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Water use efficiency of three sugar beet types at sites with and without nematode infestation – concept and first results

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Hypothesis

Water use efficiency (WUE) of the sugar beet types susceptible (sus), tolerant (tol) and resistant (res) against *Heterodera schachtii* varies between nematode-free (- nem) and nematode-infested (+ nem) sites:

+ nem: $WUE_{sus} < WUE_{tol, res}$

- nem: $WUE_{sus} = WUE_{tol, res}$

Fig. 1: Left: Site without nematodes; Right: Site with nematodes

Material & Methods

Field experiments with 3 sugar beet types (3 replications each) started in April 2013. Microclimate and soil water content at each site were recorded continuously. Evapotranspiration (ET) was calculated with the **dual crop coefficient approach** (Allen et al., 1998):

1. Calculation of the potential evapotranspiration ET_0 for reference surface grass :

$$ET_0 = \frac{0.408\,\Delta\,(R_n - G) + \gamma\,\frac{900}{T+273}\,u_2(e_s - e_s)}{\Delta + \gamma\,(1 + 0.34)\,u_2}$$ (Penman-Monteith-Equation)

2. Calculation of two crop coefficients for sugar beet: K_{cb} basal crop coefficient , K_e evaporation coefficient

3. Calculation of crop evapotranspiration ET_c: $ET_c = (K_{cb} + K_e)\,ET_0$

WUE was calculated using yield data of an intermediate harvest in June 2013: $WUE = \frac{dry\ matter\ yield\ (DM)}{crop\ evapotranspiration}$

Results

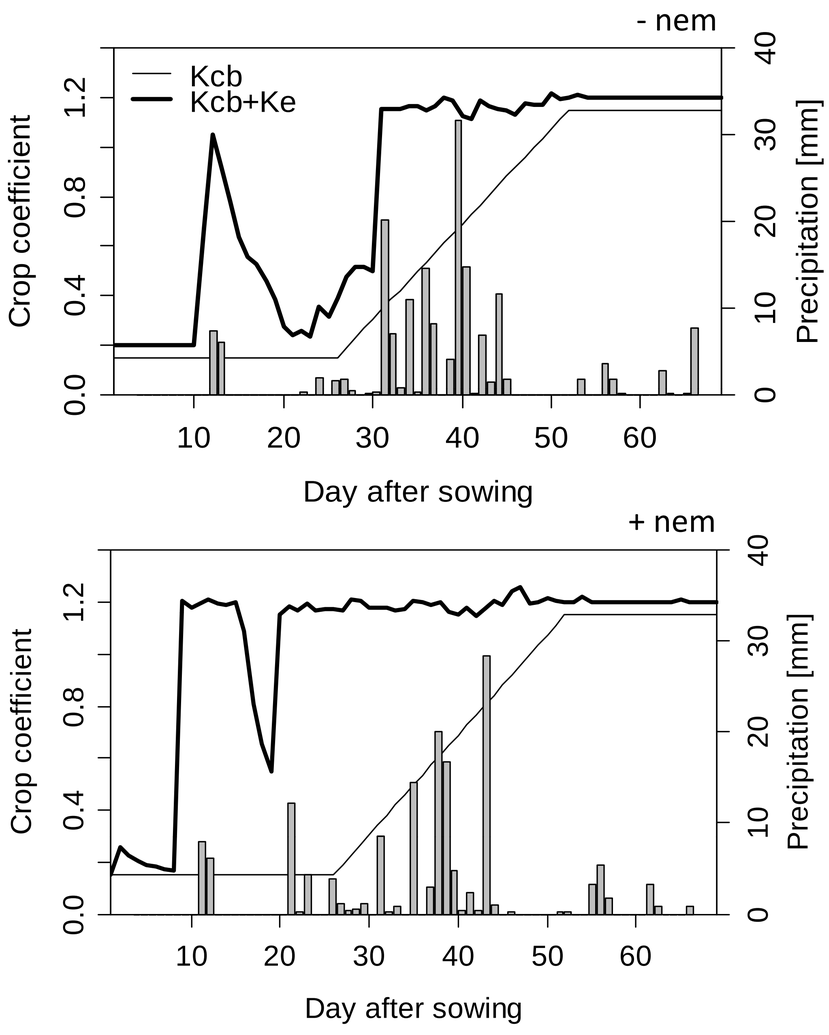

Fig. 2: Daily crop coefficients for sugar beet from sowing until June 2013; top: without nematodes (-nem), bottom: with nematodes (+ nem).

