Fertility or powdery mildew resistance?

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Powdery mildew is a fungus that infects both crop and ornamental plants. Each year, powdery mildew and other plant pathogens cause immense crop loss. Despite decades of intense research, little is known of the plant molecules that allow fungal hyphae to invade the host's epidermal cells. A European research group lead by Ueli Grossniklaus, a plant geneticist at the University of Zurich, now published a study in *Science* shedding a new light on mildew susceptibility in plants and its surprising link to reproduction.

Investigating mildew susceptibility in plants is not really a main research focus for Ueli Grossniklaus, a professor for plant genetics at the University of Zurich, Switzerland. Grossniklaus' lab mainly investigates the molecular mechanism of both sexual and asexual plant reproduction. His group conducts fundamental research on the model plant Arabidopsis thaliana, whose complete genome has been deciphered.

Recently, Grossniklaus and his team uncovered a mutant that they named nortia after an Etruscan goddess of fertility. Together with FERONIA - a gene Grossniklaus' group had previously discovered - NORTIA plays a key role in the communication between the female and male cells during fertilization. Surprisingly, examination of the structure of the NORTIA gene revealed that it was very similar to the structure the Mlo gene of barley. In barley, Mlo is responsible for powdery mildew susceptibility, with mlo mutants showing a resistance against many strains of powdery mildew infection. This mutation is the only known permanent resistance against powdery mildew infection and it is widely used in barley breeding. Plants with such inherent resistance are of great importance, as they reduce crop loss due to powdery mildew infection without the use of fungicides. Up until now, little was known about the molecular components that allow the fungus to penetrate the epidermal cells of leafs of other plants.

Pollination and fungal infections are based on similar communication mechanisms

In flowering plants, fertilization occurs after the male pollen tube penetrates the female sexual apparatus, a process controlled by NORTIA and FERONIA. Until the mid 19th century, pollen tubes were considered fungus-like pathogens, before their role in fertilization was discovered. This is because, similar to pollen tubes, pathogenic fungal hyphae penetrate the plant's tissue via tip growth. So the scientists further investigated the connection between the tip growing pollen tubes and tip growing fungus hyphae.

"NORTIA is only expressed in sexual apparatus of the plant. So there is no way for NORTIA to be responsible for powdery mildew susceptibility," Grossniklaus explained. Therefore, the researchers focused on the role of feronia, the second mutant important for pollen tube reception. Contrary to NORTIA, FERONIA is expressed in throughout the plant, including the leaf epidermis. In collaboration Ralph Panstruga's group at the Max Planck Institute for Plant Breeding Research in Cologne, Germany, the scientists could demonstrate that Arabidopsis with the wild-type FERONIA gene was susceptible to powdery mildew infection. Plants with an inactivated feronia gene, however, were resistant against powdery mildew. But the plant pays an enormous price for such resistance: the plant is infertile. Both identification processes - of either tip growing pollen tubes or invading fungal hyphae - seem to use the same or very similar molecules. As Grossniklaus stresses: "This explains why plants could not get rid of the gene causing powdery mildew susceptibility during the course of evolution."

Among researchers working on powdery mildew, these results have caused enormous interest worldwide as the signal pathway of powdery mildew infection is still poorly understood. Facing a constantly growing population, it is important to be able to breed crops beside barley with a permanent resistance against powdery mildew. The close linkage of powdery mildew susceptibility and fertility

show how difficult it will be to achieve this goal.

Provided by University of Zurich