New genetic variation from old and exotic varieties for environmentally friendly wheat cultivation

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In addition to the almost 9,000 winter wheat accessions, the scientists also grew elite varieties in the trial field and investigated resistance to yellow rust, among other traits. Credit: IPK Leibniz Institute/ C. Martin

Gene banks worldwide make an important contribution to the conservation of biological diversity. In the Federal Ex situ Gene Bank at the IPK Leibniz Institute alone, more than 150,000 old varieties are preserved. In addition to negative traits, old and exotic varieties possess many valuable gene variants that have been lost in modern varieties but may be crucial for plant production in the future. But how can this hidden treasure of valuable biodiversity be tapped for agriculture?

This is the question that a research team led by the IPK has been investigating. In an interdisciplinary approach involving plant breeders, plant geneticists, plant pathologists and bioinformaticians, they succeeded in detecting new biodiversity from old varieties for yield performance and resistance to yellow rust infestation in order to leverage it for crop production. The results were published in the journal *Nature Genetics*.

Thanks to the continuous funding of the work over six years so far by the Federal Ministry of Education and Research, it was possible to test the IPK Leibniz Institute's extensive collection of old wheat varieties for their yield performance and resistance to yellow rust in the laboratory, but also in field trials.

"This required a logistical masterstroke from all project participants and many innovative approaches to evaluate the potential of the old varieties without disruptive effects," says Dr. Albert Schulthess, first author of the study. To determine the yield potential, the old varieties were crossed with adapted elite varieties, for example. Only then became the yield potential of the old varieties clearly visible.

And that's not all: the researchers used the results to develop bridging lines for wheat breeding from promising old varieties by crossing them with current varieties. The performance of the resulting progeny surprised the researchers: "We observed higher yields in some bridging

lines as compared to important current elite varieties," says Dr. Albert Schulthess, scientist in the research group "Quantitative Genetics".

Prof. Dr. Jochen Reif, coordinator of the consortium and head of the research group, is convinced that thanks to the involvement of the two breeding companies, the biodiversity of the elite pool can be increased by using new valuable genetic variation of the bridge lines: "This is of great importance to tackle the huge problems that climate change poses to agriculture."

The results of the study enable a big step towards farming with less or no pesticide use. "Through the comprehensive sequencing of old and new varieties in combination with the valuable field data, we were able to identify possible new gene variants for resistance to yellow rust infestation," says Dr. Albert Schulthess. This would not have been possible without the decoding of the wheat genome, in which the IPK Leibniz Institute played a leading role.

"With the new genome regions we discovered in a few old varieties, we can diversify the immune system of wheat," explains Prof. Dr. Jochen Reif.

However, there are still considerable challenges to overcome before the new resistance genes can be used in plant production. For example, the resistance genes must be validated and incorporated into the background of elite lines. Ideally, a deeper understanding of the nature of the defense response would be gained at the same time. This would make it possible to use the new sources of resistance in the long term.

More information: Genomics-informed pre-breeding unlocks the diversity in genebanks for wheat improvement, *Nature Genetics* (2022). DOI: 10.1038/s41588-022-01189-7

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