Modelling root growth, soil nitrogen dynamics and nitrogen uptake of cauliflower crops

H. Kage,
C. Alt
&
H. Stützel

Institute
for
Vegetable
&
Fruit Crops

University of
Hannover,
Germany

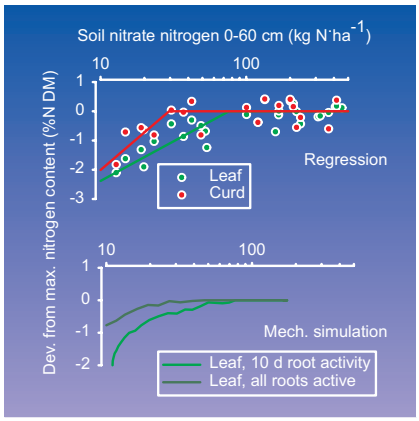
Objectives

Crops from intensive vegetable cropping systems like cauliflower often have high nitrogen uptake rates because of the high nitrogen contents of their organs and their high growth rates. These crops also have comparable low total root lengths. High specific nutrient influx rates have therefore to be maintained in order to ensure maximum growth. Critical soil nitrate levels are therefore comparably high. Mechanistic modelling of the nutrient transport and uptake processes may allow to derive fertilisation strategies ensuring optimal growth at acceptable levels of residual soil nitrate.

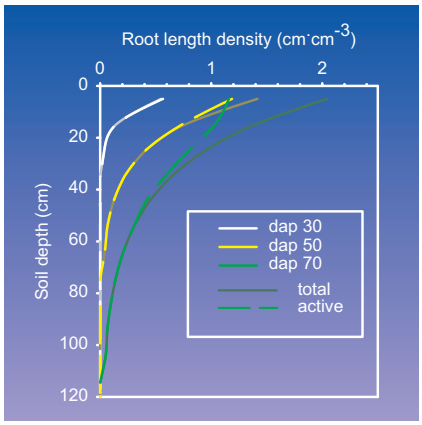
Model

The model used in this study consists of an evapotranspiration module based on the Penman-Monteith approach, a soil water transport module based on a diffusion formulation of the soil water transport equation, a module based on the convection dispersion equation for vertical nitrogen transport, a root growth module and a single root model for calculating potential, transport limited nitrate uptake rates of the root system. For the calculations shown here net nitrogen mineralisation was input. The model modules are integrated within the *HUME* modelling environment.

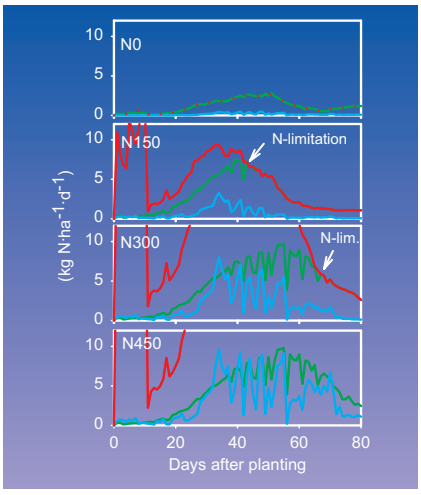
Results



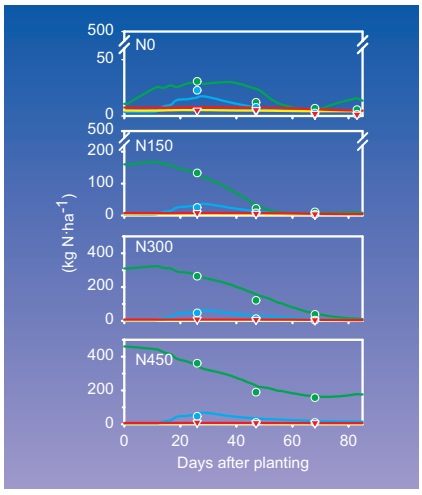
Deviation from optimal, organ mass dependent nitrogen content of cauliflower leaves and curds as a function of soil nitrate content



Simulated total and active root length density of cauliflower vs. depth and time



Simulated N uptake rate (–), apparent nitrate mass flow (–) and max. nitrate transport (–) towards roots of cauliflower for four nitrogen supply rates



Simulated soil nitrate nitrogen for four nitrogen supply rates of cauliflower
(– 0-30 cm, – 30-60 cm, – 60-90 cm, – 90-120 cm)

Conclusions

Nitrogen transport towards roots of N limited cauliflower is mainly by diffusion, but for overfertilised crops mass flow may exceed actual nitrogen demand. Emperically derived critical soil nitrogen contents for leaves of cauliflower are quite high (80 kg N/ha). This values could only be simulated using the assumption of an active uptake phase of cauliflower roots restricted to about 10 d. Curd nitrogen content is less sensitive to nitrogen supply, presumably due to sink priority. Optimal nitrogen supply regimes may use this priority, thereby increasing nitrogen harvest index without severe reductions of curd yield and quality.

Contact: kage@gem.uni-hannover.de