



**Scott Adkins**

**U.S. Horticultural Research Laboratory  
Fort Pierce, Florida**



# Acknowledgements

Carrie Vanderspool

Lisa Rouse

Jennifer Ikerd

Greg Hess

Jeff Smith

Ken Sims

Christina Thompson

Danny Cook

Rod Systma

Growers

UF-IFAS Extension

Scouts

Glades Crop Care

Red Gator

Seed Companies

NWA, FL WA

FSCF, FFVA, FTC

USDA-SCRI

USDA-Critical Issues

FDACS-SCBG

ZedX – Joe Russo

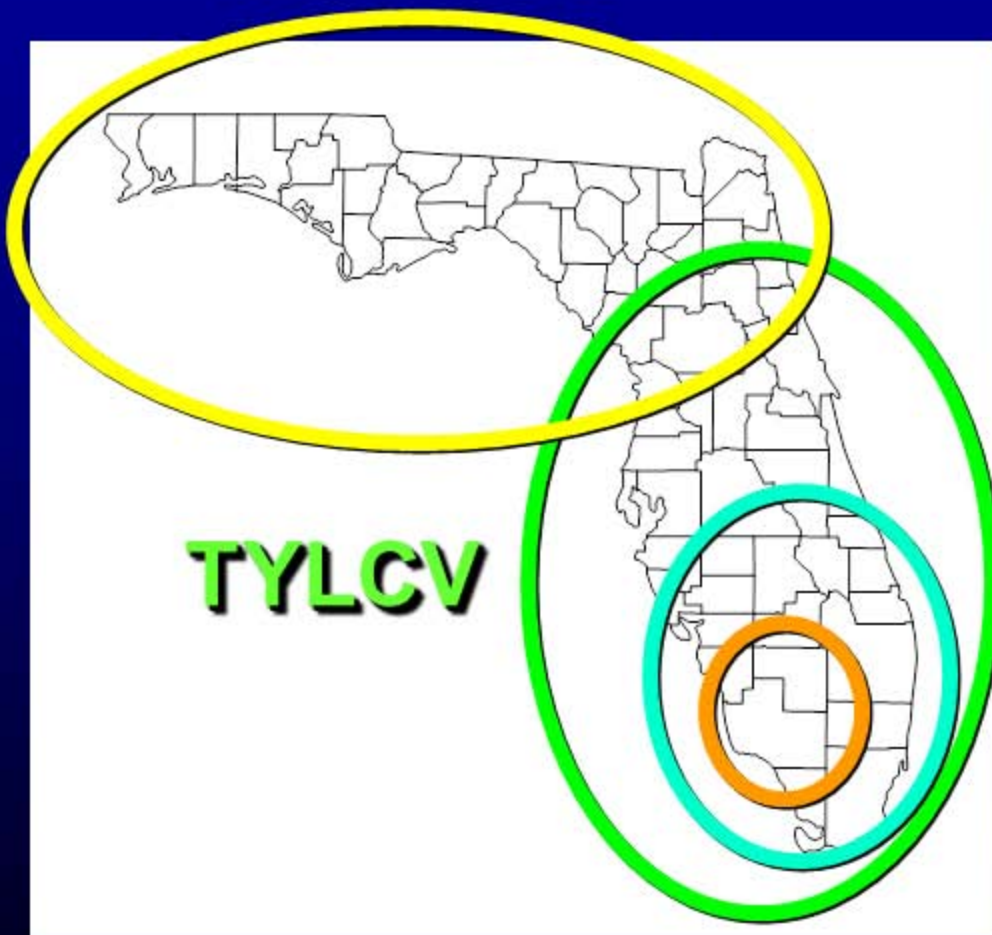
# Tomato viruses in Florida

**TSWV**

**TYLCV**

**“GRSV”**

**TCSV**



**2012**



# Tospoviruses on the move

# **Online scouting and decision support system**

- **Provide real time status of viruses & their vectors; yours & neighbors**
- **Help identify hotspots for viruses & their vectors; visualize regional pest pressure**
- **Being validated now**
- **Cooperative, area-wide management in the future**

# Adding a recommendation

# AqScouter

Welcome, Dayna Hamm

My Account Administration Statistics Log Out

FARM MANAGER SCOUTER

### Scouter Map

Pest Name

#### Profile Selection

Location

Grower

Farm

Field

#### Scouter View

2012 May

S	M	T	W	T	F	S
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

#### Observations

Grower: Dayna Grower

Farm: Dayna Farm

Field: Dayna Field

Date: 2012-05-22

Stop: 1

Status: Spray Tomorrow

Crop: Potato

Variety: Goldrush

Pest: Broadleaves

Amount: 100

Unit: Number Seen

Comments: Comments

DOWNLOAD OBS CREATE REPORT

### ADD RECOMMENDATION

\*\*\* It is the user's responsibility to ensure solutions are mixed in a proper manner in accordance with the manufacturers guidelines in addition to verifying all applicable solution intervals prior to usage.

Rec Date

#### Profile Selection

Location

Grower

Farm

Field

Lon

Lat

#### Recommendation Entry

CROP/VARIETY

PESTS

PROTECTANTS AND PRODUCTS

CARRIERS

COMMENTS

SAVE CHANGES CANCEL

Base Layer

Hybrid

Overlays

Profile Boundaries

Profile Names

Field Status

Obs from other organizations

Obs from my organization

My Obs

Boundary

Management Unit

musser1

musser2

Data Source

37.73868, 40.94051

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USDA

Bill, ZedX



# Pest intensity of an observation



Welcome, Dayna Hamm

My Account Administration Statistics Log Out

FARM MANAGER SCOUTER

### Scouter Map

Pest Name:

### Profile Selection

Location:

Grower:

Farm:

Field:

### Scouter View

2012

June

S	M	T	W	T	F	S
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
1	2	3	4	5	6	7

2010-11-27

2010-11-28

2010-11-28

2010-11-29

2011-08-16

2012-04-11

2012-04-12

2012-04-12

2012-04-12

2012-06-15

2012-06-29

2012-06-29

2012-06-29

2012-06-29

2012-06-29

2012-06-29

2012-07-02

Stop: 1Broadleaves

Stop: 1Cucumber Beetle

Stop: 1Groundnut

Stop: 1Ringspot Virus (GRSV)

Stop: 1Bacterial Spot

### Observations

Grower: Mr. Grower

Farm: Mr. Farm

Field: Field1

Date: 2012-06-29

Stop: 1

Status: Spray Today

Crop: Egg Plant

Variety: Night Shadow

Pest: Broadleaves

Amount: 5

Unit: Percent

Click and drag to move. Double Click to zoom in.



