

Digital lean phenotyping methods in the context of wheat variety testing – the cases of canopy temperature and phenology

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Abstract

Plant phenotyping plays a crucial part in the development of new crop genotypes. In this study, the applicability of relatively simple commercially available digital phenotyping devices was tested and improved in the context of wheat variety testing. Aerial thermography is used to evaluate the performance of genotypes by measuring canopy temperature (CT). Because lightweight thermal cameras for drones are prone to significant thermal drift effects due to a lack of a signal stabilizing cooling, we propose a new approach to analyze drone based thermal images. Through the inclusion of covariates such as trigger timing and the position of the drone relative to measured plots, temporal trends and viewing-geometry related effects could be mitigated, which improved the CT measurements. Correlations between measurements on 270 experimental wheat plots taken within 20 min were very strong ($R = 0.99$) and highly genotype specific with generalized heritabilities > 0.95 in many cases. In a second experiment, autonomous PhenoCams mounted on poles 12 m above the field were evaluated for their suitability to track main phenological stages and senescence as a replacement for time consuming manual field scorings. Senescence and maturity of wheat could be tracked reliably in the field for three subsequent seasons with strong correlations between field-scorings and image-based estimates ($R > 0.8$). For emergence and heading, achieved correlations were poor. Both experiments demonstrated how image-based phenotyping with a comparably simple setup can be used to derive high quality data relevant in the evaluation of the performance of wheat genotypes in the field.

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