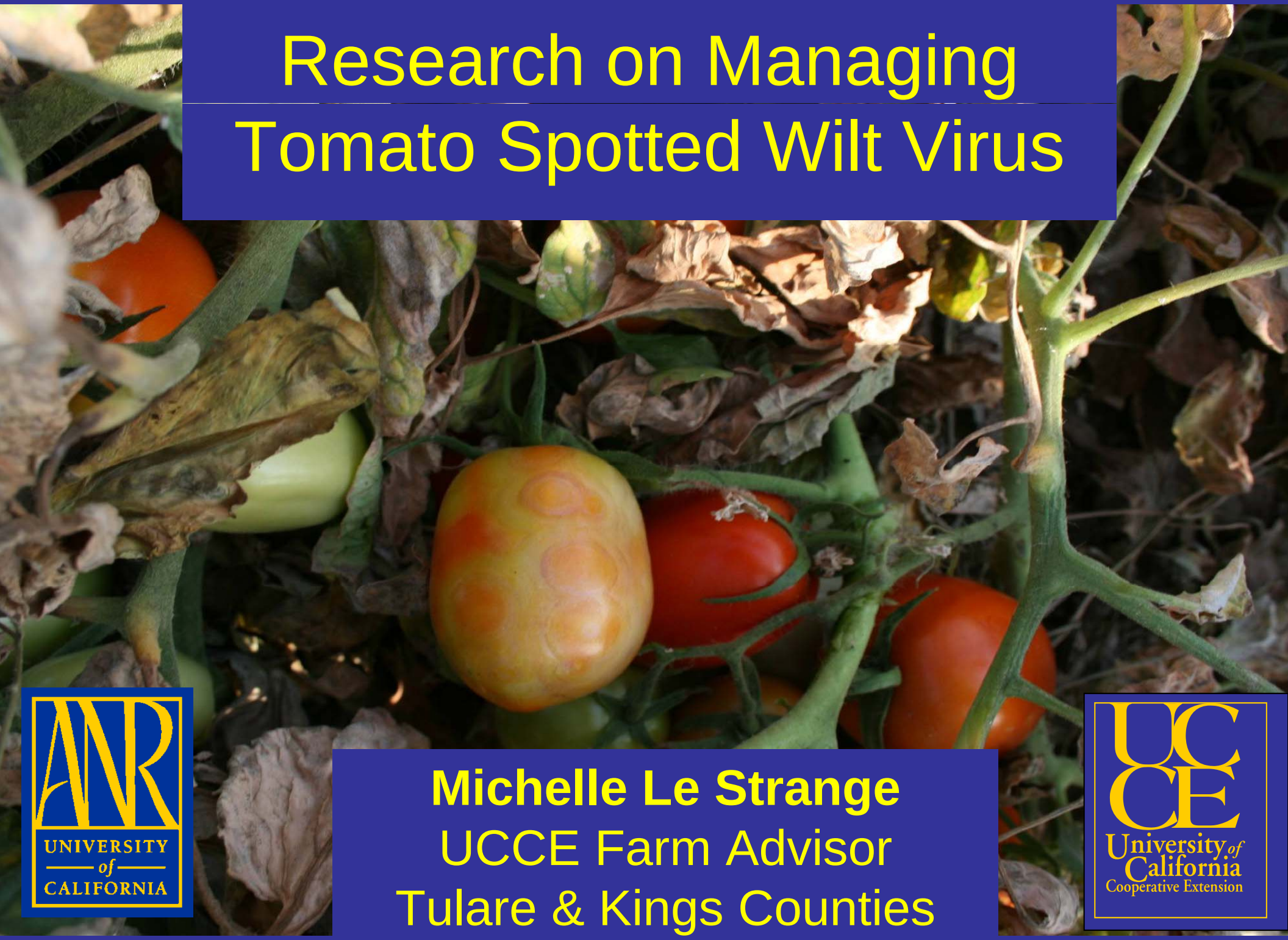
Research on Managing Tomato Spotted Wilt Virus



Michelle Le Strange
UCCE Farm Advisor
Tulare & Kings Counties

Tomato Spotted Wilt

PROBLEM: Increased Incidence in CA Tomatoes

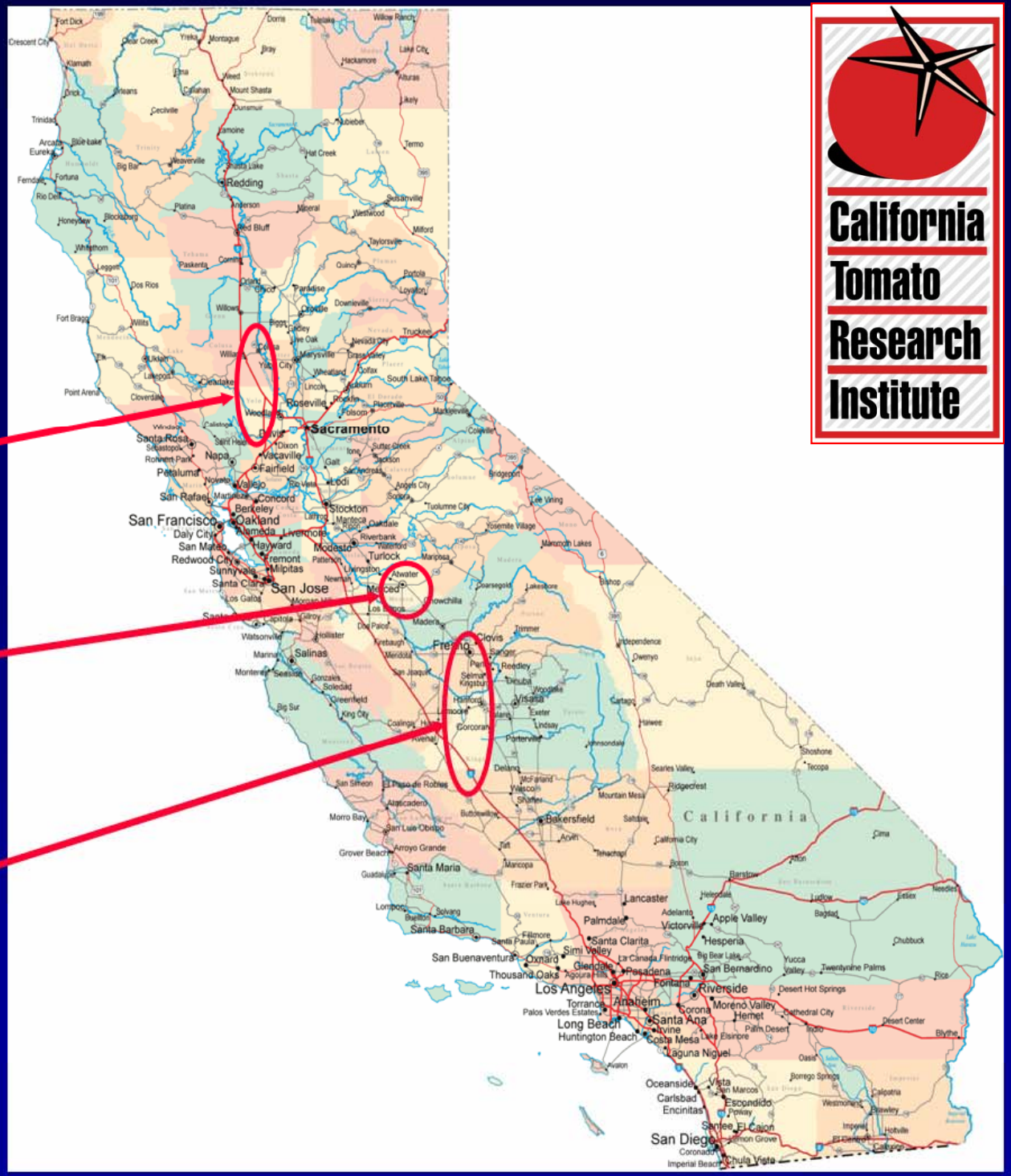
2003	Merced
2004 & 05	Coalinga area …
2006	Kettleman, Huron, 5 Points, Firebaugh
2007	Even more widespread, but less severe
2008 & 09	**More widespread in CA**

Processing tomato regions where thrips and TSWV monitoring has been ongoing

Yolo and Colusa Counties (2009)

Merced County (2008-2009)

Fresno and Kings Counties (2007-2009)



California Tomato Research Institute

TSWV Plant Host Range

Infects over 900 plants, mostly dicots

Ornamentals

- Begonia
- Geranium
- Impatiens
- Lily
- Marigold
- Mums
- Snapdragons
- Verbena
- Zinnias

Weeds

- Nightshades
- Prickly Lettuce
- Russian Thistle
- Little Mallow
- Datura
- Lambsquarters
- Morningglory
- Pigweed
- Purslane
- Sowthistle
- Chickweed

Crops

- **Beans**
- **Celery**
- **Cilantro**
- **Eggplant**
- **Lettuce**
- **Peppers**
- **Radicchio**
- **Spinach**
- **Tomatoes**

and many more …

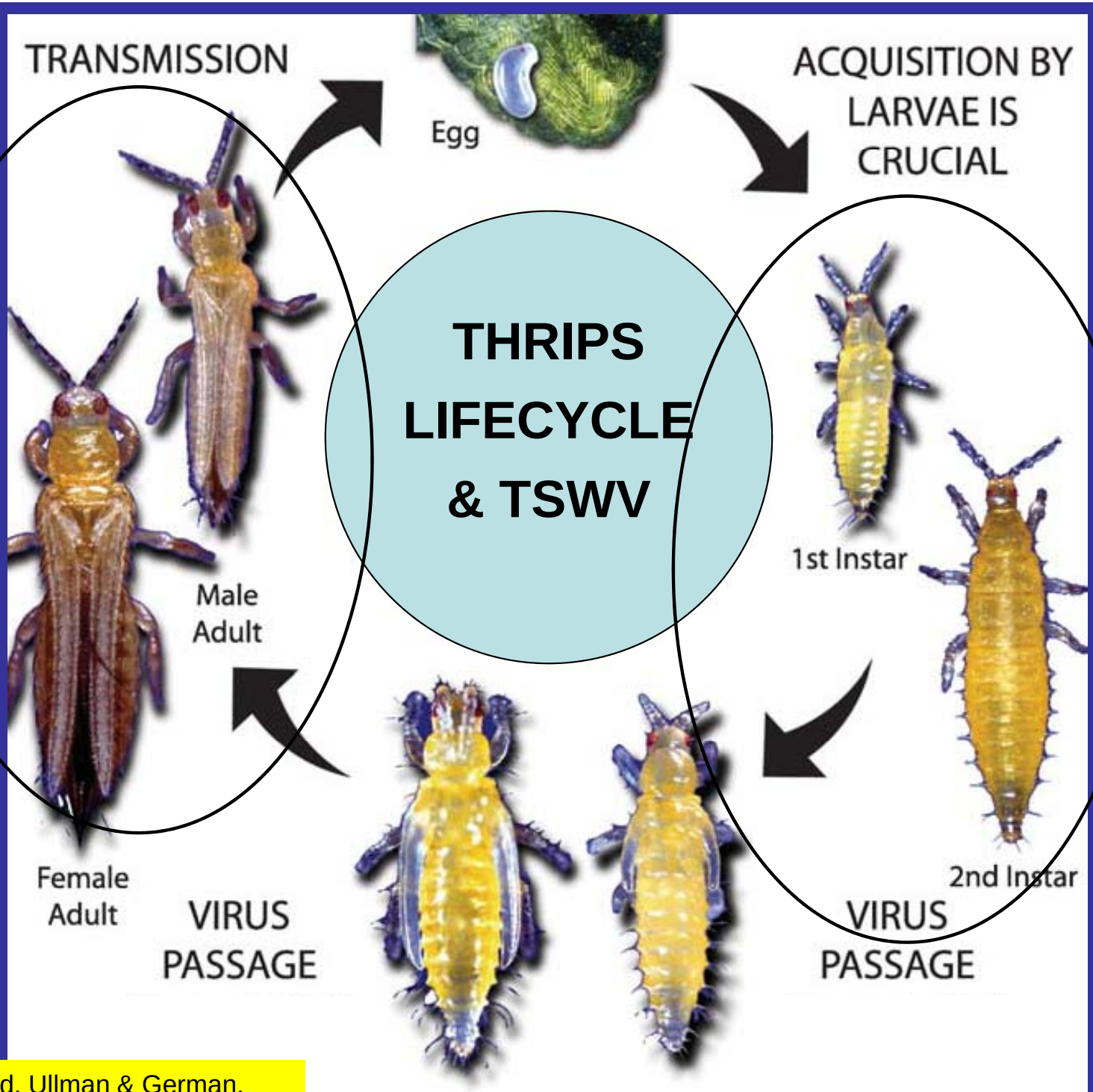
Symptoms of TSWV vary depending on when the plant is infected

- **Seedlings** - stunted and bushy; leaf yellowing and necrosis; may die, no fruit
- **Vegetative Plants** - show bronzing, necrosis, and wilting; become stunted, few fruit
- **Fruiting Plants** - range of symptoms - leaf curling, purpling, necrosis and dieback (strikes) and often just part of the plant
- **Green fruit** - diagnostic ringspots & bumps
- **Red fruit** - ringspots, irregular patterns of ripening and necrosis

TSWV symptoms can be confused with other viruses

ImmunoStrips for Detection of *Tomato spotted wilt virus*

- **Rapid and precise**
- **Easy to use**
- **Detect in the field**
- **No equipment needed**
- **Sensitivity?**



TSWV must be acquired by larvae to be transmissible.

