

Major Plant Disease Symptoms Caused by Bacteria & Virus

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Plant pathogenic bacteria

- Plant pathogenic bacteria (PPB) are important plant pathogens widely spread all over the world (Bar-On et al., 2018).
- It is estimated that from 7100 classified bacteria about 150 species are responsible for different plant diseases (Rajesh-Kannan et al., 2016).
- PPB has been classified into three families: Xantomonadaceae, Pseudomonaceae, and Enterobacteriaceae. These bacterial families harbor the following genera: *Dickeya*, *Liberibacter*, *Erwinia*, *Pectobacterium*, *Candidatus*, *Pantoea*, *Agrobacterium*, *Pseudomonas*, *Ralsonia*, *Burkholderia*, *Acidovorax*, *Xanthomonas*, *Clavibacter*, *Streptomyces*, *Xylella*, *Spiroplasma*, *Phytoplasma*, *Brenneria*, *Lonsdale* and *Xylophilus* (Agrios, 2005).
- PPV infect plants through different mechanisms; for instance, through the use of cell wall degrading enzymes (cellulases, xylanases, pectinases) or by injecting chemicals *i.e.*, *hrp* harpins, and *Avr* proteins associated with plant diseases (Alfano and Collmer, 1997).

...Plant pathogenic bacteria

- Plant pathogenic bacteria differ from nonpathogenic relatives in being able to cause diseases (physiological damage) on susceptible plants (hosts).
- Following infection, which in nature usually starts with low numbers of pathogen cells (propagules), they colonize and multiply profusely in living plant tissues, attaining very high population levels per tissue mass/area (typically up to several million-fold over initial inoculum concentrations).
- Owing to the large amounts of microbial biomass in the infected tissue and the production/release of bioactive compounds that:
 - interfere directly with biochemical signaling pathways and host physiology and gene regulation,
 - there is excessive drain of host nutrients,
 - interference with local and long-distance nutrient transport, and
 - alteration in the plant's developmental program.
- The infected plant displays macroscopic alterations (disease symptoms) that are fairly characteristic of the pathogen/host combination.

Signs & Symptoms

- A **sign** of plant disease is physical evidence of the pathogen (difficult to observe, but can include):
 - Bacterial ooze
 - Water-soaked lesions
 - Bacterial streaming in water from a cut stem
- A **symptom** is a visible effect of disease on the plant. The main symptoms in the crops include:
 - abnormal growths on roots, stems,
 - spots on leaves or fruit,
 - blights or deadening of tissue on leaves, stems or tree trunks, and
 - rots of any part of the plant, usually roots or tubers.

Common bacterial diseases and crops affected:

Bacterial disease	Factors conducive to spread	Crops affected	Symptoms
Black rot (<i>Xanthomonas campestris</i> pv. <i>campestris</i>)	Warm, wet conditions.	Brassicas.	Light-brown to yellow V-shaped lesions on the leaf, which become brittle and dry with age. Vein blackening with the necrotic area.
Bacterial canker (<i>Clavibacter michiganensis</i> pv. <i>michiganensis</i>)	Moderate temperatures and high humidity.	Tomato; capsicum; chilli	Seedlings may die and older plants may wilt and die eventually. Older plants have leaves that turn yellow and wilt only on one side. Cankers on stems and fruit. Tissue inside stems becomes discoloured.
Bacterial soft rot (<i>Pseudomonas</i> spp., <i>Erwinia</i> spp.)	Warm, wet conditions.	Wide range of vegetables, including lettuce; brassicas; cucurbits; tomato; capsicum; potato; sweetpotato; carrots; herbs.	Wet, slimy, soft rot that affects any part of vegetable crops including heads, curds, edible roots, stems and leaves. May have a disagreeable odour.
Bacterial leaf spot/Bacterial spot (<i>Xanthomonas campestris</i> - various strains)	Overhead irrigation and windy conditions.	Range of vegetables including lettuce; cucurbits; tomato; capsicum.	Lettuce – Large brown to black circular areas that start as small translucent spots; usually on outer leaves. Tomatoes and capsicums – Greasy spots on leaves and stems that go from tan to black; fruit may have circular spots with central scab. Cucurbits – Begin as small water-soaked/greasy spots on underside of leaves with corresponding yellowing on upper side; fruit may produce light-brown ooze from water-soaked markings.

