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# DRONE BASED REMOTE SENSING OF SUGAR BEET WATER-USE EFFICIENCY

## ABSTRACT

In the context of global change incidences and duration of temporal drought will increase in many regions worldwide and may cause severe yield losses of economically significant crops like sugar beet (*Beta vulgaris* L.). Minimizing drought induced yield losses should be a major concern among agronomists, and this emphasizes traits such as water-use efficiency (WUE). Generally, WUE relates a plant's carbon balance to its water consumption. At the canopy level, WUE is expressed as the ratio of net ecosystem $CO_2$ exchange (NEE) to evapotranspiration (ET). However, WUE is most commonly accessed on the basis of single leaves. Single leaf measurements are easy to perform but only poorly scale up to WUE of complex agroecosystems. Non-destructive multi-sensing approaches, such as infrared- and NDVI-screening, are excellent tools to study transpiration, leaf area development and biomass production of entire crop canopies. Recently the use of unmanned aerial vehicles (drones) for remote sensing has become popular in applied agricultural science which allows fast spectral screening of crop stands.

In our study we compare labor-intensive direct chamber-based measurements to a drone-based estimation of WUE in sugar beet stands. The trial was carried out at Cunnersdorf, Germany. The experimental site was established 25 years ago with four levels of potassium input within a 4-year crop rotation. Canopy-WUE was determined by a mobile non-steady state chamber system. A high-end quadrocopter was developed for agricultural NDVI mapping and thermal imaging.

Estimated WUE from drone-based spectral data proofed to be well and significantly correlated with chamber-based measurements. We therefore conclude that drone-based spectral remote sensing has the potential for estimating WUE of entire crop stands. Possible future applications include the screening for drought tolerant and nutrient efficient varieties, early detection of plant stress and the development of sustainable low-input fertilizer strategies. However, general algorithms have to be developed in order to make this technique applicable to a broad range of users.