In: Scaife, A. (Ed.) Proceedings - First Congress European Soc. Agronomy,
Colmar, France 1990.

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

N Claassen*, D Meyer, A Jungk
Institut für Agrikulturchemie, Universität Göttingen,
von Sieboldstr.6, D-3400 Göttingen, F.R.Germany
*Now: Institut für Pflanzenernährung, Universität Hohenheim,
Fruwirthstr. 20, D-7000 Stuttgart 70, F.R.Germany

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 P_2O_5 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.

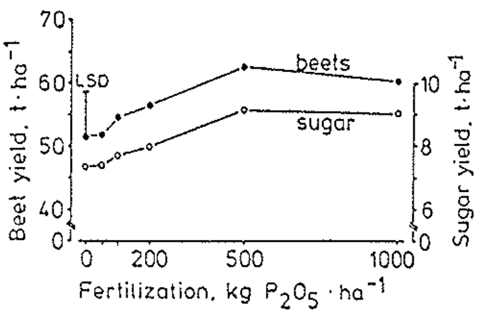

Fig. 1: Beet and sugar yield in relation to P fertilization (LSD, P = 0.05)

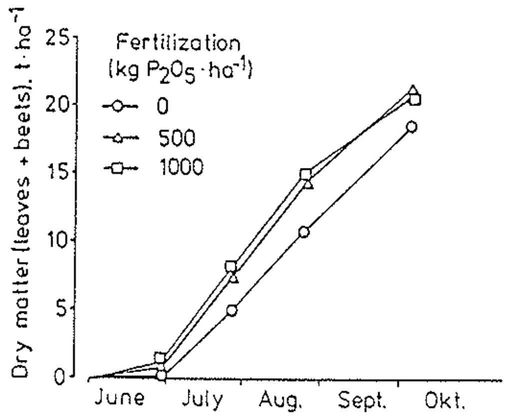

Fig. 2: Growth curves of sugar beet at different P supply

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.

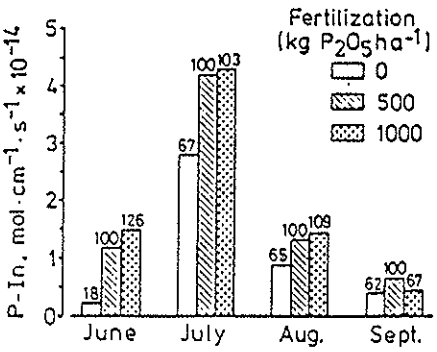

Fig. 3: Phosphorus influx per unit root of sugar beet at different P supply (plot of max. yield = 100%)

Table 1: Parameters of soil P availability of the plot without P application

period	P-CAL	C_l	θ	D_e
June	48	1.0	0.28	3.5
July	47	1.0	0.27	3.2
August	46	1.3	0.27	4.2
average values requiered for max. yield	69	6.3	0.27	9.6

P-CAL: CAL exchangeable P, mg kg^{-1}
C_l: P concentration in the soil solution, µmol L^{-1}
θ: volumetric water content of the soil, cm^3 cm^{-3}
D_e: effective P diffusion coefficient in soil, cm^2 s^{-1} 10^{-10}

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.

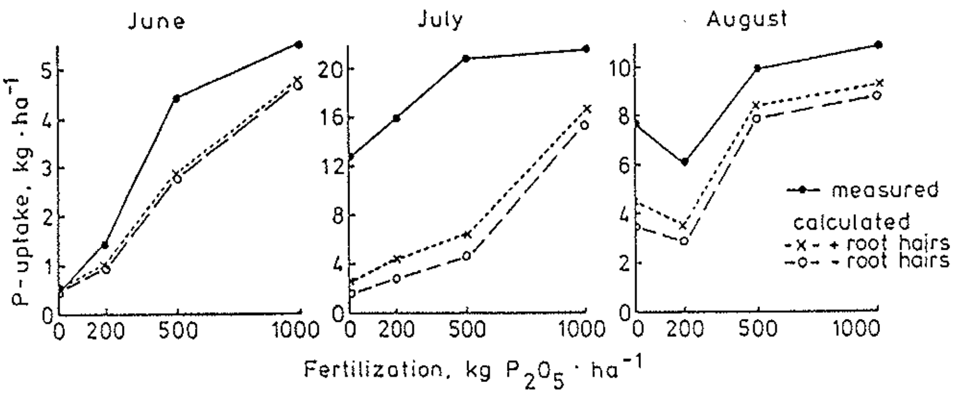

Fig. 4: Measured and calculated P uptake of sugar beet

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:

Claassen, N., Syring, K.M., Jungk, A. (1986): Plant and Soil 95, 209-220.
Winner, C. (1974): Zucker 27.517-552.