MANAGEMENT OF VIRUS DISEASES OF VEGETABLES

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AVRDC...September 25,2016

- What is virus?
- Symptoms
- Transmission
- Detection and identification
- Management

Introduction

- What is virus?
  - one kind of plant pathogens
  - smaller than bacteria
  - not a cell… “particle”
  - can cause severe diseases
- composed mainly of nucleic acid and coat protein
- usually too small to be seen under light microscope
- Different shape and size; spherical, rod

Introduction

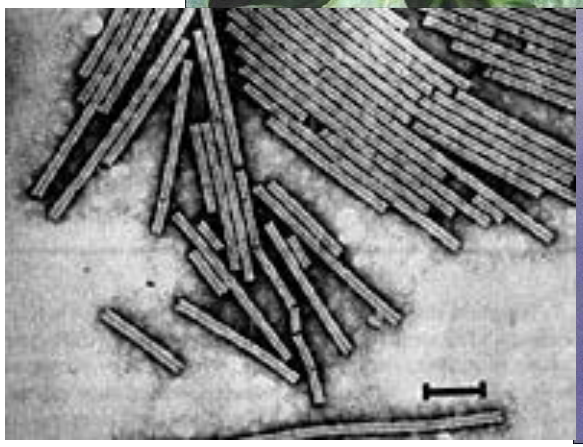
- More than 2,000 kinds of viruses are found and new viruses are described every month.
- One virus may infect one or dozens of different species of plants …… "host range"
- A plant may be infected with one or more of viruses.
- Propagate only in host cells (obligate parasite)
- Some can propagate in insect
- Enter plants by wounds or vectors
- **not infect human or animals**

Can a plant virus make you sick?

By Vincent Racaniello, A virology Professor

- One hundred trillion bacteria colonize the human intestine, 10 times the numbers of cells in entire human body.
- The vast majority of DNA viruses in the human gut are bacteriophages, which infect the resident bacteria.
- The most plentiful RNA viruses in our feces are plant viruses, and the most abundant is pepper mild mottle virus (PMMV) up to 10^9 virions per gram.
- http://www.virology.ws/2010/04/29/can-a-plant-virus-make-you-sick/

- High levels of PMMV are found in Tabasco sauce, which contains virions that are not only visible in the electron microscope, but which are infectious for plants.



Archives of Virology
August 2015, Volume 160, Issue 8, pp 2079–2082

Detection of pepper mild mottle virus in pepper sauce in China

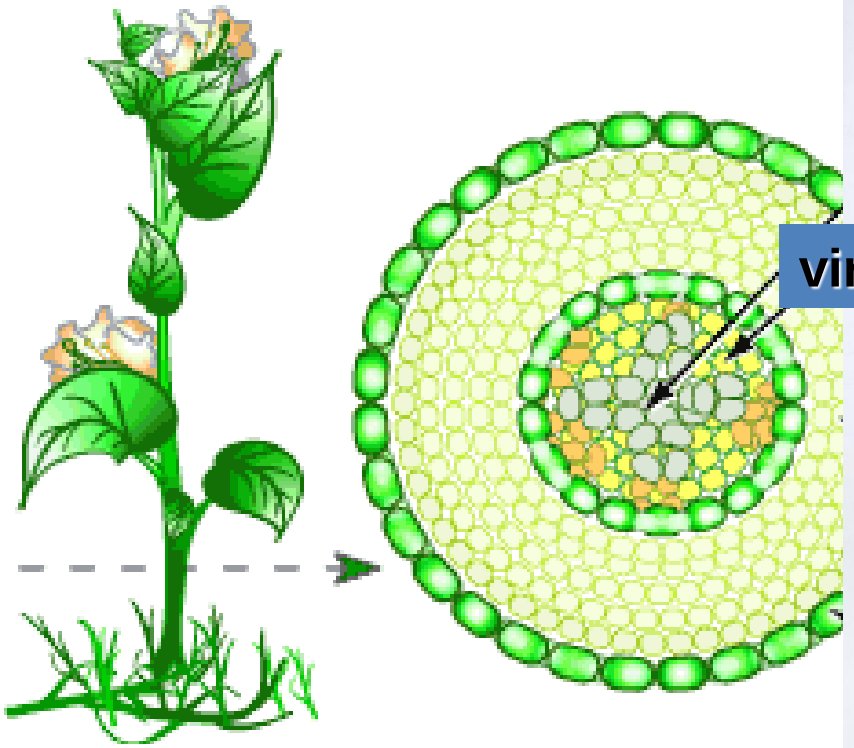
Jiejun Peng, Bingbin Shi, Hongying Zheng, Yuwen Lu, Lin Lin, Tong Jiang, Jianping Chen ✉, Fei Yan ✉

Brief Report
First Online: 29 May 2015
DOI: 10.1007/s00705-015-2454-7

Cite this article as:
Peng, J., Shi, B., Zheng, H. et al. Arch Virol (2015) 160: 2079. doi:10.1007/s00705-015-2454-7

Abstract

Pepper mild mottle virus (PMMoV) was detected by RT-PCR in all 42 pepper sauce samples from the 10 main manufacturing provinces in China at concentrations ranging from 3.8 to 8.8 (Log_{10} copies/mL). Their coat protein nucleotide sequences had 97.4 to 100 % identity to each other and 92.4 to 100 % to other published isolates. The samples remained infectious to *N. benthamiana*, indicating that commercial trade in sauce could contribute to the natural spread of PMMoV.



virus

nematode

fungi

bacteria

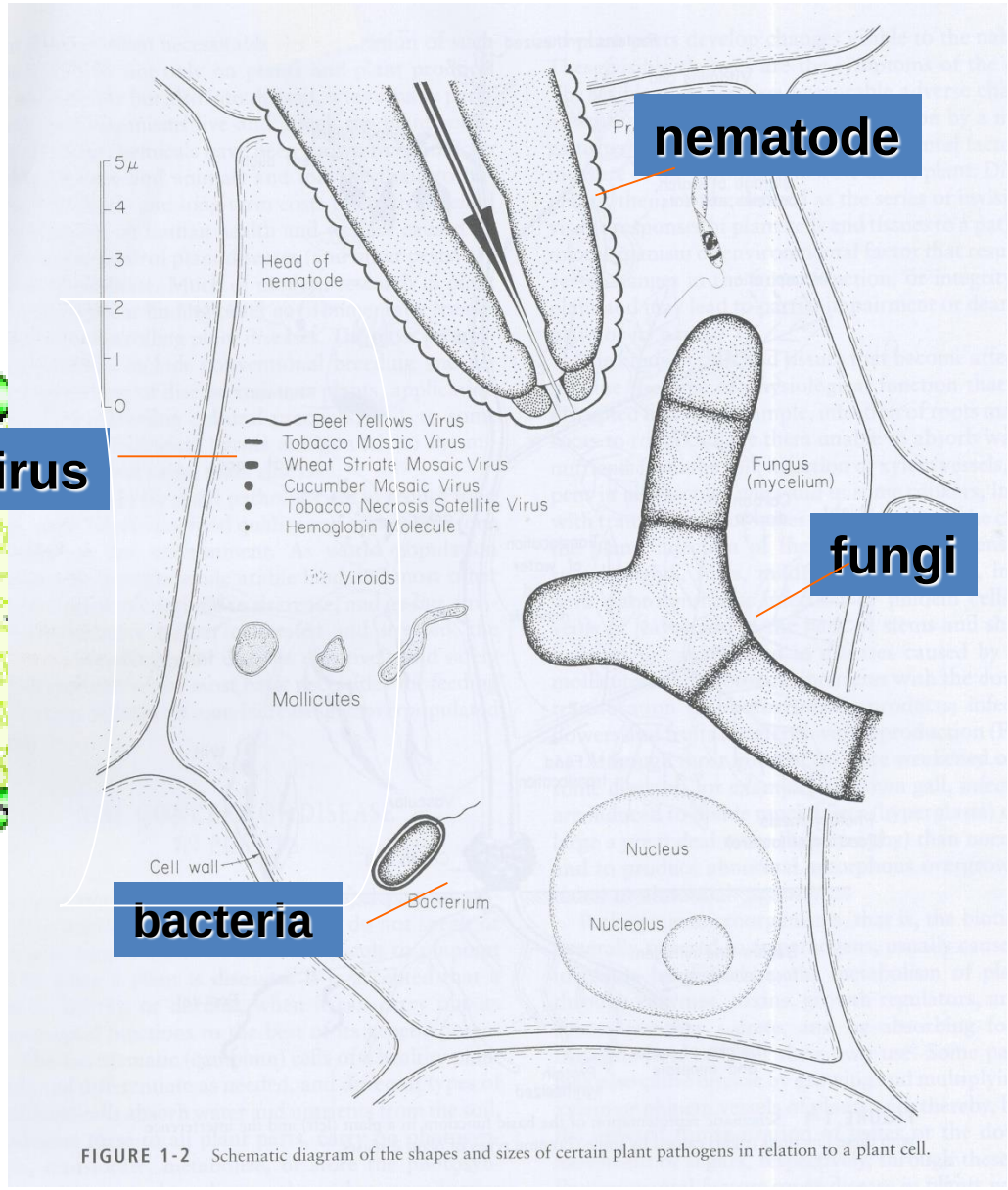
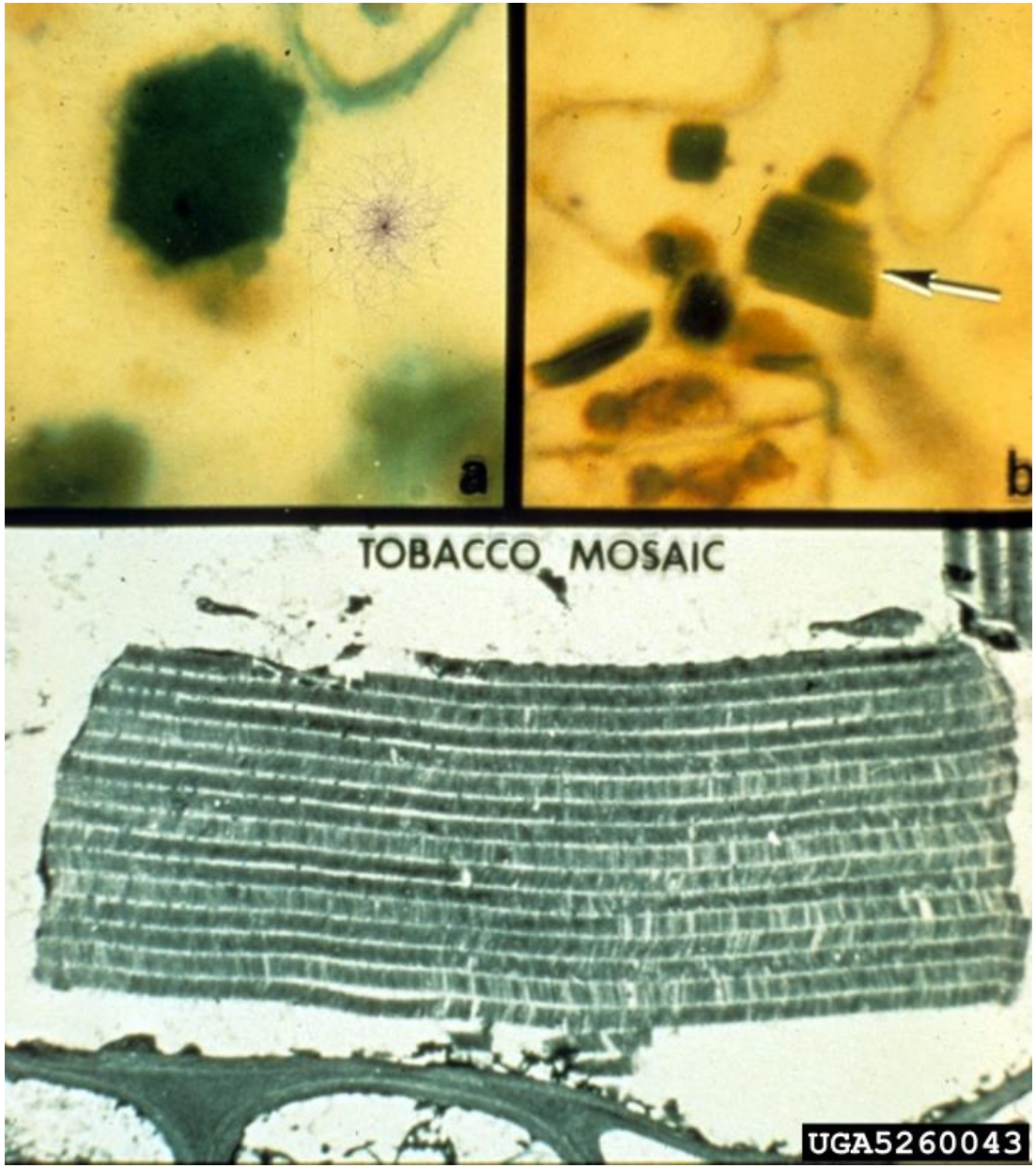


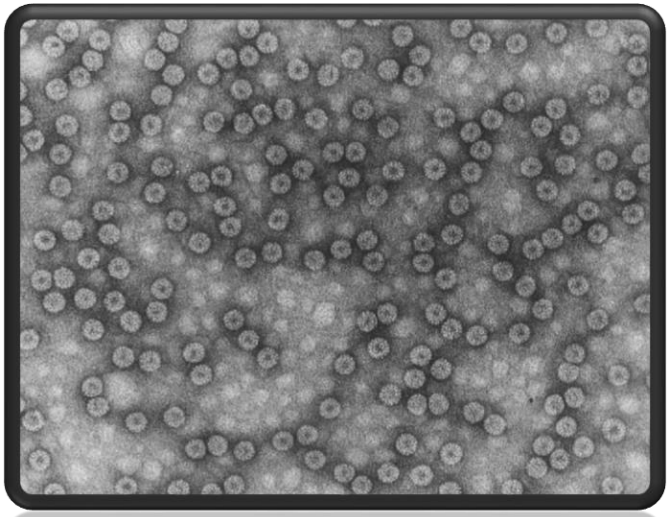
FIGURE 1-2 Schematic diagram of the shapes and sizes of certain plant pathogens in relation to a plant cell.

