Pest Management in Tomatoes

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Biology and Control of:

- Curly Top
- Spotted Wilt
- Powdery Mildew
- Stink Bug

Curly Top Disease in 2013

Curly Top Disease on Melon

Curly Top Disease on Cantaloupe

Curly Top Disease caused by several viruses

- ***Beet mild curly top virus* (BMCTV)**
- ***Beet severe curly top virus* (BSCTV)**
- ***Beet curly top virus* (BCTV) No longer detected in CA**

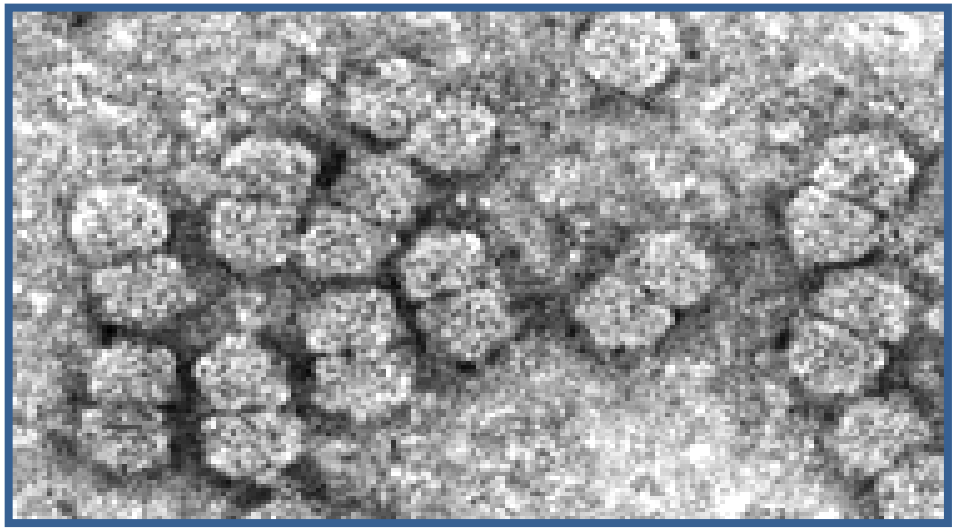
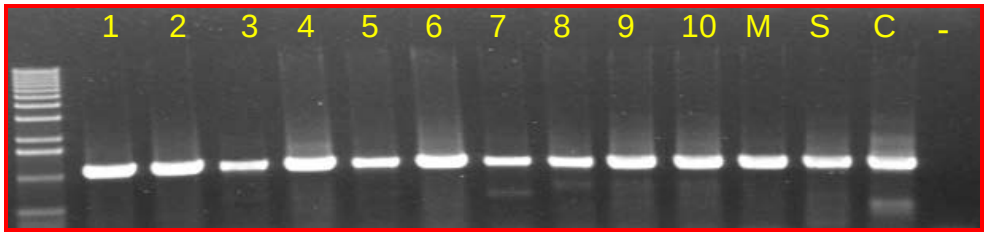


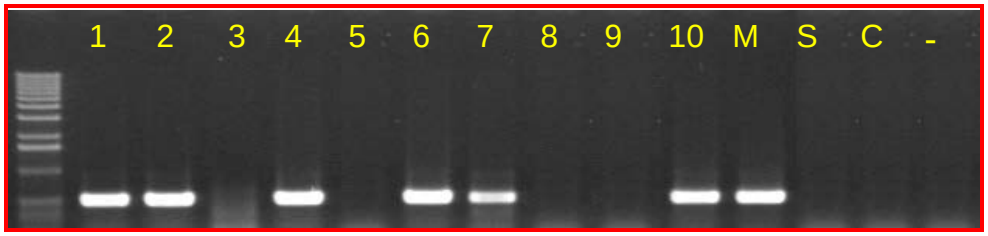
Photo from Gilbertson Presentation 9 May 2013.

PCR is currently the best method for detection of curly top viruses



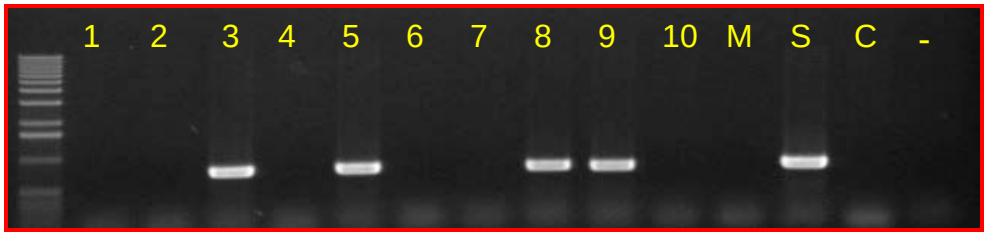
General CTV primers

1.1 kb



BMCTV

0.5 kb



BSCTV

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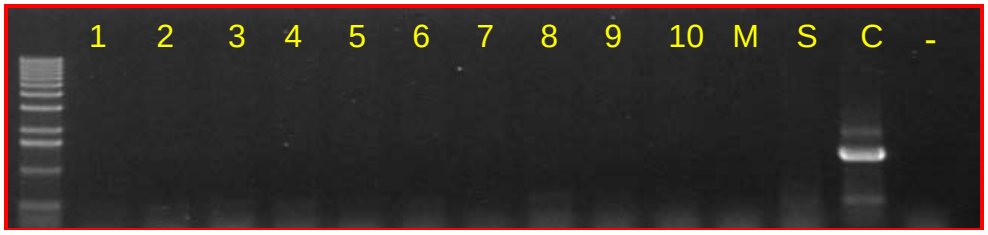


BCTV

0.9 kb

From Gilbertson Presentation 9 May 2013.

Host Range: > 300 species

- Crops: beets, beans, tomatoes, peppers, cucumbers, squash, muskmelon, watermelon, spinach.
- Weeds: filaree, perennial pepperweed, Buckhorn plantain, Russian thistle and mustard species

Bassia spp.

Russian thistle

Goosefoot

Filaree

Peppergrass

Buckhorn plantain

Beet leafhopper

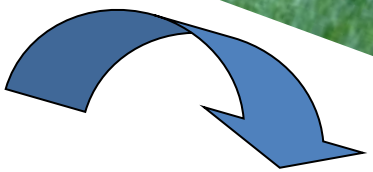
Circulifer tenellus

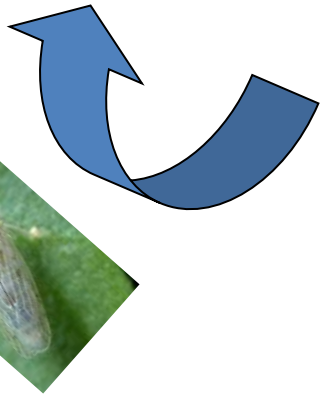
- The only vector of the curly top viruses.
- Four to 5 generations in California
- Strong flier
- Favored by warm dry conditions
- Introduced from the Middle East <100 years ago.
- Tomatoes and melons are not preferred hosts

Photo by Lori Dunning

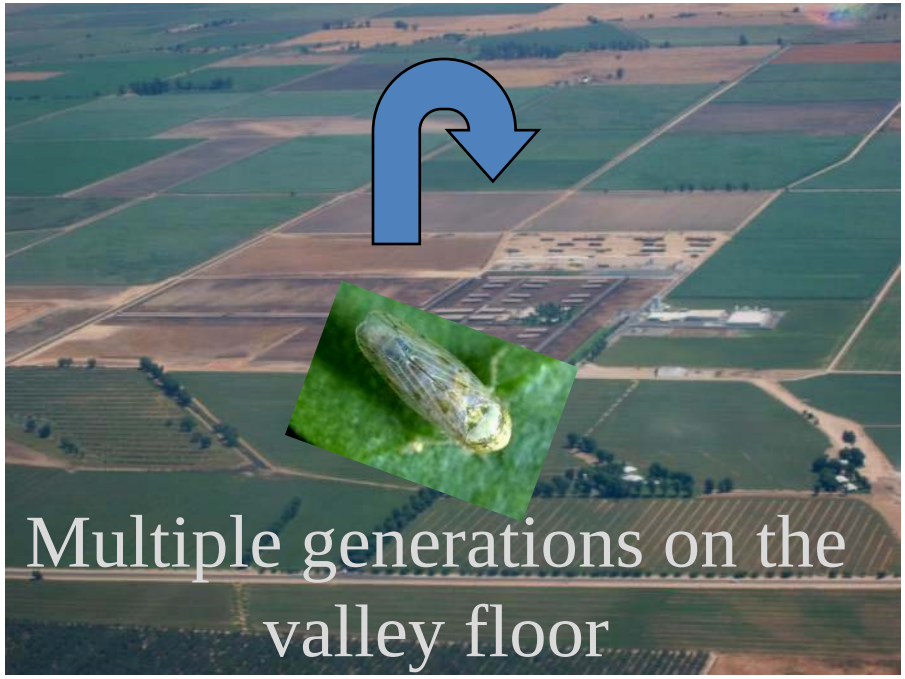
Curly Top Disease Cycle

Spring: adult leafhoppers migration





Fall: adult leafhoppers migrate for overwintering in the foothills



From Gilbertson Presentation 9 May 2013.

Location of Disease and Vector

Geology.com

- Most significant impact of Beet Leafhopper is in the western Fresno, Kings and Kern Counties
- Beet Leafhopper and Curly top virus has been detected in other parts of CA including Sacramento Valley, Salinas and Santa Clara Valleys and other Coastal Regions as well as Imperial Valley

It is possible that there may not need to be reintroduction from the foothills annually. There may be a population that overwinter on the valley floor (Chan et al. 2010 and Creamer et al. 1996).

- Chen et al. 2010. Characterization of curtoviruses associated with curly top disease of tomato in California and monitoring these viruses in beet leafhoppers. Plant Disease 94:99-108
- Creamer et al. 1996. Epidemiology and incidence of Beet Curly Top Geminivirus in naturally infected weed hosts. Plant Disease 80:533-535.

Potential Explanations for Disease Levels in 2013

- Favorable environmental conditions: Dec rain and very dry, windy late-Winter and Spring
  - Very high population densities in early Spring
  - Majority tested had virus in mid-Mar (12/14)
  - Early BLH movement to valley floor
- Plant stress
- Nearly 100% tomatoes are transplanted
- Different strain?

Disease Management Tactics

- Cultural control
- Regulatory control: CDFA Beet Curly Top Control Program
- Treatment of crop

Cultural Control

- Increase planting density
- Sanitation: weed control on roadsides, ditch banks, young orchards and vineyard
- Where possible and needed, treat weeds with insecticide before mowing or disking: If it is during production of susceptible crops.

CDFA Beet Curly Top Virus Control Program

- The objective of the BCTVCP is to reduce the incidence of Curly Top Virus in susceptible crops below a level of economic importance.
- Sampling with sweep nets identified critical areas in Coast Range and on valley floor in response to grower request.
- Treatments are timed to maximize the number of BLH present in targeted areas prior to migration.
  - Aerial treatment over rangeland and foothills
  - Ground rig treatment along ditch banks, roadsides, and fallow fields.

Insecticide Treatment of Crop

- Use with other management tactics
- Under conditions of very high pressure, may not provide commercially acceptable levels of control
- The objective is to reduce the number of times that a leafhopper transmits the virus

Specific pesticides will be mentioned in this presentation. Some are not currently registered.

Current, applicable labels should be read before writing a pesticide recommendation.

Considerations in Insecticide Treatment of Crops

- Use yellow sticky cards to detect the vector
- Drip-applied neonicotinoids for persistent migrations of lower numbers of leafhoppers
- Foliar applications for mass migrations over a short period of time.

Insecticide Treatment of Crop

IRAC #*	Trade name	Common name
1A	Vydate, Seven	Oxamyl, carbaryl
3A	Asana, Baythroid, Danitol, Mustang,	Esfenvalerate, cyfluthrin, fenpopathrin, zeta-cypermethrin
4A	Admire, Assail, Platinum, Venom	Imidacloprid, acetamiprid, thiamethoxam, dinotefuron
4A + 3A	Leverage	imidicloprid + cyfluthrin

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4A + 3A	Leverage	imidicloprid + cyfluthrin

Drip-injected neonicotinoids are an important part of the control program in many situations: If foliar application is needed, use a different mode of action.

