

Virus Presence in Central Coast Region of California

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Project in cooperation with

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UC Small Farms Program
S Clara County Pepper growers

Other Pepper Diseases

- Verticillium wilt
- Phytophthora crown and root rot
- Bacterial spot
- Powdery mildew
- Sclerotinia
- Gray mold (transplant stem, fruit)
- Southern blight (*Sclerotium rolfsii*)
- VIRUSES

Common pepper viruses and their vectors

Alfalfa mosaic virus	aphid
Cucumber mosaic	aphid
Pepper mild mottle:	seed, mech.
Pepper mottle	aphid
Tobacco/tomato mosaic:	seed, mech.
Potato virus Y	aphid
Tobacco etch	aphid
Tomato spotted wilt	thrips
Beet curly top virus	leafhopper
Beet western yellows	aphid
Potato leafroll virus	aphid

Common Pepper Viruses Central Coast

Cucumber mosaic:	aphid
Pepper mild mottle:	seed, mechanical
Tobacco/tomato mosaic:	seed, mech.
Pepper mottle:	aphid
Potato virus Y:	aphid
Tobacco etch:	aphid
Tomato spotted wilt:	thrips

Virus Similar symptoms

- Most viruses induce degrees of mosaic, mottle, vein banding, and plant stunting. Malformation, leaf cupping, and fruit distortion.
- Difficult to distinguish single from multiple virus infections in the field.
- Accurate diagnosis is dependent on laboratory tests.

Virus Similar symptoms

Variegation

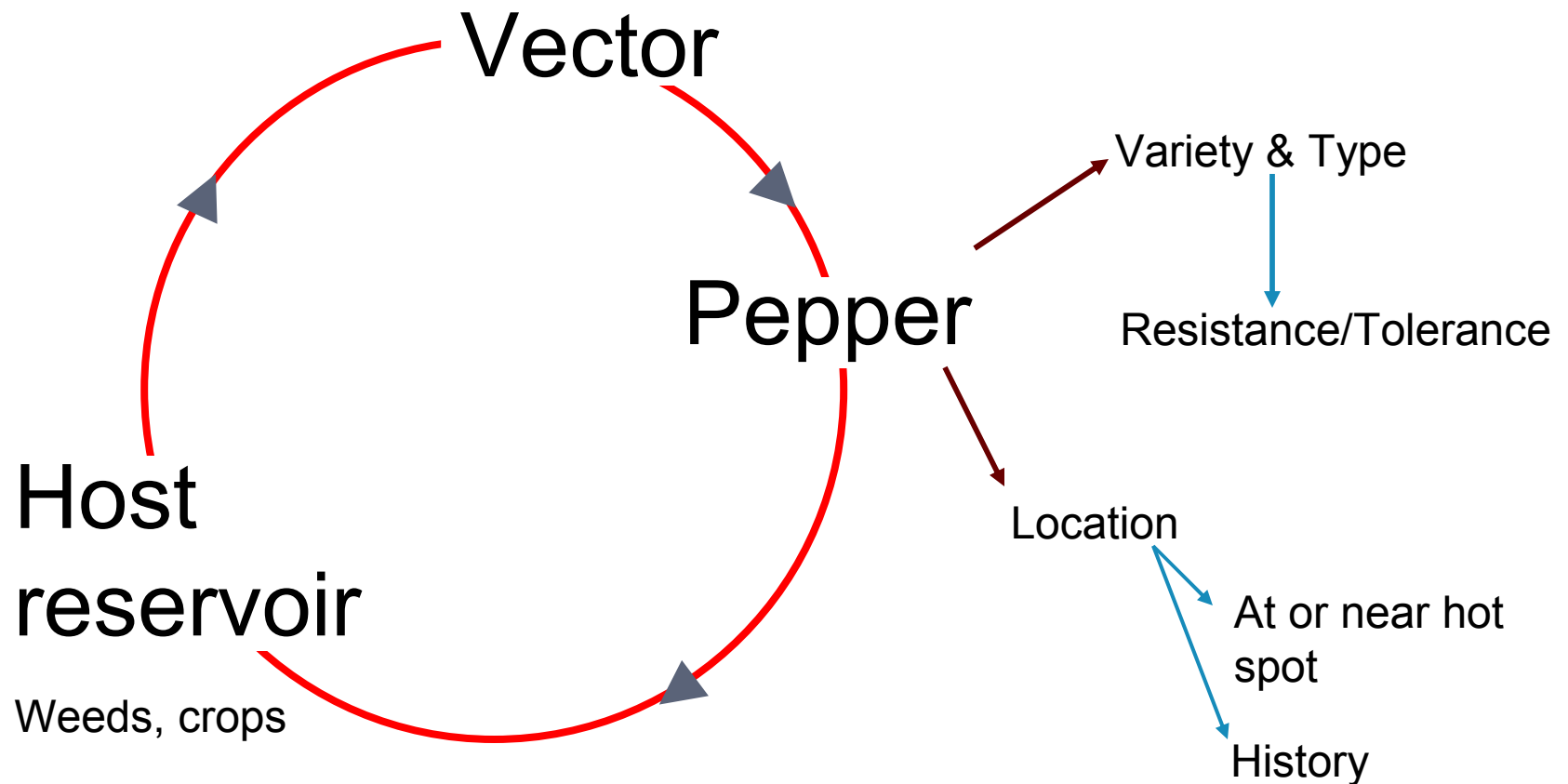
Pattern of two or more colors in a plant part, as in a green and white leaf

