Management of Curly top virus and Sw5 resistance-breaking Tomato spotted wilt

Tom Turini
University of California ANR
Fresno County Vegetable Crops Advisor

University of California
Agriculture and Natural Resources

Focus:

- Beet curly top virus
  - Insecticide efficacy in tomato crops
  - Insecticide efficacy in sugar beets
- Resistance breaking TSWV
  - Relative Susceptibility of commercially available varieties
  - Impact of insecticides on thrips population densities and TSWV incidence

Focus:

- Beet curly top virus

Beet curly top virus in Tomatoes

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


Western Fresno
Jayne Ave near I
7 December 201

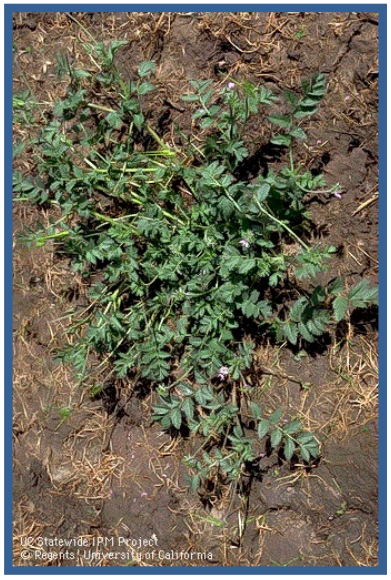
Host Range: > 300 species

- Atriplex, filaree (*Erodium spp.*), perennial pepperweed (*Lepidium latifolium)*, Buckhorn plantain (*Plantago lanceolate)*, Russian thistle (*Salsola spp.),* Shepherd's purse (*Capsella bursa-pastoris*) Bassia (*Bassia hyssopifolia), Kochia (Kochia scoparia)*

Pepperweed

Russian thistle

Goosefoot



Filaree

Buckhorn plantain

Focus:

- Beet curly top virus
  - Insecticide efficacy in tomato crops

Insecticide Program Comparison, 2015-17

- University of California West Side Research and Extension Center – Five Points
- Sun 6366 processing tomato plants were transplanted 5/22/15, 5/17/16
- 6 treatments were compared in 4 rep RCB design
- Total plants per plot recorded on, BCTV symptomatic plants were recorded at 7-14 day intervals from onset
- Hand harvest 20 row feet and sort for quality

Influence of Insecticide Applications on BCTV incidence, Five Points, 2015

Untreated Control
Verimark 13.5 oz/A tray drench (5/21/15)
Admire Pro 4 oz/A transplant water (5/22/15) Silvanto 2 fl oz directed foliar (5/22/15) Admire Pro 6.5 Drip (6/22/15)
Admire Pro 10.5 oz/A transplant water (5/22/15)
Silvanto 2 fl oz directed foliar Admire Pro 6.5 Drip (6/22/15)
Admire Pro 6.5 Drip (6/22/15)

Influence of Insecticide Applications on BCTV incidence, Five Points, 2015

	BCTV (%)				
	22 Jun	1 Jul	14 Jul	28-Jul	12-Aug
Verimark 13.5 oz/A tray drench (5/21/15)	2.8	3.7	5.7	4.3	4.8
Admire Pro 6.5 Drip (6/22/15)	10.4	11.8	9.7	8.6	6.7
Admire Pro 10.5 oz/A transplant water (5/22/15)	5.3	6.8	8.0	8.4	6.9
Admire Pro 4 oz/A transplant water (5/22/15) Silvanto 2 fl oz directed foliar (5/22/15) Admire Pro 6.5 Drip (6/22/15)	7.8	8.1	10.3	7.5	8.1
Silvanto 2 fl oz directed foliar Admire Pro 6.5 Drip (6/22/15)	11.7	12.8	11.5	9.9	9.6
Untreated Control	9.9	12.1	13.9	11.5	12.3
$LSD_{0.05}$	4.29	3.18	3.87	4.66	3.58
CV (%)	35.95	22.88	26.06	36.95	29.5

At UC West Side Research and Extension Center, 6366 transplants were planted on 22 May

7 July 2015 WSREC

Admire Pro 6.5 oz/A drip applied 22 Jun

Verimark 13.5 oz/A transplant drench

Admire Pro 10 oz/A tranplant water

Untreated

Influence of Insecticide Applications on yield and quality, Five Points, 2015

	Yield	% based on hand sort				PTAB		
	(t/a)	Red	Grn	Sun	Rot	Col	Sld	pH
Verimark 13.5 oz/A tray drench (5/21/15)	45.6	80.2	7.8	0.2	11.8	28.0	4.725	4.530
Admire Pro 6.5 Drip (6/22/15)	40.0	77.3	11.1	2.1	9.5	28.3	4.850	4.480
Admire Pro 10.5 oz/A transplant water (5/22/15)	42.1	77.6	12.8	1.4	8.2	27.5	4.675	4.545
Untreated Control	36.2	79.4	9.8	0.8	9.9	28.3	4.925	4.510
$LSD_{0.05}$	7.7	NS	NS	NS	NS	NS	NS	NS
CV (%)	11.7	9.8	35.2	93.1	31.5	6.7	5.250	1.700

At UC West Side Research and Extension Center, 6366 transplants were planted on 22 May. Harvested on 11 Sep.