Base Layer

Hybrid

Overlays

Profile Boundaries

Profile Names

Field Status

Obs from other organizations

Color

Pest Intensity

> 0.75 and <= 1

> 0.5 and <= 0.75

> 0.4 and <= 0.5

> 0.3 and <= 0.4

> 0.2 and <= 0.3

> 0.1 and <= 0.2

> 0.05 and <= 0.1

> 0.025 and <= 0.05

> 0.0 and <= 0.025

= 0

My Obs

Other Obs

Field Status

In Production

Spray Tomorrow

Spray Today

Harvesting

Harvested

Burned Down

Abandoned Field

Not Planted


20 m

100 ft

20 91535, 41.97291

Bill, ZedX

# Online scouting and decision support system



# AgScouter

**Contact Information**  
Zedx, Inc.  
369 Rolling Ridge Drive  
Bellefonte, PA 16823  
(814) 357-8490  
(814) 357-8499 (fax)  
[www.zedxinc.com](http://www.zedxinc.com)  
[information@zedxinc.com](mailto:information@zedxinc.com)

Manage pest, crop, insect and weather scouting observations





**Log In**

**User Name**

**Password**

[Forgot your Password?](#)

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[Home](#) | [Privacy Policy](#) | [Legal Terms](#)



Bill, Zedx



# Online scouting and decision support system

**D**

Scouter Home

GPS Select

-- Select Pest Category --

- Bacterial Diseases
- Fungal Diseases
- Insect
- Viral Diseases
- Weed

Pest Amount (%)

0

**E**

Scouter Home

- Squash Vein Yellowing Virus (SqVYV)
- Tobacco Etch Virus (TEV)
- Tomato Chlorosis Virus (ToCV)
- Tomato Infectious Chlorosis Virus (TICV)
- Tomato Spotted Wilt Virus (TSWV)
- Tomato Yellow Leaf Curl Virus (TYLCV)
- Watermelon Mosaic Virus (WMV)
- Zucchini Yellow Mosaic Virus (ZYMV)

**F**

Tomato Yellow Leaf Cu...

Pest Amount (%)

14

Comments

Submit

1	2 ABC	3 DEF	-
4 GHI	5 JKL	6 MNO	.
7 PQRS	8 TUV	9 WXYZ	DEL X
* # (	0 +	_	Next

# Online scouting and decision support system

**A**

GPS + Select

Record Date  
2011-06-20

+ Profile

+ Stop

- Crop

Crop  
-- Select Crop --

Crop Variety  
-- Select Crop Variety --

Field Status  
-- Select Field Status --

+ Pest

**B**

-- Select Field Status --

In Production

Spray Today

Spray Tomorrow

Harvesting

Harvested

Burned Down

Not planted

**C**

Scouter Home >

GPS + Select

Record Date  
2011-06-20

+ Profile

+ Stop

+ Crop

- Pest

Pest  
-- Select Pest Category --

Pest Name  
-- Select Pest --

Pest Amount (%)  
0

Bill, ZedX



# How can we deal with emerging viruses like **GRSV** and **TCSV**?

- Online scouting/decision support system



**Bill Turechek**



How can we deal with emerging  
viruses like GRSV and TCSV?