(Chinese evergreen plant-- *Aglaonema commutatum* 'Maria')

Pepper plant chimera



Virus disease cycle



The challenge of pepper viruses

Changes

- Unimportant → important
- Important → unimportant
- “New” viruses emerge
- virus profile can change year-to-year

Impatiens Necrotic Spot Virus on Lettuce



The challenge of pepper viruses: A 14 year old study

Fluctuation

- Year 1: dominated by Potyviruses and CMV.
- Year 2: virus presence was low.
- Year 3: viruses appeared late in the season => minimum losses
- Year 4: widespread but late in season
- Year 5: low virus spread

Virus infection shifts in pepper fields

- **PeMV** (Pepper mottle potyvirus) most frequent virus (22%) and PVY (Potato Y potyvirus) least frequent (4%).
- **CMV** (Cucumber mosaic virus) was high (20%) in selected locations and second to **PeMV**.
- **TEV** (Tobacco Etch Virus) occurred same locations as **PeMV** (Pepper mottle potyvirus), and frequently in mixed infections.
- **TSWV** marginal presence in few fields.

Central Coast: Two Year Survey

- Counties: San Benito, Santa Clara counties
- Peppers: anaheim, bell, jalapeno, yellow wax, others
- Findings:
 - Tomato spotted wilt
 - Cucumber mosaic

CC: Pepper survey for viruses

- 14 commercial pepper fields sampled
 - 7 chile pepper operations
 - 7 bell pepper fields
- Sampling for viruses
 - Year 1 - 29 samples
 - Year 2 - 99 samples



CC- Survey numbers: Year 1

- Fields: visual rating: 5% to >90% infection.
- All samples were virus positive.
- Few samples had more than one virus present.
- Total of five viruses were found.
- Strong presence of **CMV** (39%), **TSWV** (52%), or both (91%).
- Weed samples had triple infection: **TMV, CMV, TSWV**

