TSWV Control Update

Tom Turini

UC Farm Advisor, Fresno

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • *HEALTHY* ENVIRONMENTS • *HEALTHY* COMMUNITIES • *HEALTHY* CALIFORNIANS

Overview

- Diagnosis
- Recent Research
  - Sources of TSWV Inoculum
  - Thrips control
  - Varieties
- Considerations in TSWV Management

Symptoms of TSWV on Tomato Fruit

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS

Early TSWV Expression on Tomato Plants

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Infection of Young Plants = Greater Damages

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS

Potentially Confusing TSWV Symptoms

Beet curly top virus

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Alfalfa mosaic virus

Tomato necrotic spot virus

Immunostrips available from AgDia (www.agdia.com) or EnviroLogix (www.envirologix.com)

Potential Sources of TSWV in Early Season Tomatoes

- Weeds
- Winter vegetable crops
- Permanent crops (NO EVIDENCE: 5 seasons)
- Thrips emerging from pupae (NO EVIDENCE: 1 season of research)
- Transplants (NO EVIDENCE in monitored green houses, 3-5/year for 5 years).

Weed Hosts of TSWV

Five Points Area Uncultivated Field on 22 Apr 09
(2% sowthistle and 7% prickly lettuce TSWV+)

Very few questionably symptomatic plants tested have TSWV

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

Crop Hosts of TSWV

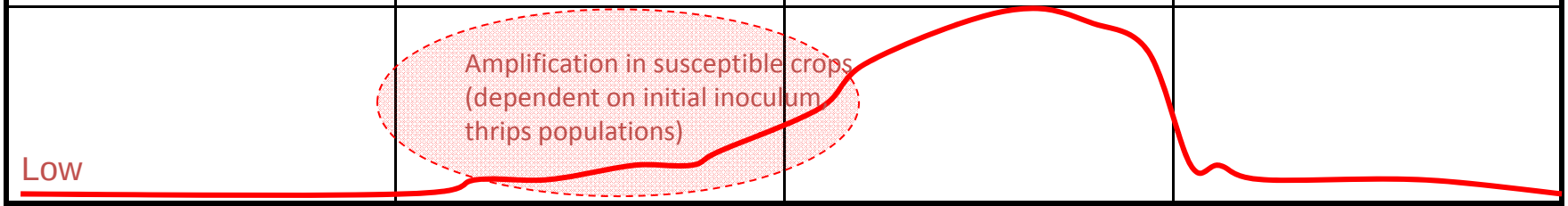
Very few questionably symptomatic plants tested have TSWV

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

From Gilbertson presentation 2011

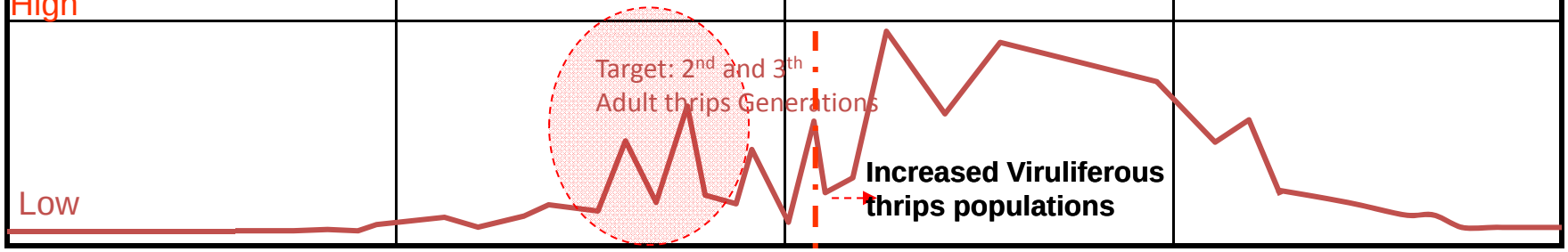
Development of TSWV in Processing Tomato Fields

Winter	Early-Mid Season	Late Season	Off Season
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)