# GRSV and TSWV resistance



**TSWV**  
**R gene: *Tsw***

# GRSV and TSWV resistance

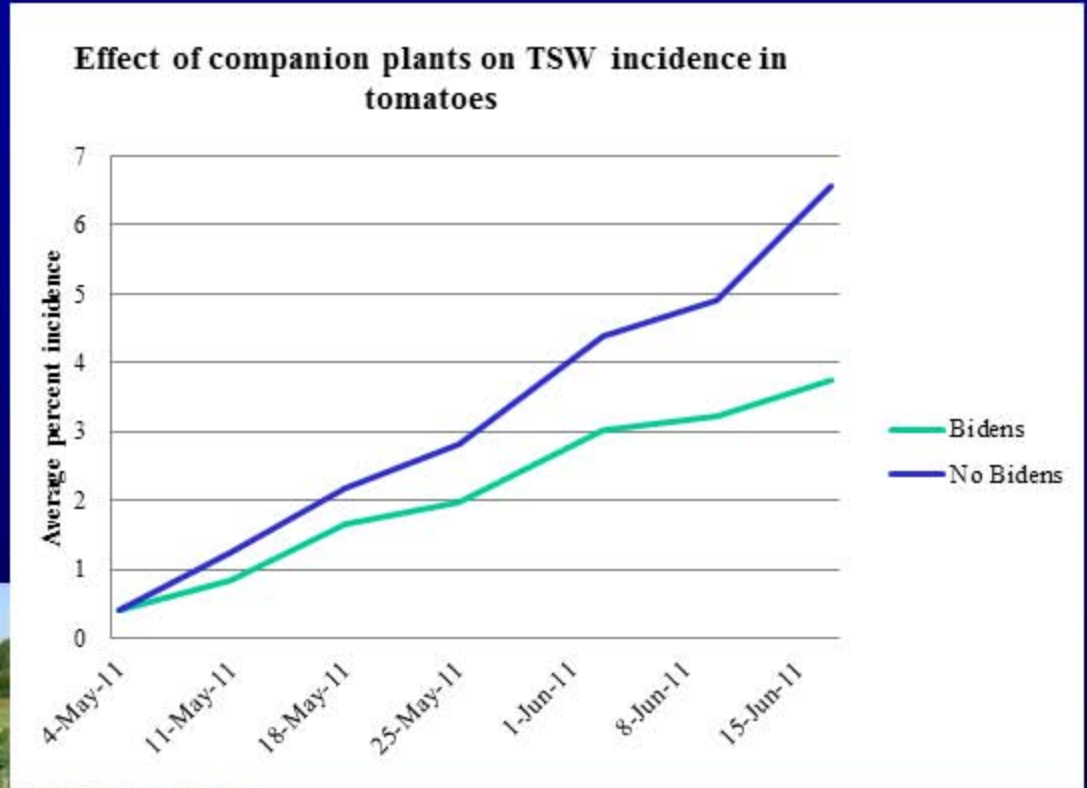


**TSWV**

**R gene:                      -    Sw5    Sw5**

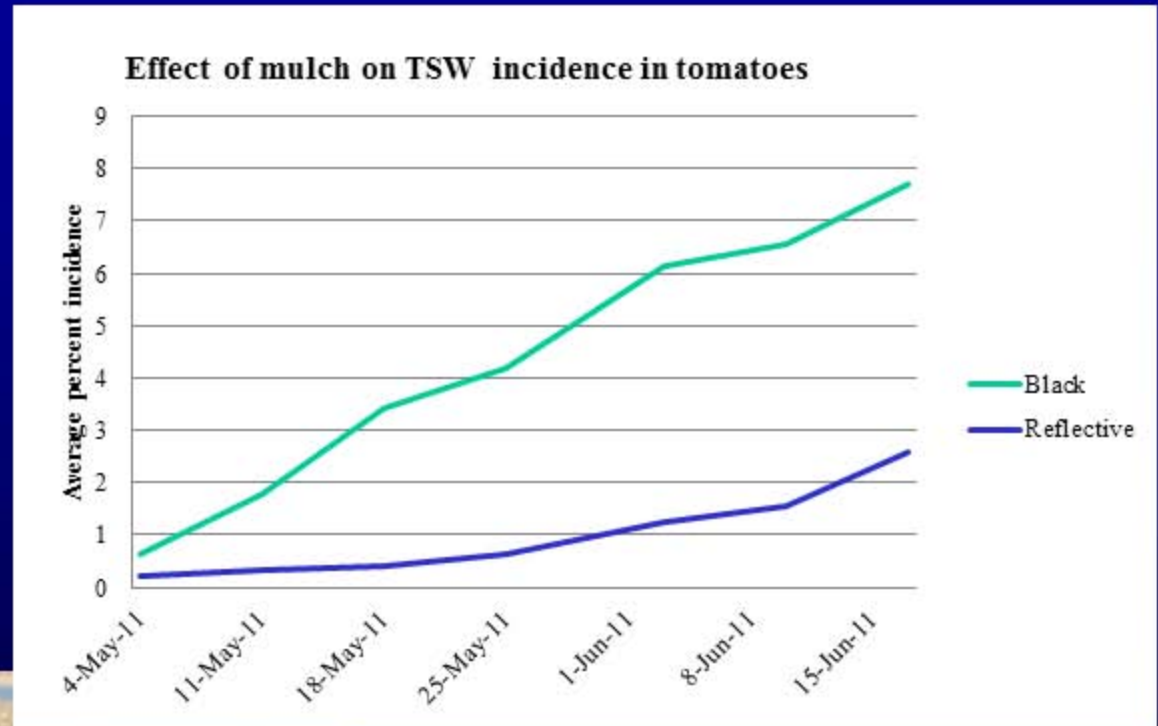


# Vector control



**Kara Tyler-Julian &  
Joe Funderburk**

# Vector control



**Kara Tyler-Julian &  
Joe Funderburk**

# Vector control

## Managing Thrips and Tospoviruses in Tomato<sup>1</sup>

Joe Funderburk, Stuart Reitz, Steve Olson, Phil Stansly, Hugh Smith, Gene McAvoy, Ozan Demirozer, Crystal Snodgrass, Mathews Paret, and Norm Leppla<sup>2</sup>

Several invasive species of thrips have established in Florida and are causing serious economic losses to vegetable, ornamental, and agronomic crops. Damage to crops results from thrips feeding and egg-laying injury, by the thrips vectoring of plant diseases, the cost of using control tactics, and the loss of pesticides due to resistance. Western flower thrips (*Frankliniella occidentalis*), which was introduced and became established in northern Florida in the early 1980s, is the major thrips pest of tomatoes. The western flower thrips did not become an economic problem in central and southern Florida until 2005 (Frantz and Mellinger 2009). Two other invasive species, melon thrips, *Thrips palmi*, and chilli thrips, *Scirtothrips dorsalis*, are not damaging pests of tomato.

review information on the situation in Florida (Funderburk 2009, Frantz and Mellinger 2009, Weiss et al. 2009).

The western flower thrips is the most efficient vector of *tomato spotted wilt virus* (TSWV). This virus is one of about twenty known species of tospoviruses (Sherwood et al. 2001a, b). Epidemics of tomato spotted wilt (TSW) occur frequently in numerous crops in northern Florida. Until recently, it was thought that TSW occurred sporadically in central and southern Florida. Most infections were confined to a few isolated plants in a field, transplants, mainly pepper, which originated from planthouses in Georgia. Secondary spread (i.e., within the field) away from the initial site of infection was rarely, if ever, seen. Recently,



# Vector control

- UV reflective mulch
- Companion plants
- “Gentle” insecticides
- Suppress vector species but encourage non-vector species and predators

Joe Funderburk, Galen Frantz, Stuart Reitz

# Vector control

- UV reflective mulch
- Companion plants
- “Gentle” insecticides

# GRSV hosts in Florida



**American black nightshade**



**Cutleaf groundcherry**



# **Reservoir control**

- **Weed, volunteer crop hosts**
- **Crop itself**
  - **Continuous cropping**
  - **Overlapping seasons**

# GRSV-infected tomato plants rogued from Florida field



**December 2010**

# **Sanitation, roguing**

- **Use virus-free transplants**
- **Rogue infected transplants  
and field plants**



# **Tospovirus management**

- **Sanitation, roguing**
- **Reservoir control**
- **Thrips vector control**
- **Resistance**
- **Decision support system**

