Geophysical Research Abstracts
Vol. 21, EGU2019-4411, 2019
EGU General Assembly 2019

Modelling variety dependant least limiting water range: assessing the limits to root elongation in field soil.

George Themistocleous (1,2), Tracy Valentine (1), Blair McKenzie (1), and Sacha Mooney (2)
(1) The James Hutton Institute, Dundee, United Kingdom, DD2 5DA, (2) University of Nottingham, Sutton Bonington, Loughborough LE12 5RD, UK

There is an unprecedented need to increase crop productivity as it is projected that global food demand may double from current levels by 2050. In order to achieve this, it is vital that crops are adapted to maintain yields in less than optimum environments, such as those with limited, non accessible or excess water and/or those with limited nutrients levels. As such, it is essential to understand the different effects soil stress factors have on plant growth and how different root traits may influence the plants interaction with soil. Accurate phenotyping methods at both the whole root scale through to the micro-scale are a pre-requisite for understanding these plant:soil interaction.

The "least limiting water range" (LLWR) (Da Silva, et al., 1994) is a computationally feasible model that can be used to estimate a range of soil volumetric water within a specific soil that is optimum for plant growth. The model integrates important soil variables such as dry bulk density, oxygen deficiency, matric suction (water availability) and soil strength (usually measured as penetrometer resistance), to designate a range of soil conditions that have minimal limitations to plant performance. However, the model is limited by intrinsic assumptions in the form of the limiting values for different the soil stressors, for example, usually a penetrometer resistance of 2 MPa is used as a "cut off" value for soil strength. This value may however represent a different % reduction in root elongation and plant performance for different species or varieties since root traits may vary significantly in their response to the same level of soil stress.

In order to develop a root trait based version of the LLWR taking into account variation in responses to soil physical properties between varieties with different root traits, a rhizotron based plant phenotyping system was developed with accompanying image analysis methods. The rhizotron based analysis pipeline can be used to image cereal roots over a growth period of at least 21 days and to quantify root macro traits (e.g. root architecture - shape branching) and micro traits (e.g. root hairs) while manipulating the LLWR soil stress factors. The above system in conjunction with a simple microscope based destructive sampling methodology which enables further micro traits (e.g. border cells) to be measured, can help quantify dynamics of root traits in response to changes in soil conditions and assess the effects that different root traits have on the LLWR of a specific cultivar.

Da Silva, A. P., Kay, B. D. & Perfect, E., (1994). Characterization of the Least Limiting Water Range of Soils. Soil Science Society of America, 58 (6), 1775-1781.