Pupal stages do not feed.

Adults emerge and resume feeding on flowers, buds, and terminal foliage.

Adults live 30 to 45 days and transmit TSWV to plants throughout

Whitfield, Ullman & German. **TOSPOVIRUS-THRIPS INTERACTIONS** Annu. Rev. Phytopathol. 2005. 43:459–89

Where is the Source of TSWV Inoculum in the SJV?

Growers and PCAs noted INCREASED:

Tomato transplants

Almond Acreage

Other susceptible crops

Radicchio plantings

Weeds in fallow lands

and speculated these areas as potential TSWV inoculum reservoirs and habitat for thrips.

TSWV Research – 2007 - 2009

Monitor Thrips (sticky cards) & % Disease

Major CA Greenhouses

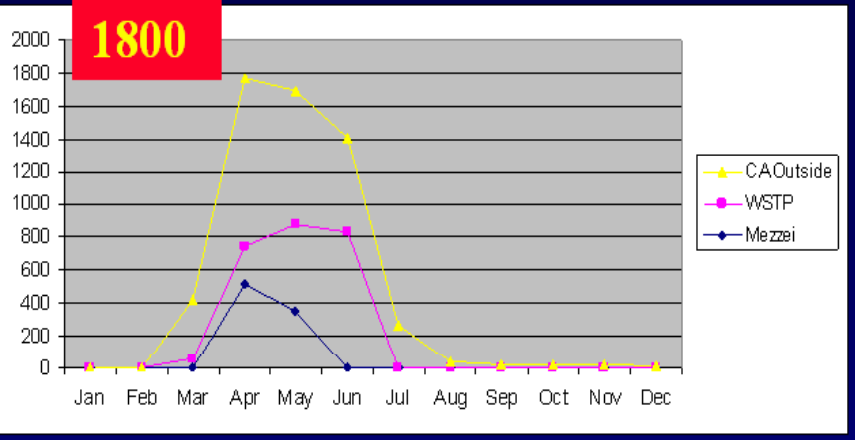
- 4 corner periphery of greenhouse operation
- Specific Grower plants