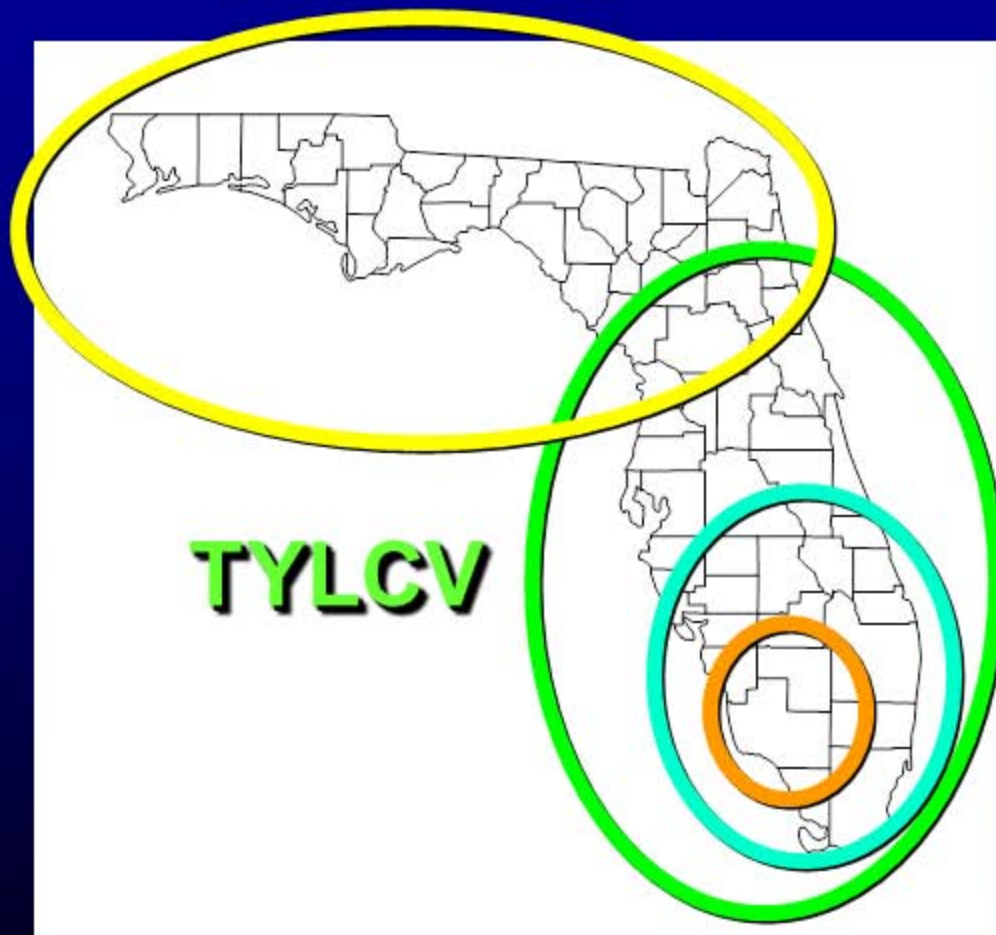
# Tomato viruses in Florida

**TSWV**

**TYLCV**

**“GRSV”**

**TCSV**



**2012**

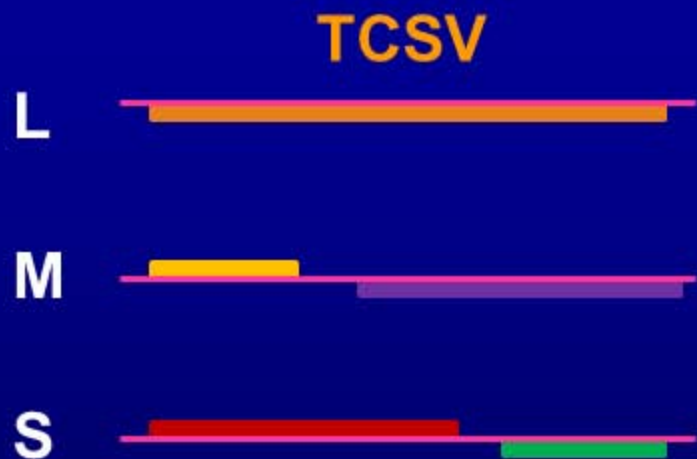


# Tospoviruses in U.S., 2012

- *Tomato spotted wilt virus (TSWV)*
- *Impatiens necrotic spot virus (INSV)*
- *Chrysanthemum stem necrosis virus*
- *Peanut bud necrosis virus*
- *Groundnut ringspot virus (GRSV)*
- “GRSV” = GRSV/TCSV reassortant
- *Watermelon silver mottle virus*
- *Zucchini lethal chlorosis virus*
- *Iris yellow spot virus (IYSV)*
- *Tomato chlorotic spot virus (TCSV)*
- *Capsicum chlorosis virus*



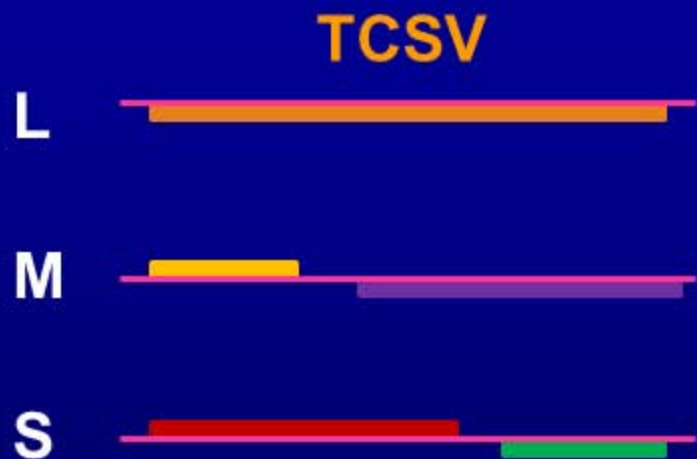
# Tospoviruses on the move



- **TCSV** detected (one parent of **GRSV/TCSV** reassortant)

- **GRSV/TCSV** reassortant behaved like its parent species (**GRSV** and **TCSV**)
- For simplicity, we decided to call the reassortant **GRSV**

# Tospoviruses on the move



- **TCSV** detected (one parent of **GRSV**/**TCSV** reassortant)

# Tospoviruses on the move

- Since March 2012 multiple tomato samples tested with atypical **GRSV** results – Collier and Hendry Counties



Leon Lucas



# Tospoviruses on the move

# Summary

- **GRSV** host and geographic range expanding in Florida; remains at low incidence generally
- Common blossom thrips and Western flower thrips transmit **GRSV** in Florida
- All Florida **GRSV** has same genotype (chromosome swap) with >99% nucleotide identity
- First interspecies chromosome swap

# Role of common blossom thrips in **GRSV** transmission in Florida

- Historically a minor species
- **GRSV** generally in low incidence
- One exceptional field with high thrips population and high **GRSV** incidence (Galen Frantz)
- **GRSV** and **TCSV** vector in South America



# **Thrips in tomato flowers in Miami-Dade County 1997-2011**

- **Florida flower thrips (~49%)**
- **Melon thrips (~30%)**
- **Western flower thrips (~14%)**
- **Common blossom thrips (~3%)**

**Galen Frantz, Glades Crop Care**

# GRSV transmission

Thrips species	Acquisition	Transmission
Western flower	7%	12%
Florida flower	4%	0%
Tobacco	0%	0%
Common blossom	41%	26%

- Common blossom thrips was most efficient **GRSV** vector, although Western flower thrips also transmitted to tomato
- Florida flower thrips acquired **GRSV** but did not transmit

