Photothermal Integration of Multi-Spectral Imaging Data via UAS Improves Prediction of Target Traits in Oat Breeding Trials

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Summary:

Crop phenotyping is both expensive and labour intensive, particularly for the large numbers of plots involved in plant breeding field trials. The modelling and prediction of significant agronomic traits using remotely sensed data is an evolving science and an attractive concept for plant breeders to make the process of selection more effective and precise. Major obstacles in creating robust prediction models include the appropriate integration of data across different years and sites. The complexity of this integration is increased by variable weather patterns, particularly at higher latitudes. In this study, spectral data from unmanned aerial system (UAS) images of eight spring, winter, and facultative oat (*Avena sativa*) breeding trials grown between 2020 and 2023 at a trial site at Aberystwyth on the western Atlantic seaboard of the UK were aligned using photothermal time units, introducing a novel approach. The data cover three years with very different weather patterns, both in terms of accumulated temperature and cloud cover.

The training set contains data from a wide variety of oat varieties, landraces, and advanced breeding lines of both spring oats and winter oats. Ground truthing included plant height, panicle emergence, grain yield, and subsequent analysis of the grain quality traits specific weight, thousand grain weight, kernel content, and hullability. β-glucan, protein, and oil content of the groat were determined using near-infrared scanning spectroscopy. UAS imaging was scheduled on an approximately fortnightly basis for all the trials. Operational limitations reduced this frequency. In total, across all the trials, there were 51 individual flights from which data were processable.

The resulting regression and classification models for various agronomic traits are of significant interest to oat breeding programmes. The potential applications of these findings include optimising breeding strategies, improving crop yield predictions, and increasing the effectiveness of resource allocation in breeding programmes.