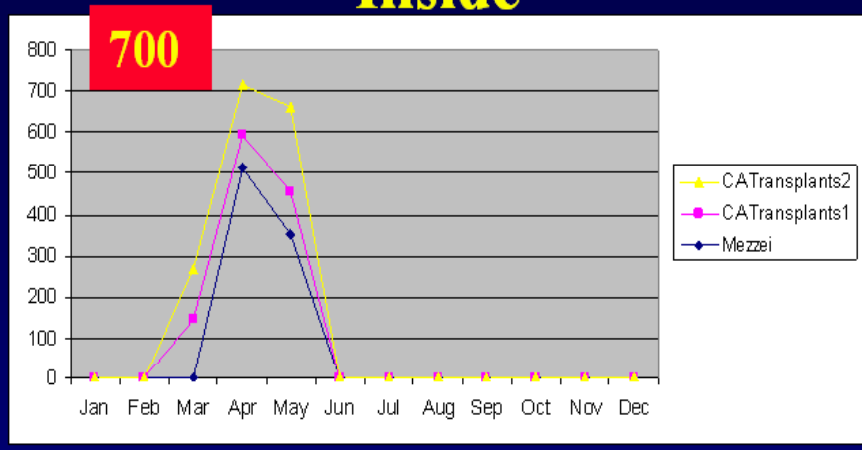
Thrips populations in the greenhouses

Outside

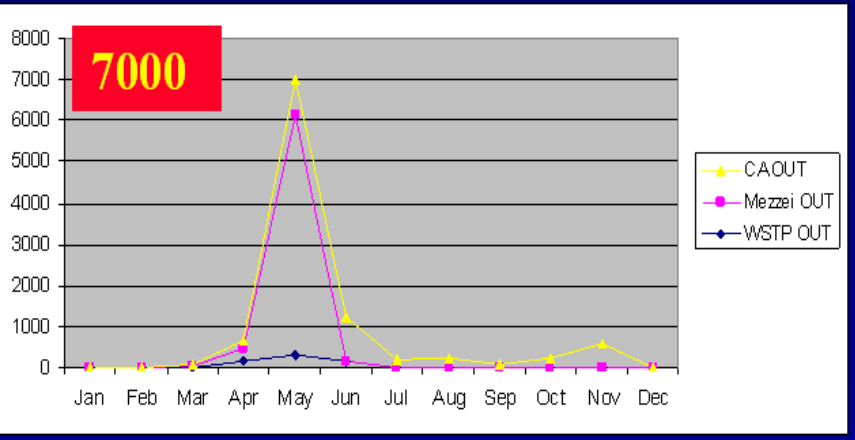
Inside

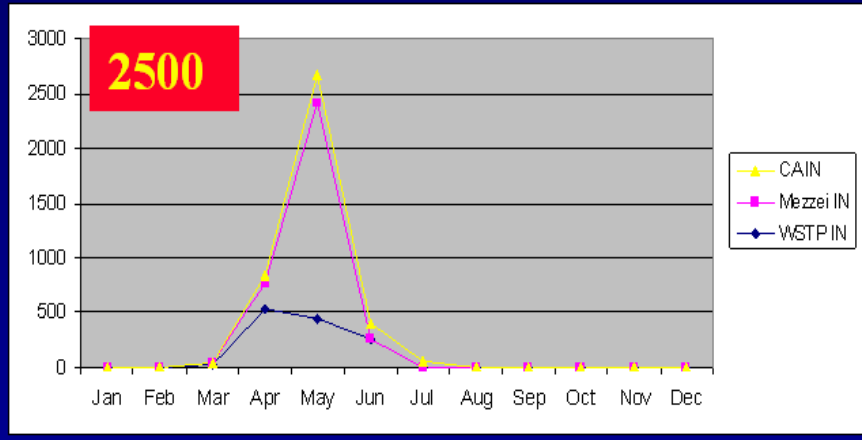
2007



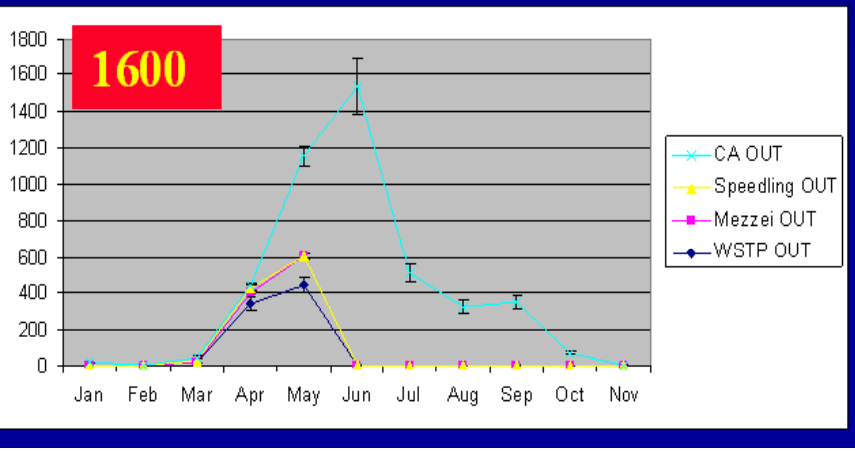


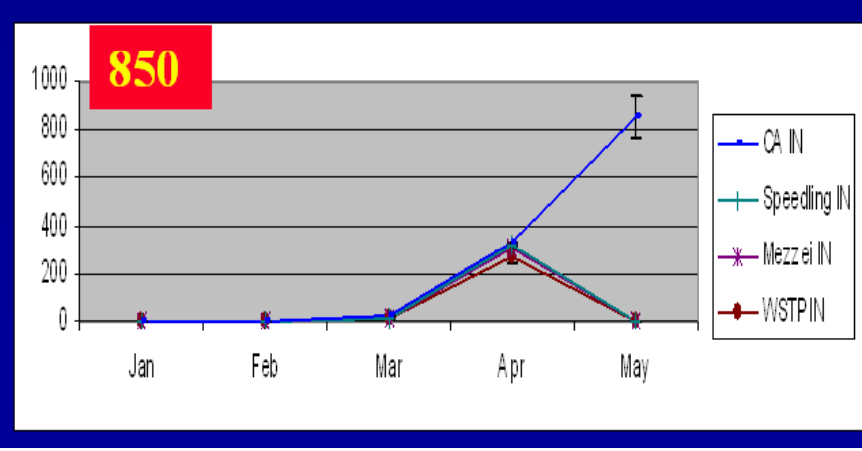
2008



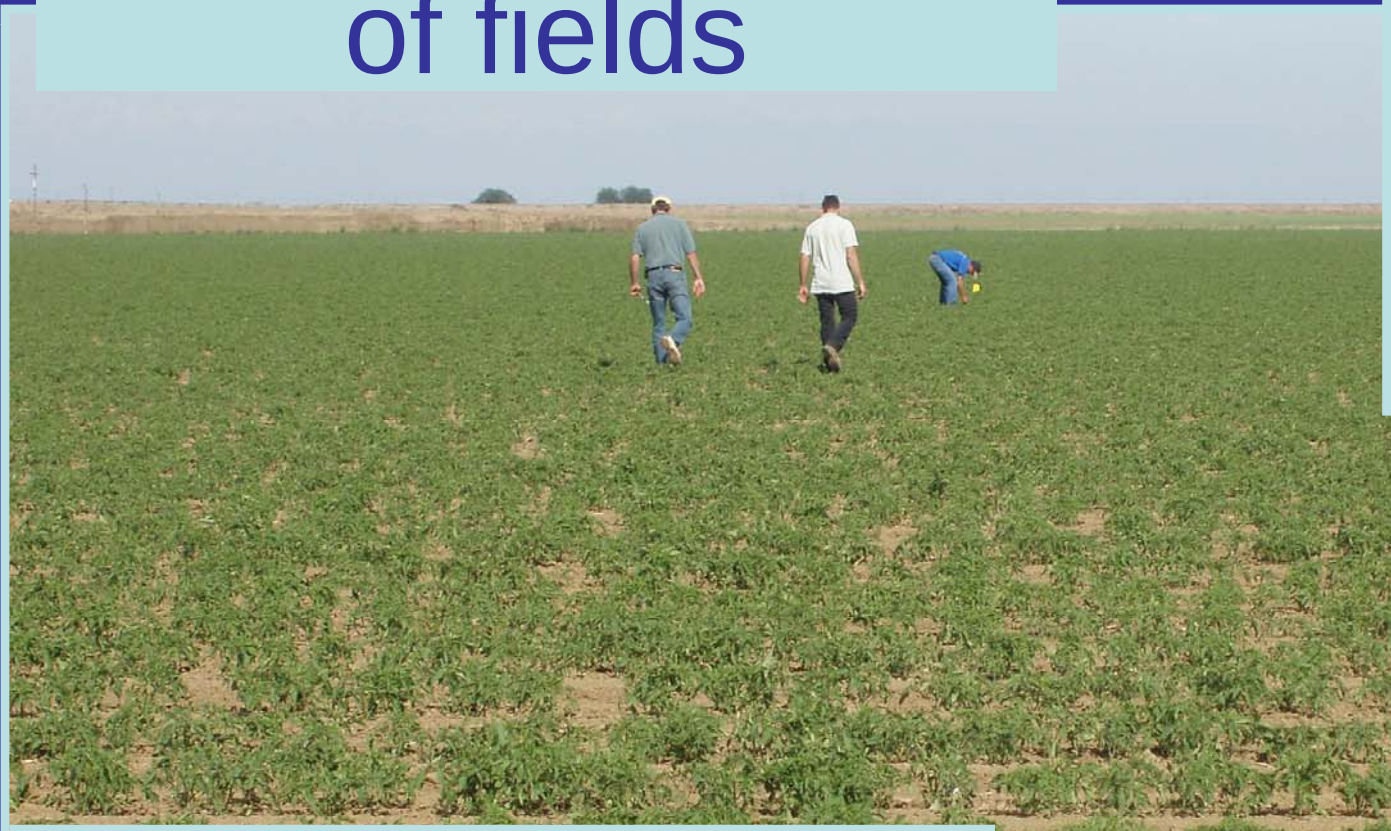


2009

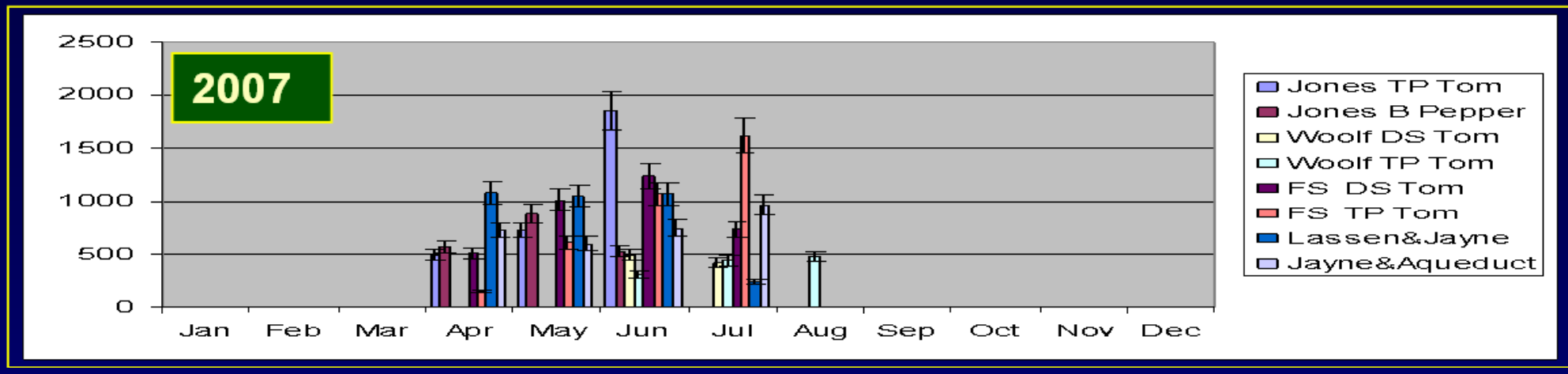


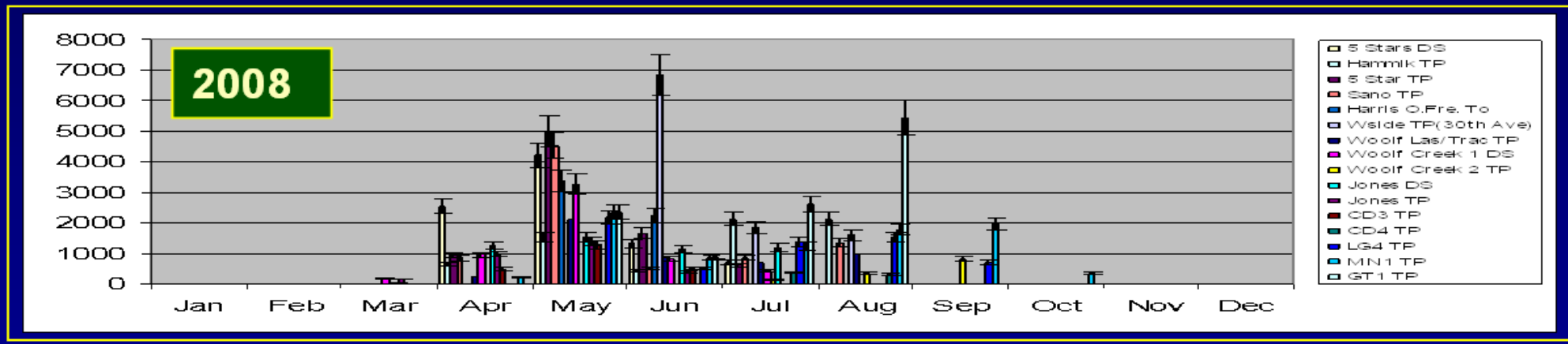


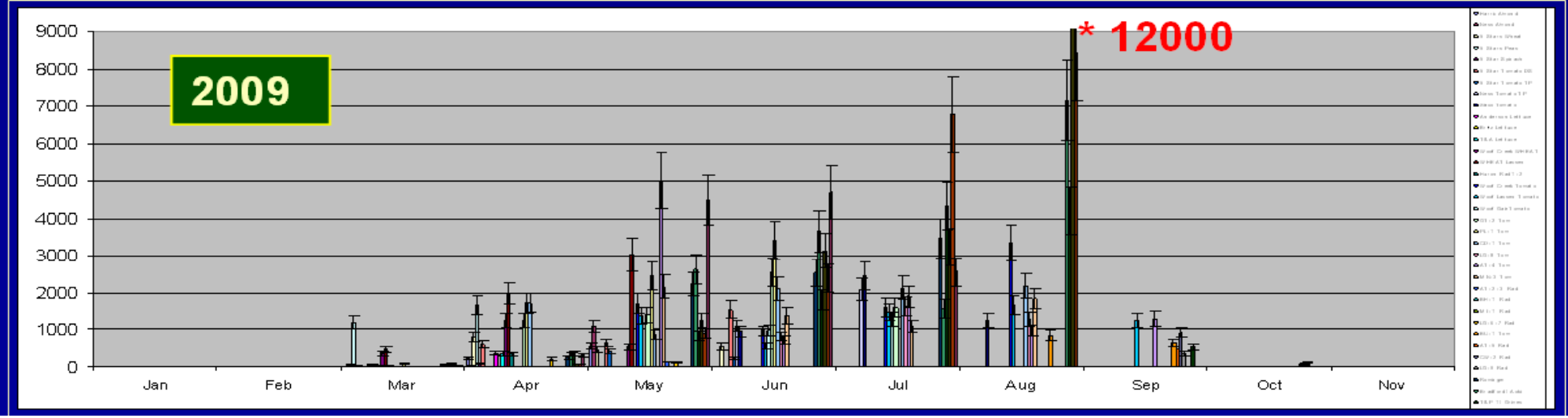
Weekly monitoring of fields



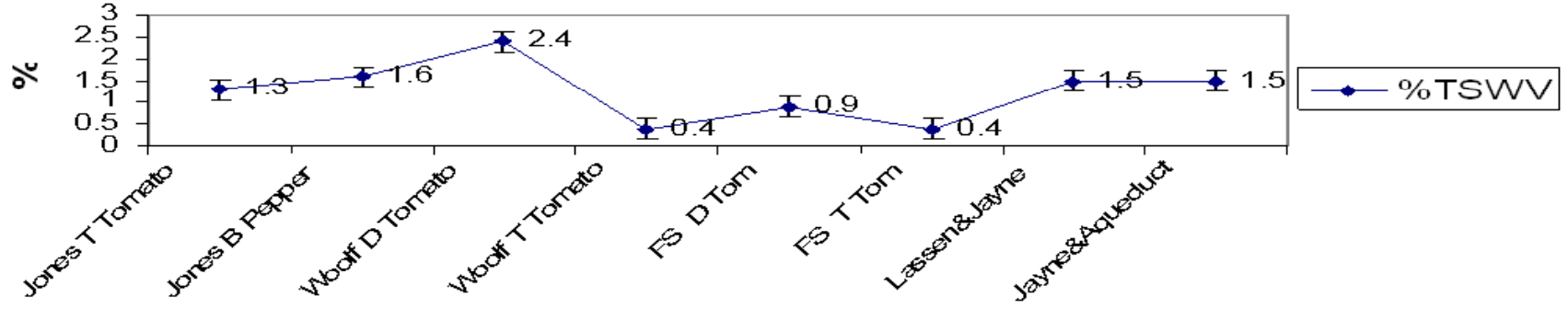
Thrips populations in the fields



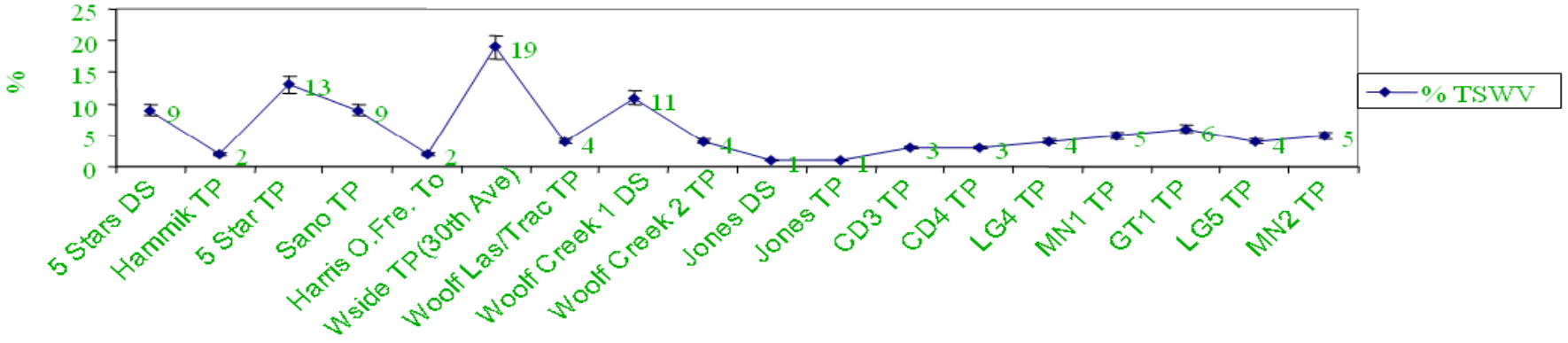




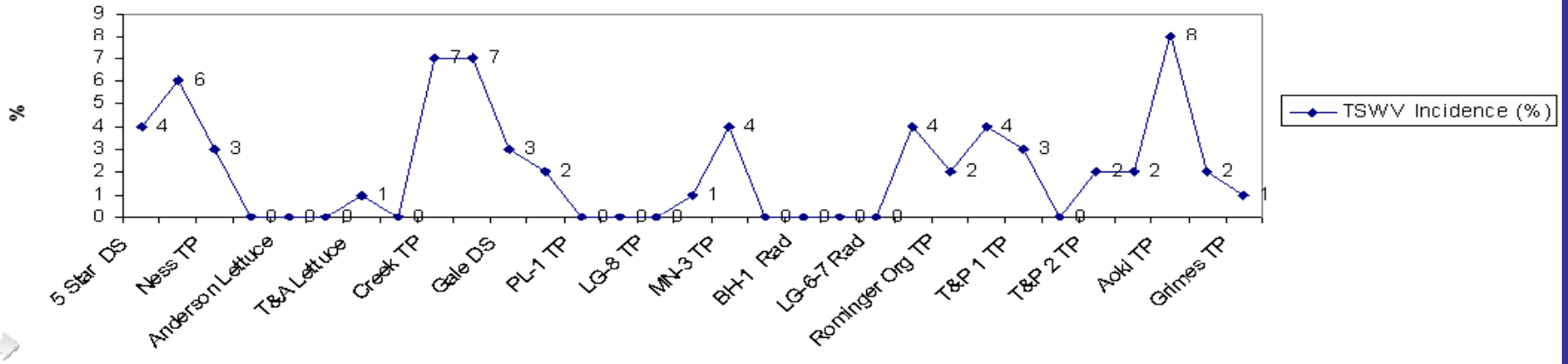
TSWV Incidence (%) 2007



TSWV Incidence (%) 2008



TSWV Incidence (%) 2009



Almond Flower Collection for Thrips

Summer 2006

Almond Leaf Collection

1 Orchard next to TSWV Tomato Field

75 trees sampled – 0 TSWV

RESULTS:

FEW Thrips – FEB 2008 & 2009

6 Orchards, 4 corners/orchard, 25 flowers/corner

Where is the source of TSWV Inoculum in the SJV?

Known host CROPS:

Tomatoes and peppers are summer crops:
MARCH – OCT 10

Lettuce has two crops per year:
Fall harvest AUG - NOV
Spring harvest NOV - APR

Potential for TSWV to bridge from crop to crop.