Influence of Insecticide Applications on yield and quality, Five Points, 2015

	Yield	% based on hand sort				PTAB		
	(t/a)	Red	Grn	Sun	Rot	Col	Sld	pH
Verimark 13.5 oz/A tray drench (5/21/15)	45.6	80.2	7.8	0.2	11.8	28.0	4.725	4.530
Admire Pro 6.5 Drip (6/22/15)	40.0	77.3	11.1	2.1	9.5	28.3	4.850	4.480
Admire Pro 10.5 oz/A transplant water (5/22/15)	42.1	77.6	12.8	1.4	8.2	27.5	4.675	4.545
Untreated Control	36.2	79.4	9.8	0.8	9.9	28.3	4.925	4.510
$LSD_{0.05}$	7.7	NS	NS	NS	NS	NS	NS	NS
CV (%)	11.7	9.8	35.2	93.1	31.5	6.7	5.250	1.700

At UC West Side Research and Extension Center, 6366 transplants were planted on 22 May. Harvested on 11 Sep.

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

Verimark 13.5 fl oz product/A Tray Drench 16 May
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
Silvanto 10.5 fl oz 6 Jun Platinum 3.67 oz drip applied 10 Jun Venom 6.0 oz drip applied on 28 Jun
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
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
Untreated control

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

Influence of Insecticide Applications on Yield and Quality, Five Points, 2016

	Yield	% based on hand sort			
	(t/a)	Red	Grn	Sun	Rot
Verimark 13.5 fl oz product/A Tray Drench 16 May	54.94	77.22	3.21	0.82	18.76
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	54.78	79.30	2.58	0.46	17.66
Silvanto 10.5 fl oz 6 Jun Platinum 3.67 oz drip applied 10 Jun Venom 6.0 oz drip applied on 28 Jun	54.92	80.70	4.28	2.23	12.79
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	45.74	81.26	2.54	1.25	14.96
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	57.97	81.29	3.20	0.08	15.42
Untreated control	39.50	72.56	4.83	0.32	22.28
$LSD_{0.05}$	12.36	NS	NS	NS	NS
CV %	15.98	10.60	57.93	126.57	41.79

Influence of Insecticide Applications on BCTV incidence, Five Points, 2018

Material(s) and rate per acre	
Vermark 12.5 fl oz	Transplant drench
Admire pro 8 fl oz/acre	Drip applied 1 Jun
Sequoia 2.5 fl oz	Transplant drench
Sequoia 4.5 fl oz	Foliar 3 Jun[u]
Sequoia 2.5 fl oz + Radiant 6.0 fl oz	Foliar 3 Jun
Radiant 10.0 fl oz	Foliar 3 Jun
Sequoia 4.5 fl oz	Transplant drench
Untreated control	

Influence of Insecticide Applications on BCTV incidence, Five Points, 2018

Material(s) and equivalent rate per acre[y]	Timing	BCTV incidence (%)[z]	
		28-Jun	2-Aug
Vermark 12.5 fl oz	Transplant drench	1.8 b	4.0 b
Admire pro 8 fl oz/acre	Drip applied 1 Jun[v]	3.7 ab	3.5 b
Sequoia 2.5 fl oz	Transplant drench	4.4 ab	6.0 ab
Sequoia 4.5 fl oz	Foliar 3 Jun[u]	4.7 ab	7.2 ab
Sequoia 2.5 fl oz + Radiant 6.0 fl oz	Foliar 3 Jun	5.3 ab	6.8 ab
Radiant 10.0 fl oz	Foliar 3 Jun	5.9 ab	7.1 ab
Sequoia 4.5 fl oz	Transplant drench	6.3 a	7.1 ab
Untreated control		7.8 a	8.7 a

Influence of Insecticide Applications on BCTV incidence, Five Points, 2018

Material(s) and equivalent rate per acre[y]	Timing	BCTV incidence (%)[z]	
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Vermark 12.5 fl oz	Transplant drench	1.8 b	4.0 b
Admire pro 8 fl oz/acre	Drip applied 1 Jun[v]	3.7 ab	3.5 b
Sequoia 2.5 fl oz	Transplant drench	4.4 ab	6.0 ab
Sequoia 4.5 fl oz	Foliar 3 Jun[u]	4.7 ab	7.2 ab
Sequoia 2.5 fl oz + Radiant 6.0 fl oz	Foliar 3 Jun	5.3 ab	6.8 ab
Radiant 10.0 fl oz	Foliar 3 Jun	5.9 ab	7.1 ab
Sequoia 4.5 fl oz	Transplant drench	6.3 a	7.1 ab
Untreated control		7.8 a	8.7 a

