



**Good Morning!**

# *Iris yellow spot virus* Epidemics in onion: Management Tactics

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WSU's main campus in Pullman, WA

Winter



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UC

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Tom Turini

# *Iris yellow spot virus* Epidemics in onion: Management Tactics

History

Current status of the disease incidence

Disease Diagnosis

Epidemiology

Ongoing research

Management Options

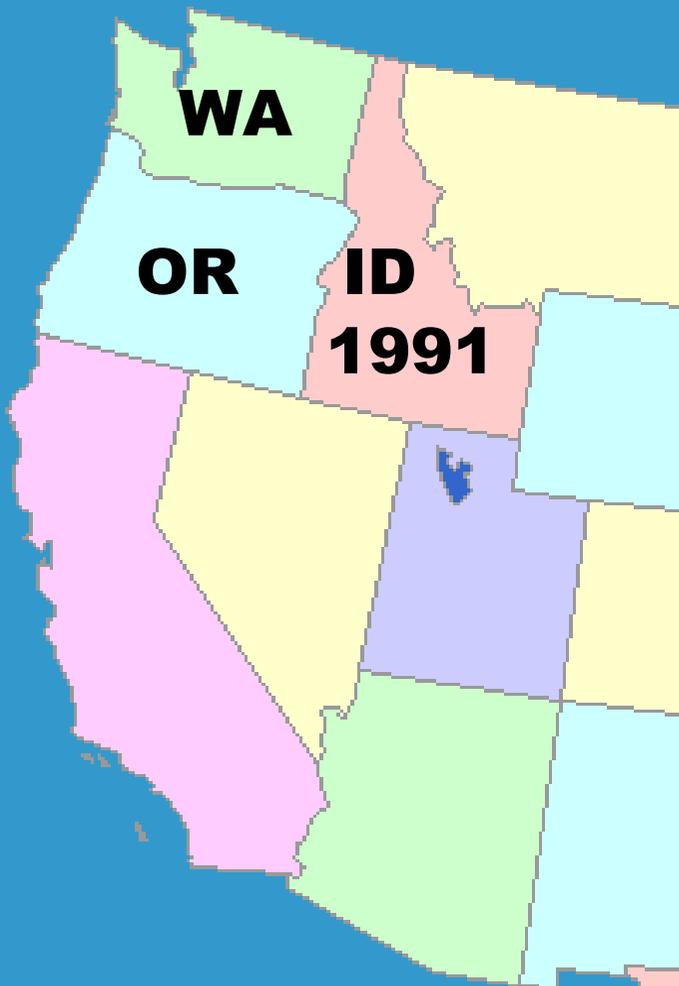
# Historical Perspective

- Symptoms suggestive of a disease found in early 90s in the Treasure Valley of Idaho
- Confused with downy mildew or purple blotch
- No fungal or bacterial pathogens could be isolated
- Drs. Krishna Mohan (UI) and Jim Moyer (NCSU)





©maps.com



# Historical Perspective

- Further research showed that the virus was same as the one reported from Israel, Brazil, and the Netherlands
- The virus is called *Iris Yellow Spot Virus (IYSV)*



Iris yellow spot virus  
in iris\*

(\*Iris and not Irish)



Toon Derks, Bulb Research Center, The Netherlands

Washington State University

# WA storage onion industry

~16,000 acres in 2001

~\$58.5 million

# 3 in US

50% export



# WA onion seed industry

~800 acres

~\$5.6 million

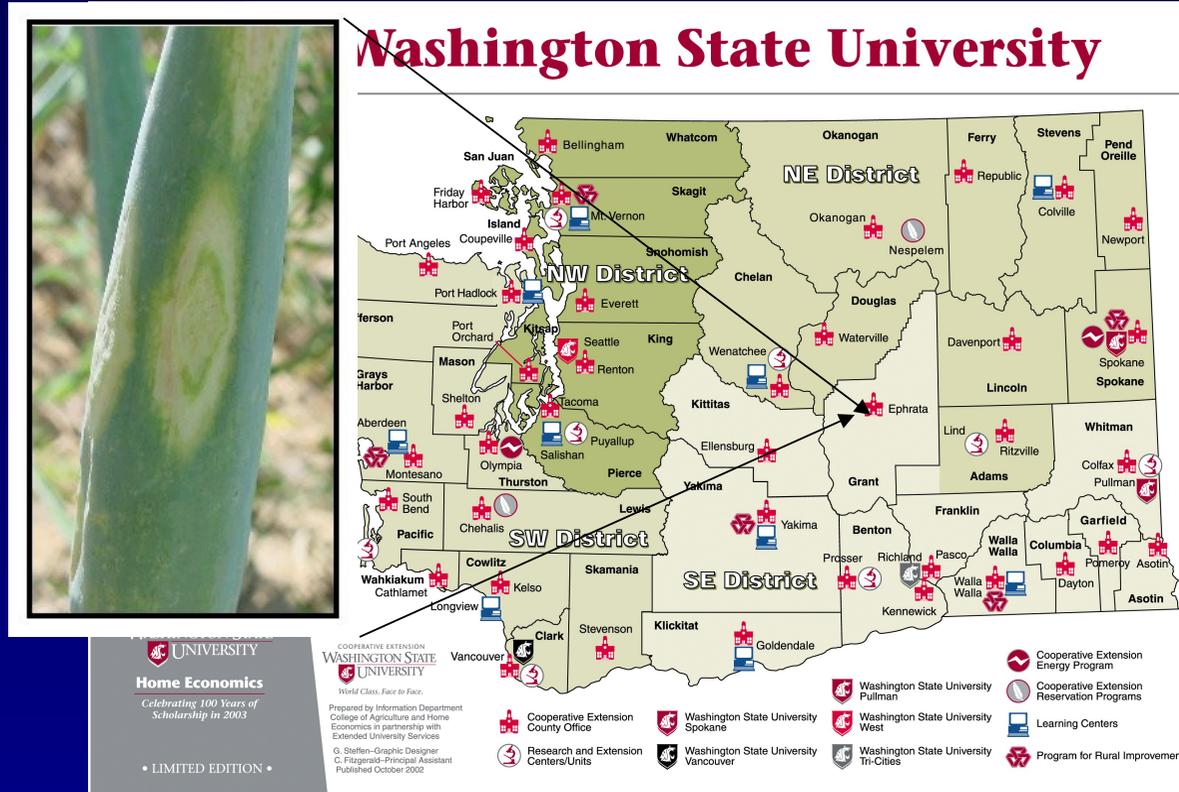
20% US & world supply

50% exported



# IYSV in WA State

- 2002: symptomatic plants were noticed in Grant Co., WA
- 2003: Virus was confirmed using lab tests







# Spread of IYSV in the US

(year reported from each state)



# Thrips-IYSV complex: World-wide occurrence

- Australia
- Brazil
- Canada
- \*Chile
- \*Egypt
- France
- \*Guatemala
- \*India
- Iran
- Israel
- Japan
- \*New Zealand
- Netherlands
- \*Peru
- \*Spain
- \*Reunion Island



An aerial photograph showing a large, rectangular, vibrant green field, likely a cover crop or young corn, situated within a larger agricultural landscape. The surrounding areas are brown and tan, indicating bare soil or mature crops. The green field is bordered by a light-colored path or road. The overall scene is captured from a high angle, showing the geometric layout of the fields.

