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Pathogenecity and Virulence Factors of Phytopathogenic Bacteria

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SUMMARY

Plants are infected by a number of bacterial plant pathogens and suffer huge crop losses due to bacterial plant diseases. Bacterial phytopathogens have their own weapons to invade host plants and cause infection in plants and these can also be referred to as pathogenecity and virulence factors. In the absence of pathogenecity factors bacterial cells may not be able to cause disease in plants thus they play an important role in disease causation in plants and host pathogen interactions.

INTRODUCTION

Phytopathogenic bacteria have been reported to cause severe and deadly diseases of plants, leading to huge economic losses in crop production. Bacterial plant diseases are more severe in areas with tropical and sub tropical climatic conditions as they favour the growth of bacterial pathogens. Plants and pathogens are always in fight with each other and each one of them tries to conquer the other. To win the battle with plants and to cause infection in plants, bacterial pathogens need some weapons known as pathogenecity and virulence factors. Pathogenecity factors are defined as ones which enhance the ability of a pathogen to cause disease, whereas virulence factors affect the degree of pathogenecity of a given pathogen. Though plants defend the attack by pathogens, bacteria have its own ways to conquer all the defense mechanisms. Bacteria evade, overcome or suppress antimicrobial plant defenses using these virulence factors, which elicit release of water and nutrients from host cells to colonize in the apoplast successfully. Most of the plant pathogenic bacteria are gram negative bacteria in the genera *Pseudomonas, Erwinia, Ralstonia and Xanthomonas* and certain Gram-positive bacteria (*Streptomyces* spp. and *Clavibacter* spp.) also cause diseases in plants. Phytopathogenic bacteria contain pathogenecity islands which are defined as regions of DNA which contain virulence genes. As in case of, *Pseudomanas syringae* pv. *phaseolicola,* the gene virPphA is essential for virulence towards the host bean plant and also functions in *P. syringae* pv. *phaseolicola* as an avirulence gene towards soybean, inducing a rapid cultivar-specific hypersensitive response.

Symptoms produced by phytopathogenic bacteria

Plant pathogenic bacteria produce different kinds of symptoms in different hosts that include:

- Galls and overgrowths,
- Wilts,
- Leaf spots,
- Specks and blights,
- Soft rots,
- Scabs and cankers


Bacterial Galls


Bacterial wilt


Bacterial leaf spot


Bacterial blight


Bacterial soft rot

Bacterial scab

Pathogenecity Factors

There are many factors which are responsible for pathogenecity of bacterial pathogens and they are as follows:

Adhesion of bacteria to host plants

To cause infection in plants some of the pytopathogenic bacteria require adherence to the plant surface. In case of Agrobacterium, the attachment needs three components; a glucan molecule, which requires three genes for its synthesis and export, genes for the production of cellulose and the att region of the bacteria genome that contains several genes for adhesion. It also has some other genes for adhesions and for pilus biosynthesis. *R. solanacearum, Xanthomonas, Pseudomonas* and *Xylella* have about 35 genes homologous to type IV pili genes, which are involved in cell to cell aggregation and protection from environmental stress in *Xanthomonas* and *Pseudomonas*, whereas type IV pili are essential in *Xylella* for the establishment of an aggregated bacterial population in the unstable environment of the xylem by adhering to the vessels in connection to components such as polysaccharides.

Secretion systems

Bacterial pathogens use a number of secretion systems to deliver effector proteins, either directly into the host cells or into the intercellular spaces. Proteases and lipases from the soft rot pathogenic bacteria *Erwinia chrysanthemi* are examples of plant pathogen effectors secreted via the Type I Seretion Systems. Pathogen effectors involved in host cell wall degradation, such as pectate lyase, polygalacturonase and cellulase from *Erwinia* and *Xanthomonas* species, are produced by the Type II Secretion Systems. The pathogenicity of several biotrophic Gram negative bacteria in the genera *Xanthomonas, Pseudomonas, Ralstonia, Erwinia* and *Pantoea* is mainly due to their capability to produce a Type III Secretion Systems, also called injectisome, by which the bacteria inject proteins involved in their virulence into plant cells. There is the evidence that the VirD2/T-DNA nucleoprotein complex is injected through the type IV pilus from *A. tumefaciens* directly into the plant cell.

