Biotic stress in plants

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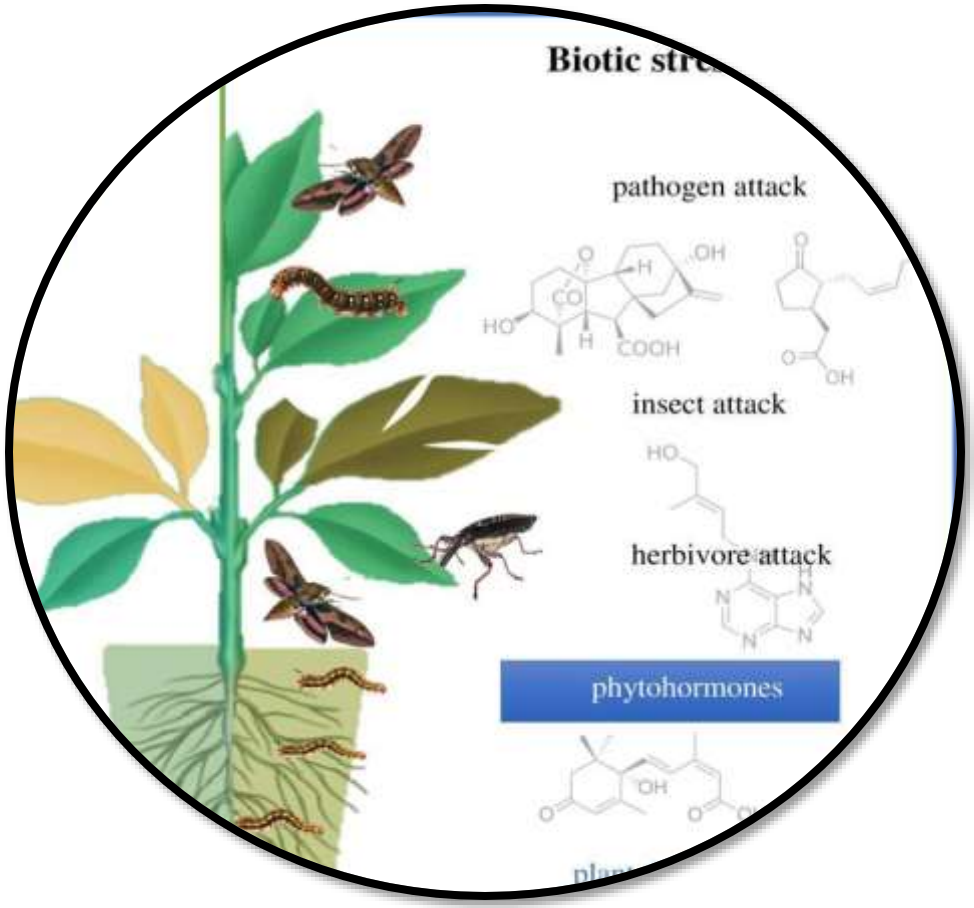
Biotic stresses

- Biotic stress is the damage occur to plant by other living organisms such as insect attack, pathogen attack, herbivores attack etc

Biotic stress in plants

- Weeds
- Insects
- Fungi
- Bacteria
- Virus
- Herbivores
- Other plants



Pathogen attack strategies

Necrotrophy, in which the plant cells are killed

Biotrophy, in which the plant cells remain alive

Hemibiotrophy, in which the pathogen initially keeps cells alive but kills them at later stages of infection

What are the plant defense mechanisms against biotic stress?

Induced structural defense

- Cell wall defense structure
- Formation of cork layer
- Formation of abscission layer
- Deposition of gums

INDUCED STRUCTURAL DEFENSE

❑ Cytoplasmic Defense Reaction

➢Some of the defense structures formed involve the cytoplasm of the cell under attack, and the process is called cytoplasmic defense reaction.

Cell Wall Defense Structure

➢It involve morphological changes in the cell wall or change derived from the cell wall of the cell being invaded by the pathogen.

➢Three main types of such structures have been observed in plant diseases.