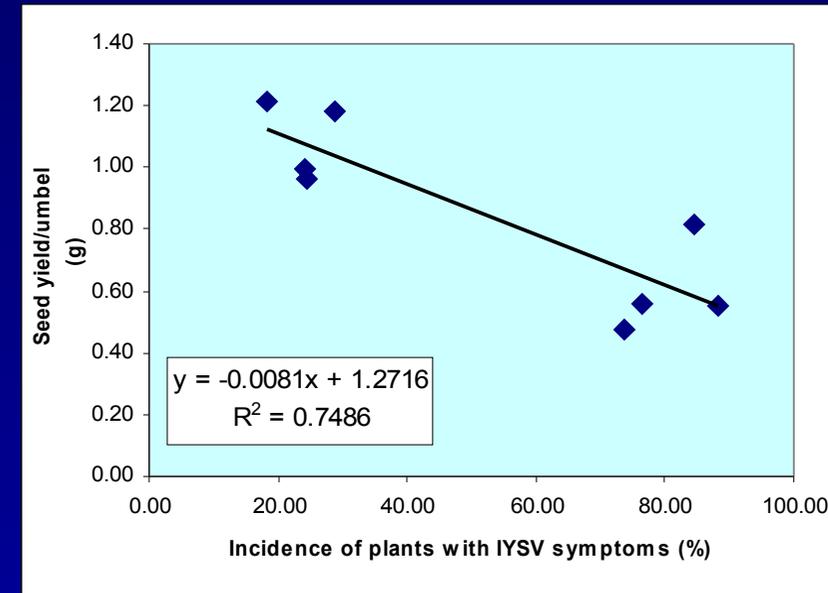
**Fred Crowe, OSU**



# Impact of IYSV

WSU Onion Cultivar Trial near Quincy, WA had severe outbreak of IYSV: all cultivars were susceptible, incidence ranging from 58% to 97%

- Significant reduction in bulb size observed
- Significant impact on onion seed production observed in 2004. In one instance, 200lb/acre instead of the usual 800 to 1,000 lb/acre.









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Secondary pathogens colonize the dried/dead tissue following IYSV infection (could lead to mis-diagnosis)





**Shallot**  
**August 2004**

Pappu et al., 2006. Arch.Virol.

IYSV recently confirmed in commercial leek in Colorado  
(Schwartz, Otto and Pappu. 2006. Plant Disease)





# IYSV found in wild onion relatives

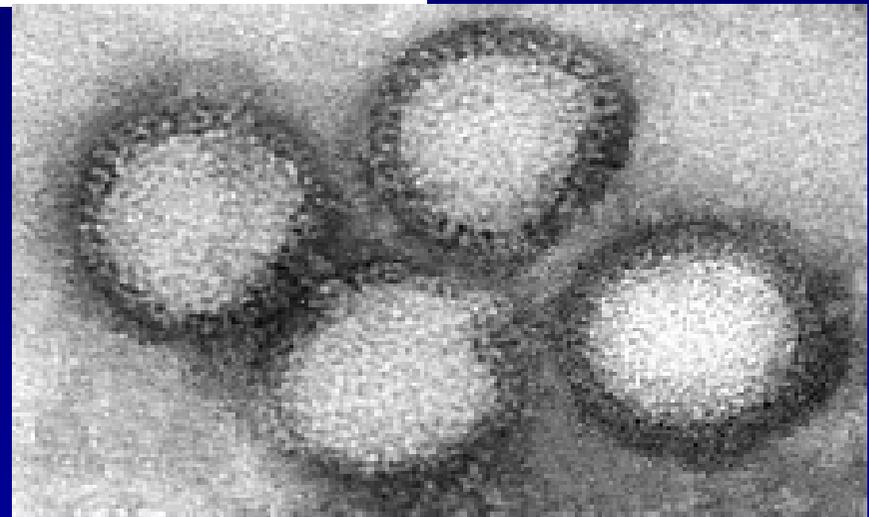
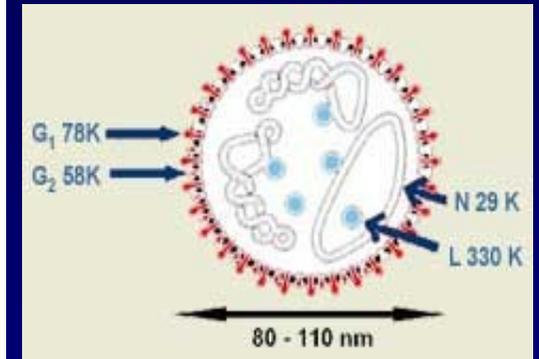
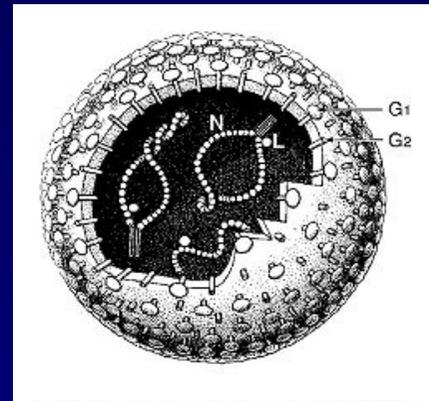
*Allium vavilovii*

Central Ferry Farm, WA

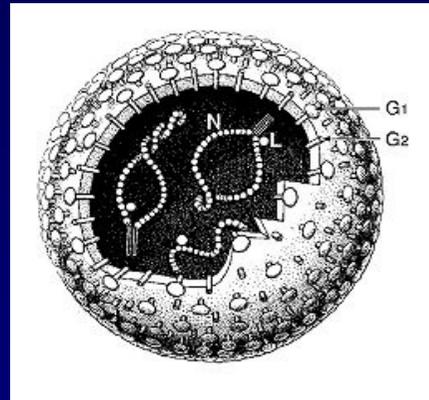
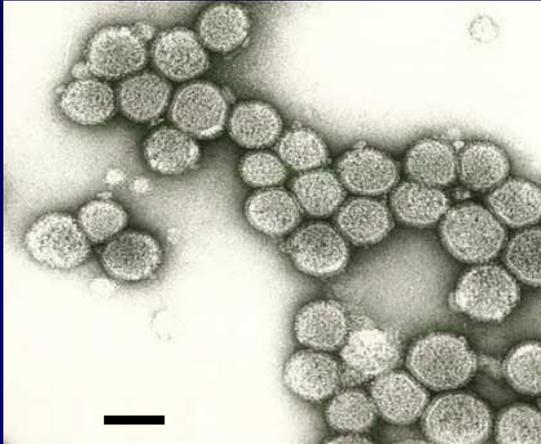
Hellier, Pappu and Dugan.  
APSnet Image of the Week  
[www.apsnet.org](http://www.apsnet.org)

# *Iris Yellow Spot Virus*

- Thrips-transmitted
  - Circulative and propagative  
(Replicates in the vector)
- 15 viruses, 8 thrips spp.