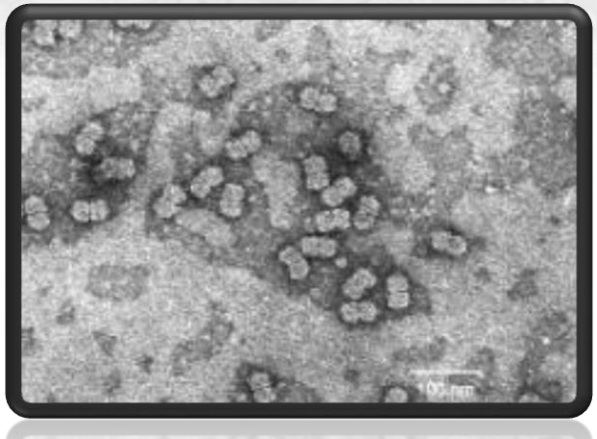


Inclusion bodies

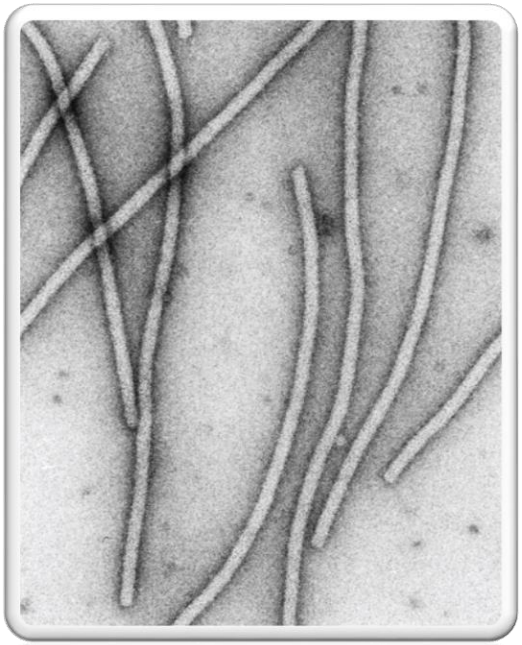
Tobacco mosaic virus is the first discovered plant virus

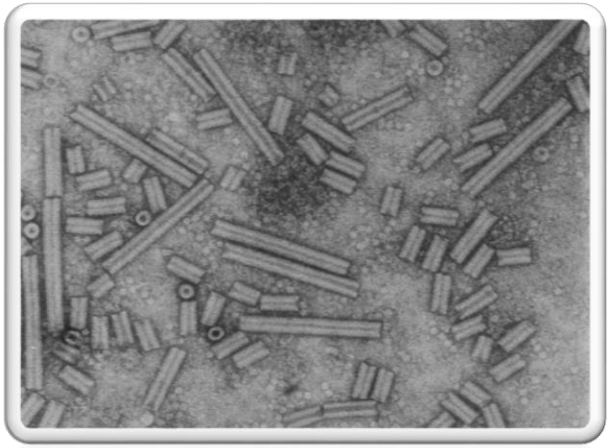
Morphology of plant viruses under TEM

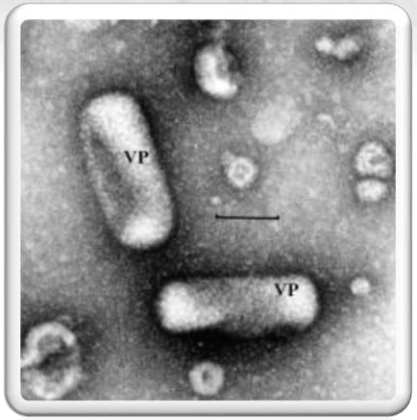




spherical

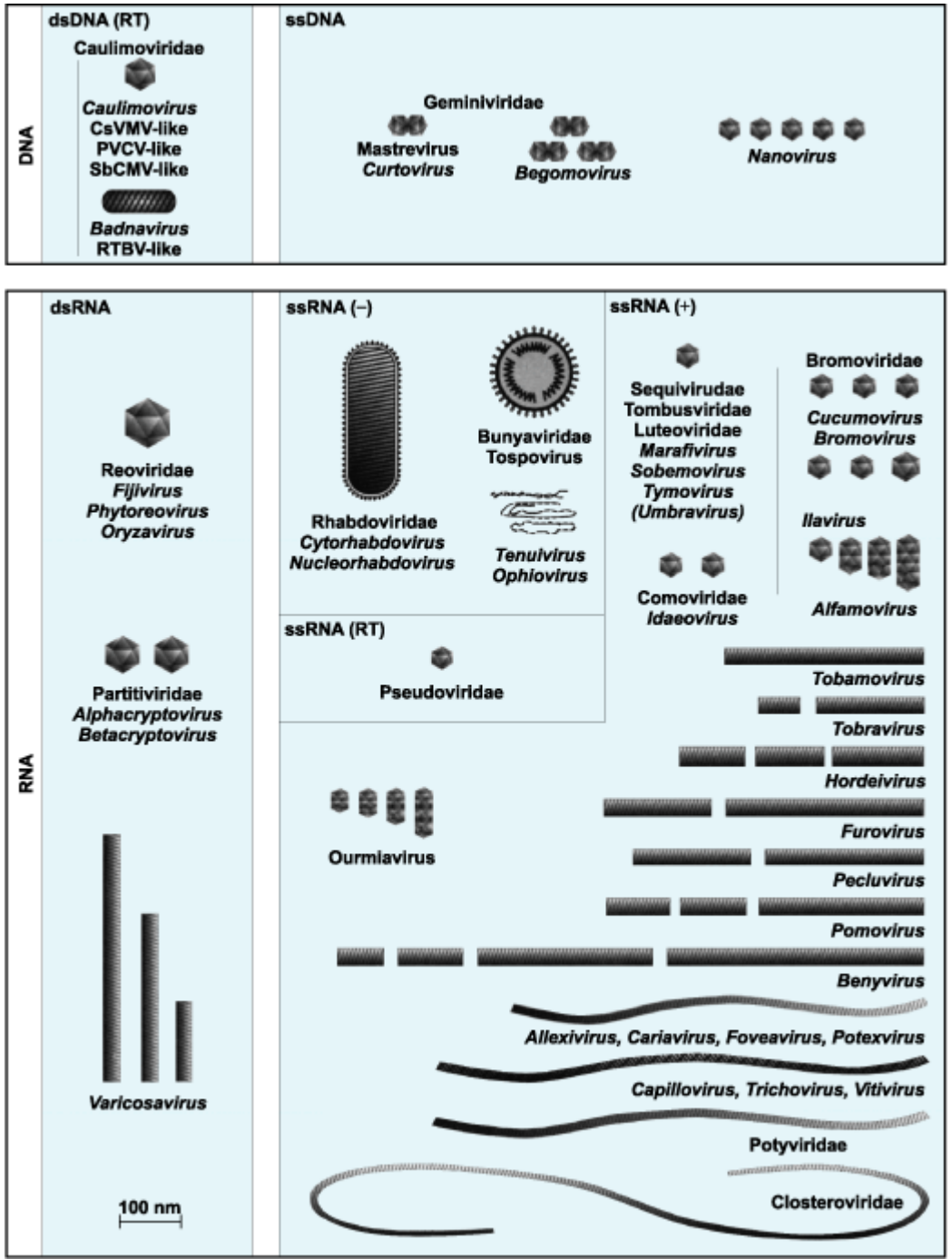






rod

Families and Genera of Viruses Infecting Plants



Nomenclature of plant virus

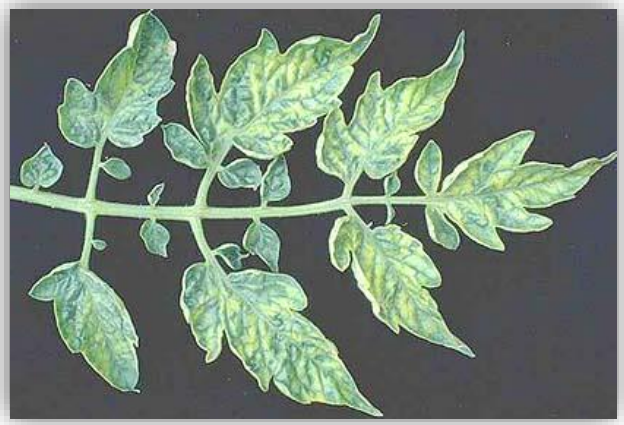
- *Tobacco mosaic virus* (TMV)
- *Tomato yellow leaf curl virus* (TYLCV)
- *Bean yellow mosaic virus* (BYMV)

(Plant + symptom + virus)

“Virus species”

Symptoms caused by plant viruses

Summer squash leaves show mosaic symptoms caused by ***Watermelon Mosaic Potyvirus*** **(formerly WMV-2).**



Tomato Mosaic Virus **(ToMV)**
Strong yellow mosaic symptoms

orange - mottle

Orchid – mosaic flower

Gerbera - mosaic

Tulip - mosaic

Melon fruit infected with **Squash Mosaic Comovirus** show strong mottled patterns and lack of netting

***Cucumber Mosaic Virus* (CMV)**

Mosaic and rugosity of foliage and color breaking on fruit of straightneck yellow squash caused by **Watermelon Mosaic Potyvirus (formerly WMV-2).**

(rugose = wrinkle)

Common mosaic seed discoloration caused by **soybean mosaic virus**

Yellow vein mosaic virus

Leaf yellowing on squash caused by ***Cucurbit aphid-borne yellows virus***

yellows-type disease on tomato plant caused by **phytoplasma**

Corn - streak mosaic

Sugarcane - mosaic

***Papaya ringspot virus* (PRSV)**

Severe blight by ***maize chlorotic mottle virus (MCMV)***

Peronosclerospora maydis

Tospovirus

Tobacco Ringspot Nepovirus infections appear as yellowish mosaic on newly infected leaves of melon and cucumber

Papaya ringspot virus **(PRSV)**

Jalapeno peppers showing typical symptoms caused by PMMoV (left) and *Tomato spotted wilt virus* (TSWV) (right)

Turnip mosaic virus symptoms on the internal leaves of cabbage.

***Tomato Mosaic Virus* (ToMV)**
Necrotic spots on fruit

upward and inward rolling of the leaf margins

White flies

***Tomato yellow leaf curl virus* (TYLCV)**. Note multiple shoots, thickened shoots and deformed yellow

Several symptoms can be caused by one virus

Leaf mosaic

Water-soaked streak on stem

Ring spot on fruit

Leaf deformation

Several symptoms can be caused by one virus

Wide host range
>40 families

Cucumber mosaic virus (CMV)

