_4$ & 0.01 \\
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