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NAPPN Annual Conference Abstract: Characterizing Rice Nitrogen Use Phenotypes from Multitemporal UAV Imagery with Manifold Learning

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Environmental stressors play a major role in determining plant phenotypic traits over the growing season. Nitrogen, a critical nutrient for plant growth, imposes serious stresses when applied in insufficient or excessive quantities in crop fields, which can directly reduce yield and the grower's profits. Due to significant variations in developmental rates and nitrogen needs across rice genotypes and environments, field phenotyping can become a challenging task. Non-linear manifold learning approaches were evaluated to account for variation in developmental rate using multispectral, multitemporal imagery acquired by an unmanned aerial vehicle (UAV). Imagery (13-16 fly-overs per plot) and ground-truth data (including biomass nitrogen content, leaf chlorophyll content, and yield) were collected on 2,345 rice research plots during the 2021 and 2022 growing seasons. To increase the size of the training set, we also evaluated inclusion of similarly sized tiles sampled from commercial row-rice fields imaged between 2019 and 2022. We compared several supervised machine learning approaches with unsupervised strategies based on manifold learning to evaluate the hypothesis that model architectures which account for variation in developmental trajectories improve prediction of yield variation in response to nitrogen addition. This work will contribute to improved nitrogen rate recommendations using UAV-acquired imagery. Optimized nitrogen prescriptions ensure satisfying the plants' nitrogen needs and contribute to reduced environment impacts and production costs.