Gene required for root hair growth, nitrate foraging found in grasses

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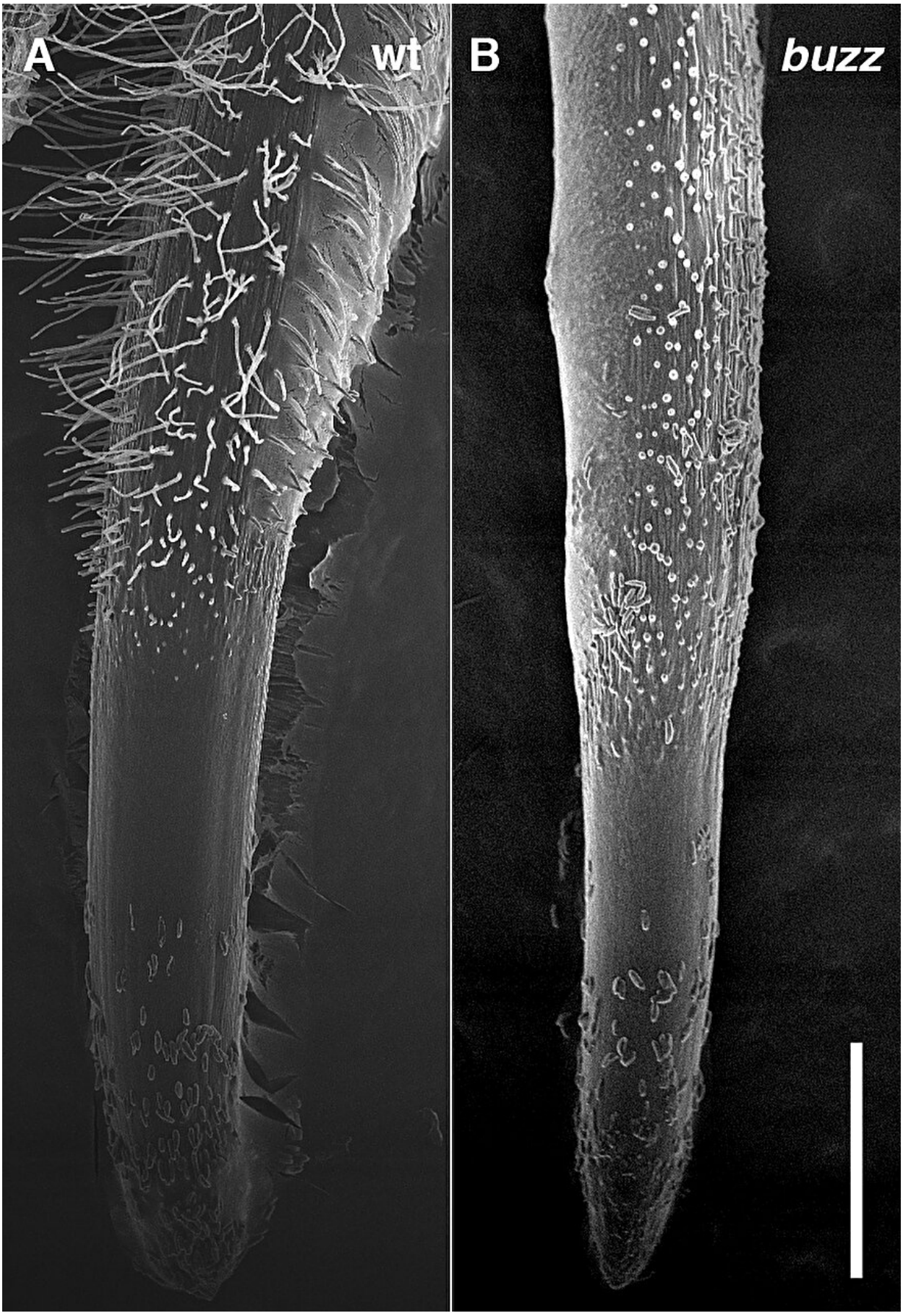
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Comparison of wild-type growing root hairs (left) and the BUZZ mutant with little root hair nubs, as seen through a scanning electron microscope. Credit: Karen Sanguinet, Washington State University

Scientists have found a plant gene that drives the growth of root hairs, the tiny structures that help plants find water and nutrients in the soil.

Identified by a team led by Washington State University researcher Karen Sanguinet, the gene, dubbed "BUZZ," causes faster-growing, denser webs of roots and may also determine how plants find and use nitrates, a prime source of nitrogen essential to plant growth. Nitrates are also used in fertilizers that can pollute the environment as runoff, and this genetic discovery could ultimately help plant scientists find ways to grow crops more sustainably.

"Nitrate runoff and nitrogen use efficiency are some of the preeminent issues facing agriculture," said Sanguinet, associate professor in WSU's Department of Crop and Soil Sciences. "If you can understand the genetic mechanisms that control nitrate uptake and signaling, as well as how plants can better use nitrate, it's advantageous for agriculture, soil, water, fertilizer application and the entire nitrogen cycle."

The study, published in the journal New Phytologist, found that the BUZZ gene adjusts root growth—both the rate and lateral root initiation—in response to the nitrate concentration in nearby soil.

"Expression of the BUZZ gene is turned up in response to nitrate, urea, and ammonia presumably so that roots can find nitrogen in the soil,"

Sanguinet said. "Loss of the gene shows a foraging root phenotype even when the nitrate supply is plentiful."

The gene is expressed at very low levels and had never been described before, which made finding it more challenging.

"For such a sensitive response, the plant needs a gene that is discreet and tightly regulated. That's what made it so hard to find," Sanguinet said.

Identifying the gene in a model grass plant is also important because its function is likely conserved given the sequence similarity between grasses. Thus it translates to crops like wheat, rice, maize and barley. These crops are vital to feeding the world's population, so a gene that could boost their ability to find and use nitrate could have a large impact.

Now that the researchers have found and validated the biological role of the BUZZ gene, they are delving deeper into this newly discovered mechanism.

"Half the battle is getting to this point," Sanguinet said. "Now we're finding cool stuff about how plants use the gene that is very specific to nitrate and root systems. Figuring out how plants work is the joy of why we do this."

Sanguinet studies both crop and model species. Model species are useful because they lay the groundwork for work in crops that are often difficult to transform and study specific gene functions. She hopes findings like this gene will lead to renewed interest in basic research.

"We hope people realize there is a place for discovery," Sanguinet said. "Unless you do the basic science that lays the groundwork for investigating molecular genetic mechanisms of growth, it won't enable the applied research that has more direct impact. It's all part of a

research arc. This is a great start to work that could be really important, and I'm excited to keep moving forward on it."

The research was led by two Ph.D. students from the Sanguinet lab: Thiel Lehman and Miguel Rosas. Sanguinet and WSU colleagues worked with scientists from South Dakota State University, Northeast Normal University in China, and the University of Massachusetts, Amherst.

More information: Thiel A. Lehman et al, BUZZ: an essential gene for postinitiation root hair growth and a mediator of root architecture in Brachypodium distachyon, *New Phytologist* (2023). DOI: 10.1111/nph.19079

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