TSWV and Curly Top Disease Management in Tomatoes

CE for Pest Management Pros
Fall 2022

Scott Stoddard, UCCE Merced County

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TSWV

Tomato Spotted Wilt Virus

- Symptoms: stunting, bronzing, necrotic spots, necrosis of vine tips “strikes”.
- Fruit deformed, bumpy, off-color, concentric rings.
- Reduced yield.
- *Symptoms vary depending on variety and plant age.*

Anecdotal

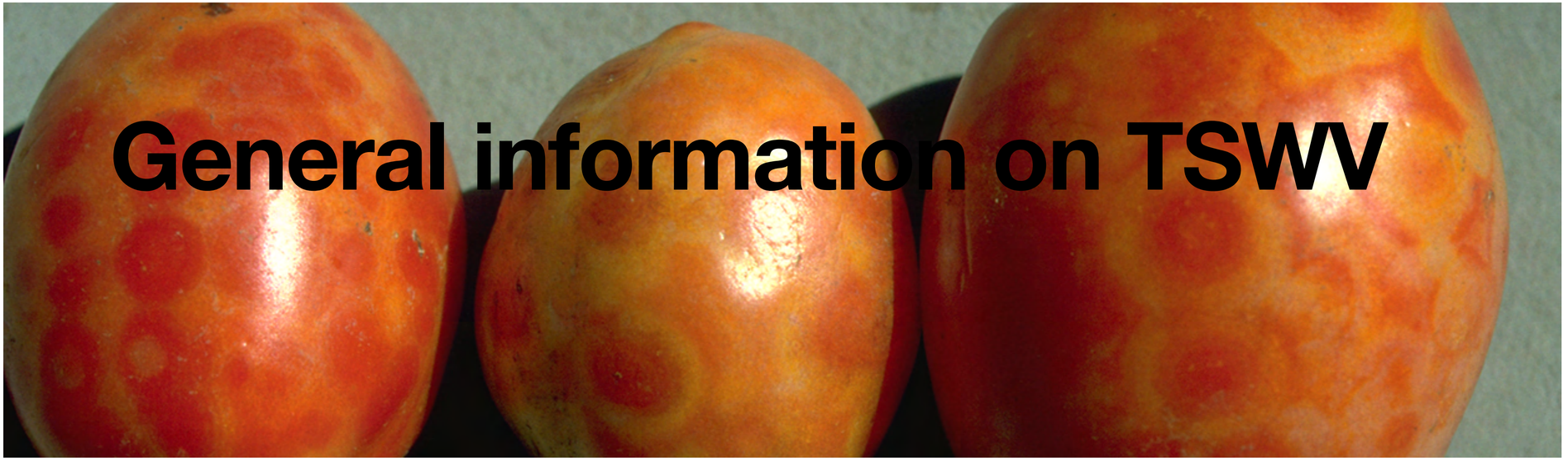
Management of Thrips in Tomatoes

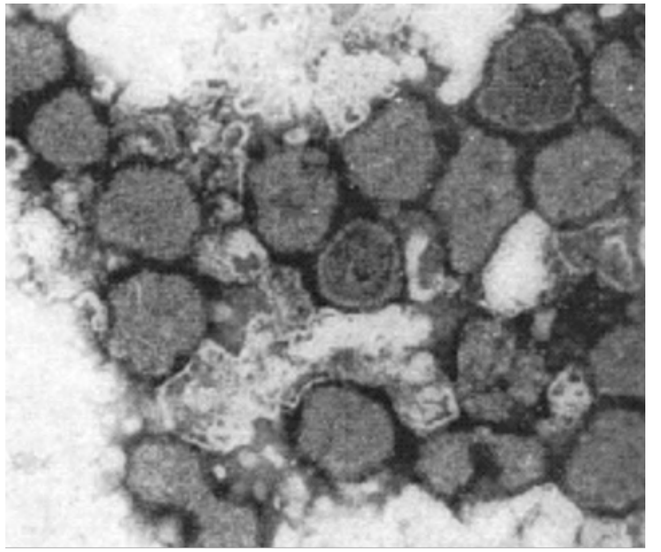
JULY 31, 2020 /

Cosmetic damage of western flower thrips on tomatoes by (A) oviposition and (B) feeding (flecking).

By Xavier Martini and Joe Funderburk

General information on TSWV





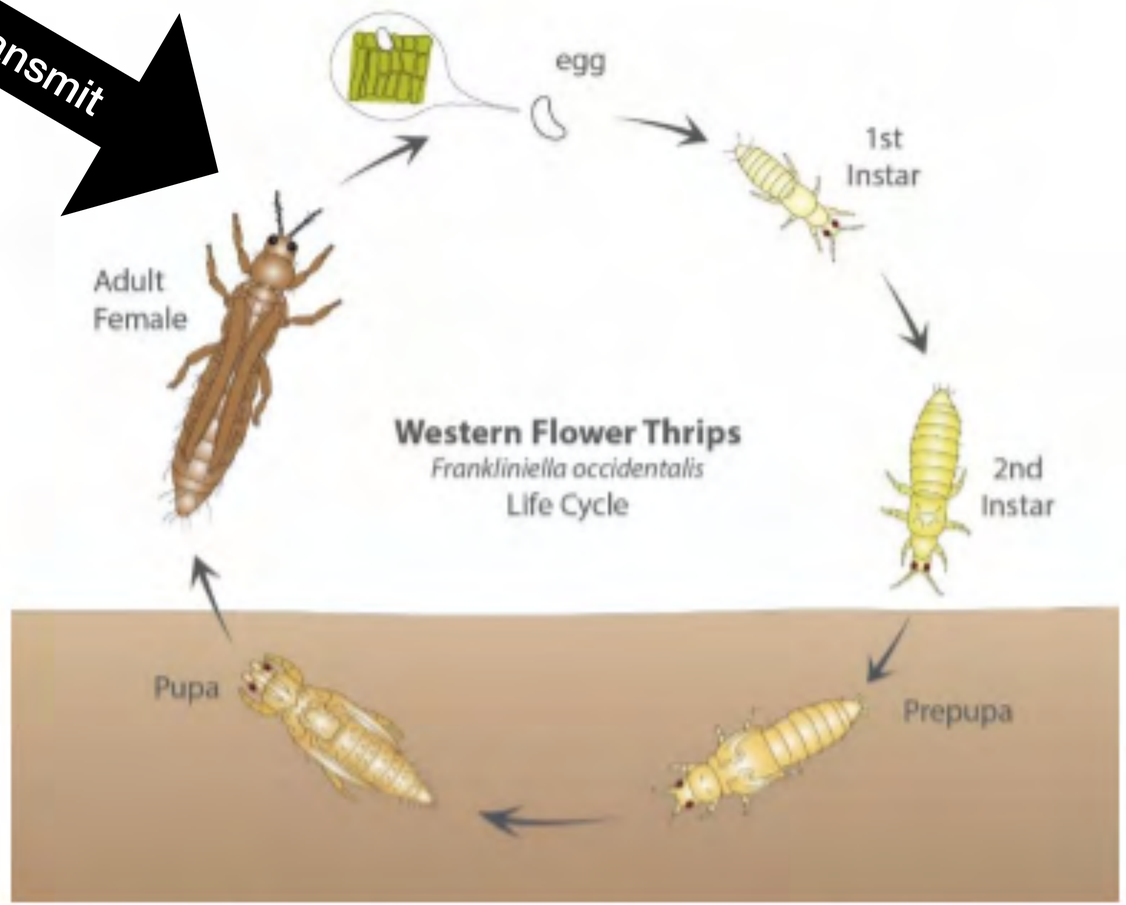
- Tospovirus: plant infecting RNA virus
- 1st reported in Australia in 1915 and CA in 1935
- Vectored by thrips, not be seed or contact or through eggs.
- Major vector in CA is Western flower thrips, *Frankliniella occidentis*
- Resistant cultivars available: in tomatoes Sw-5 gene, in peppers Tsw gene
- 2016 resistant-breaking strain (TSWV-RB) found in fresh market tomatoes

Western flower thrips are small, but extremely numerous, especially in April and May

Biology:

