Nondestructive high-throughput screening of wheat spike and grain

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Abstract

Given the changing environmental conditions, understanding internal mechanisms of crops and their interaction with the environment in abiotic stress conditions is very important. To estimate the yield of e.g. wheat, spike and grain traits are used for the selection of resilient genotypes for further breeding programs. Typically, the extraction of these traits is laborious and destructive. With automated X-ray technology a non-destructive screening of spikes can be conducted faster and more accurate. Furthermore, the technology allows extracting additional traits such as center of mass and aspect ratio of each grain, together with the position of the grain within the spike.

We present the analysis of 203 wheat accessions carried out using a portable computed-tomography system (CT). The wheat plants were exposed to either drought or combined drought and heat stress. With the EarS algorithm, spike traits were analyzed with an accuracy of 95-99%. The system scanned 4 spikes simultaneously, which resulted in a scanning-time of 7 minutes per spike. To enable a high-throughput acquisition and comparison of wheat traits, we present the required steps for automation. Thus, together with PhenoKey, we developed an automated CT-system with integrated conveyor belt for The Plant Accelerator®, University of Adelaide. This system examines spikes and grains with high throughput. The system has space for 35 spike holders, each of which can carry 30 spikes. This allows a scanning time of 13 seconds per spike. Combined with an automatic data post processing each grain can be identified and linked to the corresponding genotype.

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