Virus infection in samples: Year 1

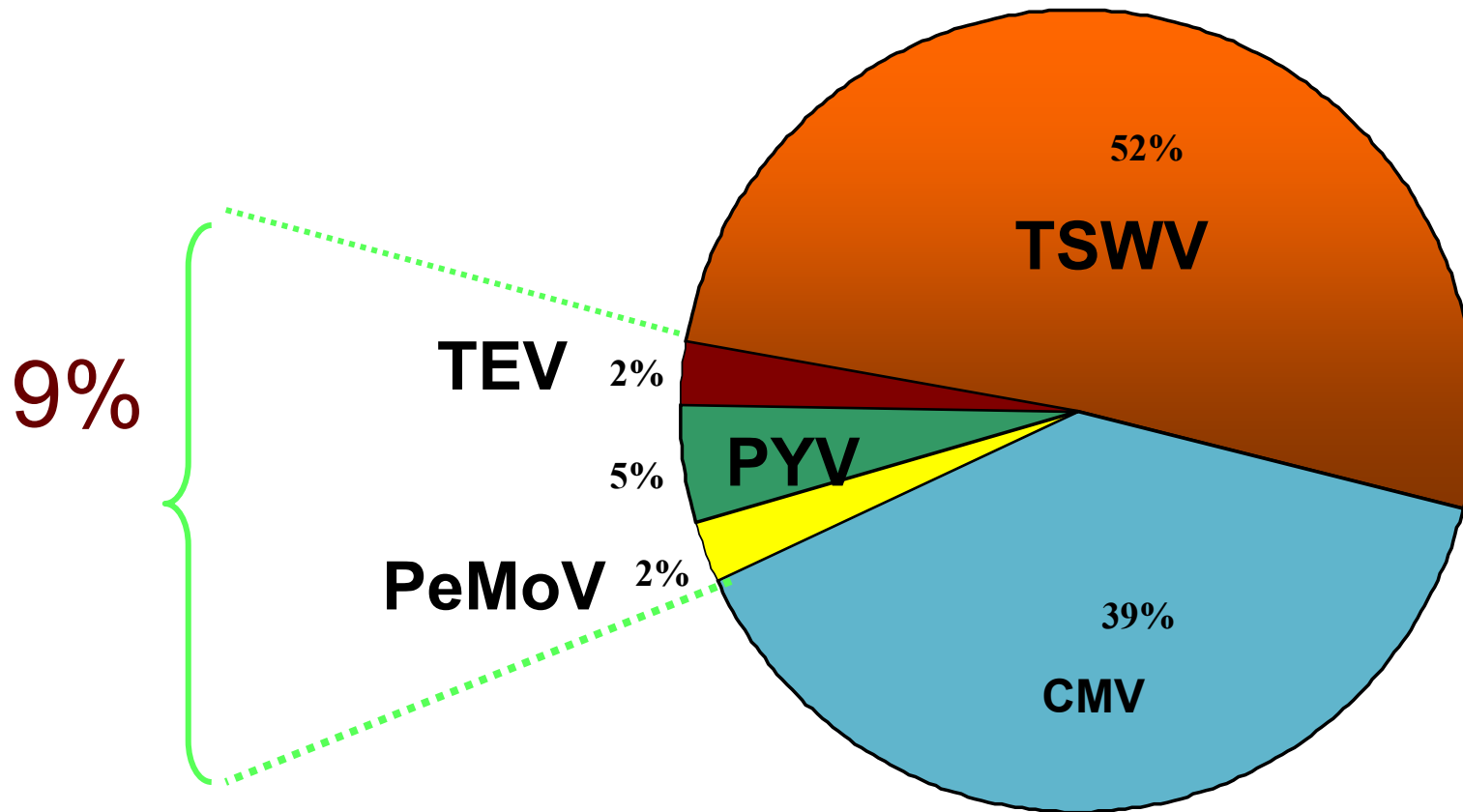
	TMV	TSWV	CMV	PeMV	PVY	TEV	total
%	2.4%	50.0%	38.1%	2.4%	4.8%	2.4%	~100%

88.1%

38% Double and triple infections

62% single infection: CMV or TSWV

Visual Proportions



Virus infection in samples: Year 2

	TMV	TSWV	CMV	PeMV	PVY	TEV	total
%	--	58%	*42%	--	--	--	--



100%

*CMV in 2 fields only

99% of cases were SINGLE infection

Summary : Year 2

- Fields: 5% to >90% infection
- All samples were positive-virus
- Few samples had more than one virus present
- Total of 5 viruses were found
- all samples had strong presence of CMV (39%), TSWV (52%), or both (91%)
- Weeds (Sowthistle) sample had TMV, CMV, TSWV



Cucumber Mosaic Virus





Cucumber Mosaic Virus--CMV

Transmission & Control

Transmission

- Green peach aphids (polyphagous- feed on many plants)
- Mechanical-less than TMV

