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Emerging effects of selected rhizosphere properties on transpiration and leaf water potential of two Zea mays L. genotypes in semi-arid environments

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Understanding the mechanisms that control water use of plants exposed to soil drying and increasing vapour pressure deficit (VPD) has important implications for crop growth in semi-arid regions with low-input agriculture. In particular, the effect of belowground processes on transpiration and stomatal regulation remains controversial. Objective of this study was to understand the role of soil properties and root hairs (as an example of rhizosphere traits) on transpiration and leaf water potential. We hypothesize that root hairs facilitate the water extraction from drying soils, particularly at high VPD, and that this impacts the relation between transpiration rate and leaf water potential. We further hypothesize that stomatal regulation attenuates the drop in leaf water potential when the soil water flow cannot match the transpiration demand and thus emphasizes the importance of root hairs on transpiration rates during soil drying.

We compared maize (Zea mays L.) with (wild-type) and without (mutant) root hairs in three different soil substrates (Alfisol, Vertisol and Sandy Soil). Transpiration and leaf water potential were monitored at varying VPD and soil moistures during soil drying. The hairless mutant showed a higher transpiration in wet soils but declined transpiration at greater water contents as compared to the wild-type. Under well-watered conditions, both genotypes had the highest transpiration rates in Vertisol. In Vertisol, both genotypes closed their stomata at relatively higher water content levels. The relation between transpiration and soil moisture strongly varied between soils. No obvious differences between the genotypes were visible in the relationship between leaf water potential and transpiration. This is explained by the prompt closure of stomata. This study provides experimental evidence of the strong link between stomatal regulation and soil-root hydraulic properties.