Cover crop residues mitigate impacts of water deficit on sunflower during vegetative growth with varietal differences, but not during seed development

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Introduction:

Drought, as a major environmental factor that limits plant growth and photosynthesis, is a challenge for agriculture in the context of climate change. High temperatures and drought stress impact crops as a function of their stage of development and genotypic tolerance. Choosing adapted sunflower (*Helianthus annuus* L.) varieties and management practices can mitigate impacts of water deficit on growth, physiology and productivity, but with complex genotype × environment interactions. Cover crops (CC), used mainly as catch crops and/or green manure, can release mineral nitrogen after destruction, which influences growth and development of the following crop.

Materials and Methods:

Here, we studied how nitrogen released by CC residues can influence water deficit responses of sunflower. In semi-controlled experiments, using the high-throughput phenotyping platform Heliaphen, we tested impacts of water deficit on vegetative and post-flowering stages of four sunflower varieties in pots, in which CC residues of rye (*Secale cereale* L.) or vetch (*Vicia villosa* R.) had been incorporated before sowing. We studied impacts of water deficit during the vegetative stage on sunflower growth and transpiration and water deficit during the post-flowering stage on sunflower physiology and productivity.

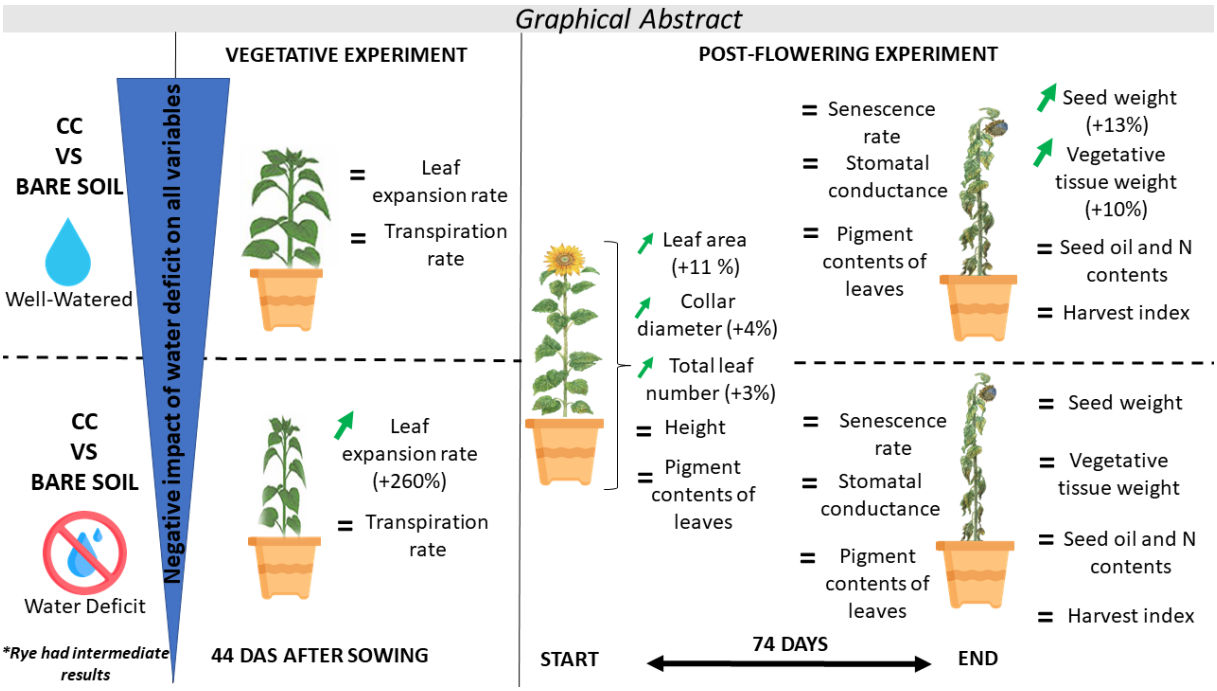
Results:

Under well-watered conditions, CC residues of vetch increased sunflower growth and productivity. Under water deficit conditions, CC residues mitigated the water-deficit response when applied during the vegetative stage, by limiting a decrease in growth, but they did not mitigate it post-flowering. Varieties responded differently to CC residues during vegetative and post-flowering stages. During seed development, severe water deficit cancelled out positive impacts of CC on productivity.

Discussion:

CC residues induced the release of mineral N during the vegetative stage, which increased the leaf expansion rate and mitigated the decrease in leaf expansion under WD during the vegetative stage. This increase in growth caused by CC residues, particularly of vetch, can explain sunflower's higher productivity in the presence of CC, which could be due mainly to the increase in carbon assimilation, with more leaf area at flowering, via an increase in interception of solar radiation by leaves and in redistribution of assimilates from vegetative tissues to seeds. However, post-flowering water deficit canceled out the positive impacts of CC on productivity by decreasing carbon assimilation and redistribution of assimilates.

Graphical abstract:



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