Eggs are small, oval, and inserted into plant tissue. Nymphs are slender and have four instars. The first two - larva I and II – feed on plant tissues while the latter two - prepupa and pupa – are non-feeding stages that are often found in the soil. Larvae are wingless and white initially and turn yellow or orange once they start feeding. Adults are small (< 2 mm), slender, and have two pairs of long, narrow wings with a fringe of hairs. The western flower thrips can occur in different color morphs such as yellow or orange, brown, and black.

transmit



Life cycle of the western flower thrips (Graphic courtesy: Biobee Biological Systems)

Can complete life cycle in 30 - 45 days

acquire

- Tomatoes
- Peppers
- Lettuce
- Radicchio
- beans and potatoes

- Malva/cheeseweed
- sowthistle
- prickly lettuce
- nightshades
- buttercup
- bindweed

TSWV Cycle in Tomatoes

thrips and alternate hosts

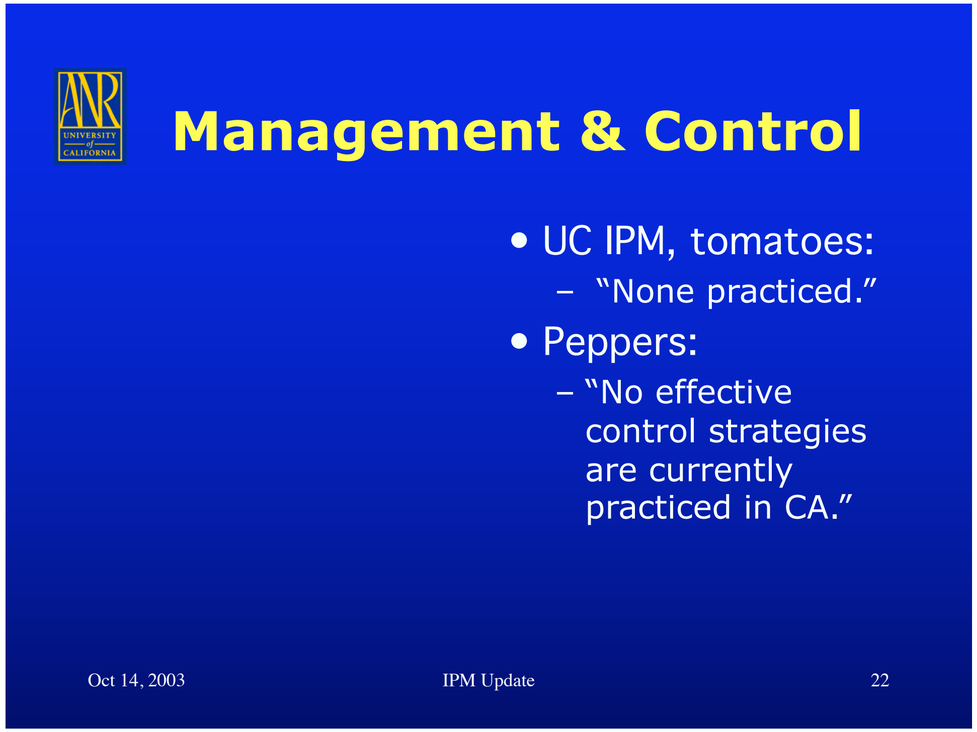
fall | winter | spring | summer

TSWV Management

LeGrand, CA, ca 2003

TSWV Management

- 2003: no management practices (UC IPM)
- 2022:
  - Cultivar resistance (Sw-5 gene)
  - Monitoring and testing
  - Weed management
  - Crop rotation
  - Insecticides



“New” Resistances

- **Tomato Spotted Wilt Virus**
  - Heinz work started in 1996
    - Simple single gene
  - Industry dynamic changed in 2006
    - Major outbreak in Westside
    - Fruit are not usable for peeling
  - Varieties released in 2009 (H5608, H5508)
    - Lower NTSS was compromise by the industry
  - Industry has responded
    - 28 of 28 experimental varieties* contain SW
  - TSWV has quickly become part of the standard package for California

* As indicated in the 2016 AgSeeds Processing Tomato Variety Guide

New fresh market cultivars are also TSWV resistant.

Varieties Compared (2019 - 2021)

resistance	variety	resistance	variety	resistance	variety
Sw5	AB0311	No Sw5	H2401	Sw5	N6441
Sw5	BP13	Sw5	H5608	Sw5	SV8011TM
Sw5	BQ273	Sw5	HM4521	Sw5	SVTM1082
Sw5	BQ413	Sw5	HM5235	Sw5	SVTM9000
Sw5	DRI319	No Sw5	HM7885	Sw5	SVTM9007
Sw5	H1293	Sw5	HM8163	Sw5	SVTM9011
Sw5	H1428	Sw5	N6415	Sw5	UG27713
Sw5	H1662	Sw5	N6420	Sw5	UG29814
Sw5	H1776	Sw5	N6426	Sw5	UG4014

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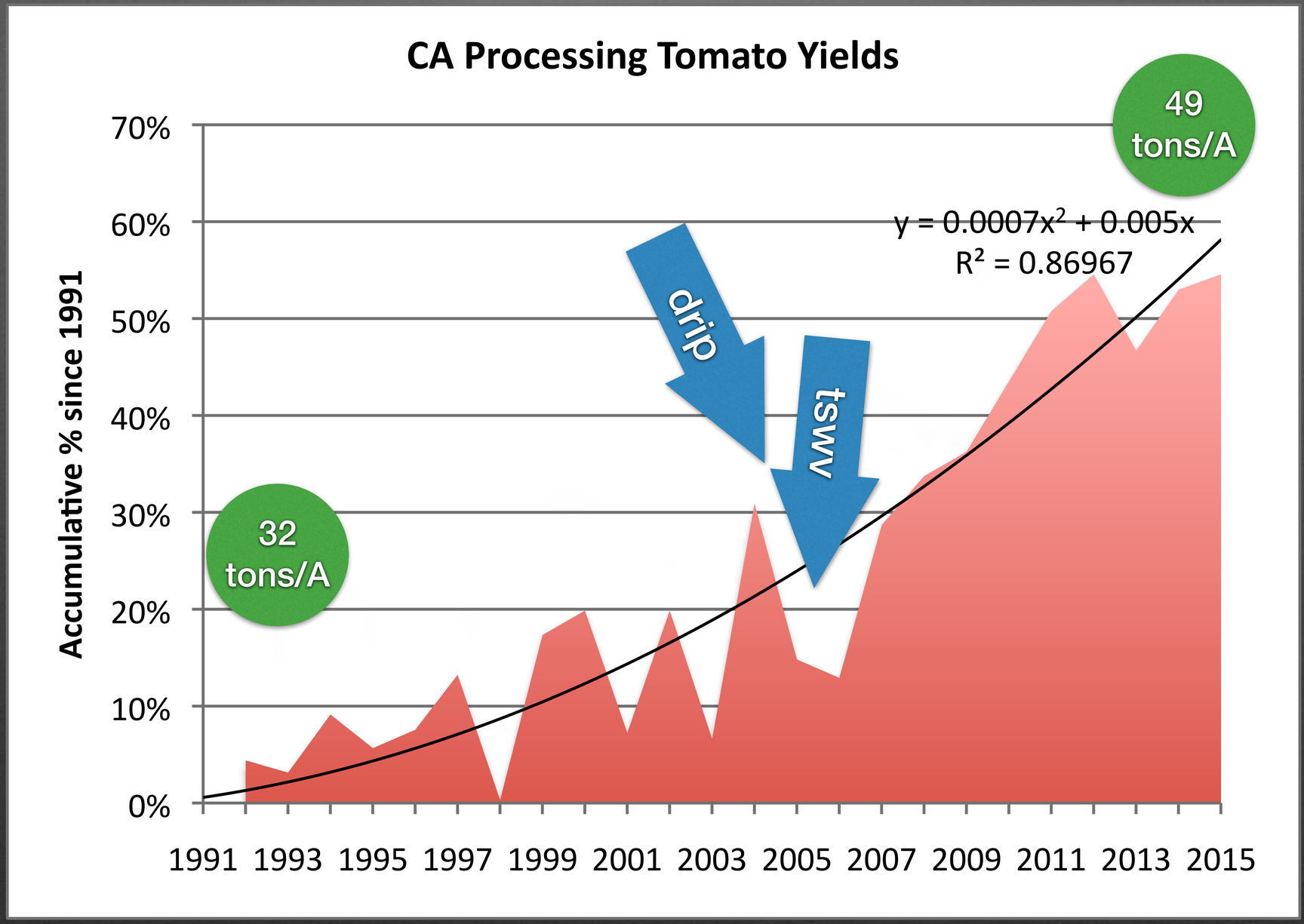
Tom Turini. https://ucanr.edu/sites/veg_crop_sjc/files/364004.pdf


