CSIRO PLANT INDUSTRY

Roots and bugs unearthed

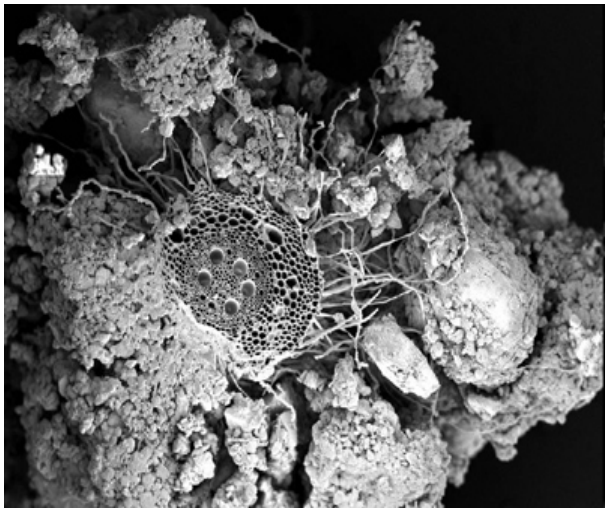
A CSIRO Plant Industry project is looking at plant roots, the organisms that live on them and whether their interactions might be used to improve crop yields.

Roots, soil organisms and crops

CSIRO researchers are looking closely at the environment around plant roots – an area so specialised and teeming with life that it has its own name – the rhizosphere.

While scientists and farmers know that root associated micro-organisms can have beneficial or detrimental effects on plants, little is known about them, how they interact with roots and each other, and how they are controlled in the paddock.

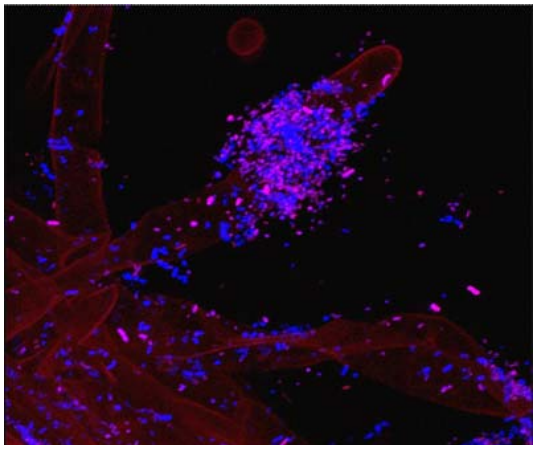
A project at CSIRO Plant Industry, focusing on wheat, is identifying rhizosphere organisms and the chemicals from roots that influence them, and is examining how rhizosphere processes are affected by farming practices and wheat cultivars.



The rhizosphere: wheat root (centre – 1 millimetre wide) with root hairs extending into rhizosphere soil.

Discovering what's below ground

Millions of bacteria and fungi occupy each cubic millimetre of rhizosphere. Only about 20 per cent of these micro-organisms have been identified. The research team is identifying and localising rhizosphere micro-organisms using CSIRO's advanced microscopy techniques and molecular probes that "light up" the bugs on the roots. Roots taken directly from farmer's fields are frozen with soil to identify interactions important for crop root function.



Fluorescing molecular probes reveal soil bacteria (each about 1 micrometre) closely associated with a wheat root.

The researchers can see how many organisms are on the roots, how close they are to each other and how roots control the organisms. Seeing below ground provides ideas as to how interactions between roots, soil and organisms can be improved with genetics or management.

Signalling between roots and soil organisms

Roots release many chemicals that feed and signal to the rhizosphere organisms. Plants expend a great deal of energy on these chemicals, sometimes for carbon food sources or as a way of interfering with the signals that are exchanged between bacteria and other soil organisms. Some of these signals change the way micro-organisms act when populations reach a critical number.

CSIRO scientists, in collaboration with the Australian National University, use High Pressure Liquid Chromatography (HPLC) to analyse chemicals from roots including sugars and phenolics.

The signalling devices between organisms and roots are analysed using "reporter" bacteria that fluoresce when they sense a signal.

At the moment, root chemicals are analysed from plants grown in the lab to minimise extraneous factors. In future, research will be conducted to see if these chemicals function in the paddock to influence wheat yields.

The details of signal "communication" between roots and organisms are still not well understood, but researchers know that they influence the rhizosphere organisms and the health of the plant, and that they vary genetically between crops and cultivars.

While the concept has great promise for improved crops, plenty of work must be done before breeders can make use of root chemicals and signals to improve rhizosphere organisms. An important step is linking laboratory and field results and filling the gap between the lab and the paddock.

Getting out into the paddock

One important discovery in the paddock was that the dead roots of previous crops survive in the soil for at least three years, directly contacting more than half the roots of young crops, and hosting many millions of organisms. These dead roots influence the new crop roots via micro-organisms.

This root-root contact partly explains how rotations influence the growth and yield of wheat, and why rotational effects are greater in no-till soil. In no-till systems where soil is undisturbed, dead roots and new crop roots colonise the same channels in the soil and are clustered together in direct contact, greatly increasing the exchange of chemicals and micro-organisms.

Roots cluster together in a root channel.

This is particularly important in intensive wheat rotations where certain bacteria and fungi are carried over into the following wheat crop, via dead roots from the preceding crop, inhibiting plant growth and yield.

Field trials are investigating which wheat genotypes do better after previous wheat in intensive no-till wheat rotations.

The project is investigating whether wheat varieties that perform better in intensive cereal rotations have fewer inhibitory rhizosphere organisms due to the chemicals released from the roots. They will then assess whether the potential exists to select for this trait in future breeding programs.

Researchers are also undertaking a survey of farmers who have been using wheat/wheat rotations.

If you have any experience with cultivars that perform better in this cropping regime, especially as part of no-till management, Dr Michelle Watt would like to hear from you. Information on yields, management practices such as inter-row sowing, and general experiences would all be useful.

Dr Watt can be contacted on 02 6246 4902 or at Michelle.Watt@csiro.au.

This research is a collaboration with the Australian National University and is supported by the Grains Research and Development Corporation.

For further information contact:
CSIRO Enquiries
Bag 10 Clayton South VIC 3169

Phone: 1300 363 400 (National local call)
+61 3 95452176 (International phone)

Fax: +61 3 9545 2175

Email: enquiries@csiro.au

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Produced by CSIRO Plant Industry Communication Group 2006