More Questions About Curly Top

- How can we predict outbreaks?
- Is tolerance to curly top disease present in current processing tomato varieties?
- Are leafhoppers overwintering on the valley floor and if so, what is the contribution to high disease levels?
- What is the best in-field management strategy?
- Is a different strain contributing to current levels?

Acknowledgements

- Consultants and growers in this vegetable production area
- Robert Gilbertson: UC Davis
- William Wintermantel: USDA ARS Salinas
- CDFA Curly Top Control Board

Symptoms of TSWV on Tomato Fruit

Early TSWV Expression on Tomato Plants

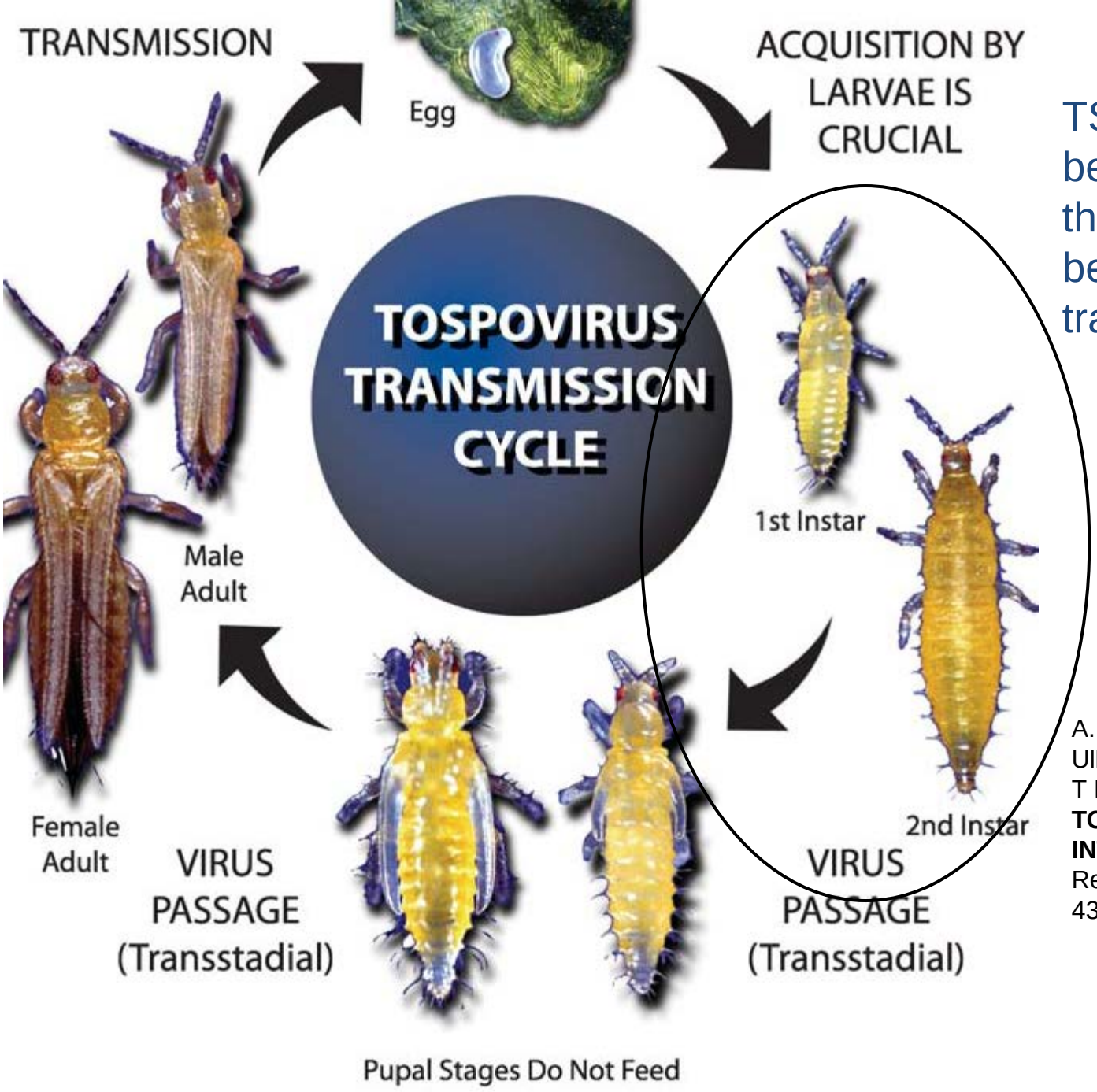
Thrips vectors of TSWV

Frankliniella occidentalis (Western flower thrips)

Primary vector of TSWV in Central California

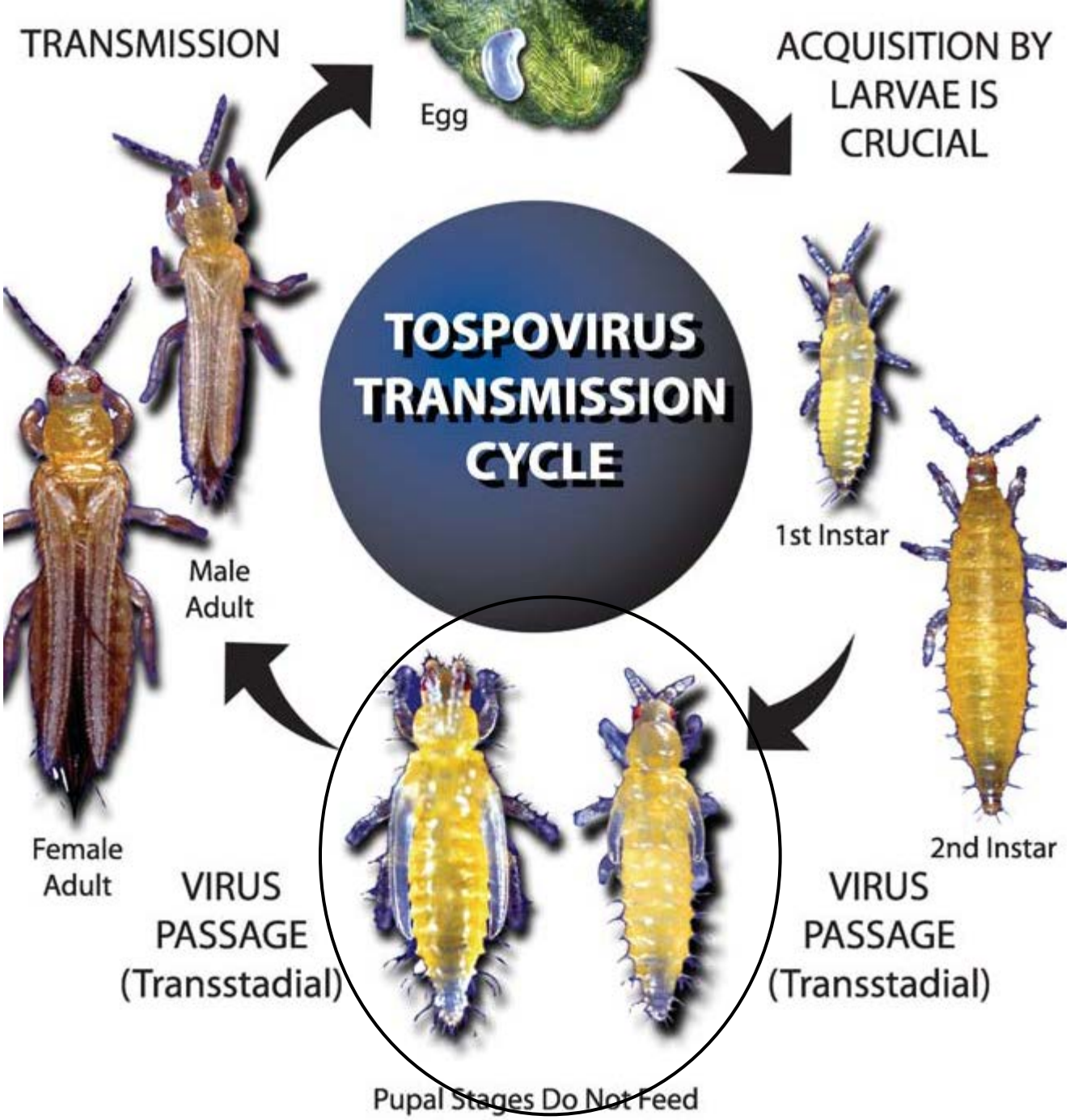
Other spp. known to vector TSWV

- *F. schultzei*
- *F. intonsa*
- *F. fusca*
- *F. bispinosa*
- *Thrips tabaci*
- *T. setosus*
- *F. gemina*
- *T. palmi*

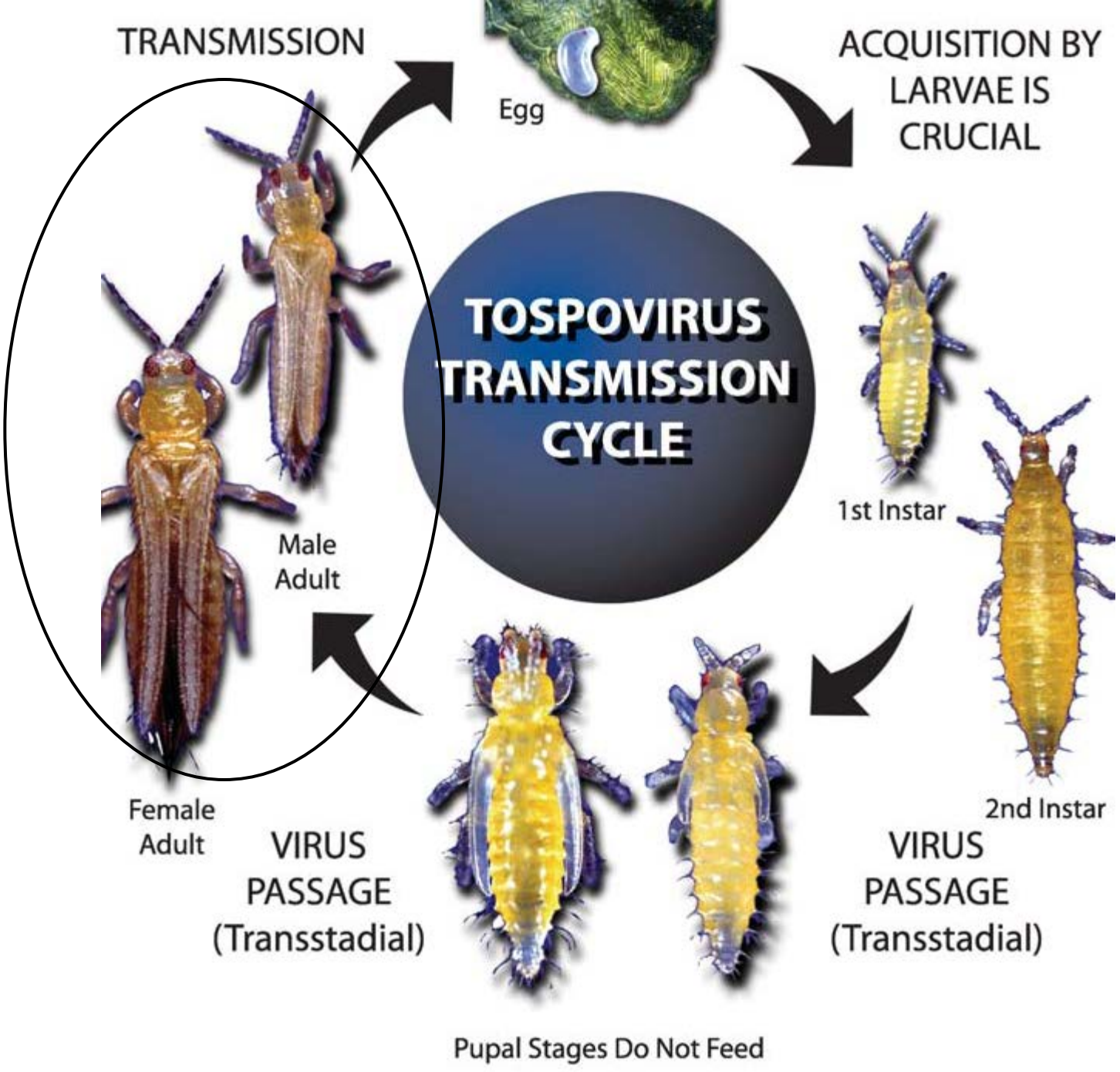


TSWV must be acquired by the larvae to be transmissible.

