

## Simulating Root Density Dynamics and Nitrogen Uptake – Can a Simple Approach be Sufficient?

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The modeling of root growth in many plant–soil models is simple and with few possibilities to adapt simulated root proliferation and depth distribution to that actually found with different crop species. Here we propose a root model, developed to describe root growth, root density and nitrogen uptake. The model focuses on annual crops, and attempts to model root growth of different crop species and row crops and its significance for nitrogen uptake from different parts of the soil volume.

The presented model was built on a simple approach, however with the capacity to simulate different root distribution patterns by changing only one parameter, namely a root form factor which controls the root density in different soil layers. Root density is calculated by a modification of the Gerwitz and Page (1974) equation for root length density, in their approach root density at the bottom of the root zone was set to a fixed value whereas the root form parameter changes during the growth season. We set a fixed value for the root form parameter for root density distribution and let the root density at rooting depth be variable.

In Figure 1 the root model flexibility is illustrated. The figure shows a situation where all parameters are equal except the form factor value ( $a_z$ ). By changing the form factor from 0 to 3 or 8 it is possible to simulate a wide range of root density profiles (Figure 1, Left part). This results in significantly different patterns in soil nitrogen uptake from different layers in the soil profile (Figure 1, Right part). By combining root form parameter, root penetration rate, root/shoot ratio and root N uptake rate, it will be possible to adapt this simple root model to simulate nitrogen uptake dynamics in a realistic way in soil-plant simulations models (Pedersen et al. in prep.).

### References

Gerwitz A. and Page E. R. 1974. Empirical Mathematical - Model to Describe Plant Root Systems 1. *Journal of Applied Ecology* 11, 773-781.

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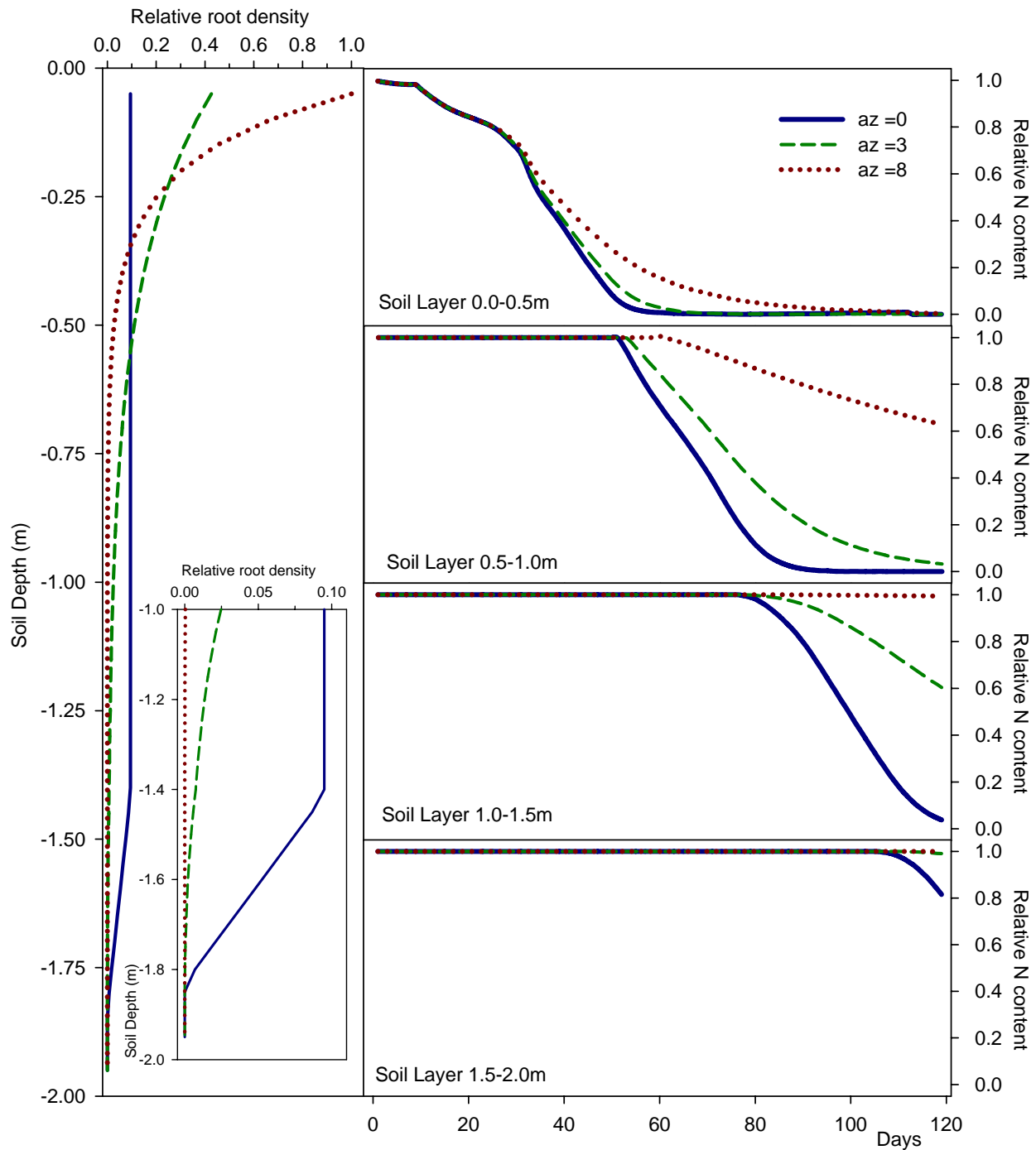


Figure 1. Simulation result from present root model where mineral content in soil was below potential nitrogen demand for the crop. Left part: Relative root density distribution in soil profile with three different form factors for  $a_z$ . All other settings are equal as root penetration rate and root biomass. Soil profile 1.0 to 2.0m with higher resolution for relative root density is shown in right part of the figure. Right part: Relative plant available nitrogen in four soil layers for three different form factors. Legend, Form factor values: Solid line (dark blue)  $a_z=0$ ; Short dash line (dark green)  $a_z=3$ ; Dotted (Dark red)  $a_z=8$ .