Yellow Vein Mosaic of Bhindi

This disease of bhindi (Okra) has taken a severe form in our country. Infection of four to five week old plants results into unusual retarded growth and only few leaves and fruits are formed on such plants. Such plants result into about 94% loss of the crop yield. The damage is relatively less on old plants.

Symptoms

The chief symptoms develop on leaves. There occurs vein clearing and veinal chlorosis of leaves. Infected leaves exhibit a very distinct yellow network of veins alongwith the thickened veins and veinlets. In severe cases the chlorosis may involve interveinal areas resulting into yellowing of entire leaf (Fig. 35). Fruits are dwarfed, malformed, distorted and yellow green in colour.

Causal organism

The *Yellow Vein Mosaic Virus* (YVMV) of bhindi is not transmitted mechanically through sap. It may artificially be transmitted through grafting. In the field YVMV is transmitted by whitefly *Bremisia tabaci*, and perhaps also by bhindi leafhopper, *Empoasca devastans*. There are several weed hosts of this virus. These are *Croton sparsiflora*, *Malvastrum tricuspidotum* and *Ageratum* sp., growing along the roadside and in wasteland areas.

Control

(1) Protection of crop from white flies and other insects, by spraying with Follidol (0.3%) or other insecticides. Spray must be done early, just after the seedlings come out, say within three weeks after germination.

(2) Four to six sprays of systemic insecticides, ekatox, metasystox, rogor, etc.

(3) Eradication of weed hosts.

(5) Disease resistant cultivars. Some wild species of *Hibiscus* and *Abelmoschus* have been found as good source of resistance.

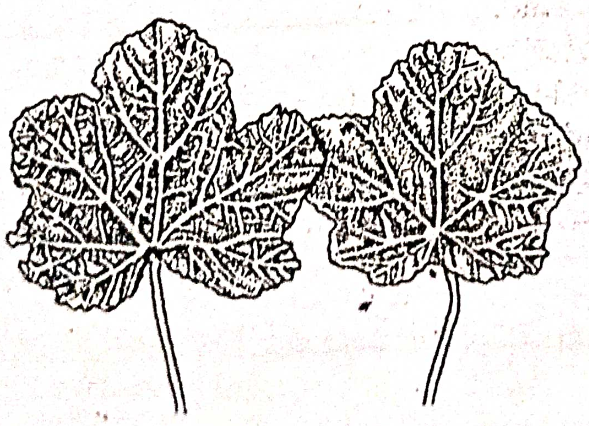

Fig. 35. Symptoms of yellow vein mosaic of bhindi.

Tobacco Mosaic Disease

This is the best known of all virus disease of plants, and worldwide in distribution. This disease affects more than 150 genera of primarily herbaceous, dicotyledonous plants including many vegetables (potato, tomato, cucurbits), flowers and weeds. There are serious losses in yield as well as quality of tobacco, tomato and some other crop plants. It is symptomless on apple and grape. TMV affects plants by damage of leaf, flower and fruit and causes stunting of the plant.

Symptoms

The symptoms include various degrees of chlorosis, curling, mottling, dwarfing, distortion, and blistering of leaves, dwarfing of the entire plant, dwarfing, distortion and discoloration of flowers, and in some plants even development of necrotic areas of leaf.

The most common symptom on tobacco is the appearance of mottled dark-green and light-green areas on leaves (Fig. 33). The dark green areas are thicker and appear somewhat elevated in a blisterlike manner over the thinner, chlorotic, light green areas. Stunting of young plants is common, and is accompanied by a slight downward curling and distortion of leaves, that may become narrow and elongated rather than normal oval shape. The petioles may become enlarged (puckered) with enlarged capitate hairs. Old leaves may not show symptoms, young ones develop typical sumptoms.

Causal organism

Tobacco Mosaic Virus (TMV) is rod shaped, 300 nm long by 15 nm in diameter (Fig. 34 a). Protein (P) consists of approximately 2130 subunits and each subunit consists of 158 amino acids. The protein subunits are arranged in a helix. The nucleic acid (NA) is single-stranded RNA and consists of about 6400 nucleotides. The RNA strand also forms a helix parallel with that of protein and is located on the protein subunits and approx. 20Å out from the inner end of the protein subunits (Fig. 34 b,c). The mol. wt. of each virus particle is between 39 and 40 million mol. wt. units.

Fig. 33. Tobacco leaf infected by TMV.