Control

- Sanitation
- Isolation
- Aphid control
- Use of Silver reflective mulch



TSWV symptoms on Tomato



Tomato Spotted Wilt Virus-TSWV

Symptoms

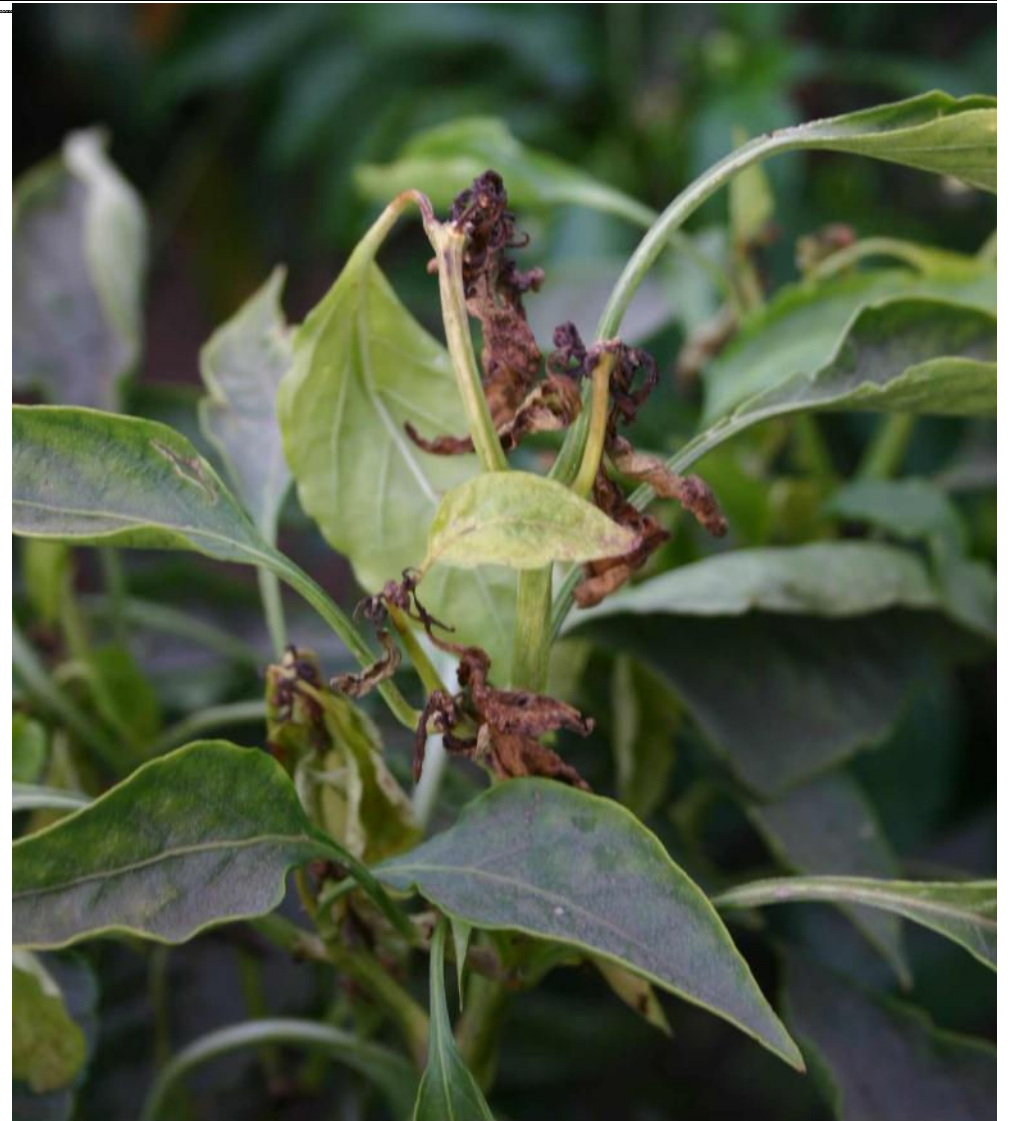


- All growth stages affected
 - Stunting
 - Mosaic symptoms: leaf/fruit
 - Sudden Necrosis
 - Stunting
 - Small fruit
 - Fruits show chlorotic spots
 - red and/or green areas surrounded by yellow halos
 - Disfigured fruit
 - Raised bumps on fruit

TSWV symptoms in pepper

- Stunting and yellowing of the plant
- Chlorotic line patterns or mosaic with necrotic spots on leaves
- Necrotic streaks on stems extending to terminal shoots
- Yellow target spots or necrotic streaks may be observed on ripe fruit.
- Disfigured fruit shape.

