In-Season Estimation of Rice Nitrogen Status With an Active Crop Canopy Sensor

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Abstract:
Timely nondestructive estimation of crop nitrogen (N) status is crucial for in-season site-specific N management. Active crop canopy sensors are the promising tools to obtain the needed information without being affected by environmental light conditions. The objective of this study was to evaluate the potential for the GreenSeeker active crop canopy sensor to estimate rice (Oryza sativa L.) N status. Nine N rate experiments were conducted from 2008 to 2012 in Jiansanjiang, Heilongjiang Province in Northeast China. The results indicated that across site-years and growth stages, normalized difference vegetation index (NDVI) and ratio vegetation index (RVI) obtained with the GreenSeeker sensor could explain 73%-76% and 70%-73% of rice aboveground biomass and plant N uptake variability in this study, respectively. The NDVI index became saturated when biomass reached about 4 t ha^{-1} or when plant N uptake reached about 100 kg ha^{-1}, whereas RVI did not show obvious saturation effect. The validation results, however, indicated that both indices performed similarly, and their relative errors (RE) were still large (> 40%). Although the two indices only explained less than 40% of plant N

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concentration or N nutrition index (NNI) variability, the RE values were acceptable (<; 26%). The results indicated some potentials of using the GreenSeeker sensor to estimate rice N status nondestructively, but more studies are needed to further evaluate and improve its performance for practical applications.

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Contents

China is the world's largest producer of rice (Oryza sativa L.), with the average yield being 50% higher than the global average [1]. However, this comes at a cost of 90% higher of nitrogen (N) fertilizer application than the world average [2], resulting in low N use efficiency and susceptibility to environmental pollution [3]–[5]. Precision agriculture has the potential to improve crop N management and mitigate negative environmental impacts of intensive agriculture [6]–[9]. A practical approach to precision N management strategy would include a regional optimum N rate calculated as an initial rough estimate of the total N needed for the rice crop, followed by split application of N fertilizer at early and mid-season growth stages. During the growing season, topdressing N rates can be further adjusted based on in-season diagnosis of rice N status [4], [10]. Hence, the development of timely, reliable, and efficient nondestructive methods for estimating rice N status is crucially important for the success of such precision management strategies.