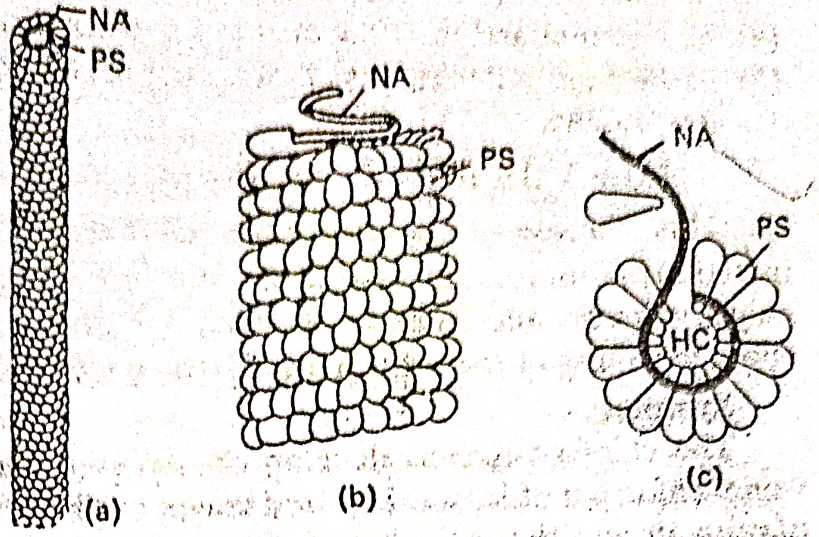

Fig. 34. Tobacco mosaic virus (TMV), (a) the rod, (b) side arrangement of protein subunits (PS) and nucleic acid (NA). (c) cross section view of the virus rod, HC-hollow core.

TMV is one of the most thermostable viruses known, the thermal inactivation point of the virus in undiluted plant juice being 93°C. However, in dried infected leaves, the virus retains infectivity even when heated at 120°C for 30 min. Infected plant may contain up to 4 g of virus per litre of plant juice and the virus retains infectivity even at dilutions of 1:1,000,000. In ordinary plant sap, the virus is inactivated in 4-6 weeks, whereas in sterile bacteria free sap the virus may survive for 5 years, and in TMV infected leaves kept dry in the laboratory the virus remains infectious for more than 50 years. TMV is transmitted readily through mechanical sap, grafting and dodder. It is not transmitted by insects, except occasionlly through their contaminated feet and jaw. The most common method of transmission of TMV in field and greenhouse is through hands of workers handling infected and healthy plants.

Disease development

TMV survives in infected leaves and stalks in the soil, on surfaces of contaminated seeds, and on contaminated seedbed cloth, and in natural leaf and manufactured tobacco including cigarettes, cigars etc. The virus initially infects wounded tissues of tobacco seedlings in seedbed or of transplants in the field. Then it spreads in the field throughout the season. TMV in all plants produces systemic infections, invading all parenchyma cells of plant. The virus moves from cell to cell through phloem. In the cytoplasm of cell TMV appears as crystalline aggregates and as amorphous bodies (x-bodies).

Control

(1) Sanitation is the main method. Crop should not be grown at least for two years in seedbeds or fields where diseased crop was grown. Removal of diseased plants and of some Solanaceous weeds harboring the virus early in the season helps in reduction and elimination of subsequent spread of the virus.

Mycoplasmas

In 1898 the French scientists, E. Nocard and E.R. Roux, studying pleural fluids of cattle suffering from bovine pleuropneumonia, discovered the organisms that were entirely different from any other microorganisms then known. When cultivated on rich organic media containing about 20% of animal serum, the organisms were found in different forms as spheroid, thin, branching filaments, stellate or asteroid structures and other irregular forms. Similar pleomorphic (Gr *pleo* = many; *morphe* = forms) organisms were later isolated from other animals as sheep. goats, dogs, rats mice, human beings. Similar forms were also found growing as saprophytes in decaying organic matter. These were named as pleuropneumonia-like organisms (PPLO). The species discovered by Nocard and Roux was given the first binomial as *Asterococcus mycoides* by Borrel *et al* (1910), meaning rounded and stellate forms with radial, mold-like filaments. It was later on put under the genus *Mycoplasma* by Nowak (1929) and these organisms are now commonly called as mycoplasmas. Characteristic features of the mycoplasmas are as follows :

(1) Unicellular, prokaryotic, usually non-motile and form fried-egg shaped colonies (Fig. 46 a,b,).

(2) Highly pleomorphic, form varying with culture conditions. Under different microscopy, they appear small coccoid bodies (Fig. 46 c), ring forms and fine filaments some of which are branched (Fig. 46 d).

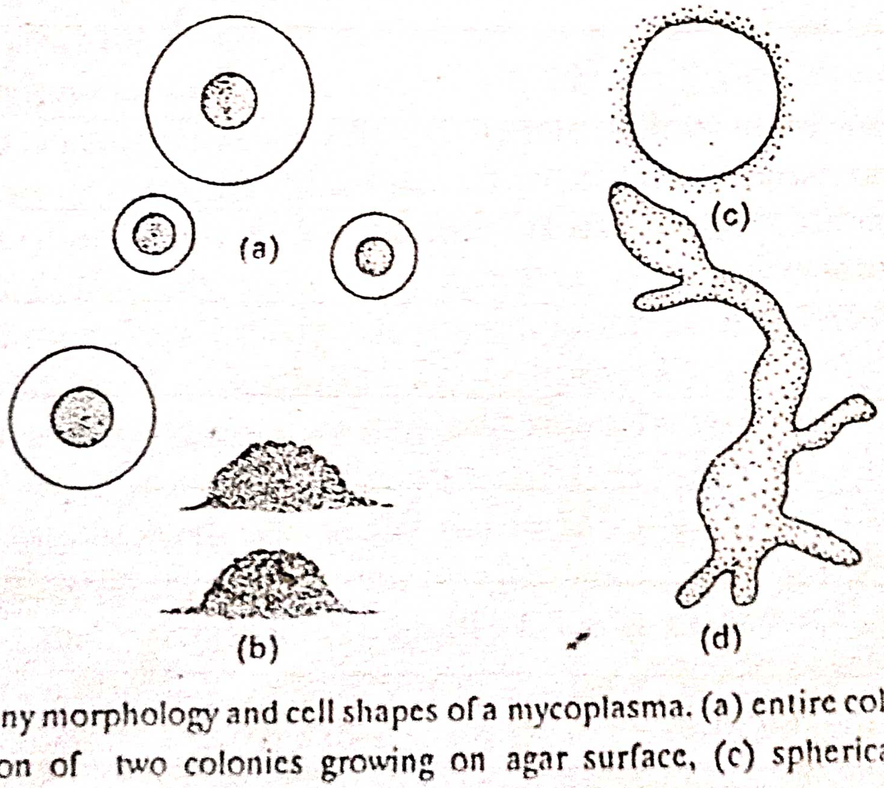

Fig. 46. Colony morphology and cell shapes of a mycoplasma. (a) entire colonies (b) longitudinal section of two colonies growing on agar surface, (c) spherical form (d) irregular filamentous form.

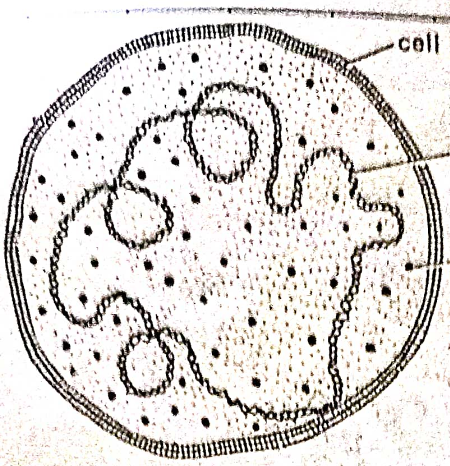

Fig. 47. Structure of a cell of mycoplasma.

(3) Filtrable through bacterial filters.
(4) Cell wall absent. Cells delimited by a triple-layered lipoproteinaceous unit membrane, the plasma membrane.
(5) Both DNA and RNA present. DNA base composition ranges from 23 to 36 (39 to 41 in *Mycoplasma pneumoniae)* mole per cent GC.(cf L-forms).
(6) Resistant to antibiotics as penicillins that act on cell walls.
(7) Inhibited by tetracyclines and similar antibiotics that act on metabolic pathways.
(8) Mostly free- living; parasites and saprophytes.

They are true cells. Like animal cells, they have, however, no demonstrable cell walls. The sole retaining structure is the cytoplasmic membrane which like most other cell membranes is phospo-lipid-protein bilayer or unit type, continuous, flexible and 7-11 nm thick.

Mycoplasmas are simpler than the cells of higher plants and animals. They possess all the necessary biochemical machinery to grow and multiply in the absence of other cells. The genetic machinery is in the form of DNA, RNA and ribosomes (Fig. 47).