Bacterial disease	Factors conducive to spread	Crops affected	Symptoms
Bacterial wilt (<i>Ralstonia solanacearum</i>)	High temperatures, high soil moisture and poor drainage. Once infection has occurred, severity of symptoms is increased with hot and dry conditions, which facilitate wilting.	Potato; tomato; capsicum; eggplant.	Wilting, yellowing and stunting of plants but they may wilt rapidly and die without any spotting or yellowing; vascular tissue appears brown and water-soaked; a white ooze appears when pressure is applied to affected tubers or stems.
Bacterial leaf spot/Bacterial spot/Bacterial blight (<i>Pseudomonas syringae</i> - various strains)	Long periods of leaf wetness.	Beet; spring onions; leeks; rocket; coriander.	Beet – irregular, round leaf spots with a grey centre surrounded by a purple margin. Spring onions/shallots – pale yellow to light-brown lesions with a water-soaked appearance around the margins; outer leaves wither and die and youngest leaf turns lemon to light-green. Leeks – brown streaking on the shank.
Bacterial blight (<i>Pseudomonas syringae</i> pv. <i>pisii</i>)	Cool, wet, windy conditions.	Peas.	Water-soaked spots on leaves and stipules which become dark-brown and papery in warm weather or black in cool weather. Water-soaked spots on pods that become sunken and dark-brown.
Bacterial speck (<i>Pseudomonas syringae</i> pv. <i>tomato</i>)	Humidity and overhead irrigation.	Tomato.	Small dark spots surrounded by a yellow halo on leaves; dark raised specks on fruit.
Bacterial brown spot (<i>Pseudomonas syringae</i> pv. <i>syringae</i>)	Cool, wet, windy conditions.	Beans.	Tan to reddish-brown spots on leaves. Water-soaked spots on pods which enlarge and become sunken and tan with distinctive reddish-brown margins.

Viral diseases of Plants

- Crop viruses represent another source of biotic stress and crop loss for farmers.
- Although plant viral disease is relatively rare compared to disease caused by fungal pathogens, and plants can tolerate high levels of infection in some cases such as tobacco mosaic virus (TMV), some infestations such as Potato-X can cause major economic losses to growers.
- However, the arsenal of tools available to control these pathogens is very limited.
- In a few instances, chemicals can be employed to control vector organisms, as most plant viruses are transmitted by such organisms feeding on plant tissue.
- However, plants understandably have evolved strategies to deal with viral pathogens, and breeding for resistance has been by far the most common and successful approach to this problem.

... Viral diseases of Plants

- Of all the diseases, those caused by viruses are the most difficult to diagnose.
- This should not be surprising - viruses produce no telltale signs that can be readily observed.
- What's more, symptoms are often quite subtle, often easily confused with nutrient deficiencies and herbicide injury.

Viral disease symptoms

- **Viruses are difficult to classify and, for lack of anything better, they were given descriptive (and sometimes colorful) names based on the disease they cause**—for example, tobacco ring spot, watermelon mosaic, barley yellow dwarf, potato mop top, citrus tristeza, sugar beet curly top, lettuce mosaic, maize dwarf mosaic, potato leaf roll, peach yellow bud mosaic, African cassava mosaic, carnation streak, and tomato spotted wilt.
- **Many of these viruses infect multiple plant species.** For example:
 - tobacco ring spot virus causes a bud blight in soybeans;
 - maize dwarf mosaic infects sorghum, Sudan grass, sugarcane and Johnson grass in addition to corn.
- Common viral disease symptoms are:
 - Mosaic leaf pattern eg. Tobacco mosaic disease
 - Crinkled leaves
 - Yellowed leaves
 - Plant stunting