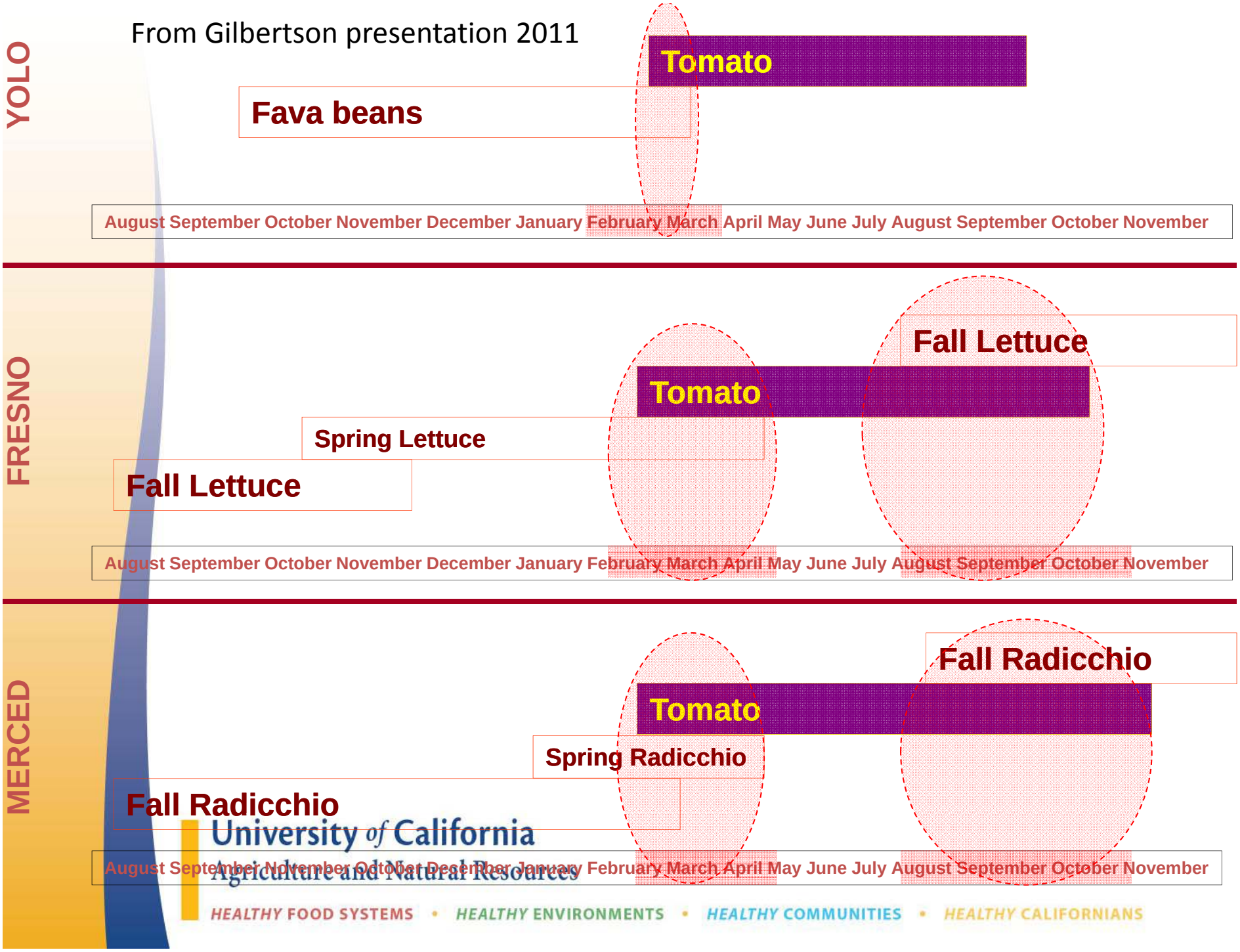
Western Flower Thrips Population Dynamics in the Central Valley of California