A. E.Whitfield, D. E. Ullman, and T L. German. 2005. **TOSPOVIRUS-THRIPS INTERACTIONS.** Annu. Rev. Phytopathol. 2005. 43:459–89



Western flower thrips develop through two quiescent, non-feeding pupal stages in the soil



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

Adults can live 30 to 45 days and transmit the viruses to plants throughout their life.

Host Range of TSWV

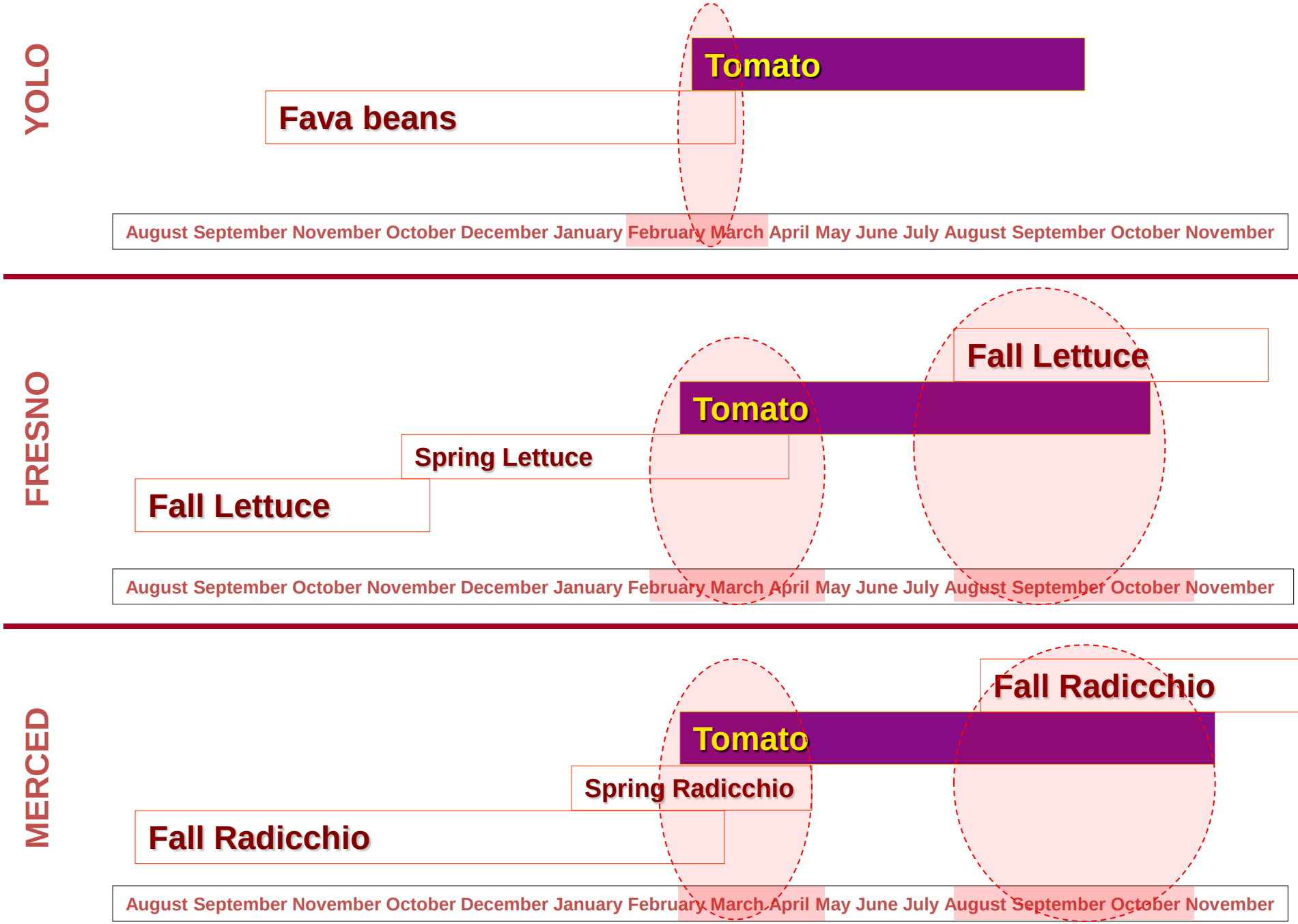
Crop Hosts

- Beans
- Celery
- Lettuce
- Tomato
- Pepper
- Potato
- Eggplant
- Radicchio
- Spinach

Weed Hosts

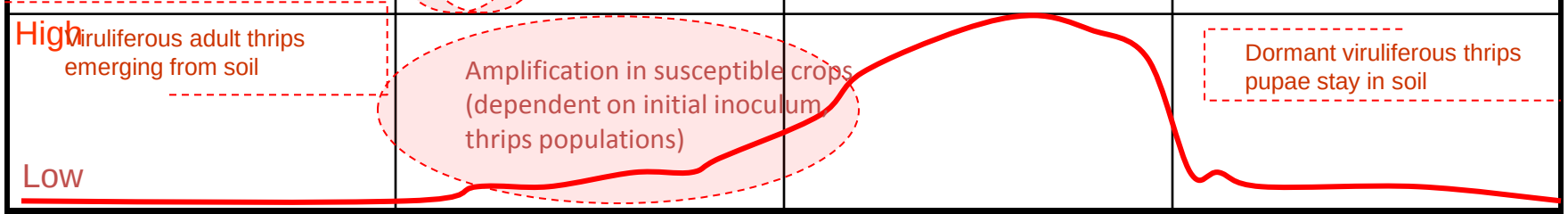
- Prickly lettuce
- Sowthistle
- Malva
- Pineapple weed
- London Rocket
- Field bindweed
- Common sunflower
- Black nightshade
- Jimson weed
- Lambsquarters
- Purslane
- Pigweed
- Russian thistle
- Hairy fleabane


e Points Area Uncultivated Field on 25 Mar
% sowthistle TSWV+)


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 October November 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

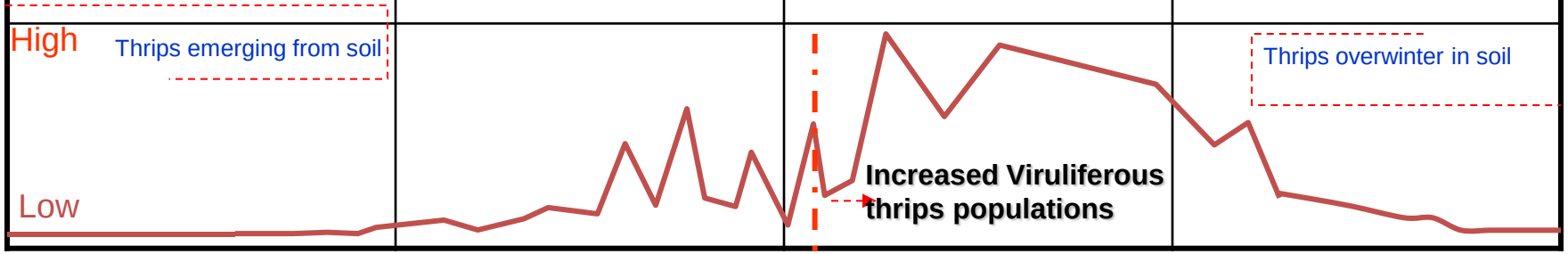
Development of TSWV in Processing Tomato Fields

Winter	Early-Mid Season	Late Season	Fall
TSWV overwinters at low levels in weeds, bridge crops and thrips	Infections with TSWV – low incidences, depending on populations of virus carrying thrips	Potential for higher incidence/epidemics and economic losses in late-planted crops. Late infections may be limited to some shoots.	Persistence in weeds, reservoir hosts, bridge crops (i.e., radicchio and lettuce) and thrips



Western Flower Thrips Population Dynamics in the Central Valley of California

Winter: Thrips overwinter at very low levels	**Spring:** Thrips populations increase	**Summer:** Peak populations	**Fall:** Populations decrease



December January February March April May June July August September October November

From Gilbertson Dec 2012.

Insecticide Efficacy/Programs

- Thrips are difficult to control.
- Resistance to several modes of action have been reported, so insecticide rotation is strongly recommended.

Thrips Efficacy (3-5 days after treatment) 2007-2011

Treatment quantity fp/ acre	Trt	Trt 24 Jul Smpled 28 Jul	Trt 17 Jun '09 Smpled 21 Jun	Trt 16 Jul '10 Smpled 20 Jul	Trt 4 Aug '11 Smpled 9 Aug
Radiant 6.0 fl oz	8.8 c (1)	0.3 bc (3)	0.8 f (1)	0.3 c (1)	7.3 c (3)
Radiant 6.0 fl oz + Prev-Am 1qt					6.0 c (1)
Dimethoate 4 EL 1 pt	9.0 c (2)	0.0 c (1)		2.0 c (3)	
Lannate SP 1 lb	9.2 c (3)	0.5 bc (4)			
HGW86 13.5 fl oz + Brigade			2.3 ef (2)		
Hero 11.2 fl oz			3.5 def (3)	3.7 c (6)	
HGW86 13.5 fl oz				10.0 ab (11)	
HGW86 20.5 fl oz					10.5 bc (5)
Mustang 4.3 fl oz + Beleaf 2.8 oz	9.5 c (4)	0.3 bc (2)			
Athena 17 fl oz + Beleaf 50SG 2.8 oz					7.0 c (2)
Beleaf 2.8 oz			4.0 def (4)	4.3 c (8)	
Surround 25 lbs		0.5 bc (4)	4.0 def (4)	5.0 bc (9)	
Agrimek 12.0 fl oz			6.0 bcd (5)		
Venom 70SG 0.895 lb	14.5 ab (8)	3.3 ab (9)		1.3 c (2)	8.0 c (4)
Assail 30SG 4.0	9.5 abc (5)			5.3 abc (10)	
Success 6.0 fl oz + Ecozin Plus	11.5 abc (6)				
Success 6.0 fl oz	13.3 abc (7)				
Requiem 2 qts					
Venom 70SG 0.895 lb	14.5 ab (8)	3.3 ab (9)		1.3 c (2)	8.0 c (4)
Athena 17 fl oz					12.8 ab (6) c
Leverage 5.1 fl oz		1.3 abc (6)			
Mustang 4.3 fl oz	15.2 abc (10)	1.3 abc			
Movento 5.0 fl oz	16.3 a (11)	2.8 ab (8)			
Microthiol 16.5	16.5 a (12)				
Requiem 3 qts			10.0 ab (8)	4.3 c (7)	
Requiem 2 qts			7.5 a-d (6)		20.3 a (8)
Untreated	14.9 ab (9)	4.3 a (10)	11.0 a (9)	10.7 a (12)	17.0 ab (7)

Treatments Demonstrating Efficacy against Thrips

Treatment quantity fp/ acre	9 Aug, 2011 Nymphs	Trt 24 Jul Smpled 28 Jul	Trt 17 Jun '09 Smpled 21 Jun	Trt 16 Jul '10 Smpled 20 Jul	Trt 4 Aug '11 Smpled 9 Aug
Radiant 6.0 fl oz	8.8 c (1)	0.3 bc (3)	0.8 f (1)	0.3 c (1)	7.3 c (3)
Radiant 6.0 fl oz + Prev-Am 1qt					6.0 c (1)
Dimethoate 4 EL 1 pt	9.0 c (2)	0.0 c (1)		2.0 c (3)	
Lannate SP 1 lb	9.2 c (3)	0.5 bc (4)			
HGW86 13.5 fl oz + Brigade			2.3 ef (2)		
Hero 11.2 fl oz			3.5 def (3)	3.7 c (6)	
HGW86 20.5 fl oz					10.5 bc (5)
Mustang 4.3 fl oz + Beleaf 2.8 oz	9.5 c (4)	0.3 bc (2)			
Athena 17 fl oz + Beleaf 50SG 2.8 oz					7.0 c (2)
Beleaf 2.8 oz			4.0 def (4)	4.3 c (8)	
Surround 25 lbs		0.5 bc (4)	4.0 def (4)	5.0 bc (9)	
Agrimek 12.0 fl oz			6.0 bcd (5)		
Venom 70SG 0.895 lb	14.5 ab (8)	3.3 ab (9)		1.3 c (2)	8.0 c (4)

Based on Insecticide Efficacy Trials in Fresno Co. (2007-12)

Consistent Control

- Radiant
- Lannate
- Dimethoate
- Beleaf (moderate)

Insecticide Modes of Action

Group #	Chemical sub-group	Primary target site of action	Trade name	Active ingredient
1A	Carbamate	Acetylcholine esterase inhibitors	Lannate LV	methomyl
1B	Organophosphate		Dimethoate 4EL	dimethoate
5	Spinosyns	Nicotinic acetylcholine receptor allosteric activators	Radiant Entrust	spinetoram spinosad
9C	Flonicamid	Selective homopteran feeding blockers	Beleaf	flonicamid

From IRAC, 2013

Insecticide Program Evaluations

2009 -12

DRIP INJECTION (Main Plot Treatments): Platinum and/or Platinum and Venom, and an untreated control.