TSWV in peppers

Found in westside Fresno & Kings Counties

TSWV in lettuce

Detected in Huron Area Lettuce Fields in FALL of 2005 – 2009, SPRING 2008

But was sporadic and not economic

Radicchio - a reservoir crop for TSWV ?

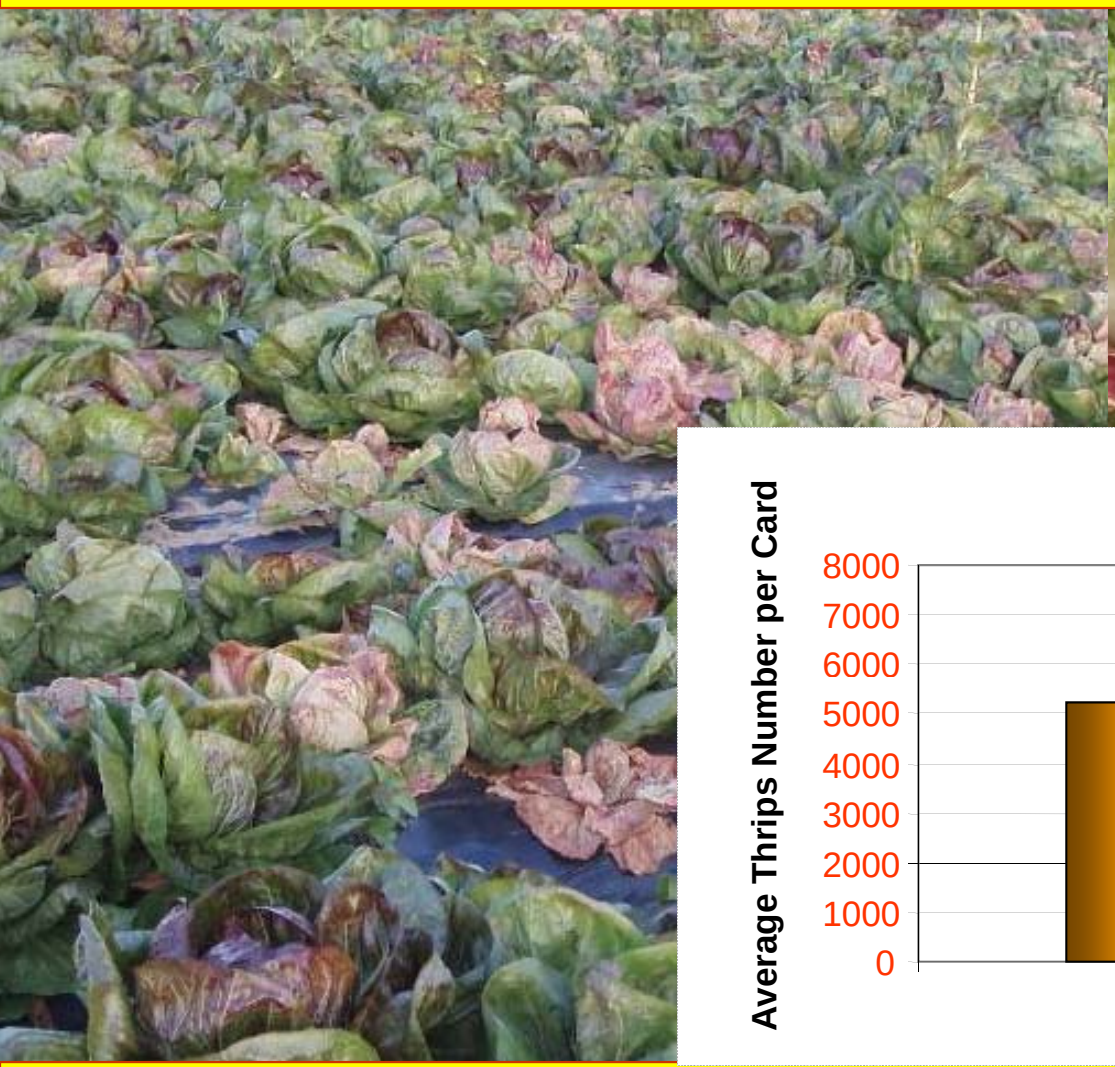
April 2005

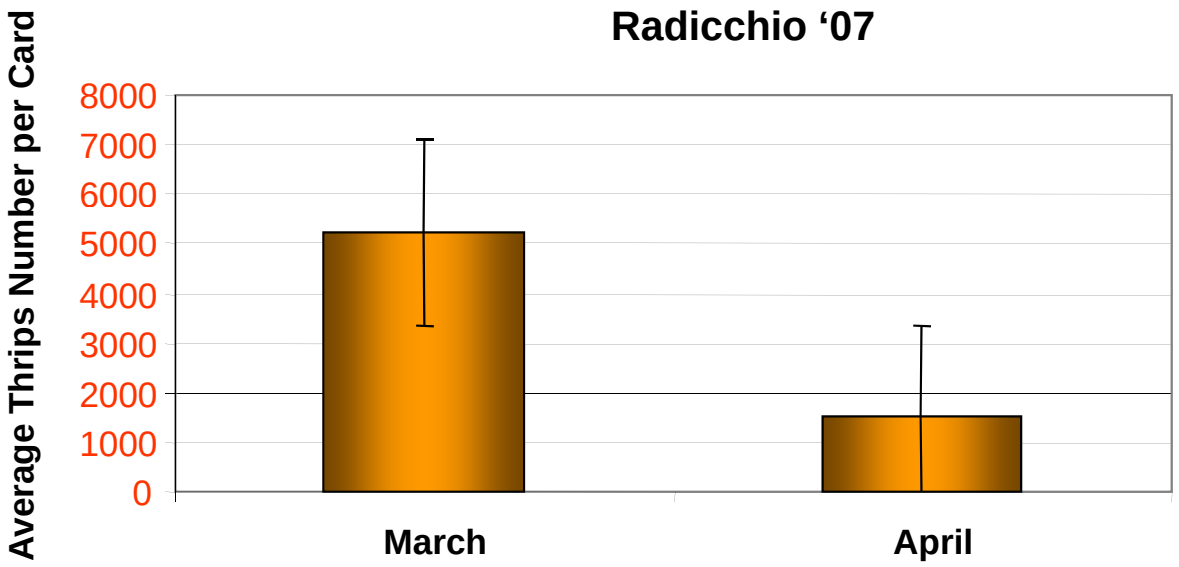
November 2006

Radicchio Field - March 2007

Radicchio – March 2007

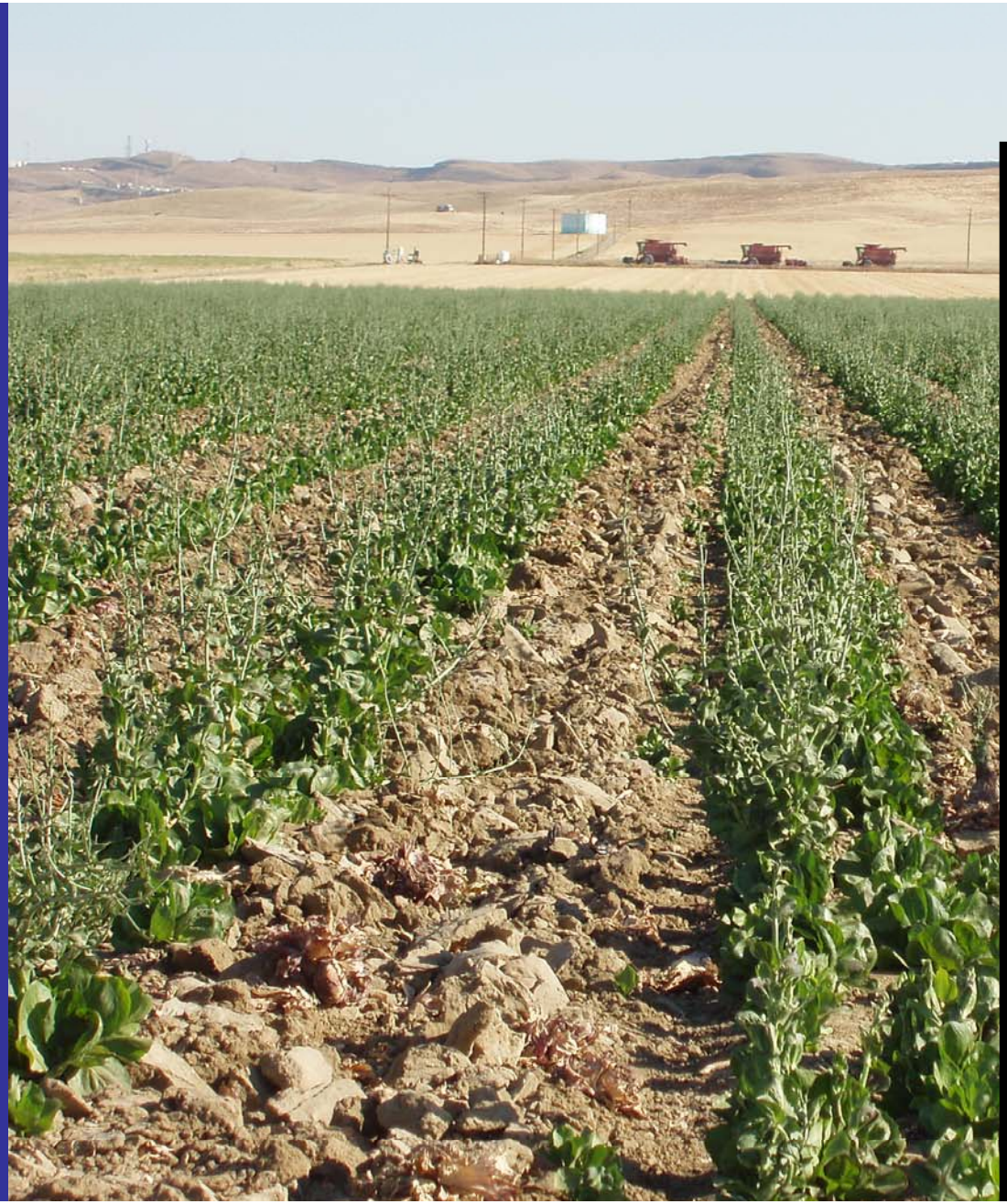
High TSW Infestation &
High populations of thrips

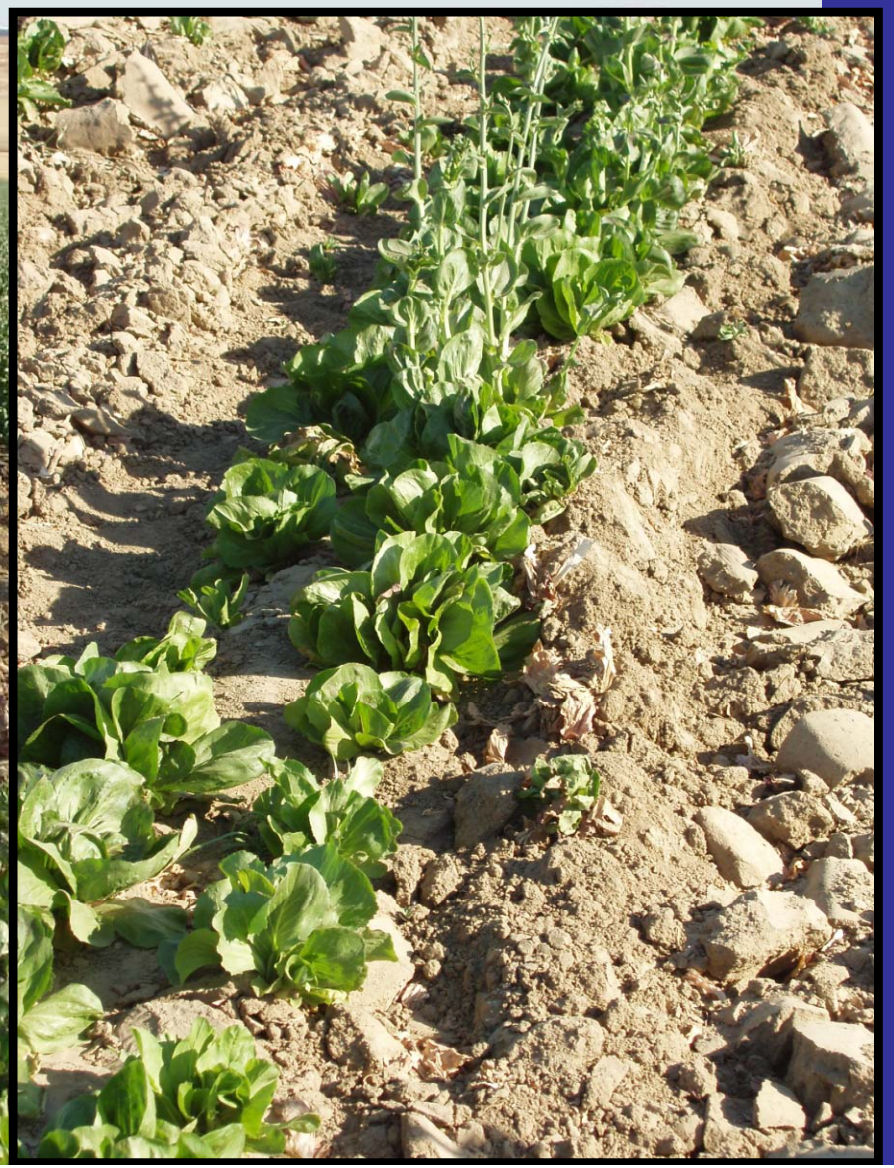




2007 - TSWV first detected in April in tomatoes near the radicchio field.

