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An Overview of Defense Mechanism against Plant Pathogens

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SUMMARY

Plants are affected mainly by pathogens like fungi, bacteria, viruses and nematodes. When pathogens attack host plant, every single plant cell is able to protect itself and neighbors immune system of plant become active against infection. Various structural and bio-chemical defenses are produced against pathogen to avoid infection. Structural defense, form different physical barriers to inhibit pathogen entry and their spread in plant system. Bio-chemical defense occurs in plant cell and tissue and produce different toxic substances which are also toxic to pathogen and inhibit the growth of pathogen. In this article we studied Plant immune system function and their benefits in agriculture and disease resistance crops.

INTRODUCTION

Farmers who have plantation as well who grow field crops know about plants diseases and its spread. Plants infected by many harmful microbes, pests and by other parasitic plants. Plants are not idle in the face of their biotic foes. Plants have immune system to fight the invading pathogens and pests. With the help of different combinations of preexisting or induced toxic chemical substances or defense structures, most plants manage to defend themselves partially or nearly completely. Plant immune receptors had acquired different mechanisms for detecting pathogenic infections. In some cases, the receptor protein directly binds a pathogen molecule as well in some receptor detects the cellular perturbations caused by the pathogen, thus resulting in hypersensitive response. Nearly all plant cells have the cellular 'suicide' machinery to restrict the spread of pathogens from the infection site to the neighbouring cells. In this way, plant cells try to resist pathogen and parasites which cause infection in plants.

Plant Immune Receptors

Immune system of plant is composed by two classes of receptors, pattern recognition receptors (PRRs) and intercellular nucleotide- binding and Leucine-rice repeat receptors NLRs (Dangl *et al.*, 2013). PRR activation induces immune responses known as PAMP-triggered immunity (PTI) including expression of immune-related genes to ward off microbes (Macho and Zipfel, 2014). N LRs coordinate a rapid and robust immune signaling response termed effector-triggered immunity, which often leads to hypersensitive response (HR, local cell death at the infection site) and limitation of pathogenic microbes (Jones *et al.*, 2016).

How do Plant Immune Receptors Activate Immunity?

Pathogen/microbe-associated molecular patterns (PAMPs/MAMPs) are recognized by host cell surface localized pattern-recognition receptors (PRRs) to activate plant immunity. PAMP-triggered immunity (PTI) constitutes first layer of plant immunity that restricts pathogen proliferation. Proteins targeted by pathogen effectors have evolved to sense the effector activity by associating with cytoplasmic immune receptors known as resistance proteins. This allows plants to activate a second layer of immunity termed effector-triggered immunity (ETI). Effector-triggered immunity (ETI) is highly specific and often accompanies hypersensitive response (HR) (Zhang and Zhou. 2010).

How did Plant Immune Receptors Evolve?

Innate immunity provides genetic toolkits for plant early fight against pathogen (Gao *et al.*, 2018). Indeed, both RLK and NLR proteins underwent dramatic expansion during the colonization of land by plants (Bowman *et al.*, 2017; Gao *et al.*, 2018). Recognition of pathogen effectors results in effector- triggered immunity (ETI). R genes encode most plant intracellular nucleotide binding- site leucine- rich repeat (NLR, also known as NBS- LRR) proteins. ETI usually induces programmed cell death at the infection site, known as the hypersensitive response (HR), and thus locally limits pathogen spread (Jones & Dangl, 2006). The perception of these signals in uninfected tissues induces the accumulation of SA and mediates massive transcriptional programming (Fu & Dong, 2013). This induced immune mechanism is termed as systemic acquired resistance (SAR). Ultimately, it leads to the production of pathogenesis- related (PR) proteins with antimicrobial activity, which protects plants from subsequent pathogen attacks (Fu & Dong, 2013).

How Can Basic Understanding of Plant Immunity Benefit Agriculture

Rapidly increasing with the world population, food is lost by disease in standing crops or in a storehouse. Knowing Immune receptors function and evolve sets the stage for their optimal use and deployment in agriculture. Few approaches focus on improving the utilization of natural disease resistance occurring in the germplasm of wild crop relatives, whereas others aim at designing synthetic disease resistance genes with beneficial features. This can be done through introduction of mutations that expand pathogen effector binding or generate sensitized 'trigger- happy' receptors with lower thresholds of sensor activation. Another strategy for engineering synthetic immune receptors is through domain engineering, either by manipulating naturally integrated domains or by introducing totally novel domains to recapitulate evolution. Although these approaches are still generally at the experimental stage, they promise to bring forward radically novel approaches to breeding disease resistance in crop plants.

CONCLUSION

Innate immune system of plant is responded to pathogen by PTI (pathogen-associated molecular pattern- or PAMP-triggered immunity) and ETI (effector-triggered immunity When pathogen attack plant start respond PTI is activated and PAMPs, triggered immunity, conserved motifs derived from pathogens, by surface membrane anchored pattern recognition receptors (PRRs). Pathogens inhibit PTI and activate effector-triggered susceptibility (ETS) in plant cell. Resistant genotypes, the intracellularly translated viral effectors are recognized by R proteins, triggering immune responses that often are associated with hallmarks of ETI, such as HR, SA accumulation, ROS production and SAR. Exploitation of natural plant defense mechanisms provides novel methods for achieving better disease management. Enhanced production of PRRs and integration of R proteins in plants via engineering can boost microbe recognition ability of plants. Multiple disease resistant plant varieties can be generated by joining the integrated proteins from various NLRs, which recognize different effectors, into a single NLR. These immune responses include induction of defense related metabolites in plants, which suppress plant pathogen.

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