Plant Protection: Finally, a general defense system against Xanthomonas, Botrytis & Co.

Technology Description

Xanthomonads, which also include *Xylella* species, are Gram-negative bacteria that cause economically devastating diseases in many agronomically important crops like tomato, bean, cotton, cabbage, citrus, prunus, olive and cereals. Here we present the means for creating plants with an enhanced defense system against Xanthomonads.

In the model plant Arabidopsis thaliana we identified the immunoreceptor ReMAX (Receptor of emax/RLP1) that serves as a sensor for *Xanthomonas* in the membrane of plant cells. Activation of this receptor by the elicitor protein emax derived from Xanthomonads triggers a general immune reaction against *Xanthomonas* and other plant pathogens. Introducing this receptor-system into susceptible plants has a big potential for making them resistant against *Xanthomonas* and other infections. 1, 2

We offer IP that protects the use of this receptor-system, its elicitor emax and tools for their biotechnological fine tuning in different genetical backgrounds.

Innovation

Up to now: Protection of crops against infection with *Xanthomonas* sp., *Xylella* or *Botrytis*, primarily via eradication of infested plantations, quarantine measures, crop rotation and, sometimes via pesticides.

Now: Protection of susceptible plants possible via crop breeding - biotechnological de novo installment or enhancement of their native receptor-based defense system ReMAX.

Market Potential / IP Status

*Xanthomonas* and *Xylella* species have been ranked within the top 10 bacterial plant pathogens. Yield loss due to *Xanthomonas* in rice cultivation can amount up to 50%. 3


We are searching for a licensing partner with strong expertise in biotechnological plant breeding.

Applications

- Breeding of crops with enhanced protection against *Xanthomonas* & Co. by transferring the ReMAX-system from *A. thaliana*. Please refer to Figure 2.

- Development of emax as fortification means for crop plantations – foliar sprays will exert an immunization against several pests. Please refer to Figure 3.
**EXPERIMENTAL DATA**

**Chimeric Receptors to transfer Resistance**

ReMAX/RLP1 belongs to the so called Pattern-recognition receptors (PRRs) that enable plants to sense the presence of specific Pathogen-associated molecular patterns (PAMPs). PRRs fall in two subclasses, the so called receptor-like kinases (RLKs) and the receptor-like proteins (RLPs). Both types of receptors have extracellular domains for the specific recognition of their respective PAMPs. RLKs comprise an intracellular kinase domain but RLPs lack such a domain and depend on the interaction with an adaptor-kinase called SOBIR1 for activation of intracellular signaling. In practice, the intricate interplay between RLPs and SOBIR1 requires fine tuning. Use of such receptors in different genetic backgrounds may need biotechnological adaptation like the construction of chimeric forms of the receptors. EKUT offers a portfolio of different strategies for constructing such functional receptors.

As an example: ReMAX proves non-functional after heterologous expression in the solanaceous species *Nicotiana benthamiana* (Fig. 2 bottom, “ReMAX”). To overcome this problem we fused the extracellular sensor-domain of ReMAX (comprising the leucine-rich repeat LRR1-32), to the intramembraneous and cytoplasmic domains of the RLP termed Eix2 from tomato that detects the fungal PAMP xylanase (Fig. 2, top). With such a chimeric receptor we gained receptor functionality of ReMAX in *Nicotiana benthamiana* (Fig. 2, bottom, “ReMAX\text{chim}”).

An alternative and more general approach consists in shuffling of the kinase domain of SOBIR1 with any given RLP. This opens the door for a universal application of RLPs in a broad range of crop plants with genetically divergent backgrounds (please refer to EKUT-0395).

**Fig. 2**: Interfamily transfer of emax perception by hybrid receptor constructs. *Nicotiana benthamiana* leaves do not respond to emax, even when transformed with ReMAX. However, these plants gain responsiveness to emax when transformed with a chimeric receptor comprising the ReMAX sensor-domain and the C-terminal part of the RLP EIX2.

**Fig. 3**: Leaves of *A. thaliana* pretreated with the elicitor emax are also more resistant against infection by the fungal pathogen *Botrytis cinerea*. Plants were pretreated for 12 h with buffer solution (control) or with the elicitor emax and inoculated with *Botrytis*. Photographs were taken 4 days post infection. Thus, emax confers resistance against a broader spectrum of plant pathogens.

**REFERENCES**

1. Jehle AK et al., 2013a. Perception of the novel MAMP eMax from different Xanthomonas species requires the Arabidopsis receptor-like protein ReMAX and the receptor kinase SOBIR1. Plant Signaling & Behavior 8, e27408
2. Jehle AK et al., 2013b. The receptor-like protein ReMAX of Arabidopsis detects the microbe-associated molecular pattern eMax from Xanthomonas. The Plant Cell 25, 2330–40

**Broad Spectrum of Resistance by a Foliar Spray of Elicitor Protein**

![Foliar spray of elicitor protein](image-url)