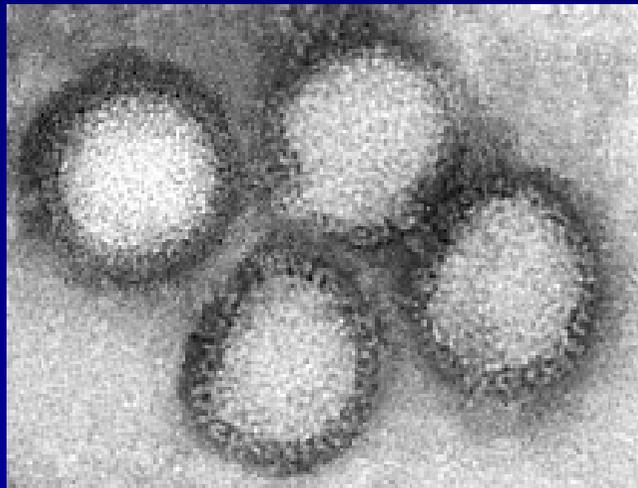
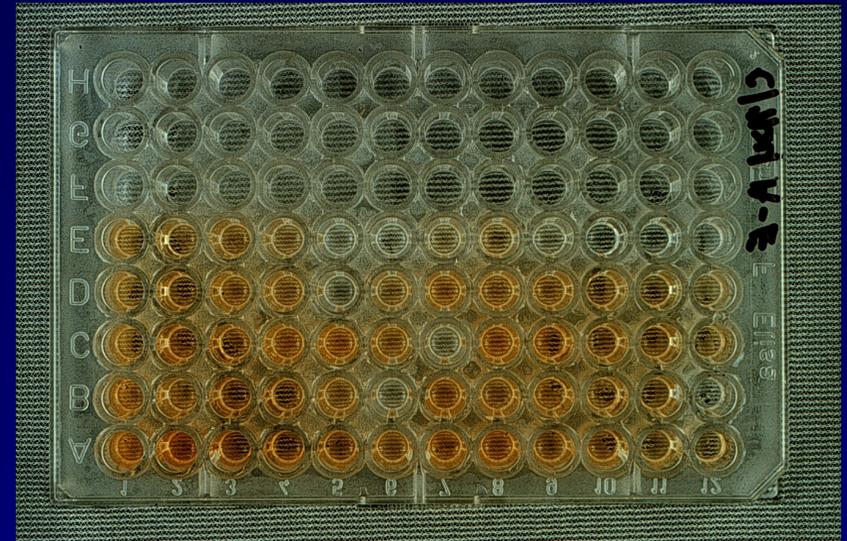
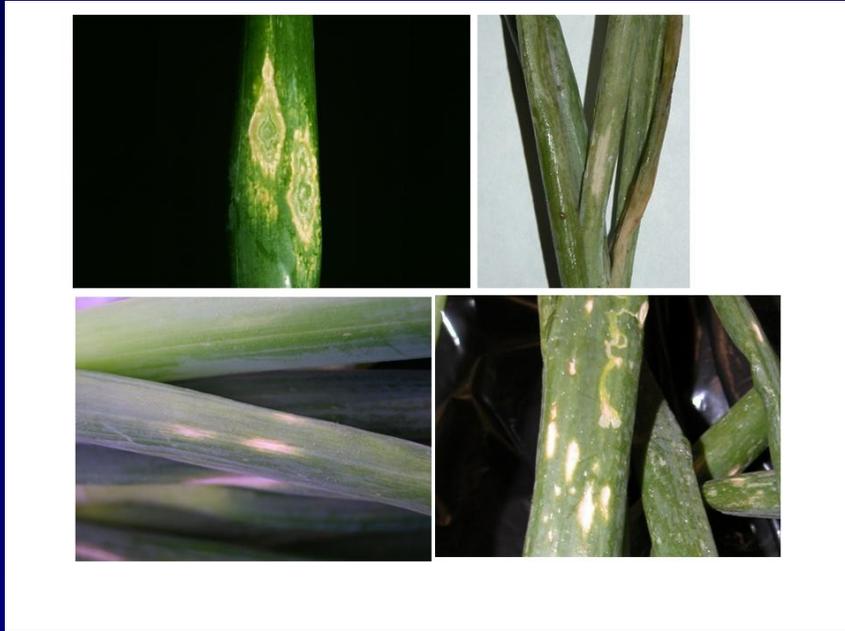
# IYSV Genome Structure and Organization



# *Biological Properties*

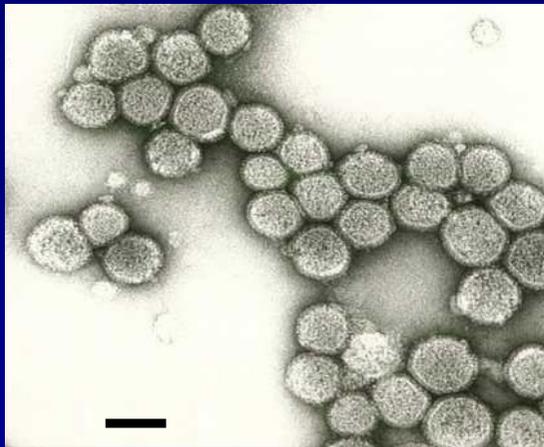
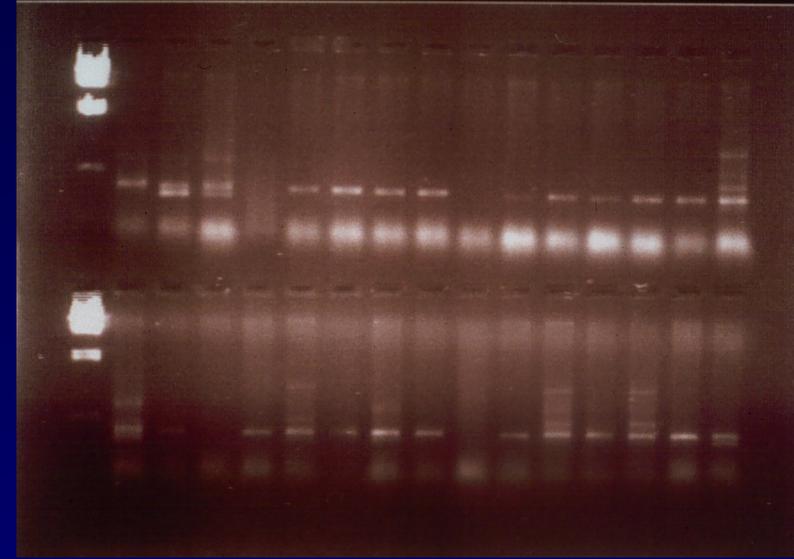
- Host range is limited (compared to *Tomato spotted wilt virus*)
- Mechanically transmissible, but with DIFFICULTY
- Unstable *in vitro*
- Symptom expression is influenced by several factors (virus strain, time of infection, environment, host genotype...)
- Considerable asymptomatic infections

# Diagnostics: Reagents are commercially available



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# Diagnostics PCR and Real time PCR



02/28/12

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# *Epidemiology of IYSV in Onion*