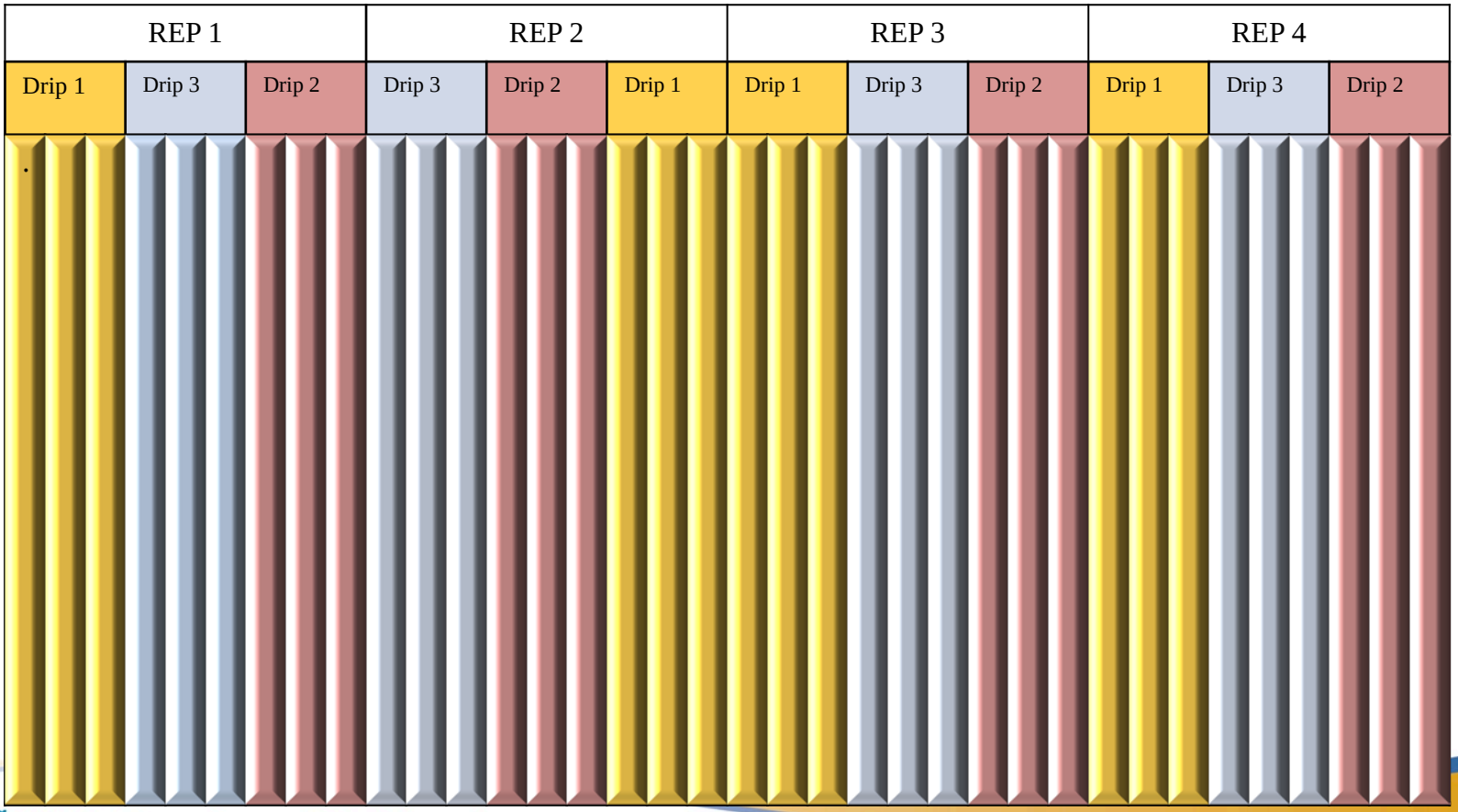
FOLIAR APPLICATIONS (Sub Plot Treatments): Three treatments 2 to 4 applications (cyazypyr transplant drench evaluated from 2010 to 2012) and an untreated control.

Insecticide Program Evaluations

2009 -11

DRIP INJECTION (Main Plot Treatments): Platinum and/or Platinum and Venom, and an untreated

Each drip treatment plot = 3 beds x 300 ft

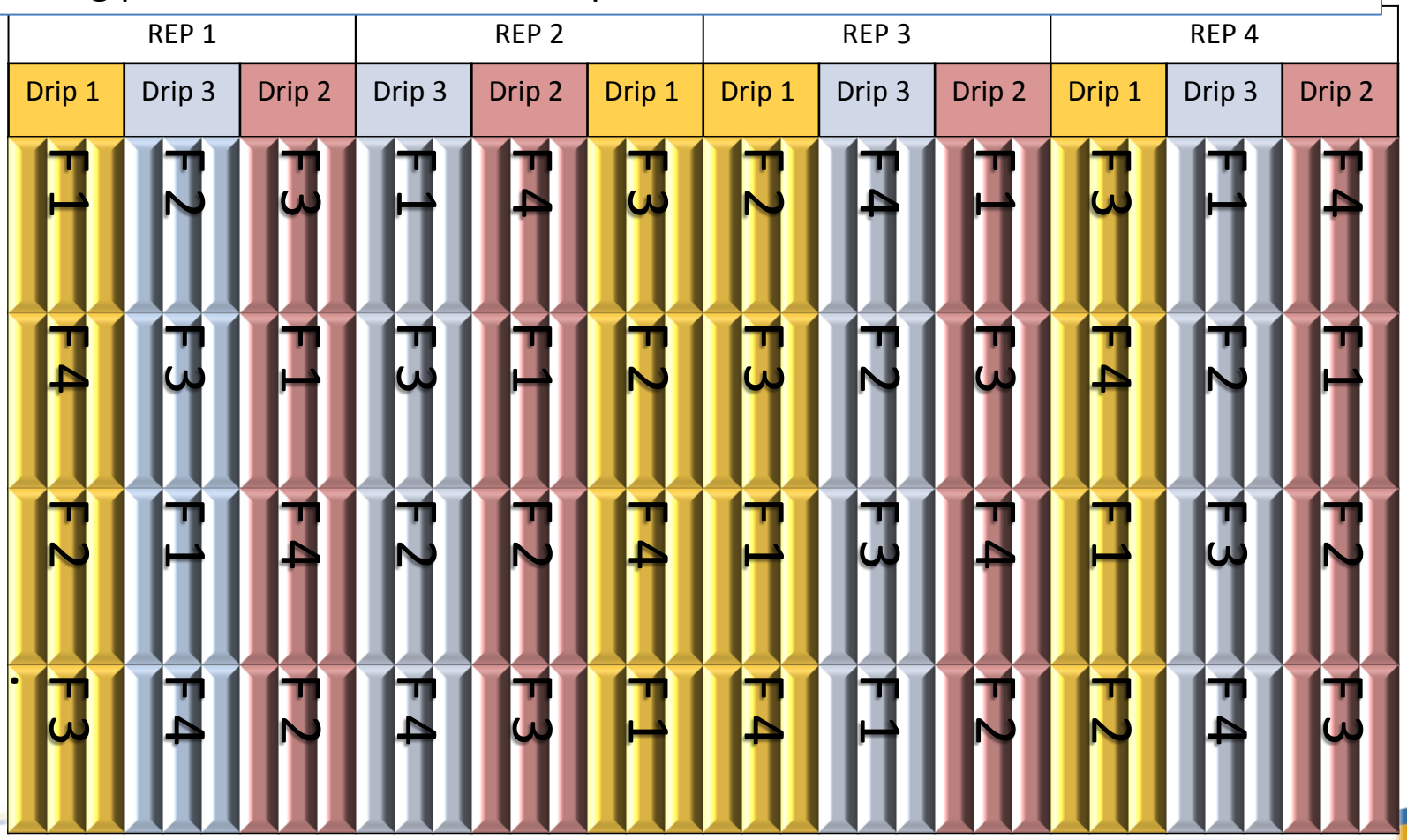


Insecticide Program Evaluations

2009 -11

FOLIAR APPLICATIONS (Sub Plot Treatments): Three treatments 2 to 4 applications and an untreated control.

75 ft-long plots x 3 beds over each drip treatment receive each foliar treatment



2009 Program
Thrips Populations and TSWV

Treatment				Thrips/25 flowers						Plants with TSWV symptoms (%)		
Injections into drip irrigation system buried to 10 in				16 Jun		23 Jun		15 Jul		23 Jun	15 Jul	14 Sep
				nymph	adult	nymph	adult	nymph	adult			
Platinum 11 fl oz (3 Jun)				2.8	76.3 a	2.3	7.6	0.1	8.7	2.3	9.4	28.4
Platinum 11 fl oz (3 Jun), Venom 3.0 fl oz (7 Jul)				1.0	88.5 ab	1.4	8.6	0.3	9.3	1.4	8.9	22.3
Untreated				1.3	110.3 b	1.4	10.3	0.4	8.0	1.4	8.6	24.3
Drip injection, probability				NS	0.035	NS	NS	NS	NS	NS	NS	NS
Foliar applications				Thrips/25 flowers						Plants with TSWV symptoms (%)		
17 Jun	1 Jul	23 Jun	15 Jul	23 Jun		15 Jul				23 Jun	15 Jul	14 Sep
				nymph	adult	nymph	adult					
Radiant 6 fl oz	Dimethoate 4EL 1pt	Lannate WP 1lb	Radiant 6 fl oz	0.1	6.9 b	0.0	6.4 b			1.9	7.1b	23.5 b
Radiant 6 fl oz	Dimethoate 4EL 1pt	Lannate WP 1lb		0.1	5.8 b	0.2	7.7 b			1.1	10.5a	20.3 b
	Dimethoate 4EL 1pt	Lannate WP 1lb	Radiant 6 fl oz	0.3	11.8 b	0.1	8.1 b			2.1	8.8ab	23.1 b
Untreated				0.6	10.7 a	0.3	12.5 a			1.6	9.6ab	33.2 a
Foliar application, probability				NS	0.008	NS	0.014			NS	0.04	0.001

