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Responsiveness of maize to soil drying is related to a decrease in belowground hydraulic conductivity

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Limited water supply is one of the largest impediments to food production worldwide in the light of climate change and increasing food demand. Stomatal regulation allows plants to promptly react to water stress and regulate water use. Although the coordination between stomatal closure and aboveground hydraulics has extensively been studied, our understanding of the impact of belowground hydraulics on stomatal regulation remains, as yet, incomplete. The overall objective of this study was to investigate the impact of belowground hydraulic conductivity as affected by differences in expressions of root and rhizosphere traits on the water use regulation of different maize genotypes.

We have utilized a novel phenotyping facility to investigate the response of a selection of 48 maize (*Zea mays* L.) genotypes exhibiting different root and rhizosphere traits to soil drying. We measured the relation between leaf water potential, soil water potential, soil water content and transpiration rate, as well as root and rhizosphere traits (e.g. root length, rhizosheath mass) between genotypes. Our hypothesis is that stomatal response to soil drying is related to a loss in soil hydraulic conductivity and that key root and rhizosphere hydraulic traits affect such relation.

We found that the genotypes differed in their responsiveness to drought and that such differences were related to belowground hydraulic traits. The critical soil water content at which plants started to decrease transpiration was related to a combination of plant- and rhizosphere traits (namely plant hydraulic conductance, maximum transpiration rate, root length and rhizosheath mass).

Genotypes with a higher maximum transpiration rate and a higher plant hydraulic conductance and a smaller root system closed stomata in wetter soil conditions, meaning earlier in the drying process. This finding is explained by a soil-plant hydraulic model that assumes that stomata start to close when the soil hydraulic conductance of the soil-plant continuum starts to decline. Those findings stress the importance of belowground hydraulic properties on stomatal regulation and thereby drought responsiveness.