Wilt
***-Tobacco etch virus* (TEV)**

Reduced fruit size and deformation

Bean yellow mosaic vrius

similar symptoms
may caused by
different viruses

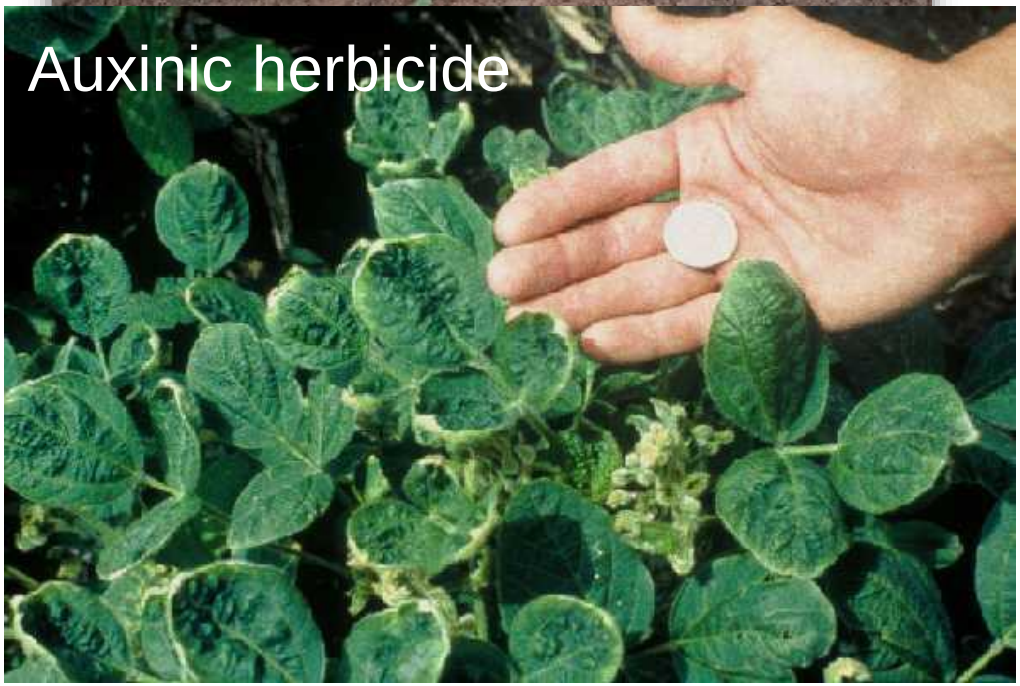
Bean common mosaic virus

Virus-like diseases

genetics

chemicals

2,4-D

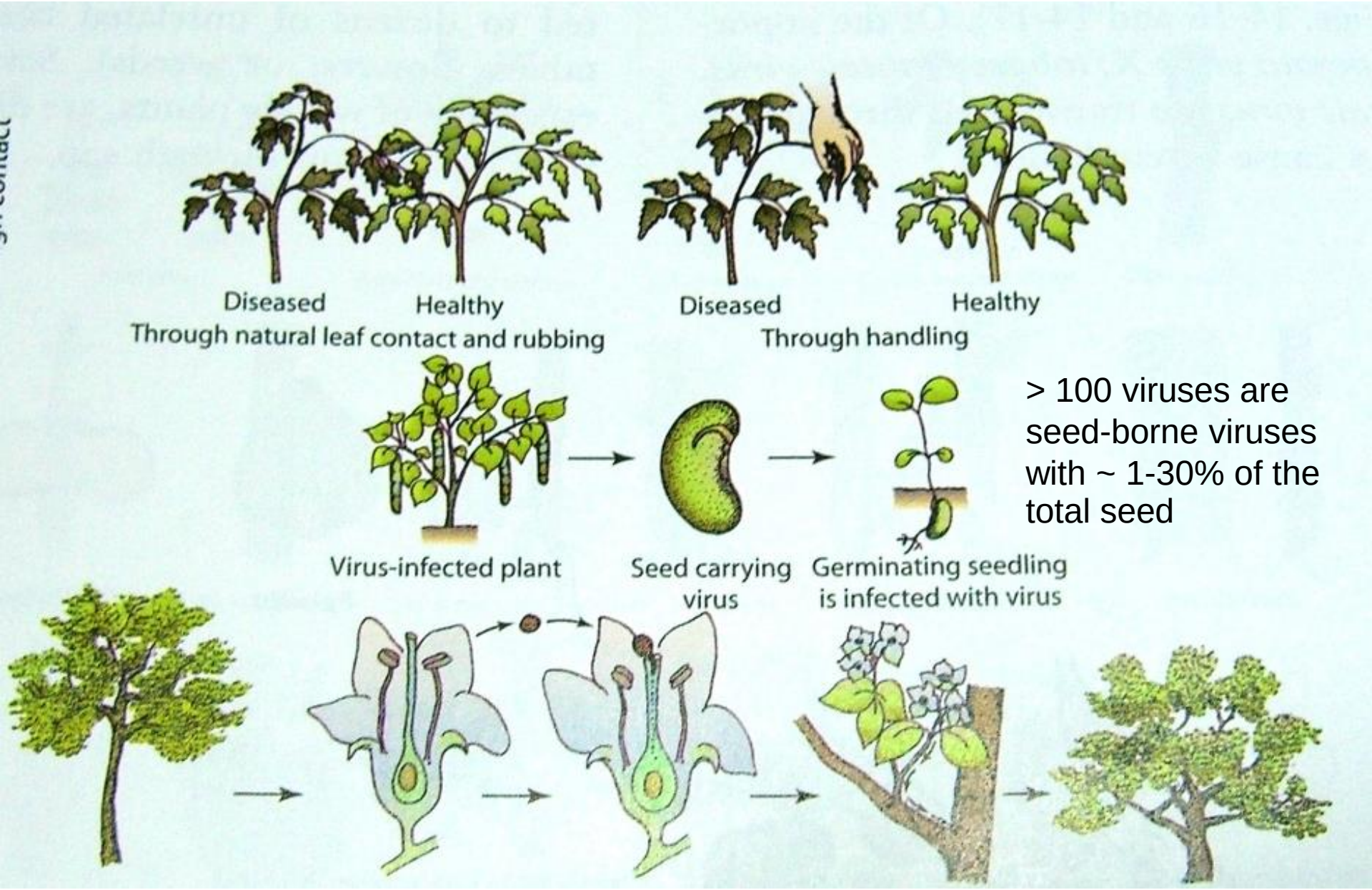


Herbicides

Hormone effect

DISEASE TRANSMISSION

Mechanical, seed, pollen transmission



> 100 viruses are seed-borne viruses with ~ 1-30% of the total seed

Insect transmission

aphids

Corn aphids

Ornage aphids

White flies

thrip

hopper

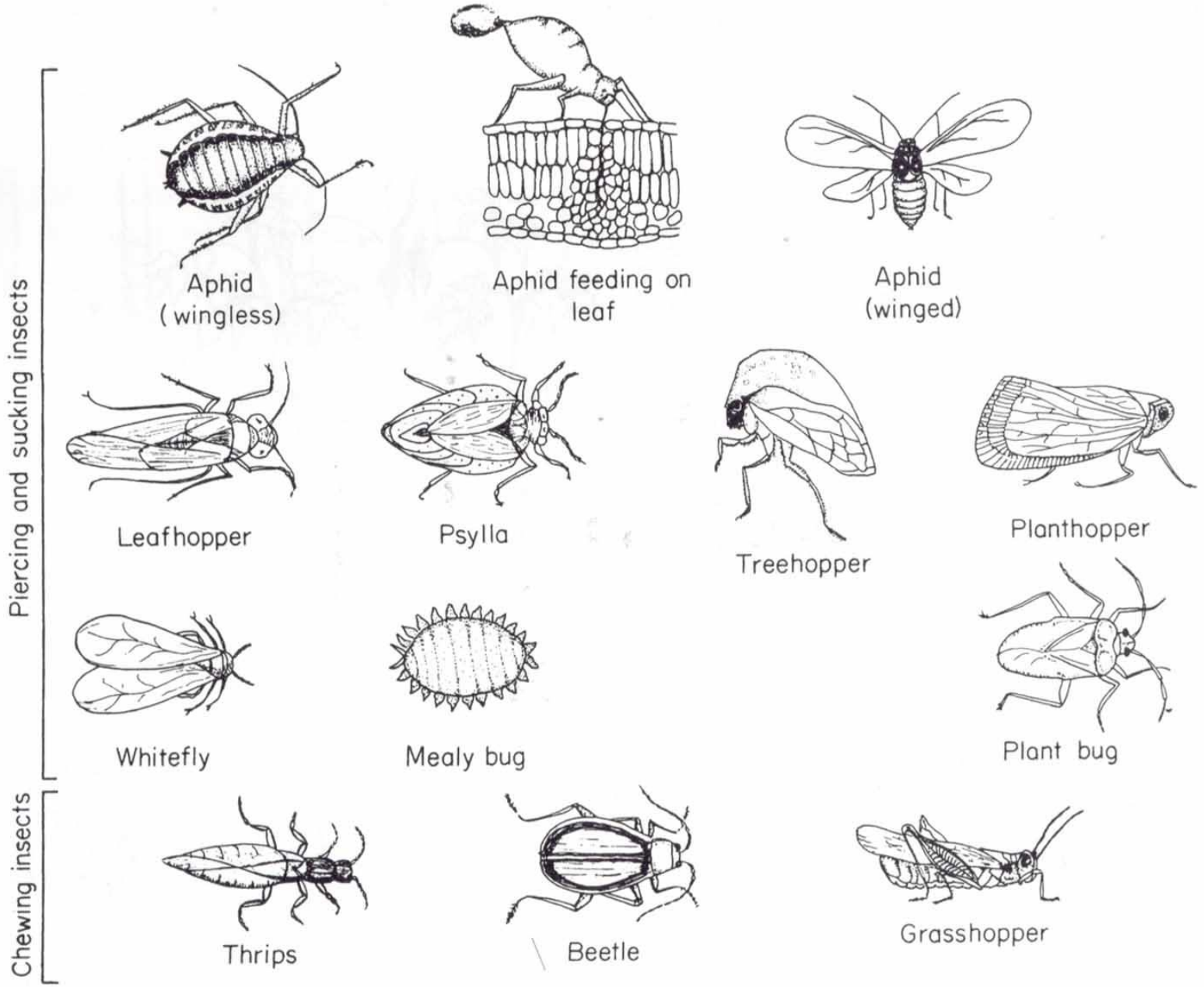


FIGURE 14-18 Insect vectors of plant viruses. Insects in second row from the top also transmit mollicutes and fastidious vascular bacteria.

Inoculativity = the ability of an aphid or other insect to deliver virus into a healthy plant.

Acquisition feed = the feeding process by which the insect acquires virus from an infected plant.

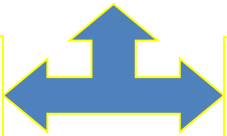
Inoculative feed = the feed during which virus is delivered into a healthy plant.

Latent period = the time after acquisition feed for which the aphid is unable to transmit the virus.

Retention time = how long the aphid retains the ability to infect plant.

Circulative transmission (persistent)

Nonpropagative
Virus do not replicate in insect

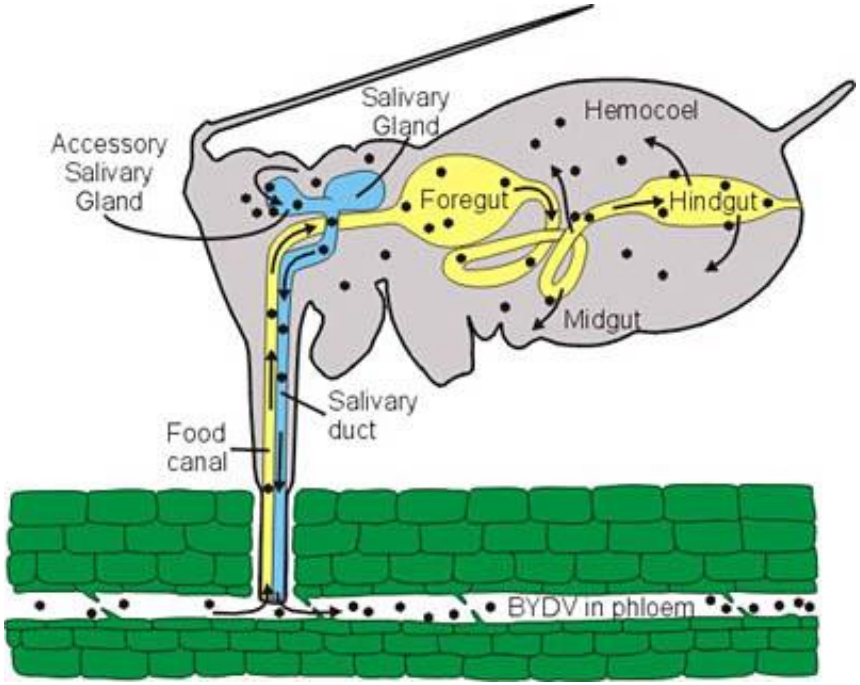


Propagative
Replicate in aphid vector,

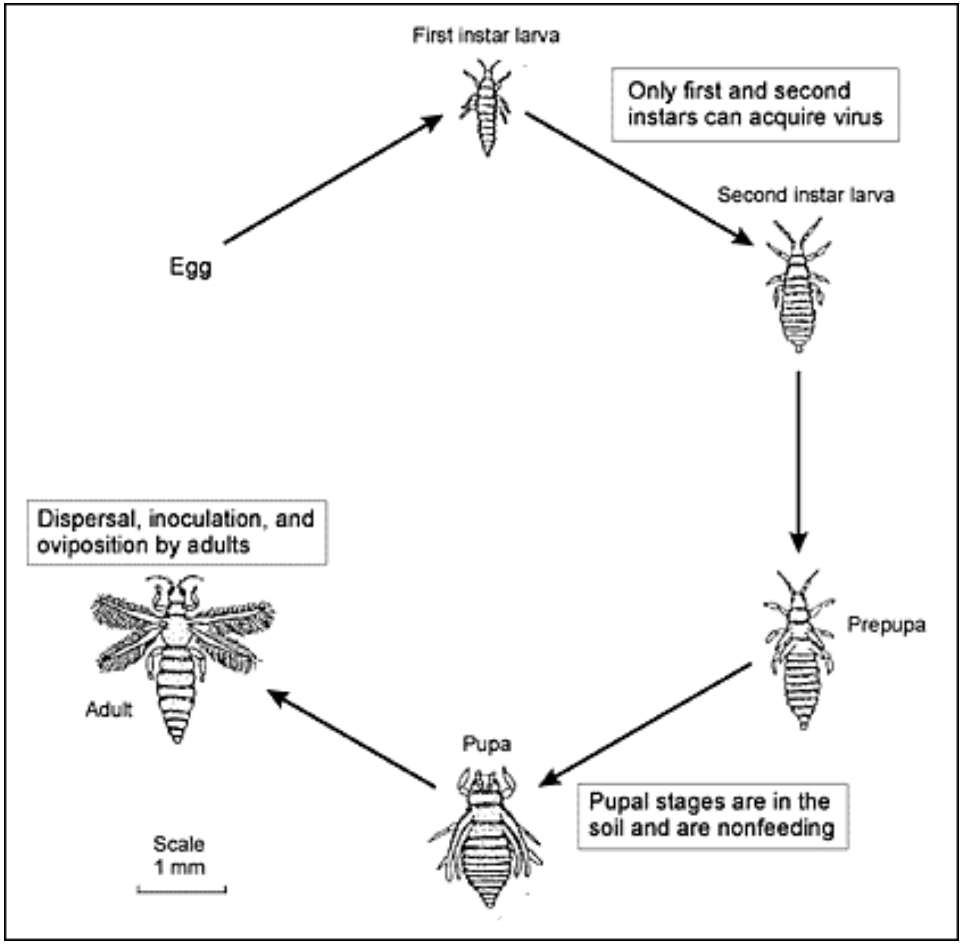
Noncirculative transmission

Nonpersistent
Stylet tip, food canal, foregut, short retention time

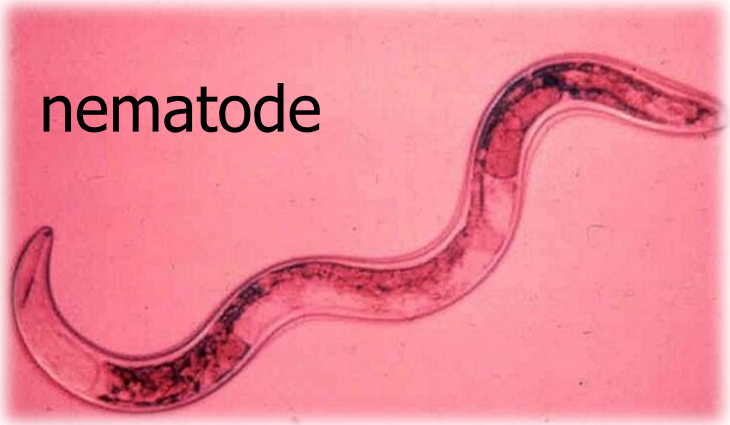
Semipersistent
Adsorbed to foregut,
Virus confined to phloem,
Longer acq. feed



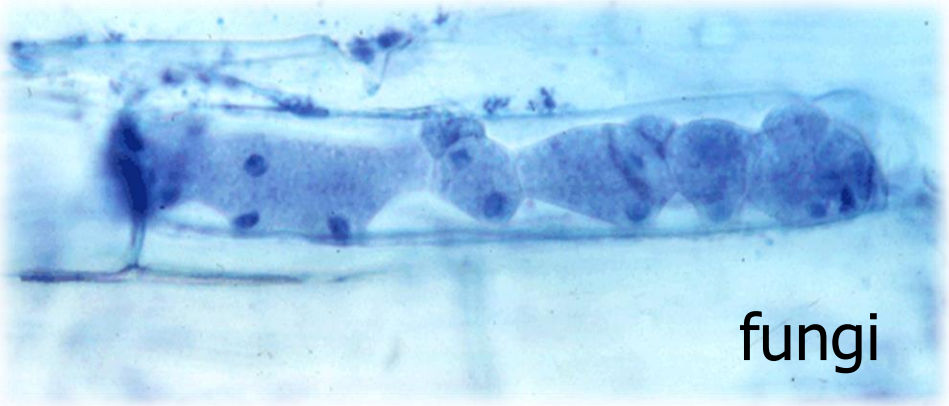
persistent transmission: (syn. circulative transmission)
a type of virus transmission in which the virus is acquired and transmitted by the vector after relatively long feeding times and remains transmissible for a prolonged period while in association with its vector (aphid vector feeding on a plant host showing the internal route of the viruses that cause barley yellow dwarf)