Effect of insecticides on beet curly top virus incidence in Fresno County, CA tomatoes ***2022***
(% plants with *beet curly top virus* symptoms)

Trade name, rate, application details and date	13-Jun	22-Jul	8-Aug
Admire Pro at 10 fl oz/a in transplant water 27 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt 28 Jun	0.45	3.31	3.77 c
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt 28 Jun DRIP BeLeaf 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	0.00	4.80	5.76 bc
Admire Pro 4.0 oz/A in transplant water 27 May Admire Pro 6.5 oz/A 10 Jun	0.00	7.44	6.74 ab
A21377X 6.16 fl oz/A 15 and 28 Jun	1.42	5.39	7.32 ab
Admire Pro at 10 fl oz/a in transplant water 27 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt/a 28 Jun DRIP BeLeaf Drip 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	0.00	6.93	7.60 ab
Movento 5.0 oz/A 10 and 24 Jun	0.00	8.97	8.97 ab
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt /a 28 Jun BeLeaf 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	0.00	9.37	9.37 ab
Sivanto Prime 7 oz/A in transplant water 27 May Sivanto Prime 21 oz/A 10 Jun	0.63	8.50	9.54 ab
A21377X 5.13 fl oz/A 15 and 28 Jun	0.00	9.22	9.70 ab
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May	0.00	9.82	9.82 ab
Sivanto Prime 28 oz/A drip at the first irrigation 3 Jun	1.74	12.37	13.62 a
Untreated	0.96	10.99	14.66 a
Treatment Probability	0.195	0.099	0.041
Coefficient of Variation (%)	265.217	61.165	55.140

Focus:

- Beet curly top virus
  - Insecticide efficacy in tomato crops
  - Insecticide efficacy in sugar beets

Comparison of insecticides for control of beet leafhopper in sugar beets: 2020 -2022

Location: University of California West Side Research and Extension Center in Fresno County

Crop: Beet curly top resistant sugar beets

Experimental design: Four rep RCB with 3 row x 70 ft

Evaluation: 1 to 7 days after treatment, ten sweeps per plot and record counts of nymphs and adult beet leafhoppers.

2020 Results: Conventional Treatments

Beet leafhopper/ 10 sweeps

	Insecticide trade name, rate/acre (active)[z]	BLH[y]
1	Baythroid 2.6 fl oz (cyfluthrin)	0.00
2	Warrior II 1.6 fl oz (lambda-cyhalothrin)	0.00
3	Sevin SL 32 fl oz (carbaryl)	0.25
4	Malathion 5EC 32 fl oz	0.50
5	Mustang 3.0 fl oz (zeta-cypermethrin)	2.00
6	Admire Pro 1.6 fl oz (imidicloprid)	2.25
7	Success 4 fl oz (spinosad)	2.75
8	Untreated control	3.50
	LSD 5%	1.89
	CV (%)	91.35

[z] On 13 Jul, materials were applied.

[y] On 17 Jul, plots were swept with 15 in-daim. net and the number of beet leafhoppers was recorded.

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1	Baythroid 2.6 fl oz (cyfluthrin)	0.00
2	Warrior II 1.6 fl oz (lambda-cyhalothrin)	0.00
3	Sevin SL 32 fl oz (carbaryl)	0.25
4	Malathion 5EC 32 fl oz	0.50
5	Mustang 3.0 fl oz (zeta-cypermethrin)	2.00
6	Admire Pro 1.6 fl oz (imidicloprid)	2.25
7	Success 4 fl oz (spinosad)	2.75
8	Untreated control	3.50
	LSD 5%	1.89
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3	Sevin SL 32 fl oz (carbaryl)	0.25
4	Malathion 5EC 32 fl oz	0.50
5	Mustang 3.0 fl oz (zeta-cypermethrin)	2.00
6	Admire Pro 1.6 fl oz (imidicloprid)	2.25
7	Success 4 fl oz (spinosad)	2.75
8	Untreated control	3.50
	LSD 5%	1.89
	CV (%)	91.35

[z] On 13 Jul, materials were applied.

[y] On 17 Jul, plots were swept, and number of beet leafhoppers was recorded.

