



## Pitahaya Diseases

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### Diseases – *Cause for Concern?*

- Pitahaya imported into California, and exported from California (to Hawaii for instance)
  - Is it disease-free?
  - How can we know it is disease free?
  - Are we ruining our industry??

## California has a Huge Advantage!

### *In Pitahaya Production*

- Our dry climate allows us to grow this fruit without fungicides (at least until something new comes along)
- The tropical countries have to use a lot of fungicides, much like avocado production
- This is the one and only advantage to a prolonged drought in California!

## Diseases in California

- Generally, with our dry climate, the diseases are few, however:
- Plants can be damaged by intense light, and this damaged tissue may be susceptible to stem rot caused by a bacterium
- Plants can be damaged by too much irrigation water, making them susceptible to root rot caused by several fungi



## Disease Caused by Bacteria

- Soft rots of the stem and blades are caused by *Xanthomonas campestris* and *Erwinia carotovora*
- Several countries report these as *Enterobacteria cloacae* (2009). Are they the same??
- Calcium deficiency in Mexican plantings has been shown to make this problem worse



## Soft Rots

- Soft stem rot caused by *Erwinia caratovora* in Taiwan matches a stem rot found in Calif.
- Infection starts from injured areas (sunburn, other diseases spots caused by anthracnose)
- Control includes pruning out dying stems and spraying with copper sulfate



## Diseases Caused by Fungi

- Dothierella (*Botryosphaeria*)
- Anthracnose (*Colletotrichum*)
- *Bipolaris*
- *Fusarium*
- *Alternaria*
- *Phytophthora*

## Botryosphaeria

*Brown Stem Spot Disease*

- *Botryosphaeria dothidea*
- First reported in Mexico in 2003
- The *Fusicoccum* stage was isolated in pure culture, re-inoculated and the exact same symptoms were produced
- Small chlorotic specks which enlarge up to 5 cm in diameter



## Botryosphaeria

- Picture is from Thailand



## Botryosphaeria Disease Management

- Prune off dead limbs and dispose away from the plantings. Maintain a thick layer of mulch to hasten decomposition of fungi on the ground. Use good sanitation and optimal cultural practices to minimize disease.
- When weather changes from cool to warm, appropriately modify the irrigation program, and pay special attention to irrigation needs during periods of hot weather.



## Anthracnose

- *Colletotrichum gloeosporioides*
- Reported in S. Florida in 2007
- Reddish brown lesions with conspicuous chlorotic haloes developed concentrically on the edges of vine ribs.
- Lesion centers became white and coalesced to rot much of the vine column, and in severe cases, only the vascular column in the vine center was not diseased

— From Palmateer, Ploetz, van Santen and Correll 2007



## Management of Anthracnose

- Remove diseased branches
- Clean clippers with 10% bleach
- If high rainfall and misty wet conditions, apply copper hydroxide prior to wet conditions. Copper will reduce new infections, but will not “cure” an existing infection.
- Check the registrations!



## Bipolaris Fruit Rot



- This rot begins as small tan, circular lesions on the fruit surface and as the disease progresses the lesions enlarge and turn black.
- Usually a black felt-like growth of the fungus can be observed on the lesions. Under ideal conditions (warm and humid), the fruit develop large areas of soft rot.

## Bipolaris fruit rot

- The lesions are caused by a fungus, *Bipolaris cactivora*. This species causes stem and fruit rot of cacti (including pitahaya) in California, Florida, Europe and Japan.
- Former name was *Helminthosporium*



## Bipolaris fruit rot

- The disease is most severe on mature and ripe fruit. While young stems are susceptible to *B. cactivora*, mature stems are relatively resistant to infection.
- *Bipolaris* rot on ornamental cactus is most severe between 75-91 F.
- In general, diseases caused by *Bipolaris* are favored by humid conditions.
- Inoculum sources include diseased plants in the field and crop residue. Conidia are most often spread by wind, irrigation and rain.

## Bipolaris fruit rot - Florida

- Small, circular, light brown, depressed lesions expanded to form large areas of rot on flowers and fruit in 7 to 10 days.
- These lesions produced large amounts of dark fungal spores.
- On mature plant stems, wound-inoculated treatments formed 1.8 to 3.4 mm lesions, but nonwounded inoculations and controls were negative. Lesions were light tan, circular, and did not sporulate.
  - T. L. B. Tarnowski, A. J. Palmateer, and J. H. Crane, University of Florida, Tropical Research and Education Center, Homestead 33031-3314



## Bipolaris fruit rot

- “The high incidence of fruit rot affecting commercial operations in Miami-Dade County over the past 2 years requires an effective disease management strategy.”