Differences in precipitation patterns between the nematode-free and the infested site caused differences in the calculated evaporation coefficients K_e at both sites. In general, K_e increases with the amount of precipitation, and $K_{cb} + K_e$ cannot exceed a maximum value (fig. 2). This value is determined by the energy available for evapotranspiration at the soil surface.

For calculation of WUE, daily ET_c values from the day of sowing until the day of the intermediate harvest in June 2013 are summed up and normalized on dry matter yield.

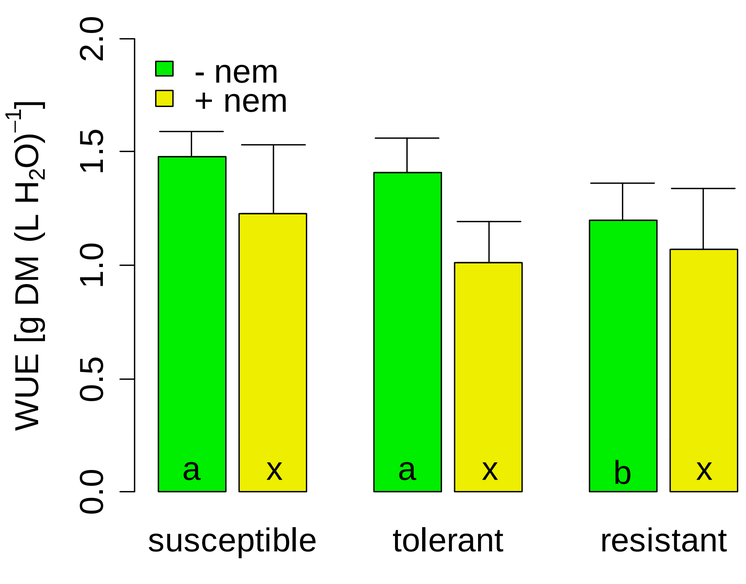

Fig. 3: Mean values of WUE with standard deviation at the nematode-infested (+nem) and the nematode-free site (-nem), June 2013 (ANOVA with significance level <0.05).

At the nematode-free site WUE of the resistant sugar beet type is significantly lower than WUE of the tolerant and of the susceptible type. There are no significant differences in WUE of the three sugar beet types at the infested site. WUE_{tol} and WUE_{sus} are significantly lower at the infested site than at the nematode-free site (fig. 3).

Discussion

In general, WUE is low compared to other studies (2.5 - 3.5 g DM per L H_2O (Roth et al. (2005)), but we could only calculate WUE for the period from sowing to the middle of the growing season. At that time the yield is still low, and the main portion of yield is formed in July to September.

As expected, without nematodes water use of the susceptible type is more efficient compared to the resistant type, because at the infested site nematodes cause root damages which can limit water uptake and thus reduce biomass production. At infested sites water use of the tolerant sugar beets is expected to be more efficient than that of the susceptible type because of a better developed rooting system. We didn‘t observe this yet, probably due to the early harvest time in the mid season before the susceptible type‘s roots are severely damaged. After the final harvest in October we will be able to derive whether nematodes significantly affect WUE of different types of sugar beets or not.

References

Allen, R. G., Pereira, L. S., Raes, D., Smith, M., 1998: Crop evapotranspiration – Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56.

Roth et al., 2005: Wasserhaushaltsgrößen von Kulturpflanzen unter Feldbedingungen; Thüringer Landesanstalt für Landwirtschaft.

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