➢The outer layer of the cell wall of parenchyma cells coming in contact with incompatible bacteria swells and produced an amorphous, fibrillar material that surrounds and traps the bacteria and prevents them from multiplying.

➢Cell walls thicken in response to several pathogens by producing what appears to be a cellulosic material.

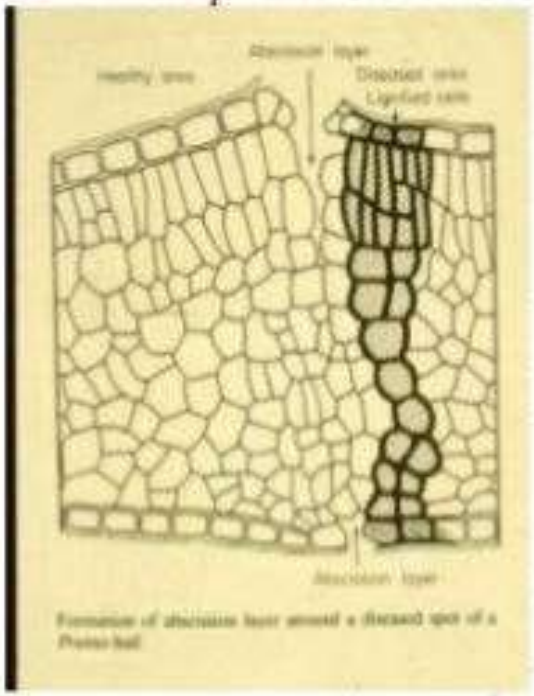
➢Callose papillae are deposited on the inner side of cell walls in response to invasion by fungal pathogen.

➢ Formation Of Cork And Abscission Layer

The formation of cork or abscission layers can limit the size of lesions, and consequently the extent of damage that can be caused by a single infection.

e.g. Cork layer *Rhizoctonia solani* canker in potato

Abscission layer *Xanthomonas pruni* shot hole



Provide protection by -

Inhibiting the further spread of pathogen

➢ Block the spread of toxic substances of the pathogen

➢ stop the flow of nutrients to infection point

DEPOSITION OF GUM

- Various types of gums are produced by many plants around lesions after infection by pathogen or injury.
- Gums secretion is most common in stone fruit trees but occurs in most plants.
- Generally these gums are exudated by plant due to the stressed condition.
- The production gum by these trees by the process called as gummosis.

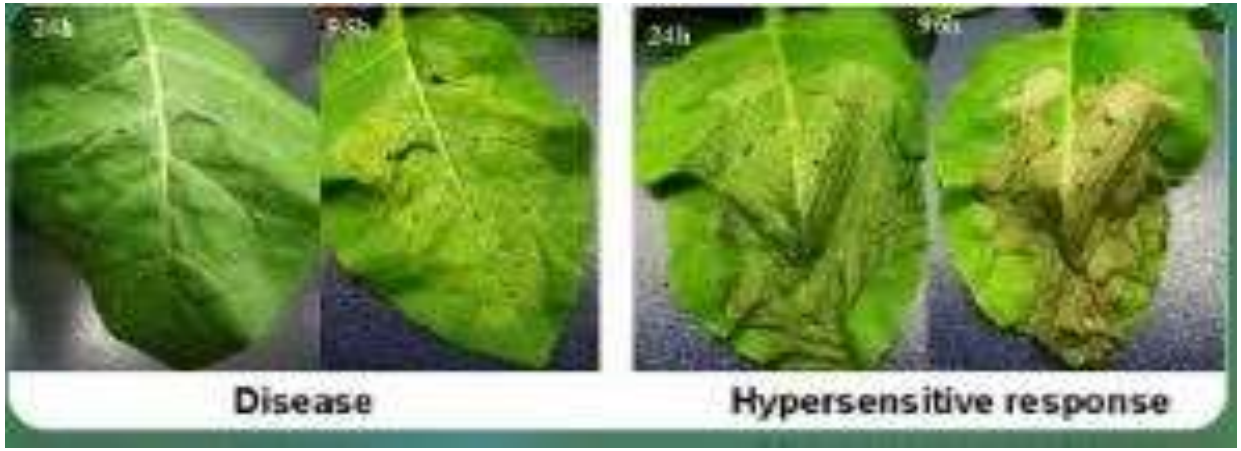
Induced chemical defense

- Hypersensitive response (HR)
- Pathogenesis – related protein (PR Protein)
- Phytoalexins
- Systemic acquired Resistance

