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Using Hyperspectral Sensor and Machine Learning to Predict Water Potentials of Wild Blueberries during Drought Treatment

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Abstract : Detecting water stress on crops early and accurately is crucial to minimize its impact. This study aims to measure water stress in wild blueberry crops non-destructively by analyzing proximal hyperspectral data. The data collection took place in the summer growing season of 2022. A drought experiment was conducted on wild blueberries in the randomized block design in the greenhouse, incorporating various genotypes and irrigation treatments. Hyperspectral data (spectral range: 400-1000 nm) using a handheld spectroradiometer and leaf water potential data using a pressure chamber were collected from wild blueberry plants. Machine learning techniques, including multiple regression analysis and random forest models, were employed to predict leaf water potential (MPa). We explored the optimal wavelength bands for simple differences (RY1-R Y2), simple ratios (RY1/RY2), and normalized differences (|RY1-R Y2|/ (RY1-R Y2)). NDWI ((R857 - R1241)/(R857 + R1241)), SD (R2188 – R2245), and SR (R1752 / R1756) emerged as top predictors for predicting leaf water potential, significantly contributing to the highest model performance. The base learner models achieved an R-squared value of approximately 0.81, indicating their capacity to explain 81% of the variance. Research is underway to develop a neural vegetation index (NVI) that automates the process of index development by searching for specific wavelengths in the space ratio of linear functions of reflectance. The NVI framework could work across species and predict different physiological parameters.

Keywords : hyperspectral reflectance, water potential, spectral indices, machine learning, wild blueberries, optimal bands
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