Securing our future food production through better understanding of disease resistance genes in crops

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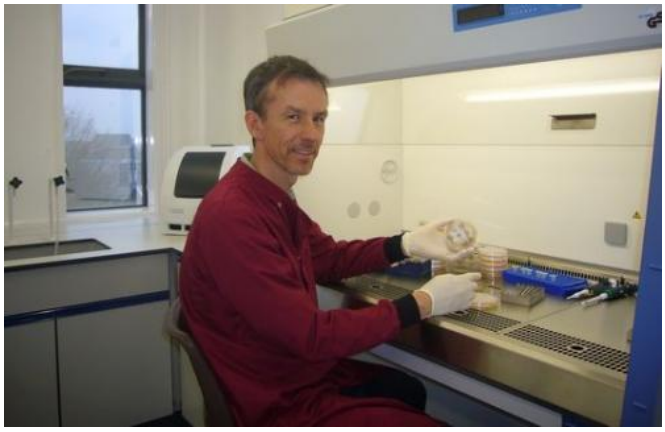

A new understanding as to how plants defend themselves against some pathogens that cause crop diseases is proposed by researchers from the University of Hertfordshire to help scientists breed new, more successful disease-resistant agricultural crops. The new concept is called effector-triggered defence or ETD.

Breeding agricultural crops for resistance against disease pathogens is essential in the quest to secure global food production. However, despite efforts to control them, crop diseases still account for fifteen percent of the losses in the world's food production. Farmers spray their crops with fungicides to control these plant diseases, but their effectiveness is limited as disease pathogens mutate to become insensitive to the fungicides.

New molecular and genetic insights

By exploiting new molecular and genetic insights, the research, done in collaboration with Pierre de Wit from Wageningen Agricultural University in the Netherlands, provides a better understanding of the defence system of crop plants against the damaging pathogens that grow in the spaces between plant cells. This provides new opportunities to improve the effectiveness of breeding crops for resistance against disease.

Dr Henrik Stotz, Marie Curie Fellow and lead researcher from the School of Life and Medical Sciences at the University of Hertfordshire, said: "As traditional methods of controlling crop disease become less effective, the need to breed new strains of crops with an inbuilt resistance to the disease pathogens increases.

"In the same way that humans have developed immune responses against human disease pathogens, crops can be bred for resistance against disease pathogens, but we need to improve our understanding of effective resistance mechanisms within plants. Our research enhances the traditional understanding of the plant defence system and describes a new concept describing how plants protect themselves against the pathogens that grow in the space outside plant cells (the apoplast) – a new concept called effector-triggered defence or ETD."

Plant defence systems

Plant defence systems consist of interconnected tiers of receptors, which are found both outside and inside the plant cells. Both sets of receptors sense the invasive pathogen and respond to its intrusion. The two receptor systems have different classes of plant receptor proteins to detect different types of pathogen molecules.

The current understanding of plant defence is that plants, using these receptors, have two forms of defence. Pattern-triggered immunity (PTI) is the

first line of defence, operating soon after the pathogen has landed on the plant surface. Before the pathogen has entered the plant, its presence of specific pathogen molecules or patterns is recognised by the host plant's immune systems. This then activates immune responses to stop the pathogen and so protect the plant from infection.

The second line of defence is referred to as effector-triggered immunity (ETI), this is based on the detection of disease pathogens by the plant's genes – there is a relationship between the gene in the host plant and the gene in the pathogen. The concept of ETI was developed to describe defence against pathogens that enter into plant cells (e.g. wheat rusts and mildews, potato late blight pathogens) and fits their defence mechanisms well. The presence of the pathogen in the cell activates specific proteins that cause death of both the plant cell and the invading pathogen.

Dr Stotz continued: "This concept of plant ETI does not really explain the second line of defence in the interaction of plant hosts protecting themselves against extracellular fungal pathogens – i.e. those foliar fungal pathogens that get into the leaf of the plant to exploit the space between its cells, known as the apoplast, to retrieve nutrients from the plant. These include the damaging pathogens that cause septoria leaf blotch on wheat, barley leaf blotch, apple scab and light leaf spot on oilseed rape. The ETI concept does not hold for defence against those pathogens that go into the leaf but not into the cells.

"Through our research we discovered that defence against extracellular pathogens (ETD) involves different plant genes from those involved in the defence against intracellular pathogens. We identified some specific resistance genes that code for receptor-like proteis (RLPs) and described how they operated against the pathogens. We feel immunity is too strong a term for this new defence mechanism because these extracellular pathogens can survive and even sexually reproduce on resistant hosts, and so we refer to it as 'defence'."

New concept of plant defence

Professor Bruce Fitt, professor of plant pathology at the University of Hertfordshire, added: "This new understanding of plant defence through ETD suggests different operations of specific resistance genes which will help us to be more successful in breeding new strains of crops for resistance. This is essential in the battle for global food security to protect the world's future food sources."

The paper "Effector-triggered defence against apoplastic fungal pathogens" is published online at *Trends in Plant Science*.

More information: "Effector-triggered defence against apoplastic fungal pathogens." Henrik U. Stotz, Georgia K. Mitrousia, Pierre J.G.M. de Wit, Bruce D.L. Fitt. *Trends in Plant Science*, Published Online: May 21, 2014. DOI: dx.doi.org/10.1016/j.tplants.2014.04.009

Provided by University of Hertfordshire

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