

How plant Immune System Works?

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Abstract

Plant diseases have major effects on agricultural production and the food supply. Currently, worldwide crop losses due to disease are estimated to exceed hundreds billion dollars. Although application of fungicides and pesticides has helped control plant diseases, chemical control is economically costly as well as environmentally undesirable. Therefore, the development of new strategies based on a plant's own defense mechanisms for disease control is critical for sustaining agricultural production and improving our environment and health. From this point of view this review how plant immune system work against pathogen?

Keywords: Defense genes; Elicitors; Induced defense; Reactive oxygen species; Signal Transduction

Introduction

Phyto-pathogenesis is a global problem, posing a serious threat to food security. One of the major challenges for a very rapidly growing world population is the need to meet up the demand for adequate food supply. This requires ecologically sound, compatible strategies in agriculture for sustainable crop production. However emerging and re-emerging plant diseases continuously challenge this ability; consequently, the control of plant diseases continues to be an uphill task [1]. Plant diseases have major effects on agricultural production and the food supply. Currently, worldwide crop losses due to disease are estimated to exceed hundreds billion dollars. Although application of fungicides and pesticides has helped control plant diseases, chemical control is economically costly as well as environmentally undesirable. Therefore, the development of new strategies based on a plant's own defense mechanisms for disease control is critical for sustaining agricultural production and improving our environment and health. From this point of view this review how plant immune system work against pathogen?

How plants identify different parasites

For plants to effectively control invading pathogens, they must recognize such pathogens as foreign non-host components. Thus, they have evolved very effective signaling mechanisms that help them in microbial pathogens detection. Pathogen recognition is often detected after the perception of intruding microbes or their products by microbe or pathogen associated molecular patterns (MAMPs or PAMPs). These are certain class of plasma membrane bound extracellular receptors. These can recognize microbial elicitors. In the presence of MAMPs, PRPs are activated leading to production of active defense responses against these pathogens. This ensures that the would-be pathogens are stopped before they could cause any serious infection in the plant [2].

Signal transmission in the plant immune response

Pathogens are recognized by perception of elicitors through the receptors that are either located on the plasma membrane or in the cytosol. A signal transduction chain is initiated after binding of the elicitor ligand to its receptor. In turn these signal messenger molecules activate the transcription factors regulating plant defense gene expression [3].

Defense signaling regulatory compounds

These are the molecules sharing in transduction the effect of the elicitors to the whole plant cellular system. These are such as:

Calcium and ion channels: The earliest reactions of plant cells to elicitors lead to changes in plasma membrane permeability leading to influx of calcium and proton, and efflux of potassium and chloride. These ion fluxes are necessary for the oxidative burst induction, defense gene activation and phytoalexin production. Plasma membrane-located ion channel open as a result of binding the elicitor to its receptor which stimulate elevated cytosolic calcium levels, as well as activate additional ion channels and pumps that cause the other ion fluxes observed [4].

Protein kinases: Many evidences and *in vivo* phosphorylation data suggest that phosphorylation cascades are involved in defense signaling at many different levels. protein kinases activate downstream signaling elements through phosphorylation [2].

Reactive oxygen species: Elicitor-mediated calcium influx, as well as transient elevation of cytosolic calcium levels which stimulate the accumulation of reactive oxygen species (ROS), such as superoxide, hydrogen peroxide and hydroxyl free radical. ROS is a central component of the plants defense machinery. ROS act as direct toxic substances to pathogens, catalyze the defense physical barriers and are involved in signaling the defense reactions, such as phytoalexin synthesis and defense gene activation, programmed cell death [4].

Ethylene: The simplest hormone in plants is the gaseous ethylene. It is involved in various developmental processes, such as plant growth and fruit ripening. Besides these processes, it is also involved in environmental stress signaling upon wounding or pathogen attack [5].

Transcription factors regulating plant defense gene expression

Transcription factors are defined as transcriptional regulators that function by binding to specific cis-regulatory elements present in the promoters of target genes [6].

Plant Response to Pathogens

Plant responses to the presence of pathogens involve biochemical, cellular level defenses and defenses at tissue level. The ability of plant to mount an active defense response is under genomic control [7]. These responses include the following:

Induced histological defense

After the establishment of infection in plant cells, the host defense system tries to create barriers to prevent the pathogen to colonize of other tissues. This may be at various levels such as: Lignifications, Suberization, Abscission layers, Tyloses [8-11].

Induced cellular defense

There are different types of cellular defense structures such as changes in cell walls which play a limited role in defense. Such observable changes in cell wall structures include; synthesis

of secondary wall and papillae formation, callose deposition, structural proteins, induced cytoplasmic defense that present last line of host defense which may be effective against slow growing pathogens, weak parasites or some symbiotic relationship [12].

Induced biochemical changes

The induced biochemical changes in host plants are the last line of host defense. This limit either the plant is susceptible or resistant to the pathogen. The role of biochemical factors in host defense is based on four main attributes which include:

- A. Association of the substance protection against disease at the site where protection occurs.
- B. Isolation of the substance from the host showing protection against the disease.
- C. Conferment of protection by the isolated substance when introduction into to the appropriate susceptible host.

Similarity of the nature of protection induced to the natural agents of a resistant plant [11].

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