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Comparing irrigation strategies for soybean at a sub-humid site in Austria

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The main part of the Austrian agricultural production takes place in the northeast of the country, which is characterized by humid to dry-subhumid conditions. The driest areas have about 500 mm mean annual precipitation. Mean temperature was about 9.5°C in the second half of the 20th century, but increased by 1°C during the past decades. According to climate change scenarios, further temperature increase is expected. As a consequence, crop water demand and thus irrigation demand are increasing. Furthermore, alternative irrigated crops are planted because of changing environmental as well as economic conditions. Although irrigation has a long tradition in some of the growing areas, farmers have little experience with water- and energy-saving strategies. However, such strategies become more and more important.

As a first step to optimizing irrigation of soybean in this region, we evaluated three irrigation strategies with respect to efficiency. The experimental field of 1 ha, located at 48.27°N, 16.69°E, and 160 m a.s.l., was divided into four plots. Soil texture was loam. The irrigation water was distributed through drip lines, pipelines with sprinklers, and a wheel irrigation boom with nozzles. The fourth part of the field was not irrigated (only rainfed). In 2018, the three irrigation plots were irrigated according to farmers' experience on July 31 and August 9. The resulting amounts were 40 mm (drip), 70 mm (sprinkler), and 50 mm (nozzles). To evaluate soil and plant water status, four monitoring stations were installed, each equipped with sensors to measure soil water content, air temperature, and canopy temperature.

While the irrigation boom enabled fairly uniform water distribution and a considerable increase of soil water content, sprinkler irrigation was prone to wind drift and evaporation losses. This caused smaller soil water content in the sprinkler variant, although the largest amount of water was applied to this part of the field. When canopy temperature exceeded ambient air temperature by more than 3°C, this was considered as indicator for plant water stress. In the rainfed variant, such a stress phase occurred throughout August. The sprinkler irrigated variant became stressed mid of August and so was the drip irrigated variant, even though to a smaller extent. The irrigation boom represented full irrigation (no stress), resulting in 3600 kg/ha yield. The sprinkler and drip irrigated variant both yielded 3400 kg/ha. At the merely rainfed plot only 2300 kg/ha were harvested. Overall, drip irrigation was more efficient than the other strategies, but several adaptations are recommended to optimize farmers' decisions. In this regard, the monitoring stations provided helpful data.