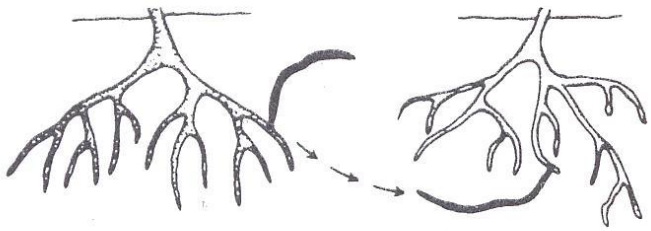


white fly life cycle

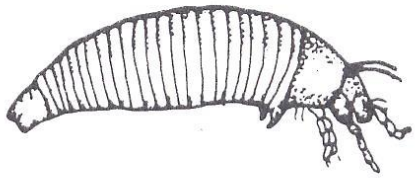

nematode


mite


fungi

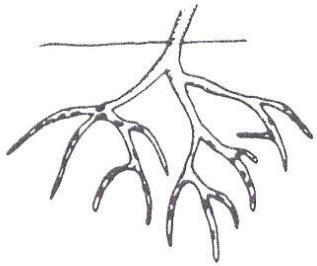


Virus transmission by nematodes

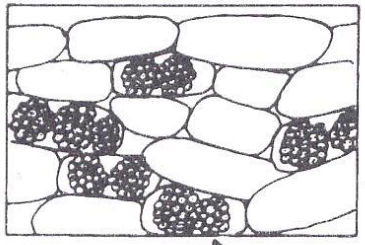


Eriophyid mite

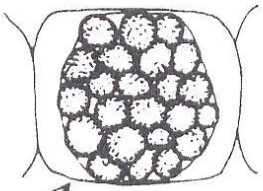
Mite vector of plant viruses

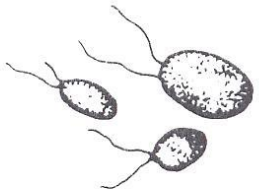


Plant infected with virus and fungus

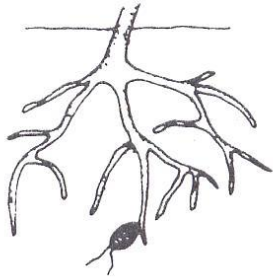


Fungal zoosporangia in root of virus-infected plant





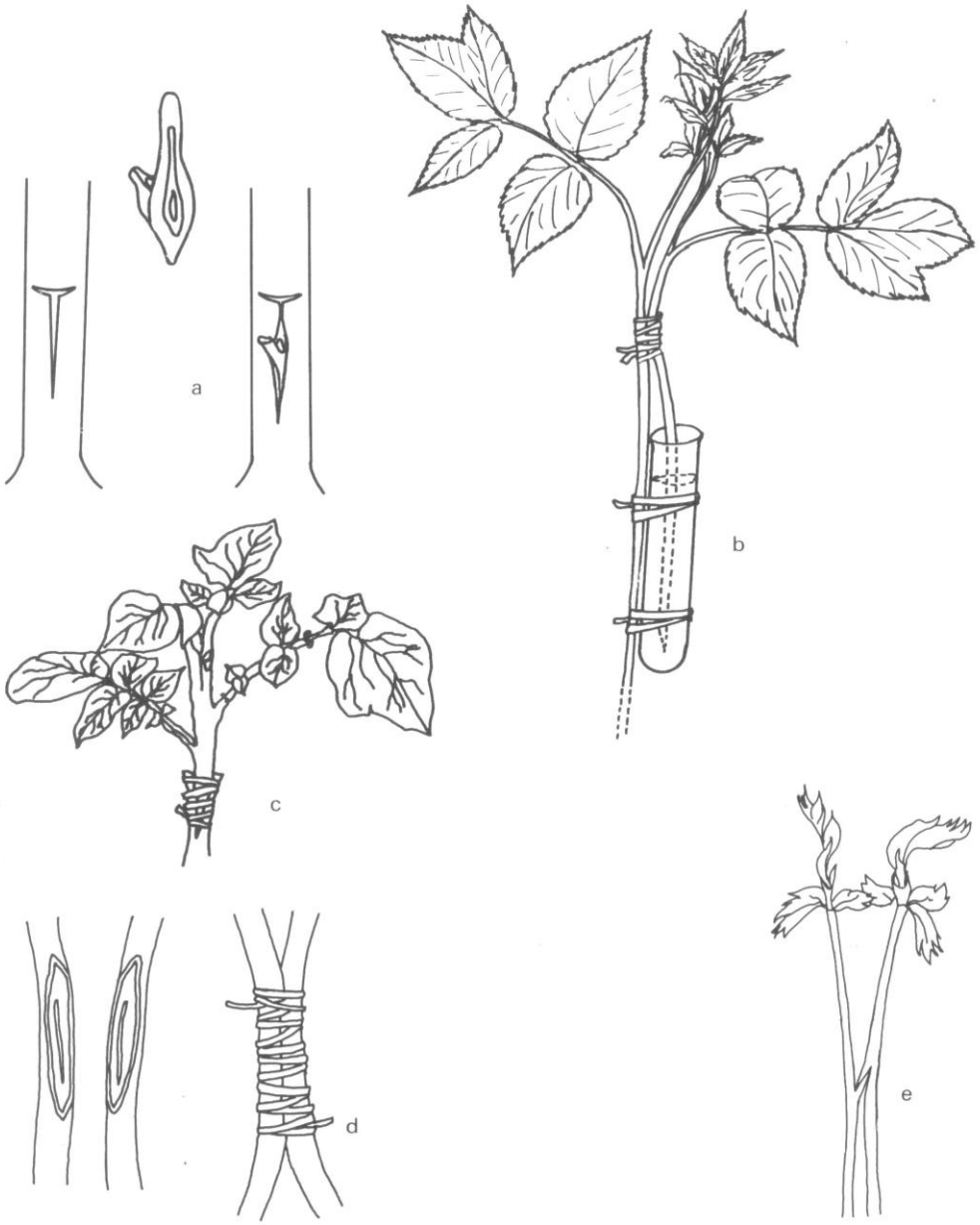
Virus-carrying zoospores leave plant



Zoospore infects new plant and transmits virus

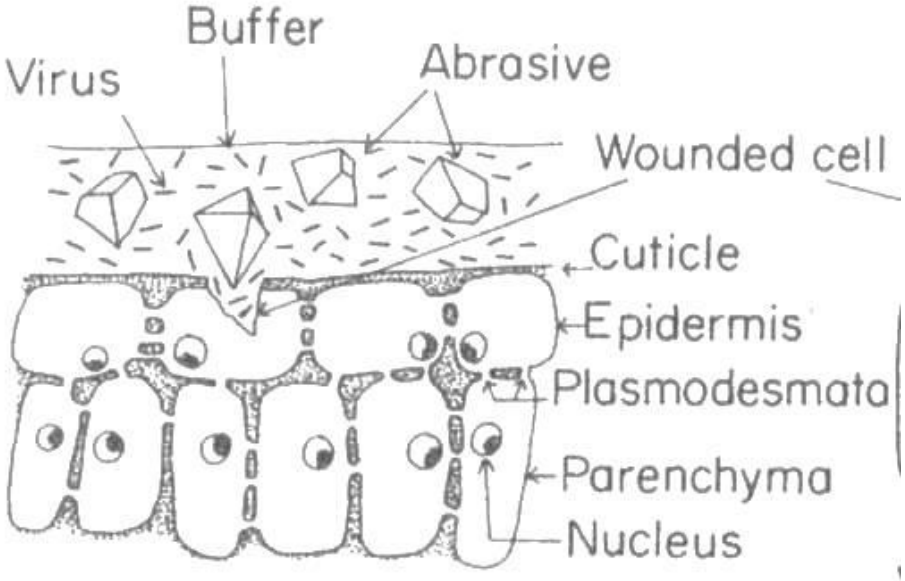
FIGURE 14-20 Transmission of plant viruses by nematodes, mites, and fungi.

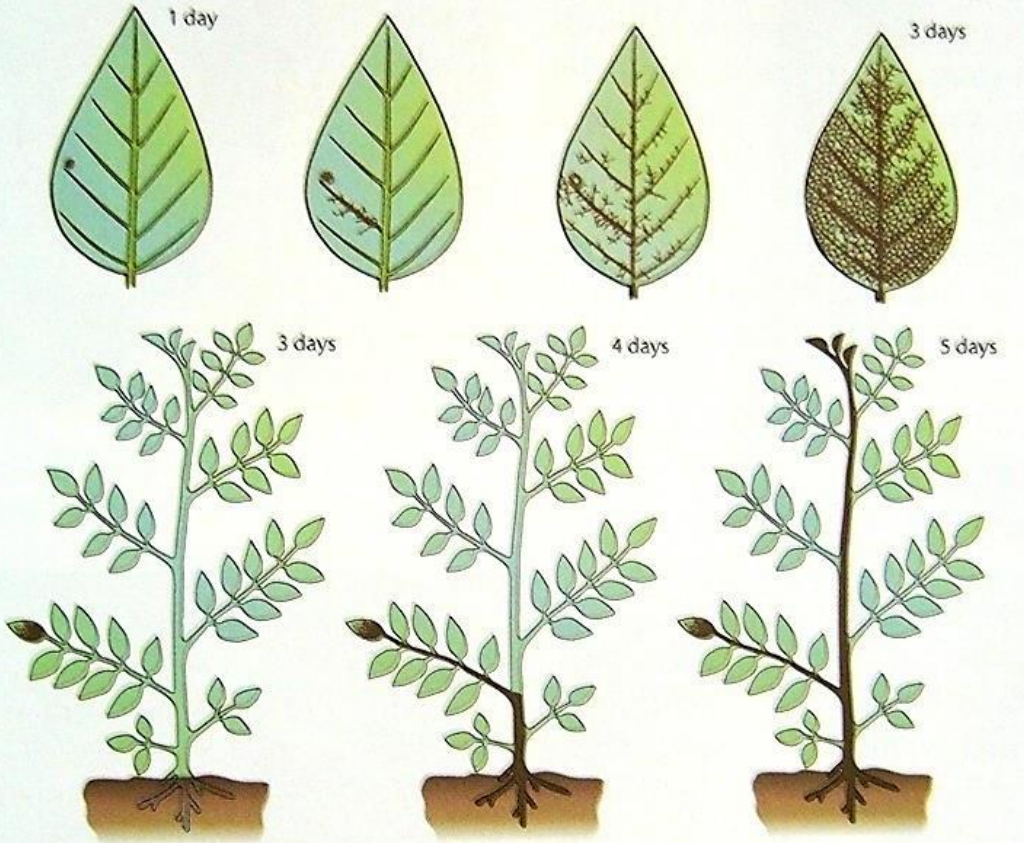
Vegetative transmission



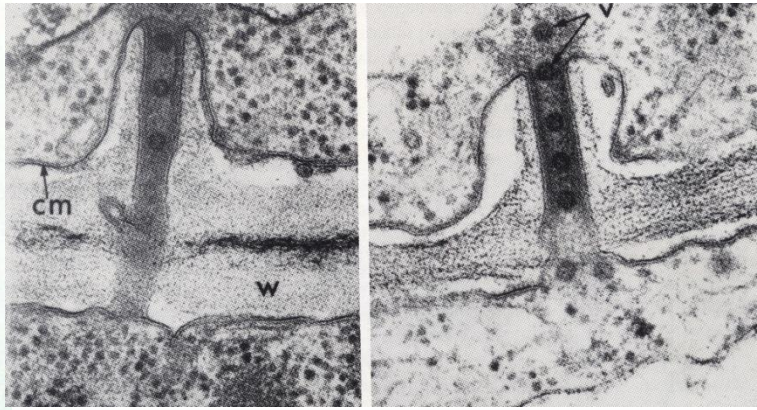
carborundum

Mechanical inoculation

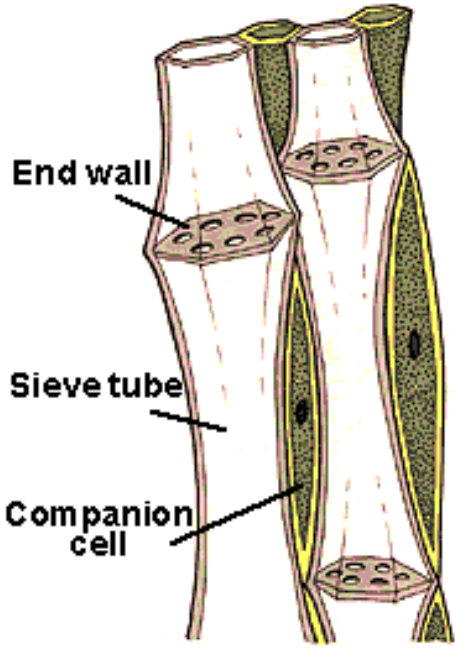




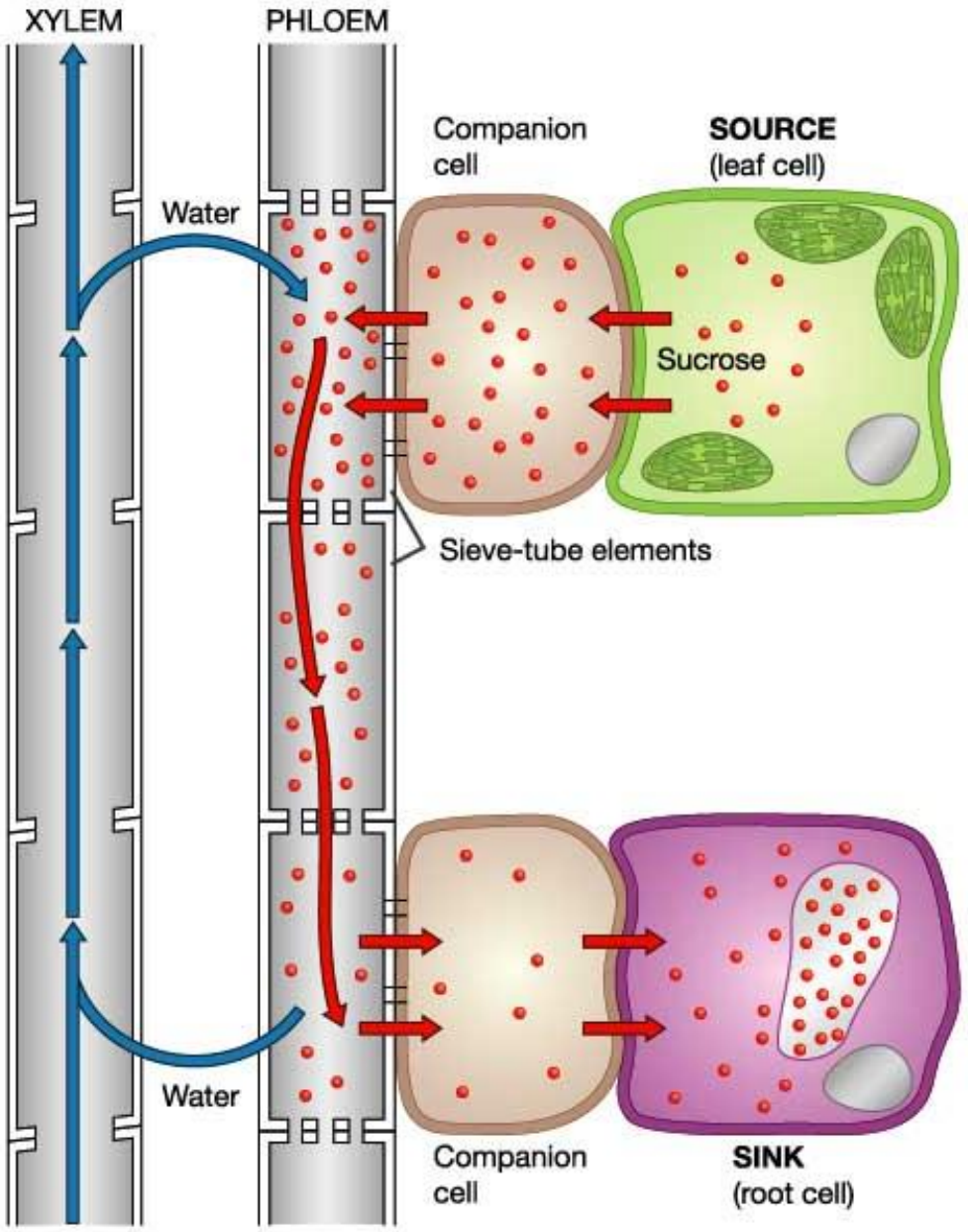
- Movement of virus in plant
- 8-10 mm/day by cell-to-cell movement



Zinnia leaf-
dahlia mosaic virus



Phloem cells are alive. Companion cells provide the energy for the tube cells. The end walls of the tube cells hav pores through which food is transported from cell to cell ir the form of dissolved sugars



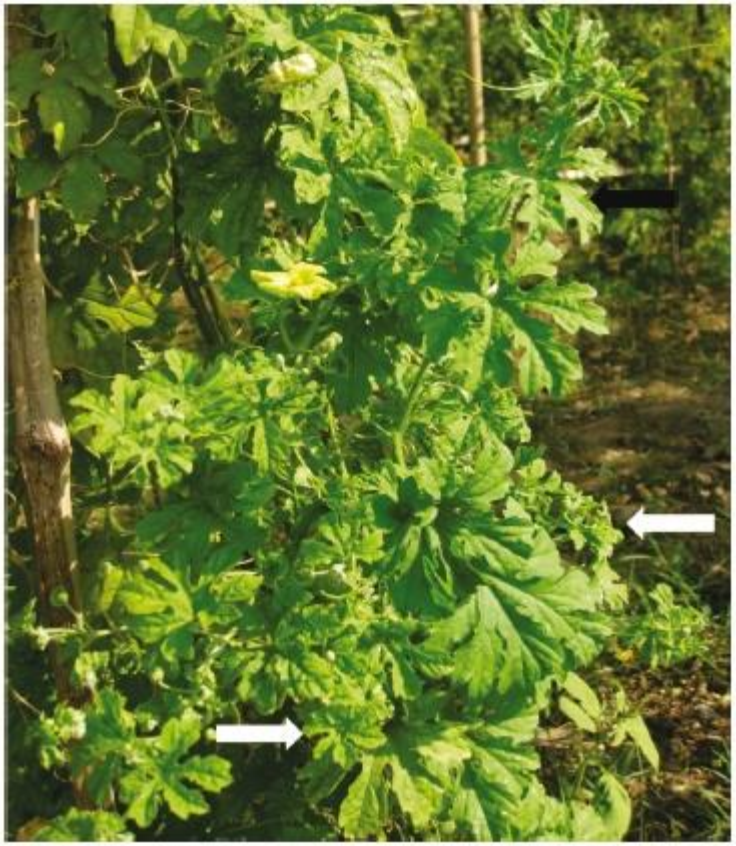
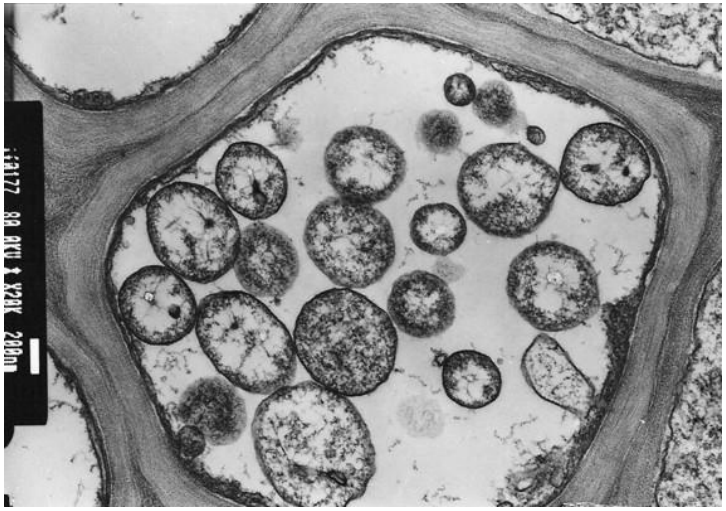


FIGURE 1 - Little leaf symptom on naturally infected bitter gourd plants exhibiting yellowish green, thickened, puckered leaves and internodes shortening (white arrow) compared to normal healthy vine (black arrow).