Radicchio Crop – May 2008-09 VERY CLEAN - NO TSWV



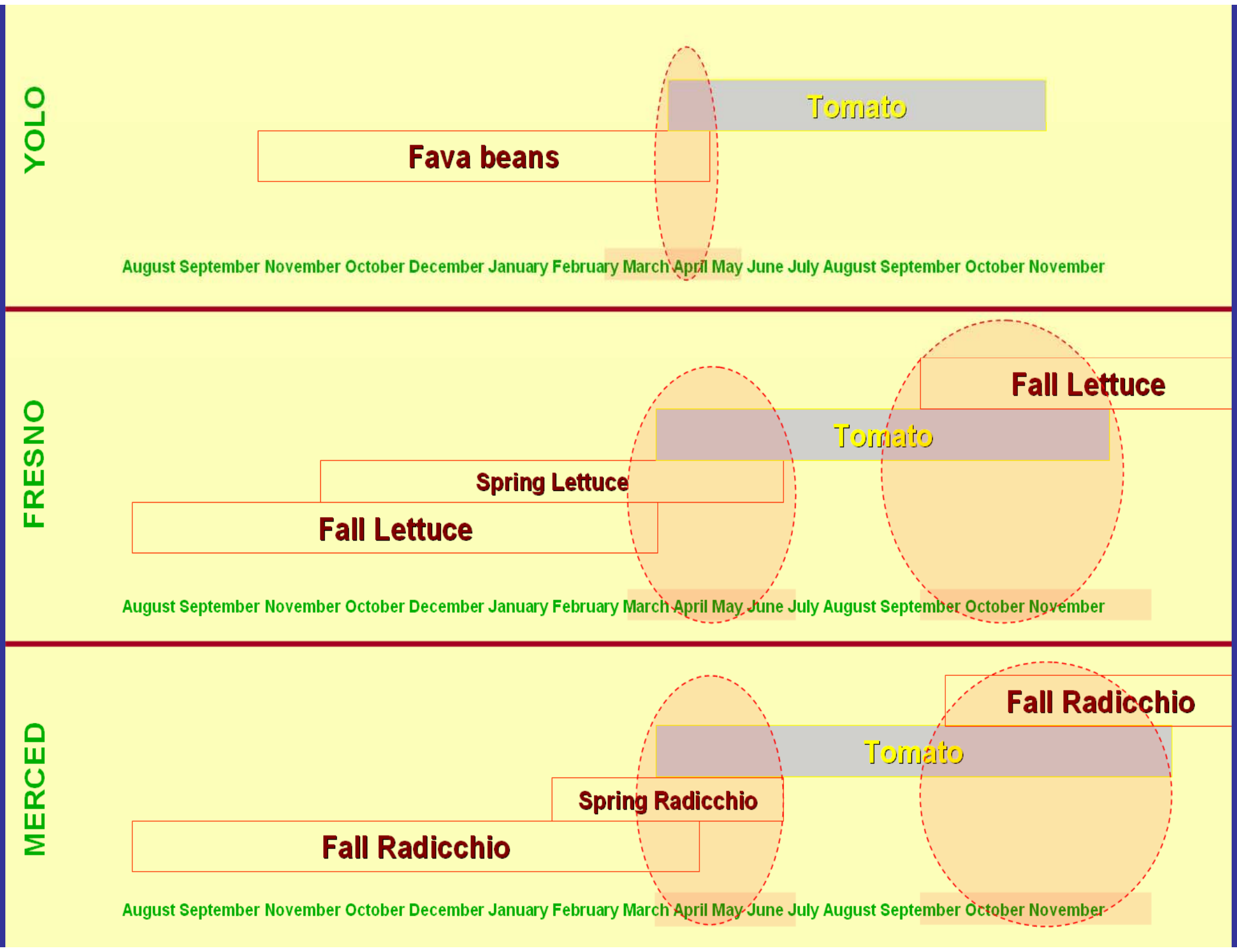


Growers took a proactive approach to TSWV management.

Radicchio Crop – May 2008 & 2009

VERY CLEAN - NO TSWV

Growers took a proactive approach to TSWV management.


YOLO
Tomato
Fava beans
August September November October December January February March April May June July August September October November
FRESNO
Fall Lettuce
Tomato
Spring Lettuce
Fall Lettuce
August September November October December January February March April May June July August September October November
MERCED
Fall Radicchio
Tomato
Spring Radicchio
Fall Radicchio
August September November October December January February March April May June July August September October November

TSWV : Where is the source of the Virus?

100s of PLANTS SAMPLED in 2005 – 2006 on westside Fresno and in Merced county

CROPS	WEEDS	ORNAMENTALS
Tomato	Russian thistle	Canna Lily
Potato	Ground cherry	Calla Lily
Lettuce	Black nightshade	Daisy
Pepper	Prickly lettuce	Dahlia
Radicchio	Tree tobacco	Sweet pea
Eggplant	Bindweed	Zinnia
Cauliflower	Mallow	Nasturtium
Celery	Nettle	Poppy
Spinach	Sowthistle	Petunia
Pea		Chrysanthemum

+ 100 more that tested negative

Red = tested positive

Weed survey results for TSWV incidence (Fresno and Merced counties 2008-2009)

Weed	Tested (+)	Weed	Tested (+)
Barnyard grass	25 (0)	Lambs quarters	63 (0)
Black nightshade	25 (0)	Malva	110 (1)
Bindweed	25 (0)	Mustard	60 (0)
Bur clover	25 (0)	Nettle	25 (0)
Common sunflower	25 (0)	Pigweed	25 (0)
Dodder	25 (0)	Prickly lettuce	90 (2)
Fiddle neck	25 (0)	Purslane	25 (0)
Ground cherry	25 (0)	Russian thistle	25 (0)
Groundsel	40 (1)	Sowthistle	60 (1)
Jimsonweed	25 (0)	Tree tobacco	25 (0)

(+) number of plants tested positive for TSWV by immunostrips and/or PCR

Weed RESULTS:

NEGATIVE for TSWV

11 species, 5 samples each (4 Locations)

Bindweed, Bur clover, Fiddleneck, Groundsel, Lambsquarters, London rocket, Malva, Nettle, Prickly lettuce, Sowthistle, Wild radish

Weed Collection for TSWV

July 2008 – Fresno & Kings Counties

9 species, 5 samples each

Barnyardgrass, Black nightshade, Dodder, Lambsquarters, Pigweed (tumble), Purslane, Sowthistle, Thornapple (Datura – jimsonweed), Tree Tobacco

NEGATIVE for TSWV

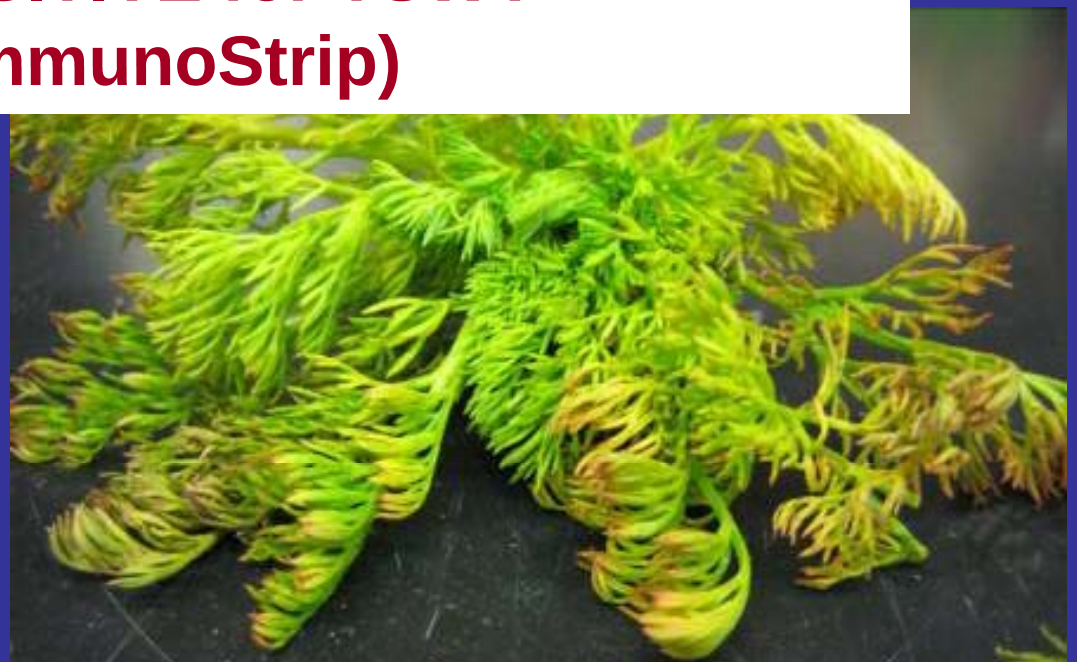
Weed Collection for TSWV

March 2008 – Merced County

Malva is PCR and ImmunoStrip Positive

Weed Collection for TSWV March 2008 – Merced County

PRICKLY LETTUCE and Fennel - samples are POSITIVE for TSWV (PCR and ImmunoStrip)



Weeds Summary – 2006-2008

- A variety of weeds were collected over years in areas known to have TSWV outbreaks.
- Most samples were negative for TSWV, with an incidence of <0.1%.
- Weeds that were positive: groundsel, Malva, prickly lettuce, & sowthistle.
- Weeds do not seem to be the important inoculum reservoir for TSWV.

But then came 2009

But then came 2009

- A few TSWV HOT SPOTS resurfaced
- WEEDS in nearby Fallow FIELDS were sampled more aggressively in those areas
- higher percentages of TSWV incidence was found in some weeds
- especially PRICKLY LETTUCE & SOWTHISTLE

It looks like TSWV and Thrips could build up in these weeds!

