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RAPID ASSESSMENT OF RADIATION USE EFFICIENCY USING CANOPY 3D MODELS

Yoon Ju Cho[1], Oorbessy Gaju[1], Velu Govindan[2], Rob Lloyd[1], Simon Pearson[1], and Ravi Valluru[1]

[1]Lincoln Institute for Agri-Food Technology, University of Lincoln
[2]International Maize and Wheat Improvement Center (CIMMYT)

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YOON JU CHO[1], OORBESSY GAJU[1], VELU GOVINDAN[2], ROB LLOYD[1], SIMON PEARSON[1], RAVI VALLURU[1]

[1]Lincoln Institute for Agri-Food Technology, University of Lincoln, Lincoln, UK;

[2]International Maize and Wheat Improvement Center (CIMMYT), Mexico

ORCiD: 0000-0002-4242-0930

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Global wheat production needs to increase by 60% to ensure food security in the future. Radiation use efficiency (RUE), defined as dry matter production per unit of light energy consumption, is an important trait that contributes to wheat yield potential. Traditionally, RUE is estimated through sequential biomass cuts evaluated against cumulative light interception, which is less precise and non-specific to genotypes. 3D models have recently been shown promise in estimating light interception when used along with ray tracing algorithms, mostly deployed in single plant-based models, while light interception at the canopy level remains to be explored. In this study, a mobile robotic phenotyping platform equipped with dual multispectral laser sensors was used to generate canopy 3D data. Using this platform, 100 spring wheat genotypes were scanned at heading stage to understand the genetic variation for RUE and its associated traits under field conditions. Ray-tracing algorithms were used to estimate the fraction of intercepted photosynthetically active radiation (FIPAR) for all genotypes, validated through a hand-held light ceptometer. Genotype-specific RUE was calculated as a slope between dry biomass and accumulated PAR. 3D model-based FIPAR was in close agreement with ceptometer-derived FIPAR. 3D model-derived RUE showed a large genetic variation across 100 wheat genotypes. It explained a higher variation in grain yield than ceptometer-derived RUE. These results indicate that canopy 3D models can be used as a rapid method for estimating canopy RUE in wheat, and potentially are extendable to other cereals.