— T. L. B. Tarnowski, A. J. Palmateer, and J. H. Crane, University of Florida, Tropical Research and Education Center, Homestead 33031-3314

## Management of Bipolaris fruit rot

- Currently there are no fungicides labeled for use on pitahaya in California and Florida.
- Cultural management includes limiting canopy wetness by irrigating in the morning so plant surfaces can dry quickly throughout the day.
- Maintain a weed free planting and remove and discard diseased plants (i.e. stems, fruits, and flowers) promptly when symptoms occur.
- *(From the Sarasota Fruit and Nut Society)*



## Other Diseases

- Collar rot (*Phytophthora sp*) reported in Vietnam
- Root rots caused by *Fusarium sp* and *Alternaria sp*.
- Do we have these here and if so, how bad are they?

Pitahaya plant from the field  
(July, 2013)



Outer stem cut away



Infection in the xylem and phloem



*Fusarium* conidia in pure culture  
(isolated from this same plant)



Another view, with mycelium



## Which *Fusarium*?

- *Fusarium* sp. been isolated for several years by other plant pathologists
- Dr. Akif Eskalen is the first to identify to species by analyzing DNA
- The verdict?

## Diseases Caused by Viruses

- Viruses are much smaller than bacteria.
- They enter the cells of a plant and are multiplied by the host. Viruses live and multiply only within living cells.
- Viral diseases are usually introduced by the use of infected plants or by insects. They can be spread to healthy plants by the feeding activity of sucking insects such as aphids and leafhoppers, or on the hands and tools of maintenance workers.
- Currently there is no chemical control for a virus once it infects a plant. Although most viruses are specific to only a few types of plants, prompt and complete removal to prevent its potential spread is recommended when a virus is discovered.

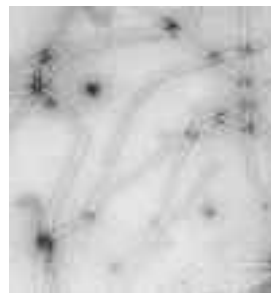
## Cactus Virus X

- During a survey of diseases of pitaya in Taiwan, some plants were found with systemic mild mottling on the stems.
- Transmission by sap or grafting, no insect, mite or nematode vectors are known



## Cactus Virus X

- Long flexuous rods



**First Report of *Cactus virus X* on *Hylocereus undatus*  
(Cactaceae) in Taiwan**

February 2001, Volume 85, Number 2

Pages 229.1 - 229.1

- A virus was mechanically transmitted that caused necrotic local lesions on *Chenopodium amaranticolor* and chlorotic lesions on *C. quinoa*. This virus also caused necrotic lesions with chlorotic halos on *Gomphrena globosa* and small chlorotic spots followed by systemic infection in *Celosia argentea*
- Electron microscopic examination of negatively stained extracts from diseased plants revealed a flexuous rod-shaped virus with a length of 480 to 520 nm.

## Control of Cactus Virus X

- Once the plant is infected, you can't cure the plant
- The best control is prevention
  - Buy disease-free plants
  - Propagate from seeds (most plant viruses do not pass into the seed)
  - Clean pruning tools with 10% Chlorox plus soap in-between plants
  - Get rid of prunings...do not give them away! **Hard to do when you have a new industry!**


## Diseases Caused by Nematodes Cactus Root Knot



*Thank you!*








# UCR

## Viruses and Viral Diseases of Cacti and Succulents

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## Introduction

- Overview of viruses



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- Common diseases and symptoms in plants



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- Cactus/succulent specific diseases



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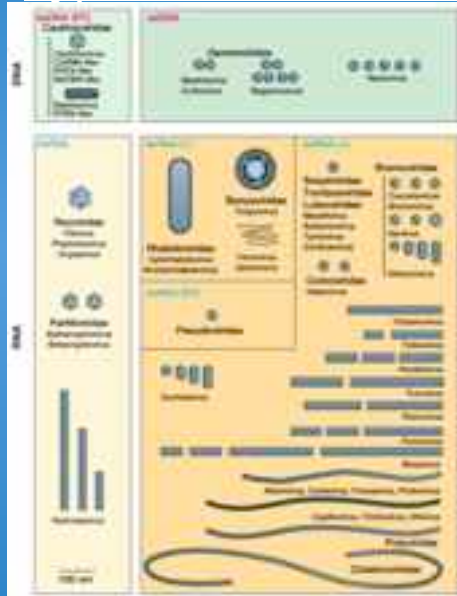
- Overview of viruses
- Common diseases and symptoms in plants
- Cactus/succulent specific diseases
- **Prevention and management**