Five Points Area Uncultivated Field

25 March 2009 (6% sowthistle TSWV+)


INSV
TSWV
SAMPLE
SAMPLE

Five Points Area Uncultivated Field

22 April 2009

(2% sowthistle - 7% prickly lettuce TSWV+)

Inoculum Reservoir Conclusion

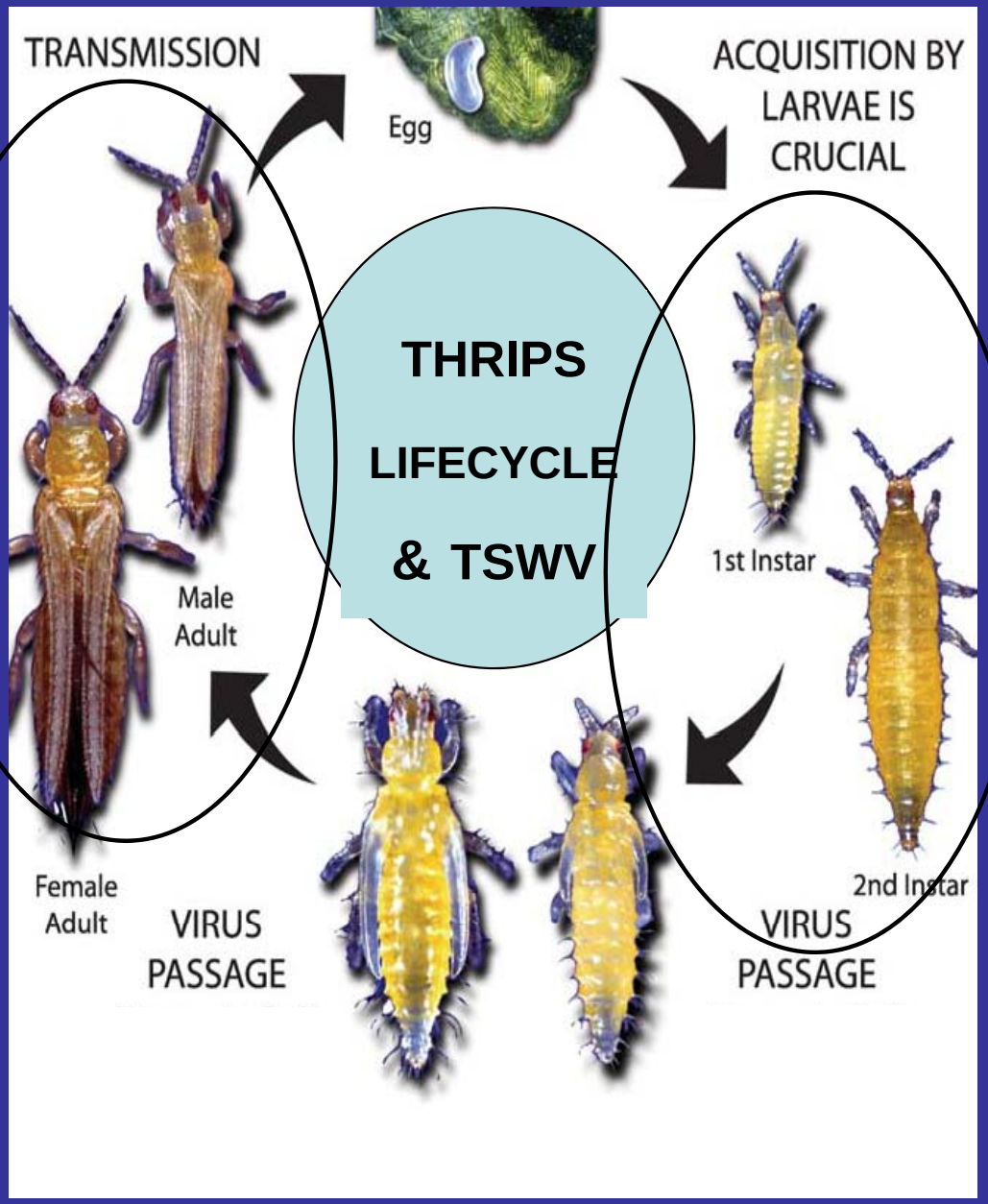
1. **Pepper & tomato crops** can amplify the virus and serve as an inoculum reservoir when thrips are there.
2. **Lettuce** is not such a big threat as an inoculum reservoir or bridge crop, because most lettuce is on an aggressive insecticide program.
3. **Radicchio** is a crop that poses a big threat as a potential TSWV inoculum reservoir and bridge crop, however it appears that the threat can be managed with thrips management and crop sanitation.
4. **Almonds** & flowers don't appear to be a threat.
5. **Weeds MAY BECOME** an important inoculum reservoir, if WEEDY areas are UNCHECKED and ALLOWED to build up.

Recent Research

Insecticides for thrips/TSWV management (Turini)

– Insecticide comparisons

– Influence of insecticide programs on TSWV incidence



Limitations of Thrips Control with Insecticides

- Thrips adults and larvae prefer sheltered areas of the plant (flower or bud tissues).
- Thrips populations can increase very rapidly, 200-300 eggs/female.
- Insecticide resistance is a concern.

Thrips on Pickup Truck - May 2009

Western Flower Thrips

Some materials tested may not be registered on tomatoes or peppers.

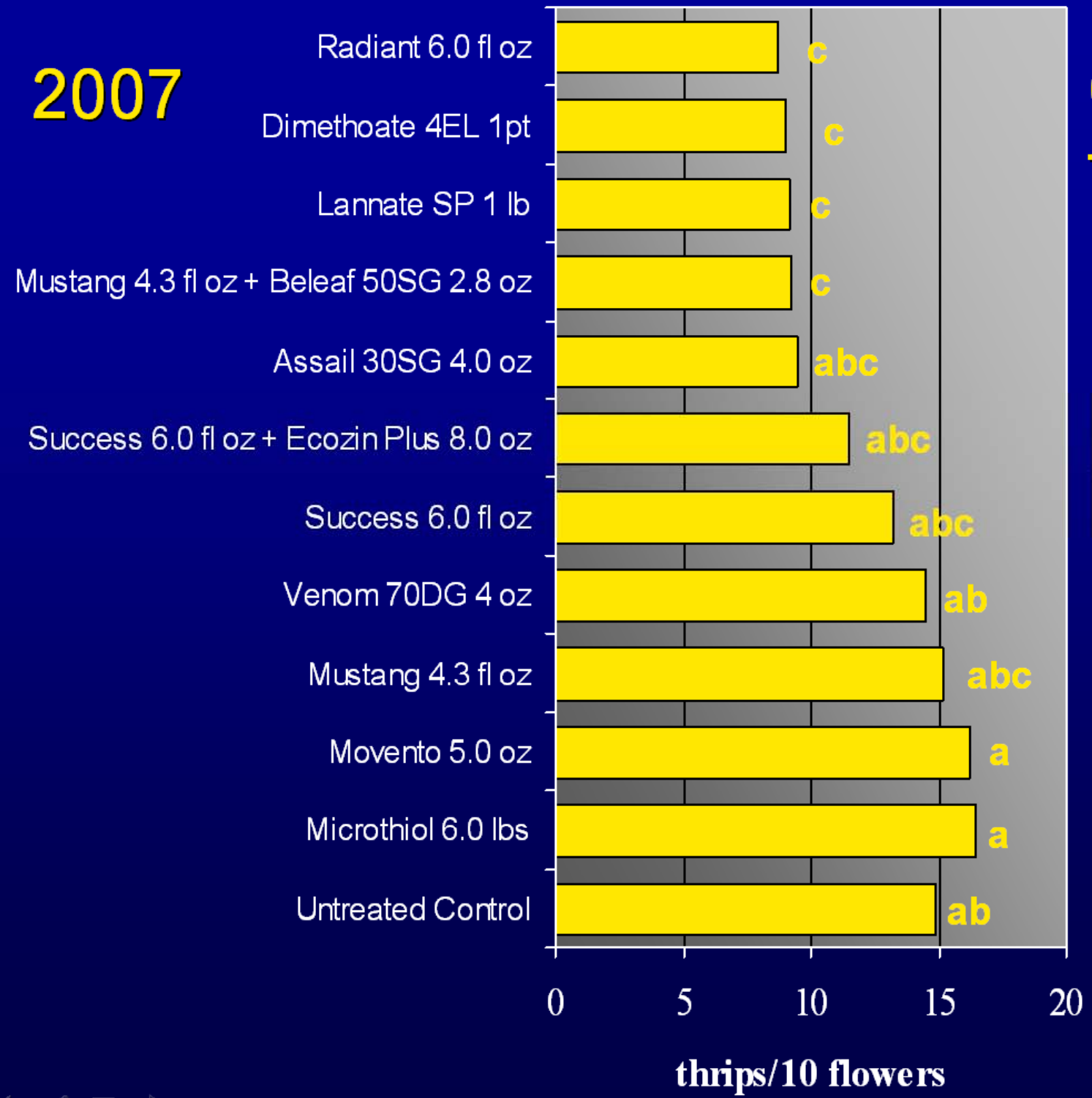
All applicable labels should be read before writing a pesticide recommendation.

Insecticide Comparisons 2007-2009 (Turini)

- Varieties and plant dates
  - H 9997 direct seeded on 9 Mar 07
  - H 9665 direct seeded on 9 Apr 2008
  - H 8004 transplant on 14 May 2009
- Materials were applied in the equivalent of 25 gallons of water with Induce 0.25%
- Experimental design: four-replication randomized complete block

Thrips Counts (4 days after treatment)