Induced chemical defense

Hypersensitive response (HR)

- The hypersensitive response is localized death of host cells at site of infection
- It is the result of a specific recognition of a pathogen attack by the host
- The HR is considered to be a type of programmed cell death



Hypersensitive response (HR)

The hypersensitive response is the plant defense response initiated by:

- The recognition by the plant of specific pathgen-produced signal molecules known as elicitors.
- Recognition of the elicitors by the host plant activates a cascade of biochemical reactions in the attacked and surrounding plant cells, leads to new or altered cell functions and to new or greatly activated defense - related compounds.

The most common new cell functions include:

- A rapid burst of reactive oxygen species, leading to a dramatic increase of oxidative reaction.
- Increased ion movement, especially of K+ and H+ through the cell membrane.

Production of Pathogenesis – Related Proteins (PR- Proteins)

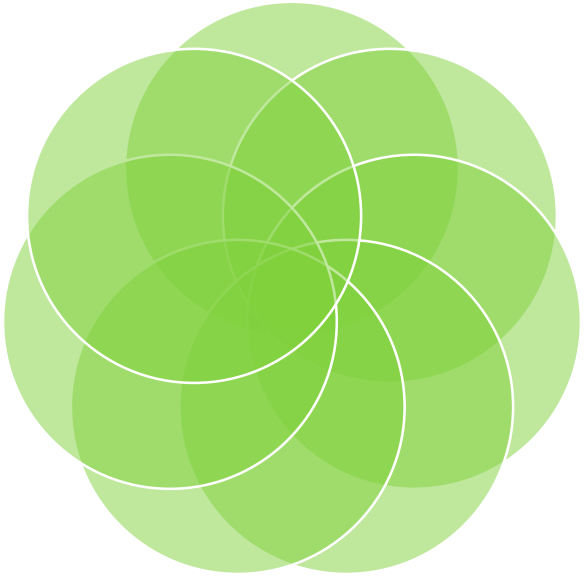
- Pathogenesis related proteins, called PR-proteins- A group of plant coded proteins
- Are structurally diverse group toxic to invading pathogens.
- Produced under stress
- They are widely distributed in plants in trace amounts but are produced in high concentration following pathogen attack or stress.

Groups of PR-proteins

The better known PR protein are:

thaumatinelike proteins

PR-1 proteins



PR 4 proteins

B-1,3-glucanases

lysozymes

chitinases

Phytoalexins

- Concept given by Borger and Muller.
- Defined as antibiotics produced in plant.
- Paxaton (1981) defined phytoalexins are low molecular weight antimicrobial compounds which are synthesized by and accumulates in plant cells after microbial infection
- Involves the role of elicitors in their production.

Systemic Acquired Resistance (SAR)

- SAR is a mechanism of induced defense that confers long-lasting protection against a broad spectrum of microorganisms.
- Enhance resistance against subsequent attack by a wide array of pathogen.
- The vasculature provide the excellent channel for transport of systemic signals.
- SAR takes 24-48 h to start, can last for months

Involves gene activation and a transmitted signal.