Tomato spotted wilt virus



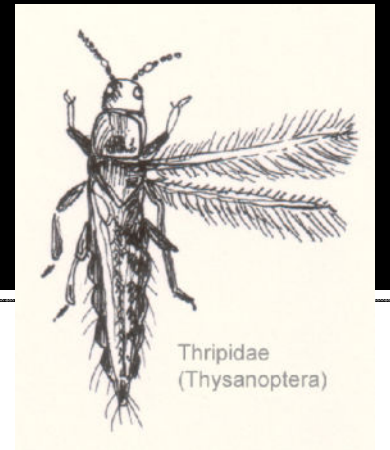
Tomato spotted wilt virus



Tomato spotted wilt virus



Tomato spotted wilt virus



- First discovered on tomato in 1919 in Australia.
- Late 80's - greenhouse (INVS-impatiens necrotic spot virus).
- Infects well over 900 plant species and growing!
- Field – Tomato spotted wilt virus (TSWV).
- Thrips vector TSWV

Vector: Thrips

Eight species in two genera, *Frankliniella* and *Thrips*, are reported to transmit TSWV (Mound 1996, Webb et al. 1998).

Some of the main vectors are the

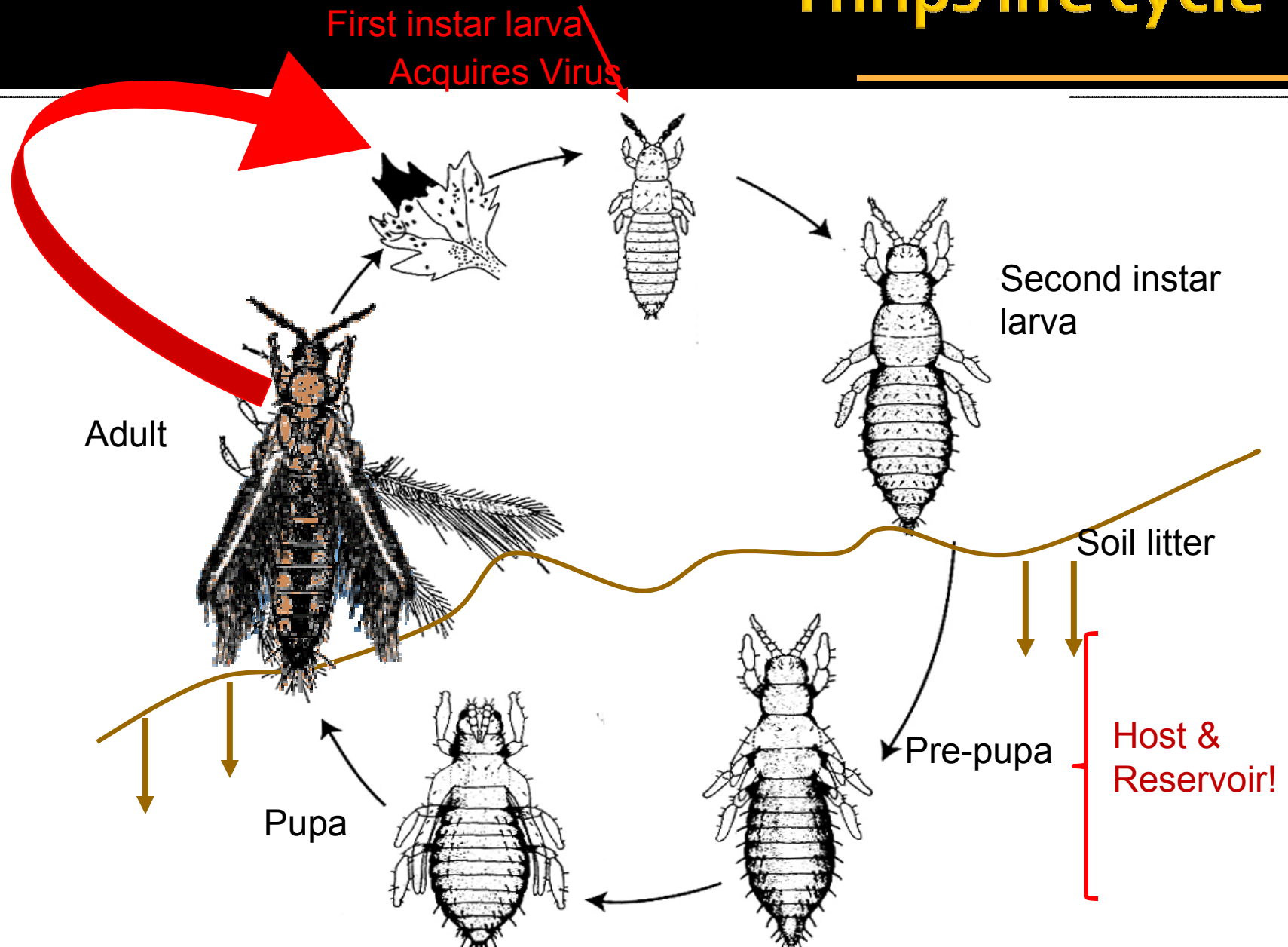
Western flower thrips (*Frankliniella occidentalis*/ Polyphagous)

