Sink-sink and source-sink interactions between stems and reproductive structures of sunflowers with ontogeny and water stress

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We investigated how sunflowers differing in stem height respond to the timing of water stress. The following hypotheses were tested: H1) Plants with short stems will provide a small sink to compete with the developing inflorescence for assimilate in the period from head visible to first anthesis (HV-FA). Consequently, they will maintain head growth (more florets) if stress during this time reduces assimilate supply. H2) Plants with great capacity to store assimilates in the stem before anthesis and to re-mobilize them during grain filling will be able to maintain a high flux of assimilates to the seeds when exposed to stress after anthesis.

Methods

Glasshouse grown plants of cvs. Cannon (standard height, Cargill), Beauty (semi-dwarf, Cargill) and Dwarf 2 (dwarf; experimental hybrid, Ag Seed) were exposed to water stress during HV-FA, anthesis-physiological maturity (FA-PM) and HV-PM. Carbon fluxes (Jc, g glucose per period) to or from stems, roots, heads and seeds were estimated for the stress periods using a modified version of Lemcoff and Loomis' model (1). This is a three-compartments model including (i) structural dry matter corrected by its production value, (ii) labile carbohydrate, and (iii) maintenance respiration.

Results and discussion

There was no relation ($P>0.2_5$) between floret number at anthesis and Jc to the heads during HV-FA. This suggests that, contrary to hypothesis 1, floret survival of sunflowers exposed to water stress before anthesis is mediated by direct (e.g. low water potential of the florets) or indirect (e.g. modifications of the hormonal balance of the florets) effects of water stress and not by carbon availability. A direct test of this alternative hypothesis is necessary.

There was a close association between Jc to the seeds and Jc from the stems from FA tc PM (Fig. 1). This relationship discriminates between cultivars more clearly than between water treatments. This underlines the importance of stems as a source for carbon for grain filling in sunflower and also demonstrates a considerable genotypic variability.

We conclude that the strength of the stem as sink for carbon before anthesis and its role as a source afterwards is critical to the yield of sunflowers even without water limitations. The hypothesized negative effect of strong stems competing for assimilates with the developing reproductive structures before anthesis is probably irrelevant.

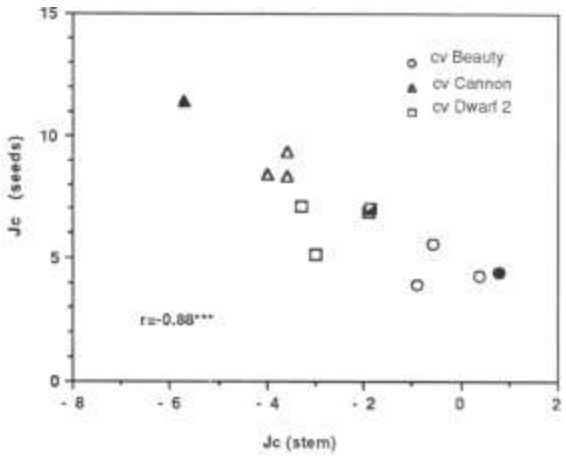

Fig. 1. Jc to the seeds vs. Jc from the stems of well watered (solid symbols) and stressed (open symbols) sunflowers

1. Lemcoff, J.H. and Loomis, R.S. (1986). Crop Sci. 26: 1017.