2009 Yield and Quality

Treatment				Yield	fruit character based on 20 lb sample (%)					Fruit quality		
Injections into drip irrigation system buried to 10 in				(tons/ acre)	red	green	rot	sun burn	TSW symp.	color	°brix	pH
Platinum 2SC 11 fl oz (3 Jun)				36.5	42.2	2.2	25.7	26.3	3.7	25.688	4.706	4.624
Platinum 2SC 11 fl oz (3 Jun), Venom 3.0 fl oz (7 Jul)				36.9	45.0	3.8	19.1	27.1	4.9	25.875	4.700	4.602
Untreated				35.8	49.0	3.6	16.0	28.8	2.6	25.813	4.744	4.606
Drip injection, probability				NS	NS	NS	0.02	NS	NS	NS	NS	NS
Foliar applications												
17 Jun	1 Jul	23 Jun	15 Jul									
Radiant 6 fl oz	Dimethoate 4EL 1pt	Lannate WP 1lb	Radiant 6 fl oz	37.6	44.9	2.9	18.1	28.1	6.0	25.667	4.783	4.621
Radiant 6 fl oz	Dimethoate 4EL 1pt	Lannate WP 1lb		37.0	46.1	3.7	18.6	29.4	2.2	26.083	4.675	4.604
	Dimethoate 4EL 1pt	Lannate WP 1lb	Radiant 6 fl oz	36.7	45.9	3.1	20.5	28.1	2.4	26.000	4.692	4.608
Untreated				34.2	44.7	3.1	23.9	24.0	4.3	25.417	4.767	4.610
Foliar application, probability				NS	NS	NS	NS	NS	NS	NS	NS	NS
Drip injection/foliar application interaction, probability				0.05	NS	NS	NS	NS	NS	NS	NS	0.05

NO TREATMENT DIFFERENCES

2010 Program
Thrips Populations and TSWV

Treatment					Thrips/25 flowers				Plants with TSWV symptoms (%)	
Injections into drip irrigation system buried to 10 in					2 Jul		27 Jul		3 Aug	27 Aug
					nymph	adult	nymph	adult		
Platinum75SG 3.67 oz (25 May), Venom 6.0 oz (30 Jun) Actigard (25 May, 8,15,22, 30 Jun, 9, 21 Jul)					2.833	35.500	2.583	32.083	38.131	43.256
Platinum75SG 3.67 oz (25 May), Venom 6.0 oz (30 Jun)					2.417	28.083	2.333	20.833	29.373	36.944
Untreated					1.667	24.583	1.333	21.750	36.876	44.462
Drip injection, probability					NS	NS	NS	NS	NS	NS
Foliar applications					Thrips/25 flowers				Plants with TSWV symptoms (%)	
Trans. drench 29 Apr	9 Jun	23 Jun	7 Jul	16 Jul	2 Jul		27 Jul		3 Aug	27 Aug
					nymph	adult	nymph	adult		
HGW	Radiant 6.0 fl oz	Dimtht 4EL 1pt.			2.778	34.222	2.000	29.333	31.604	39.356
	Radiant 6.0 fl oz	Dimeth 4EL 1pt.			2.111	24.111	2.000	24.556	36.716	38.196
	Radiant 6.0 fl oz	Dimeth 4EL 1pt.	Radiant 6.0 fl oz	Dimeth 4EL 1pt.	1.222	27.111	1.556	22.111	31.444	39.524
Untreated					3.111	32.111	2.778	23.556	39.410	49.141
Foliar application, probability					NS	0.0184	NS	NS	NS	NS

NO TREATMENT DIFFERENCES

2010 Yield and Quality

Treatment Injections into drip irrigation system buried to 10 in	Yield (tons/ acre)	Fruit quality (% by weight)					
		red	grn	rot	Sun burn	B E rot	TSWV
Platinum75SG 3.67 oz (25 Jun), Venom 6.0 oz (30 Jul) Actigard (25 May, 8,15,22, 30 Jun, 9, 21 Jul)	34.8	59.2	14.2	2.0	1.2	2.1	21.3
Platinum75SG 3.67 oz (25 Jun), Venom 6.0 oz (30 Jul)	31.8	59.1	15.8	1.8	1.1	5.0	17.7
Untreated	33.1	57.3	18.9	3.2	0.6	2.4	22.5
Drip injection, probability	NS	NS	NS	NS	NS	NS	NS

Foliar applications					Yield (tons/ acre)	Fruit quality (% by weight)					
Trans. drench 29 Apr	9 Jun	23 Jun	7 Jul	16 Jul		red	grn	rot	Sun burn	B E rot	TSWV
HGW86-435	Radiant 6.0 fl oz	Dimeth 4EL 1pt.			35.1	61.4	16.4	1.3	1.4	2.8	16.7
	Radiant 6.0 fl oz	Dimeth 4EL 1pt.			33.6	57.9	15.1	2.1	0.5	3.3	21.1
	Radiant 6.0 fl oz	Dimeth 4EL 1pt.	Radiant 6.0 fl oz	Dimeth 4EL 1pt.	34.7	60.3	15.6	3.8	0.9	2.6	16.9
Untreated					29.6	54.6	11.5	2.3	1.0	3.3	27.4
Foliar application, probability					NS	NS	NS	NS	NS	NS	NS

2011 Influence of Programs on Yield/Quality

Treatment					Yield (tons/ acre)	Fruit quality (% by weight)					PTAB		
Injections into drip irrigation system buried to 10 in						red	grn	rot	Sun burn	TSWV	color	solids	pH
Platinum75SG 3.7 oz (22 Jun), Venom 6.0 oz (12 Jul)					29.535	55.6	6.3	12.6	5.4	19.6	23.417	5.833	4.560
Platinum75SG 3.67 oz (22 Jun), Venom 6.0 oz (22 Jul)					29.246	61.4	8.1	9.3	3.3	17.9	24.167	5.508	4.453
Untreated					33.878	62.7	7.0	9.1	3.1	18.2	24.167	5.667	4.540
Drip injection, probability					NS	NS	NS	NS	NS	NS	NS	NS	NS
Foliar applications					Yield (tons/ acre)	Fruit quality (% by weight)					PTAB		
Trans-plant drench 17 May	24 Jun	6 Jul	14 Jul	21 Jul		red	grn	rot	Sun burn	TSWV	color	solids	pH
HGW	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	37.958	64.3	7.6	9.5	2.8	15.9	24.111	5.522	4.532
	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	30.368	59.6	9.0	11.0	4.7	15.7	23.444	5.622	4.548
	Radiant 10.0 fl oz	Dimeth 4EL 1pt.			30.248	61.1	7.4	9.5	3.1	18.9	24.444	5.667	4.529
Untreated					24.968	54.6	5.2	11.3	5.1	23.8	23.667	5.862	4.582
LSD p=0.05					4.716	NS	NS	NS	NS	6.193	NS	NS	NS
AB					NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)					15.4	13.8	49.2	55.5	71.8	33.66	4.20	4.61	1.10

2011: Influence of Programs on TSWV Symptom Incidence

Treatment					TSWV %			
Injections into drip irrigation system buried to 10 in					22 Jun	12 Jul	12 Aug	25 Aug
Platinum75SG 3.7 oz (22 Jun), Venom 6.0 oz (12 Jul)					1.967	14.402	51.167	49.989
Platinum75SG 3.67 oz (22 Jun), Venom 6.0 oz (22 Jul)					1.613	12.837	52.918	41.701
Untreated					2.258	12.088	56.805	43.467
LSD, P=0.05					NS	NS	NS	NS
Foliar applications								
Trans. drench	24 Jun	6 Jul	14 Jul	21 Jul	TSWV %			
HGW	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	1.505	9.279	40.239	32.445
	Radiant 10.0 fl oz	Dimeth4EL 1pt.	Radiant 10.0 fl oz	Dimeth 4EL 1pt.	2.200	15.043	48.416	40.346
	Radiant 10.0 fl oz	Dimeth 4EL 1pt.			2.004	14.359	54.859	40.578
Untreated					2.075	13.755	71.006	66.842
LSD, P=0.05					NS	5.184	8.521	7.578
AB					NS	NS	NS	0.0334
CV (%)					91.27	39.93	16.04	16.98

Influence of insecticide programs for control of thrips on incidence of Tomato spotted wilt virus symptomatic plants, Fresno Co., 2012

Treatment[z]						TSWV %[y]			
Injections into drip irrigation system buried to 10 in						6 Jun	20 Jun	18 Jul	23 Aug
Platinum75SG 3.7 oz (7 Jun), Venom 6.0 oz (27 Jun)						0.1	5.4	28.7	19.8
Platinum75SG 3.7 oz (7 Jun) cyazypyr 13.5 oz (27 Jun)						0.1	5.8	14.1	17.9
Untreated						0.2	4.3	21.7	21.2
Probability						NS	NS	NS	NS
Foliar applications						TSWV %			
Trans. drench	12 Jun	22 Jun	29 Jun	9 Jul	18 Jul				
cyazypyr	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	0.3	4.3	13.7	13.2
	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	0.0	5.2	31.9	13.2
	Radiant 10 fl oz	Dimth 4EL 1pt.				0.3	4.5	16.8	18.6
Untreated						0.0	6.6	23.7	33.5
$LSD_{0.05}$						NS	NS	NS	9.4
AB						NS	NS	NS	NS
CV (%)						317.1	67.38	108.6	36.87

Influence of insecticide programs for control of thrips on incidence of Tomato spotted wilt virus symptomatic plants, Fresno Co., 2012

Treatment[z]						TSWV %[y]			
Injections into drip irrigation system buried to 10 in						6 Jun	20 Jun	18 Jul	23 Aug
Platinum75SG 3.7 oz (7 Jun), Venom 6.0 oz (27 Jun)						0.1	5.4	28.7	19.8
Platinum75SG 3.7 oz (7 Jun) cyazypyr 13.5 oz (27 Jun)						0.1	5.8	14.1	17.9
Untreated						0.2	4.3	21.7	21.2
Probability						NS	NS	NS	NS
Foliar applications						TSWV %			
Trans. drench	12 Jun	22 Jun	29 Jun	9 Jul	18 Jul				
cyazypyr	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	0.3	4.3	13.7	13.2
	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	0.0	5.2	31.9	13.2
	Radiant 10 fl oz	Dimth 4EL 1pt.				0.3	4.5	16.8	18.6
Untreated						0.0	6.6	23.7	33.5
$LSD_{0.05}$						NS	NS	NS	9.4
AB						NS	NS	NS	NS
CV (%)						317.1	67.38	108.6	36.87

Influence of insecticide programs for control of thrips on incidence of Tomato spotted wilt virus symptomatic plants, Fresno Co., 2012

Treatment[z]						TSWV %[y]			
Injections into drip irrigation system buried to 10 in						6 Jun	20 Jun	18 Jul	23 Aug
Platinum75SG 3.7 oz (7 Jun), Venom 6.0 oz (27 Jun)						0.1	5.4	28.7	19.8
Platinum75SG 3.7 oz (7 Jun) cyazypyr 13.5 oz (27 Jun)						0.1	5.8	14.1	17.9
Untreated						0.2	4.3	21.7	21.2
Probability						NS	NS	NS	NS
Foliar applications						TSWV %			
Trans. drench	12 Jun	22 Jun	29 Jun	9 Jul	18 Jul				
cyazypyr	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	0.3	4.3	13.7	13.2
	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	0.0	5.2	31.9	13.2
	Radiant 10 fl oz	Dimth 4EL 1pt.				0.3	4.5	16.8	18.6
Untreated						0.0	6.6	23.7	33.5
$LSD_{0.05}$						NS	NS	NS	9.4
AB						NS	NS	NS	NS
CV (%)						317.1	67.38	108.6	36.87

Influence of insecticide programs for control of thrips on incidence of fruit expression of Tomato spotted wilt virus and yield and other quality parameters in Fresno Co., 2012.

Treatment[z]						Yield (tons/ acre)[w]	Fruit quality (% by weight)[y]					PTAB[x]		
Injections into drip irrigation system buried to 10 in							red	grn	rot	sun brn	TSWV	color	solids	pH
Platinum75SG 3.7 oz (7 Jun), Venom 6.0 oz (27 Jun)						29.5	57.1	5.2	28.4	3.6	5.7	21.9	5.34	4.48
Platinum75SG 3.7 oz (7 Jun), cyazypyr 13.5 oz (27 Jun)						26.7	48.3	4.8	33.8	2.2	10.9	22.1	5.30	4.45
Untreated						24.3	47.6	5.9	35.2	3.2	8.1	22.3	5.41	4.45
Drip injection, $LSD_{0.05}$						2.46	NS	NS	NS	NS	NS	NS	NS	NS
Foliar applications						Yield (tons/ acre)	Fruit quality (% by weight)					PTAB		
Trans. drench	12 Jun	22 Jun	29 Jun	9 Jul	18 Jul		red	grn	rot	Sun brn	TSWV	color	solids	pH
cyazypyr	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	29.0	54.9	5.9	31.5	2.3	5.3	22.3	5.38	4.45
	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	28.3	54.7	5.8	27.9	3.4	8.2	21.8	5.26	4.44
	Radiant 10 fl oz	Dimth 4EL 1pt.				26.6	51.1	4.3	33.0	2.8	8.6	21.8	5.43	4.47
Untreated						23.0	43.1	5.2	37.5	3.4	10.9	22.6	5.34	4.48
$LSD_{0.05}$						3.07	NS	NS	NS	NS	NS	NS	NS	NS
AB						0.03	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)						13.7	22.7	40.6	28.3	58.9	52.7	4.8	6.43	1.30

Foliar applications showed promise as a component of a program, but the drip applied materials did not.