## What are Viruses?

- Small plant pathogens, 20-2000 nm  
(1 nm=25 millionth of an inch)

## Types of Plant Viruses

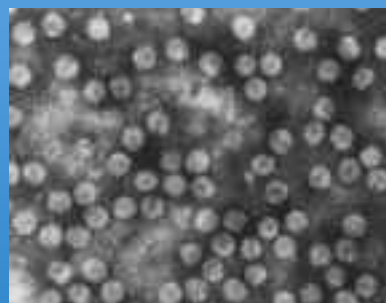


## Viruses

- Composed of nucleic acid (DNA or RNA) surrounded by a self made protective coat protein



*Tobacco mosaic virus*



*Cucumber mosaic virus*



## Viruses

- Require host components and living cells to multiply (=replicate)



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  - insects      nematodes      fungi      HUMANS
  - propagation
  - tools
  - any touching





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- Host range may be narrow (few) or wide (many)



### Host range of Impatiens Necrotic Spot and Tomato Spotted Wilt Tospoviruses-over 1,000 total

#### Ornamentals

ageratum	chrysanthemum	geranium	poppy
amaranthus	cineraria	gladiolus	primrose
amaryllis	coleus	gloxinia	ranunculus
anemone	columbine	hydrangea	salvia
aster	coreopsis	impatiens	sinningia
baby's breath	cosmos	lobelia	snapdragon
begonia	cyclamen	marigold	stock
calceolaria	dahlia	nasturtium	tiger lily
calendula	delphinium	N.G. impatiens	verbena
calla lily	exacum	peony	zinnia
campanula	forget-me-not	petunia	
china aster	gaillardia	phlox	

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Host range of Impatiens Necrotic Spot and Tomato Spotted  
Wilt Tospoviruses-over 1,000 total

<u>Vegetables</u>	<u>Weeds</u>
broad bean	beggar ticks
cauliflower	black nightshade
celery	morning glory
eggplant	burdock
lettuce	chickweed
pea	galinsoga
pepper	lamb's quarters
potato	shepherd's purse
snap bean	sowthistle
spinach	purslane
tomato	yellow clover

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**Viruses**

Types of Symptoms

– Mosaic/Mottle


		
Mandevilla	Fern	Hosta

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## Viruses

### Types of Symptoms


– Mosaic/Mottle



Bean



Lettuce




Monocots

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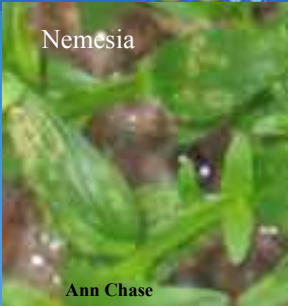
## Viruses