DISEASE DETECTION & IDENTIFICATION

Diagnosis of Plant Viruses

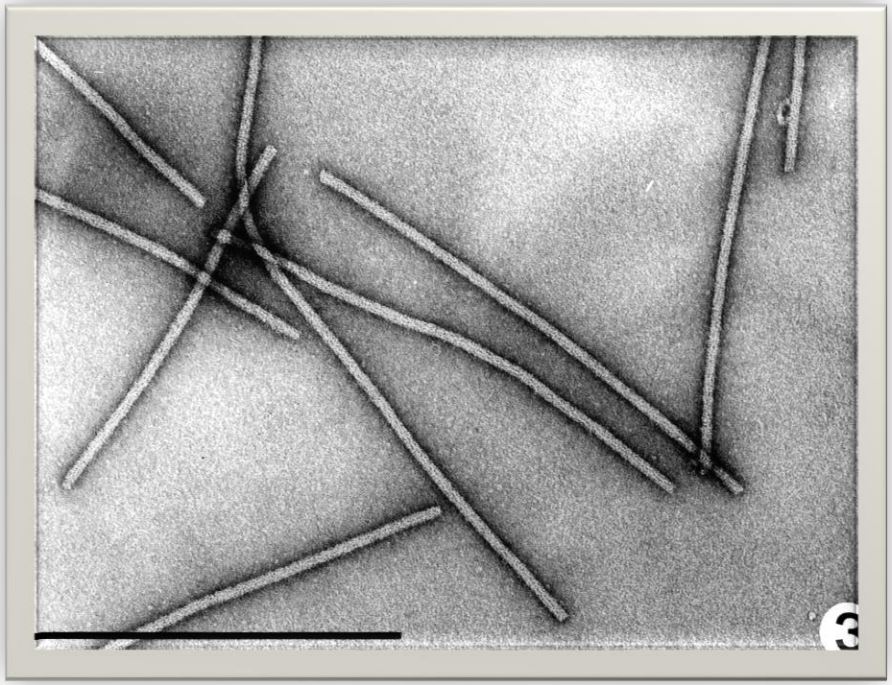
- Observation of symptom on plant; leaf, flower, fruit, stem, root, tuber, bulb, etc.
- Data collection on field area and environment
- Observation of signs that may be caused by other plant pathogens (fungi, bacteria, nematode, nutrient deficiency, etc.) or insects.
- Identification of viruses

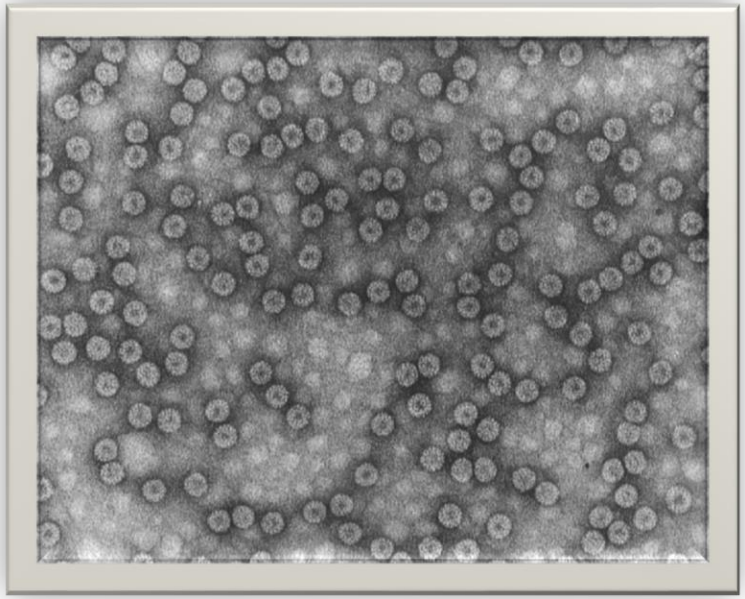
Identification of viruses

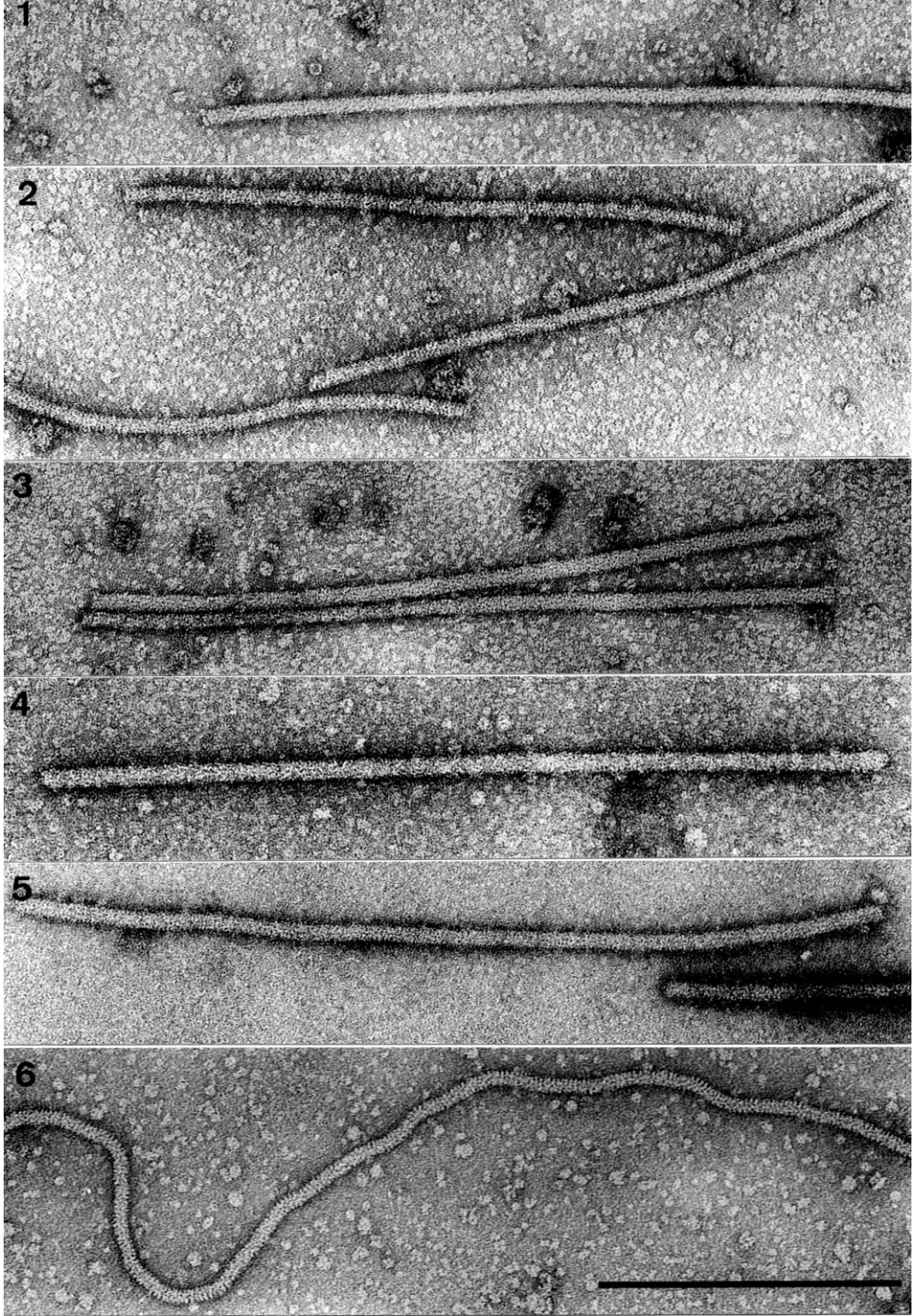
- Determination of size and shape by transmission electron microscope
- Determination of host range
- Determination of insect vectors
- Identification by serological techniques
  - Enzyme-linked immunosorbent assay (ELISA)
  - Dot immunobinding assay (DIBA)
  - Immunostrip, lateral flow assay
- Identification by DNA techniques
  - polymerase chain reaction (PCR)
  - DNA hybridization

Determination of size and shape by transmission electron microscope

Morphology of plant viruses







ZYMV

PVX

PVS

SPLV

SPMYEV

CTV

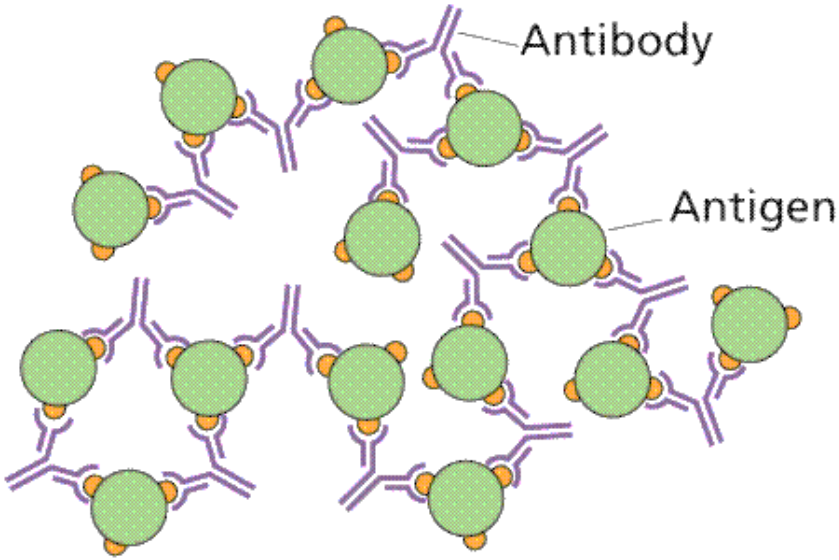
Control of Virus Diseases

- **Prevention**
  - Virus-free propagating materials
  - Resistant varieties; breeding, GMO
  - Control of insect vectors
  - Cross protection
- **Eradication**
  - Remove infected plants
  - Eradicate weeds and alternative hosts
  - Cultural practice; crop-free period, crop rotation..
- **Therapy**

Routine detection

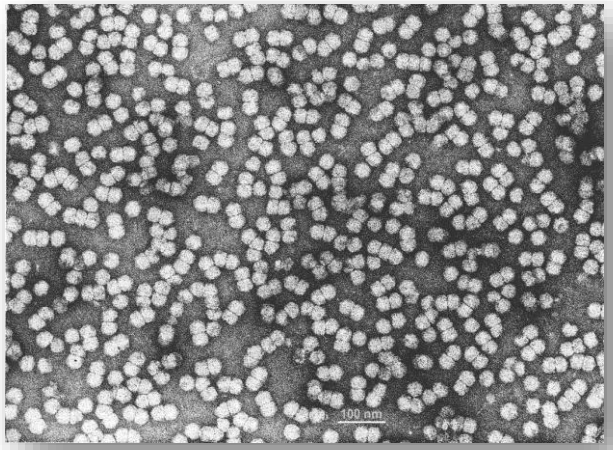
- Identification by serological techniques
  - Enzyme-linked immunosorbent assay (ELISA)
  - Dot immunobinding assay (DIBA)
  - Immunostrip, lateral flow assay
- Identification by DNA techniques
  - Polymerase chain reaction (PCR)

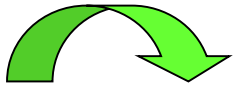
Identification by serological techniques