Influence of Variety on Disease

- Processing and fresh market varieties are available with single gene resistance (SW5)
- Varietal response to TSWV were compared from 2007-12 in 13 trials.
- Based on results from a minimum of 3 trials per variety, a ranking of levels of susceptibility was created.

Tomato cultivar	Direct seeded 8 Mar, rated 3 Aug 2007			Transplanted 16 Apr, rated 18 Aug 2008			Transplanted 13 May, rated 16 Sep 2008			Direct Seeded 13 May, rated 23 Sep 2008			Transplanted 22 May, rated 21 Sep 2009			Transplanted 16 Apr, rated 3 Jun 2010			Transplanted 20 May, rated 3 Jul 2010			Transplanted 22 Apr, rated 9 Sep 2010			Transplanted 17 May, rated 23 Aug 2011		
PX 002*[z]													0.0	e[y]	(16)												
AB0311*																									0.0	e	(12)
AB 8058*	0.3	f	(08)	0.0	e	(13)	0.5	f	(13)	0.3	e	(13)															
AB5508*																									0.8	e	(11)
H 5608*																0.0	c	(14)	0.6	e	(13)	0.0	f	(12)			
N 6394*																0.0	c	(14)	0.0	e	(14)	6.9	f	(10)	2.5	e	(10)
N 6385*																0.6	bc	(12)	0.0	e	(14)	2.7	f	(11)			
HMX 7883													18.2	d	(15)												
SUN 6368	6.5	c-e	(06)	2.7	de	(12)	5.3	d-f	(11)	2.0	de	(12)													29.4	b-d	(06)
H 5508																0.6	bc	(12)	0.0	e	(14)						
HMX 5893	4.3	ef	(07)																								
N 6390													24.7	a-d	(11)												
UG 19406																0.7	bc	(11)	1.8	cde	(11)				18.8	cd	(09)
UG 4305				8.7	c	(05)	3.0	ef	(12)	3.0	d	(09)															
H 4007				7.7	c	(06)	10.0	b-d	(09)	2.8	de	(10)	25.8	a-d	(10)	2.7	bc	(07)	0.9	de	(12)	26.5	e	(09)			
H 2005	13.3	ab	(02)	4.3	c-e	(11)	7.8	c-e	(10)	3.0	d	(08)															
H3402																									20.8	cd	(08)
HMX9905																									30.9	bc	(05)
PX 1723				7.3	c	(08)	11.5	a-d	(08)	3.8	cd	(06)															
BQ 205																1.3	bc	(10)	2.3	b-e	(08)				27.4	b-d	(07)
H 9780	6.5	c-e	(06)	7.0	c-	(09)	12.8	a-c	(06)	2.8	de	(11)	20.4	cd	(13)	3.8	ab	(03)	4.7	ab	(02)	33.6	de	(07)	37.6	b	(02)
HMX 7885													34.5	ab	(04)	0.0	c	(14)	1.9	b-e	(10)	50.2	bc	(04)			
CXD 255													30.2	a-d	(07)	2.0	bc	(09)	3.8	a-c	(06)	32.1	de	(08)			
BQ 163																2.7	bc	(07)	1.9	b-e	(09)						
H 2506	7.0	c-e	(05)																								
HMX 6903													29.2	a-d	(08)												
AB 2	7.0	c-e	(05)	6.0	cd	(10)	13.3	a-c	(05)	3.8	cd	(07)	27.6	a-d	(09)	3.2	bc	(05)	3.9	a-c	(04)	74.3	a	(01)			
SUN 6366													18.5	d	(14)	3.9	ab	(02)	3.9	a-c	(05)	37.4	bc	(04)			
CXD 282													31.8	a-c	(05)	3.1	bc	(06)	3.5	a-d	(07)	46.0	b-d	(05)			
NDM 5578				13.3	b	(04)	12.0	a-c	(07)	4.5	cd	(04)															
PX 650													30.5	a-d	(06)												
RD SPRING	11.5	bc	(03)																								
NUN 672				14.0	b	(03)	15.0	ab	(03)	4.3	cd	(05)															
H 2601	9.8	bcd	(04)	7.3	c	(07)	17.2	a	(01)	8.0	b	(02)	35.8	ab	(03)												
AB 3													25.1	b-d	(12)	7.3	a	(01)	5.3	a-c	(01)	60.4	ab	(02)	53.4	a	(01)
H 8504													36.4	ab	(02)	3.4	bc	(04)	4.2	a-c	(03)	56.7	b	(03)			
HM 6898				18.7	a	(02)	13.8	a-c	(04)	6.0	bc	(03)	37.7	a	(01)												
H 7709																									33.4	b	(04)
H 8004	18.0	a	(01)	20.3	a	(01)	16.0	ab	(02)	11.3	a	(01)													35.2	b	(03)

Genetic resistance (SW5)		Low		Variable or Medium		High	
AB 8058	paste	BQ 163	paste, peel	H 2005	multi use	H 8004	multi use
H 5608	paste	H 2206	multi use	SUN 6366	multi use	BOS 602	multi use
N 6394	multi use	UG19406	multi use	H 1015	early multi	H 8504	paste
H 5508	paste	SUN 6368	peel, solids	NDM 5578	multi use	HM 6898	multi use
H 5608	multi use	H 4007	multi use	CXD 282	multi use	H 2601	pear
N 6385	peel, solids	K 2769	----------	AB 2	multi use	AB 3	multi use
UG 15908	peel	H 3044	multi use	H 9780	multi use	NUN 672	viscosity
		N 6397	multi use	K 2770	----------	APT410	multiuse
		UG 15308	peel	CXD 255	multi use		
		BQ 205	multi use	HMX 7885	pear		
		UG 4305	multi use	PX 1723	dice, peel		

Development of a risk assessment index for thrips and TSWV in processing tomato fields

- Point values assigned based upon TSWV losses based on growing conditions
- Factors considered include:
  - Variety
  - Planting date
  - Insecticide program
  - Thrips populations
  - Proximity to TSWV-susceptible crops
  - TSWV history in the growing area

Modified from R. L. Gilbertson, 2012

Monitored Fields 2012

		TSWV %	Risk Index
	Northern Counties		
RO	Winters, Yolo	0	120
BF	County Line, Colusa	7	160
AO	County Line, Colusa	0	80
PR	Dixon, Solano	2	115
EG	Robin,Sutter	12	160
YL	Yolo Town,Yolo	7	165
	Merced County		
PT	Rogers Rd, Paterson	2	145
GC	Gun Club Rd, Gustine	1	150
FM	Fentem Rd, Gustine	2	135
BC	Bert Crane Rd, Merced	0	120
DF	Dickenson Ferry Rd, Merced	0	140
LG	Le Grand Rd, Merced (Fresh Market)	0.5	135
BH	Buchanan Hallow Rd, Merced (Fresh Market)	0.5	110
	Fresno County		
North	Firebough area	7	165
Oakland	Five Points area	12	155
Mt.Whitney	Five Points area	0	145
Tranquility	Tranquility area	2	150
Nees	Firebough area	14	160
Harris	Five Points area	0.5	105
	Kings County		
Tomato #1	Lassen Ave between Phelps and Jayne	2	105
Tomato #2	Laurel Ave at Avenal Cutoff	0.3	110
Tomato #3	Nevada Ave & Kent	2	110
Tomato #4	El Dorado Ave near Dorris	5	115
Tomato #5	Lassen Ave & Tornado	7	145

Less than or equal to 95

Low

Greater than 100 or equal to 150

Moderate

Greater than 150

High

From R. L. Gilbertson, 2012

IPM for thrips and TSWV

Before planting

- **Varietal selection**
- **Plant TSWV resistant varieties (with *Sw*-5 gene) especially in hot-spot areas or late-planted fields Varieties without the *Sw-5* gene vary in susceptibility**
- **Plant TSWV- and thrips-free transplants**

From R. L. Gilbertson, 2012

IPM for thrips and TSWV

During the season

- **Field placement** (avoid planting near established fields of susceptible crops with confirmed TSWV infection)
- **Monitor fields for thrips** (yellow sticky cards) and TSWV
- **Manage thrips with insecticides** at early stages of crop development when thrips populations begin to increase
- **Rotate insecticides** to minimize development of insecticide resistance in thrips
- **Removal of TSWV-infected plants** early (seedling infection) and when percent infection is low (<5%)
- **Weed control in and around fields**

From R. L. Gilbertson, 2012

Integrated TSWV Management

After harvest

-Promptly remove and destroy plants after harvest

-Avoid 'bridge' crops that are TSWV/thrips reservoirs and overlap with tomato/pepper (e.g., radicchio, lettuce, fava bean)

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

From R. L. Gilbertson, 2012

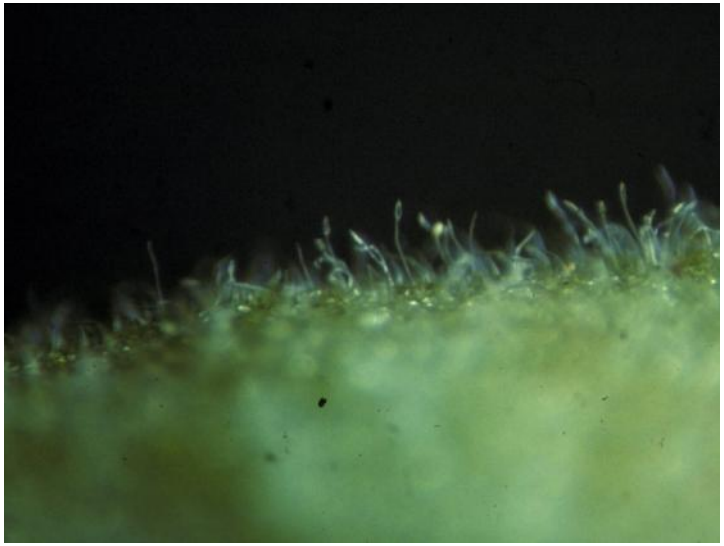
TSWV Team

- **UC Davis**
  - Ozgur Batuman
  - Li-Fang Chen
  - Neil McRoberts
  - Diane Ullman
  - Robert Gilbertson
  - Thrips counters
- **UCCE**
  - Michelle LeStrange
  - Gene Miyao
  - Scott Stoddard
  - Tom Turini

- **California Tomato Research Institute (CTRI)**

- **California processing tomato growers and PCAs**

Tomato Powdery Mildew
Leveillula taurica (Oidiopsis sicula)



Background

- Environmental conditions:
  - wide range of temperatures
  - favored by high relative humidity
- No immunity in tomato varieties
- Managed with fungicide programs

Fungicide Resistance Details

FRAC Code	Group Name	Trade Names (common names)	Resistance Potential
3	DeMethylation Inhibitors (DMI)	***Mettle*** *(tetraconazole),* ***Rally*** *(myclobutanil)*	Medium
7	Succinate dehydrogenase inhibitor (SDHI)	***Endura*** *(boscalid)* ***Fontelis*** *(penthiopyrad)*	Medium
11	Quinone outside Inhibitors (Q_oI) or Strobilurins	***Cabrio*** *(pyraclostrobin),* ***Quadris*** *(azoxystrobin),*	High
13	Quinolines	**Quintec** (quinoxyfen)	Medium
F6	Microbial	**Sonata** (Bacillus pumilus); **Taegro** (B. subtilis);	Low
M2	Inorganic – Sulfur	*Various*	Low
M5	Chloronitriles (pthalonitriles)	*Various (chlorothanlonil)*	Low
U6	Phenylacetamid	**Torino** (cyflufenamid)	Manage resistance
U8	Aryl-phenyl-ketone	**Vivando** (metrafenone)	Medium

