Quantifying physiological trait variation with automated hyperspectral imaging in rice

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BodyText: Hyperspectral imaging (HSI) system can facilitate the study of crop physiological responses to abiotic stress. It has been established in automated controlled-environment across the globe. Nonetheless, each crop in every new environment requires specific experimental design and data analysis pipeline. At Purdue University's Ag Alumni Phenotyping Facility (AAPF), 15 *indica* and eight *tropical japonica* rice genotypes were raised up to 13 weeks old under two nitrogen treatments. HSI data were collected two to three times *per* week and 14 physiological traits relating to growth, photosynthesis capacity and water transportation were measured manually. With principal component analysis (PCA), physiological trait data showed the effects of subpopulation and treatment whereas only treatment effect could be revealed in HSI data. Changes of reflectance around 715 nm (in the red edge region) were associated with the treatment effect in HSI data based on the loadings of PCA. By training support vector machine classifiers, we found that classification accuracy of treatment levels in HSI data was 80% or greater when the rice plants were six to 10 weeks old. Furthermore, leaf-level nitrogen content (*N*, %) and carbon to nitrogen ratio (*C:N*) could be predicted from HSI data by building partial least squares regression models (PLSR) with featured wavelengths. The R^2 values for *N* and *C:N* were 0.83 and 0.73, respectively, and normalized root mean square error of prediction for *N* and *C:N* were 13.67% and 14.39%, respectively (in validation datasets). This is the first study that showed the potential use of HSI on rice at AAPF.