Large-scale breeding applications of UAS enabled genomic prediction

Andrew Herr[1], Peter Schmuker[1], and Arron H. Carter[1]

[1]Affiliation not available

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Abstract

Breeding for improved, reliable cultivars despite growing environment irregularity can be challenging. Unmanned aircraft systems (UAS) are a popular high-throughput phenotyping technology that has been shown to help understand the mechanisms associated with crop productivity and create a potential for improved breeding strategy by providing unique insight into environmental response and cultivar productivity. Spectral reflectance indices (SRI), including both vegetation and water indices like NDVI, NDRE, and NWI were used to evaluate 11,593 Washington State University winter wheat breeding plots between 2019 and 2022. SRIs were then used with genomic data in univariate and multivariate gBLUP model predictions for grain yield. Prediction accuracy was evaluated on a leave-one-year-out validation strategy. Including SRI data as fixed effects in univariate genomic prediction models can improve prediction accuracy over the control but is unreliable across years. When used in multivariate models, SRIs improve prediction performance across years but minimally when considering the computationally more efficient base model. In univariate models, when test year NDVI data was used to calculate breeding values, prediction performance was at least 16% better than the control, ranging in prediction accuracy from 0.54 in 2019 to 0.93 in 2020. This study highlights the limitations of SRI and its use in genomic selection, especially when dealing with large breeding populations across environmental extremes. A significant application for the technology can be found in early season UAS data collection to aid accurate predictions in late season, a helpful tool in tight turnaround times commonly experienced in winter crop breeding programs.

***Andrew W Herr[1]**, Peter Schmuker[1], Arron H. Carter[1]*

[1]Department of Crop and Soil Sciences, Washington State University, Pullman, WA, USA

ORCiD: ORCID 0000-0001-5111-2342

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