University of Zurich[UZH]

Department of Plant and Microbial Biology

Wheat Resistance Gene Protects Barley and Maize from Fungal Diseases - also in Field Conditions?

Research for improved disease resistance in crop plants

In agricultural systems, crop plants are exposed to naturally occurring and changing pathogens. Many of these pathogens can infect plant varieties and are controlled by pesticides to avoid yield losses or reduced harvest quality. Producing disease-resistant plants is thus an important aim in plant breeding. For efficient breeding, the underlying principles of disease resistance must be known. The study of the molecular basis of the plant immune system is a dynamic research area with considerable international activity.

Lr34 – a durable resistance gene from wheat against fungal diseases

Hundreds of resistance genes protecting different cereal species from fungal diseases are already known. One of these genes, characterised by a durable, partial effect against several fungal species, was identified and molecularly isolated (cloned) by the University of Zurich in collaboration with research groups from Australia and Mexico. Named *Lr34*, the gene occurs in some wheat varieties and protects them from fungal diseases such as mildew and rust. The *Lr34* resistance gene has been extensively used worldwide for over a century in wheat breeding and cultivation. And yet, fungal pathogens have still not adapted to this resistance – in other words, *Lr34* is as effective as ever. Many known resistance genes contain a blueprint for receptors enabling the plants to recognise pathogens. By contrast, Lr34 is structurally a so-called ABC transporter – a membrane protein that actively transports substrates into the interior of a plant cell, or from the interior to the outside.

Lr34 is also effective in other cereals

Lr34 was transferred from wheat to barley, rice, maize and sorghum by genetic engineering methods. Interestingly, *Lr34* protected against fungal diseases in all these different cereals, as shown by the results of laboratory and greenhouse tests (Figures 1 and 2). The *Lr34* barley was also successfully tested for fungal resistance in Agroscope's open glasshouse in Reckenholz, where field-like conditions prevail.

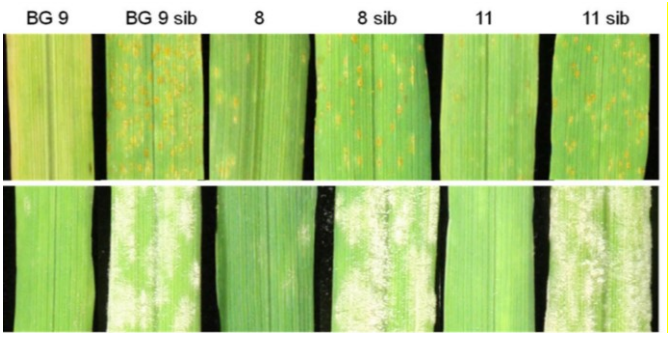

Figure 1: Results of the disease-resistance testing of the greenhouse-raised barley lines. The transgenic barley lines BG 9, 8 and 11 exhibited improved resistance to rust (above) and mildew (below) compared to the sister lines BG 9 sib, 8 sib and 11 sib, all without the *Lr34* transgene.

Figure 2: Results of the disease-resistance testing of the greenhouse-raised maize lines. All six maize leaves were infected with the causal agent of northern corn leaf blight. Left: The three leaves containing the *Lr34* transgene exhibited no disease symptoms. Right: These three leaves do not contain the *Lr34* transgene, and became diseased.

Field trials with barley and maize

After the gratifying results of the laboratory, greenhouse and open glasshouse, the protective effect of *Lr34* will now be tested in the field. Since sorghum and rice are currently of little agronomic importance in Switzerland, *Lr34* barley and *Lr34* maize are the only two cereals that undergo further testing at Agroscope in Reckenholz. The field trials will expose them to the normally occurring pathogens, namely, the causal

agents of northern corn leaf blight *(E. turcicum)* and of common smut *(U. maydis)* in *Lr34* maize, and the barley leaf rust *(P. hordei)* and powdery mildew *(B. graminis.* f.sp. *hordei)* pathogens in *Lr34* barley. In addition, researchers are studying whether genetic modifications also influence plant development and yield in the maize and barley lines.

Aims of the trial

Plants have developed a sophisticated immune system that allows them to distinguish between pathogenic and harmless or beneficial microbes and to trigger the appropriate defense mechanism. The primary aim of the field trials is to improve our understanding of the function and effectiveness of *Lr34*.
The new findings from the trials will be published in international journals and presented at international symposia. Further development of the transgenic barley and maize lines for commercial applications is not planned.

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The GM plants in focus

Barley

In order to produce the transgenic barley lines, the spring barley variety 'Golden Promise' was transformed via Agrobacteria with the wheat-derived *Lr34* gene. In the field trial, three transgenic barley lines are being tested. One of them expresses *Lr34* under the control of the native wheat-derived *Lr34* promoter. The other two lines express the transgene via a barley-derived pathogen-inducible promoter (i.e. the *Lr34* gene is only transcribed when the plant is infected by pathogens).

Maize

In order to produce the transgenic maize lines, the maize variety 'Hi-II' was transformed via Agrobacteria with the wheat-derived *Lr34* gene. In the field trial, two transgenic maize lines are being tested. In both lines, the transgene *Lr34* is expressed under the control of the native wheat-derived *Lr34* promoter.

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Further Information

Further information on the field trials on the Protected Site can be found at www.protectedsite.ch.

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