Scientists discover how plants fight major root disease

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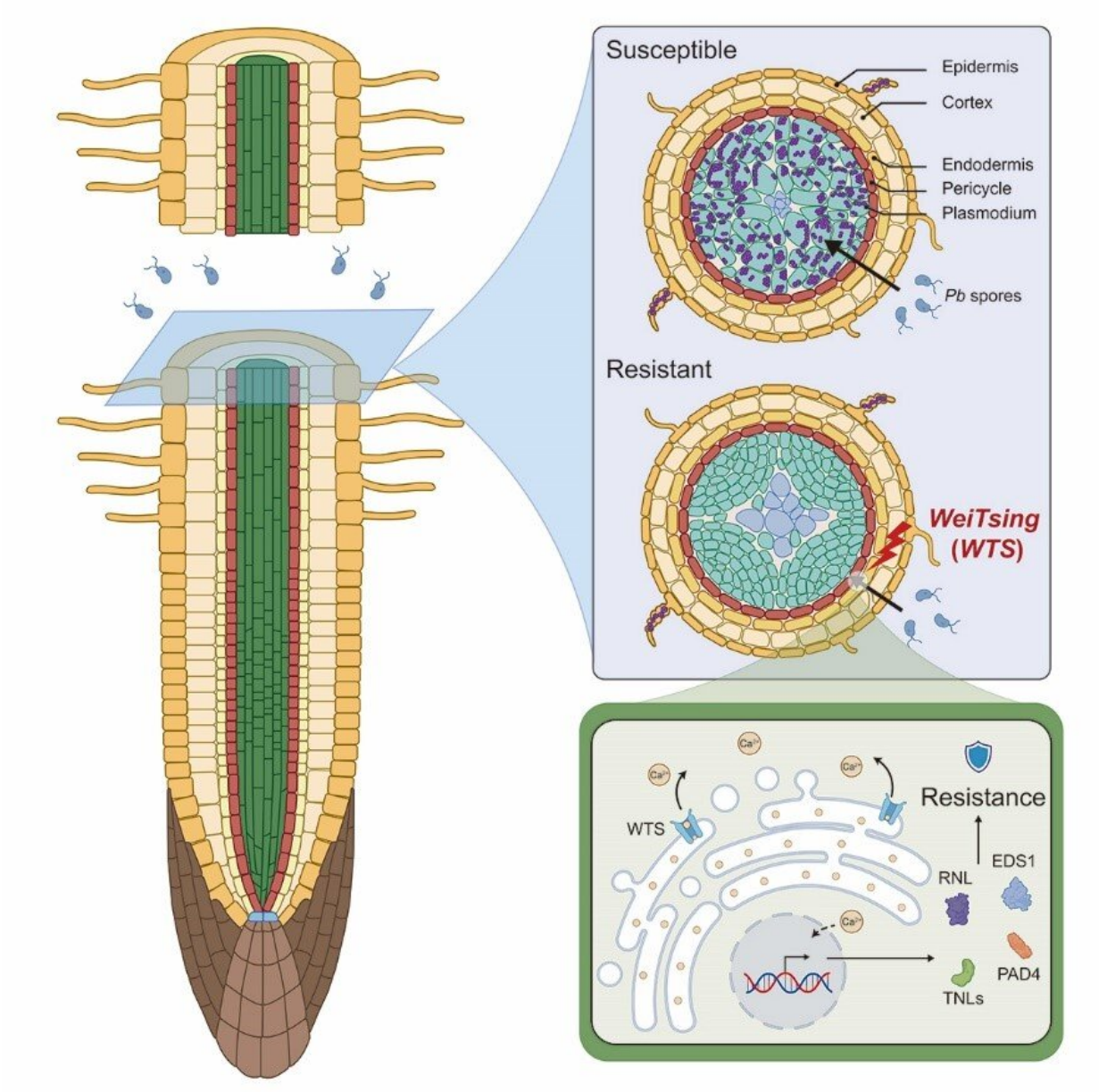

WTS encodes an ER-localized Ca^{2+} release channel, triggering immune response to protect stele from P. brassicae invasion. Credit: Cheng Hangyuan

Researchers led by Chen Yuhang and Zhou Jianmin from the Institute of Genetics and Developmental Biology of the Chinese Academy of Sciences have shown how plants resist clubroot, a major root disease that threatens the productivity of Brassica crops such as rapeseed.

The study, which uncovers novel mechanisms underlying plant immunity and promises a new avenue for crop breeding, was published in *Cell*.

Clubroot, a soil-borne disease, is the most devastating disease of Brassica crops. In China, approximately 3.2–4 million hm^2 of agricultural land is affected by clubroot each year, resulting in a 20%–30% yield loss. Resting spores of Plasmodiophora brassicae (Pb), the causal pathogen of clubroot, are viable in soil for up to 20 years, making contaminated soil unsuitable for Brassica crops.

To date, only two clubroot resistance genes have been cloned, and their resistance has broken down as a result of newly evolved virulent Pb isolates.

In this study, the newly identified resistance gene WTS confers resistance to all Pb isolates tested, including isolates that are virulent toward existing resistant rapeseed varieties. Thus, WTS is a broad-spectrum resistance gene and offers great potential for breeding clubroot disease resistance in crops.

WTS is not expressed in the absence of the pathogen. However, upon Pb infection, WTS is strongly induced exclusively in the pericycle, a critical layer of root cells surrounding the stele. The stele is the cylindrical

central vascular portion of root containing critical tissues, including xylem and phloem that are essential for nutrient and water transport.

In susceptible plants, Pb invades and colonizes the stele, blocking nutrient and water transport. Expression of WTS in the pericycle activates plant defenses and prevents Pb from colonizing the stele. WTS thus defines a defense mechanism that is specifically activated at the right place and right time to ensure normal plant growth and development.

In addition, WTS encodes a novel protein. Structural analysis by cryo-EM has revealed that WTS self-assembles into a previously unknown pentameric architecture with a central pore.

Further studies have also shown that the WTS protein complex functions as an endoplasmic reticulum-localized calcium release channel that increases cytosolic calcium ions, a critical secondary signal for the activation of plant defenses.

The intriguing disease resistance mechanisms uncovered by the researchers represent a new paradigm in plant immunity against soil-borne pathogens. The cloned WTS gene offers new hope for breeding Brassica crops resistant to a devastating disease that is otherwise difficult to control.

More information: Jian-Min Zhou, WeiTsing, a pericycle-expressed ion channel, safeguards the stele to confer clubroot resistance, *Cell* (2023). DOI: 10.1016/j.cell.2023.05.023. www.cell.com/cell/fulltext/S0092-8674(23)00542-1

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