One gene makes the difference: research team achieves breakthrough in breeding winter-hardy faba beans

Press Release

Scientific Contact
Dr. Martin Mascher
Phone: +49 39482 5243
mascher@ipk-gatersleben.de

Media Contact
Christian Schafmeister
Phone: +49 39482 5461
schafmeister@ipk-gatersleben.de

Gatersleben, 10.03.2026 **An international research team involving the IPK Leibniz Institute has discovered a small yet significant genetic difference in faba beans. Whether a plant survives the winter or can only be grown in spring hinges on a single location in the genome. The results of the study, which could significantly speed up the development of hardy varieties, were published today in the journal 'Nature Genetics'.**

The faba bean is an ancient crop. It is particularly valuable because it is high in protein, and can convert nitrogen from the air into a form that can be used by plants in the soil. This makes it a sustainable alternative to soy, particularly in Europe. However, many varieties are not winter-hardy. In cold regions, they do not survive frost.

Firstly, the research team succeeded in significantly improving the reference genome of the faba bean. Various methods, such as optical mapping, were used to assemble the genome's individual sections more precisely. "Our new reference for the field bean genome is an accurate blueprint with significantly fewer gaps, better anchoring on the six chromosomes, and provides a reliable basis for breeding," emphasised Prof. Dr. Murukarthick Jayakodi, who created an initial genome reference at the IPK in 2023. Building on this, in a second step, the researchers examined more than 400 winter and summer lines and systematically compared the corresponding genetic material.

At the same time, they carried out association analyses. These examine which genetic differences are associated with certain characteristics - in this case, winter hardiness. They also investigated which genes are activated in cold conditions. They were particularly interested in genes already known to be involved in cold resistance in other plant species.

"We were surprised to find that a single allele at a single gene locus is enough to distinguish between winter and summer varieties," said Hailin Zhang, the study's first author. This is comparable to a light switch: it is either on, or off. Depending on the variant of this gene, the plant is winter-hardy - or it is not.

This exact gene locus also emerged as the strongest signal in an analysis of winter hardiness. The genes located there belong to the CBF/DREB transcription factor group. These switch genes activate many other protective mechanisms in cold weather. "We were able to demonstrate that these genes are significantly activated in cold conditions. This confirms that they play a central role in frost tolerance," explained Hailin Zhang. These genes can be thought of as a kind of emergency plan. When the temperature drops, the plan is activated and the plant prepares for frost.

But that's not all. The same gene locus has also been linked to stable yields in different environments. "The fact that the same gene locus influences both winter hardiness and yield stability was an especially exciting discovery for us," said Dr. Martin Mascher, head of the 'Domestication Genomics' research group at the IPK. This means that this one genetic

‘control centre’ has several significant effects. This new knowledge can accelerate the breeding of robust winter field beans, which yield almost 50 per cent more in Europe. As a domestic source of protein, they can also reduce dependence on imports.

Original publication:

Zhang, Windhorst *et al.* (2026): Allelic variation at a single locus distinguishes spring and winter faba beans. Nature Genetics. DOI: 10.1038/s41588-026-02524-y

Photo:

The photo shows well-differentiating winter-hardiness of a diverse set of spring and winter faba beans inbred lines. Photo: Windhorst