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Plant water relations under drought in organic and conventional farming systems

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Due to climate change, agricultural production systems will be progressively subjected to more frequent and severe weather events, such as prolonged summer drought. Thus, there is an increasing need for a better understanding about soil-plant water relations during periods of water shortage.

To evaluate the performances of organic and conventional farming systems with different tillage intensities in drought conditions, we used portable rainout shelters to compare with normal rainfed conditions. Plant water uptake depths were quantified using stable oxygen isotopes in water. Water stress was estimated using a combination of leaf water potential measurements in the field and plant vulnerability to xylem embolism with the cavitron technique, and was described as percentage loss of hydraulic conductivity (PLC). When plants are stressed during drought, high tensions in the xylem from evaporation at leaf surface and low soil water potential might induce air embolisms, which can block the water transport causing high PLC. Therefore, lower PLC implies higher drought resistance.

Under intensive tillage compared to conservation tillage, plants were taller with higher yield and whole plant biomass, as well as less stressed with lower PLC. Meanwhile, the negative correlation between PLC and plant height for barley suggests that factors determining PLC also alter plant height according to different soil conditions (soil physical properties and water availabilities). Analyses indicate that the sown pea-barley mixture was generally more resistant to drought under 1) intensive compared to conservation tillage and 2) in organic compared to conventional farming. The positive effects of intensive tillage could be attributed to increased water harvesting due to higher total porosity in strongly disturbed (intensely tilled) topsoil. Organic farming enhances soil biota and soil carbon, but how this translates into increasing plant resistance to drought has to be studied more in detail. Outcomes of this work will provide an ecophysiological perspective the response of farming systems to climate change.