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Abstract

Integrated High-Throughput Phenotyping with High Resolution Multispectral, Hyperspectral and 3D Point Cloud Techniques for Screening Wheat Genotypes on Sodic Soils †

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Abstract: Wheat production in southern Queensland, Australia is adversely affected by soil sodicity. Crop phenotyping could be useful to improve productivity in such soils. This research focused on adapting high-throughput phenotyping of crop biophysical attributes to monitor crop health, nutrient deficiencies and plant moisture availability. We conducted an aerial and ground-based campaign during several wheat growing stages to capture crop information for 18 wheat genotypes at a moderately sodic site near Goondiwindi in southern Queensland. Three techniques were employed (multispectral, hyperspectral, and 3D point cloud) to monitor crop characteristics and predict biomass and yield. Spectral information and vegetation indices (VI) such as, normalized different vegetation index (NDVI), modified soil adjusted vegetation index (MSAVI), and leaf area index (LAI) were derived from multispectral imagery and compared with ground-based agronomic data for biomass, leaf area, and yield. Significant correlations were observed between NDVI and yield (R^2 = 0.81), LAI (R^2 = 0.74), and biomass (R^2 = 0.65). Partial least square regression (PLS-R) modelling using hyperspectral spectroscopy data provided crop yield predictions that correlated significantly with observed yield (R^2 = 0.65). The 3D point cloud technique was effective with comparison to in field manual measurements of crop architectural traits height and foliage cover (e.g., for height R^2 = 0.73). For, this study multispectral techniques showed a greater potential to predict biomass and yield of wheat genotypes under moderately sodic soils than hyperspectral and 3D point cloud techniques. In future, the genotypes will be tested under more severely sodic soils to monitor crop performance and predicting yield.

Keywords: wheat genotypes; phenotyping; vegetation indices; multispectral; hyperspectral; 3D point cloud; sodic soils