PHOSPHORUS ACQUISITION OF FIELD GROWN SUGAR BEET AND ITS EVALUATION WITH A SIMULATION MODEL

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Sugar beet is known to respond to P application in early growth stages particularly (Winner, 1974). The objective of this research is to study P uptake efficiency in the course of the growing season.

Methods: In a field experiment on a luvisol from loess (pH 7.5) with plots ranging in the P concentration of the soil solution from 1 to 16 μmol L⁻¹, shoot and root growth and P uptake of sugar beet was measured in intervals during the growing season 1987.

Results: Yield of sugar beet increased by 20% with P application (Fig. 1). Growth limitation of the shoot on the unfertilized plot was strongest in early growth stages (Fig. 2). In June growth rate of the plants without P reached only 20% of the plants treated with 500 kg P₂O₅ ha⁻¹. Nevertheless, growth rates of the plants without P application increased to 80% in July, 90% in August and 110% in September of the plants with P.

![Graph showing beet and sugar yield in relation to P fertilization](image1)

Root length was almost unaffected by P application, however, because of the differences in shoot weight, the plants had a higher root to shoot ratio in the plots without P.

In July, P influx per unit root was generally much higher than in June (Fig. 3) even though the parameters of P availability in soil remained almost constant (Table 1). Furthermore, P influx into plants without P fertilization was only 18% of maximum in June, but increased by a factor of 10 in July and reached 67% of the maximum. It must therefore be concluded that P uptake efficiency of sugar beet strongly depends on the stage of growth.

![Graph showing growth curves of sugar beet at different P supply](image2)
A mathematical simulation model (Claassen et al., 1986), based on soil parameters of P transport towards the root by mass flow and diffusion and on Michaelis-Menten kinetics of P uptake, was used to calculate P influx. Calculated and measured P uptake were similar in June (Fig. 4). However, in July, uptake was 5 times higher than predicted by the model. Root hairs explained a small fraction of this difference only.

Conclusions: Growth of sugar beet responded to P application only in the early season. This was associated with much lower P uptake efficiency of the roots in the early compared to later stages of growth. This increase in uptake efficiency is not predicted by a "mechanistic" mathematical model indicating that sugar beet mobilized P chemically.

It can therefore be concluded that P nutrition of sugar beet markedly depends on chemical P mobilization of soil P by plant roots.

References: