CPT-507

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What are viruses?

Viruses are very small (submicroscopic) infectious particles (virions) composed of a protein coat and a nucleic acid core.

They carry genetic information encoded in their nucleic acid, which typically specifies two or more proteins. Translation of the genome (to produce proteins) or transcription and replication (to produce more nucleic acid) takes place within the host cell and uses some of the host's biochemical "machinery".

Viruses do not capture or store free energy and are not functionally active outside their host. They are therefore parasites (and usually pathogens) but are not usually regarded as genuine microorganisms.

Most viruses are restricted to a particular type of host. Some infect bacteria, and are known as bacteriophages,

whereas others are known that infect algae, protozoa, fungi (mycoviruses), invertebrates, vertebrates or vascular plants.

However, some viruses that are transmitted between vertebrate or plant hosts by feeding insects (vectors) can replicate within both their host and their vector.

Viroids, are infectious RNA molecules that cause diseases in various plants. Their genomes are much smaller than those of viruses (up to 400 nucleotides of circular single-stranded RNA) and do not code for any proteins.

DEFINITION: A **virus** is a subcellular, submicroscopic, infectious obligate parasite composted of nucleic acid within a protein coat that uses the host cellular machinery to replicate itself.

Why are viruses important?

Viruses cause many diseases of international importance. Viruses also cause many important plant diseases and are responsible for huge losses in crop production and quality in all parts of the world.

Infected plants may show a range of symptoms depending on the disease but often there is leaf yellowing (either of the whole leaf or in a pattern of stripes or blotches), leaf distortion (e.g.

curling) and/or other growth distortions (e.g. stunting of the whole plant, abnormalities in flower or fruit formation).

Virtually all plants that humans grow for food, feed, and fiber are affected by at least one virus. It is the viruses of cultivated crops that have been most studied because of the financial implications of the losses they incur. However, it is also important to recognise that many "wild" plants are also hosts to viruses.

Although plant viruses do not have an immediate impact on humans to the extent that human viruses do, the damage they do to food supplies has a significant indirect effect.

II Properties/characteristics of viruses

- Do not divide or multiply on their own.
- Reproduce by inducing the host cell to form more virus.
- Do not consist of cells and therefore have no organelles.
- Cannot penetrate cells on their own - enter through wounds or vectors
- Are not self-motile - depend upon various types of vectors for transmission.
    - The virus nucleic acid is encapsidated by a protein. The protein surrounding the nucleic acid is referred to as the coat protein or capsid which is formed by protein subunits.
    - The majority of plant viruses are made up of RNA. At least 80 viruses contain DNA.
    - 60-95% of the virus is made of protein and the remaining 5-40% is nucleic acid.
    - The RNA or DNA is what carries the genetic information.

How are viruses classified?

Within each group, many different characteristics are used to classify the viruses into

families, *(Virus families represent groupings of genera of viruses that share common characteristics and are distinct from the member viruses of other families. Virus families are designated by names with the suffix -viridae. Most of the families of viruses have distinct virion morphology, genome structure, and/or strategies of replication, indicating phylogenetic independence or great phylogenetic separation.),*

genera, *(Virus genera represent groupings of species of viruses that share common characteristics and are distinct from the member viruses of other genera. Virus genera are designated by terms with the suffix -virus.)*

and species, *(in 1991, the ICTV accepted the definition of a virus species proposed by van Regenmortel (1990), as follows: "A virus species is defined as a polythetic class of viruses that constitutes a replicating lineage and occupies a particular ecological niche.").*

Typically, a combination of characters are used and some of the most important are:

- Particle morphology: the shape and size of particles as seen under the electron microscope.

1) Particle morphology:

- Rigid rod particles : i.e. Tobacco mosaic virus
- Flexuous or filamentous particle i.e. Potato virus X
- Isometric, spherical or polyhedral particles: Cucumber mosaic virus
  Geminated particles: i.e. Tobacco yellow dwarf virus
- Bacilliform: i.e. Broccoli necrotic yellow virus
- Genome properties: this includes the number of genome components and the translation strategy. Where genome sequences have been determined, the relatedness of different sequences is often an important factor in discriminating between species.

The highest level of virus classification recognises six major groups, based on the nature of the genome:

- (+) ssRNA : i. e. Tobacco mosaic virus.
- (-) ssRNA: i. e. Tomato spotted wilt virus.
- dsRNA: i. e. Wound tumor virus
- ssDNA: i.e. Beet curly top virus

1b) Genome segments

i. monopartite (genome in one segment)
ii. bipartite (genome divided in two segments)
iii. multipartite (genome divided in three or more segments)

- Single-stranded DNA (ssDNA): there are two families of plant viruses in this group and both of these have small circular genome components, often with two or more segments.
- Reverse-transcribing viruses: these have dsDNA or ssRNA genomes and their replication includes the synthesis of DNA from RNA by the enzyme reverse transcriptase; many integrate into their host genomes. The group includes the retroviruses, of which Human immunodeficiency virus (HIV), the cause of AIDS, is a member. There is a single family

of plant viruses in this group and this is characterised by a single component of circular dsDNA, the replication of which is *via* an RNA intermediate.

- Double-stranded RNA (dsRNA): some plant viruses and many of the mycoviruses are included in this group.
- Negative sense single-stranded RNA (ssRNA-): in this group, some or all of the genes are translated into protein from an RNA strand complementary to that of the genome (as packaged in the virus particle). There are some plant viruses in this group and it also includes the viruses that cause measles, influenza and rabies.
- Positive sense single-stranded RNA (ssRNA+): the majority of plant viruses are included in this group. It also includes the SARS coronavirus and many other viruses that cause respiratory diseases (including the "common cold"), and the causal agents of polio and foot-and-mouth disease.

- Biological properties: this may include the type of host and also the mode of transmission.

  natural host range
  mode of transmission in nature
  vector relationships
  geographic distribution
  pathogenicity, association with disease
  tissue tropisms, pathology, histopathology

- Serological properties: the relatedness (or otherwise) of the virion protein(s).

Antigenic Properties

serologic relationships, especially as obtained in reference centers

1. **Diseases of field crops**
2. Diseases of cereal crops (e.g. diseases of wheat, rice, millet, maize, sorghum etc)
3. Diseases of sugar crops (e.g. diseases of sugarcane, sugar beet etc)
4. Diseases of oil seed crops (e.g. diseases of sunflower, soybean, sesame etc)
5. Diseases of fiber crops (e.g. diseases of cotton)
6. Diseases of pulses (e.g. diseases of gram, lentil, mung been etc)
7. Diseases of fodder (e.g. diseases of lucern, berseam, millet, maize, sorghum etc)

1. **Diseases of horticultural crops**

a. Diseases of vegetables (e.g. diseases of summer/winter vegetable crops, i.e. diseases of chilies, tomatoes, cucurbits etc)
b. Diseases of fruit crops (e.g. diseases of summer/winter vegetable crops, i.e. diseases of mango, banana, citrus etc)
c. Diseases of ornamentals (e.g. diseases of flowers i.e. rose etc)

Fibre plants

COTTON

Cotton leaf curl is recorded as most destructive diseases
COTTON LEAF CURL VIRUS (CLCV)

This disease is also called leaf crinkle. A virus causing leaf curl of cotton was first recorded in Nigeria (1912), Sudan (1924), Tanzania (1926), Philippine (1959). It is quite difficult to present accurate estimates of the losses due to cotton leaf curl disease, because the losses vary from year to year and from one area to the other. Sometimes the cotton fields have been found to show as much as 100 percent damage.

PATHOGEN: The disease causing virus belongs to Gemini group, sometimes refer as Gossypium virus 1. Cotton leaf curl virus

DISTRIBUTION: Africa, Nigeria, Sudan, Tanzania, Philippine and Pakistan.

HOST RANGE: More than 30 different crop, weed and ornamental plants are reported as hosts.

SERIOUSNESS: Cotton, lady's finger, tomato, chili, cucurbit (especially water melon), beans, sunflower, sesame, soybean, cow peas, egg plant (brinjal),

TRANSMISSION: The disease transmitted by feeding of the white fly, Bemissia tabacci within 6.5 hours. The virus is not transmitted by sap, seed or soil.

SYMPTOMS: Upward and downward curling of leaves accompanied by small and main vein thickening **(SVT & MVT)** on leaves, pronounced on underside. If a diseased leaf is viewed from beneath against the light, thickened vein found darker green and opaque than normal. In extreme but not in frequent cases, formation of cup shaped or leaf laminar (veins) outgrowth called "enation" appears on the back or underside of the leaf. The newly produced leaves are small, excessively crinkled and curled at the edge. Primary stem often tends to grow taller than normal. The internodes being elongated and irregularly curved but sometimes the whole plant is stunted. The flowers checked in growth and become abortive. Bolls remained small in size and failed to open. All parts of badly hit plants are very brittle and ready broken.

CONTROL: Cultivation of resistant varieties is only safe measure. Crop rotation with non host crop. Proper use of irrigation and fertilizers. Potassium fertilizer improves the disease resistant power in plants. Vector, white fly must be controlled. All alternate hosts (including weeds) must be eradicated before, during and after cotton crop. Deep plowing with short duration in fallow lands help to control weed hosts. The disease **(CLCV)** is not seed transmitted but use of healthy seed, acid delinting and chemical seed treatment is recommended as preventive measure. Use of proper cotton production technology is economical and most effective for management of all diseases (including this).

CEREALS

RICE: *Oryza sativa*

Pathogen: Rice yellow mottle virus (RYMV)

Is the most economically important viruses of rice.

Host Range: can affect irrigated low land and up land susceptible varieties.

Symptoms; chlorotic mottling and streaking on leaves. Intensity of symptoms vary with resistance level of variety.

Damage: delayed flowering and yield loss with deformation of panicles. Loss can exceed 95%.

Distribution: Africa

Control; Plant resistant varieties.

SUGARCANE

Mosaic, grassy shoot and chlorotic streaks are considered major viral diseases of sugarcane.
MOSAIC

PATHOGEN: Sugarcane mosaic virus (SMV).

DISTRIBUTION: Wherever sugarcane is grown.

HOST RANGE: The disease causing virus has a wide range and infects a large number of grasses.

TRANSMISSION: Aphids, Mechanical, and is seedborne in corn.

PERPETUATION: Grasses and infected sugarcane crop.

SYMPTOMS: Newly leaves are unrolled from spindle. Irregular oval or oblong, pale green blotches of various sizes occur on leaves, with various widths. Stunted shoots, twisted and distorted leaves in some cultivars. Mottling of stem, causing death of tissue and cankered areas in other cultivars may also occur.

CONTROL: Rogue out infected plants.

MAIZE AND SORGHUM

STREAK DISEASE has been reported as viral disease but has not importance with reference to damaging the crop.

DISTRIBUTION: Asia and Africa.

HOST RANGE: Maize and sorghum.

TRANSMISSION: Through leafhoppers (not seed or sap).

SYMPTOMS: Initially, circular, colorless spots occur on lowest exposed portions of young leaves. Spots are scattered at first but later on become closer. Narrow, broken, chlorotic stripes occur along veins. The stripes may coalesce to form wider stripes.

CONTROL: Sow resistant varieties.

LEGUMES

BEAN CROPS

MOSAIC is considered as major threat to almost all **BEAN CROPS.**

PATHOGEN: Bean yellow mosaic (BYM) and Common bean mosaic (CBM).

DISTRIBUTION: Generally wherever field beansare grown.

TRANSMISSION: Yellow mosaic is transmitted through aphids only but common mosaic is seedborne, may also transmit through aphids, pollens and by mechanical mean.

SYMPTOMS: Differences between symptoms may vary greatly between plants. However, in both diseases, the general symptoms include dwarfing, excessive branching or bunches, leaf cupping and typical symptoms of mosaic.

CONTROL: Disease free seed is suggested for common mosaic. Resistant varieties or rouging of infected plants are best way against both diseases.

GROUNDNUT

ROSETTE is alone important viral disease of groundnut.

PATHOGEN: Groundnut rosette virus (GRV).

DISTRIBUTION: Africa, Java and Pakistan.

TRANSMISSION: Mechanically.

SYMPTOMS: An overall stunting of plants with typical rosette or clumped appearance is common symptom. Affected plants have flattened growth at the top portions associated with

leafy growth and malformed buds. Young leaflets become faint in colour followed by chlorosis. Chlorotic and mottled leaf, and blossom and pod formation is reduced. Early infection causes small, sessile flowers that do not open.

CONTROL: Sow resistant varieties. Diseased plants should be uprooted and destroyed.

SESAME

LEAF CURL is recorded as problematic disease.

TRANSMISSION: White fly, Bemissia spp. is the main vector in nature, and graft transmission is reported successful for producing the disease.

SYMPTOMS: Diseased leaves are markedly reduced in size, become slightly thick and brittle and dark green in colour. Affected plants are stunted and bear scanty capsules having poor seed setting. Early infection may result in severe reduction in yield.

CONTROL: Diseased plants and weeds must be collected and destroyed. The vector white fly may be controlled.

Horticultural crops

TOMATO

LEAF CURL is considered as secondarily important viral disease of the tomato crop that may also cause considerable loss in quality and quantity of produce.

PATHOGEN: Tomato yellow leaf curl virus

TRANSMISSION: White fly, Bemissia tabacci.

SYMPTOMS: Dwarfing, twisting and curling of leaves, mottle vein clearing, excessive branching, stunting of plants and partial or complete sterility.

CONTROL: Planting resistant varieties.

CHILI

SYMPTOMS: Curling of leaves, accompanied by thickening and swelling of veins. Clusters of leaves with reduced size. The whole plant assumes bushy appearance with stunted growth. Fewer flowers and fruit, but if are formed, are much reduced in size and are curled.

CONTROL: Planting resistant varieties.

LADY'S FINGER (BHINDI OR OKRA)

YELLOW VEIN MOSAIC is considered very important disease.
PATHOGEN: Hibiscus or Bhindi yellow vein mosaic virus.
TRANSMISSION: White fly, Bemissia tabacci.

SYMPTOMS: Vein clearing, vein chlorosis, yellow veins enclosing green patches of the leaf. Veins are thickened on lower surface of the leaf. Fruits are develop malformed and reduced in size, mostly are yellow, small, tough and fibrous.

CONTROL: Planting resistant varieties. Eradication or rouging of infected plants and weeds.

CUCUMBER (CUCURBIT)

MOSAIC is recorded as major problem in almost all members of cucurbit.

PATHOGEN: Cucumber mosaic virus (CMV).

DISTRIBUTION: World wide.

HOST RANGE: Wide range of hosts than any other virus.

SERIOUSNESS: Cucurbit, peppers, spinach, tomatoes, beets, beans, banana, crucifers, lilies, zinnia and many weeds.

TRANSMISSION: Sap and several insects. Mostly 6 spp. of aphids, including Myzus persicae and Aphis gossypii. Not through seed in cucumber but is in some hosts.

PERPETUATION: Through weeds, flowers and crop plants.

SYMPTOMS: Cotyledons turn yellow and wilt. Young leaves become mottled, distorted, wrinkled and their edges begin to curl downward forming rosette like clump. The plants appear dwarfed, leaves become half to their normal size. Few runners, flowers and fruits. Older leaves develop chlorotic and necrotic areas that cover entire leaf and killed leaves hang down or fall off. Fruit shows pale green or white areas intermingled with dark green, raised areas. Often form rough, wartlike projections, cause distortion, are somewhat misshapen but have smooth gray white colour with some irregular green areas. Often have bitter taste and upon picking become soft and soggy.

CONTROL: Resistant varieties. Use of disease free seedlings. Elimination of alternate hosts (including weeds). Control of insect vectors.

PAPAYA

LEAF CURL is important viral disease of papaya.

DISTRIBUTION: Where papaya is grown.

TRANSMISSION: White fly, Bemissia tabacci.
SYMPTOMS: Almost all the leaves of the plant are reduced in size and show malformation and sever curling, crinkling and distortion. The margins of the leaves are curved or rolled downward and or inward. Vein clearing and thickening also take place. The leaves become brittle and growth of the plant is arrested. Sometimes, plants become partially or completely sterile depending on growth stage and severity of the disease. If the fruits are formed, these are disfigured and mummified.

CONTROL: Planting resistant varieties. Eradication of diseased plants.

Root and tuber crops
Cassava,
Disease: African cassava mosaic disease
Pathogen; ACMV, EACMV
Symptoms, mosaic, leaf distortions
Vector: whiteflies. *B. tabaci*
Distribution: East, Africa, SSA.
Control, plant resistant varieties.

Yam:
Yam mosaic virus.
Symptoms, yellowing of leaves, retarted growth, small yam tubers
Trans, aphids
Control, control vectors

Tree crops:

Cocao *Theobroma cacao*

Cocoa is one of the most important economic species of plants in many west African countries, particularly Ghana, Nigeria, Cote'l Voire and seria leone. The most important disease is the swollen shoot disease.

Pathogen: *Cocoa swollen shoot virus*. About 20 strains of the virus is known in Nigeria.

The vectors are mealybugs, *Pseudococcus njalensis*

Symptoms: red veins on newly formed leaves that later turn yellow in colour (vein clearing). Unusual swellings on stems and roots of affected plants. Infected pods are brownish and small in size. The disease reduces growth in affected plants and may lead to plant death.

Control: remove infected trees i.e cut down and burn. Spray to kill vectors. Ensure virus free stock for planting.