LSI SUPPORT FOR PhD-STUDENTS IN APPLIED AREAS

Monitoring Cd stress in durum wheat using neutrons: Providing new answers to the problem

THE PURPOSE OF THE PHD PROJECT

Cd accumulation in wheat from the Swedish soils in a varying climate is a major environmental issue that the Swedish wheat producers are facing today. Understanding wheat genotype responses to Cd (and drought) stress and its management with aim to reduce Cd uptake and accumulation in wheat may help to improve wheat grain quality for the Swedish wheat producers. The aim of the PhD project is to study the impact of Cd and drought stresses on wheat plant growth and development.

USING A LARGE SCALE INFRASTRUCTURE

Neutron-based imaging offers a unique opportunity to study water dynamics and monitor Cd impact on the wheat plant root development. This technique can therefore be very useful for the evaluation of Cd (and drought) stresses and prediction of a genotype response to applied stresses in plant breeding and milling-baking industries. The study performed is a collaborative innitiative between the Department of Plant Breeding, SLU, Alnarp and Lilla Harrie Valskvarn, Kävlinge that aims to find solution for Cd problem, and the IMAT neutron imaging beamline of the ISIS Neutron and Muon Source at the Rutherford Appleton Laboratory, UK. The latest neutron based imaging methods were used here to monitor the Cd stress on durum wheat plant growth.

RESULTS AND IMPACT

From the pre-study conducted in the greenhouse it was observed that the genotypes differing in Cd uptake responded differently to different Cd levels tested, especially when Cd and drought stresses were applied. The genotype more sensitive to Cd uptake was impacted severely when Cd and drought stresses were combined. From the neutron imaging results it was observed that this Cd sensitive genotype developed different root architecture of plants grown in the “industrial” soil (from the field) compared to the plants grown in sand.

The neutron imaging results clearly indicated that it is possible precisely to monitor Cd stress induced differences in root volume (**Figure 1**) in different types of growing media (including miniaturized “industrial” environment). Although, further work could include Cd localisation in the roots using additional neutron and x-ray scattering methods.

Positive impact on the PhD student development consists of planning and performance of the experiments, pre-testing and neutron imaging, learning about the technical basis of the neutron beam-line and measurements via a great number of video meetings (due to closed ISIS and Covid restrictions). Data acquisition-extraction with the beamline experts, practical hands-on on large data sets and a choice of software were important training aspects for the PhD student.

Positive impact on the industry is new knowledge on the high-Cd accumulating wheat cultivar growing requirements (e.g. specific soil type), which is among important agronomic practices to reduce Cd uptake in wheat. However, the drought factor should be further explored in different types of analysis (e.g. combining studies using neutrons and X-rays).

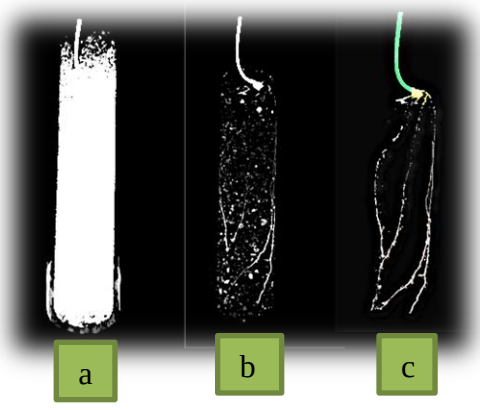

Figure 1. Extraction of wheat root information from 3D neutron image; a- obtained image; b- extracted image indicating plant roots and soil structure; c- extracted root volume.

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