# Is **GRSV** transmitted by other Florida thrips species?

- Florida flower thrips (*F. bispinosa*)
- Tobacco thrips (*F. fusca*)
- Common blossom thrips (*F. schultzei*)

**Craig Webster, Stuart Reitz and Galen Frantz**



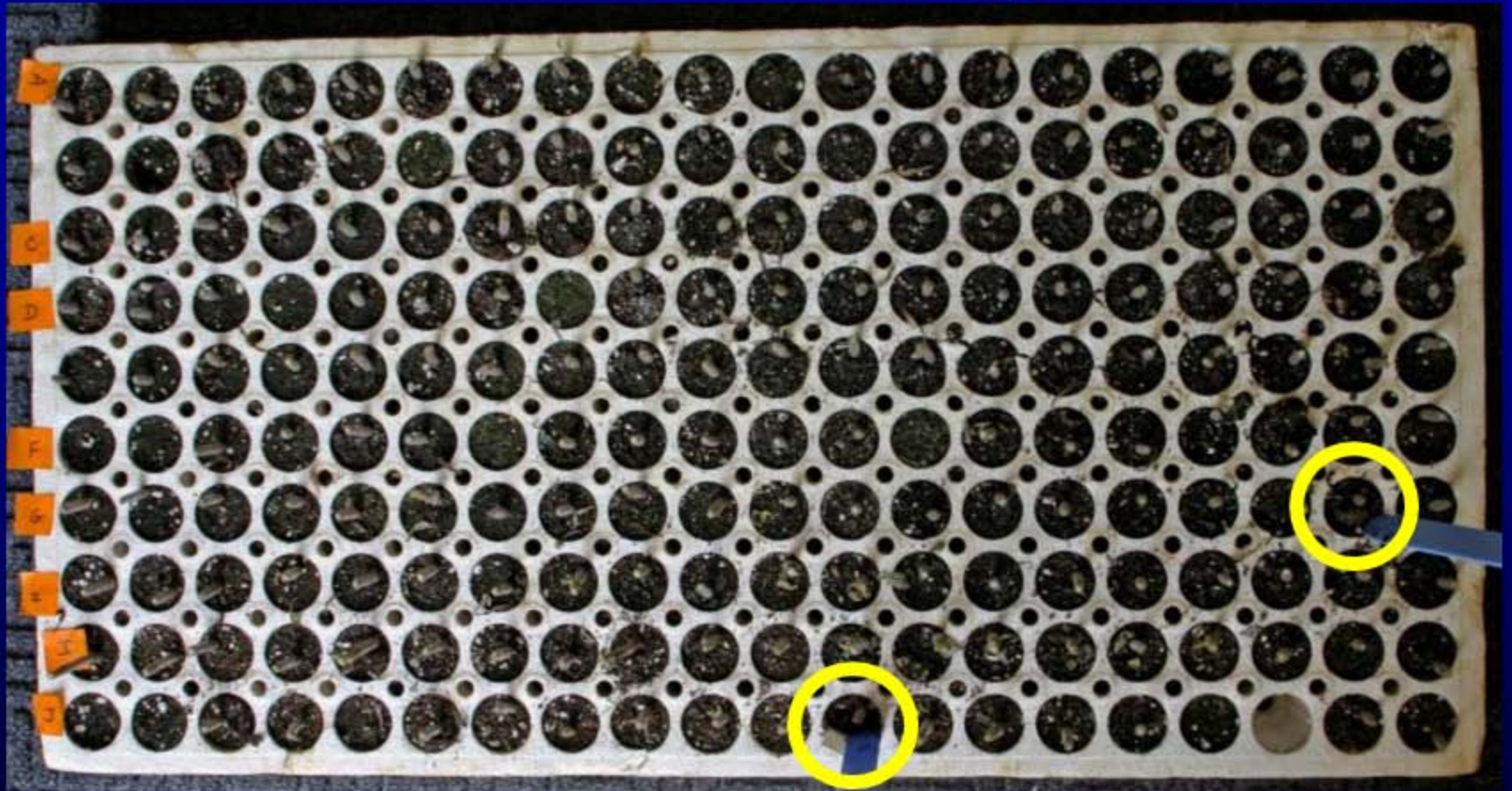
# GRSV is transmitted by Western flower thrips