CA Processing Tomato Yields
Accumulative % since 1991
70%
60%
50%
40%
30%
20%
10%
0%
1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015
49 tons/A
32 tons/A
drip
tswv
y = 0.0007x² + 0.005x
R² = 0.86967

RB-TSWV

resistance-breaking

- 1st seen in 2016 in Fresno county
- 2017 observed in Merced
- Fresh market types more susceptible

Resistance-breaking TSWV distribution, 2019

- 2017: Additional reports in Fresno and Merced
- 2018: Continuing issues in Fresno and Merced with reports in Kern and Kings
- 2019: Lower overall but throughout Fresno Co.
- Since 2020, verified in northern California

Tom Turini. https://ucanr.edu/sites/veg_crop_sjc/files/364004.pdf

Virus testing

TSWV specific quick tests

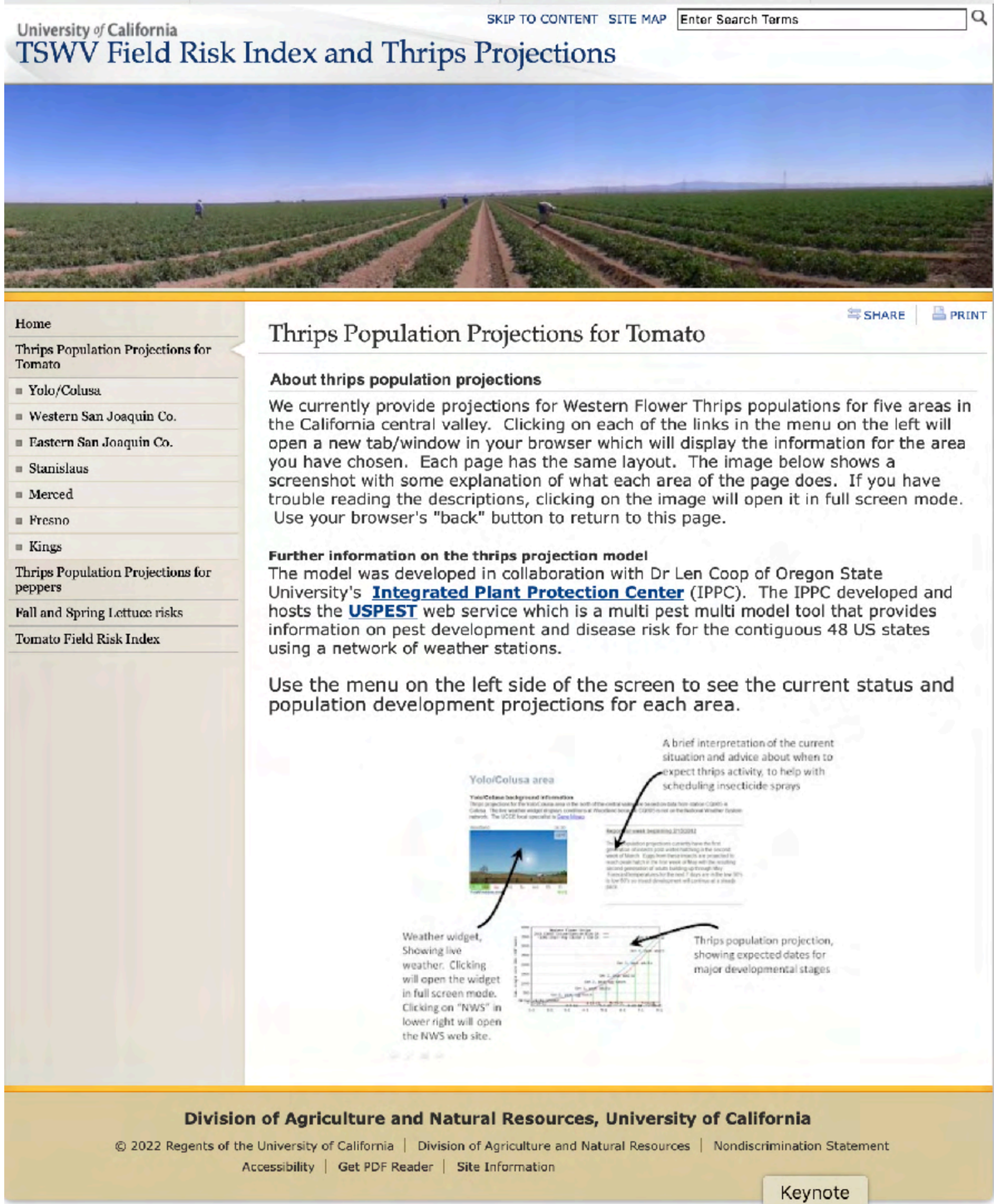
- AgDia
- Takes about 5 minutes
- Accurate, but can’t differentiate between RB-TSWV and WT-TSWV
- PCR testing for RB strain by Bob Gilbertson, UCD

Thrips monitoring

computer model based on GDDs

https://ucanr.edu/sites/TSWVfieldriskindex/Thrips_Population_Projections/

Unlike with leafhoppers, little is known about how winter weather will impact potential thrips pressure the following year; populations usually peak in April/May.



Weed management

especially winter annuals

- Usually low virus incidence
- Sowthistle has been the most commonly infected weed, but <10% of samples
- Buttercup on orchard (walnuts) floor: LeGrand and Gustine

Other crops

crop rotations, alternate crops, adjacent crops, crop timing

winter bridge crop for both virus and thrips

staggered tomato planting
summer bridge crop for both virus and thrips

winter bridge crop for thrips

Management of thrips to manage TSWV

foliar insecticides

- Management of thrips best done through foliar insecticides*
    - * Verimark (cyantraniloprole) is the exception.
- Practical limitations: hard to kill thrips, thrips have high reproductive rates, thrips float in from adjacent fields
- Most are disruptive to beneficial insects (wasps, ladybugs, lacewings, minute pirate bug).
- Potential for secondary pest problems (leafminers)
- Cost

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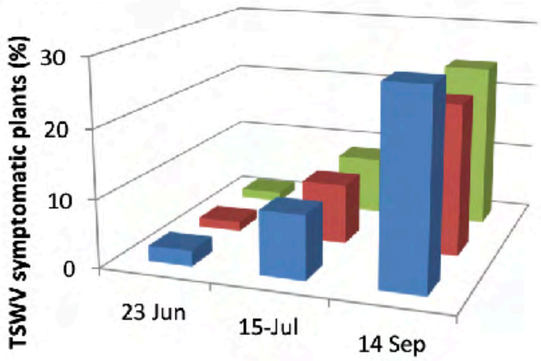
Insecticides

CA registered on tomatoes and suggested by UCIPM

Group #	Chemical sub-group	active ingredient	trade name	rate
5	spinosyns	spinetoram	Radiant SC	6-10 oz/A
5	spinosyns	spinosad	Entrust, Success	1.25-2.5 oz/A 4-8 oz/A
1B	organophosphates	dimethoate	Dimethoate 400	½ pt/A
1A	carbamates	methomyl	Lannate	1 pt/A
3A	pyrethroids	cyhalothrin, esfenvalerate	Warrior, Asana, Danitol	varies
28	diamide	cyantranilaprole	Verimark, Exiril	

