Roots hold answer to better yields

Researchers are focusing on wheat plant roots to further enhance crop efficiency. *Sarah Henly* finds out more from NIAB researcher Steven Bentley

Exploiting wheat root genes that better use resources such as nitrogen fertiliser could potentially raise yields by 0.8t/ha.

True or false? Deep rooting wheat varieties are most drought tolerant? Types with a high density of roots are most efficient at taking up nitrogen fertiliser?

Steven Bentley of NIAB is confident the answers are within rooting distance. He co-ordinates a project that is uncovering new facts to help plant breeders find desirable genes to augment future varieties.

"We must be careful when making and testing hypotheses because our understanding of roots has been limited by their relative inaccessibility. But our initial findings suggest the underground half of a wheat plant has enormous potential to improve yield or allow for reduced inputs."

The idea is to find and exploit genes conferring rooting traits with a yield or agronomic advantage. The first step is to characterise the roots and identify genetic markers associated with root traits. Once genetic markers can be developed, there should be rapid progress, he believes.

"It's not surprising plant breeders have focused on manipulating the canopy to improve yield potential. Root studies are difficult and time-consuming due to the lack of accurate tools available for research. But we are developing new ways to measure roots and relating their features to agronomic parameters."

Scientists at the John Innes Institute have looked at 100 wheat varieties – including old ones such as Cappelle Desprez and more modern wheats like Xi19 – to reveal the extremes of root variation. Plants were grown in gritsand-filled tubes of 1m length, called rhizotubes, so as not to restrict rooting depth.

The team has distinguished four main rooting types – shallow versus deep rooting, and high versus low density roots. Obviously, root patterns change as plants grow during the season, so measurements are made at a standard time – just after flowering -– when root mass tends to be maximal.

Several field-based methods are being employed to collect root data, including soil washing to extract roots, and wheat tissue DNA extraction from soil. One collaborator is working with a root scanner to avoid small roots being missed, and another is looking at interactions of roots with soil fungi.

Mr Bentley explains: "Ultimately, plant breeders will be able to select not only for improved yield, but also for drought tolerance, better nutrient uptake and the like. That is good news for growers in any situation and under any farming constraint that should arise."

Another HGCA-funded wheat project looking at exploiting genes for greater yield and better use efficiency of resources such as nitrogen fertiliser and plant growth regulators is due to publish its findings next December. It has focused on three genes which together have the potential to increase yield by 0.8t/ha, but with a consequent crop height rise and increased lodging risk.

Having identified genetic markers associated with height that have no effect on yield, ADAS's Pete Berry believes the trade-off between yield potential and height can be lessened with appropriate combinations of height genes that increase yield without increasing height much. A key objective is to find reliable markers for these genes, to assist plant breeders.

HGCA perspective by *Shamal Mohammed*

Research and knowledge transfer manager, HGCA

"Improving plant uptake of fertilisers and other inputs can reduce costs and lower the environmental effect of crop production.

"This project aims to characterise root types and develop the tools necessary to identify the genes needed to produce wheat varieties with consistently good rooting potential. In the hands of plant breeders, the information can be used to develop markers to select varieties with root types suitable for all manner of farming scenarios. We will see the benefits of this research in the wheat varieties available in the years ahead."

Research reasons

HGCA

Good rooting is essential for high yielding wheat crops, but it hasn't been a priority for breeders due to the difficulty in studying roots. HGCA research aims to improve understanding of rooting and, thereby, identify the key traits for breeders.

Project: New wheat root ideotypes for improved resource use efficiency and yield performance in reduced input agriculture
Timescale: March 2011- April 2016
Researchers involved: ADAS, JHI, NIAB and the University of York
Funders: HGCA, BBSRC, BASF, Frontier, KWS, Limagrain, Monsanto, RAGT and Syngenta
Cost: Total £1m, including in-kind contributions from the companies involved plus HGCA levy funding of £100,000
Read more: Interim reports on projects 3575 and 3543 at www.hgca.com/research

Key findings

- Root structure relates to crop performance under different environmental conditions
- From a pool of 100 varietal lines, 22 pinpointed as having exploitable rooting potential