

X-Ray Computed Tomography Imaging for Rapid and Automated 3D Cereal Spike Phenotyping

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The architecture and structure of cereal spikes are key indicators of quality and yield and are determined by both genetic and environmental factors. Traditional phenotyping methods for cereal spike trait measurements rely largely on manual work and are often qualitative or destructive, which leads to loss of spatial information. In this study, by using the newly installed X-ray computed tomography (X-ray CT) system at the Plant Accelerator (Australian Plant Phenomics Facility), we developed a high-throughput and non-destructive method to analyse cereal spikes. The fully automated algorithm generates detailed grain traits measurement, including count, weight, size, surface area, sphericity and spatial position. The average scan time required per sample cassette is under 7 minutes for 30 cereal spikes. Various cultivars of wheat, barley, oat and sorghum have been tested, and the results have confirmed the high accuracy and efficiency of using the X-ray CT system in grain studies. To further utilise the obtained 3D information, a pipeline for analyse spike and spikelet morphological traits has been developed for wheat spikes and oat panicles. This method allows to study the spikelet morphological traits by categorising the spikelets base on grain count, volume and weight, which can potentially bring the insights of the relationship between the development of single or multiflorous spikelets and grain quality and yield. The innovative X-ray CT system can efficiently generate grain and spike traits in high-throughput and non-destructive way, which provides a new method to contribute to a better understanding of cereal screening and breeding directions.