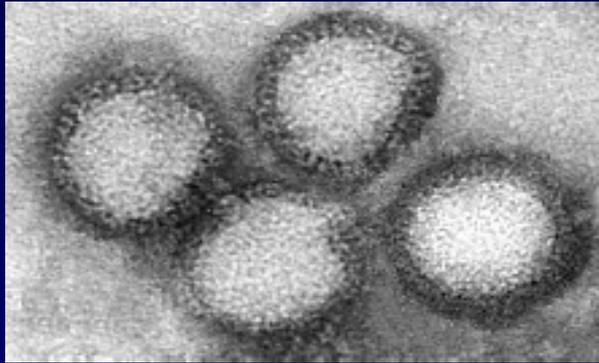
- Transmitted by onion thrips
- The virus probably multiplies in the thrips vector
- Iris, Leek, shallot, garlic and chives are also susceptible
- Several weeds are hosts of IYSV
- Overlap between seed and bulb crops in PNW provides the 'green bridge'
- Transplants carrying viruliferous thrips

# Epidemiology of IYSV in Onion

- No evidence of seed transmission
- So, only possible means of virus introduction is by viruliferous thrips coming into a field  
or
- Transplants carrying viruliferous thrips



# Thrips-transmitted tospoviruses



**5,000 spp. of thrips: only 8 spp.  
transmit these viruses (about 15)**

**One sp. can transmit >one virus**



Eggs Laid in Plant Tissue

Egg

Feeding Stages

Larva I

Larva II

**Thrips Development**

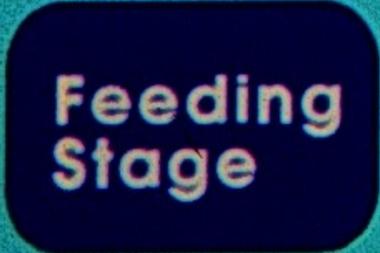
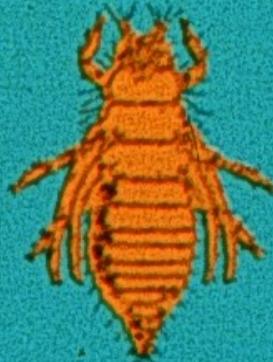
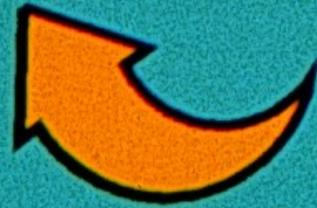
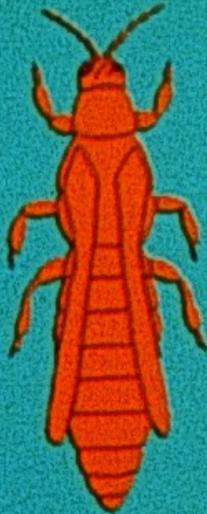
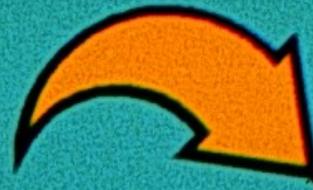
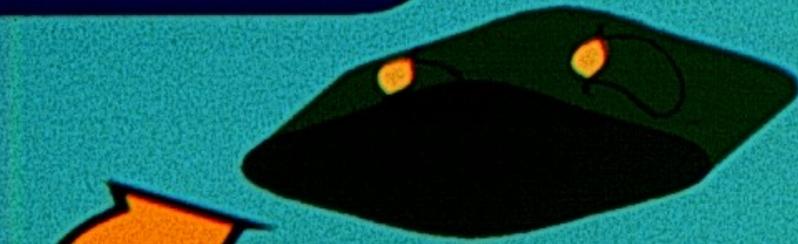
Adult

Pupa I

Feeding Stage

Pupa II

Non-Feeding Pupal Stages



**Survey, collect and test various crops  
and weeds to identify virus reservoirs**





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Puncture vine  
*Tribulus terrestris*



Redroot pigweed  
*Amaranthus retroflexus*



Lambs Quarter:  
*Chenopodium album*

Prickly lettuce  
*Lactuca serriola*



Kochia  
*Kochia scoparia*



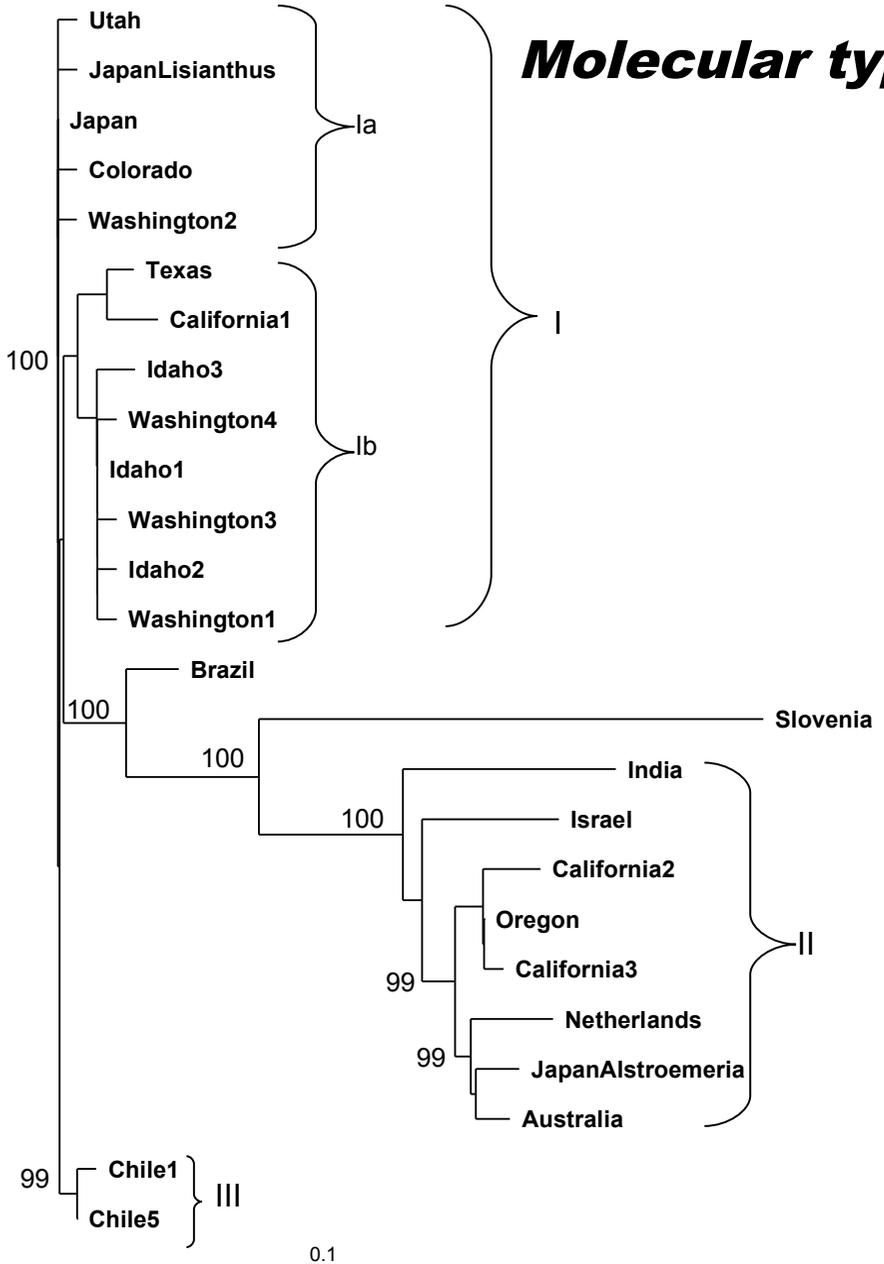
# *Molecular Variability*

- More is known about the population structure at the molecular level
- Most of the viral genome was cloned and sequenced.
- Individual genes from different isolates can be easily sequenced and phylogenies conducted



