NAIST® Research Highlights

Nara Institute of Science and Technology | **Plant Immunity Laboratory** www.naist.jp/en

Plant disease

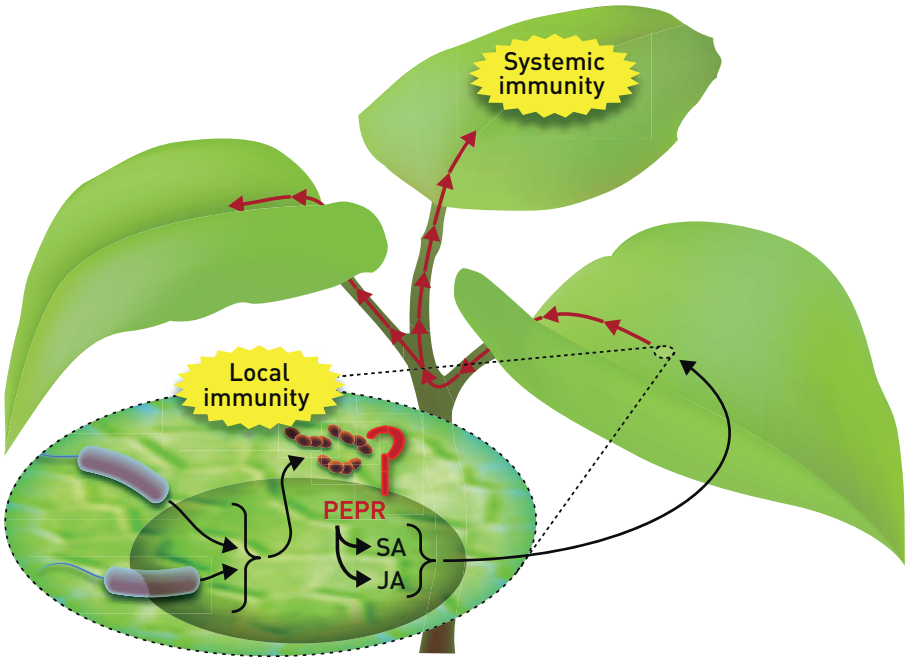
Understanding plant immunity, both near and far

A signaling pathway, linking local and systemic immunity in plants, could be used to create disease-resistant crops

Plants employ a two-fold defense against disease: local immunity immediately surrounding a pathogen, and systemic immunity further away. However, the molecular pathways linking pathogen recognition with immunity are poorly understood. NAIST researchers are investigating a cellular component central to both local and systemic immunity, providing a potential target for developing disease-resistant crops[1].

Plant immunity develops through detection of both pathogen molecules and endogenous danger signals. The latter include small protein fragments called PROPEPs, which bind to receptors (PEPRs) on the cell surface. The NAIST team, led by Yusuke Saijo, formerly of the Max Planck Institute for Plant Breeding Research, Cologne, Germany, is investigating how PEPRs coordinate local and systemic immunity.

"The components of the *Arabidopsis* PEPR pathway are evolutionarily conserved in higher land plants including important crops."



The NAIST team's proposed model for the role of PEPRs in plant immunity. Pathogen attack causes the release of Pep peptides which are received by PEPRs. This activates hormonal salicylic (SA) and jasmonic acid (JA) pathways, resulting in both local and systemic immunity to the pathogen.

Using mutant *Arabidopsis* – small flowering plants related to cabbage and mustard – Saijo's team determined that PEPRs contribute to local immunity, through perception of PROPEPs. They then tested systemic immunity by inoculating PEPR-defective mutants with a pathogen and looking for defense-response markers in uninfected parts of the plant. The mutants had reduced numbers of markers, indicating that PEPR has a critical role in systemic immunity, which is in turn vital to plant survival. As Saijo explains, "In contrast to animals, plants don't have specialized mobile immune cells." Systemic immunity enables pathogens to be resisted, "not only in the infected cell, but also in its neighbours and distant organs. Our work indicates that local action of the PEPR pathway strengthens an as-yet-unidentified systemic signal from the pathogen-challenged site, enhancing systemic immunity in distant, unchallenged tissues."

The team also catalogued the genes switched on by PEPRs. They found that PEPRs co-activate two branches of the plant immune system, mediated by the hormones salicylic and jasmonic acid. However the detailed mechanisms underlying systemic immunity remain to be elucidated, and the lab — which prides itself on its intellectual flexibility and international outlook — continues to investigate the molecular-genetic and biochemical pathways involved.

These results suggest that PEPRs provide a critical control center in plant defense, connecting internal and external triggers, co-activating salicylic and jasmonic acid pathways that would typically antagonize each other, and linking immediate local defense with long-distance systemic immunity (see figure). According to Saijo, "The components of the *Arabidopsis* PEPR pathway are evolutionarily conserved in higher land plants including important crops."

He continues: "The systemic immune system can enhance plant disease resistance against a broad spectrum of pathogens in a sustainable and cost-efficient manner. Thus, our work shows the potential of endogenous signals, such as PROPEPs, and PEPRs, as tools to increase disease resistance in crops."

Reference

1. Ross, A., Yamada, K., Hiruma, K., Yamashita-Yamada, M., Lu, X. *et al*. The Arabidopsis PEPR pathway couples local and systemic plant immunity. *The EMBO Journal* **33**, 62–75 (2014).

More information about the group's research can be found at the Plant Immunity Laboratory webpage:
http://bsw3.naist.jp/eng/courses/courses111.html