**Stuart Reitz**



# GRSV-infected transplants



**GRSV detected in symptomatic transplants only**



# GRSV-infected transplants





# GRSV-infected transplants



mid-August 2010 to present

Leon Lucas, Glades Crop Care

# GRSV field survey



- Only TSWV detected in peanuts
- GRSV only detected in solanaceous plants

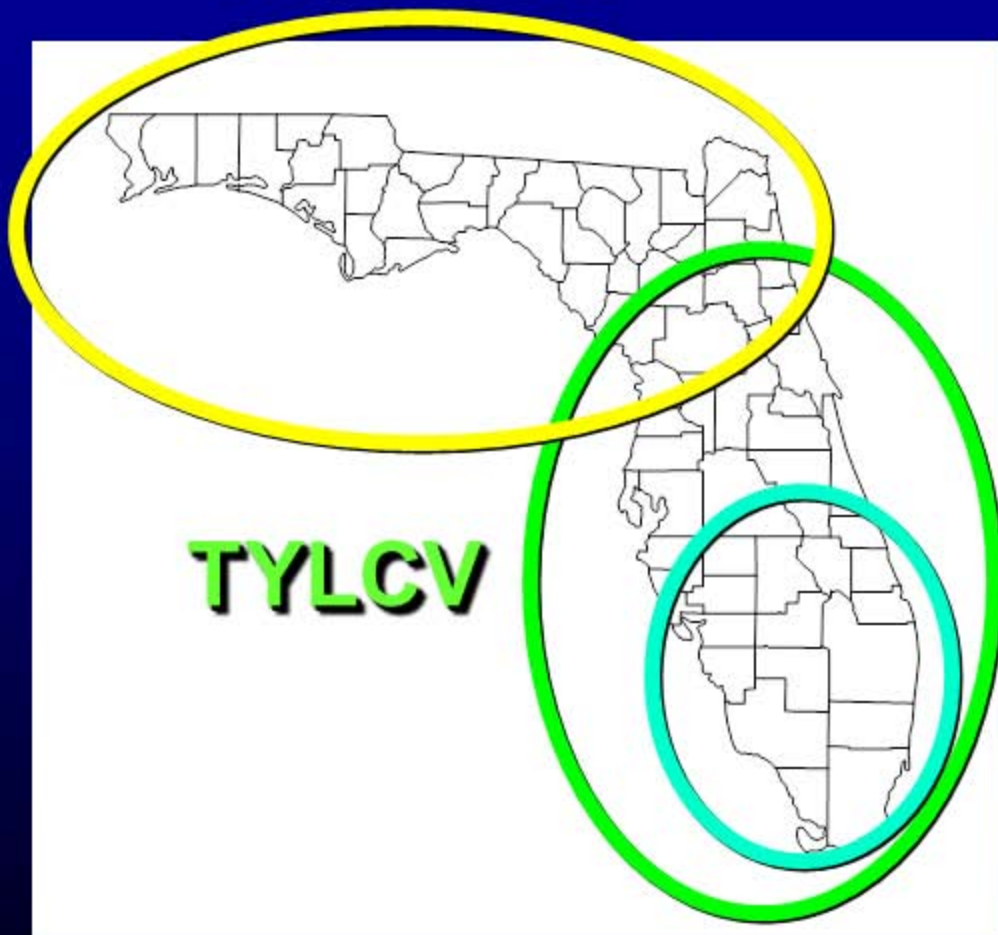
Galen Frantz, Gene McAvoy

# Tomato viruses in Florida

**TSWV**

**TYLCV**

**GRSV**



**2012**

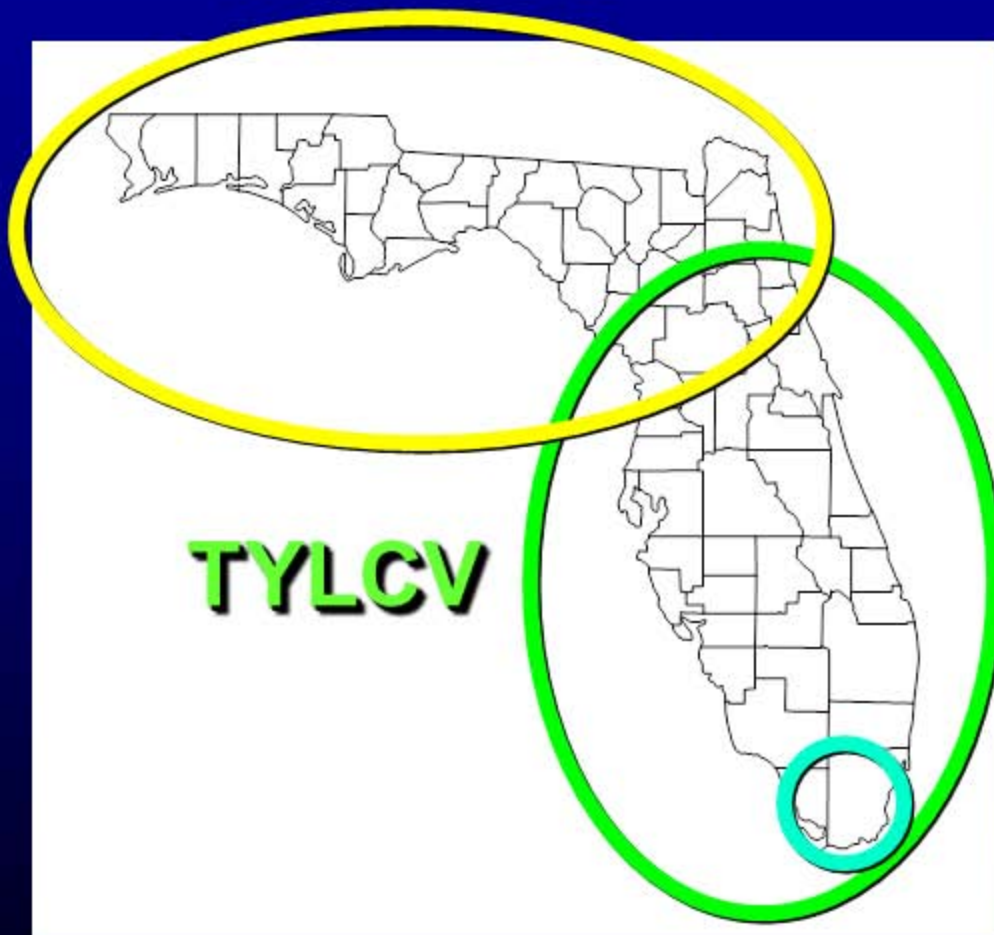


# Tomato viruses in Florida

**TSWV**

**TYLCV**

**GRSV**



# **GRSV detection in Florida**

- **Miami-Dade (November 2009)**
- **Collier**
- **Hendry**
- **Martin**
- **Lee**
- **Palm Beach**
- **Manatee**
- **St. Lucie**
- **Charlotte (March 2012)**

# GRSV field survey

- Only TSWV detected in samples from outside of Florida
- GRSV only detected in Florida





# GRSV field survey

- **Southeastern U.S. vegetable production (focused on tomato)**
- **Plants with typical tospovirus symptoms (>500 to date)**



# GRSV experimental host range



- Only solanaceous plants infected
- No legume hosts



# GRSV experimental host range





# GRSV hosts in Florida



**Cutleaf groundcherry**  
**(*Physalis angulata*)**  
**St. Lucie County**  
**(November 2011)**

# GRSV hosts in Florida



**American black nightshade (June 2011)**

# GRSV hosts in Florida



eggplant (March 2011)