### Types of Symptoms

– Ringspots/Line Patterns




Impatiens



Nemesia

Ann Chase




Tobacco

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## Viruses

### Types of Symptoms

– Flower break



*Tulip flower breaking virus*



*Angelonia flower break virus*


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## Viruses


### Types of Symptoms

– Leaf deformation

*Portulaca*



Healthy



Infected

## Viruses

### Types of Symptoms

– Fruit deformation



## Viruses

### Types of disease

– Stunting

*Citrus tristeza virus*





## Viruses

### Types of Symptoms

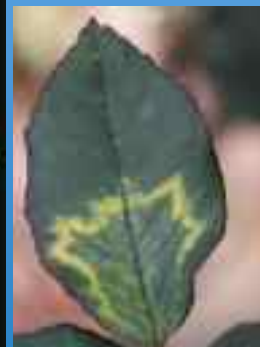
- None

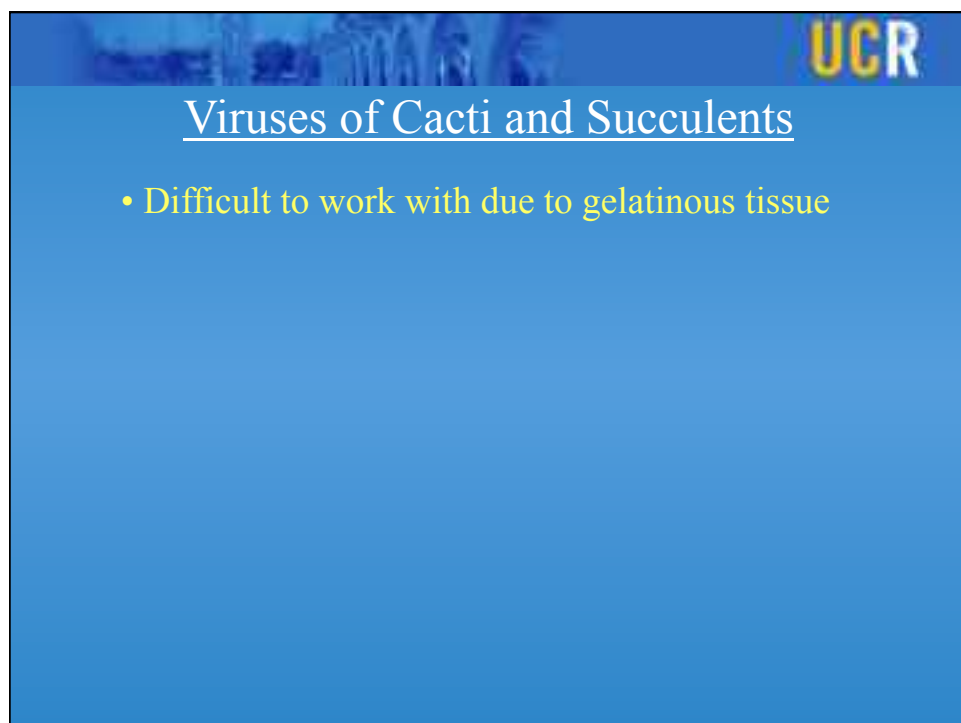
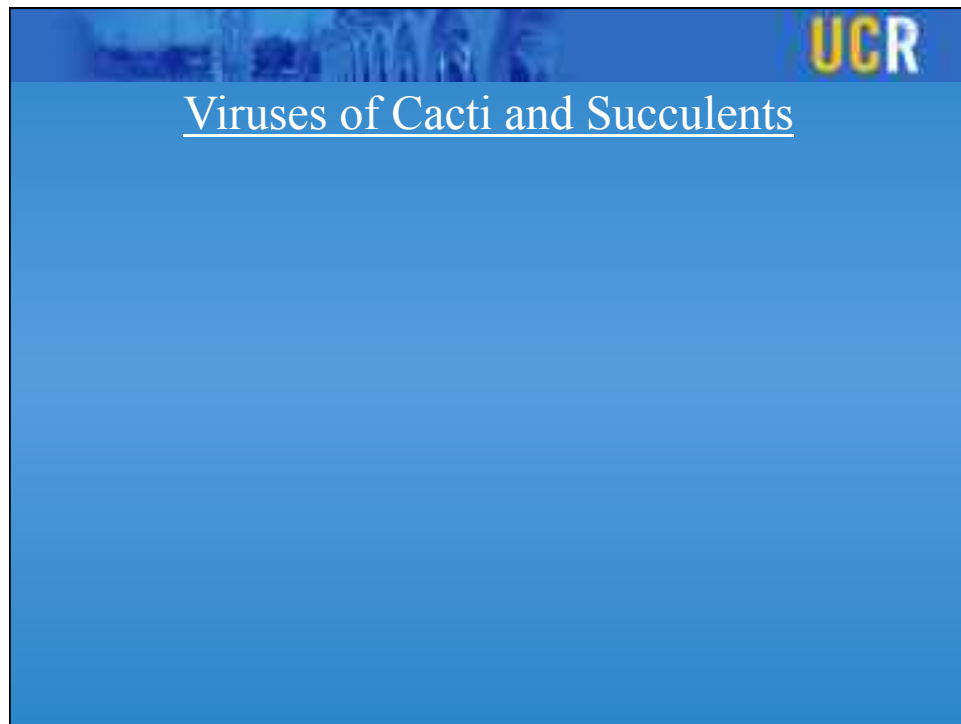


## Rose Mosaic

### Multiple viruses involved

- *Rose mosaic virus* (= *Apple mosaic virus*)
- *Prunus necrotic ringspot virus*
- *Arabis mosaic virus*







## Viruses of Cacti and Succulents


- Difficult to work with due to gelatinous tissue
- Distribution of viruses can be uneven in plants



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- Difficult to work with due to gelatinous tissue
- Distribution of viruses can be uneven in plants
- Not a lot of research on these plant hosts





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*Cactus virus X*



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- Found in all plant parts including buds, flowers and fruit
- **Relatively high infection levels in most hosts**