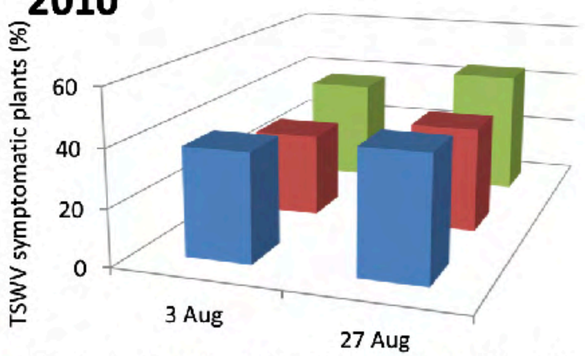
Influence of Drip-Applied Insecticides

2009



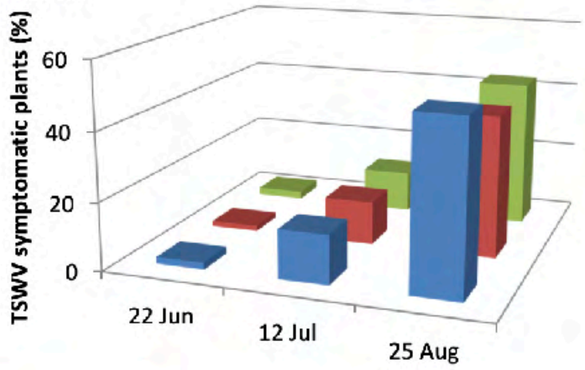
thiamethoxam 193 g (3 Jun)
thiamethoxam 193 g (3 Jun), dinotefuron 294 g (7 Jul)
Untreated

2010



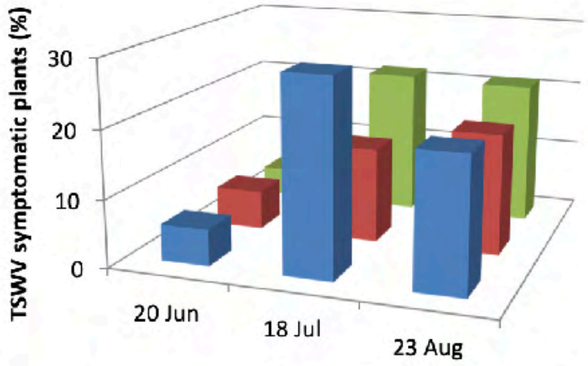
thiamethoxam 193 g (25 May), dinotefuron 294 g (30 Jun)*
thiamethoxam 193 g (25 May), dinotefuron 294 g (30 Jun)
Untreated
* Weekly injections of acibenzolar-s-methyl 35g/ha

2011



thiamethoxam 193 g (22 Jun), dinotefuron 294 g (12 Jul)
thiamethoxam 193 g (22 Jun), dinotefuron 294 g (22 Jul)
Untreated

2012

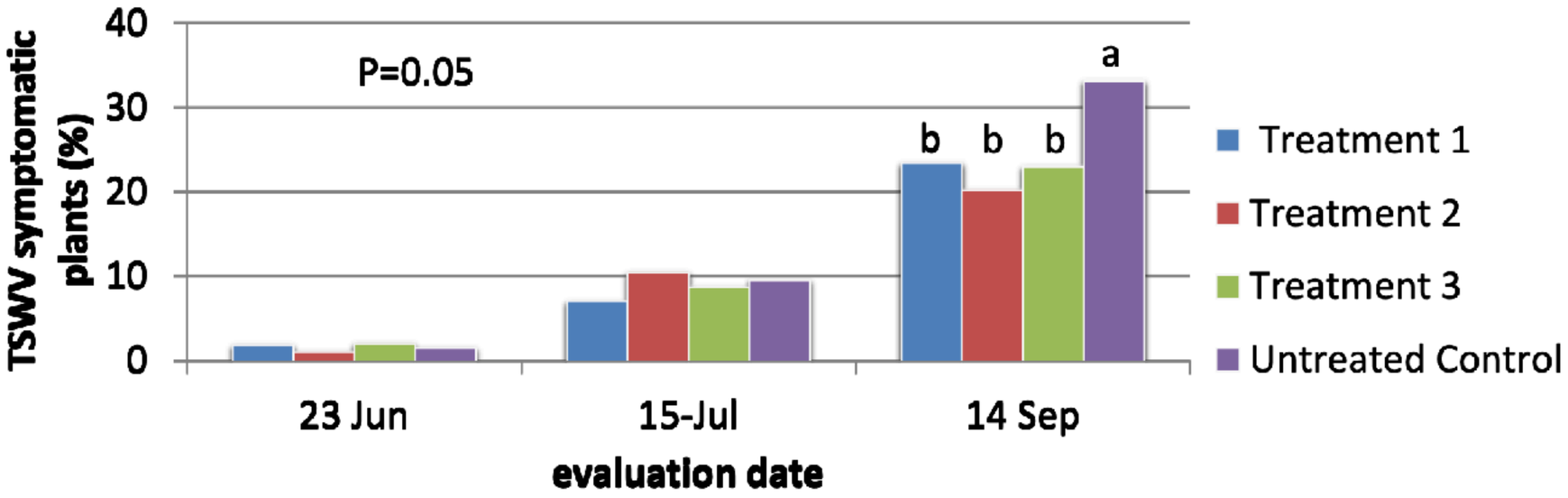


thiamethoxam 193 g (7 Jun), dinotefuron 294 g (27 Jun)
thiamethoxam 193 g (7 Jun), cytraniliprole 197 g (27 Jun)
Untreated

no significant reduction in TSWV from drip applied Venom (dinotefuron) or Platinum (thiamethoxam) as compared to UTC.

Tom Turini, farm advisor, Fresno County

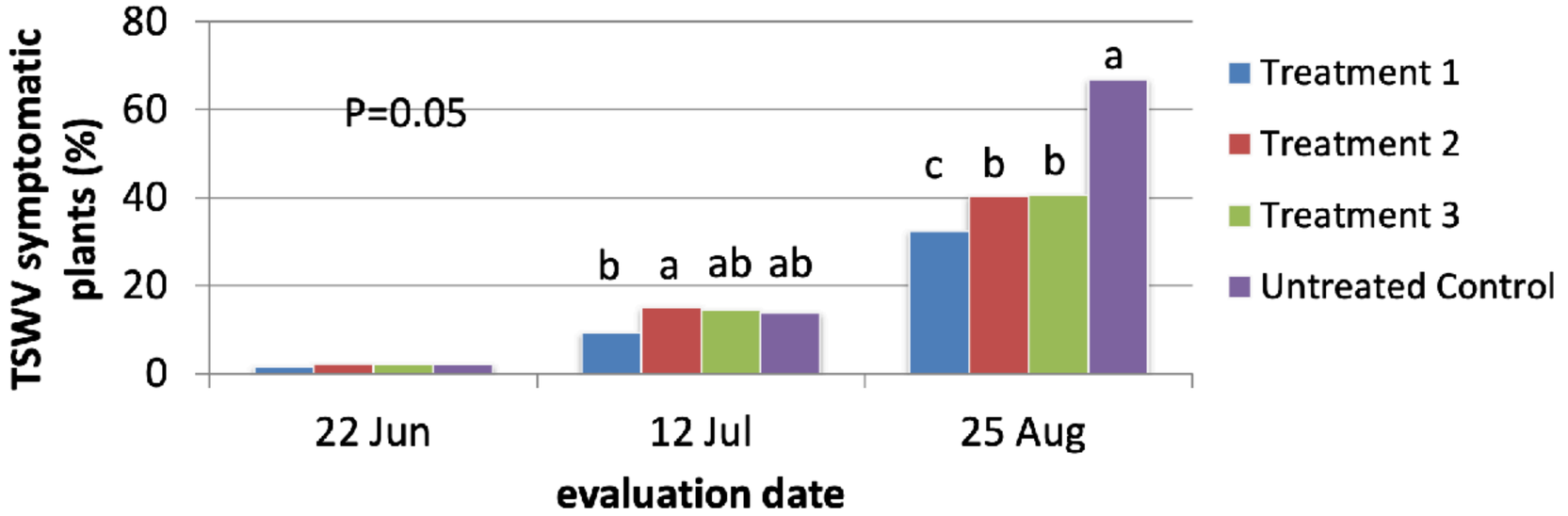
Foliar Treatment Impact on TSWV Symptomatic Plant Incidence 2009



Foliar insecticides significant reduced TSWV in both years

	date of application, quantity ai/ha		
	17 Jun	1 Jul	15-Jul
Treatment 1	spinetoram 87 g	dimethoate 560 g	spinetoram 87 g
Treatment 2	spinetoram 87 g	dimethoate 560 g	
Treatment 3		dimethoate 560 g	spinetoram 87 g
Untreated control			

Foliar Treatment Impact on TSWV Symptomatic Plant Incidence 2011



	date of application, quantity ai/ha				
	Trans. drench	24-Jun	6-Jul	14-Jul	21-Jul
Treatment 1	cyantraniliprole 197 g	spinetoram 87 g	dimethoate 560 g	spinetoram 87 g	dimethoate 560 g
Treatment 2		spinetoram 87 g	dimethoate 560 g	spinetoram 87 g	dimethoate 560 g
Treatment 3		spinetoram 87 g	dimethoate 560 g		
Untreated Control					

Effect of Verimark applied to transplants one day prior to planting on thrips densities 14 days post-plant in Fresno County, CA 2021.