# GRSV hosts in Florida



**tomatillo (November-December 2010)**

# GRSV hosts in Florida



**pepper (December 2010)**



# GRSV-infected tomato fruits



**May 2011**



**April 2012**



# GRSV-infected tomatoes in field

April/May, Martin County



2010



2012

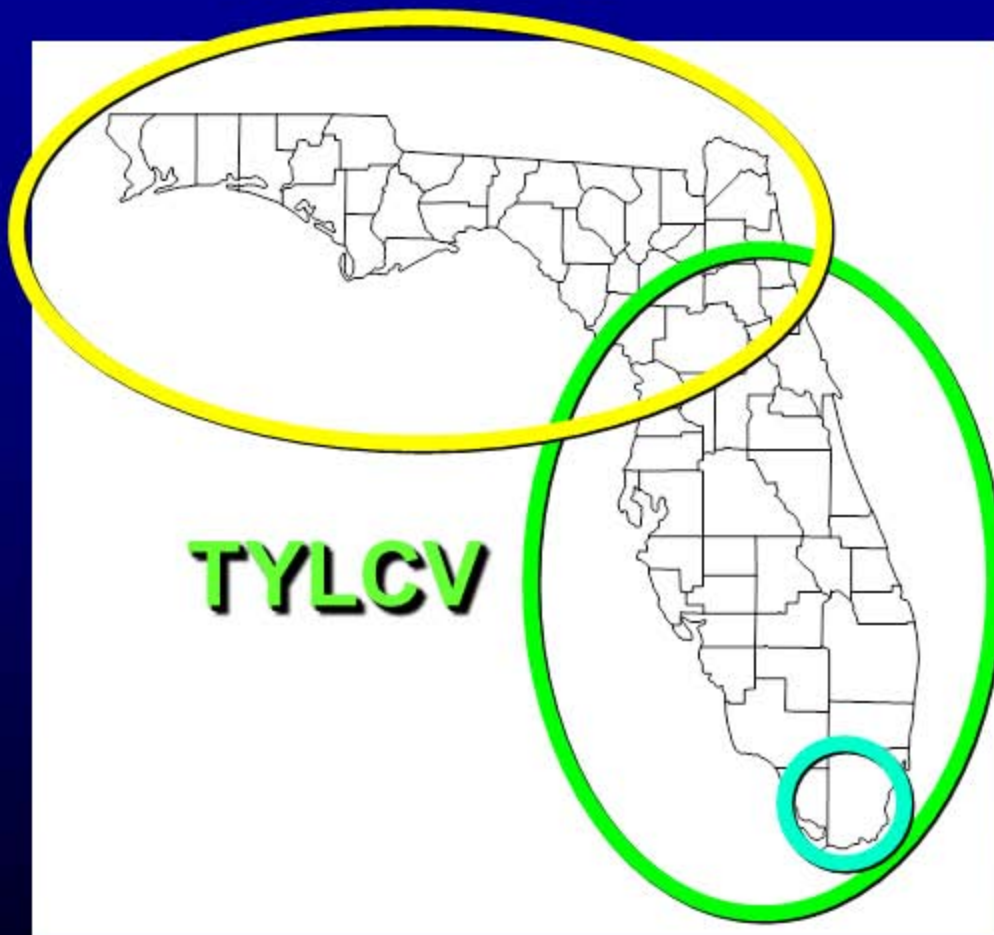
Glades Crop Care

# Tomato viruses in Florida

**TSWV**

**TYLCV**

**GRSV**



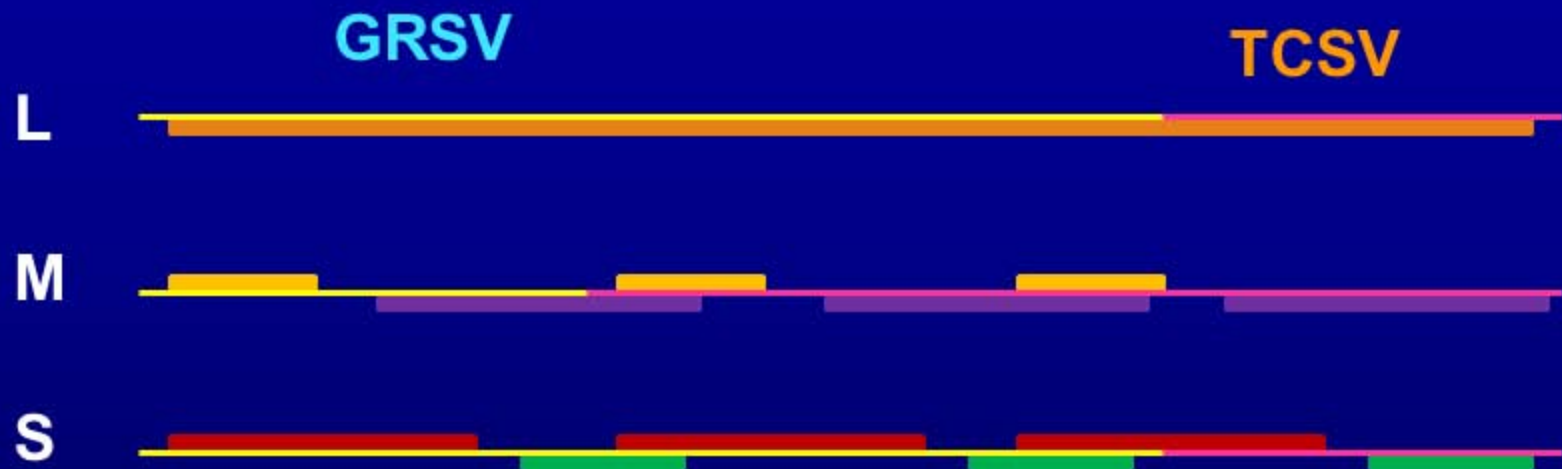


# Genome reassortment

- **GRSV/TCSV** reassortant behaved like its parent species (**GRSV** and **TCSV**)
- For simplicity, we decided to call the reassortant **GRSV**



# Genome reassortment



- S and L RNAs from **GRSV** whereas M RNA from *Tomato chlorotic spot virus* (TCSV) = a chromosome swap
- Represents an emerging virus with unique combination of genes from parent species (**GRSV** and **TCSV**)

# First report of *Groundnut ringspot virus* in Florida



December 2009

One genome segment (chromosome)  
is from *Tomato chlorotic spot virus*!



# First report of *Groundnut ringspot virus* in Florida



December 2009



# Tospoviruses on the move



**December 2009**

**Glades Crop Care**

# Tospovirus particles

RNAs (chromosomes)

L (Large)

M (Medium)

S (Small)

