From Canopy to Kernel: A Multi-Sensor Approach to Wheat Drought Tolerance

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Abstract

Machine vision techniques like RGB imaging are valuable for measuring plant growth by tracking changes in size and shape over time. By using non-destructive, continuous monitoring, these techniques are especially useful for assessing canopy growth under different experimental conditions like drought. However, canopy monitoring has limitations, like being unable to observe kernel growth hidden in spikes. To address these challenges, we did a study on the growth of a recurrent parent Yecora-rojo (called Yecora) and its 2nd backcrossed progenies under pre-heading and post-heading water limitation. The goal was to evaluate RGB imaging's capability in quantifying their differences in tolerance to limited watering. The plants were grown in a controlled environment. RGB sensors captured images three times a week until 20 days after heading. The side projected area (SPA) was used as an indicator of growth. We showed the difference in recovery after stress by using the numerical approximation of the area under the curve for two progenies that outperformed Yecora under limited watering. Furthermore, the continuous measurements let us identify specific time points contributing to these differences. The grains from individual plants were phenotyped using a laser-based size determination system, evaluating length, width, and area per kernel. This method provides a complete picture of the total kernels produced by a single plant and helps study varietal differences. This study identified two BC2 progenies, Yecora156 and Yecora190, as targets for further field studies and breeding to develop the next breeding population.

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