2021 Results: Conventional Treatments

Beet leafhopper/ 10 sweeps

	Insecticide trade name, rate/acre (ai)	28-Jun		29-Jul	
1	Warrior II 1.6 fl oz (lambda-cyhalothrin)	2.00	b	0.00	d
2	Baythroid 2.6 fl oz (cyfluthrin)	1.50	b	0.25	d
3	Malathion 5EC 32 fl oz	1.50	b	0.50	d
4	Mustang 3.0 fl oz (zeta-cypermethrin)	2.75	ab	0.75	d
5	Beleaf 4.3 oz (flonicamid)	2.25	b	4.25	cd
6	Admire Pro 1.6 fl oz (imidicloprid)	6.75	ab	5.75	bcd
7	Success 4 fl oz (spinosad)	3.75	b	6.75	bcd
8	Sefina 14 fl oz (afidopyropen)	7.75	ab	9.50	abc
9	Sivanto Prime 14 fl oz (flupyradifurone)	5.75	ab	10.00	abc
10	Exeril 20.5 fl oz (cyantrilaprole)	6.75	ab	11.25	ab
11	Untreated control	13.75	a	15.75	a
	cv	62.16		47.71	

[z] On 24 Jun and 27 Jul, materials were applied.

[y] On 28 Jun and 29 Jul, plots were evaluated.

2021 Results: Conventional Treatments

Beet leafhopper/ 10 sweeps

	Insecticide trade name, rate/acre (ai)	28-Jun		29-Jul	
1	Warrior II 1.6 fl oz (lambda-cyhalothrin)	2.00	b	0.00	d
2	Baythroid 2.6 fl oz (cyfluthrin)	1.50	b	0.25	d
3	Malathion 5EC 32 fl oz	1.50	b	0.50	d
4	Mustang 3.0 fl oz (zeta-cypermethrin)	2.75	ab	0.75	d
5	Beleaf 4.3 oz (flonicamid)	2.25	b	4.25	cd
6	Admire Pro 1.6 fl oz (imidicloprid)	6.75	ab	5.75	bcd
7	Success 4 fl oz (spinosad)	3.75	b	6.75	bcd
8	Sefina 14 fl oz (afidopyropen)	7.75	ab	9.50	abc
9	Sivanto Prime 14 fl oz (flupyradifurone)	5.75	ab	10.00	abc
10	Exeril 20.5 fl oz (cyantriliprole)	6.75	ab	11.25	ab
11	Untreated control	13.75	a	15.75	a
	cv	62.16		47.71	

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2021 Results: Conventional Treatments

Beet leafhopper/ 10 sweeps

	Insecticide trade name, rate/acre (ai)	28-Jun		29-Jul	
1	Warrior II 1.6 fl oz (lambda-cyhalothrin)	2.00	b	0.00	d
2	Baythroid 2.6 fl oz (cyfluthrin)	1.50	b	0.25	d
3	Malathion 5EC 32 fl oz	1.50	b	0.50	d
4	Mustang 3.0 fl oz (zeta-cypermethrin)	2.75	ab	0.75	d
5	Beleaf 4.3 oz (flonicamid)	2.25	b	4.25	cd
6	Admire Pro 1.6 fl oz (imidicloprid)	6.75	ab	5.75	bcd
7	Success 4 fl oz (spinosad)	3.75	b	6.75	bcd
8	Sefina 14 fl oz (afidopyropen)	7.75	ab	9.50	abc
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	cv	62.16		47.71	

[z] On 24 Jun and 27 Jul, materials were applied.

[y] On 28 Jun and 29 Jul, plots were evaluated.

2022 Results (Beet leafhopper/ 10 sweeps)

	Insecticide trade name, rate/acre (ai)	14-Jul		21-Jul	
1	Malathion 5EC 32 fl oz	1.00	c	0.50	b
2	Warrior II 1.6 fl oz	1.25	c	0.50	b
3	Baythroid 2.6 fl oz	1.00	c	0.75	b
4	Mustang 3.0 fl oz	1.50	c	1.00	b
5	Sefina 10.0 fl oz	2.00	bc	1.00	b
6	Sefina 14.0 fl oz	1.75	bc	2.00	ab
7	Beleaf 4.28 oz	4.00	abc	2.00	ab
8	Admire Pro 1.6 fl oz	2.50	bc	2.25	ab
9	Exeril 20.5 fl oz	6.00	ab	2.50	ab
10	Sivanto Prime 14.0 fl oz	3.00	abc	3.75	ab
11	Success 4.0 fl oz	4.75	abc	3.75	ab
12	untreated	7.25	a	4.75	a
	cv	95.69		97.18	

[z] On 13 and 19 Jul, materials were applied.