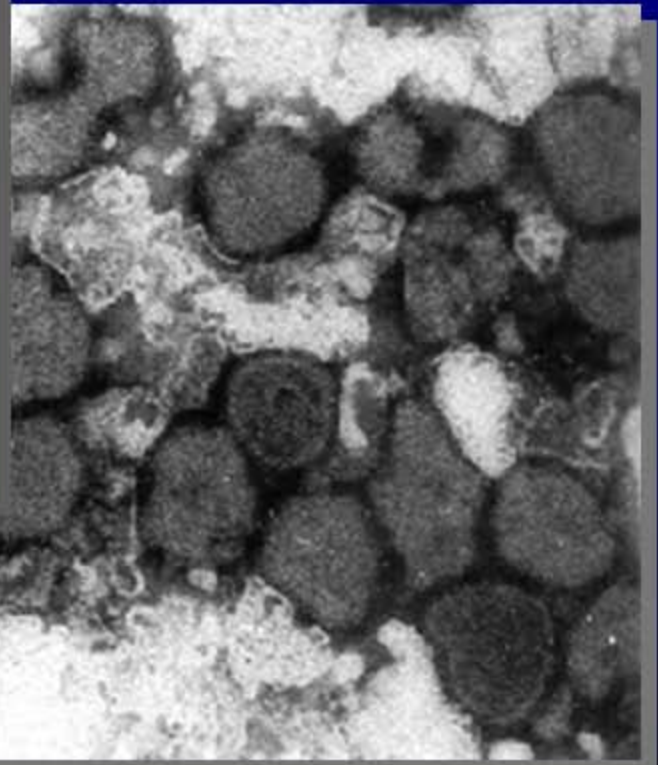
Proteins

L

G1

G2

N

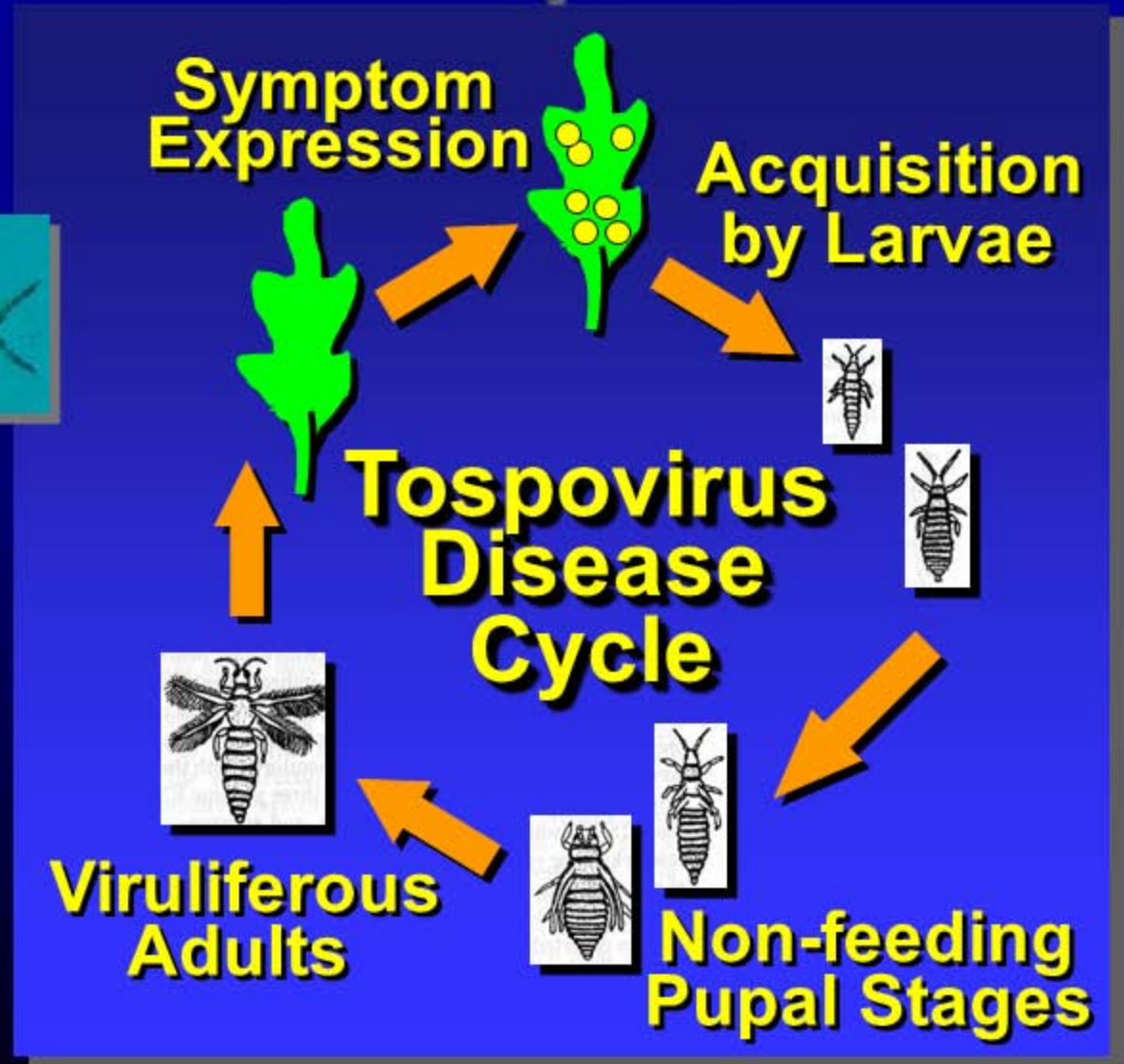




# Thrips transmit tospoviruses



**Western flower  
thrips**  
**Tobacco thrips**  
**Melon thrips**





# No seed transmission of tospoviruses



# Why care about Tospoviruses?





# Why care about Tospoviruses?





# Why care about Tospoviruses?



# Tospoviruses in U.S., 2009

- *Tomato spotted wilt virus (TSWV)*
- *Impatiens necrotic spot virus (INSV)*
- *Chrysanthemum stem necrosis virus*
- *Peanut bud necrosis virus*
- *Groundnut ringspot virus*
- *Watermelon silver mottle virus*
- *Zucchini lethal chlorosis virus*
- *Iris yellow spot virus (IYSV)*
- *Tomato chlorotic spot virus*
- *Capsicum chlorosis virus*
- *Tomato necrotic ringspot virus*



# Tospoviruses

- **Tomato spotted wilt virus (TSWV)**
- **Impatiens necrotic spot virus**
- **Chrysanthemum stem necrosis virus**
- **Peanut bud necrosis virus**
- **Groundnut ringspot virus**
- **Watermelon silver mottle virus**
- **Zucchini lethal chlorosis virus**
- **Iris yellow spot virus**
- **Tomato chlorotic spot virus**
- **Capsicum chlorosis virus**
- **Tomato necrotic ringspot virus**

# What's a Tospovirus?



# ***Groundnut ringspot virus and Tomato spotted wilt virus - Tospoviruses in Florida***

**Scott Adkins, Craig G. Webster,  
H. Charles Mellinger, Galen Frantz,  
William W. Turechek, Eugene McAvoy,  
Stuart R. Reitz and Joe Funderburk**

**USDA-ARS, Glades Crop Care, UF Extension  
and University of Florida**