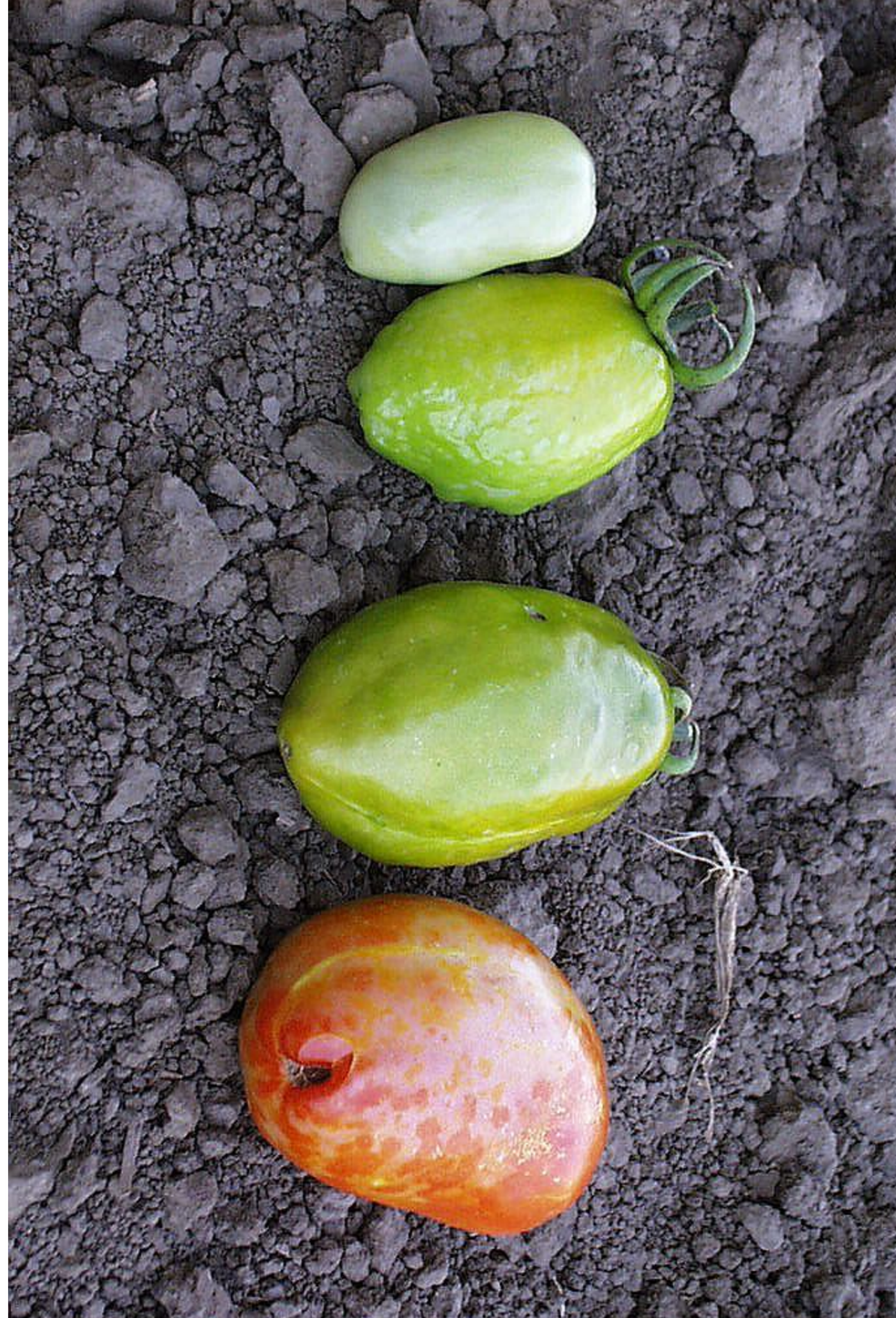
Insecticide trade name, rate per acre[z]	6/2/21 adults[y]
Verimark 13.5 fl oz/a transplant drench	4.25
Untreated control	19.00
Treatment probability	0.0030
Coefficient of Variation (%)	80.42

[z] On 18 May, Verimark was applied to the trays in the equivalent of 13.5 fl oz per acre based on a plant density of 8712 plants per acre.

[y] On 2 Jun (15-days post-treatment), three plants per plot of the Verimark treatment and in the untreated control were carefully covered with a zip-lock bag, the plant was cut, and the bag was sealed. Then, samples were frozen, rinsed with water over a 150 mesh/inch screen, poured over the top of the screen into petri plates and thrips were counted under a 40x dissecting scope.

Management Guidelines for TSWV

- Verify TSWV using AgDia test strips.
- Avoid planting next to “source” fields.
- Control thrips early with insecticide sprays.
- Use resistant cultivars even though RB-TSWV is increasing.
- Use foliar applied insecticides and rotate different modes of action (use different Group #s). Both Radiant and dimethoate have a high level of efficacy in recent trials.
- Verimark applied as a transplant drench provides additional suppression.

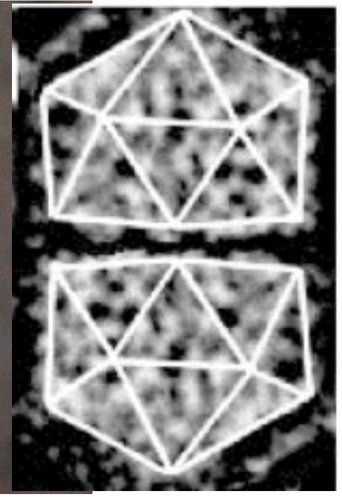


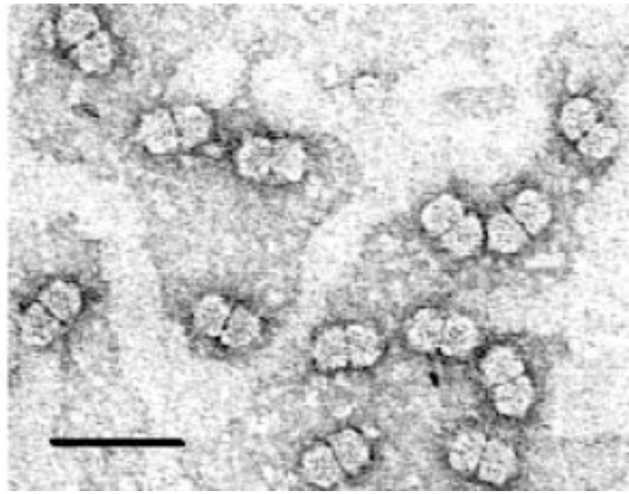
BCTV

Beet Curly Top Virus

- Symptoms: stunting with light green to yellow leaves, upward leaf rolling, purpling of older leaves, purple venation.
- Infected early, plants die. Infected late, plants curly and turn purple; marble-sized fruit that mature early.
- Reduced yield.
- *Symptoms vary depending on variety and plant age.*