Onion thrips (*Thrips tabaci* Lindeman)

Tobacco thrips (*Frankliniella fusca*).

TSWV replicates in thrips vectors → the insect is not only **spreads** the virus, but serves as a virus **host**.

Thrips life cycle



TSWV hosts - ornamentals

- *Alstroemeria, Anemone, Antirrhinum, Araceae, Aster, Begonia, Bouvardia Calceolaria, Callistephus, Celosia, Cestrum, Columnea, Cyclamen, Dahlia, Dendranthema x grandiflorum, Eustoma, Fatsia japonica, Gazania, Gerbera, Gladiolus, Hydrangea, Impatiens, Iris, Kalanchoe, Leucanthemum, Limonium, Pelargonium, Ranunculus, Saintpaulia, Senecio cruentus, Sinningia spp, Tagetes, Verbena, Vinca and Zinnia.*

Impatiens Necrotic Spot Virus on Nicotiana



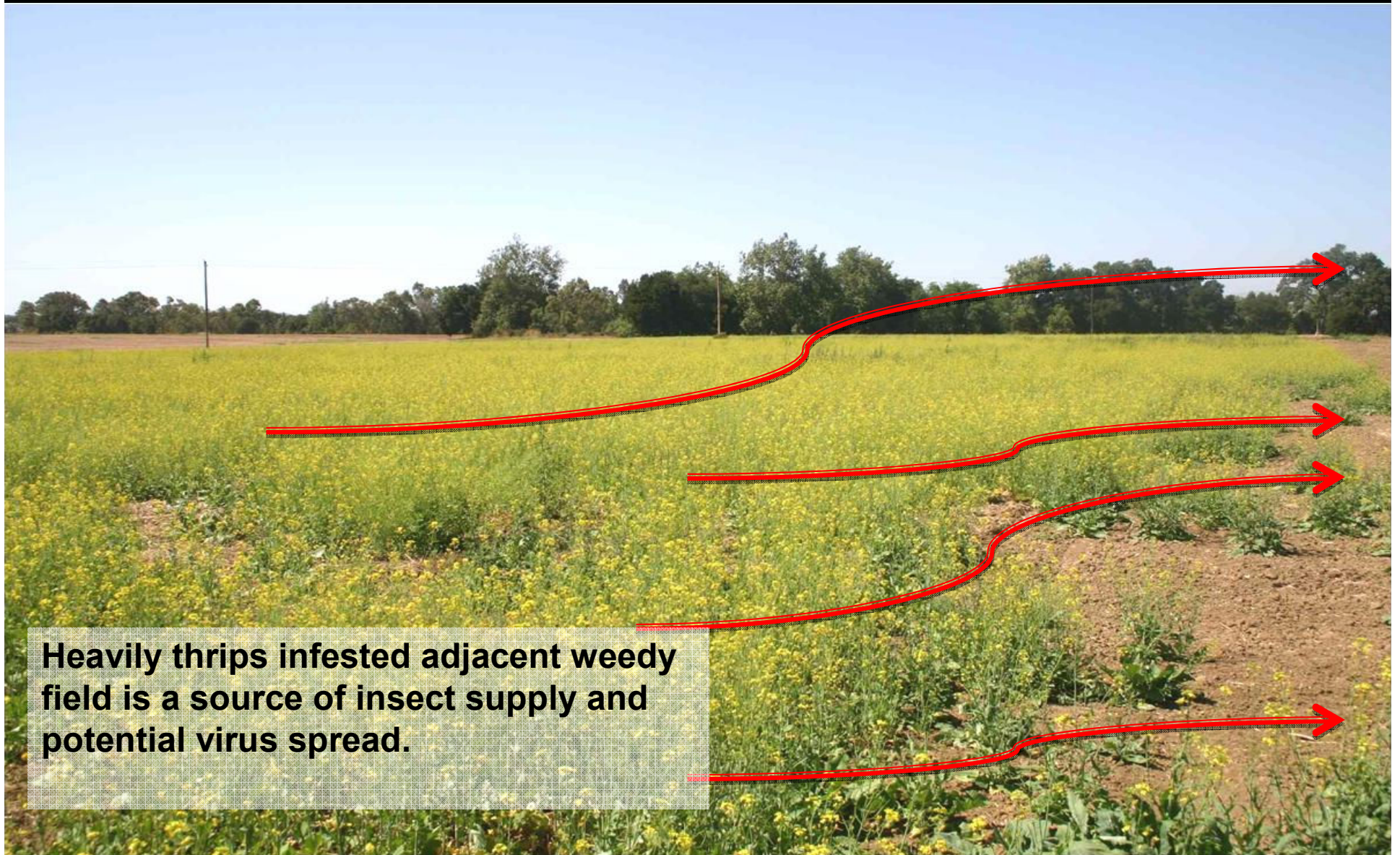
Some TSWV hosts - crops

- Tomato
- Peanut
- Tobacco
- Lettuces
- Faba bean
- Lettuce
- Endive
- Celery
- Eggplant
- Artichoke
- Cowpea
- Cucumber
- Cauliflower
- Cucumber
- Spinach

Plant sanitation: Greenhouse to field

- Field
 - Inspection
 - Sanitation
 - Rogue and remove infected plants/fruit
- Greenhouse
 - Exclusion
 - Sanitation
 - Rogue and remove infected material

Minimizing virus spread



Heavily thrips infested adjacent weedy field is a source of insect supply and potential virus spread.