<b>Isolate Designation</b>	<b>Host</b>	<b>Year collected</b>	<b>Region or country of origin</b>	<b>GenBank Accession Number</b>
WARR9	Onion	2004	Grant Co., WA, USA	DQ233468*
WAPasco	Onion	2004	Franklin Co, WA, USA	DQ233469*
WAGrant	Onion	2003	Grant Co., WA, USA	DQ233470*
Shallot	Shallot	2004	Grant Co., WA, USA	DQ233471*
IDNampa	Onion	2005	Canyon Co., ID, USA	DQ233472*
IDNew Plymouth	Onion	2005	Payette Co., ID, USA	DQ233473*
IDParma	Onion	2004	Canyon Co., ID, USA	DQ233474*
California1	Onion	2005	Imperial Co., CA, USA	DQ233475
California2	Onion	2005	Los Angeles Co., CA, US	DQ233476*
Colorado	Onion	2004	Weld Co., CO, USA	DQ233477*
Utah	Onion	2004	Davis Co., UT, USA	DQ233478*
Oregon	Onion	2004	Jefferson Co., OR, USA	DQ233479*
Australia	Onion		Australia	AY341825
Brazil	Onion		Brazil	AF067070
Israel	Lisianthus		Israel	AF271129
Japan	Onion		Japan	AB180921
Japan – Alstroemeria	Alstroemeria		Japan	AB121025
Japan – Lisianthus	Lisianthus		Japan	AB121026
Netherlands	Iris		The Netherlands	AF001387
Slovenia	Leek		Slovenia	AY377428

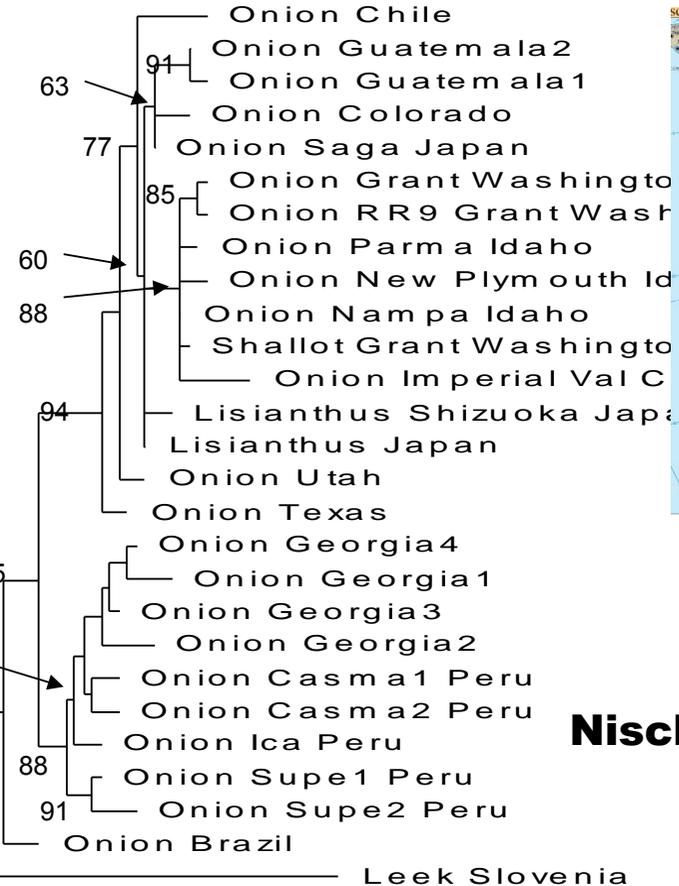
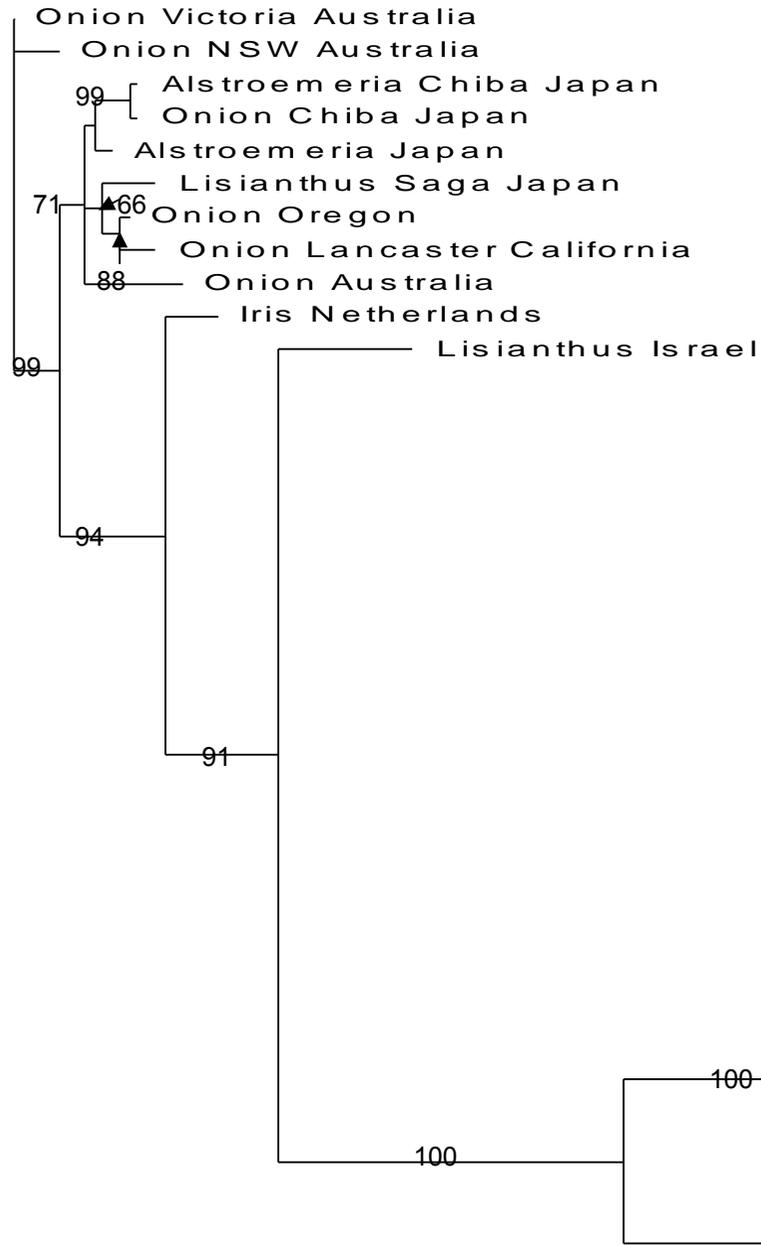
# ***Molecular typing of Iris yellow spot virus isolates***



## **Data obtained so far:**

**Based on sequence analysis, it appears there are two distinct populations of IYSV in the US:**

- One that is prevalent in the PNW**
- One that is present in OR and so. CA**



— 5 changes

**Nischwitz et al. 2007**

# Ongoing Research

Searching for over-wintering hosts for the virus  
Are there any perennial hosts for the virus?