General information on Curly Top





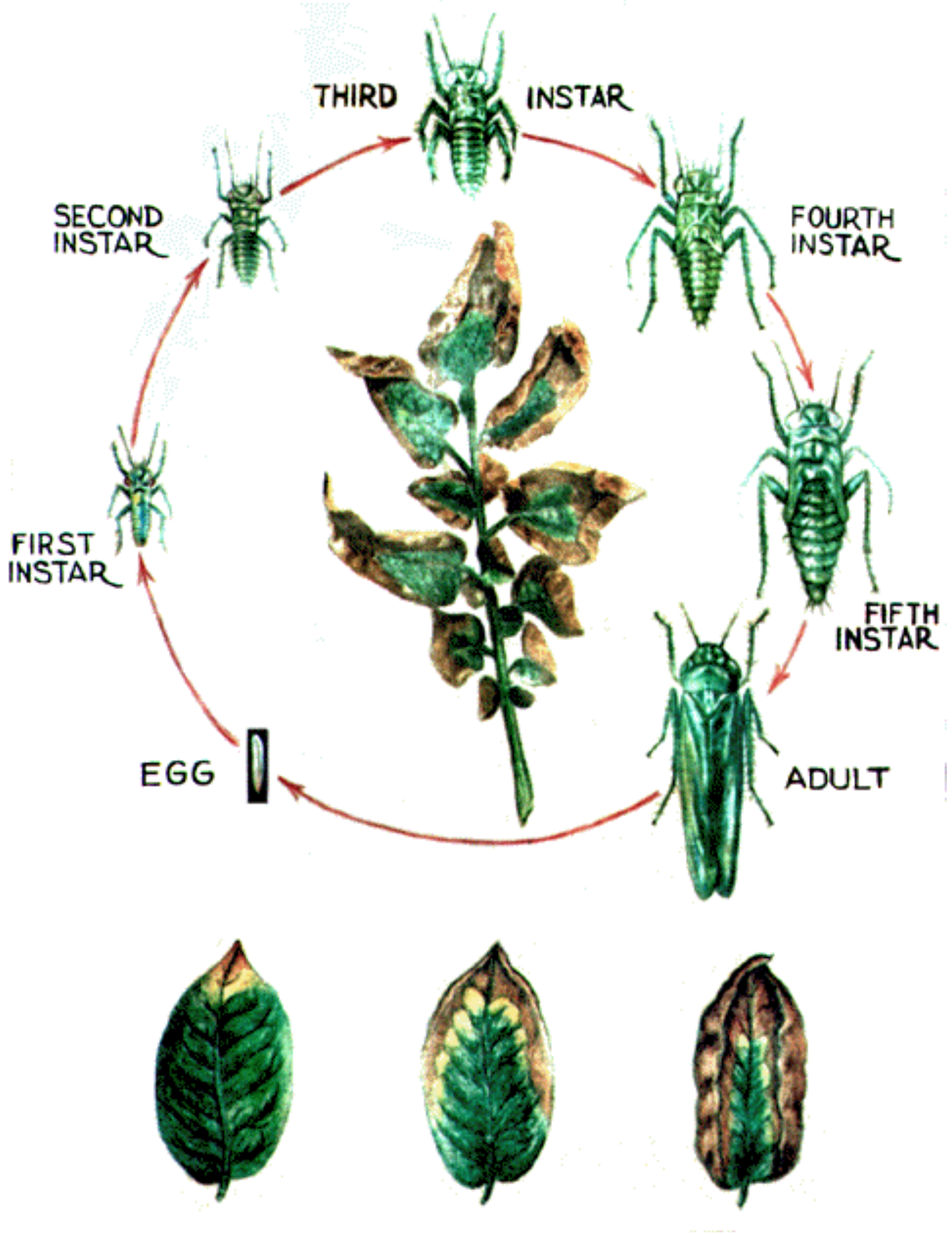
- Geminivirus: composed of circular, single-stranded DNA genome that is packaged within a pair of quasi-isometric particles, hence, the name ‘geminate’, or twinned particles. *J.K. Brown, in Encyclopedia of Virology (Third Edition), 2008.*
- Vectored by beet leafhopper.
- No plant resistance in commercial cultivars.
- Sporadic disease that can cause significant yield declines when pressure is high and plants are young when infected.

Beet Leafhopper

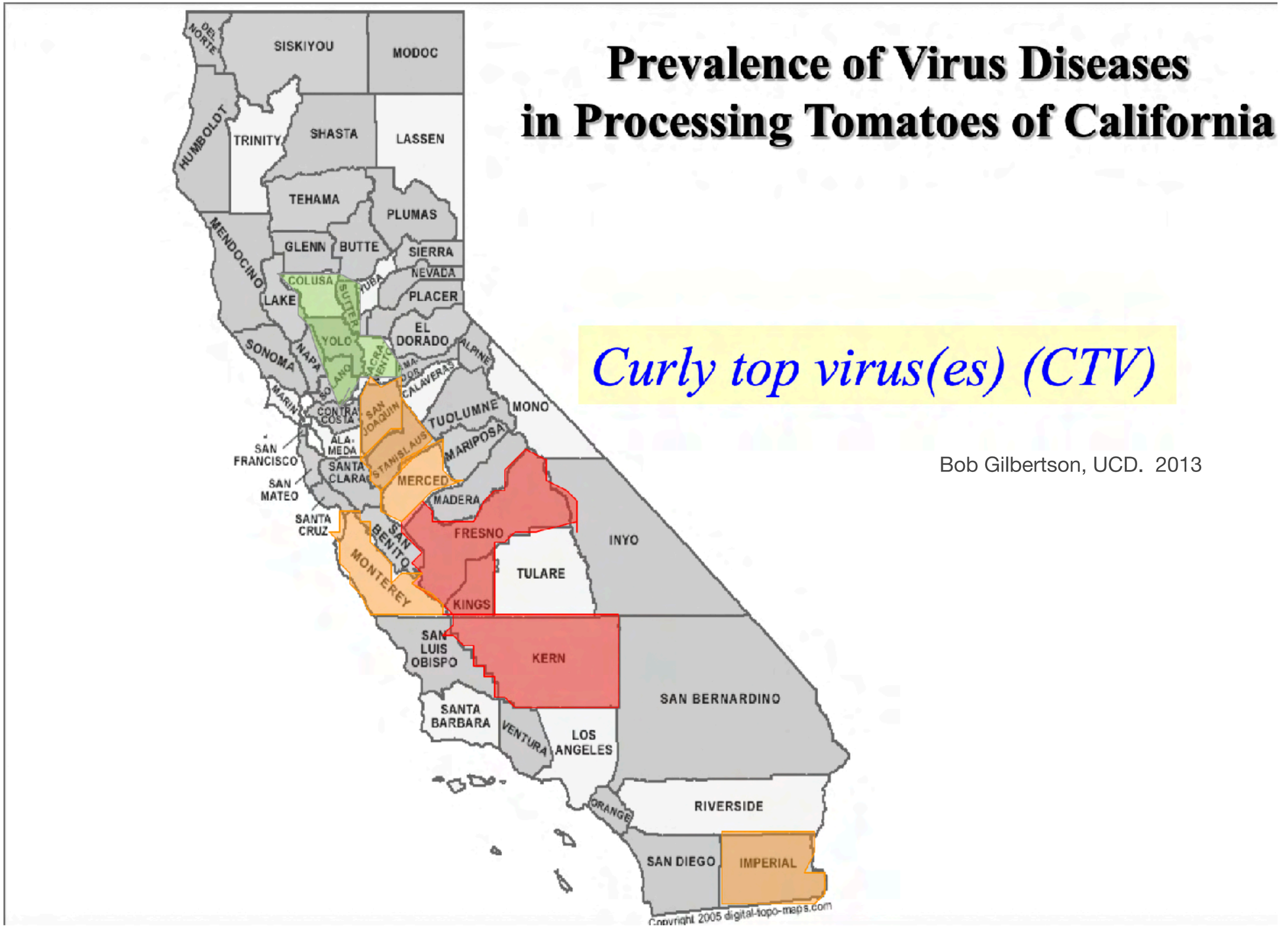
Circulifer tenellus

Biology

- Same insect order as aphids and whiteflies (Homoptera). Sucking-piercing mouthparts.
- Overwinter on weed hosts in the foothills and south Coastal Range. Adults move onto the Valley floor as weeds dry down in the spring.
  - Anecdotal evidence suggests there are “hot spots” where adults overwinter in tomato production areas in SJV on weeds that also host BCTV.
  - Prefer plants in the Chenopodiceae family: sugar beets, lambsquarters, halogeton, Russian thistle, greasewood.
- Leafhoppers can transmit the virus even if they only feed for a brief period (minutes). A virus-infected leafhopper will transmit the virus for the duration of its life, often resulting in long distance spread of the virus.