FRAC: Fungicide Resistance Action Committee

Pre-Packaged Mixtures

FRAC Codes	Group Name	Trade Names (common names)	Resistance Potential
11 and 7	Quinone outside Inhibitors (Q_oI) + Succinate dehydrogenase inhibitor (SDHI)	**Priaxor** (pyraclostrobin + fluxapyroxad), **Luna Sensation** (trifloxystrobin + fluopyram), **Pristine** (pyraclostrobin + boscalid)	High + Medium
11 and 3	Q_oI + DeMethylation Inhibitors (DMI)	**Quadris Top** (azoxystrobin + difenoconazole)	High + Medium

FRAC: Fungicide Resistance Action Committee

2009 Treatments (22, 31 Jul, 12 and 21 Aug)	**Foliage with powdery mildew (%)**				**Necrosis rating**			
	22 Aug		1 Sep		25 Aug		2 Sep	
Luna Sensation 7.6 fl oz+Dyne-Amic (D)	5.3	c	13.3	b	1.5	ef	2.0	c
Quadris Top 8 fl oz + D	5.8	c	18.5	b	1.3	f	1.8	c
Quadris Top 8 l oz + D (1,3) Bravo Weather Stik 2.75 pt (2,4)	15.0	c	21.8	b	2.8	cde	3.3	c
Torino 3.4 oz + D	11.0	c	22.5	b	1.3	f	2.0	c
Vivando 15 fl oz + Widespread Max 0.03%	17.0	c	45.8	a	2.0	def	3.3	c
Cabrio 16 oz + D (1,3) Rally 4 oz/A + D (2,4)	34.3	b	49.8	a	3.3	bcd	5.0	b
Cabrio 16 oz + Franchise 0.25% (1,3) Rally at 4 oz + Widespread Max 0.03 % (2,4)	38.0	b	53.8	a	4.0	bc	6.5	ab
Flint 3.0 oz + D	39.8	b	60.5	a	3.8	bcd	5.5	b
Cabrio 16 oz + Franchise 0.13% (1,3)[u] Rally at 4 oz/A + Widespread Max 0.03% (2, 4)	33.8	b	61.8	a	3.5	bcd	5.0	b
Regalia at 0.5% + Cabrio 8 oz + D	42.3	b	62.5	a	3.5	bcd	5.8	b
Regalia 0.5% + Rally 2.5 oz + D	37.3	b	63.0	a	3.7	bc	5.8	ab
Microthiol 10.0 lb	50.5	ab	65.0	a	2.8	bcde	6.3	ab
Regalia 1.0% + D	59.0	ab	67.5	a	4.8	ab	7.8	ab
Bravo Weather Stik 2.75 pt	59.0	ab	70.3	a	4.8	ab	7.3	ab
Untreated Control	70.3	ab	74.3	a	6.0	a	8.8	a


Hand harvest of 15 ft x 66 in bed on
9 Sep 2009

Fungicide Efficacy, Yield and Quality

FIVE POINTS-AREA TRIAL	FRUIT YIELD AND QUALITY				
Fungicides	Marketable yield (tons)	Sunburn (%)	PTAB color	Soluble solids (°Bx)	pH
Quadris Top 8 fl oz + Dyne-Amic 0.25%	41.3	6.1	27.8	4.8	4.378
Quadris Top 8 fl oz + Dyne-Amic 0.25% (1,3) alt. Bravo Weather Stick 2.75 pt (2,4)	33.7	13.7	32.0	4.7	4.368
Cabrio 16 oz+DyneAmic 0.25% (1,3) Rally 4 oz+ DyneAmic 0.25% (2,4)	30.8	11.5	32.0	4.9	4.415
Cabrio 16 oz+Franchise 0.13% (1,3) Rally 4 oz Widespread Max 0.03 (2,4)	27.9	22.1	33.5	4.6	4.385
Cabrio 16 oz+Franchise 0.25% (1,3) Rally 4 oz Widespread Max 0.03 (2,4)	27.0	17.4	30.3	4.6	4.428
Nontreated control	22.1	29.6	29.8	4.3	4.467
LSD 5%	6.2	11.8	NS	0.6	0.090
% CV	14.9	47.0	11.37	8.4	2.63

Yield reduction of 46%

FIVE POINTS-AREA TRIAL		2009					
		Foliage affected by mildew (%) 2-Sept				Necrosis rating 4-Sept	
Treatments	Applications	basal		terminal			
Quadris/Rally, 7 day interval, 6-26 to 8/27	10	31.0	c	13.8	c	1.5	c
Quadris/Rally, 7 day, late, 7/30 to 8/27 -	5	38.0	c	15.0	c	2.0	bc
Sulfur 7 day, 7/2 to 8/13	7	13.8	e	17.8	c	1.0	c
Quadris/Rally, 14 day interval, 7/2 to 8/27	5	50.3	b	28.3	bc	3.3	b
Quadris/Rally, 7 day, early, 7/2 to 8/6	6	26.5	d	49.3	b	2.8	b
Nontreated control	0	96.3	a	86.8	a	7.5	a
LSD 5%		11.8		19.8		1.2	
CV (%)		18.4		37.5		27.0	

Mechanical harvest of 75 ft x 66 in bed on 19 Sep

FIVE POINTS-AREA TRIAL				FRUIT YIELD AND QUALITY						
Fungicides	Spray interval	Spray dates	Applications	Yield (tons)		Sunburn (%)	PTAB color	Soluble solids (°Bx)		pH
Sulfur dust	7	7/2 to 8/13	7	34.0	a	17.3	25.3	5.38	a	4.51
Quadris alt. Rally: early start	7	7/2 to 8/6	6	31.0	ab	21.8	29.5	4.43	c	4.47
Quadris alt. Rally	7	6/26 to 8/27	10	29.7	abc	25.2	27.8	4.68	bc	4.51
Quadris alt. Rally: late start	7	7/30 to 8/27	5	26.3	bcd	21.7	30.3	4.88	b	4.46
Quadris alt. Rally	14	7/2 to 8/5	5	23.6	cd	18.7	27.5	4.23	cd	4.51
Nontreated control		none	0	22.3	d	25.2	28.0	4.00	d	4.57
			LSD 5%	6.2		NS	2.5	0.34		0.08
			% CV	14.9		27.59	5.93	4.95		1.13

Yield reduction of 34%

2010 Treatments, 2, 17 and 31 Aug 2010	**Foliage with powdery mildew (%)**		
	13 Aug	30 Aug	14 Sep
Luna Sensation 7.6 fl oz + Dyne-Amic 0.125%	0.50	1.25	3.25
Quintec 6.0 fl oz + Wetcit 0.25%	1.25	3.50	4.00
Quadris 6.2 fl oz + D 0.125%	0.75	1.50	4.25
Quintec 6.0 fl oz + D 0.125%	1.50	2.25	5.75
Quadris Top 8 fl oz + Actigard 0.75 oz + D 0.125%	0.75	1.00	6.25
BAS 703 8.2 fl oz + D 0.125%	1.75	2.50	6.75
Torino 3.4 fl oz + D 0.125%	1.00	1.75	7.50
Quadris Top 8 fl oz + Dyne-Amic 0.125%	1.00	1.75	7.75
Quadris Top 8 fl oz + Wetcit 0.25%	0.50	3.50	14.00
Sonata ASO at 4 quarts/A + D 0.125%	4.75	13.25	15.25
Fontellis16 fl oz + D 0.125%	2.25	5.25	15.75
Fontellis 24 fl oz + D 0.125%	3.50	10.25	17.25
BAS 639 14 fl oz + D 0.125%	1.00	6.25	18.75
BAS 500 7F 12.3 fl oz + D 0.125%	1.50	5.50	19.25
Cabrio 16 oz + D 0.125%	3.25	3.50	21.00
Untreated Control	8.00	15.50	23.25
Rally4.0 oz + Induce 0.25 %	4.00	11.25	25.00
LSD	2.84	4.79	10.41
CV (%)	91.07	63.8	57.92

2011

Treatments	Disease severity rating (0-10)[y]					
	30-Aug	7-Sep		14-Sep	
Quadris Top 8 fl oz	0.23	0.25	ab	0.18	e
Quintec at 4 floz	0.10	0.15	b	0.23	de
Priaxor 8 oz	0.10	0.25	ab	0.23	de
Torino SC 3.4 fl oz	0.13	0.23	ab	0.23	cde
Luna Sensation 7.6 fl oz	0.15	0.20	ab	0.25	cde
Priaxor 8 oz alt. w/ Vivando 15 fl oz + Silglow 0.05%	0.30	0.33	ab	0.35	bcde
Vivando 15 fl oz + Silglow 0.05 %	0.20	0.40	ab	0.53	bcde
Bravo Top 1.5 pt	0.33	0.53	ab	0.60	abcde
Mettle 8 oz	0.28	0.73	ab	0.90	abcd
Fontelis LEM SC 24 fl oz *without surfactant*	0.58	0.80	ab	0.93	abc
Bravo Top 2 pt	0.65	0.93	ab	1.00	abc
Bravo Top 1.5 pt *without surfactant*	0.53	0.58	ab	1.05	abc
Fontelis LEM SC 24 fl oz	0.85	1.08	ab	1.18	ab
Sonata ASO at 4 quarts	0.75	0.88	ab	1.38	a
Untreated Control	0.68	1.05	a	1.38	a

2012, Comparison of Conventional Fungicides

Treatments (24 Jul, 3 and 14 and 30 Aug)	**Disease severity rating (0-10)[y]**
	6 Sep
Quintec 12 fl oz	0.10
Quintec 6 fl oz	0.33
Quintec 4 fl oz	0.48
Fontelis 1.67SC 1.0 pt/acre (1,3) Quadris Top 8 fl oz + NIS 0.25% v/v (2,4)	0.75
Quadris Top 8 fl oz	1.03
Luna Sensation 5 fl oz	1.45
Torino 3.4 fl oz	1.50
Picoxy 2.08 SC 24 fl oz	1.55
Picoxy 2.08 SC 12 fl oz	1.63
BAS 700 04F 4.5 fl oz/acre + NIS 0.062%	2.08
Mettle at 8 fl oz	2.60
Priaxor 8 fl oz +NIS 0.062%	2.65
Mettle at 4 fl oz	2.70
Torino NO SURFACTANT	2.85
Mettle at 6 fl oz	2.88
Untreated Control	5.25
$LSD_{0.05}$[x]	1.31
CV (%)	49.30

2012 Comparison of Bio-Fungicides in a Conventional Program

Treatments 27 Jul, 7 and 20 Aug, and 4 Sep	**Disease severity rating (0-10)[y]**
	14 Sep
Quintec 4.0 fl oz	0.44
Quintec 4.0 fl oz (2,3)	0.68
Regalia 2 qts (1); Quadris Top 8 ounces + Regalia 1qt (2,3)	0.85
Regalia 2qts (1) Regalia 1qt+Quintec 4 fl oz (2,3)	1.08
Fontelis 1.67SC 1.0 pt (1,3) Quintec 4 fl oz (2,4)	1.10
Quadris Top 8 fl oz (1,3)	1.49
Taegro 5.2 oz (1,3) Quadris Top 8 fl oz (2,4)	2.18
Quadris Top 8 fl oz (1,3) Taegro 5.2 oz (2,4)	2.23
Quadris Top 8 fl oz (2,4)	2.33
Microthiol Dispress 20 lbs(1), Sonata 4 qts (2-4)	2.58
Quadris Top 8 fl oz (1,3) Sonata 4 qts (2,4)	2.60
Sonata 4 qts (1-4)	6.00
Taegro 5.2 oz (1-4)	6.10
Control	6.73
$LSD_{0.05}$[x]	1.46
CV (%)	**39.14**