# Thrips control

Onion thrips is the vector of IYSV

Does thrips control result in reduced disease incidence?

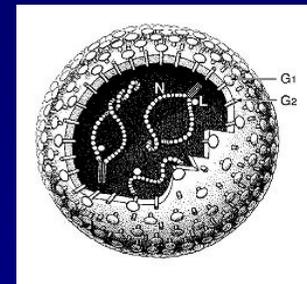
Is there a window for thrips control to maximize the benefit?

## Role of thrips vectors and thrips dynamics

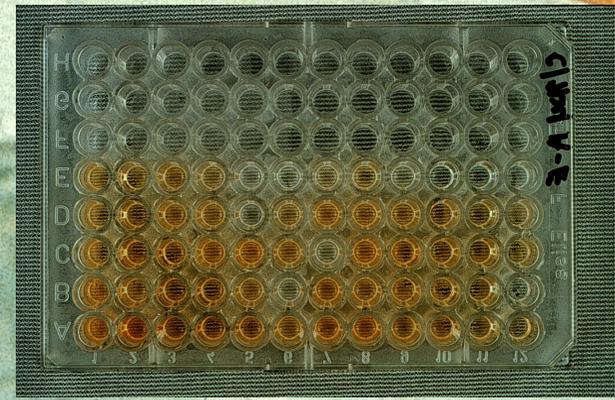
Virus is not seed-transmitted  
Only means of spread is by thrips

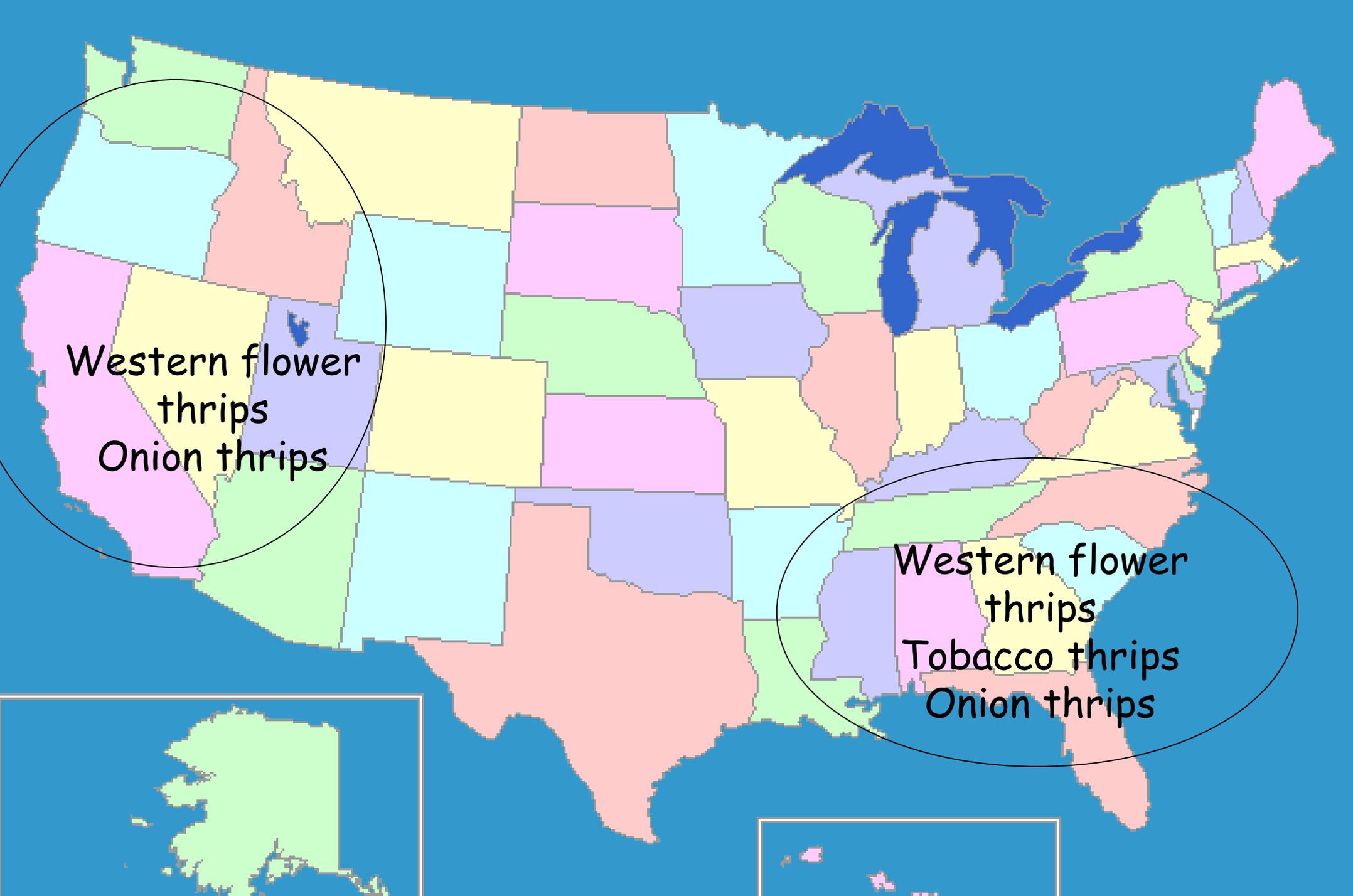
Disease epidemic depends on

1. the number of thrips vectors
2. their migration
3. the proportion of transmitters among the known vectors