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 presentation 2011



University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

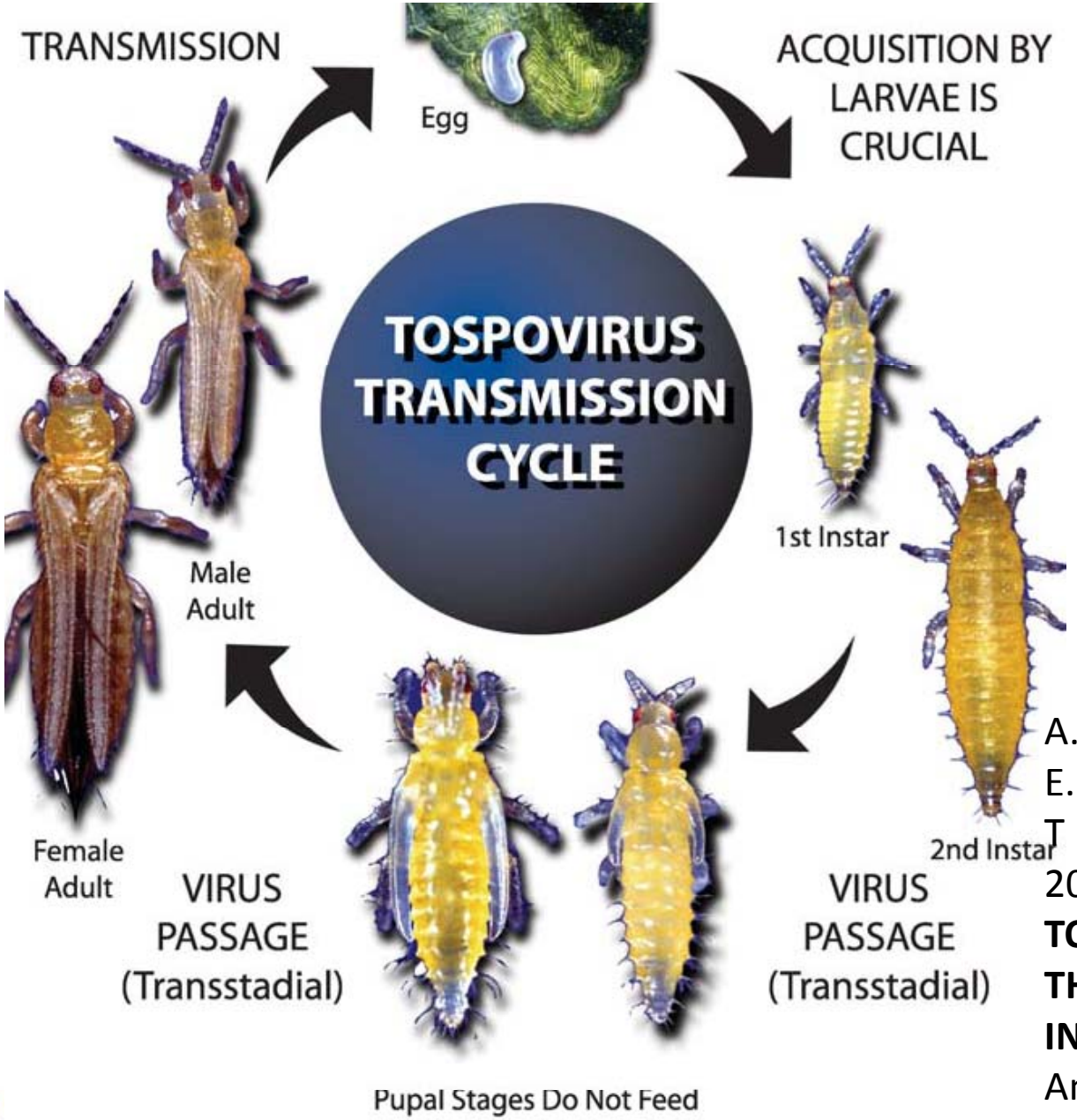
Thrips vectors of TSWV

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*



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

From Gilbertson presentation 2011

Western flower thrips transmission comparison FRESNO vs. YOLO

	Fresno		Yolo	
Experiment	**Male**	**Female**	**Male**	**Female**
I	5/9	3/11	-	-
II	3/10	4/10	5/10	4/10
III	9/10	7/10	0/10	1/10
IV	1/10	1/11	1/7	2/11
V	3/11	0/9	1/8	0/6
Subtotal	**21/50 (42%)**	**15/51 (29%)**	**7/35 (20%)**	**7/37 (19%)**
Total	**36/101 (36%)**		**14/72 (19%)**	

Conclusions

- **Male adult thrips tend to transmit TSWV more efficiently than female adult thrips for the Fresno population**
- **The overall transmission efficiency of Fresno thrips (36%) was greater than for Yolo thrips (19%)**
- **This may explain, at least in part, why there is less TSWV in Yolo County even though thrips populations are higher than in Fresno County**

Insecticide Efficacy/Programs Fresno County

- Not all materials appearing in this study are currently registered.
- 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 25 Jul Sampled30 July	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 abc (6)
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)

Effective Insecticides

- Radiant
- Beleaf
- Lannate
- Dimethoate
- Agrimek (1/1)
- Venom (2/4)

