Research briefing

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Improving crops from the roots up

Dr Ive De Smet, BBSRC David Phillips Fellow in the Division of Plant and Crop Science

Producing enough safe and affordable food for a growing population is one of the biggest global challenges of the future. Research by Dr Ive De Smet has taken us a step closer to breeding hardier crops that can better adapt to changing environments and fight off attack from parasites.

Hardier crops essential for future food security

In a paper published in the Proceedings of the National Academy of Sciences of the United States of America (PNAS), researchers from The University of Nottingham have shown that they can alter root growth in the plant Arabidopsis thaliana by controlling an important regulatory protein.

Dr Ive De Smet, a ***Biotechnology and Biological Sciences Research Council (BBSRC)*** David Phillips Fellow in the University's Division of Plant and Crop Science, said: "The world's population is increasing, and a new green revolution is even more pressing to deliver global food security.

"To achieve this, optimising the root system of plants is essential and these recent results will contribute significantly to our goal of improving crop growth and yield under varying environmental conditions."

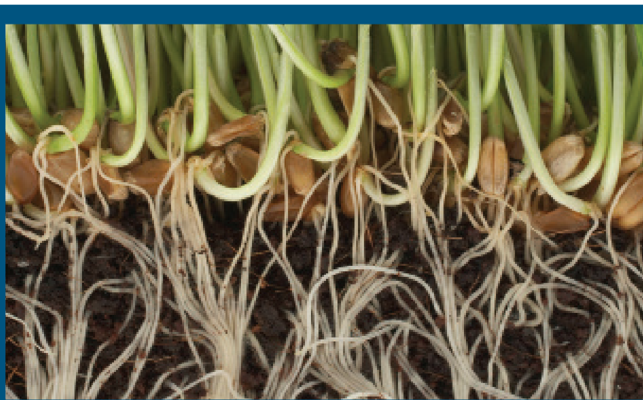
The work was carried out by an international team of researchers. Led by scientists from the ***Plant Systems Biology Department*** in the life sciences research institute ***VIB*** in Flanders, Belgium, and ***Ghent University***, the study also involved experts from ***Wake Forest University*** in the US and the ***Albrecht-von-Haller Institute for Plant Sciences*** in Germany.

Plant root biology is essential for healthy plant growth and, while the so-called hidden half of the plant has often been overlooked, its importance is becoming increasingly recognised by scientists.

Despite this, particularly in view of the critical role plants play in global food security, improving plant growth by modulating the biological architecture of root systems is an area which is largely unexplored.

In this latest research, the scientists modulated levels of the protein, transcription factor WRKY23, in plants, analysed the effects on root development and used chemical profiling to demonstrate that this key factor controls the biosynthesis of important metabolites called flavonols.

Altered levels of flavonols affected the distribution of auxin, a plant hormone controlling many aspects of development, which resulted in impaired root growth. Altered levels of flavonols affected the distribution of auxin, a plant hormone controlling many aspects of development, which resulted in impaired root growth.



What controls the formation of offshoots?

Researchers used technology that enabled synchronous root branches, allowing them to isolate the cells that induce root branches. Comparing the active genes from these cells with those that are crucial to normal cell division, the researchers identified a set of genes — including the ACR4 gene — that controls asymmetric cell division and sends out a signal for the formation of root branches.

The ACR4 gene contains the DNA code for a receptor kinase, a protein that detects external signals and transmits them to controlling mechanisms within a cell. When the ACR4 function was disrupted, so was the precisely orchestrated asymmetric cell division. The researchers inferred that ACR4 plays a key role in the creation of root branches and reacts to environmental factors. This knowledge enables us to control the formation of root branches. Promoting an extensive root system can help plants better absorb nutrients, requiring less fertiliser. Such plants can also grow more easily in dry or infertile soils and are more firmly anchored in the ground.

Slowing down secondary root formation can help tuberous plants to concentrate on producing nutrients. It also makes harvesting easier. These findings on asymmetric cell division, similar to stem cell division in animals, could provide insight into how animal stem cells specialise. Irregular cell division plays a role in the development of various cancers, and similar control mechanisms might underlie this process.

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Healthier and hardier crops

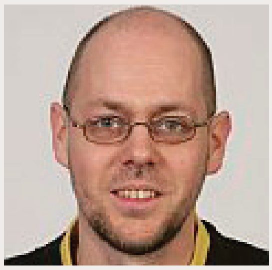
The results of the research can now be used to produce new plant lines, such as crops which are economically valuable, which have an improved root system, making them better able to resist environmental changes which could lead to plant damage or poor yield.

In addition, WRKY23 was previously found to play a role in the way plants interact with types of nematode parasites, which could lead to further research into how to prevent attacks from the creatures during the early stages of plant growth.

The paper ***Transcription Factor WRKY23 Assists Auxin Distribution Patterns During Arabidopsis Root Development Through Local Control on Flavonol Biosynthesis.*** featured in the online Early Edition of the Proceedings of the National Academy of Sciences of the United States of America.

This research was funded by: VIB, Ghent University, IWT, FWO, EMBO, UIAP, BelSPO and NSF.

Global food security is a priority research area for The University of Nottingham and is part of ***Impact: The Nottingham Campaign***.



Dr Ive De Smet

The world's population is increasing, and a new green revolution is even more pressing to deliver global food security. To achieve this, optimising the root system of plants is essential and these recent results will contribute significantly to our goal of improving crop growth and yield under varying environmental conditions.

Dr Ive De Smet

Dr Ive De Smet is a BBSRC David Phillips Fellow in the Division of Plant and Crop Science at The University of Nottingham. He leads a research team which is interested in the involvement of membrane-associated receptor-like kinases in registering and conveying (positional) information during plant (lateral) root development. Specifically, the team is investigating the ACR4-dependent signalling cascade, which has been found to be important for root development (De Smet et al. 2008, Science 322:594-597).

In the framework of a David Phillips BBSRC Fellowship, the team will identify substrates and ligands for the membrane-associated receptor-like kinase ACR4. It will combine the expertise of its lab in genetics and root development with that of partner labs competent in proteome-wide analyses. The characterisation of this homeostatic ligand/receptor signalling mechanism, that can integrate mobile signalling molecules to control formative cell divisions during organogenesis, provides an excellent tool to study short range, cell-to-cell communication during growth and development.

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Funding bodies

IWT is the government agency for Innovation by Science and Technology. It helps Flemish companies and research centres to realise their research and development projects. It offers funding, advice and a network of potential partners and supports the Flemish Government in its innovation policy.

VIB is a life sciences research institute, based in Flanders, Belgium. It performs basic research with a strong focus on translating scientific results into pharmaceutical, agricultural and industrial applications.

EMBO is an organisation of leading life scientist members that fosters new generations of researchers to produce world-class scientific results. It supports researchers. It provides platforms for scientific exchange and training in cutting-edge technologies so that the high standards of excellence in research practice are maintained. It helps shape science and research policy for a world-class European research environment.

Funding also came from: ***NSF***, ***BelSPO, FWO*** and UIAP. It also included ***Ghent University.***

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