EGU21-11716, updated on 13 Jun 2021
https://doi.org/10.5194/egusphere-egu21-11716
EGU General Assembly 2021

Winter wheat and maize under varying soil moisture: from leaf to canopy

Thuy Huu Nguyen[1], Matthias Langensiepen[1], Thomas Gaiser[1], Heidi Webber[2], Hella Ahrends[1], Hubert Hueging[1], and Frank Ewert[2]

[1]University of Bonn, Institute of Crop Science and Resource Conservation (INRES), Katzenburgweg 5, 53115 Bonn, Germany
[2]Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Landscape Systems Analysis, Eberswalder Strasse 84, 15374 Muencheberg, Germany

Drought is one of the most detrimental factors limiting crop growth and production of important staple crops such as winter wheat and maize. For both crops, stomatal regulation and change of canopy structure responses to water stress can be observed. A substantial range of stomatal behavior in regulating water loss was recently reported while the crop growth and morphological responses to drought stress depend on the intensity and duration of the imposed stress. Insights into the responses from leaf to the canopy are important for crop modeling and soil-vegetation-atmosphere models (SVAT). Stomatal responses and effects of soil water deficit on the dynamic change of canopy photosynthesis and transpiration, and seasonal crop growth of winter wheat and maize are investigated based on data collected from field-grown conditions with varying soil moisture treatments (sheltered, rainfed, irrigated) in 2016, 2017, and 2018. A reduction of leaf net photosynthesis (An), stomatal conductance (Gs), transpiration (E), and leaf water potential (LWP) was observed in the sheltered plot as compared to the rainfed and irrigated plots in winter wheat in 2016, indicating anisohydric stomatal responses. Maize showed seasonal isohydric behaviour with the minimum LWP from -1.5 to -2 MPa in 2017 and -2 to -2.7 MPa in the extremely hot and dry year in 2018. Crop growth (biomass, leaf area index, and yield) was substantially reduced under drought conditions, particularly for maize in 2018. Leaf water use efficiency (An/E) and crop WUE (total dry biomass/canopy transpiration) were not significantly different among treatments in both crops. The reduction of tiller number (in winter wheat) and leaf-rolling and plant size (in maize) resulted in a reduction of canopy transpiration, assimilation rate, and thus biomass. The seasonal isohydry in maize and the seasonal variability of LWP in winter wheat suggest a possibility to use the same critical LWP thresholds for maize and wheat to simulate the stomatal control in process-based crop and SVAT models. The canopy response such as dynamically reducing leaf area under water stress adds complexity in simulating gas exchange and crop growth rate that needs adequate consideration in the current modeling approaches.