Leibniz Institute of Plant Genetics and Crop Plant Research (IPK)
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Two genes, two harvests – adapting barley for double cropping

Press Release

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Gatersleben / Beijing, 5 November 2026. **An international research team at the IPK Leibniz Institute has shown how combining two gene variants enables double cropping in cereals. The combination allows barley to mature earlier without compromising grain yield under the growing conditions investigated. Using precise genome editing, the team also confirmed the effect of a key genetic change in wheat. The findings open up new opportunities to tailor cereal development more precisely to cropping schedules and environmental conditions. The results were published in the science magazine "Nature".**

Growing two crops in succession on the same land requires a tight schedule. In parts of central and eastern China, farmers sow barley in autumn and harvest it in late spring. It is then followed by a summer crop, such as rice. For this cropping sequence to succeed, the barley must mature in time. An early harvest also helps the crop avoid heat and rain towards the end of the growing season. A research team led by Ping Yang at the Chinese Academy of Agricultural Sciences, working with researchers at the IPK, investigated the genetic changes that enable this adaptation. The team combined historical data spanning eight decades with field trials and molecular genetic studies. IPK researchers contributed genomic analyses and expertise in barley's genetic diversity and evolutionary history to the international collaboration. The study examined 505 representative Chinese barley varieties and 27 introduced reference lines. Their genetic data reveal how the genetic makeup of Chinese barley varieties has changed since the 1940s. Introduced varieties, particularly those from Europe, brought valuable yield and quality traits. However, their longer development period poses a challenge for established cropping systems in which barley is followed by another crop.

The team identified a variant of the PHYTOCHROME C (PhyC) gene, in combination with the VERNALIZATION 1 (VRN1) gene, as a key molecular component. PhyC encodes a light receptor that regulates flowering time. A single amino acid substitution in the protein accelerates ear emergence and maturity. The analyses indicate that this gene variant originated in East Asian barley germplasm and became more widespread during modern breeding. Early maturity is not necessarily advantageous, however. When combined with a variant of the flowering regulator VRN1 typical of spring barley, the early-maturing PhyC variant can reduce biomass and impair yield-related traits. The crucial factor is therefore its combination with a VRN1 variant typical of winter barley, which is involved in the response to prolonged periods of cold. Under the field conditions investigated, this gene combination enables earlier development without reducing grain yield. The two genes lie close together on the same chromosome and can therefore be inherited together. Their combination has left a clear signature in barley's breeding history. Its frequency in Chinese autumn-sown varieties has increased since the 1960s. Since the 1990s, more than 60 per cent of the modern Chinese autumn-sown varieties examined have carried this combination.

"Our findings show how a favourable combination of two gene variants became established in Chinese barley breeding over several decades," explains Martin Mascher of the IPK Leibniz Institute. "Analysing historical varieties allows us to trace how breeding has genetically adapted barley to the requirements of double cropping."

To test whether the genetic change actually causes earlier development, the research team used a precise genome-editing technique known as base editing. This allows researchers to

replace individual DNA building blocks in a targeted way. The team recreated the naturally occurring change in barley and wheat, confirming that the gene variant causes the plants to develop earlier. In rice, however, the same genetic change has the opposite effect: the plants flower later. This is probably due to differences in the mechanisms that regulate responses to day length. Barley and wheat are long-day plants, whereas rice, a short-day plant, responds differently to light signals.
“The study shows that adapting crops depends not only on individual genes, but also on how they are combined,” explains Nils Stein of the Leibniz Institute. “Modern genome-editing methods allow us to test the effects of such genetic changes directly, opening up new opportunities for plant breeding.”

The study combines an analysis of 80 years of breeding history with experimental evidence of a key gene variant's function. It shows how selecting favourable gene combinations has enabled crops to adapt to intensive cropping systems. For future breeding, this knowledge offers new opportunities to tailor flowering and maturity times to different growing conditions. Further field trials are needed to establish whether the identified gene combination also performs well in other varieties and growing regions.

Original publication:
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Figure: Differences in development during a field trial: barley plants carrying an early-maturing gene variant (left) produce ears earlier than plants without this variant (right). Photo: Ping Yang, Institute of Crop Science, Chinese Academy of Agricultural Sciences