Prevalence of Virus Diseases in Processing Tomatoes of California



Curly top virus(es) (CTV)

Bob Gilbertson, UCD. 2013

- sugar beets
- tomatoes
- peppers
- melons (2013)
- hemp

- lambsquarters
- Russian thistle
- greasewood

Weeds in the Goosefoot family (Chenopodiaceae)

Curly top management

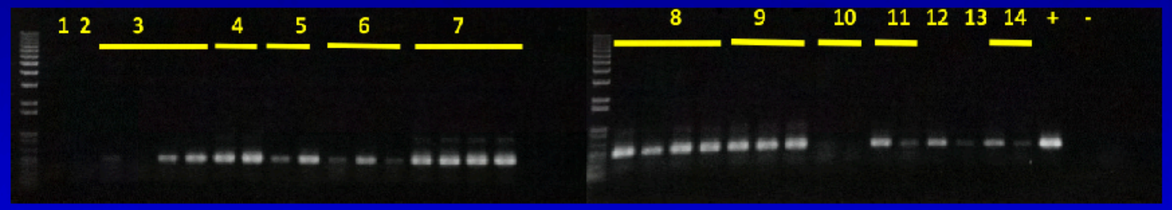
Curly Top Management

- CDFA BCTV Control Board monitors leafhopper populations in the foothills and Valley floor using sweetnets, insecticide sprays over several thousand acres each spring.
- No models, but early wet winters and dry springs tend to create conditions where potential for curly top outbreaks increases.
  - 2013, 2021, 2022 …… 2023?
- Testing: no quick tests. Only PCR.

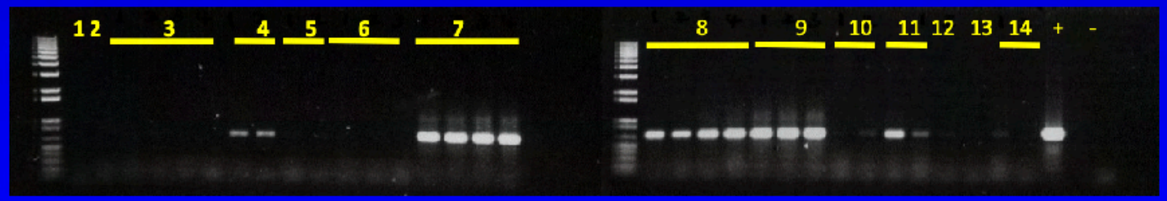
Curly Top Outbreak of 2013

- In 2013, beet leafhopper populations detected in the foothills by the CDFA CTVCB were approx. 5X higher than normal
- High levels of BMCTV and BSCTV were detected in leafhopper samples sent to our laboratory in March and April

Detection of curly top viruses in leafhoppers collected by the CDFA CTVCB in 2013



BMCTV

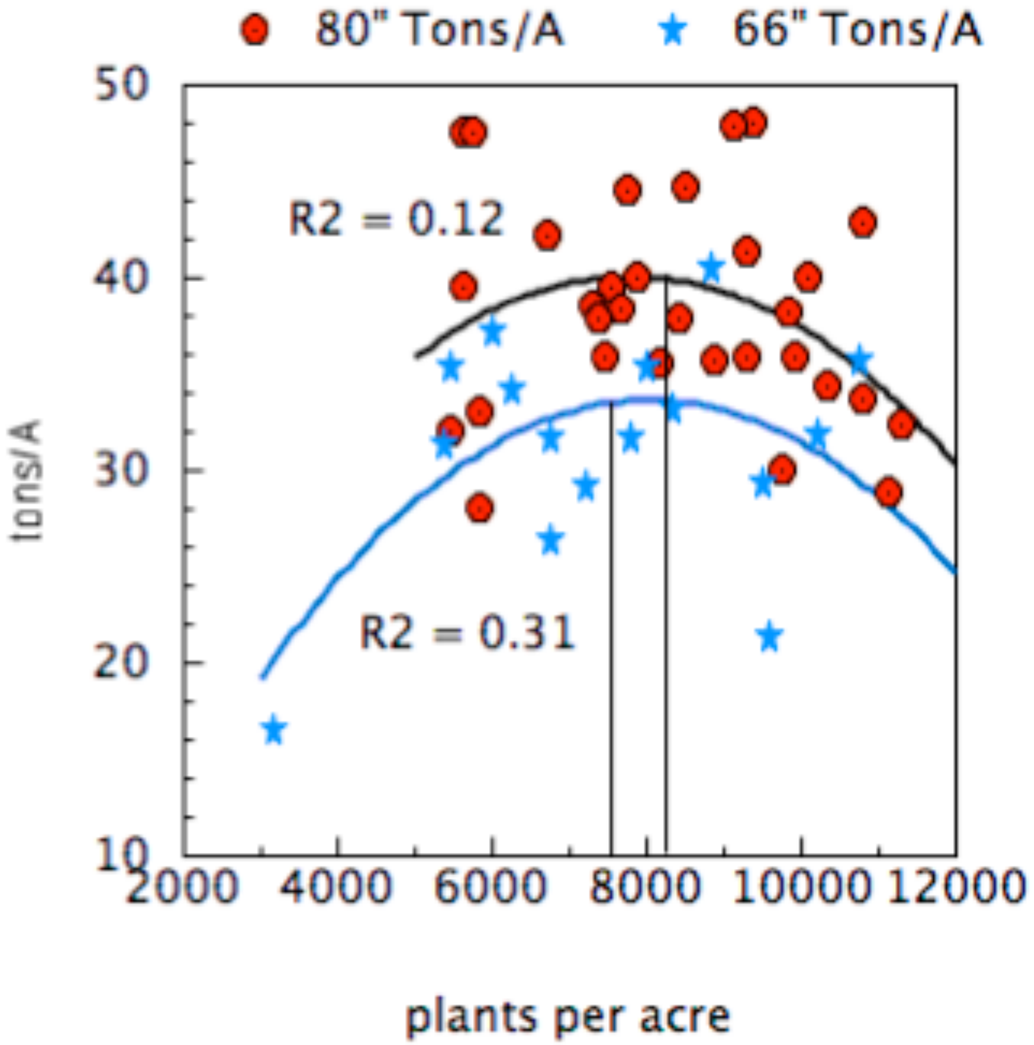


BSCTV

Dr. Robert Gilbertson, UC Davis.
https://ucanr.edu/sites/veg_crop_sjc/files/182170.pdf

Curly top management

- increase plant population
- Location: avoid BCTV - prone areas (I-5 and Hwy 33 south of Patterson)
- no genetic resistance
- insecticides



Curly Top Management

systemic insecticide program applied through the drip

- Imidacloprid (Admire) at planting fb thiamethoxam (Platinum/Actara) or dinotefuran (Venom) at 2 - 3 weeks after transplanting.

- Verimark (cyantraniloprole) applied as a transplant drench before planting followed by Platinum or Venom.

- Practical limitations: 50% reduction in virus incidence.

