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X-Ray Computed Tomography for Non-Invasive 3D Imaging of Plant Tissues: Its Advancements and Applications

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DESCRIPTION

EX-ray Computed Tomography (CT) has revolutionized the field of medical imaging, providing detailed 3D representations of internal structures without the need for invasive procedures. However, CT is not limited to medical applications and has found use in other fields, including plant science. With the advancements in X-ray CT, it has become a valuable tool for non-invasive, non-destructive visualization and quantification of internal structures in 3D in plants.

Analyze how two okra genotypes, Hassawi okra and the commercial Clemenson genotype respond to various X-ray dosages in terms of germination and biochemical analyses. Different X-ray dosages were administered to the two okra genotypes (0 Gy-100 Gy). According to the results, when compared to untreated plants, the two okra genotypes significantly increased in all morphological criteria, total pigment, enzymatic antioxidants (ascorbic acid, glutathione and anthocyanin) and nonenzymatic antioxidants (ascorbate peroxidase, catalase and superoxide dismutase). In contrast, the two okra genotypes were significantly more affected by lipid peroxidation and oxidative damage (hydrogen peroxide and superoxide anion) when exposed to high doses of X-rays above 5 Gy.

Traditional optical-based techniques for visualizing plant tissues are limited by the size and transparency of the sample and only provide 2D information. Optical Projection Tomography (OPT) allows for 3D structural data of small samples, but still requires sample preparation and staining. Non-invasive methods like PET and MRI have also been used, but they are better suited for physiological studies.

X-ray micro-CT has emerged as a powerful tool for 3D imaging of plant tissues and organs. The imaging process is based on differential attenuation of X-rays in relation to tissue density and atomic number. Recent advances in X-ray CT technology have allowed for high-resolution imaging of plant structures, including roots, leaves, flowers and fruits. The ability to image the internal structures of plant tissues and organs in 3D without destroying the samples has greatly expanded the scope of plant research.

X-ray CT has been used to study plant development and organogenesis, to quantify the distribution of nutrients and water in plant tissues and to investigate the effects of environmental stress on plant growth. For example, X-ray CT has been used to study the development of Arabidopsis thaliana, a model plant for genetic research and to quantify the distribution of water in maize roots. X-ray CT has also been used to study the impact of drought stress on the growth and development of tomato plants. One of the major advantages of X-ray CT is its ability to obtain 4D data, which allows for the visualization of changes in plant tissues over time. Recent technological advancements have allowed for the non-invasive imaging of plant root growth in 4D, revealing new insights into the mechanisms of root

development and the impact of environmental conditions on root growth. This ability to capture dynamic changes in plant tissues in 3D and 4D will greatly enhance our understanding of plant growth and development.

In addition to its use in plant science research, X-ray CT has potential applications in agriculture and horticulture. X-ray CT can be used to visualize the internal structures of fruits and vegetables, which can aid in the selection of high-quality produce for consumers. X-ray CT can also be used to study the impact of different environmental conditions on plant growth and development, which can inform the development of new agricultural practices. X-ray computed tomography is a valuable tool for non-invasive, non-destructive imaging of plant tissues and organs in 3D and 4D. Recent advancements in X-ray CT technology have greatly expanded the scope of plant research and have potential applications in agriculture and horticulture. X-ray CT has the potential to revolutionize our understanding of plant growth and development and improve the quality of produce for consumers.