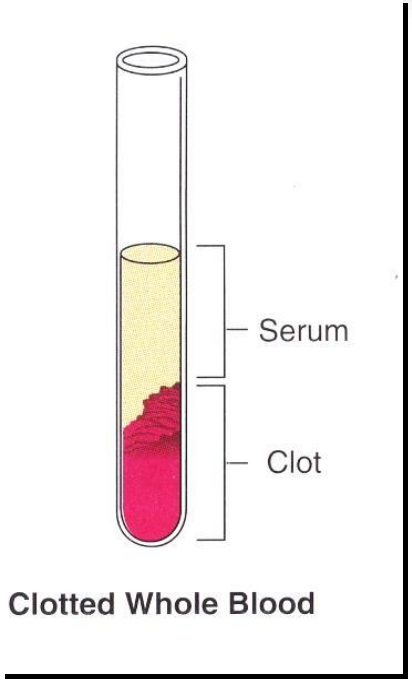
Antigen-antibody reaction

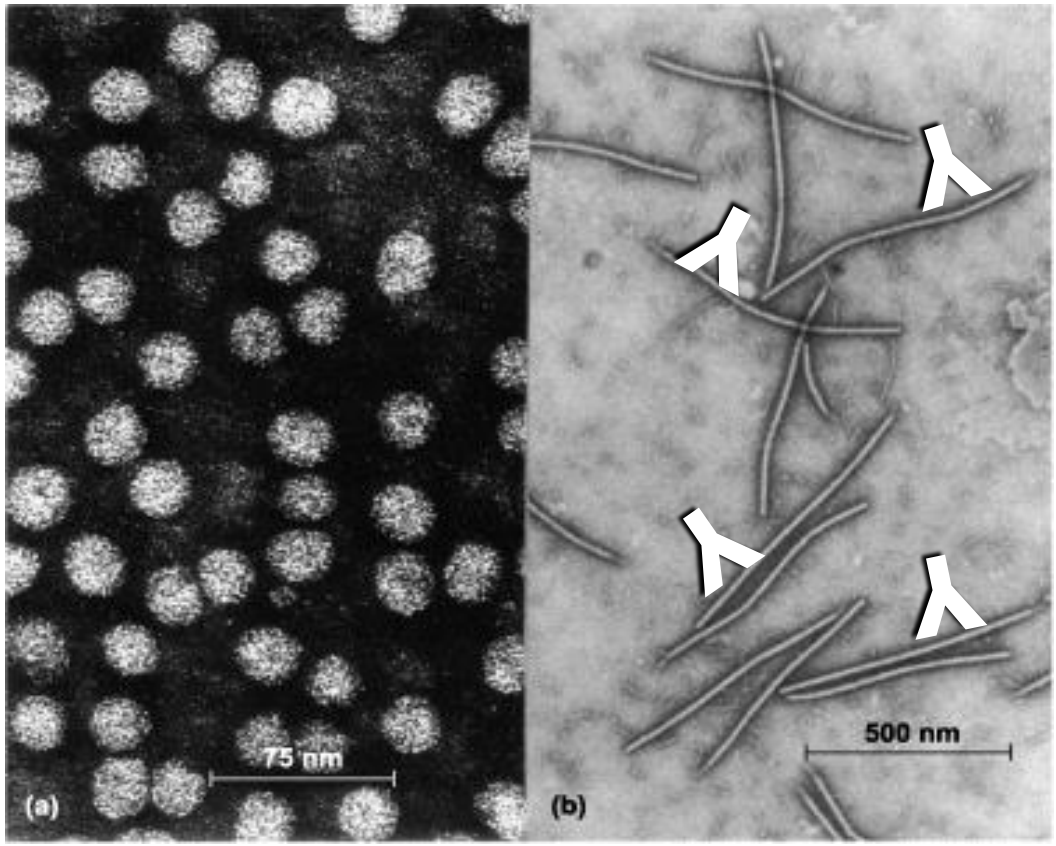
Antiserum production





antiserum

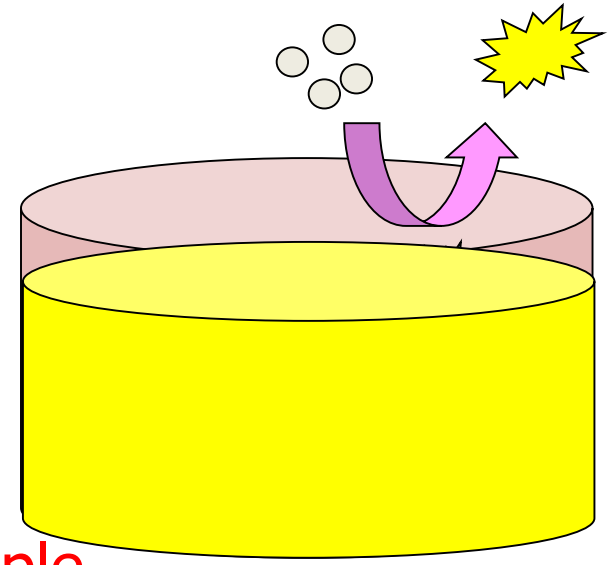




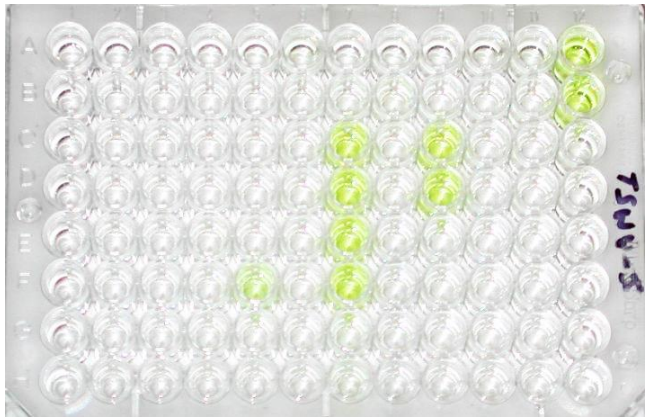
Virus-specific antibody

- Enzyme-linked immunosorbent assay (ELISA)
- Dot immunobinding assay (DIBA)
- Direct tissue blot immunoassay

Enzyme-linked immunosorbent assay (ELISA)



Plant sample



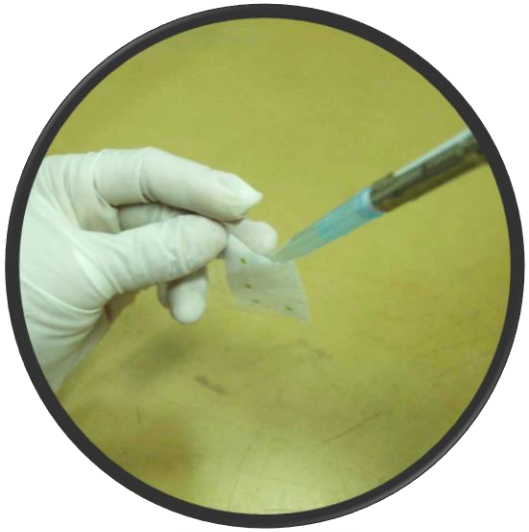
ELISA reader

ELISA kit

DOT IMMUNOBINDING ASSAY (DIBA)

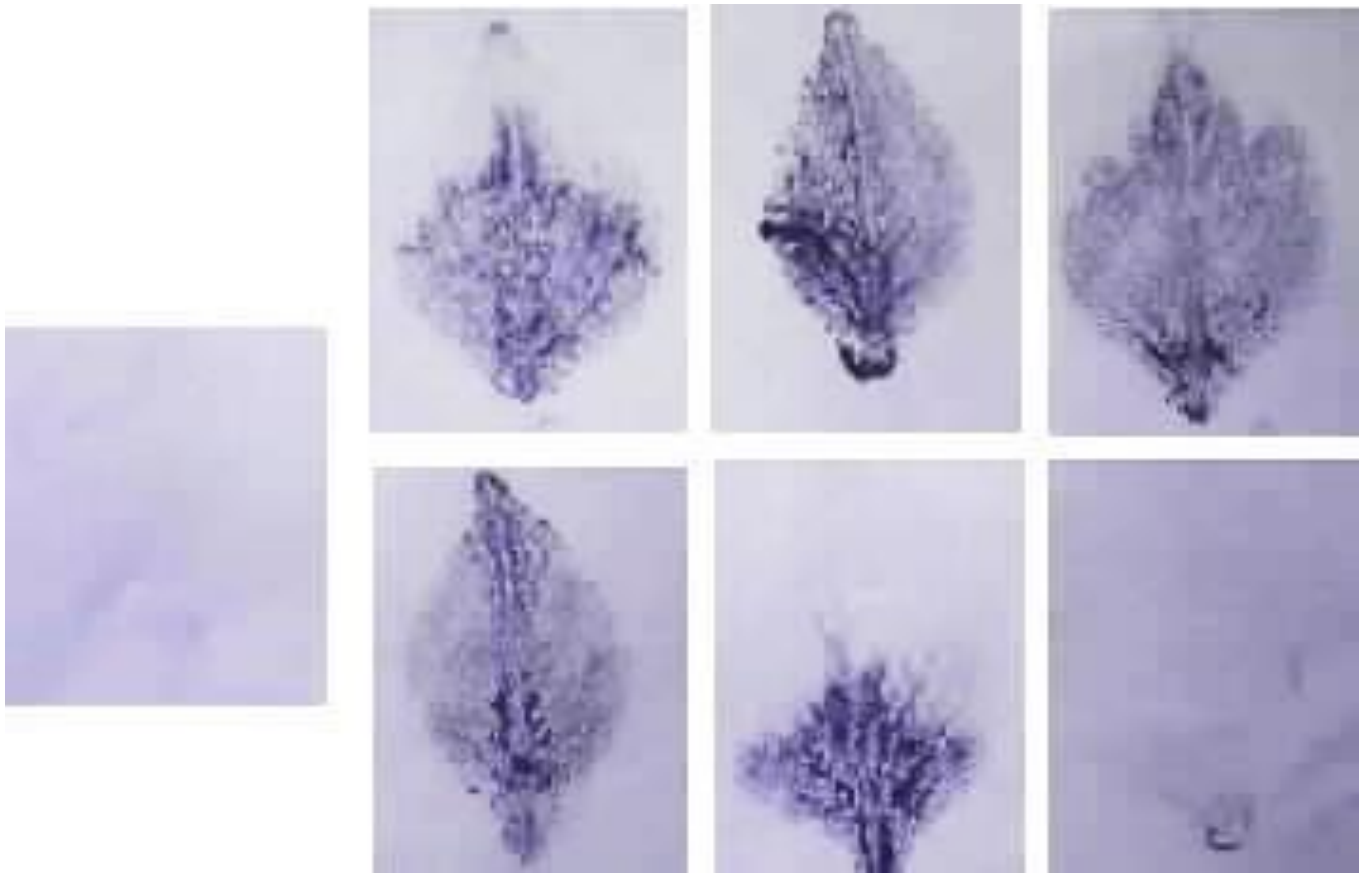
Nitrocellulose membrane

Load drops of antigen (plant sap)

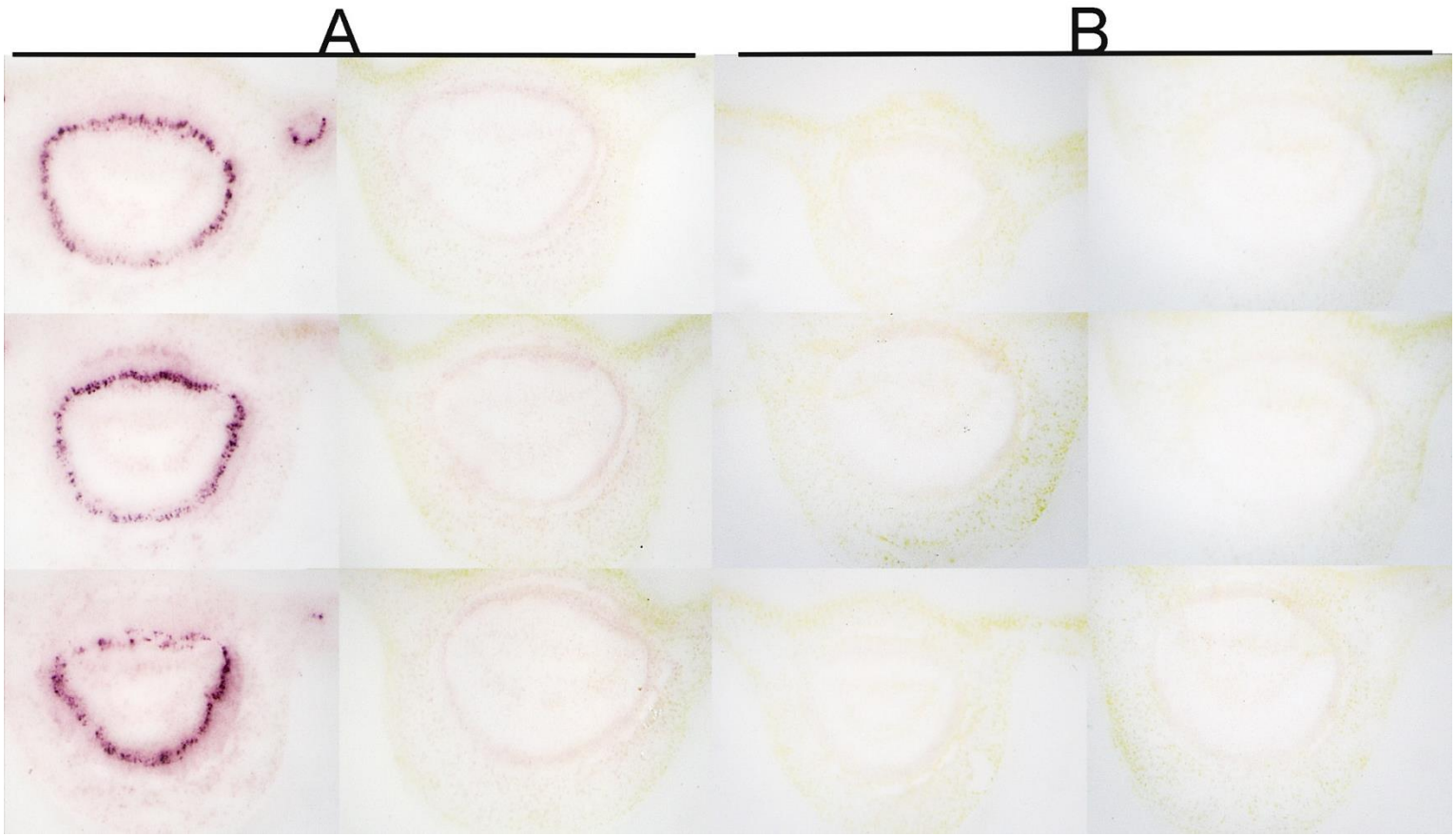


Reacting with specific antibody and color development in a plastic bag

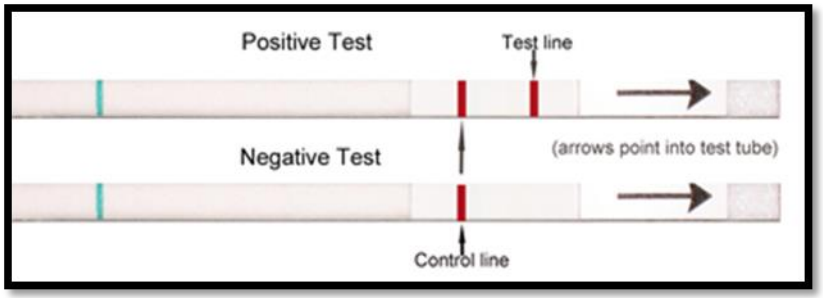
Direct tissue blotting assay

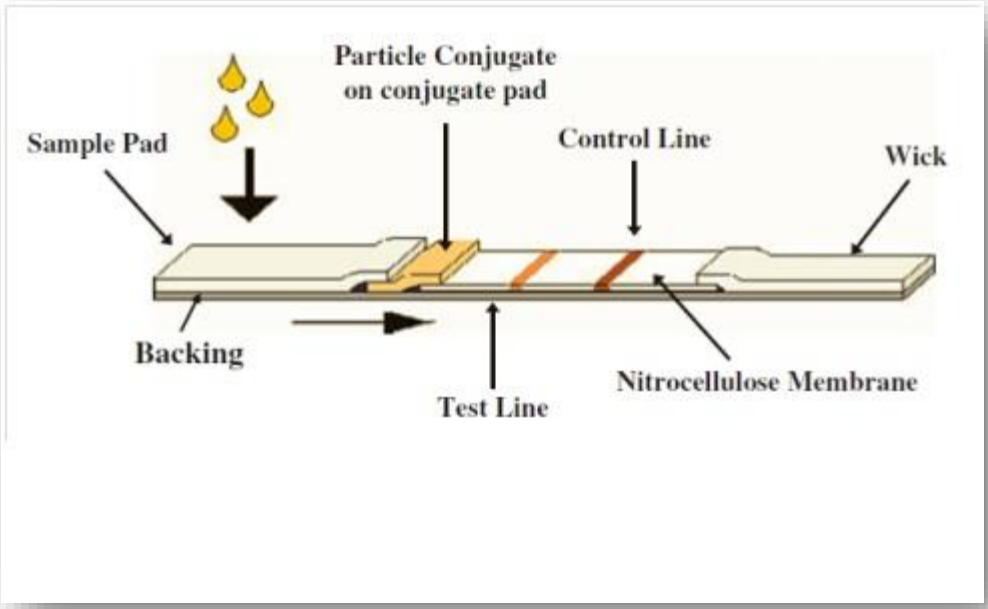


Localization and Distribution of '*Candidatus* Liberibacter asiaticus' in Citrus and Periwinkle by Direct Tissue Blot Immuno Assay with an Anti-OmpA Polyclonal Antibody



Immunostrip (Lateral flow assay)