They vary in size mostly from 300 nm to about 0.2 μm in diameter. The volume of the smallest PPLO is about 1×10^{-3} μm^3. The internal structure is typical of prokaryons generally and closely resembles that of true bacteria. The cell membrane encloses the cytoplasm which contains numerous ribosomes, a network of fibrillar DNA, electron dense areas, ribosomes, soluble RNA and soluble protein. Nuclear structures, however, are less evident than typical bacteria. Ribosomes are clearly visible and mesosomes are absent.

However, cells of mycoplasma divide unevently into very minute bodies called the **elementary bodies** or **minimal reproductive units.** They are commonly formed inside the large bodies or mature cells (Fig. 48). These elementary bodies range in size from about 330 nm to 450 nm. These can pass through bacteria retaining filters like viruses but are viable on ordinary media. These have bacteria-like structure. These bodies are often cited as the smallest independently living entities. These represent a stage in the life cycle. They enlarge to form long filaments and mycelia and chains of minute spheres like conidia but

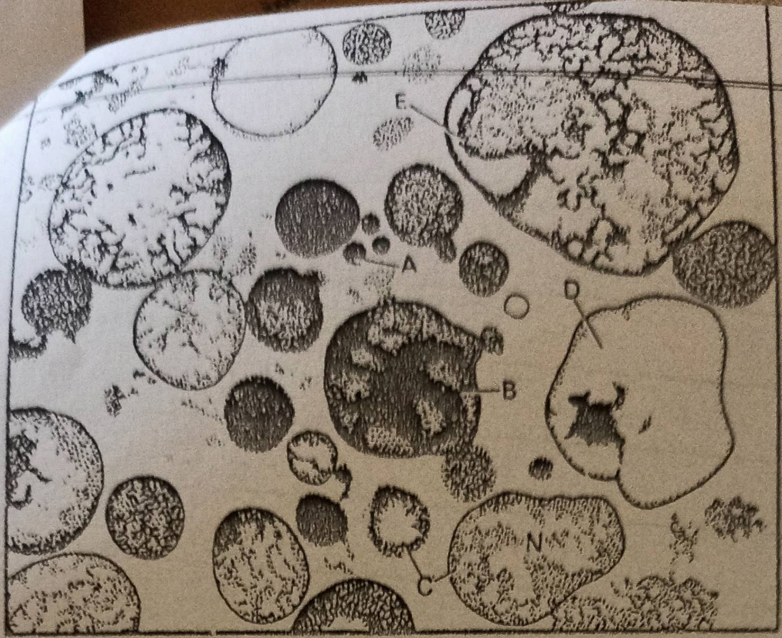

Fig. 48. Diagrammatic sketch showing ultrastructure of *Mycoplasma hominis.* A variety of forms may be seen, ranging in size from 0.1 to 0.9 µm. A-a small dense form (elementary body), B-a form with finely granular cytoplasm divided into light and dark areas, C-cells containing "nuclear areas" (N) with net-like strands and cytoplasm with ribosome-like granules, D-form consisting of an empty plasma membrane instead of watery appearance, E-the form having a membrane-bound vacuole.

much smaller in size. It is thought by some that these conidia-like bodies are liberated and that each increases in size to become larger body several µm in diam, inside which new elementary bodies are formed. These are released by rupture of the membrane of larger body. Growth rate of mycoplasma is very rapid, generation time 1-3 hrs. Like viruses and animal cells, mycoplasmas are resistant to penicillin. Many other types of structures are also present.

Plant-pathogenic Mycoplasmas

For many years the yellows of plants were thought to be caused by viruses. In 1967, however, the Japanese workers. Doi *et al* discovered pleomorphic mycoplasma-like organisms in the phloem cells of plants affected by different yellows-type diseases. Since then MLOs have been found to be associated with over 70 plant diseases which infect over 300 genera of plants. They occur from temperate to tropical regions but it is in the warmer areas that serious losses occur in crops as coconuts, citrus, rice, maize, cotton and potatoes. They also occur in insects and as saprophytes in soil and sewage. A number of mycoplasmal diseases of plants are listed by Ghosh and Raychoudhuri (1972). During 1940s there occurred unusual increase in cases of human pneumonia. Monroe Eaton isolated a tiny virus like agent from the respiratory tract of patients. This was named *Mycoplasma pneumoniae,* the Eaton agent. The disease came to be known as primary atypical pneumonia (PAP). *Mycoplasma hominis* causes a