Fungicide Comparison 2013

Treatments 25 Jul, 5, 16 and 30 Aug	**Disease severity rating (0-10)**[y]		
	14 Aug	3 Sep	13 Sep
Quintec 4 fl oz	0.78	1.53	3.70
Quintec 12 fl oz	0.73	1.48	3.78
Quintec 6 fl oz	0.75	0.85	4.03
Priaxor 6 fl oz	0.78	2.15	4.18
Priaxor 8 fl oz	0.38	1.95	4.20
Quadris Top 8 fl oz	0.38	1.38	4.50
Luna Sensation 4 fl oz + Sonata 2.0 qts (1), Sonata 3qts (2) Luna Sensation 4.0 oz+ Sonata 2.0 qts (3), Sonata 3 qts (4)[x]	0.75	1.98	4.55
A13703N 8 fl oz	0.43	1.88	4.58
Luna Sensation 5 fl oz (1,3)	0.80	1.70	4.65
A19334A 8.5 fl oz	1.00	2.03	4.71
Quadris Top 8 fl oz (1,3)	0.77	2.80	4.80
A19334A 13 fl oz	0.60	1.68	5.18
Fontelis 1.67SC 1.0 pt (1,3) Quadris Top 8 fl oz (2,4)	1.05	2.40	5.30
Quadris Top 8 fl oz (1), Taegro 5.2 oz (2), Quadris Top 8 fl oz + Taegro 5.2 oz (3), Taegro 5.2 oz (4)	0.73	2.75	5.33
Luna Sensation 5 fl oz (1), Sonata 3qts (2) Luna Sensation 4.0 oz+ Sonata 2.0 qts (3), Sonata 3 qts (4)	0.88	3.08	5.40
Vivando (BAS 56003) 15 fl oz	1.18	4.05	5.70
Gem 3 oz (1), Sonata 3 qts (2), Gem 2 oz+Sonata 2qts (3),Sonata 3qts (4)	1.00	3.23	5.93
Untreated Control	1.83	6.28	7.10
$LSD_{0.05}$[w]	0.408	1.053	1.395
CV (%)	34.98	30.96	20.20

Powdery mildew fungicides

- Sulfur dust (or wettable sulfur)
- Quadris Top (3 + 11)
- Quadris (11), Cabrio (11)
- Biofungicides (Sonata, Regalia, Taegro & others)
- Rally (3)
- Priaxor (7 + 11)
- Fontelis (7)
- Quintec (13)
- Luna Sensation (7 +11)
- Torino (U6)
- Vivando (U8) Not registered
- Mettle, Rhyme, Indar (3)

Acknowledgements

- California Tomato Research Institute (CTRI)
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- West Side Research and Extension Center
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- Michelle Le Strange: Kings/Tulare Farm Advisor
- Gene Miyao: Yolo Co. Farm Advisor
- Scott Stoddard: Madera/Merced Farm Advisor

Consperse Stink Bug in Fresno County

Consperse stink bug: ***Euschistus conspersus***

Stink Bug Species Reported in CA

- Consperse stink bug: *Euschistus conspersus*
- Redshouldered stink bug: *Thyanta pallidovirens*
- Say's stink bug complex: *Chlorochroa sayi* and *Chlorochroa uhleri*
- Southern green stink bug: *Nezara viridula*

<u>Recently reported in CA</u>

- Brown marmorated stink bug *(Halyomorpha halys)*

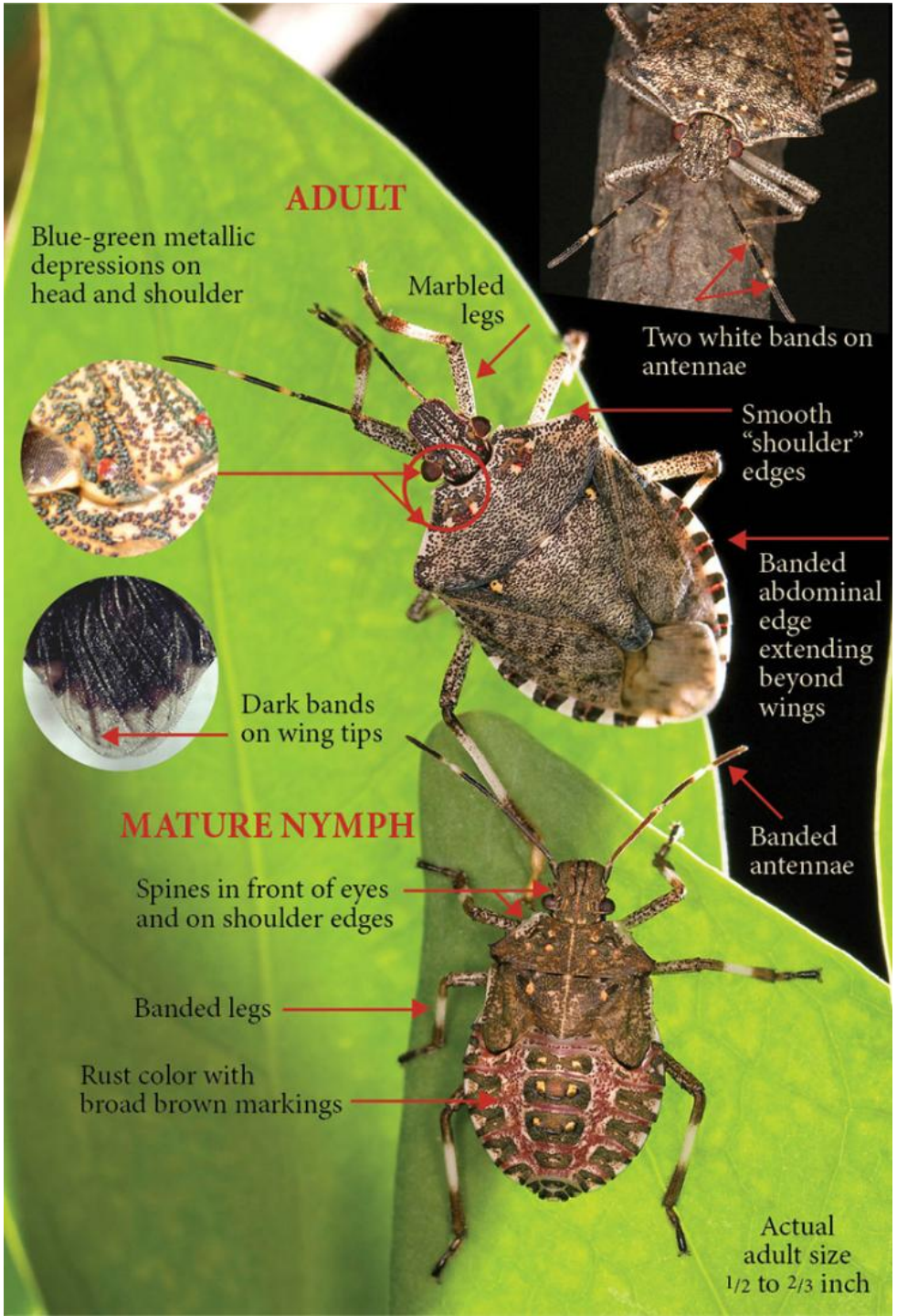
Say's stink bug complex: *Chlorochroa sayi* and *Chlorochroa uhleri*

Redshouldered stink bug: *Thyanta pallidovirens*

Consperse stink bug: *Euschistus conspersus*

Southern green stink bug: *Nezara viridula*

Brown marmorated stink bug (BMSB), *Halyomorpha halys*



Life cycle

- Overwinter as adults on the ground under leaves, in orchards, legume crops, or on certain weeds such as Russian thistle, mustards, and little mallow (cheeseweed).
- In March or April, they move from the overwintering site mate and ley eggs
- There are multiple generations per year dependent upon temperatures

Current Management and Detection Methods Used were Not Adequate in Many Fields

- All fields damaged had been treated
- However, the UC recommended monitoring methods are not being used.

Why did Populations and Damage Increase?

- Changes in insecticides used
- Increase in permanent crops which may serve as overwintering sites
- Mild winters
- Different species?

The Following Recommendations are Adapted UCIPM

http://www.ipm.ucdavis.edu/PMG/r783300211.html

Pheromone Traps

- To monitor consperse stink bug activity and distribution in a field
- Place double-cone traps baited with an aggregation pheromone in fields at flowering.
- Pheromones are not commercially available for the other species.

Model for Consperse Stink Bug

- For prediction of nymphal emergence, which is the stage most susceptible to control by any available pesticide.
- Calculate degree-days from the date adult stink bugs are first captured in pheromone traps.

http://www.ipm.ucdavis.edu/calludt.cgi/DDMODEL?MODEL=CSB&CROP=tomatoes

Stink Bug Monitoring

- Take samples beginning when fruit reach one inch in diameter.
- Sample with a beating sheet or tray, and also examine the soil under the beating.
- Vine shaking method: Search for stink bug under vines or shake plant over 16-inch cafeteria-style tray.

Number Sampled to Damage

Stink bug numbers detected to fruit damage is one-third to one-half of a stink bug per tray shake on average will result in about 5% damaged fruit.

Treatment Decision

Treatment is more likely to be necessary in fields committed to solid-pack or dice canning. Treatment may be necessary in processing tomatoes for paste if yeast or fungal pathogens introduced by the bugs cause damage.

California Tomato Research Institute Funded Project Initiated in 2014

- Documentation of overwintering sites and seasonal population densities
- Demonstrate use of pheromone traps for early detection and refine use for management decisions
- Assess efficacy of insecticides and insecticide rotations against Consperse stink bug

Insecticides with Acitivity Against Stink Bug

> 80% control (adults and nymphs)	
Beta cyfluthrin	Baythroid
Permethrin	Ambush, Pounce and others
Lambda-cyhalothrin + thiamethoxam	Warrior II + Actara
Bifenthrin	Brigade, Bifenture, Capture, and others
Dimethoate	Dimethoate
Dinotefuron	Venom
> 60% control (adults and nymphs)	
Beta-cyfluthrin + imidacloprid	Leverage
Lambda-cyhalothrin	Warrior II
Thiamethoxam	Actara
Clothianidin	Belay
Methomyl	Lannate
< 50% control of adults and > 80% control of nymphs	
S-cypermethrin	Hero, Mustang Max

From Frank Zalom (UC Davis Entomology)

Insecticide

IRAC #*	Trade name	Common name
28	Coragen	chlorantraniliprole
3A	Danitol	fenpopathrin
1B	Dibrom 8E	Naled
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam
7C	Knack	pryproxyfen
4A + 3A	Leverage	imidicloprid + cyfluthrin
15	Rimon	novaluron
4A	Venom	dinotefuran
3A + 28	Voliam Xpress	lambda-cyhalothrin + chlorantraniliprole
3A	Warrior II	lambda-cyhalothrin

* IRAC# refers to mode of action as assigned by the Insecticide Resistance Action Committee

Programs to be Evaluated

Treatment
Injections into drip irrigation system buried to 10 in
Platinum75SG 3.7 oz (14 to 21 days post plant), Venom 6.0 oz (21 days after first application)
Platinum75SG 3.7 oz (1st detection of stink bug), Venom 6.0 oz (22 Jul)
Untreated

Foliar applications		
First trapping detection or observation of feeding damage	When detected at 1 stink bug/3 plants	If needed: When detected at 1 stink bug/3 plants
	Dibrom 8E 1.0 pts	Leverage 2.7 3.75 oz
	Leverage 2.7 3.75 oz	Dibrom 8E 1.0 pts
Leverage 2.7 3.75 oz	Lannate	Leverage 2.7 3.75 oz
Untreated		

Vegetable Crops Research Update
8:30 through 12:00 pm - Friday, February 14, 2014
UC West Side Research and Extension Center

8:00	**Registration**
8:35	**Irrigation and salinity in processing tomatoes: Research results**
	Tom Turini
8:55	**Update on herbicide carryover studies**
	Kurt Hembree-UCCE, Fresno County
9:25	**Bagrada bug**
	Surendra Dara-UCCE, San Luis Obispo and Santa Barbara Counties
10:10	**Recent research in nematode control**
	Joe Nunez-UCCE, Kern County
10:40	**Beet curly top virus program status: Recent developments**
	Jennifer Willems-CDFA, Fresno
11:00	**Curly top virus biology and management**
	Robert Gilbertson-UC Davis, Dept. Plant Pathology
12:00	**Adjourn**

Questions?

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