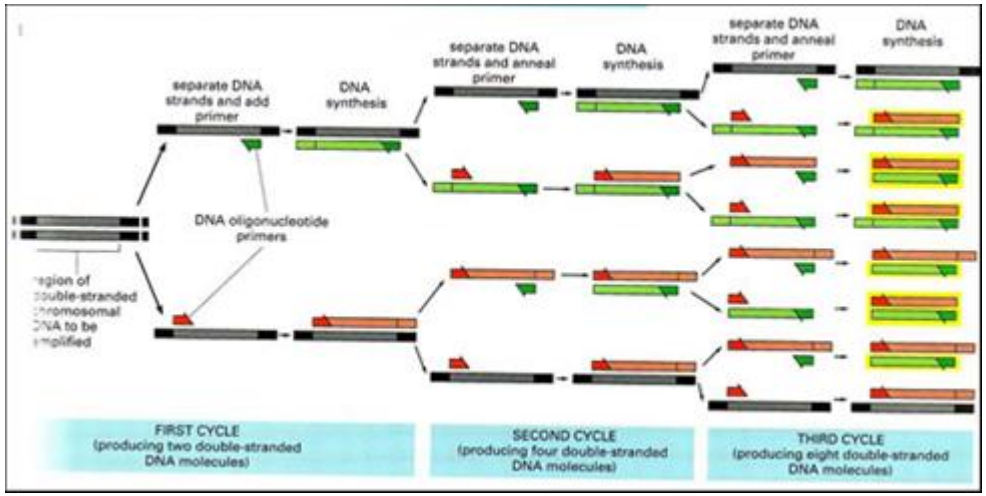


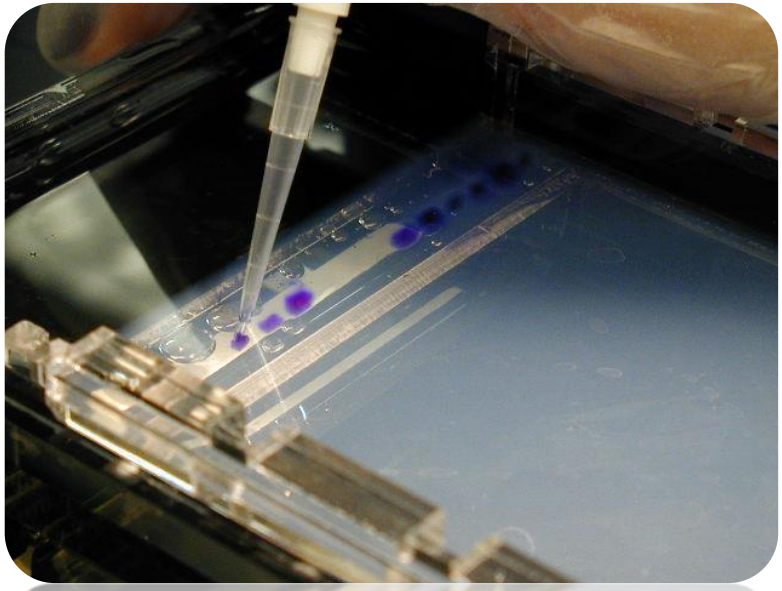

Particle Conjugate
on conjugate pad
Sample Pad
Control Line
Wick
Backing
Test Line
Nitrocellulose Membrane

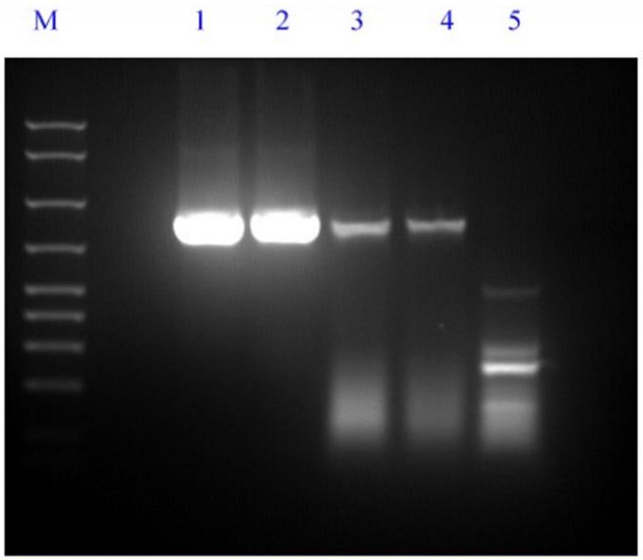

Multiplex detection Kit
Aac / Potyvirus / WMV-2
Extraction Buffer
15 ml
Extraction Buffer
15 ml

POLYMERASE CHAIN REACTION

Specific primer for each virus







M) Amplisize MW Marker

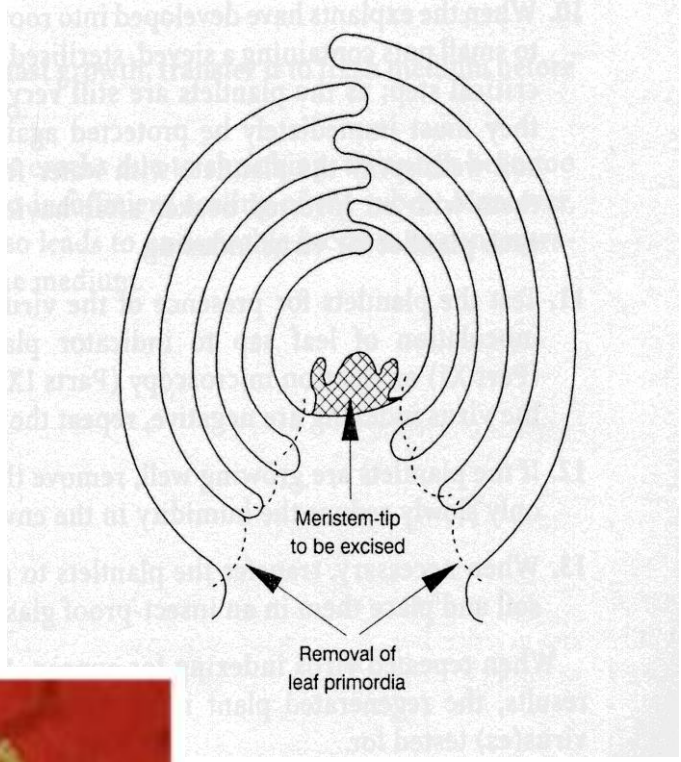
1-2) Control Plasmid
3-4) RT-PCR of CAII
5) Beta Actin Control

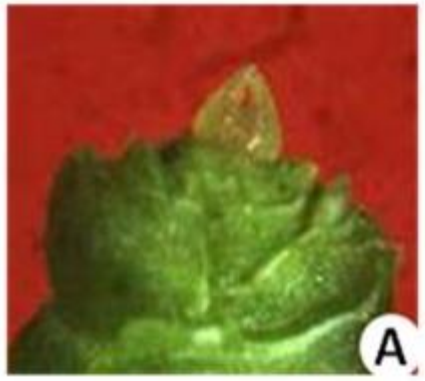
Several PCR reactions were set up on the RNA isolated from experiment 14. One PCR reaction was a positive control using a plasmid with the CAII gene already cloned into it. The second reaction was an RT-PCR (reverse transcription - polymerase chain reaction) using the RNA isolated from experiment 13 to amplify the CAII gene. The final reaction was a beta actin control RT-PCR on the isolated RNA.. Each reaction was set up in duplicate. An aliquot of each was loaded and run in a 1% agarose/TBE gel and stained with ethidium bromide.

Control of Virus Diseases

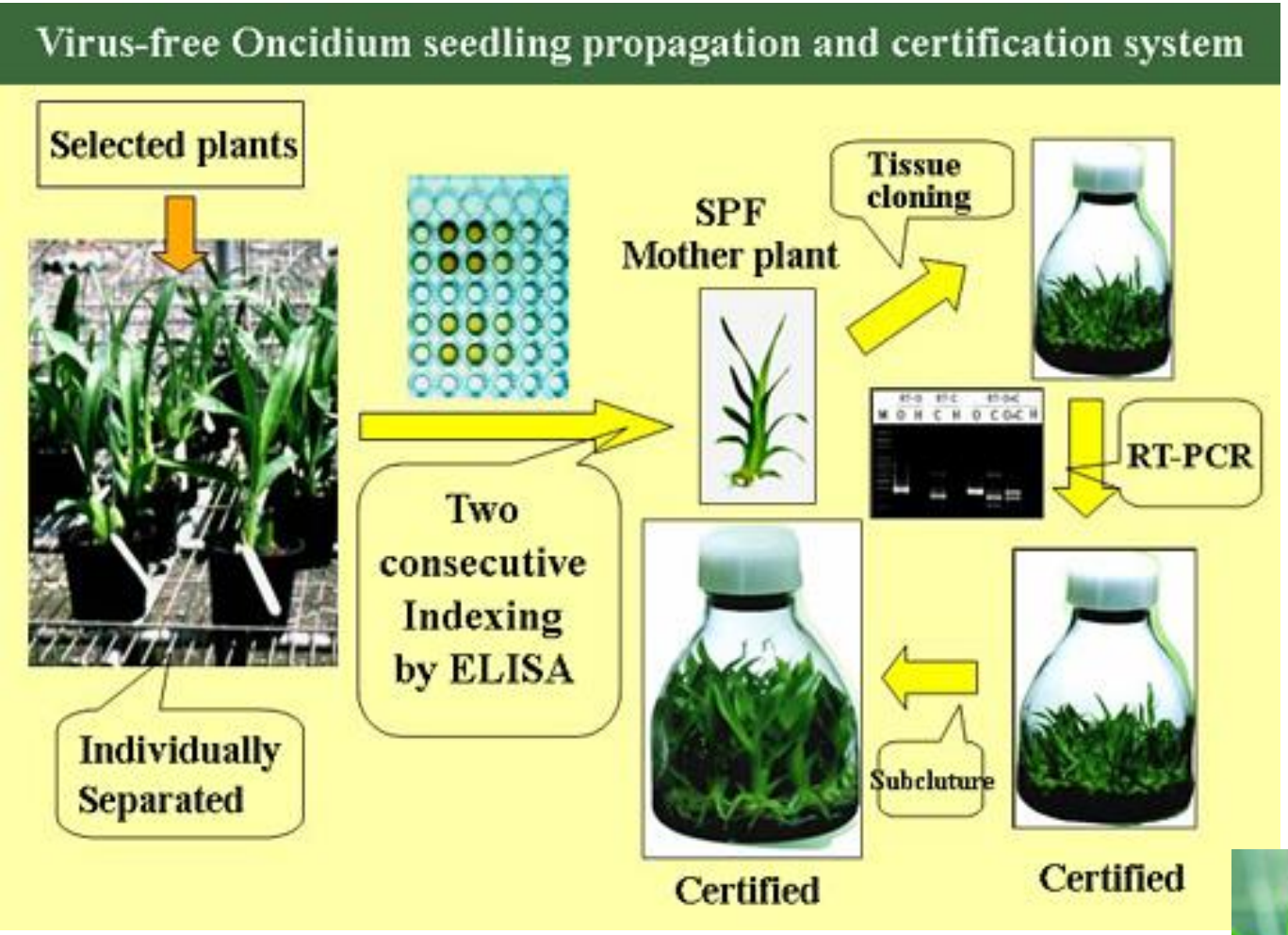
- **Prevention**
  - Virus-free propagating materials
  - Cross protection
  - Resistant varieties; breeding, GMO
  - Control of insect vectors
- **Eradication**
  - Remove infected plants
  - Eradicate weeds and alternative hosts
  - Cultural practice; crop-free period, crop rotation..
- **Therapy**

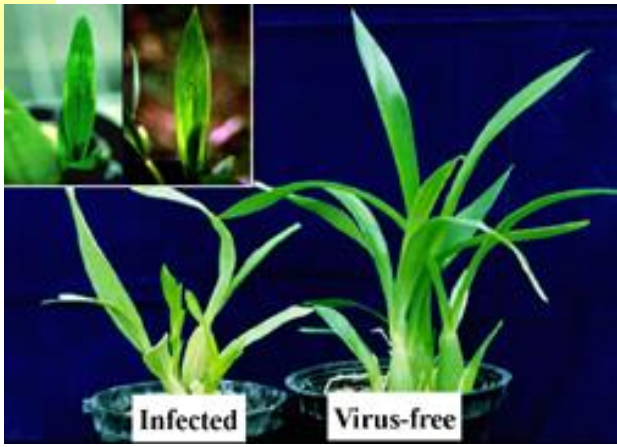
Meristem-tip culture



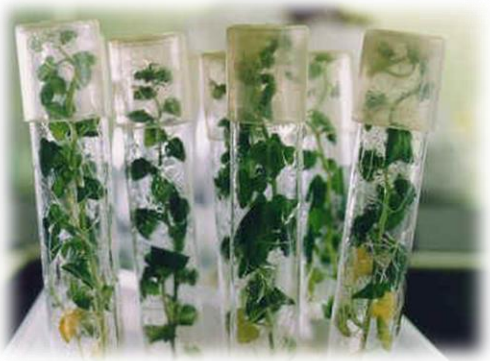


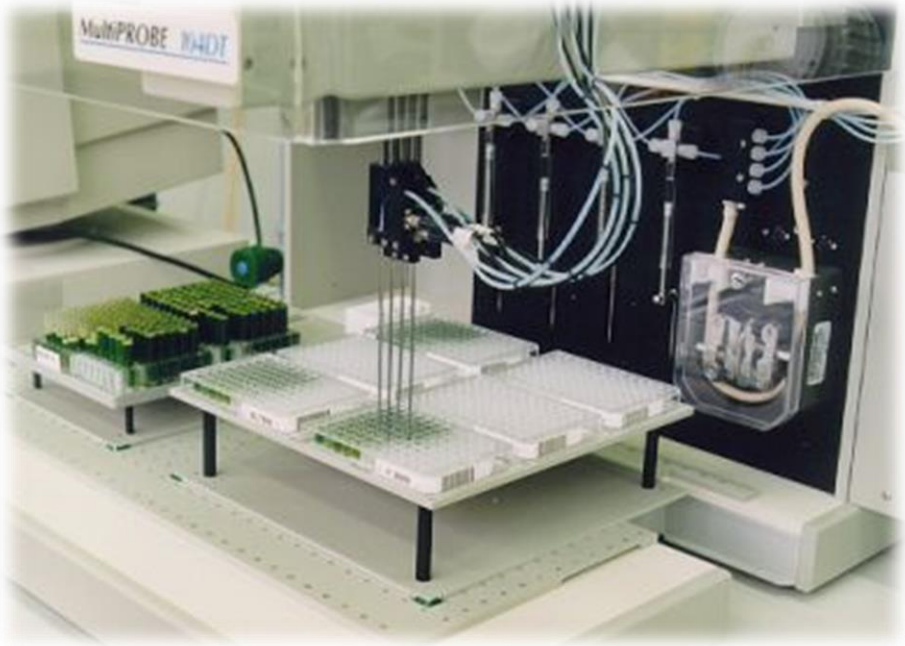
Virus-free Oncidium seedling propagation and certification system





Certification of disease-free planting materials





Cross protection

by infecting young plants with mild strain of virus to prevent the infection of severe strain of the same virus.

Inoculate mild strain

Resistant plant

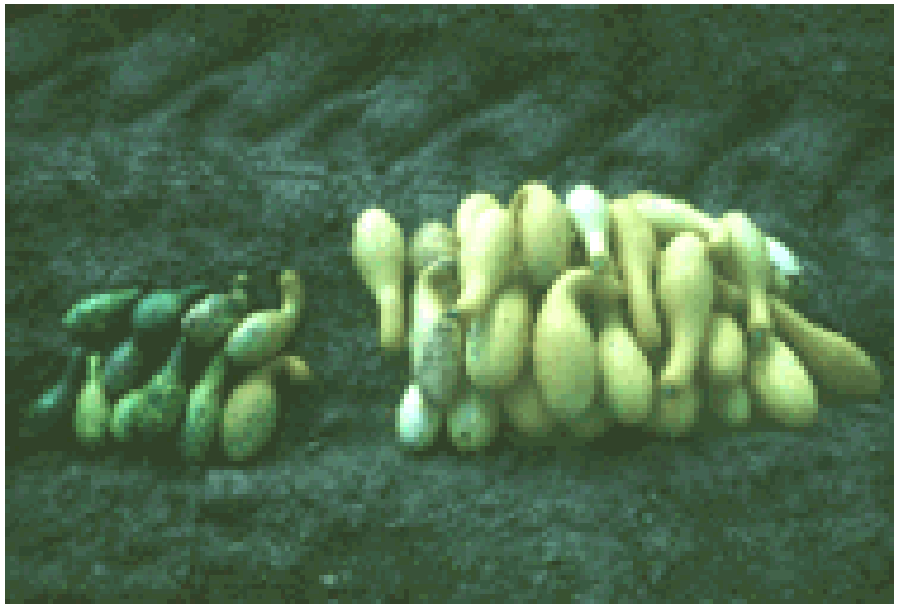
No symptom after challenging with the severe strain

Resistant varieties

Papaya resistant to papaya ring spot virus

Squash resistant to..

