Daisy Newsletter no. 9

The Daisy code, v. 5.31

The new code contains to important changes:

1) There is a new column (HI) in the harvest log file. It contains the Harvest Index of the crop.
2) A new model for root nitrogen uptake has been added. The effect of switching to the new model is that N uptake is slower, especielly for low N concentration is the soil. The model is further described below.

A new model for root nitrogen uptake

In the traditional description of nitrate uptake by the root in Daisy, the diffusion towards the root can be influenced by the concentration of nitrate at the root surface (NO3_root_min) or the maximum uptake rate (MxNO3Up).

In the new description, the nitrate uptake uptake is still governed by transport to the root surface (mass flow and diffusion) but it is combined with uptake kinetics at the root surface as described by Michaelis-Menten kinetics. The uptake kinetics of nitrate is governed by a dual-affinity system (Tsay et al. 2007) viz. a high affinity system with a low uptake capacity and a low affinity system with high uptake capacity.

The dual-affinity uptake kinetics can be described as:

$$I = \frac{F_1 C_r}{K_1 + C_r} + \frac{F_2 C_r}{K_2 + C_r}$$

where I is the root uptake, F and K refer to the max uptake rate and the half-saturation constant, respectively, and the subscripts 1 and 2 refer to the high affinity system and low affinity system, respectively.

Characterizing nitrate uptake Tsay et al. (2007) suggests 50 µM (0.7 mg NO-3-N/L) and 5 mM (70 mg NO-3-N/L) for the half-saturation constant for the high and for the low affinity system, respectively. The max uptake rates are more uncertain. Based on preliminary calibrations of max uptake rates we suggest a value of 25 ng/cm/h and 250 ng/cm/h for the high and for the low affinity system, respectively.

A full description of the new root model will be uploaded on the Daisy homepage, under http://daisy.ku.dk/publications/notes/

The new description is presently used in an ongoing project, but has only been subject to limited testing.

Tsay, Y-F., Chiu, C-C., Tsai, C-B., Ho, C-H., and Hsu, P-K. (2007) Nitrate transporters and peptide transporters. FEBS letters 581: 2290-2300.

Recent studies in which Daisy has been used

Salazer at al. have calibrated Daisy for maize production on coarse-textured (with 1.6-18.1 % clay) soils in the Mediterranean zone of central Chile. The study includes experimental sites that are rainfed or with different types of irrigation (furrow, pivot), different types of fertilizer (mineral, organic) and different crop rotations. Particularly the components related to organic matter turnover, nitrification and immobilization were calibrated, together with dispersivity and maximum rooting depth and saturated hydraulic conductivity. They found that Daisy was able to predict water and N dynamics for the sols in question.

Yin and co-workers have tried to predict grain N for crop rotations in Europe for winter wheat, winter barley, spring barley, springoat, winter rye, pea and winter oilseed rape, using 12 different models. Daisy were tested in both continuous simulation and single year simulation. Not so surprisingly they found that the better calibrated crop models also performed better. However, the continuous simulation did not show any superiority over single year runs in predicting grain N. Thus, models should provide reliable simulation of the soil N and water cycles when simulating crop rotations in continuous simulation mode in order to decrease uncertainty when simulating crop grain N. The multi-model ensemble significantly improved the precision of predicting grain N over the use of single models. Most crop yield N contents could be simulated with sufficient accuracy (MAPE < 15%) using the mean of 3–5 models with detailed calibration.

Recent articles

Salazar, O., Nájera, F., Tapia, W. and Casanova, M. (2017): Evaluation of the DAISY model for predicting nitrogen leaching in coarse-textured soils cropped with maize in the Mediterranean zone of Chile. Agricultural Water Management 182: 77–86.

Yin, X., Kersebaum, K.C., Kollas, C., Baby, S., Beaudoin, N., Manevski, K., Palosuo, T., Nendel, C., Wu, L., Hoffmann, M. and Hoffmann, H. (2017). Multi-model uncertainty analysis in predicting grain N for crop rotations in Europe. European Journal of Agronomy, 84: 152–165.