Tomato spotted wilt virus

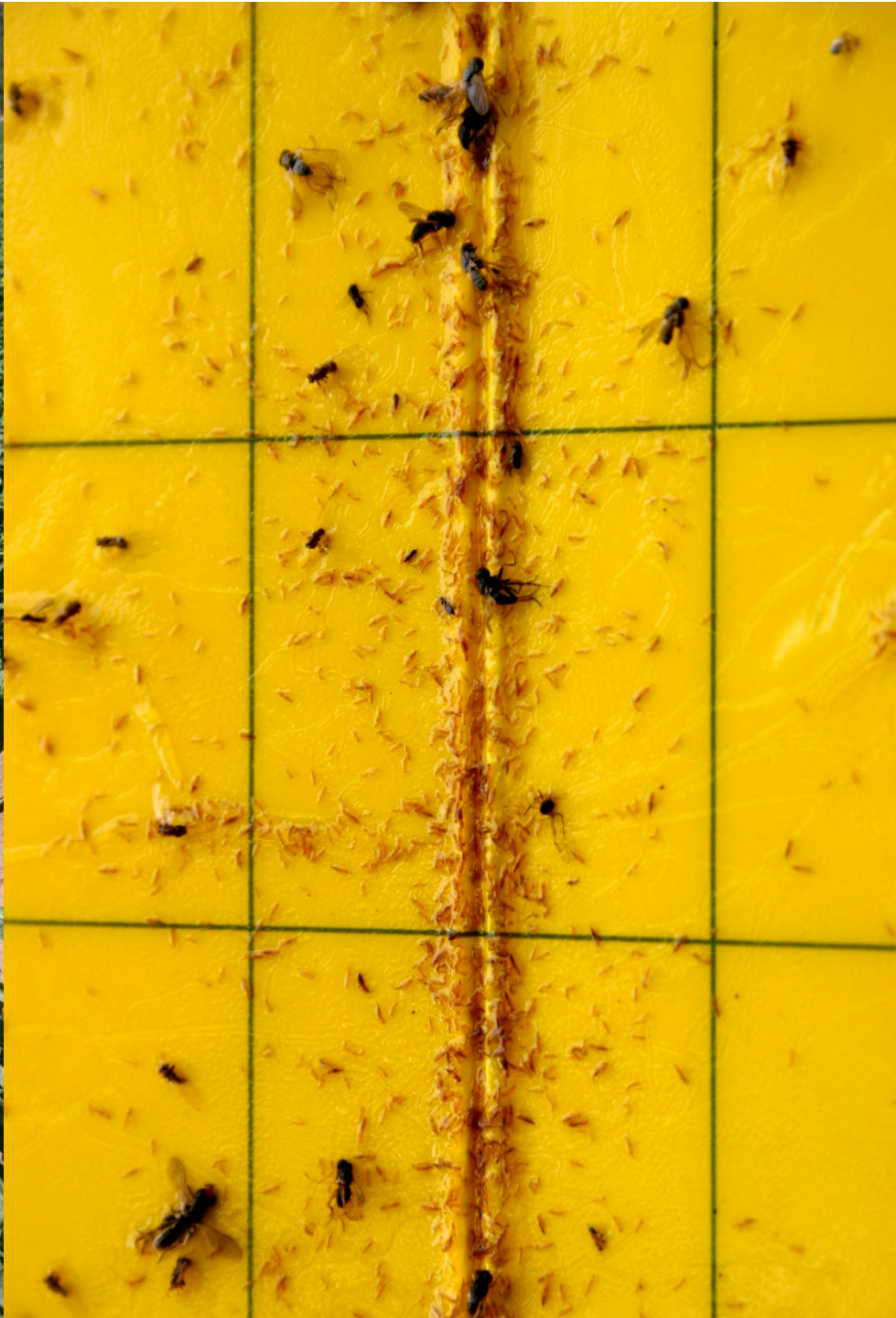
Cultural Practices

- Sanitation
 - Weed control
 - Remove volunteer solanacea plants
 - Disinfect tools
 - Eliminate all sources of thrips at end of each crop
- Thrips management
 - Rotate chemicals to minimize resistance development
 - Maintain beneficial predators
 - *Orius insidiosus* is the most important predators of thrips that have been identified
- Use disease resistant varieties if available

Summary: What can be done

- Scout pepper fields frequently
- Monitor
 - Sharply “thump” the flowers onto a white plate. Adults and larvae are stunned temporarily for counting. Magnification of 25 x or more is needed to determine the individual species of adults.
 - Yellow sticky cards for monitoring of adult thrips
- Test suspected infected plants for TSWV
- Sanitation: Remove infected plants/fruit
- Remove volunteer plants and weeds from the field and surrounding areas





Summary: What can be done

- Reduce cultivation within the field to avoid movement of thrips from infected sources
- Use certified clean stock for propagation
- Alternate control strategies and pesticides
 - Reflective mulches (+ chemical strategies)
- Limit development of insecticide resistance :
 - Alternate tank mixes of products w/ similar modes of action
 - Rotate different classes of insecticides
- Isolation when possible, especially in greenhouses



Thank you!

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