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	Insecticide trade name, rate/acre (ai)	14-Jul		21-Jul	
1	Malathion 5EC 32 fl oz	1.00	c	0.50	b
2	Warrior II 1.6 fl oz	1.25	c	0.50	b
3	Baythroid 2.6 fl oz	1.00	c	0.75	b
4	Mustang 3.0 fl oz	1.50	c	1.00	b
5	Sefina 10.0 fl oz	2.00	bc	1.00	b
6	Sefina 14.0 fl oz	1.75	bc	2.00	ab
7	Beleaf 4.28 oz	4.00	abc	2.00	ab
8	Admire Pro 1.6 fl oz	2.50	bc	2.25	ab
9	Exeril 20.5 fl oz	6.00	ab	2.50	ab
10	Sivanto Prime 14.0 fl oz	3.00	abc	3.75	ab
11	Success 4.0 fl oz	4.75	abc	3.75	ab
12	untreated	7.25	a	4.75	a
	cv	95.69		97.18	

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	Insecticide trade name, rate/acre (ai)	14-Jul		21-Jul	
1	Malathion 5EC 32 fl oz	1.00	c	0.50	b
2	Warrior II 1.6 fl oz	1.25	c	0.50	b
3	Baythroid 2.6 fl oz	1.00	c	0.75	b
4	Mustang 3.0 fl oz	1.50	c	1.00	b
5	Sefina 10.0 fl oz	2.00	bc	1.00	b
6	Sefina 14.0 fl oz	1.75	bc	2.00	ab
7	Beleaf 4.28 oz	4.00	abc	2.00	ab
8	Admire Pro 1.6 fl oz	2.50	bc	2.25	ab
9	Exeril 20.5 fl oz	6.00	ab	2.50	ab
10	Sivanto Prime 14.0 fl oz	3.00	abc	3.75	ab
11	Success 4.0 fl oz	4.75	abc	3.75	ab
12	untreated	7.25	a	4.75	a
	cv	95.69		97.18	

[z] On 13 and 19 Jul, materials were applied.

[y] On 14 Jun and 21 Jul, plots were evaluated.

Beet leafhopper and *Beet curly top virus*

- Verimark (transplant treatments) most consistently reduced curly top under low to moderate pressure early season. Increased yields were observed under moderate pressure
- Neonicotinoid-treatments reduced curly top incidence.
- Pyrethroid and malathion applications to resident populations (based on sugar beet studies) showed consistent efficacy.

Beet Curly Top Virus managment

- Sanitation
- Manage the leafhopper in weedy areas and rangeland
- Treat tomatoes with Verimark or a neonicotinoid early in the growing season to reduce disease incidence.

Focus:

- Beet curly top virus
  - Insecticide efficacy in tomato crops
  - Insecticide efficacy in sugar beets
- Resistance breaking TSWV

TSWV Resistance Breaking Isolate in Fresno County:

- Sw5-resistance detected in April 2016
- Detected in winter weeds by 2017
- Present in tomatoes lacking Sw-5
- Was more common in processing tomatoes mid- to late-season than the wild type strain by 2018

Focus:

- Beet curly top virus
  - Insecticide efficacy in tomato crops
  - Insecticide efficacy in sugar beets
- Resistance breaking TSWV
  - Relative Susceptibility of commercially available varieties

Relative Susceptibility of Processing Tomato Varieties to TSWV (2019 - 2021)

- Quantify response of commercial varieties to TSWV
- Document strain present

University of California
Agriculture and Natural Resources

Ag Seeds and **TS&L** commercial field trials (Fresno, Kings and Merced)

Company representatives provided maps of commercial trials

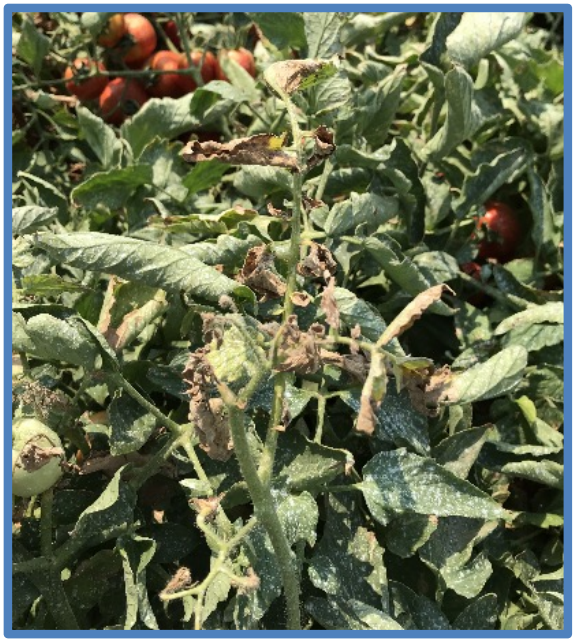
UC Advisors evaluate trials with substantial TSWV levels w/in 3 weeks of harvest (6-9 trials/year)

Representative samples of at least six entries from at least three trials per year are tested for resistance breaking status (R. Gilbertson lab)

