Introduction

Microtomography (micro-CT) is a non destructive technique that uses X-rays to investigate internal anatomy and morphology of organisms. It generates a series of projections reflecting the level of attenuation of X-rays after crossing an object from different angles during its rotation. Projections are then collected and reconstructed to obtain a 3D stack volume. Micro-CT is an emerging technique in plant seed science and technology [1,2,3,4] because of its ability to assess numerous seed structures (i.e. embryo, cotyledons, teguments, cavities, etc.) and quality (i.e. cracks, insect damage, defects, etc.) with a high accuracy (up to 5 micron resolution). Seed external appearance does not reflect the quality of the seed. Seed may seem intact while it can be damaged, cracked, have an abnormal color, high humidity, etc. The use of micro-CT can thus provide more information about seed quality. It can also be used for the characterization of varieties for different traits or for coated/treated seeds for the physical quality of the treatment. Here, capabilities of micro-CT coupled with image processing algorithms we developed are discussed for different applications on seeds.

Applications of X-ray micro-CT to plant seeds

Three-dimensional High-resolution Measurements of internal and external seed structures

Morphological seed characters may be used for the assessment of complex and quantitative traits such as seed resistance, germination potential and other agronomic traits. Examples for such direct measurements are image-based analysis of the shoot area or testa thickness.

For the AKER project, we use micro-CT and automated image processing pipeline to quantify several sugar beet seed structures from micro-CT images. The pipeline separates three morphological structures of the seed namely the embryo, the perisperm and the seed coat (Figure 1). Once these separated structures are analyzed separately in order to extract phenotyping quantitative traits such as volumes, shapes, length, etc.

Insect damage detection and quantification

In this work, we attempt to show the relevance of micro-CT either in high-resolution for the characterization of internal morphologies (Applications on sugar beet and faba bean seeds) or in medium-resolution and high throughput of a lot of seeds (Applications on coated seeds, and insect damage on pea and faba bean. Future prospects involve the increase of automation level of the whole process (treatment and pick-up of the seeds) to attend high throughput phenotyping. In addition, the possible use of Microtomography for detection and quantification of pathogens, priming effect, and inhibition process will be tested on different seed species.

References


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