Western flower thrips  
Onion thrips

Western flower thrips  
Tobacco thrips  
Onion thrips

# Optimizing Irrigation Schedule and fertilizer

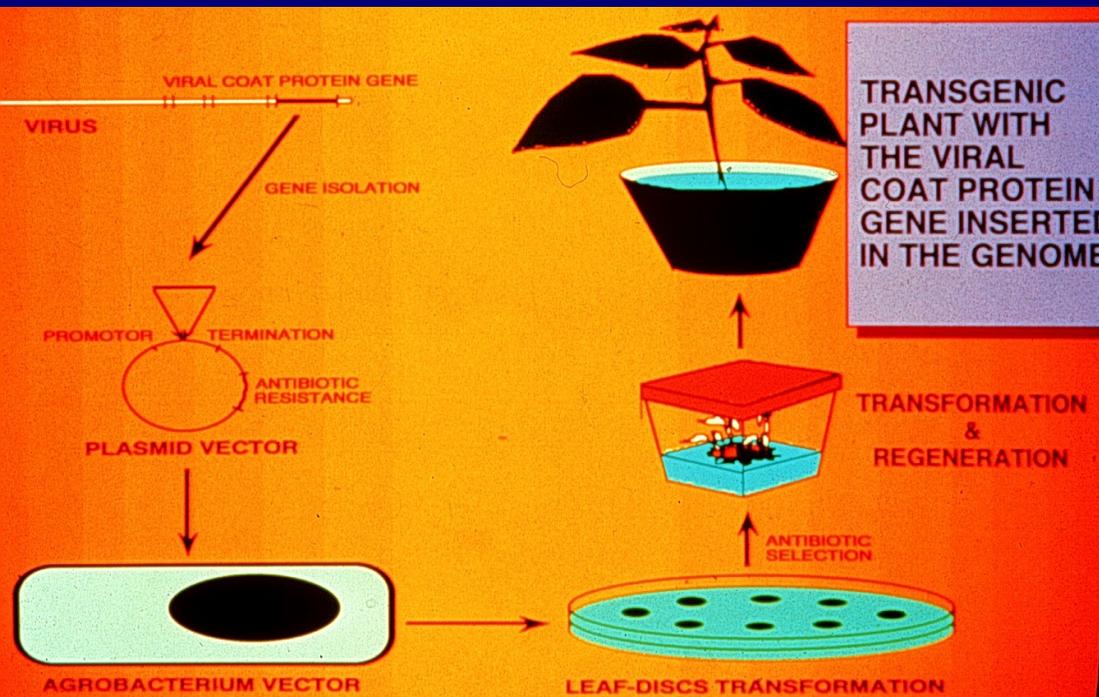
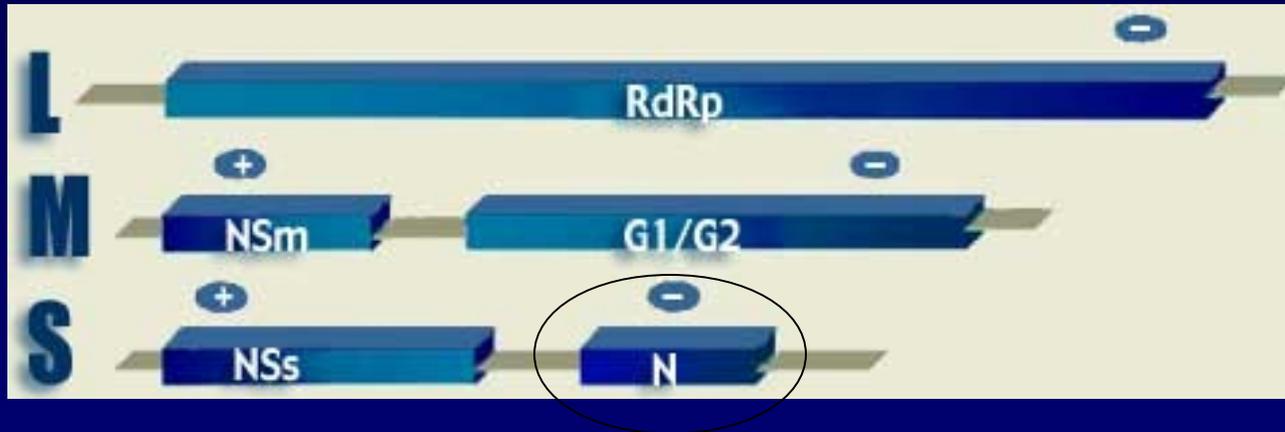


# Screening for Virus Resistance

## Oregon State University, Ontario, OR



# Gene silencing approach for introducing IYSV resistance in onion



- Transgenic tobacco had significantly less disease



-Transgenic tobacco had significantly less disease



## Spotted wilt in Tobacco:

- Pre-plant treatment with Actigard reduced disease incidence
- More effective when combined with imidacloprid



Pappu et al., 2000. *Crop Protection*  
Csinos et al., 2001. *Plant Disease*

Actigard:  
registered for blue mold

Varying results with IYSV in  
onion



# Steps to reduce IYSV

## Steps to reduce IYSV

**Field sanitation:** Clean up onions left over from fall harvest.



# Steps to reduce IYSV

## Reduce plant stressors

Maintain proper soil fertility

Uniform plant stand

Avoid soil compaction

Avoid irrigation stress

# Steps to reduce IYSV

## Practice sound thrips management

Take steps to reduce thrips populations  
Soft insecticides and thrips control during  
early part of the season seem to reduce the  
final incidence

However, thrips control alone may NOT  
reduce the disease incidence.

## **Steps to reduce IYSV**

### **Examine crop rotation and nearby crops**

As winter wheat and dry beans dry down, thrips leave en masse seeking nearby green crops, including onions

# Steps to reduce IYSV

**Separate seed and bulb crops**

**Where possible, to avoid the 'green bridge'**

No single tactic is likely to suppress the disease

Several tactics are needed to reduce the incidence  
(worked for other thrips-transmitted viruses)

The relative importance of these factors/tactics  
needs to be established

What is likely to work:

An integrated disease management program that  
Consists of pre-plant measures as well as specific  
tactics during the season

# **A Risk Index for IYSV in onion?**

## **Factors that could contribute to IYSV outbreaks:**

- History of IYSV incidence in a given field**
- Separation between seed and bulb crops**
- Stresses that could affect plant vigor (irrigation, soil compaction, soil fertility)**
- Uniform plant stand (or lack of it)**
- Control Weeds and volunteer onions**
- Thrips management practices**
- Choice of cultivar**

## \$\$\$ from

- California Garlic and Onion Res. Adv. Board
- Nevada Onion Commission
- WA State Commission for Pesticide Registration
- USDA-CSREES
- WSU Agricultural Research Center
- Pacific Northwest Vegetable Association
- Columbia Basin Vegetable Seed Association

A vast field of harvested onions is laid out on the ground to dry. The onions are small and round, with their green tops still attached. They are arranged in neat rows across the entire field, which is covered in a layer of brown soil. The scene is captured from a high angle, showing the repetitive pattern of the onions stretching towards the horizon.

**Thank you!**

## IYSV in onion:

Some answers but lot of questions still remain

- Economic impact is increasing: Severe lo\$\$e\$ in seed and bulb crops
- We know very little about the virus and its interaction with its host (onion)
- Alternative hosts are being reported
- Role of various thrips species in disease spread is not known
- Management of thrips population may reduce the disease impact

## **Four steps to reduce IYSV**

### **Reduce plant stressors**

Maintain proper soil and plant fertility, uniform plant stand, avoid soil compaction and avoid irrigation stress.

### **Practice sound thrips management**

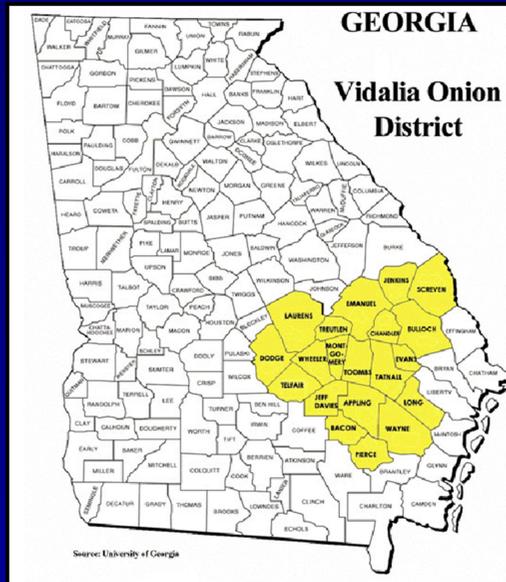
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### **Examine crop rotation and nearby crops**

As winter wheat and dry beans dry down, thrips leave en masse seeking nearby green crops, including onions.