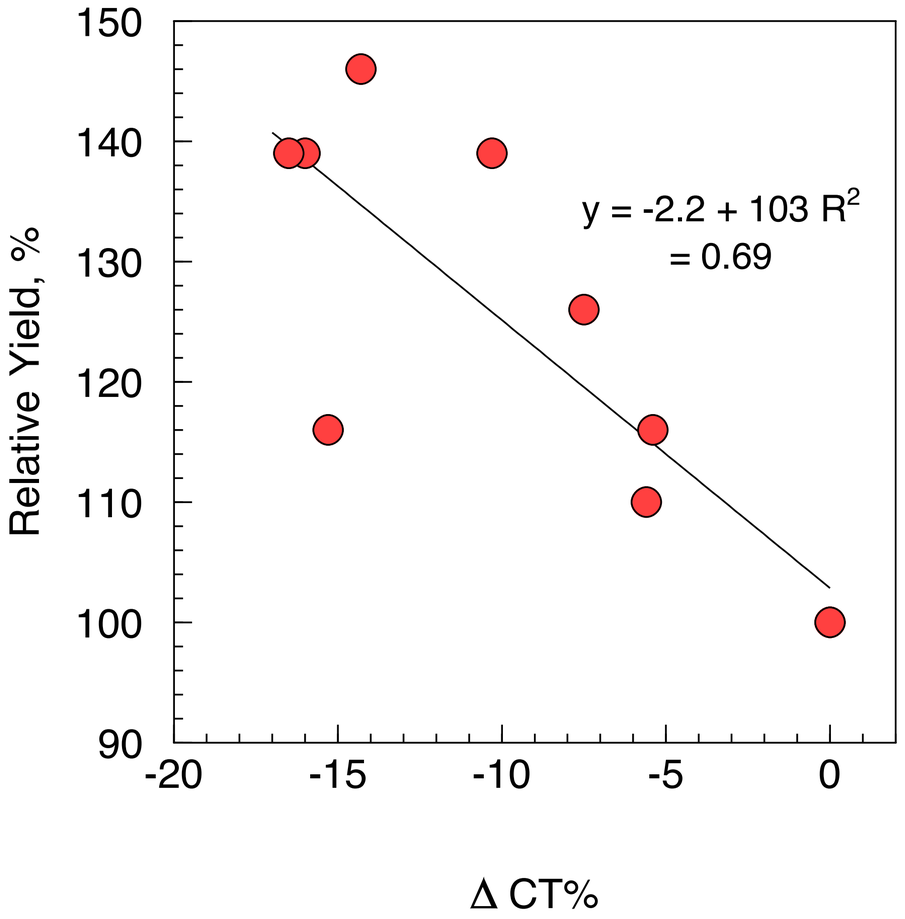
Influence of Insecticide Applications on BCTV incidence, Five Points, 2016

	BCTV (%)				
Treatment, application (date applied)	10-Jun	17-Jun	23-Jun	30-Jun	6-Jul
Verimark 13.5 fl oz product/A Tray Drench 16 May	0.17	0.97	1.15	3.50	11.25
Admire Pro 4.0 fl oz/a) transplant water 17 May Verimark 10 fl oz/A drip applied 10 Jun Verimark 10 fl oz/A drip applied 28 Jun	0.27	1.37	1.47	4.00	10.75
Silvanto 10.5 fl oz 6 Jun Platinum 3.67 oz drip applied 10 Jun Venom 6.0 oz drip applied on 28 Jun	0.91	3.76	3.58	6.94	17.00
Admire Pro 4.0 oz transplant water 17 May Platinum 3.67 oz drip applied 10 Jun Venom 6.0 oz drip applied on 28 Jun	0.09	1.44	1.53	4.87	12.00
Verimark 13.5 fl oz product/A Tray Drench 16 May Platinum 3.67 oz drip applied 10 Jun Venom 6.0 oz drip applied on 28 Jun	0.62	1.06	1.85	3.87	13.00
Untreated control	1.54	3.37	4.48	9.18	27.25
$LSD_{0.05}$	1.01	1.27	1.70	1.87	2.24
CV %	11.89	42.19	48.05	22.98	27.04

Tom Turini, UCCE Fresno

BCTV effects on processing tomato yield

UC WSREC 2015 - 2016



2015-16 combined

Tom Turini, UCCE Fresno

Delta CT% = change in curly top between untreated control and insecticide treated plots. Relative Yield% = yield of treated plots compared to untreated.

Table 2. Verimark treatment results, fresh market tomatoes near Gustine, CA, 2016 (curly top and TSWV).

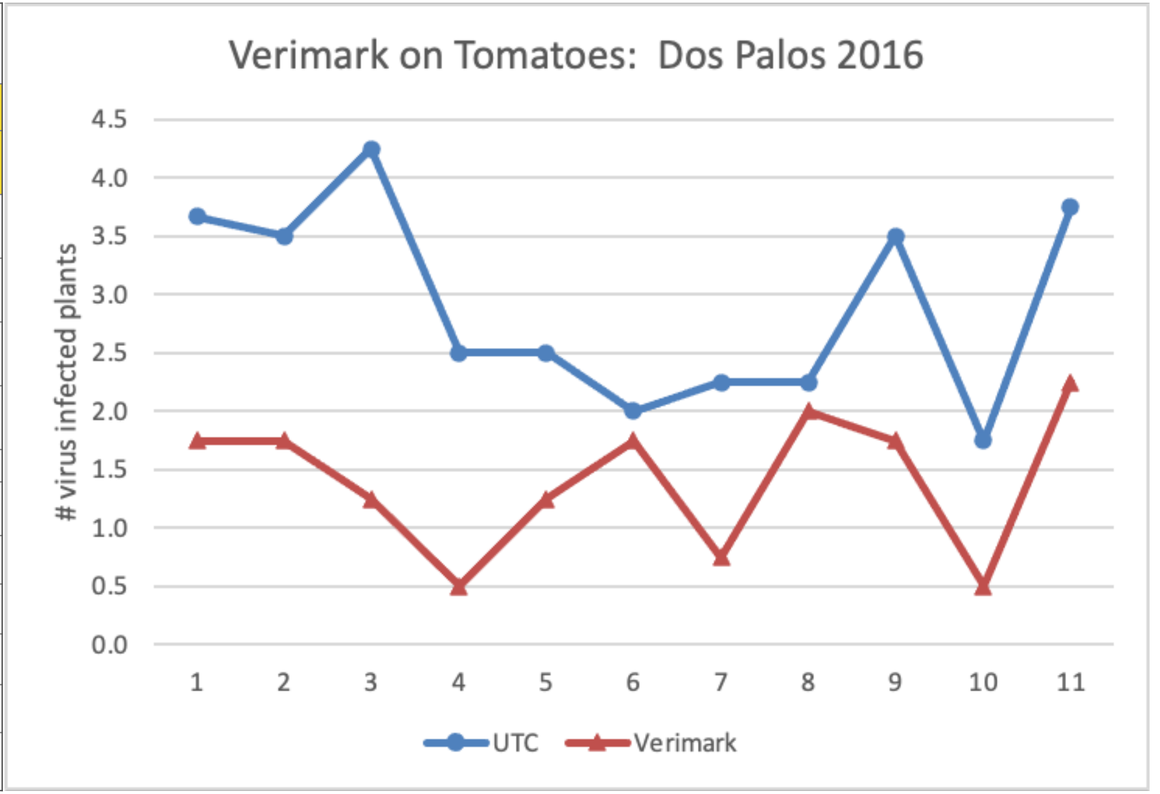
		# virus infected plants/A			% reduction vs		yield
plot	treatment	8/30/16	9/15/16	10/4/16	30-Aug	4-Oct	boxes/A
1	UTC	84.6	---	129.1	---	---	1294
2	Admire + Verimark	5.4	---	54.5	94%	58%	1716
3	Admire 8 oz/A	43.6	100.7	84.4	48%	35%	1516
4	Verimark 13.5 oz/A	19.1	87.1	73.5	77%	43%	1571
	LSD 0.05	35.3	NS	NS			
	CV, %	57.9	80.4	39.6			

LSD 0.05 = least significant difference at the 95% probability level. NS = not significant.

CV% = coefficient of variation

Yield = total marketable yield from commercial harvest crew, in 25-lb boxes/A (not replicated).

Virus infection includes both BCTV and TSWV.



TSWV or BCTV or AMV?

lab diagnostics needed to confirm prior to fruiting

- TSWV: use AgDia quick test, about $5/test.
- AMV: negative TSWV test but dark cortex in stem near base of plant.
- BCTV: negative TSWV test and clear cortex. PCR test ~ 1 week.

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AMV

BCTV

TSWV
on resistant plant

TSWV and BCTV

viruses impacting tomatoes

- TSWV: Vectored by thrips. Manage using resistant varieties and foliar insecticides.
- BCTV: Vectored by leafhoppers. Manage using systemic insecticides through the drip system.

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