Mechanism of infection

Pl. Path. 111  (Cr. Hrs. 3+1)

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Mechanism of infection

- Mechanical forces of the pathogen
- Chemical force
  - Enzymes (rots)
  - Toxins (leaf spots/ blights)
  - Growth regulators (Overgrowth)
Cell wall composition
Plant leaf anatomy
Schematic representation of the structure and composition of the cuticle and cell wall of foliar epidermal cell.
Plant Cell wall Composition

• **Cuticular wax**: consist of primary alcohols, acids. Ketones, esters and paraffin hydrocarbons

• **Cuticle**: (Cutin)
  – A polyester of unbranched derivatives of C16 and C18 hydroxy fatty acids and dicarboxylic acid molecules

• **Pectin** - are polysaccharides that contain 1,4-linked α-D-galacturonic acid units – galactururonan molecules.
Plant Cell wall

- **Cellulose** - a polysaccharide composed of 1,4-linked \(\beta-D\)-glucose residues.
  - Cellulose is a polymer made of repeating glucose molecules attached end to end.
  - A cellulose molecule may be from several hundred to over 10,000 glucose units long. **Occurs in microfibrils in cell wall,**

- **Hemicellulose**
  is branched polysaccharides composed of 1,4-linked \(\beta-D\)-hexosyl residues. The predominant hemicellulose is xyloglucan. glucuronoxylan, arabinoxylan, glucomannan, and galactomannan.

- **Proteins:** Aminoacids
- **Lipids:** oils & fats
- **Starch:** glucose molecules
Enzymes in pathogenesis

- Mostly play role in soft rot diseases caused by fungi & bacteria
- Also produced by nematodes
- Activity also found in viral infections
- Plant pathogenic enzymes generally disintegrate the structural components of host cells, affect protoplast and interfere with the normal functioning
Cuticular wax

• consist of primary alcohols, acids. Ketones, esters and paraffin hydrocarbons

• Found layer or granulation or projections on or from cuticle

• Mostly penetration by mechanical forces of the pathogen (fungi and parasitic plants)

• some pathogen have been found to produce enzymes causing degradation of cuticular wax e.g.
  – Puccinia hordei; Pestalotia malicola
Cell wall degrading Enzymes

- **Cuticular enzymes Cutinases**; are the esterases and break the ester linkage between cutin molecules.

  These degrade cutin, which is an insoluble polyester of C16–18 hydroxy fatty acids and is the main component of the plant surface.

  *(Penicillium, V. inequalis, Erysiphe graminis f.sp. hordei, Streptomyces scabiesies Botrytis cinerea)*
Cutin degradation

- Cutin polymer

\[ \text{cutinase} \]

- Fatty acid derivatives (Monomers & oligomers)- Initially small amount of enzyme is produced, after formation of monomers & oligomers, induces more cutinase production

\[ \text{cutinase} \]

- These enzymes soften the cuticle
- Some of the fatty acid present in wax also induces cutinase production
- Glucose suppresses the expression of the cutinase gene
Pectin degrading Enzymes

- Pectin act as a cementing material between cells
- Enzymes called as pectinases or pectolytic enzymes
- Produced by fungi (*Collteotrichum*), bacteria (*Pseudomonas solanacearum*) and nematodes (*Meloidogyne javanica*)
- Three types of pectinases produced by different pathogen are
  - Pectin esterase (PE) or pectin methyl esterase (PME)
  - Poly galactururonases (PG & PMG)
  - Pectin trans eliminase (PTE)
Pectin

Pectinase

Endo-pectin Lyase

Pectinase

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Pectin esterase (PE) or Pectin methyl esterase (PME)

- These hydrolyze the methyl ester group of the pectinic acid to methyl alcohol and pectinic acids of reduced methoxy contents and finally to pectic acid.
- These alter the solubility of pectinic chains so that they may be attacked by chain splitting enzymes i.e. PGs.
- PME produced by *Erwinia* sp., *Xanthomonas campestris*; also by leaf spot fungi
Polygalacturononases

- Also called as chain splitting enzymes.
- These hydrolyze a galacturonan-containing plant polysaccharide, pectin, which is mixed with cutin on the plant surface. These includes:
  - These are of two types
    - Polygalacturononases (PG)
    - Poly methyl galacturononase (PMG)
    - These may Exo PG or PMG or Endo PG/ PMG
- PG acts when the substrate is pectic acid
- PMG acts when the substrate is pectin
Pectin trans eliminase or Pectate lyases

- Pectin is also broken down by these enzymes, by elimination of water molecules rather than hydrolysis.
  - Produced only by *Erwinia carotovora* causing soft rot of carrot
  - *X. campestris*
- The pectolytic enzymes causes liquification of the pectic substances which hold the cell together and lead to maceration of tissues thus facilitate the pathogen entry into host
Cellulose degrading enzymes

- Cellulases (1,4-glucanases)
  The core structural unit of the plant cell wall is digested by these enzymes.
  e.g. Pythiaceous fungi, *Rhizoctonia*, *Fusarium*, *Sclerotium*, *P. graminis tritici* etc.
H-bond

Glucose

Cellulose

cellulase

β-glucosidase

Cellulose \rightarrow \text{disaccharide cellobiose} \rightarrow \text{aglucose}
Hemicellulases (cross linking glycans)

These degrade various complex polysaccharide polymers that are found within the plant wall and between cells.

- (xylanases, Mannase and others)
- Produced by *Sclerotinia sclerotiorum*
Lignin degrading enzymes

- Lignases (Polyphenol oxidases)
- Mostly produced by bsidiomyctetes
  - E.g. Armilleria mellia causing wood rotting of forest trees
Protein degrading enzymes

- Proteinases – Protease
- Stemphylium botryosum - leaf spot of alfalfa

Starch degrading enzymes

Complex sugars (Amulose, amylopectin)
- Amylases

Lipid degrading enzymes
- Oils & fats as phospholipids & glycolipids
- Lipases; phospho-lipidases
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