Switzerland green lights field tests on CRISPR yield-enhanced barley

Agroscope has been granted approval by the Federal Office for the Environment for a field trial with spring barley. The focus is on a barley gene that has been disabled by new breeding techniques. The trial, which will be launched in spring 2024 on the Protected Site in Zurich-Reckenholz and will run for three years, aims to determine whether yields can be increased in this manner.

The *CKX2* gene is involved in the regulation of seed formation. Disabling this gene by means of a new breeding methods (CRISPR/Cas9 genome editing) brings about increased yields in rice and oilseed rape (see, below, ‘From rice to barley’).

International collaboration

Researchers from Freie Universität Berlin have observed that barley possess two slightly different copies of this gene. In partnership with scientists from the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), they produced barley lines where both copies were disabled. These lines developed more grains per spike in the greenhouse. Together with Freie Universität Berlin, Agroscope is now investigating these barley plants on the Protected Site to answer the following questions, among others:

- Do the plants also produce more grains per spike under field conditions, and does this result in higher yields?
- Do both copies of the gene need be disabled, or is knocking out one sufficient?
- Does disabling one or both copies of the gene modify other characteristics besides yield under field conditions?

No foreign DNA

Researchers disabled either one or both copies of the *CKX2* gene in various barley lines using the precise CRISPR/Cas9 technique. Unlike the plants previously studied on the Protected Site, the barley lines produced in this manner contained no foreign DNA. Although such an alteration could also occur via random natural mutation, these barley lines are treated as genetically modified plants (GMPs), since a novel technique is being applied that modifies the plant genome – hence the field trial’s need for the authorisation of the Federal Office for the Environment.

Trials from spring 2024 onwards

The field trial will begin in spring 2024 on the Protected Site at Agroscope Zurich-Reckenholz and will run for around three years. For practical reasons, research is being conducted with the old malting barley

variety ‘Golden Promise’, which is not cultivated in Switzerland. This variety is comparatively easy to genetically modify, and is thus often used in research. However, the knowledge gleaned from the trials will also be applicable to modern varieties of barley, and, with good prospects of success, to additional cereal species such as wheat or spelt.

Discussions on regulation are ongoing

The regulation of plants from new breeding techniques such as CRISPR/Cas9 is currently being discussed in various countries. According to a first ruling of the EU Parliament last week, plants which could also arise by chance in nature (without foreign DNA) are to be less strictly regulated in future. The Swiss Federal Council is expected to submit proposals as to how it envisages the future authorisation scheme for such GMPs in mid-2024.

From rice to barley

Crop yield formation is complex and involves many different genes. However, Japanese researchers have discovered that the mutation of the *CKX2* gene in rice has an unexpectedly significant effect on yield. Results were so convincing that they are now used in rice breeding.

Research results show that genes corresponding to the *CKX2* gene from rice also play a role e.g. in oilseed-rape yield formation. Therefore, it is reasonable to study this effect in further crops. In the best-case scenario, at the end of these trials on the Protected Site it will be possible to issue a recommendation as to whether breeders should disable one or both *CKX2* genes in order to boost yields. What is certain, however, is that important information will be provided on the function of the *CKX2* genes in barley – and hence further pieces of the puzzle will be available for a better understanding of yield formation.

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