- Genes induced:

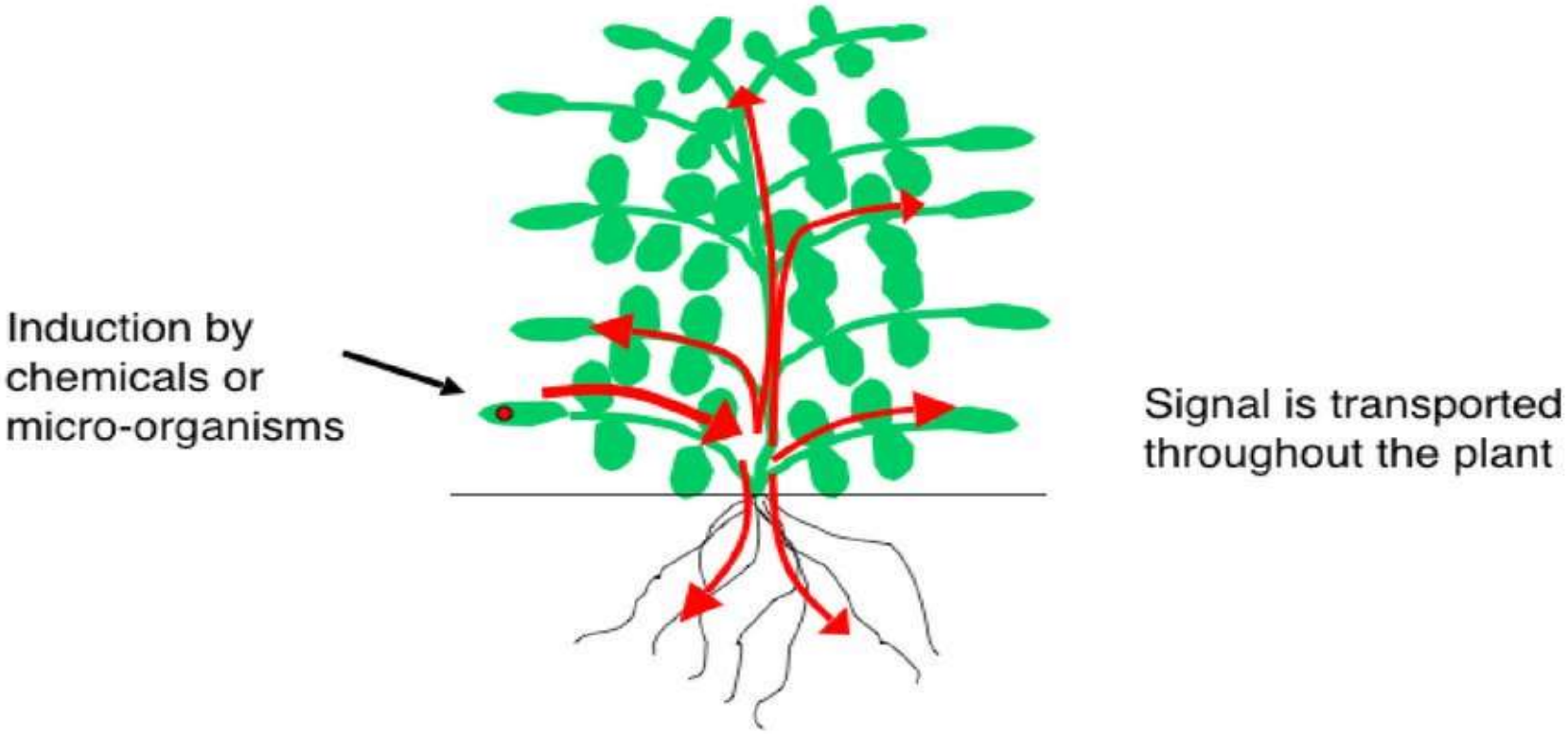
  chitinases

  β 1,3- glucanases

  other PR proteins

Systemic Acquired Resistance

SAR mode of action acts like a vaccine in humans.



Induction of Systemic Acquired Resistance

- Production of H2O2 (plus antioxidants) Hydrogen peroxide has been associated secondary induction of SAR and direct toxic activity to invading pathogens
- Thickening of plant cell wall Production of phenolic (lignin, tannic acid) that strengthen walls and inhibit pathogen enzymes
- Accumulation of pathogenesis related proteins "PR-proteins" chitinases, ß-1,3 Glucanases.
- These enzymes accumulate in vacuole of plant cell. Upon attack, they directly degrade fungal cell walls. Indirectly, their action results in the release of fungal wall components that elicit additional defense reactions

Thank you