Cell wall degrading enzymes

Cell wall degrading enzymes play an eminent role in pathogenesis by facilitating penetration and tissue colonization, but they are also virulence determinants responsible for development of symptom. Soft rot bacteria in Pectobacterium genus (*Pectobacterium carotovorum, Pectobacterium chrysanthemi, Pectobacterium atrosepticum*) produce a wide range of enzymes leading to deconstruction of plant cell wall compounds than any other plant pathogenic bacteria. Pectinases are expected to be most important in pathogenesis, because they are responsible for tissue maceration by degenerating the pectic substances in the middle lamella and eventually, for cell death. *X. campestris pv. campestris*, the causal agent of black rot of crucifers, have genes for two pectin esterases and polygalacturonases, four pectate lyases, five xylanases and nine cellulases.

Toxins

P. syringae pv. syringae, produces necrosis-inducing phytotoxins, lipodepsipeptides, which are categorized into two groups, such as mycins and peptins. Both phytotoxins induce necrosis in plant cells and create pores in plant plasma membranes, thereby promoting transmembrane ion flux and cell death. Chlorosis

inducing phytotoxins include coronatine produced by *P. syringae pvs. atropurpurea, glycinea, maculicola, morsprunorum* and, tabtoxin produced by *P.syringae* pvs. *tabaci,* coronafaciens and phaseolotoxin secreted by *Pseudomonas savastanoi pv.phaseolicola* and *P. syringae pv. Actinidiae.* Coronatine induces hypertrophy of storage tissue, thickening of plant cell walls, accumulation of protease inhibitors, compression of thylakoids and inhibition of root elongation. Albicidins produced by *Xanthomonas albilineans* cause chlorosis in leaves and interfere with host defense mechanisms and thereby the bacteria gain systemic invasion of the host plant.

Extracellular polysaccharides

Extracellular polysaccharides (EPS) are associated with bacterial cell as a capsule, or produced as fluidal slime, or present in both forms. EPS play important role in pathogenesis of many bacteria either by direct interference with host cells or by providing resistance to oxidative stress. EPS1 is the main virulence factor of the bacterial wilt disease caused by *R. solanacearum* in solanaceous crops, since eps mutants were severely reduced in systemic colonization of tomato plants when introduced through unwounded roots and did not produce typical wilt symptoms even when directly inoculated into stem wounds. EPS, amylovoran and levan are pathogenicity and virulence factors, respectively, of *E. amylovora*, the pathogen causing fire blight in some rosaceous plants. Amylovoran affects host plants principally by blocking the vascular tissues; thereby inducing wilt of shoots and is known a pathogenicity factor.

CONCLUSION

The phytobacterial pathogens possess a large number of factors to cause disease in plant and to suppress the plant defense mechanisms thus play vital role in plant pathogen interactions. All these factors are utilised by different bacterial pathogens to produce varied symptoms in different host plants thus they forms the base of the type of symptoms produced by a specific bacteria in a specific host plant.

REFERENCES

Melotto M and Kunkel B N. 2013. Virulence Strategies of Plant Pathogenic Bacteria, In: The Prokaryotes–Prokaryotic Physiology and Biochemistry, ERosenberg, E Stackebrand, E F DeLong, F Thompson, S Lory (eds.), Springer-Verlag,Berlin,: 61-82.

Prasannath K. 2013.Pathogenicity and Virulence Factors of Phytobacteria. *Scholars Academic Journal of Biosciences*,1(1):24-33

Salmond G P. C. 1994. Secretion of Extracellular Virulence Factors by Plant Pathogenic Bacteria. *Annual Review of Phytopathology*,; 32:181-200.