Insecticide Program Evaluations

2009 -11

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

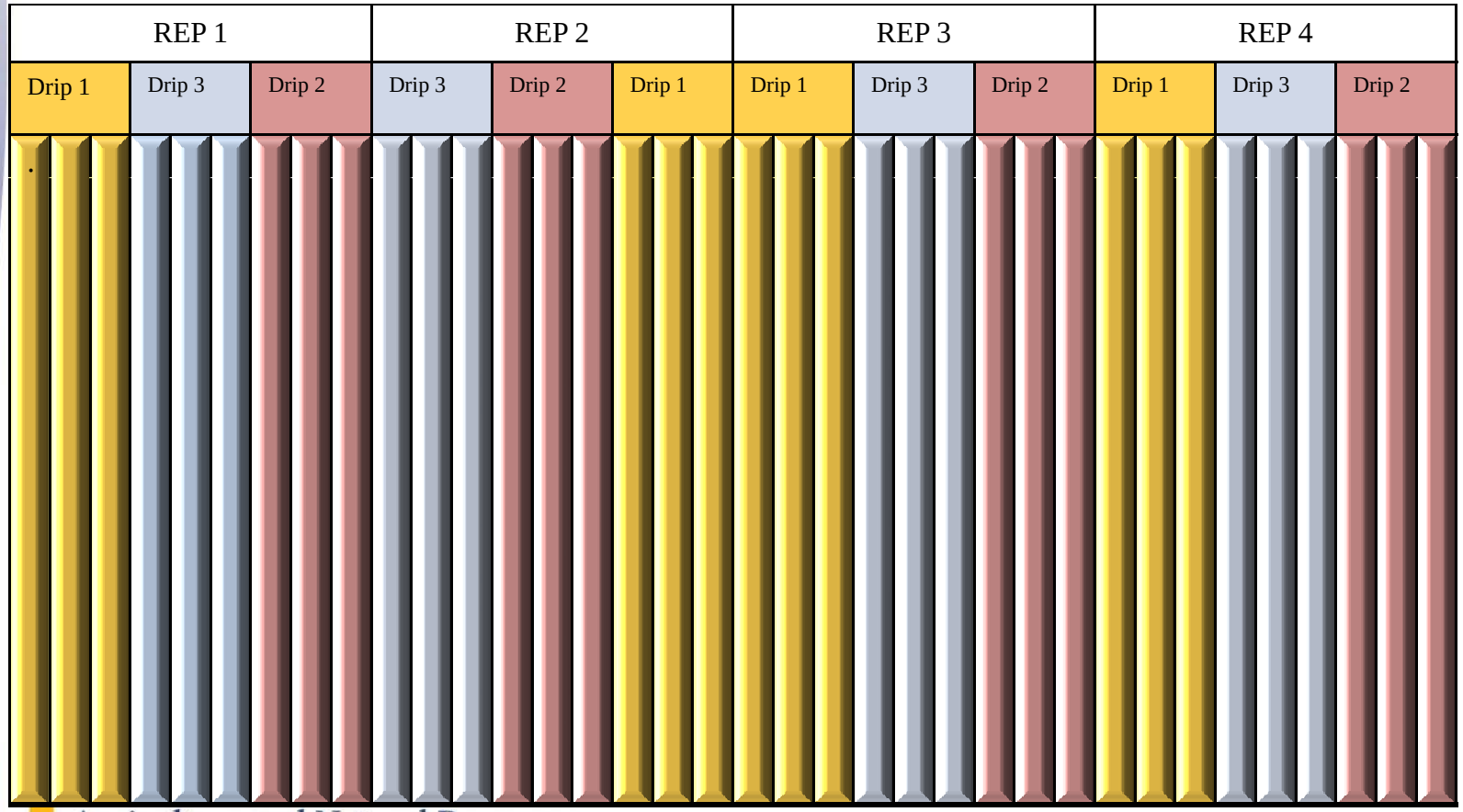
FOLIAR APPLICATIONS (Sub Plot Treatments): Three treatments 2 to 4 applications (HGW86-435 transplant drench evaluated in 2010&11) and an untreated control.

