

How root growth is stimulated by nitrate: Researchers decipher signalling chain

Gatersleben, 20.02.2026 **Nitrogen fertilisation is essential for producing plant-based food. However, excessive soil nitrate levels impair the quality of soil, water and contribute to climate change. Plants that can access and utilise available nitrate more effectively require less fertiliser, which is an important principle for more sustainable agriculture. An international research team involving the IPK Leibniz Institute has now discovered a molecular mechanism that enables plants to improve their root growth and access and utilise soil nitrate more effectively. The study's results were just published in the journal 'Nature Plants'.**

When 200 natural accessions of the model plant *Arabidopsis thaliana* grown in a nitrate-enriched medium were compared, one observation stood out: some accessions formed significantly longer lateral roots than others. Genetic analysis revealed a difference in a gene called *MEKK14*. "A single amino acid in the MEKK14 protein determines how strongly a plant develops its lateral roots in the presence of nitrate," explains Xiaofei Zhang, the study's first author. Plants expressing the more active protein variant grow better in nitrate-rich environments.

The gene encodes a kinase, which is a protein that can phosphorylate and activate other proteins. "In the study, we showed that nitrate activates an extensive signalling cascade involving several kinases and transcription factors, ultimately enhancing the growth of lateral roots," says Zhongtao Jia, who started this work at the IPK and finished it at China Agricultural University in Beijing. It is a kind of alarm chain: nitrate is the trigger, MEKK14 is the first switch and the transcription factor CCA1 is a central coordinator. Ultimately, the roots explore the soil more effectively for nitrate.

Of particular interest is that the central transcription factor CCA1, which is activated at the end of the kinase signalling pathway, activates the crucial gene MEKK14. This creates an amplifier loop. "We have thus discovered a positive feedback mechanism that amplifies the nitrate signal and causes the root to grow continuously into the nitrate-containing medium," explains Zhongtao Jia. This loop ensures that the plant adapts its root architecture over the long term, rather than just responding briefly.

However, the signalling cascade does not directly stimulate growth; instead, it activates the plant hormone auxin. When auxin signalling is activated, cell division in the meristem and cell expansion in the elongation zone are increased, resulting in longer lateral roots. Without a functioning signalling cascade, however, the auxin signal remains weak. The researchers have thus succeeded in linking nitrate signals, a MAPK signalling cascade and a component of the plant's 'internal clock' (CCA1) with the growth hormone auxin for the first time.

The results also offer new perspectives on sustainable agriculture. "Our study presents a new molecular approach for improving root growth under ample nitrogen supply," explains

Press Release

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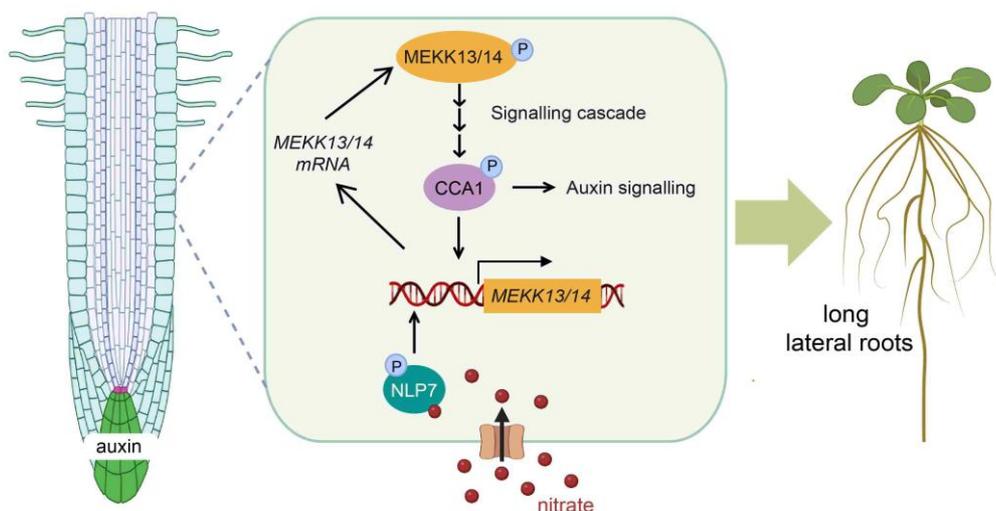
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Prof. Dr. Nicolaus von Wirén, head of IPK's 'Physiology and Cell Biology' department and co-corresponding author. "If we can identify gene variants in crops that affect this signalling cascade differently, we will have a new target for breeding that better adapts root growth to soil nitrogen availability and thus helps using nitrogen fertilisers more efficiently."

Original publication:

Zhang *et al.* (2026): A feedback regulatory loop by MAPK-CCA1 engages auxin signalling to stimulate root foraging for nitrate. Nature Plants. DOI: [10.1038/s41477-026-02225-8](https://doi.org/10.1038/s41477-026-02225-8)

Graphic:



Using the model plant Arabidopsis, the research team demonstrated that nitrate activates an extensive signalling cascade involving several kinases and transcription factors, ultimately enhancing the growth of lateral roots.