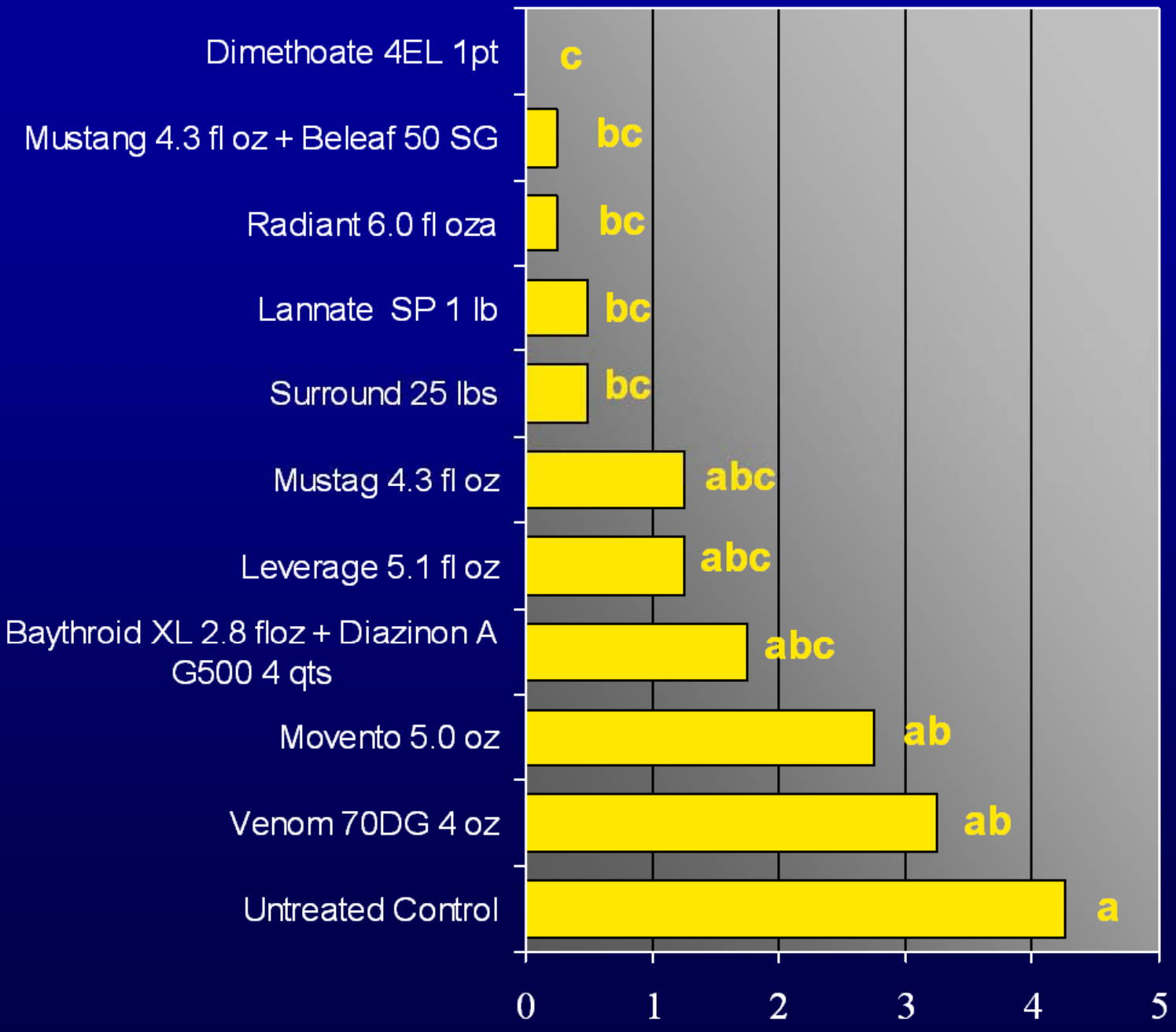
2007



All materials were applied on 1 Jun with Induce 0.25% v/v

2008

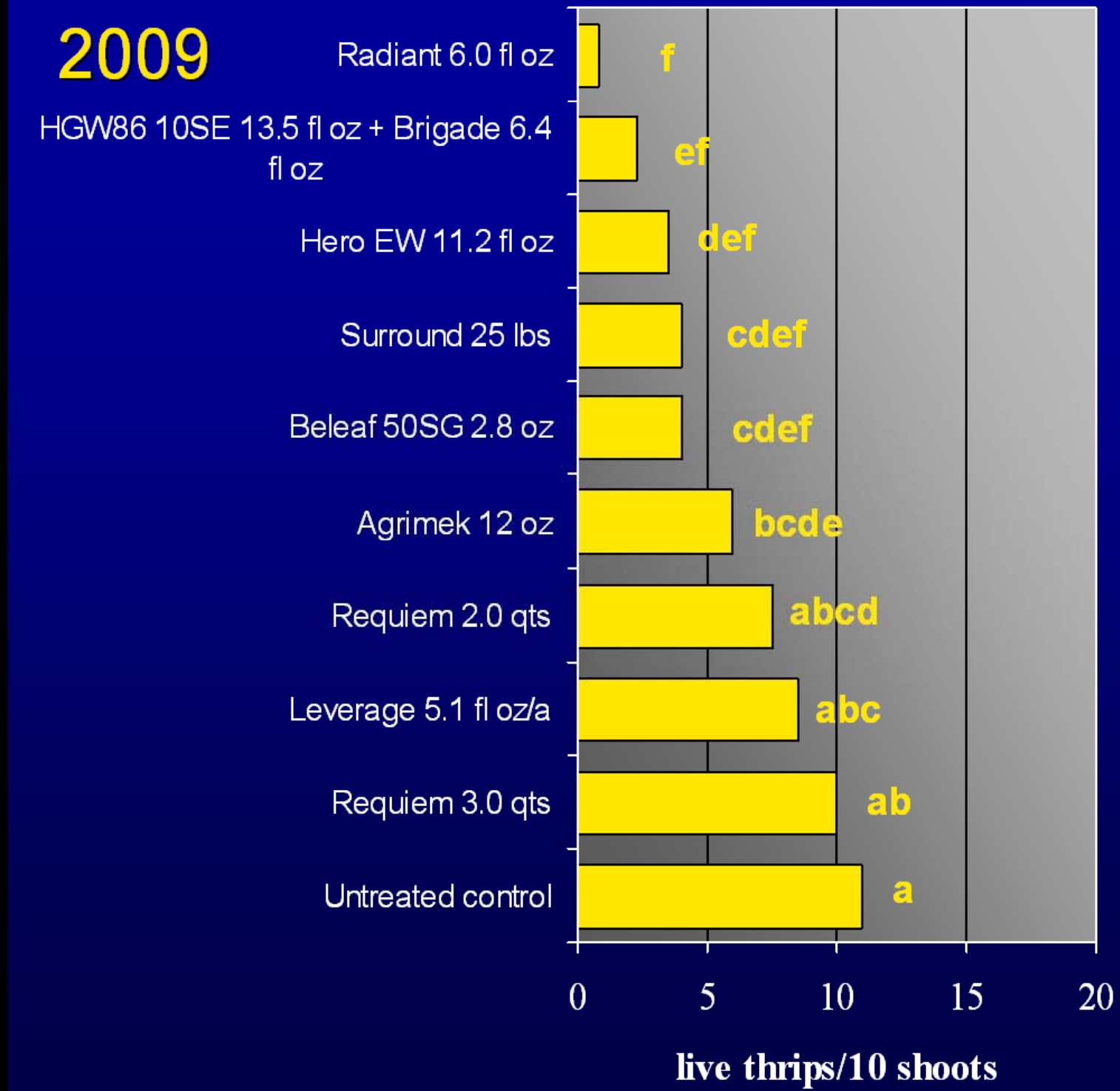
Live Thrips (4 days after treatment)



All materials were applied on with Induce 0.25% on 24 Jul

2009

Thrips Counts (4 days after treatment)



All materials were applied on 17 Jun with Induce 0.25% v/v

Recent Research

Materials Showing Efficacy Against Thrips in Multiple Fresno Co. Trials

- Dimethoate (2/2)
- Lannate (2/2)
- Radiant (3/3)
- Beleaf + Mustang (2/2)
- Surround (2/2)

Insecticide Programs (Turini)

H-8004 transplanted on 14 May 2009

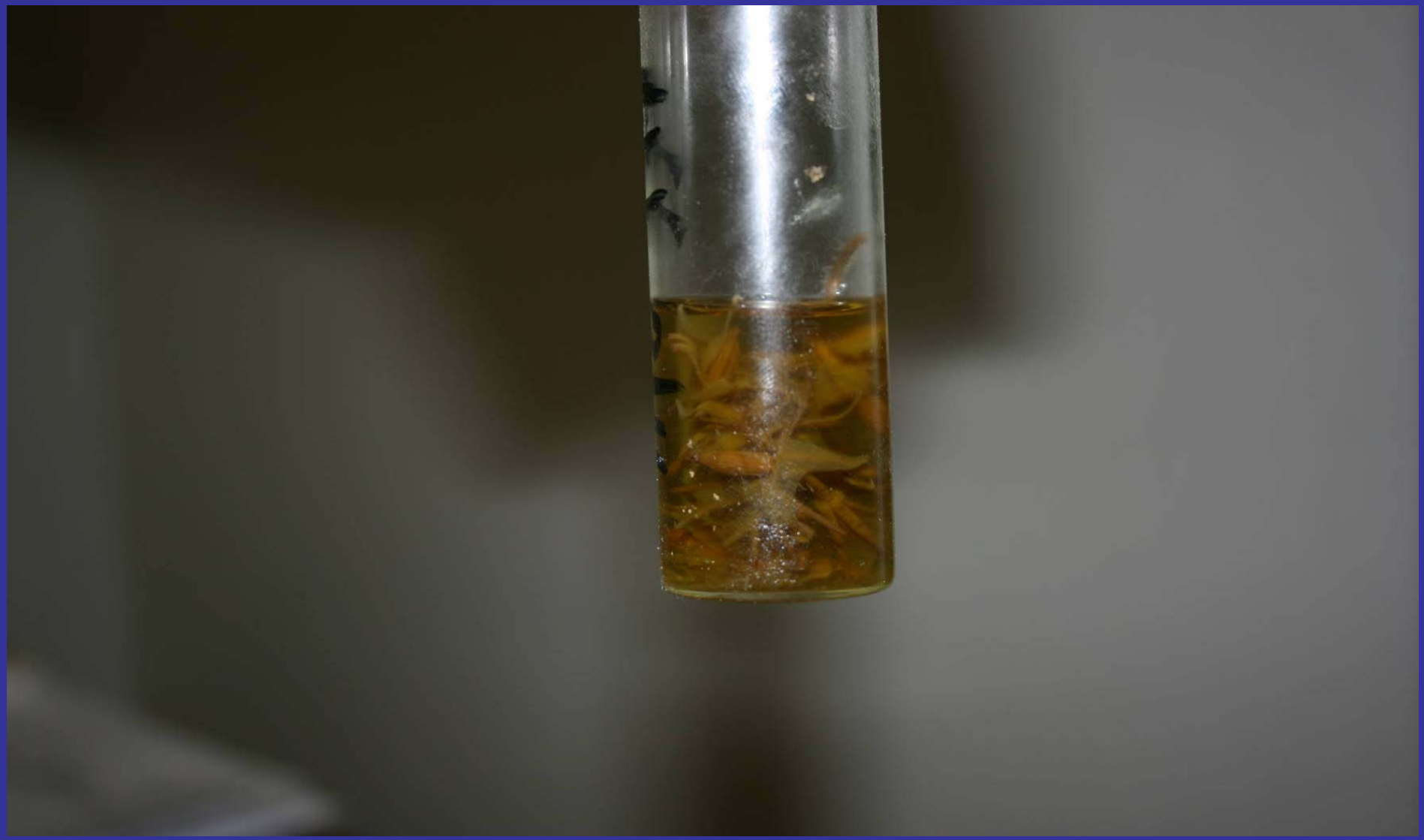
Main Plot (drip injected into three 66" beds, 315 ft long)

- Platinum 11 fl oz (3 Jun)
- Platinum 11 fl oz (3 Jun) and Venom 3.0 fl oz (7 Jul)
- Untreated

Sub-plots 75' row (foliar applied in 20 gpa water @ 30psi)

# apps.	17 Jun	1 Jul	16 Jul	21 Jul
4	Radiant 6 fl oz	Dimethoate 4EL 1pt	Lannate WP 1lb	Radiant 6 fl oz
3 early	Radiant 6 fl oz	Dimethoate 4EL 1pt	Lannate WP 1lb	
3 late		Dimethoate 4EL 1pt	Lannate WP 1lb	Radiant 6 fl oz
Untreated				

Counted Thrips
25 flowers/plot



Counted plants with TSWV 14 Sep

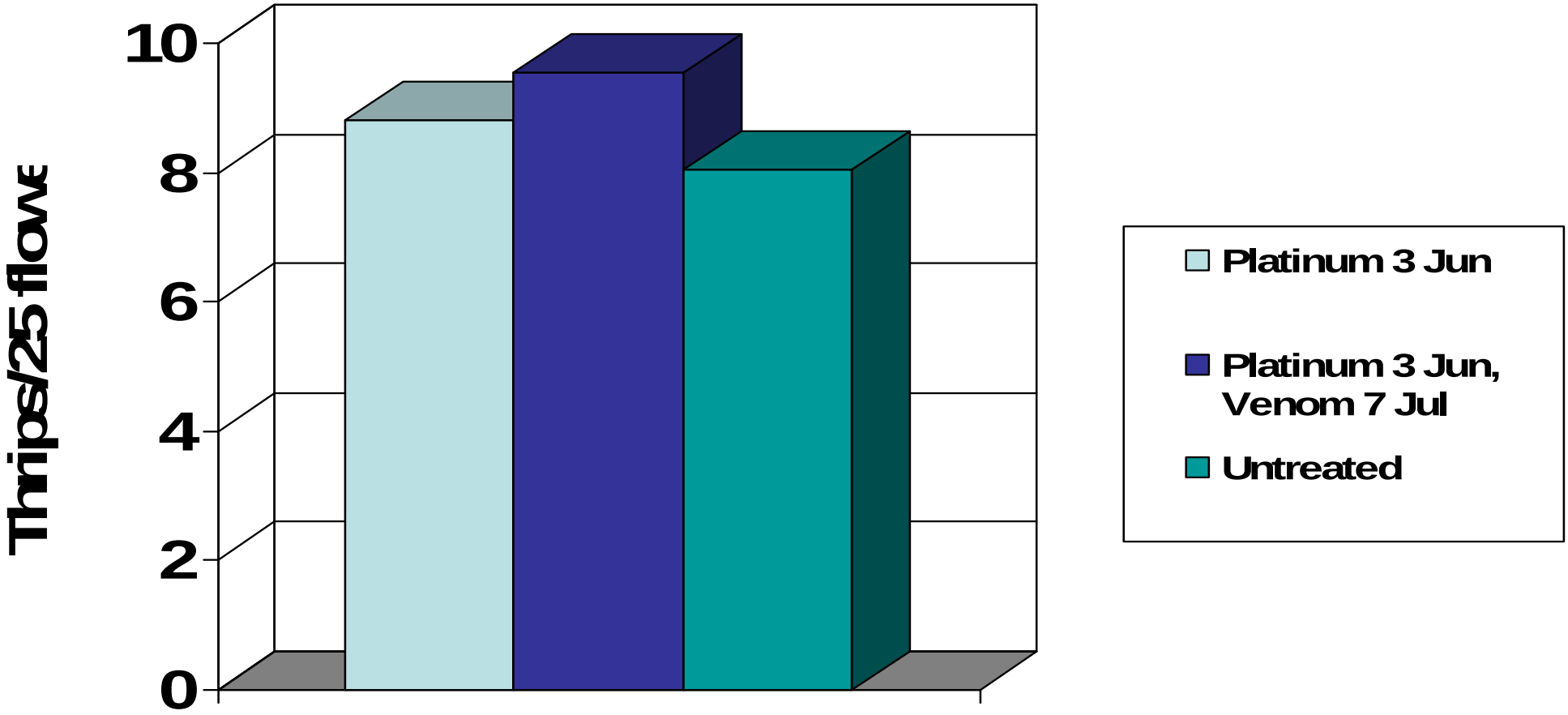
Thrips densities Results

Soil-Applied Insecticide (1 application)