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

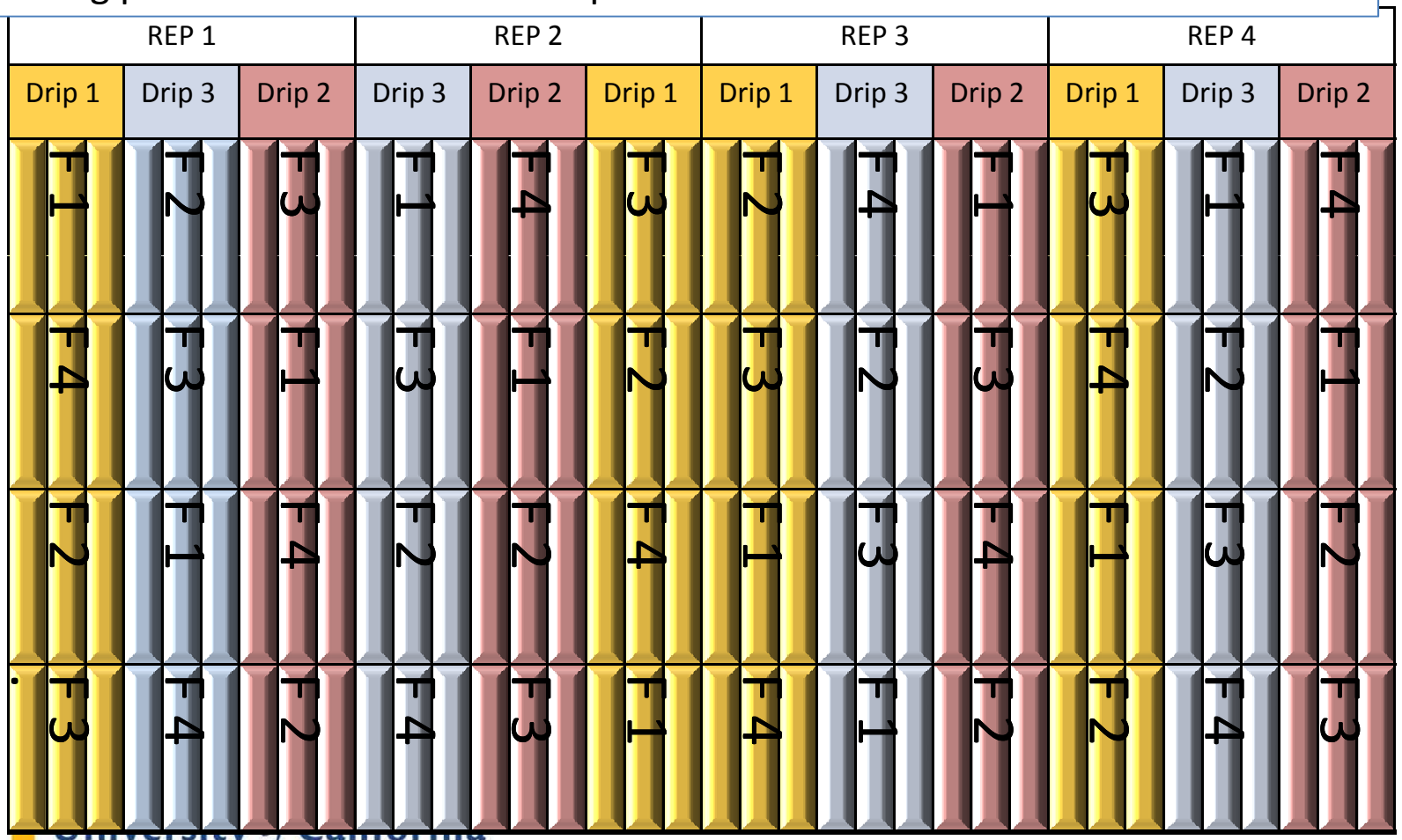


Insecticide Program Evaluations

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

University of California
Agriculture and Natural Resources
HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

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 11 fl oz (3 Jun)				36.5	42.2	2.2	25.7	26.3	3.7	25.688	4.706	4.624
Platinum 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					Yield (tons/ acre)	Fruit quality (% by weight)					
Injections into drip irrigation system buried to 10 in						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 thrips and TSWV Symptom Incidence