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

Symptom Categories

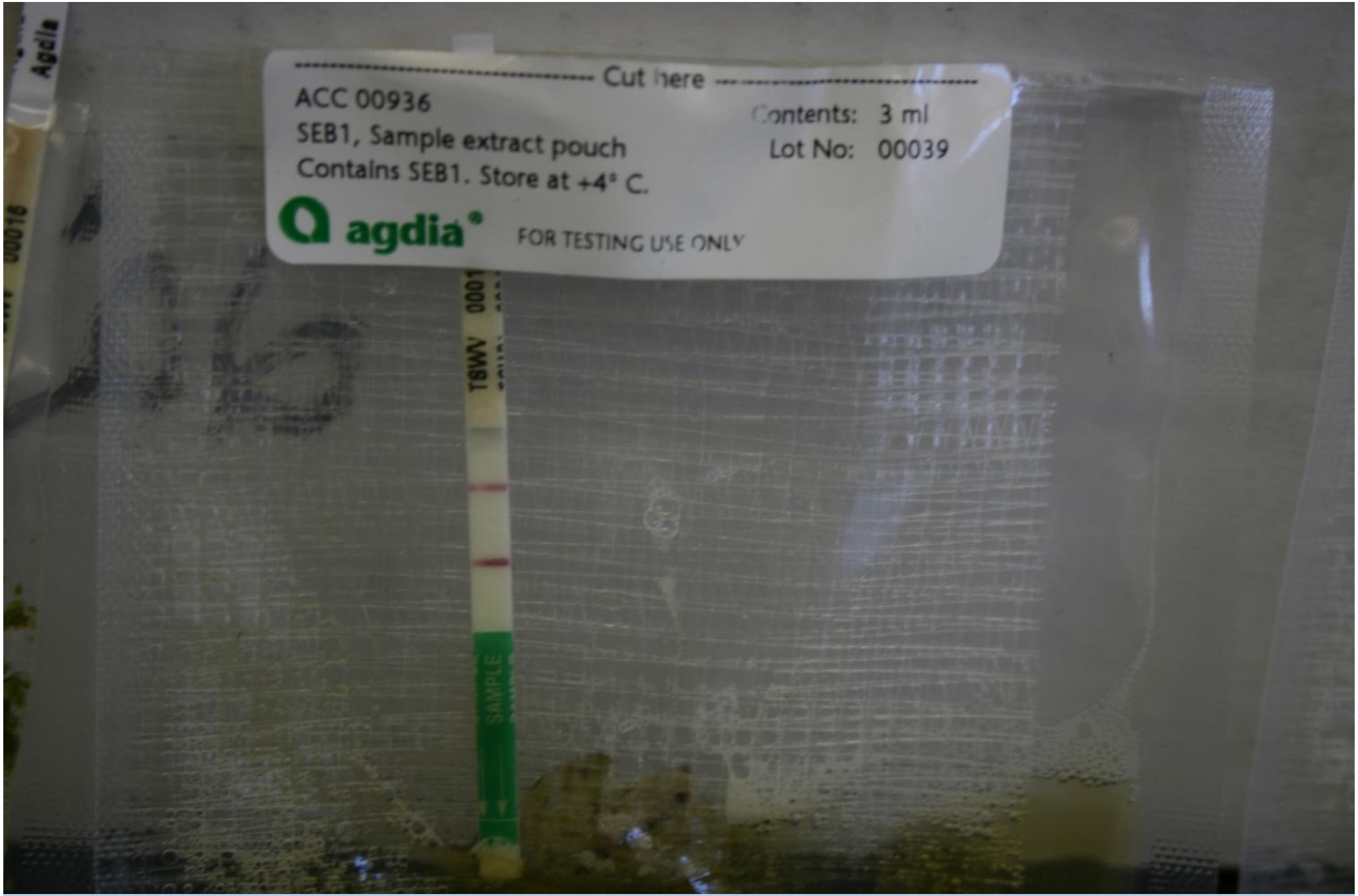


1 shoot dieback

2 fruit symptoms with few foliar symptoms

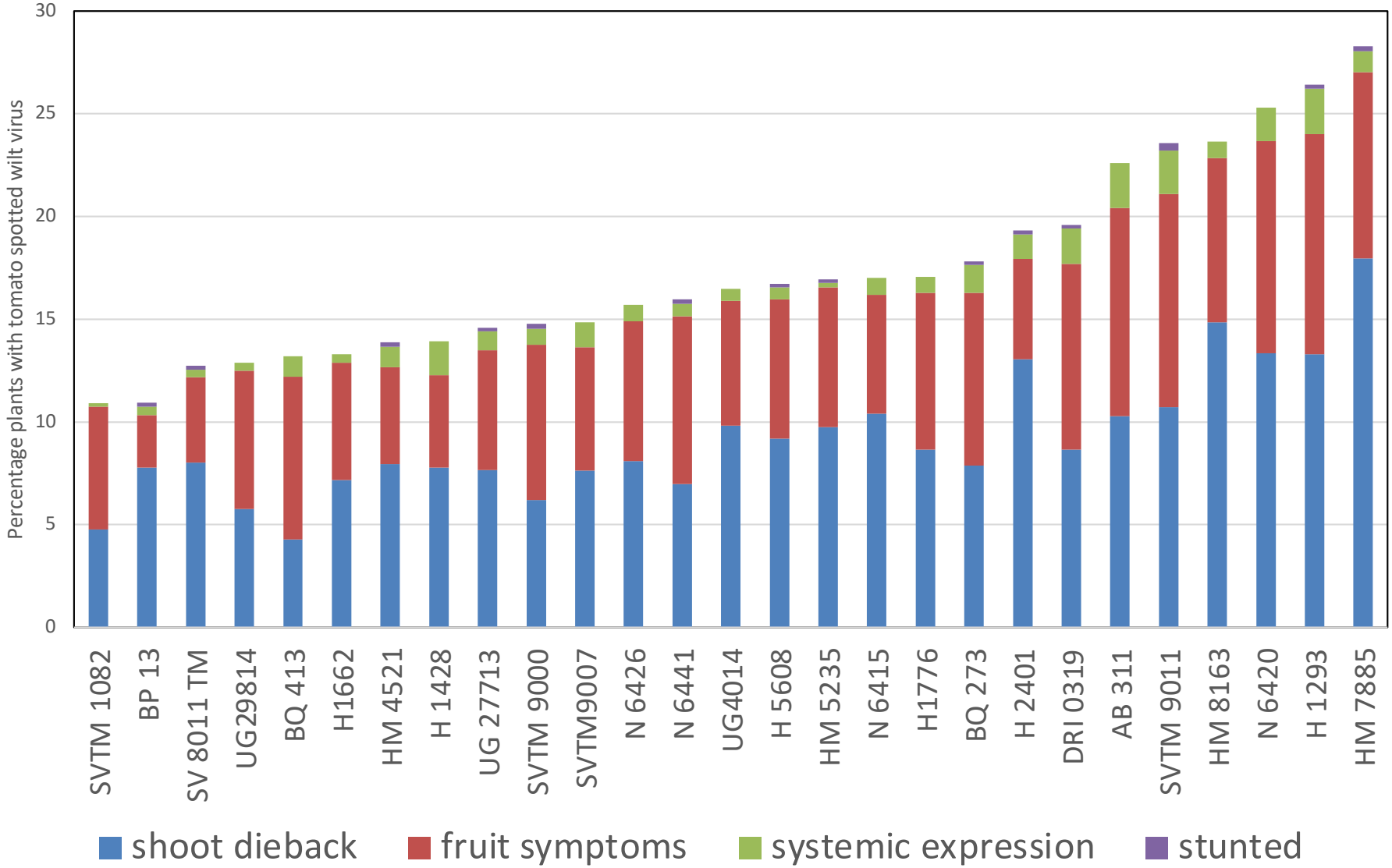
3 systemic symptoms through leaves and fruit

4 collapse



Immunostrips available from AgDia (www.agdia.com)

Disease Incidence (27 entries x 18 sites) 2019-21



Disease Incidence (27 entries x 18 sites) 2019-21

entry	Use	TSWV (%)		entry	Use	TSWV (%)		
BP13	early	7.38398	e[z]	N6426	thick	13.2468	abcde	
SV8011TM	inter	7.75929	de	UG4014	early	13.5282	abcde	
SVTM1082	thin	8.34033	cde	HM5235	inter	13.5476	abcde	
UG29814	inter	8.57453	cde	N6415	thick	14.2621	abcde	
H1662	thick	10.107	bcde	H2401	thick	14.7516	abcde	No Sw5
BQ413	early	10.2285	bcde	BQ273	early	14.9422	abcde	
UG27713	thin	10.5225	abcde	DRI319	thin	17.1124	abcde	
H1428	thick	10.5777	abcde	HM8163	pear	20.5663	abcde	
SVTM9000	early	11.5547	abcde	SVTM9011	early	21.4305	abcde	
SVTM9007	thick	11.67	abcde	AB0311	thin	21.7692	abcd	
N6441	inter	11.7315	abcde	N6420	pear	22.3952	abc	
HM4521	inter	11.8613	abcde	H1293	pear	25.0618	ab	
H1776	thick	12.7992	abcde	HM7885	pear	25.8357	a	No Sw5
H5608	thick	13.151	abcde					

Focus:

- Beet curly top virus
  - Insecticide efficacy in tomato crops
  - Insecticide efficacy in sugar beets
- Resistance breaking TSWV
  - Relative Susceptibility of commercially available varieties
  - Impact of insecticides on thrips population densities and TSWV incidence

