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Modelling plasticity and response of lupin roots to heterogeneous environments

Root systems are fundamental to crop productivity. Searching for root traits underpinning efficient nutrient acquisition has received increased attention in modern breeding programs aimed at improved crop productivity. In the recent ARC Discovery project, we established a high-throughput novel phenotyping platform (Chen *et al., Functional Plant Biology* 2011, 38: 355−363), and examined genotypic variability in underlying root traits efficient in capturing water and nutrients in a large germplasm of narrow-leafed lupin (*Lupinus angustifolius*) using both phenotyping and modelling approaches (Chen *et al., Plant Soil* 2011, 348: 345−364; *Plant Soil* 2012, 354: 141−155; *Crop & Pasture Science* 2013, 64: 588–599; *Plant Soil* 2013, doi: 10.1007/s11104-013-1741-x). Two current functional-structural root architectural models, ROOTMAP and *SimRoot*, were used in our root study to investigate root-soil interactions through representing the relationships between rooting traits and the non-uniform supply of soil resources.

This talk will be focusing on one modelling simulation study aimed to predict and identify phenotypic plasticity, root growth responses and phosphorus (P)-use efficiency of contrasting genotypes to localised soil P in a glasshouse. Two wild lupin genotypes with contrasting root system were grown in cylindrical columns containing uniform soil with three P treatments (nil and 20 mg P kg^{-1} either top-dressed or banded) in a glasshouse. Computer simulations were carried out with the both models which were parameterised with root architectural data from our hydroponic phenotyping study. Both experimental and simulation outcomes demonstrated that i) root hairs and root proliferation increased plant P acquisition and were more beneficial in the localised P fertilisation scenario, ii) placing P deeper in the soil might be a more effective fertilisation method with greater P uptake than top dressing, iii) the combination of P foraging strategies (including root architecture, root hairs and root growth plasticity) is important for efficient P acquisition from a localised source of fertiliser P, and iv) root models based on different resource allocation hypothesis differ in the simulated root growth and nutrient uptake. Our research highlights the potential of root models in the aid of selection of root traits for improved plant performance in specific environments. A brief summary of related root studies undertaken in the recent and current ARC projects is expected to be present.

Brief Biography

Yinglong (Alan) was awarded a PhD at Murdoch University in 2006, and Master Degree in Agriculture (by research) (1997) and Bachelor Degree in Science (1994) in China. He was a Research Assistant Professor and Group Leader in Soil Microbiology at the Chinese Academy of Forestry (1994-2002). Yinglong was an ACIAR Fellowship at CSIRO (1997-1998), Visiting Scientist at INRA (France, 2000), Visiting Research Associate at Murdoch University (2001). Yinglong has been working at UWA as a Research Associate since 2006. He published three books, 5 book chapters, edited one international conference proceedings, and published 24 articles in ISI-indexed journals including New Phytologist, PLoS ONE, Plant Physiology and Biochemistry, Plant Soil, Mycorrhiza. Yinglong is an appointed external referee of European Research Council (ERC) Advanced Grant proposals, and was an International Adviser and Regional Coordinator for Centre for International Forestry Organization Research (CIFOR).