

Prokaryotes: classification of prokaryotes according to Bergey's Manual of Systematic Bacteriology. General characteristics of bacteria and examples of phytopathogenic bacteria, fastidious vesicular bacteria, phytoplasmas and spiroplasmas

Phytoplasma

Phytoplasmas are small, unicellular, gram-positive non-motile bacteria like prokaryotes intermediate between viruses and bacteria. They differ from true bacteria in the absence of cell wall. **Phytoplasma is first observed in the phloem of the mulberry plants infected with dwarf disease.** Highly pleomorphic and their size range from small spherical bodies to large irregularly tubular to filamentous-branched structures (175 – 250nm). They are bounded by a triple layer unit lipoprotein membrane of 10 nm thickness without a rigid cell wall (wall-less prokaryotes) and lack the ability to synthesis cell wall materials. They have cytoplasm, ribosome and a strand of nuclear material devoid of nuclear membrane. Both DNA and RNA are present.

They are free living, parasitic and saprophytic and reproduce by budding and binary fission. They are filterable through bacterial filters and require sterol for their growth. They are sensitive to antibiotics like tetracycline, chloramphenicol and erythromycin and highly resistant to penicillin. On artificial media, they form **poached egg or fried egg shaped colonies** with central nipple. They are usually transmitted by grafting, dodder and by mechanical means. Beside this, Leafhoppers, plant hoppers and psyllids act as vectors. The phytoplasma disease are characterized by yellowing, chlorosis or bronzing of foliage, shortening of internodes, reduction in leaf size, proliferation of axillary buds, phyllody and virescence, proliferation of secondary roots and abnormal fruits and seeds. Flowers from diseased plants are often sterile. Symptoms in a disease may show few or many of the above symptoms. The important symptoms are:

Little leaf

In little leaf axillary buds are induced to form very small chlorotic leaves in clusters giving the plant a bushy appearance.

Little leaf of brinjal

Symptoms

The most characteristic symptoms is the reduction of leaf size, Both the petiole and lamina are involved in the reduction. The leaves become almost sessile. The leaves become thin, soft, glabrous and pale green in colour. The



growth of axillary buds including buds is stimulated and this is accompanied by the shortening of internodes. The plant presents a characteristic pushy appearance, are absent floral parts whenever they are found. But they are modified into green structures. As a rule the affected plants are sterile and do not bear fruits.

Phytoplasma

Ovoid or spherical, 40-300 nm in diameter and lack a rigid cell, wall.

Vector

Jassid- *Hishimonas phycitis*.

Phyllody

Floral parts are hypertrophied and transformed into, green leafy structures. This is also known as **phyllody** or **green flowering**.

Phyllody of sesame

Symptoms

The affected plants are stunted. The entire inflorescence is replaced by a growth consist of green, short, twisted leaves closely arranged on the stem with very short internodes. The calyx becomes polysepalous and shows multicostte veination against gamosepalous nature of healthy flowers. The sepals become leaf-like and found to remain smaller in six. The corolla become polypetalous and deep green. The veins of flower parts become thick and conspicuous. The anthers become green' and contain abnormal pollen grains. The carpels are transformed into leafy outgrowth which forms a pseudosyncarpotis ovary by their fusion at the margins. The ovary becomes very enlarged and flattened.



Vector

Leafhopper- *Orosius albicinctus*.

Grassy shoot

In grassy shoot disease the shoot becomes thinner with narrow and numerous chlorotic leaves resembling grass plants.

Grassy shoot of sugarcane

Symptoms

The disease is characterized by the production of numerous lanky tillers with small and narrow leaves, with or without albinism (white leaf). Shoots grow from diseased setts remain dwarfed or stunted. Diseased plants exhibit varying degrees of loss of chlorophyll, ranging from total green to white; premature and excessive tillering gives a crowded (grass-like) appearance to the clump. Affected clumps are stunted and exhibit premature proliferation of auxiliary buds. Canes are thin with short internodes. Canes are not millable.



Phytoplasma

Ovoid, spherical and irregular. 300 to 400 nm in diameter.

Vector

Proutista moesta

Witches' broom

Witches' broom is the broom-like erect growth or mass proliferation caused by dense clustering of branches.

Potato witches broom

Symptoms

The infected plants: Pave spreading type, numerous filamentous colourless stems bearing small, simple leaves and aerial tubers. Plant growth is, suppressed. Affected plants do not produce tubers or, it may produce small, size tubers which develop hairy sprouts

Vector

Leaf hopper- *Aleurodes dravidanus*.

Spike

In spike, leaves are reduced in size and branches become stiff and pointed spike-like structure.

