New study on the immune system of plants: It works differently than expected

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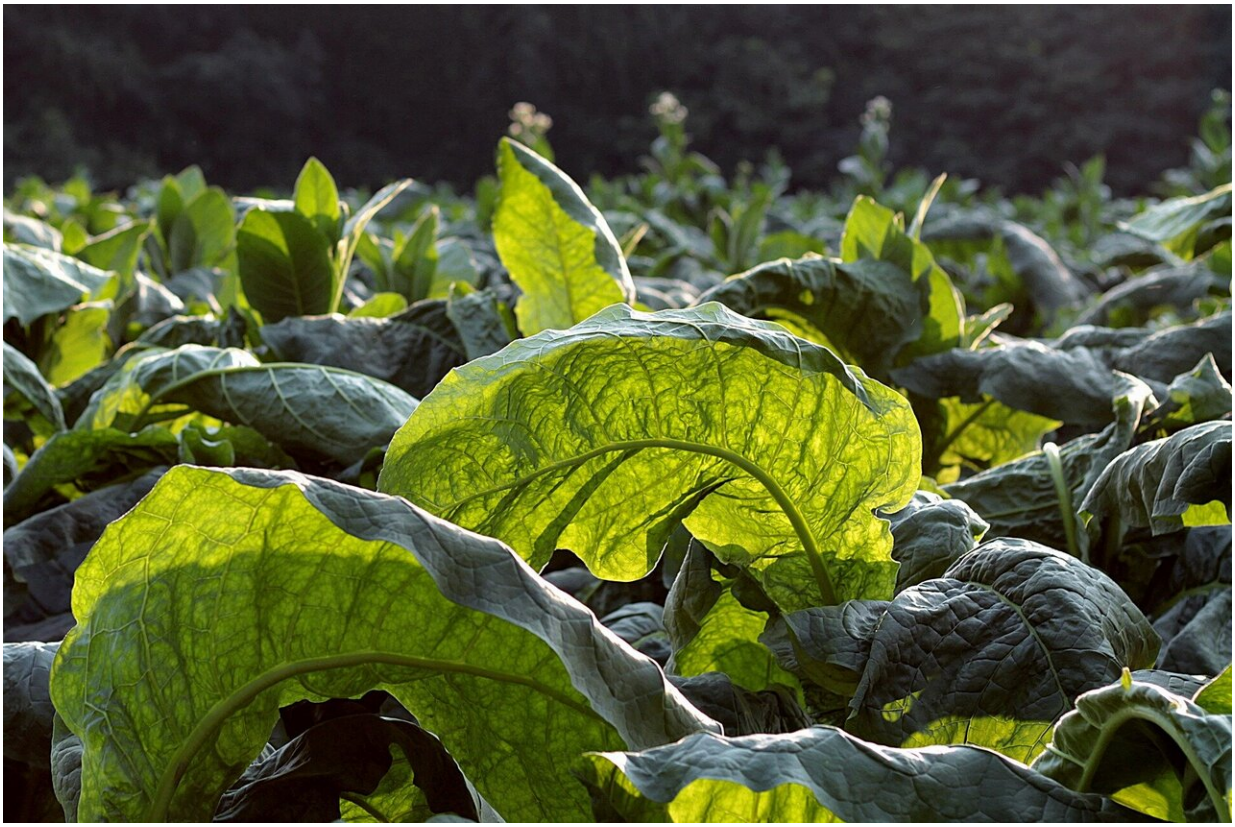

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What happens at the molecular level when plants defend against invading pathogens? Previously it was assumed that the processes were roughly the same in all plants. However, this is not true, as a team of biologists

from Martin Luther University Halle-Wittenberg (MLU) has demonstrated in a new study published in the scientific journal *The Plant Cell*. The researchers investigated defence processes in the wild tobacco plant *N. benthamiana* and found that the processes work quite differently than previously thought. The team also describes in the study how they discovered this complex interaction with the aid of CRISPR/Cas9 genome editing techniques.

When warding off pathogens, plants only have their innate immune systems to fall back on. "A plant's immune system is rather simple. Special receptor proteins on the surface of the plant cells can recognize pathogens and fight them off. This induces a low-level immune response," says Dr. Johannes Stuttmann from the Institute of Biology at MLU. However, some bacteria have found a way to overcome this defence mechanism: They inject so-called effector proteins directly into the plant cell to suppress defence reactions. Over the course of evolution, plants have adapted to this trick and have developed other receptor proteins. These proteins recognise the invaders inside the cell via the effector proteins, and rapidly trigger a strong immune reaction. "Since plants do not have their own immune cells or antibodies, the intracellular receptor proteins play a key role in the plant's immune response," explains Stuttmann.

So far, the fundamental principles of plant immune systems have primarily been studied in thale cress (Arabidopsis thaliana), a relatively simple model organism. Stuttmann's group now wanted to find out whether these findings could also be transferred to the tobacco plant *N. benthamiana*. According to Stuttmann, its genome is considerably more complex and has yet to be completely sequenced. However, the plant has several advantages that make it interesting for further research.

The team investigated a special class of receptors inside the cell called TNL receptors. This class of immune receptors is known to only

function properly in conjunction with a specific protein complex. In order to see whether the same genes are responsible for the immune systems of the two plant species, the researchers first knocked-out several candidate genes in tobacco using genome editing techniques and then swapped genes between the two species. They then tested whether the plants still reacted to pests. "An unexpected complexity was discovered: While a TNL receptor in the tobacco plant also worked in thale cress, this did not apply to the genes of the protein complex. In fact, tobacco plants require a different protein complex than thale cress for a TNL-receptor-induced immune response. The signalling pathways for immune reactions in different plants appear to vary," says Stuttmann. This is surprising because it was previously assumed that these processes were largely identical in plants, since the proteins involved have changed relatively little in the course of plant evolution.

"The widespread notion that findings from Arabidopsis thaliana can easily be transferred to other species often proves false," concludes Stuttmann. At the same time, the new study serves to establish *N. benthamiana* as a model organism for these and other questions.

More information: Johannes Gantner et al, An EDS1-SAG101 Complex is Essential for TNL-mediated Immunity in Nicotiana benthamiana, *The Plant Cell* (2019). DOI: 10.1105/tpc.19.00099

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