### *Cactus virus X* on *Hylocereus* (Dragon fruit)



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*Cactus virus X on Hylocereus (Dragon fruit)*



Chlorosis and Mottling



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*Cactus virus X on Hylocereus (Dragon fruit)*



Twisting of arms






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Viruses of Cacti and Succulents


Other Viruses

- Zygodactylus virus X, Schlumbergera virus X
- Opuntia tobamovirus
- Cactus 2 virus (carlavirus)
- Saguaro cactus virus (carmovirus, sphere, AZ)



## Management

- No “cure”



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- Decontaminate tools and surfaces with bleach, quaternary ammonium, chlorhexidine, etc (follow labels)



## Avoidance/Testing Protocols

- Scout routinely for symptoms



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- Eliminate hosts outside GH, weeds, landscape plants
- Regular testing for most common pathogen/host combos
- Collect younger leaves, with symptoms if available



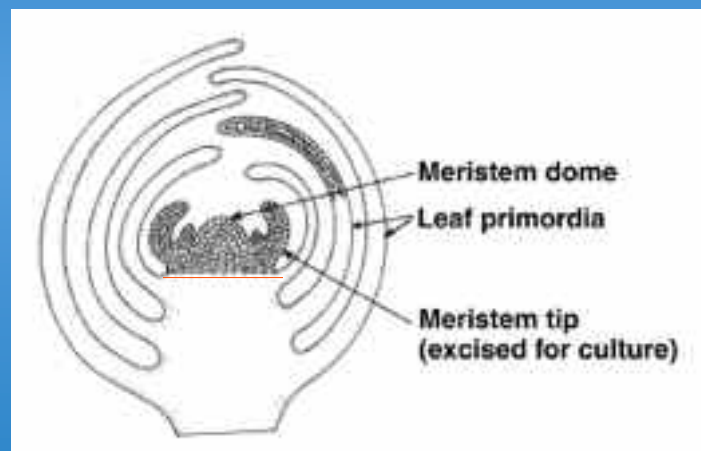
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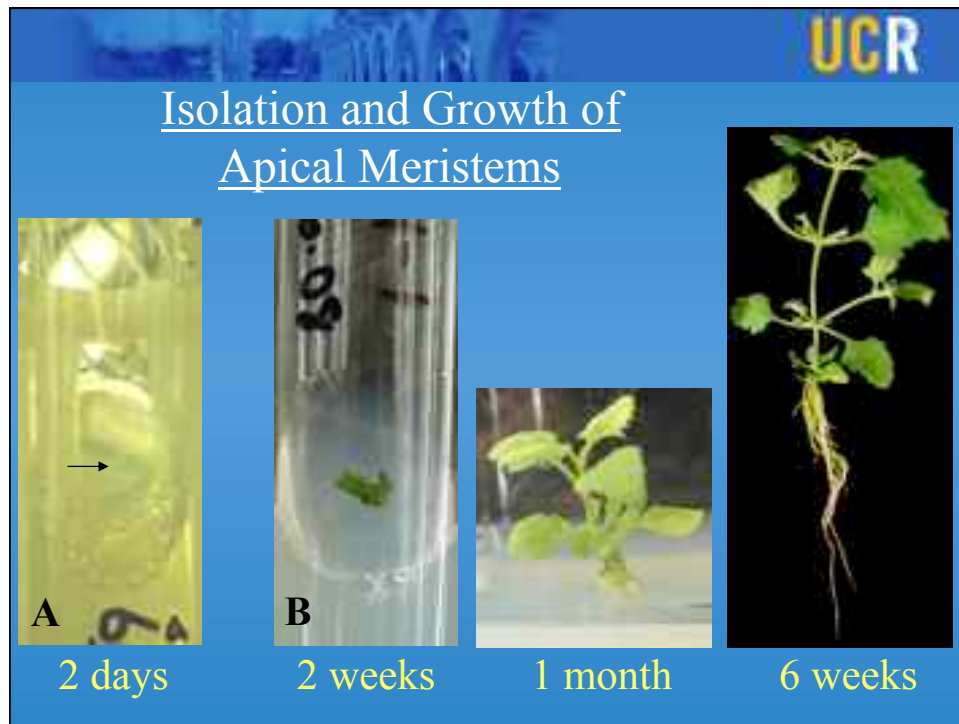


## Production of Virus Free Ornamental Plants

- Virus infected plants undergo meristem shoot tip isolation with or without heat therapy

### Removal of apical dome for virus exclusion





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Virus detection over time from a new “clean” variety

- 18 lines of *Diascia* newly out of selection/clean up



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