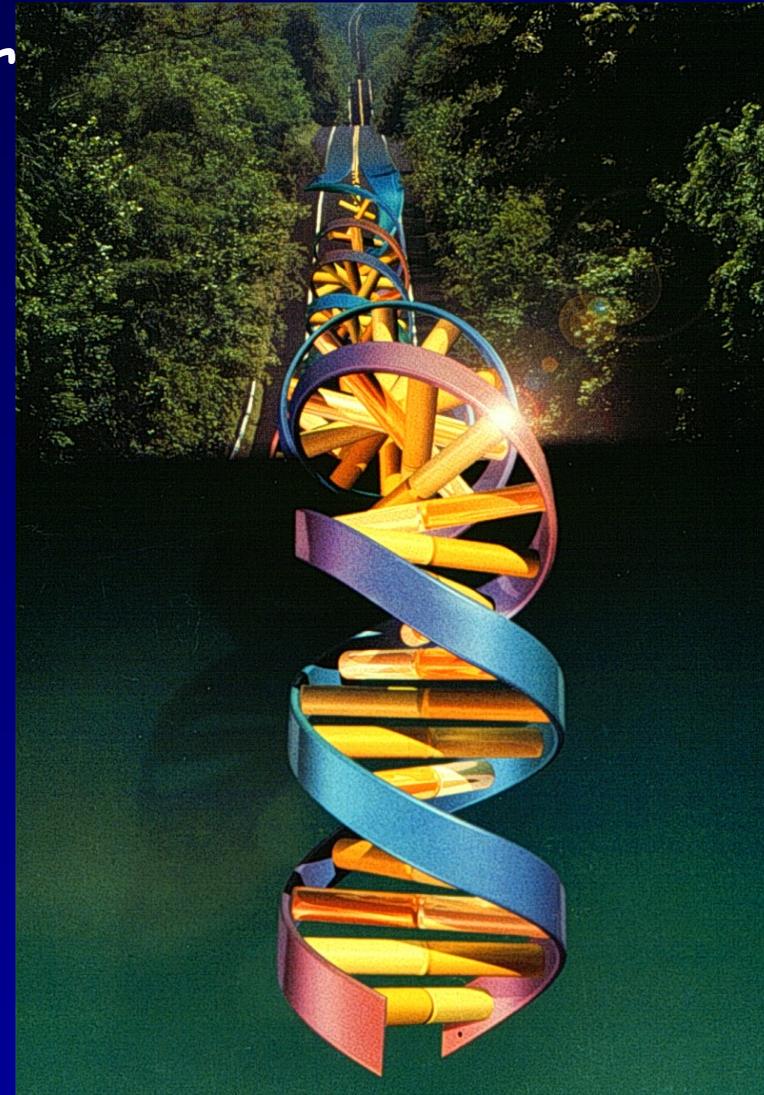
# Biological Variability

- IYSV was often found with TSWV as a mixed infection in Georgia
- We have not seen this scenario in the western US
- Diamond-shaped lesions are less common in Georgia



# *Molecular Variability*

- Genetic variability studies useful for 'attribution'
- Determining the point/path of introduction and spread
- Potential correlation with biological variability
- Gene silencing constructs



# Epidemiology of IYSV in Onion

- Confirmed vector of IYSV is onion thrips
- Two other thrips species present in the US that vector tospoviruses:
  - Western flower thrips (transmit TSWV and INSV)
  - Tobacco thrips (transmits TSWV)



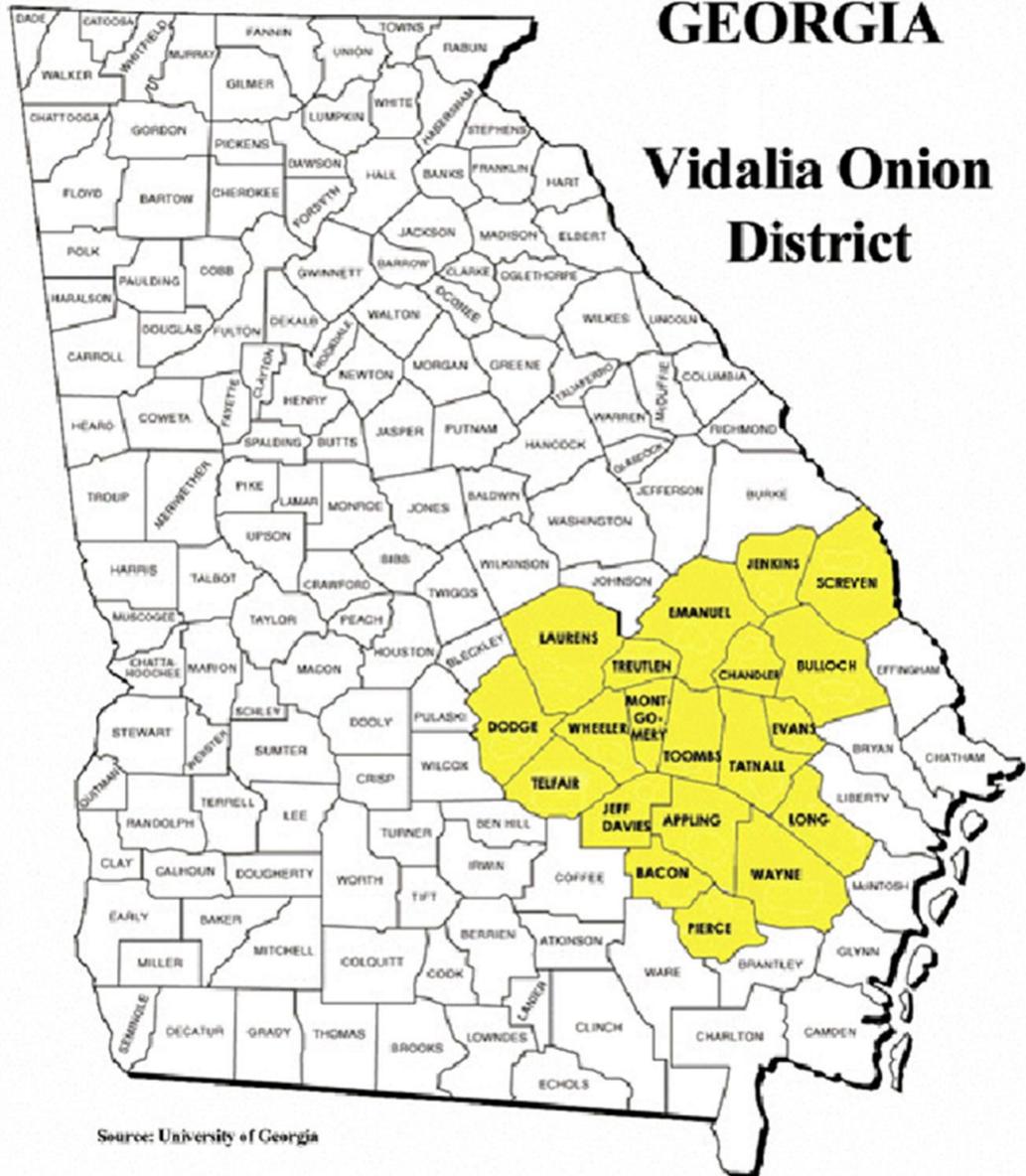
# Impact

- Brazil: called 'Sapeca'. 100% losses in bulb and seed crops
- Israel: 60% incidence, heavy bulb and seed losses
- Idaho: Beginning in 2000, dramatic increase in disease incidence in both bulb AND seed crops



# GEORGIA

## Vidalia Onion District



Source: University of Georgia



Very few onion thrips on onion



Predominantly tobacco thrips!

