



## Field Trial with Genetically Modified Spring Wheat with Improved Powdery Mildew Resistance

### *Why are powdery mildew-resistance genes researched?*

For a good wheat yield, healthy plants are essential. However, wheat is threatened by diseases, the majority of which are caused by fungi. For nearly 15 years now, researchers from the University of Zurich have been investigating how plants protect themselves against such fungal diseases. Here, they focus inter alia on the wheat *Pm* genes, which confer resistance to the powdery mildew pathogen (*Blumeria graminis* f. sp. *tritici*). Powdery mildew is a significant disease of wheat worldwide. Since the *Pm* genes under study belong to the largest class of plant resistance genes, the results will also be applicable to other plant diseases and their control. The University of Zurich is thus contributing to basic research on disease resistance in crops.

### *Which genes were introduced into the wheat lines?*

The introduced genes come from other wheat lines. Known as *Pm3*, *Pm8* and *Pm17*, they provide resistance to powdery mildew. *Pm8* and *Pm17* originate from rye, but were transferred into many wheat varieties by classical breeding. *Pm3* exists in different variants, referred to as 'alleles'. The *Pm3* alleles as well as *Pm8* and *Pm17* were molecularly isolated (cloned) and have been intensively researched since then. Wheat lines to which different *Pm* genes were transferred by genetic engineering are being used in the current field trials, which have been taking place on the Protected Site at Agroscope's Zurich Reckenholz site since 2014. Furthermore, different *Pm* genes and alleles were stably combined in a single plant by crossing these wheat lines. In addition to the transferred *Pm* genes, all genetically modified (GM) wheat lines carry the *manA* gene that

serves as a selection marker. The *manA* gene occurs naturally in bacteria, soya and several other legumes. In tissue culture – an early stage of production of the GM wheat lines – it helps to distinguish the small percentage of GM plants from non-GM plants. The *manA* gene has no influence on resistance to powdery mildew.

### *Have the genetically modified plants already been tested in the field?*

The team from the University of Zurich conducted field trials at the Agroscope sites in Zurich-Reckenholz and in Pully from 2008 to 2010 in collaboration with other researchers from Swiss universities and Agroscope (wheat-cluster.ch). In these NRP 59-funded projects, studies were carried out on the benefits and biosafety of twelve wheat lines that each carry one of six different *Pm3* alleles.

Launched in 2014, the new field trials focused on five of these wheat lines carrying the *Pm3a*, *Pm3b* (two lines), *Pm3d* and *Pm3f* alleles. Four lines combining two of these *Pm3* alleles each as well as three lines containing the *Pm3e* allele were added. The results of these trials were published in international journals (see overleaf) as well as being presented at international symposia.

### *What will be studied in the new trials?*

Since 2019, additional new wheat lines that have undergone thorough investigation in both the laboratory and greenhouse are now being tested in the field. These are wheat lines that carry *Pm8* and *Pm17* alleles both individually and in combination with one another or with *Pm3* alleles, as well as wheat lines with three and four stably combined *Pm3* alleles.

The aim of the field trials is to gain further knowledge about the functioning of resistance genes and their combination.

### *Are the genetically modified wheat lines a health risk?*

No. One of the reasons for this is that the introduced *Pm* genes come from other wheat lines, all of which are already used agriculturally. The allergy potential is therefore the same as for currently cultivated wheat varieties. The product of the introduced genes is not toxic for the fungus causing the powdery mildew disease, but it does give the plant the ability to detect its presence. After detection occurs, the plants use their immune system to fight off the fungus.

The *manA* selection marker is present in GM maize varieties approved as food for humans in other countries. There are no indications of *manA* having a harmful effect.

### How is the project funded?

The project is funded by the University of Zurich.

### What happens after the trials?

The new findings from the trials will be published. The wheat lines will be kept for potential further research activities, and propagated from time to time in the greenhouse for this purpose. Further development of the wheat lines for commercial applications is not planned.

### The trial in numbers

Period of trial:

Trial Permit B13001: 2014 - 2018

Trial Permit B18001: 2019 - 2023

(March to August of each year)

New GM wheat lines since 2019:

2 lines with 3 *Pm3* alleles

1 line with 4 *Pm3* alleles

4 lines with *Pm17*

3 lines with *Pm8*

1 line with *Pm17* and *Pm8*

2 lines with *Pm17* and 1 *Pm3* allele

## Contact

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## Publications

Koller T., Brunner S., Herren G., Sanchez-Martin J., Hurni S., Keller B. (2019) Field grown transgenic *Pm3e* wheat lines show powdery mildew resistance and no fitness costs associated with high transgene expression. *Transgenic Research* 28: 9-20.

Koller T., Brunner S., Herren G., Hurni S., Keller B. (2018) Pyramiding of transgenic *Pm3* alleles in wheat results in improved powdery mildew resistance in the field. *Theoretical and Applied Genetics* 131: 861-871.

## Further Information

Further information on the field trials on the Protected Site can be found at [www.protectedsite.ch](http://www.protectedsite.ch).