16 Jun (13 days after treatment)

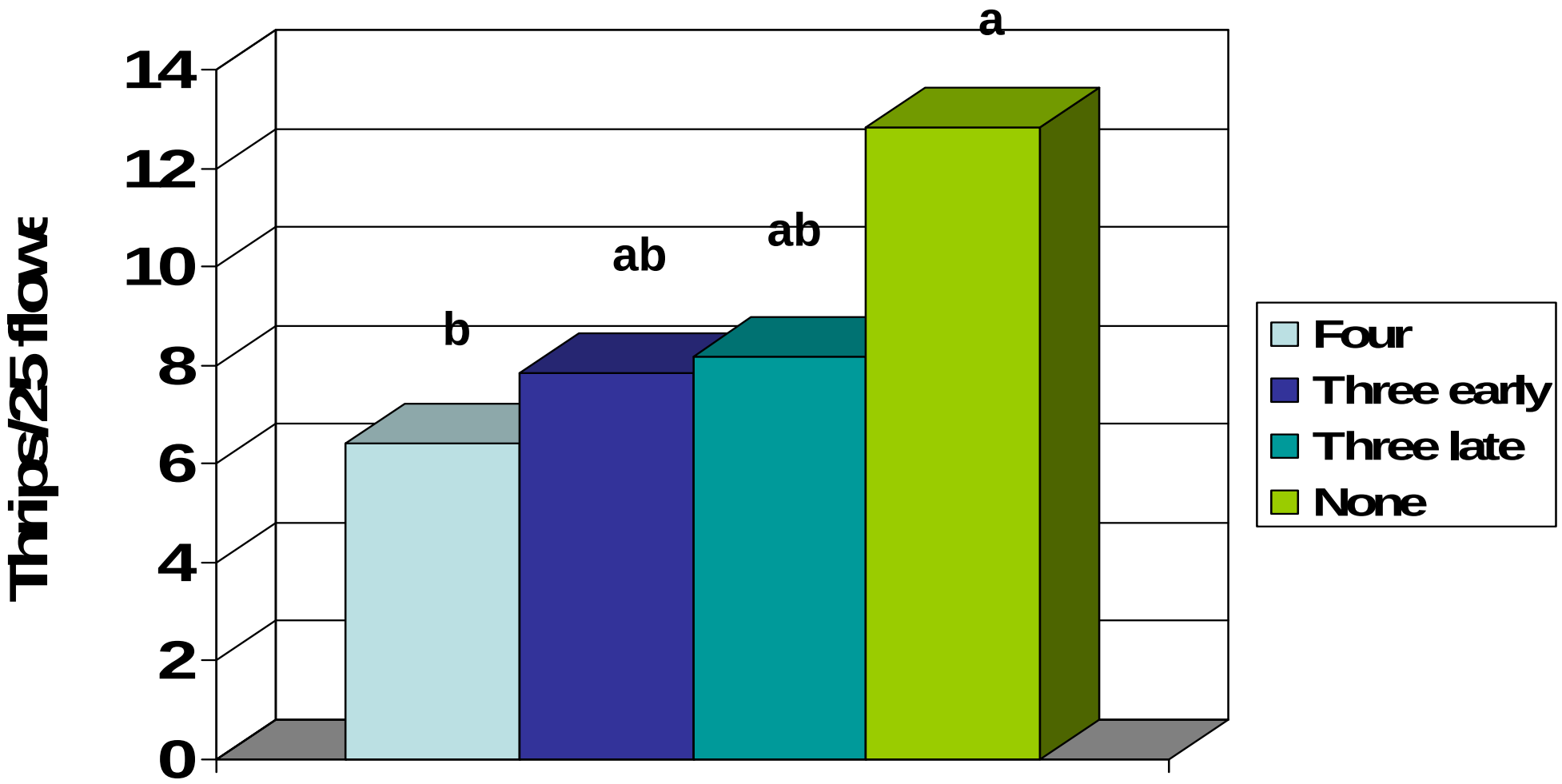
Treatment	Thrips/25 flowers
Platinum 11 fl oz on 3 Jun	82.37
Untreated	110.25
P (group comparison)	0.052

Thrips Densities
Soil-Applied Insecticide
(flowers collected 15 Jul)

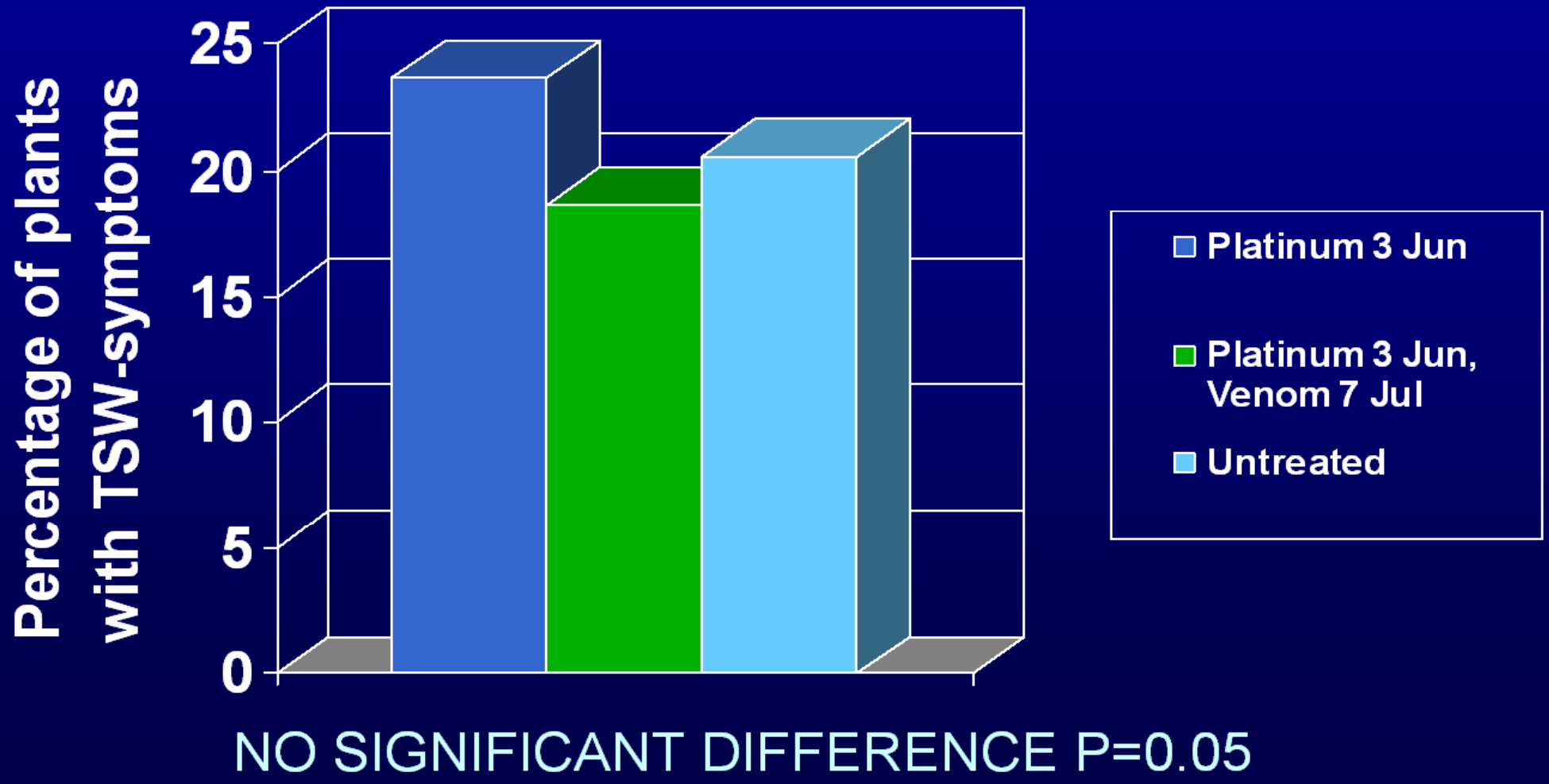


NO SIGNIFICANT DIFFERENCE P=0.05

Thrips Densities
Foliar-Applied Insecticide
(flowers collected 15 Jul)

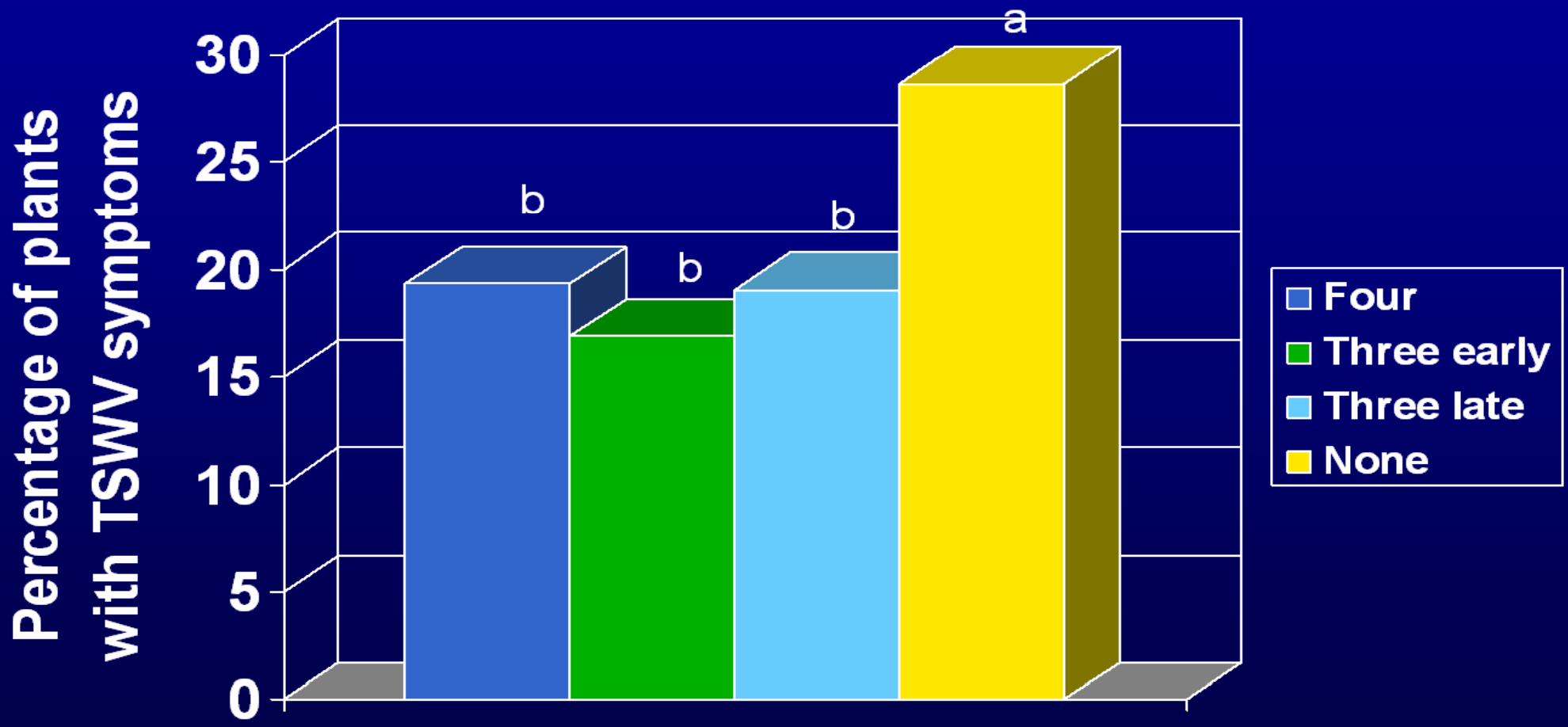


TSW-Plant Symptoms Incidence
Soil-Applied Insecticide



NO SIGNIFICANT DIFFERENCE P=0.05

TSW-Plant Symptoms Incidence
Foliar-Applied Insecticide



TSWV Research Continues in 2010

Development of an IPM strategy

Before planting

- Use virus & thrips-free transplants

- If thrips are present on transplants, manage populations prior to planting in the field

Before planting

Prevent initial infections

- **Plant TSWV resistant varieties (contain *Sw*-5 gene)**
- **Varieties without *Sw-5* gene vary in susceptibility to TSWV**

IPM Strategy

During season

- Avoid planting near established fields of susceptible crops with confirmed TSWV infection
- Monitor fields for thrips (yellow sticky cards) & TSWV
- Manage thrips with insecticides at early stages of crop development
- Rotate chemicals to minimize development of insecticide resistance in thrips
- Remove plants if infected at the seedling stage

IPM Strategy

After harvest

- Promptly remove and destroy old tomato plants and other host crops or volunteers on a regional basis.

- Avoid ‘bridge’ crops that carry the TSWV and overlap with tomato/pepper (e.g., radicchio).

- Control weeds/volunteers in fallow fields, non-cropped, or idle land near next year’s tomato fields.

Thank You
Are there any questions?

Acknowledgements:

CA Tomato Research Institute

UCCE Farm Advisors: Tom Turini, Scott Stoddard, and Michelle Le Strange

UC Davis: Bob Gilbertson, Virologist, Plant Pathology Dept.

Oscar Batuman, Post Doc Researcher, Plant Path

Dianne Ullman, Entomologist, Entomology Dept.