- *Zucchini yellow mosaic virus* (ZYMV), *Watermelon mottle virus 2* (WMV-2), *and Cucumber mosaic virus* (CMV).



Comparative yield of fruit from border row (infected) with that from transgenic plant row that did not become infected.

Effect of virus on fruit distortion and coloration. Fruits in the foreground are from virus infected plants, are distorted, and have mosaic green and yellow patterns. The fruits in the background are from the same field but are from virus resistant transgenic plants. Note that the fruits are not deformed and show the typical yellow color.

squash
zucchini yellow mosaic virus
watermelon mosaic vurs –2

Control of Virus Diseases

- Prevention
  - Virus-free propagating materials
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  - Control of insect vectors
  - Cross protection
- Eradication
  - Remove infected plants
  - Eradicate weeds and alternative hosts
  - Cultural practice; crop-free period, crop rotation..
- Therapy

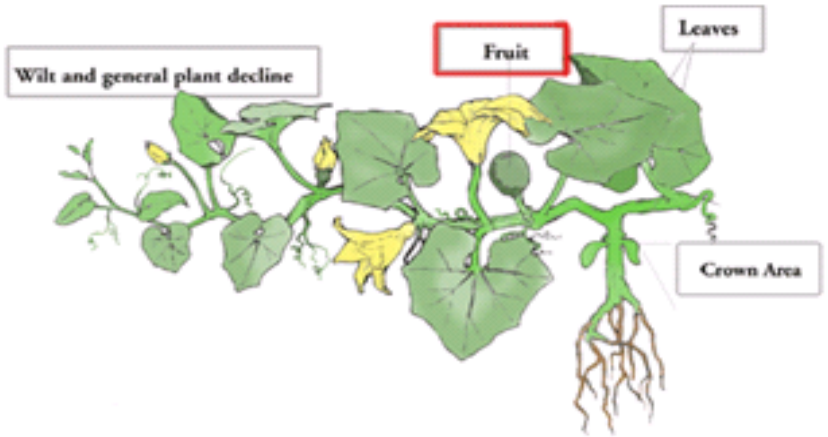
CORNELL UNIVERSITY

Vegetable MD Online

Department of Plant Pathology, Ithaca, NY 14853

- Diseases By Crop (Fact Sheets)
- Search Function
- Photo Gallery
- News Articles/ Disease Alerts
- Diagnostic Keys NEW!
- Virus Weed Hosts/ Rotation Lists
- Resistant Varieties
- Glossary of Plant Pathology Terms
- Vegetable Guidelines
- Vegetable IPM Links
- Other Vegetable Links
- Cornell Plant Disease Clinic
- Home

Diagnostic Key:Diseases of Cucurbit Fruits



Bacteria

- Angular leaf spot
- Bacterial leaf spot

Phytoplasma

- Aster Yellows

Viruses

- Viruses

Fungi/oomycete

- Anthracnose
- Choanephora
- Fusarium dry rot
- Gummy stem blight black
- Phytophthora fruit rot
- Plectosporium blight
- Pythium
- Scab
- Sclerotinia white mold
- Septoria

Miscellaneous

Viruses

Viruses: Fruit	Fruit symptoms present
 Symptoms shown on melon	See symptoms on: Pumpkin & Gourd; Cucumber; Melon; Summer Squash; Winter Squash No Photos Available; Watermelon      
	Fruit mottled, discolored (e.g. green blotches), distorted, bumpy, malformed. Plant stunted. Leaf symptoms also.

Miscellaneous

Miscellaneous: Fruit	Fruit symptoms present
 Symptoms shown on pumpkin	See symptoms on: Pumpkin & Gourd; Cucumber No Photos Available; Melon; Summer Squash No Photos Available; Winter Squash; Watermelon No Photos Available      

ALSO SEE:

Diagnostic Key —Cucurbit: Wilt and General Plant Decline and Crown Area

Diagnostic Key —Cucurbit: Diseases of Leaves

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Diseases By Crop (Fact Sheets)

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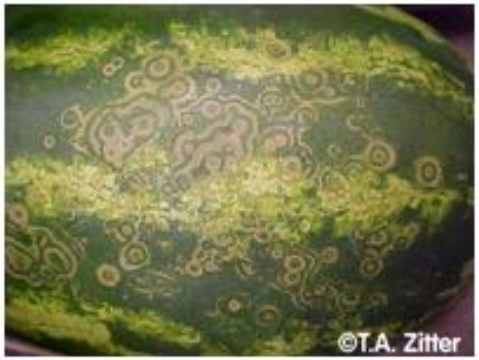
Symptoms of viruses on watermelon fruit



unmarketable. A complex of viruses is able to infect cucurbits. a plant group that includes cucumber, melon, squash, pumpkins, and watermelon. The most important viruses are cucumber mosaic (CMV), squash mosaic (SqMV), watermelon mosaic I (WMV-1), watermelon mosaic 2 (WMV-2), and zucchini yellow mosaic (ZYMV). With the exception of SqMV, which is seedborne in melon and transmitted by beetles, the other major viruses are transmitted by several aphid species in a nonpersistent manner.

Major Cucurbit Viruses

***Squash mosaic virus* (SqMV)** can cause an important disease of melons and squash in New York. The virus is seedborne in muskmelon and is spread in nature principally by the spotted and striped cucumber beetles. The virus is carried within the seed and cannot be eliminated by hot water or chemical treatment with tusodium phosphate.

Symptoms consist of pronounced chlorotic mottle, green veinbanding, and distortion of leaves of young seedlings. On mature plants, leaves show intense dark green mosaic, blistering, and hardening, suggestive of a hormonal herbicide effect (fig. 1). Infected fruit coming from such plants show a strong mottled pattern with a lack of netting on melons (fig. 2). Control measures include selection of disease-free seed and cucumber beetle control.

***Cucumber mosaic virus* (CMV)** is probably the most widely distributed and important virus disease of cucurbits in New York. The virus overwinters in many perennial weed sources especially attractive to aphids when weed growth resumes in the spring. Early infection of squash and melons is particularly common. Aphids are the main and most efficient method of virus spread. Summer squash displays severe downward cupping along the midvein and leaf reduction from which the plants fail to recover (fig. 3). Color breaking of squash fruit is usually seen, but is not unique for this virus; other viruses causing this symptom include watermelon mosaic viruses 1 and 2, squash mosaic virus, and zucchini yellow mosaic virus. Early decline of muskmelon vines is usually attributed to CMV infection and should not be confused with collapse or "sudden wilt," which is a more complex disease and a plant-stress-related syndrome. CMV may be seedborne to a limited extent in some crops and weeds such as common chickweed *(Stellaria media)*. Good CMV-resistant (actually tolerant since plants are infected by the virus) cucumber varieties are commercially available and produce a high percentage of unmottled fruit. All other commercially grown cucurbits are susceptible to CMV, although in yellow summer squash varieties that also carry a "precocious yellow gene," this gene serves to mask the color breaking common with cucurbit viruses (see discussion under WMV-2).

***Watermelon mosaic virus 2* (WMV-2)** is the second most important cucurbit virus in New York. This virus can infect and produce symptoms on all commercially grown cucurbits. This aphid-transmitted virus causes milder symptoms on the foliage of most infected plants like squash (fig. 4), and growers have seen a lessening of foliar symptoms following fertilization. Fruit distortion and color breaking are still a problem on varieties like yellow straightneck squash (fig. 5). Use of varieties such as 'Multipik' (fig. 6) can prolong the harvest period because the fruit are marketable in spite of foliar symptoms. The host range for WMV-2 is not limited to cucurbits, thus opening the possible overwintering of this virus in several leguminous species such as clover. Mixed infections of cucurbits with CMV and WMV-2 are common by the end of the season.

***Watermelon mosaic virus 1* (WMV-1)** is aphid transmitted, and infection is limited to cucurbits. Although more common in the southern and western regions of the United States, this virus has been recovered in New York several times since it first occurred in epidemic proportions in 1969. This virus is capable of infecting all commercial cucurbit crops. The foliage of affected plants shows strong mosaic, distortion, and deep leaf serration (fig. 7). Fruits are also malformed with knobby overgrowth (fig. 8).

***Zucchini yellow mosaic virus* (ZYMV)** is a recently described virus disease of cucurbits, first identified in Europe in 1981. It has since been reported from most southern and southwestern states and was found in New York State in 1983. The virus has characteristics very similar to WMV-1 and WMV-2 (nonpersistent aphid transmission, etc.), and like WMV-2, its host range is not limited to cucurbits. Currently, none of the genetic factors that confer resistance to WMV-1 or WMV-2 are able to control ZYMV, but other resistance sources have been identified. Muskmelon, watermelon, and squash are severely affected by ZYMV. Foliar symptoms consist of a prominent yellow mosaic, necrosis, distortion, and stunting. Fruits remain small, greatly malformed, and green mottled, including fruit of the variety 'Multipik' (fig. 9). It is too early to tell which weed hosts may serve to overwinter this virus in New York.

Minor Cucurbit Viruses or Disease Agents

Minor Cucurbit Viruses or Disease Agents

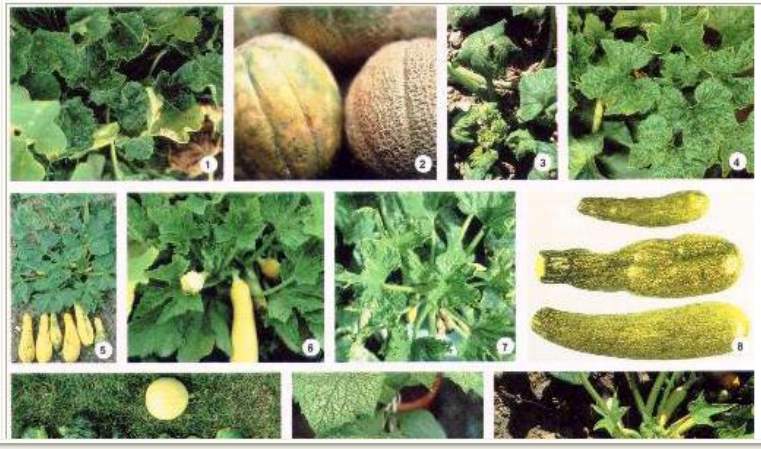
Tobacco ringspot virus **(TRSV)** is mainly transmitted by nematodes *(Xiphinema americanun)*. Melons and cucumbers are most commonly affected by this virus. The virus has been known on rare occasions to be seedborne in cucurbits. The newly infected leaves show a very bright mosaic with plant stunting (fig. 10). but subsequent leaves are reduced in size and develop a dark green color.

Tomato ringspot virus **(TmRSV)** causes severe damage to summer and winter squash, but shows only mild symptoms in the other cultivated cucurbits. Like TRSV, TmRSV is nematode transmitted and can be overwintered on many weed species without expressing symptoms.

Clover yellow vein virus **(CYVV)** is an aphid- transmitted virus that can infect summer squash and was previously considered to be the severe strain of bean yellow mosaic virus. The virus produces a yellow specking on the foliage of infected plants.

Aster yellow mycoplasma **(AY)**, formerly thought to be caused by a virus, has been recovered from infected squash in the state. This leafhopper-transmitted disease organism causes plants to become yellowed and stunted (fig. 11).

Click on Photo for Magnification



Agricultural Technology Management Agency
Kangra

Click To See Photographs of Different Insect Diseases

Success Stories

Mushroom Cultivation
Brinjal Cultivation
Cattle's Productivity
Silk Cocoons
Crop Diversification
Tomato Cultivation
Vermi-composting
Potato Cultivation

OTHER ASPECTS

Achievements
Seminars
Technical Trainings
Exposure Visit
Demonstrations
Financial Position
Successful Interventions
Summary
Collection of Diseases

Damping of the Seedings	Bacterial Wilt in Chilli	Early Blight of Chilli	Brinjal Fruit Borer	Brown Spot of Soyabean
Red Pumpkin	Colococacia Blight	Bacterial Wilt in Brinjal	Early Blight of Potato	Late Blight Of Potato on leaves
Late Blight Of Potato on fruit	White Grub	Wilt of Potato	Fruit Fly of Cucurbits	False Smut of Paddy
Fruit Fly of Guava	Rice Blast	PTM affected Potato	Tomato leaf Minor	Leaf blight of Grapes
White Rust of Mustard on Floral Parts	Yellow Vein Mosaic of Okra – Viral Disease	Powdery Mildew of Cucurbits	Loose Smut of Wheat	Downey of cucurbits
Purple Blotch of Onion	Mustard Aphid	Leaf Curl of Tomato	Angular Leaf spots of Mash	

Hawaii Pest and Disease Image Gallery (Miscellaneous Plants and Crops)

Online *quick* reference for Hawaii's growers

Scot C. Nelson <snelson@hawaii.edu>, University of Hawaii at Manoa (UHM), College of Tropical Agriculture and Human Resources (CTAHR), Department of Plant and Environmental Protection Sciences (PEPS)

How to use this site: **Crops are listed in brown font in alphabetical order** by common or scientific name and **pests and plant health problems are listed below each crop in black bold font**, with different symptoms or other important aspects listed adjacent to each pest entry. Browse and click on an image associated with a particular problem. View, save or print the image. *Click on your browser's "back arrow" to return to this page.* If you would like more information, please contact the University of Hawaii at Manoa Cooperative Extension Service.

The Pest & Disease Image Gallery

Abutilon (*Abutilon menziesii*)
- **Rust (fungus, *Puccinia heterospora*):** | rusted leaves 1 2 3 4 | text [PDF] |

***Abutilon molle* (hairy Abutilon)**
- **Rust (fungus, *Puccinia heterospora*):** | rusted foliage 1 2 3 | orange flower 1 |

***Abutilon striatum* (flowering maple, parlor maple, Indian mallow, 'Gold Dust')**
- **Abutilon Mosaic Virus (AMV): |** foliar mosaic 1 2 3 4 5 6 | text (external link) |

Aglaonema (*Aglaonema comutatum*)
- **Bacterial leaf blight (bacterium, *Erwinia carotovora*):** | leaf spots, hydrosis and blight 1 |

Avocado (*Persea americana*)
- **Algal leaf spot (algae, *Cephaleuros virescens*):** | leaf spots 1 2 3 4 |
- **Anthracnose (fungus, *Colletotrichum gloeosporiodes*):** | fruit lesions and with blight with sporulation 1 2 3 | scattered, sunken spots on fruit 1 |
- **Mites (insect, Persea mite, *Oligonychus perseae*):** | damage to avocado leaves 1 2 3 4 |

Banana (*Musa* spp.)

Beach morning glory (*Ipomoea pes-caprae* subsp. *brasiliensis*, Pohueuhue)

Cercospora leaf spot (fungus, *Cercospora* sp.): | leaf spots 1 2 3 |

Beans (*Phaseolus vulgaris*)
- **Chinese rose beetle (insect, *Adoretus sinicus*):** | "windowing" of foliage 1 2 |
- **Root knot (nematode, *Meloidogyne* spp.):** | string bean galled and knotted roots 1 |
- **Spider mites (insect, Carmine spider mite, *Tetranychus cinnabarinus*):** | speckly on bean leaf 1 |

Tom yum koong

Som tum

Massaman Beef Curry


Enjoy visiting Thailand