Getting to the root of the problem: soil, nitrogen, water and root dynamics

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Increasing drought and the cost/sustainability of nitrogen (N) fertiliser use are of growing concern. Overuse of N fertilisers has resulted in high environmental costs, such as leaching of soluble N forms and nitric oxide pollution into the atmosphere. Therefore, plant use efficiency of N is not maximised. This may be further exacerbated by drought conditions, because soil N availability is regulated by soil moisture. With climate change models projecting that water availability will become more erratic in the near future, the demand for understanding combined effects of variable water and N supply on wheat (above- and below-ground) is necessary.

Plants have evolved, or been bred for, root traits which optimize water and N uptake. Here results of an experiment in which root responses to combinations of water and N stress are presented. This work focused on identifying root traits associated with water and N uptake efficiency in plants, the hypothesis being that the suite of traits responsible for (efficient) water uptake would be the same for N uptake. The experiment was carried out at the Plant Accelerator® using the DroughtSpotter, which permits very fine-scale control of soil moisture dynamics by precisely measuring pot weight in real-time and irrigating plants according to a pre-programmed water level. The aim was to quantify the impact of different soil moisture regimes (adequate, deficit and variable) and increasing levels of soil N supply on soil N cycling, N uptake and root response in wheat.

Identifying and quantifying root responses of wheat to varying degrees of water and N stress will provide better insight into how crops and the environment interact. Understanding trade-offs between water and N uptake efficiency can lead to the development of crop management strategies to help improve crop productivity and improve the environmental and economic sustainability of food production.