Treatment[z]					Thrips densities (thrips/25 flowers)						TSWV %[y]			
Injections into drip irrigation system buried to 10 in					23 Jun		18 Jul		28 Jul		22 Jun	12 Jul	12 Aug	25 Aug
					nymph	adult	nymph	adult	nymph	adult				
Platinum75SG 3.7 oz (22 Jun), Venom 6.0 oz (12 Jul)					6.75	56.75	8.69	17.25	6.44	23.06	2.0	14.4	51.2	50.0
Platinum75SG 3.67 oz (22 Jun), Venom 6.0 oz (22 Jul)					------	--------	11.75	19.88	8.00	23.06	1.6	12.8	52.9	41.7
Untreated					4.38	54.13	7.38	19.63	10.00	22.13	2.3	12.1	56.8	43.5
LSD, P=0.05					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Foliar applications					Thrips densities (thrips/25 flowers)						TSWV %			
Trans. drench	24 Jun	6 Jul	14 Jul	21 Jul										
HGW	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	4.63	53.63	4.17	10.83	7.58	22.08	1.5	9.3	40.2	32.4
	Radiant 10 fl oz	Dimth 4EL 1pt.	Radiant 10 fl oz	Dimth 4EL 1pt.	------	------	3.92	12.58	9.00	22.75	2.2	15.0	48.4	40.3
	Radiant 10 fl oz	Dimth 4EL 1pt.			------	------	12.08	22.42	8.08	22.25	2.0	14.4	54.9	40.6
Untreated					6.50	57.25	16.92	29.83	7.92	23.92	2.1	13.8	71.0	66.8
LSD, P=0.05					NS	NS	4.092	7.105	NS	NS	NS	5.2	8.5	7.6
AB					NS	NS	0.01	NS	NS	NS	NS	NS	NS	0.033
CV (%)					37.33	27.07	52.69	44.84	43.76	39.65	91.27	39.93	16.04	16.98

Observations/Status

- Foliar applications have reduced TSWV incidence in replicated trials.
- Drip applied materials have not
- It is likely that movement of large numbers of TSWV carrying thrips from outside of the trial greatly influenced results in 2010.

Influence of Variety on Disease

- Processing and fresh market varieties are available with single gene resistance (SW5)
- In processing tomato variety comparisons, TSWV resistant varieties have excellent yield with or without virus pressure.
- Differences in susceptibility to TSWV exist among susceptible varieties.

2011 Variety Comparison

Treatment[z]	TSWV %				
	Jul 18	Aug 11	Aug 23		
AB3	25.0	50.1	53.4	a	(1)
H9780	11.7	34.3	37.6	b	(2)
H8004	16.9	31.9	35.2	b	(3)
H7709	30.0	30.1	33.4	b	(4)
HMX9905	19.2	27.6	30.9	bc	(5)
SUN6368	14.4	23.9	29.4	bcd	(6)
BQ205	19.2	25.5	27.4	bcd	(7)
H3402	9.8	20.8	20.8	cd	(8)
UG19406	6.8	16.3	18.8	cd	(9)
N6394	0.0	0.8	2.5	e	(10)
H5508	0.0	0.0	0.8	e	(11)
AB0311	0.0	0.0	0.0	e	(12)
LSD	9.065	13.497	12.292		
CV%	49.39	43.09	35.34		

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)

Processing Tomato Variety Ranking based on 9 replicated trials

	Genetic resistance (SW5)		Low		Variable or Medium		High		
	AB 8058	paste	H 4007	multi use	AB 2	multi use	AB 3	multi use	
	H 5508	paste	SUN 6368	peel, solids	BQ 205	paste, peel	H 2601	pear	
	H 5608	paste	UG 4305	multi use	CXD 255	multi use	H 8004	multi use	
	N 6394	multi use	UG 19406	multi use	CXD 282	multi use	H 8504	paste	
	N 6385	peel, solids			H 2005	multi use	HM 6898	multi use	
					H 9780	multi use	NUN 672	viscosity	
					HMX 7885	pear			
					NDM 5578	multi use			
					PX 1723	dice, peel			
					SUN 6366	multi use			

TSWV Symptoms on SW5 Variety

- Fruit has symptoms that are not characteristic of TSWV on susceptible variety.
- Leaves are symptomless
- TSWV is present in shoots of SW5 varieties with fruit symptoms.

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 (treatment with**

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

From R. L. Gilbertson, 2011

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, 2011

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, 2011

Acknowledgements

California Tomato Research Institute

Growers and PCAs

Robert Gilbertson

Ozgur Batuman

Li-Fang Chen

Neil McRoberts

Diane Ullman

Robert Gilbertson

Thrips counters

Michelle LeStrange

Gene Miyao

Scott Stoddard


Thank you