Sandal spike

Symptoms

Sandal spike is a yellows type disease with witches, broom effect. Two types of symptoms are produced in this disease.

a. Rosette spike

Internodes are shortened and leaves become very small in size. This results in crowding of leaves in the leaf bearing, branches. Developing new leaves are further reduced in size. Such leaves in diseased trees stand out stiffly on the branches like spike. Phylloid flowers are produced in the trees.

b. Pendulous spike

In this apical growth of branches are continuous without proper thickening leading to dropping of branches. Dormant buds do not develop or grow and hence no rosette appearance.

Vector

Leafhoppers – *Nephotettix virescens*.

Yellowing

In yellowing the leaves are yellow and plants are stunted.

Yellow dwarf in rice

Symptoms

The characteristic symptoms are general chlorosis, stunting and excessive tillering. The chlorotic leaves are pale green or pale yellow. Plants infected early may die prematurely. They produce very poor panicles or none at all.

Vector

Green leafhopper - *Nephotettix cincticeps*, *N. virescens* and *N. nigropictus*.

Spiroplasma

Spiroplasmas are helical mollicutes. The first known spiroplasma is com stunt (*Spiroplasma kunkelii*) and spiroplasma first cultured *in vitro* is citrus stubborn (*S. citri*). These spiroplasmas infect their respective leafhopper vectors. Spiroplasmas are cells that vary in shape (pleomorphic). They may be spherical to slightly ovoid (100 to 250 nm in dia), helical filaments (helical filaments *in vitro* measure 3000 to 5000 nm in length and 100 to 200 nm in dia) and non-helical filaments. Unlike phytoplasmas, spiroplasmas can be obtained from their host plants or their insect vectors and cultured on nutrient media. They require cholesterol for their growth. They produce fried egg appearance (0.2 mm in dia) on solid media.

They produce mostly helical forms in liquid media. . They multiply by binary fission. They lack a true cell wall and are bounded by a triple layered membrane. The helical filaments are motile. They move by a slow undulation of the filament and by a rapid, rotary screw motion of the helix. There are flagella but intracellular fibrils are present. They are resistant to the antibiotic penicillin but inhibited by tetracycline. Spiroplasmas in plants are found in phloem tissues and are spread by leafhoppers.

Symptoms of spiroplasma

Stunt

Stunting of plant with shorter internodes giving the plant a bunchy appearance at the top.

i. Com stunt - *Spiroplasma kunkelii*

Symptoms

Faint **yellowish streaks** appear on the youngest leaves. As the plant matures, leaves first become yellow, later the leaves turn red to purple. Internodes are shortened and the plant gives **bunchy appearance** at the top. The plants are **stunted**. Infected plants have more cobs than healthy plants. But the **cobs are smaller and bear little or no seed**. Tassels of infected plants are usually sterile.



Vector Leafhoppers *Dalbulus elimatus*, *D.maidis*, *Graminella nigrifrons*

Citrus Stubborn Disease

In some Mediterranean countries and in California, stubborn is regarded as the greatest threat to production of sweet oranges and grapefruit. The trees produce fewer fruits and many of them are too small and not to be marketable. In California, approximately two million orange, grapefruit, and tangelo trees are so severely affected that they are practically worthless.

Symptoms

Affected trees show a bunchy upright growth of twigs and branches. Internodes are shorter. Shoots are found in large numbers. Multiple buds and sprouts are common. Some of the affected twigs show die back. The bark is thickened and sometimes pin holed. The trees show stunting and appear flat topped. The leaves show yellowing and blotching, mottling and become abnormally small. Excessive winter defoliation is common. Affected trees bloom at all seasons,

especially in the winter. Flowers become very small. The infected trees bear only fewer fruits. Some of the fruits are very small, lopsided, or otherwise deformed. Such fruits have normally thick rind from the stem end to the fruit equator. Fruits tend to drop prematurely. Many fruits become mummified. Fruits are usually sour or bitter and have an unpleasant odour and flavour. Fruits have many poorly developed, discoloured and aborted seeds. In severely infected plants, the roots die, leading to lethal wilting.

Pathogen

Spiroplasma citri. It is found in the sieve tubes of stubborn – diseased citrus phloem. *Spiroplasma citri* was the first mycoplasma like organism of a plant disease to be cultured. In phloem sieve tubes it is present as spherical, ovoid or elongated forms and occasionally as helical filaments. In liquid cultures, it appears primarily as motile helical filaments. The pathogen is Gram-positive. The pathogen is insensitive to penicillin but is highly sensitive to tetracycline and less to amphotericin, neomycin and digitonin. The pathogen has a sharp optimum temperature for growth at about 30 to 32°C

Host-range

S. citri attacks *Citrus* spp., Madagascar periwinkle, lettuce, black mustard, horse radish, cabbage, water melon, cherry, peach, onion, leek and pear.

Transmission

Citrus stubborn disease is transmitted by leafhoppers belonging to at least six species in three genera (*Circulifer*, *Macrosteles* and *Scaphytopius*.).

