Non-destructive seed phenotyping and time resolved germination testing using X-ray

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October 30, 2023

Abstract

Current phenotyping technologies, whether based on cameras, LIDAR or hyperspectral imaging, are capturing mainly 3D surfaces and are limited, to penetrate into growth media and internal tissue and structures. 3D X-ray computed tomography (CT) alleviates many of these shortfalls by enabling a non-destructiv visualization of optically inaccessible plant structures, allowing for the 3D reconstruction and measurement of objects at high resolution and high throughput. We will present a range of fully automated, industrially validated 3D X-ray CT based technologies, that enable to visually and quantitively follow up in 4D the entire plant development cycle from flowers/ears to seeds to germinating seedling in filter paper to plants and root structures in soil. We will emphasize the non-destructive fully-automated 3D phenotyping of seeds and the resulting germinating seedlings including their internal organs in filter paper across time, i.e. in 4D, at a current throughput of 200 seeds/min and 25 seedlings/min, respectively.

The presented technologies, being universally applicable across plant and crop species, allow for the quantitative, objective and reproducible assessment of morphological seed and seedling traits in 4D. They provide powerful tools to investigate any influence, whether genetic, environmental or treatment-related on seed quality and the germination capacity, vigor and 3D phenotype of the resulting seedling over large samples as big data. We will present the technologies and data on traits such as seed quality, seedling development, degree of abnormalities, germination capacity and vigor across different crop types.

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Keywords: 3D/4D phenotyping, spike, seed, seedling, germination, X-ray, automation. Non-destructive