Insecticide Comparison Methods

Trial details

Location: University of California West Side Research and Extension Center

Experimental design: 4 rep RCB

Plot size: One bed x 75 ft

Plant Date: 19 May 2021 and 27 May 2022

Variety: AB311, H5608

Irrigation: sub-surface drip 10 in depth

Soil: Panoche clay loam

Transplant treatment: 1 day prior to planting, Verimark was applied to the trays
Transplant water application: In 2022 only; in equivalent of 175 gal/acre

Drip application: Insecticides were injected into the sub-surface drip system

Foliar application: All other materials were applied in the equivalent of 30 gal/a

Evaluation

Plant wash technique: On 2 and 9 Jun 2021 and in 2022, three plants per plot of the Verimark treatment and in the untreated control. Thrips were counted under a 40x dissecting scope.

Flower dissection: On 22 and 28 Jun 2021, 10 flowers per plot were collected, dissected under 40x dissecting scope and number of nymph and adult thrips were recorded

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	6/2/21 adults
Verimark 13.5 fl oz/a transplant drench	4.25
Untreated control	19.00
Treatment probability	0.0030
Coefficient of Variation (%)	80.42

Effect of Verimark applied to transplants one day prior to planting on thrips densities 21 days post-plant in Fresno County, CA 2021.

Insecticide trade name, rate per acre	6/9/2021 adults[z]	6/9/2021 nymphs	6/9/2021 total
Verimark 13.5 fl oz/a transplant drench[y]	13.75	0.75	14.5
Admire Pro 10.5 fl oz injected 2 Jun[x]	21.00	3.00	24.00
Untreated control	19.00	1.25	20.25
Treatment probability	0.4041	0.1331	0.294
Coefficient of Variation (%)	21.54	105.90	23.09

Effect of Verimark applied to transplants one day prior to planting on thrips densities 12 days post-plant in Fresno County, CA ***2022***

Insecticide trade name, rate per acre	8 Jun, adults[z]
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May	38.50
Admire Pro at 10 fl oz/a in transplant water 27 May	35.75
Admire Pro 4.0 oz/A in transplant water 27 May	37.25
Sivanto Prime 28 oz/A drip at the first irrigation 3 Jun	30.00
Sivanto Prime 7 oz/A in transplant water 27 May	35.25
Untreated	34.00
Treatment probability	0.12
Coefficient of Variation (%)	90.75

Effect of insecticides on thrips densities in Fresno County, CA 2021

Insecticide trade name, Formulated product per acre	thrips counts per 10 flowers	
	22 Jun	28 Jun
Admire Pro 10.5 fl oz injected	7.00	9.75
Verimark 13.5 fl oz/a[w] + Radiant 6 fl oz	9.75	12.25
Movento 5.0 fl oz/acre	13.25	10.75
Dimethoate 400 16 fl oz	14.00	9.25
Movento 3 fl oz and Agrimek 3.5 fl oz	15.50	13.75
Radiant 6 fl oz	14.75	10.75
Exirel 20.5 fl oz/acre	14.25	12.25
Success 6.0 fl oz/acre	14.75	13.00
Sivanto 14.0 fl oz	16.75	7.50
Untreated control	18.00	14.25
Agrimek 3.5 fl oz/acre	21.00	11.75
Sefina 14 fl oz/acre	19.00	10.75
Verimark 13.5 fl oz/a[w]	23.75	9.50
Treatment Probability[v]	0.0884	0.2542
Coefficient of Variation (%)	48.02	33.62

Effect of insecticides on thrips densities in Fresno County, CA 2022 (thrips per 10 leaves)

Trade name, rate, application details and date	21-Jun	9-Jul	19-Jul	6-Aug
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May	7.00	1.00	8.00	9.75
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt /a 28 Jun BeLeaf 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	9.75	0.75	10.50	12.25
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt 28 Jun DRIP BeLeaf 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	13.25	1.00	14.25	10.75
Admire Pro at 10 fl oz/a in transplant water 27 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt/a 28 Jun DRIP BeLeaf Drip 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	14.00	0.75	14.75	9.25
Admire Pro at 10 fl oz/a in transplant water 27 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt 28 Jun	15.50	0.50	16.00	13.75
Admire Pro 4.0 oz/A in transplant water 27 May Admire Pro 6.5 oz/A 10 Jun	14.75	1.00	15.75	10.75
Sivanto Prime 28 oz/A drip at the first irrigation 3 Jun	14.25	1.00	15.25	12.25
Sivanto Prime 7 oz/A in transplant water 27 May Sivanto Prime 21 oz/A 10 Jun	14.75	1.25	16.00	13.00
Movento 5.0 oz/A 10 and 24 Jun	16.75	0.50	17.25	7.50
A21377X 5.13 fl oz/A 15 and 28 Jun	18.00	2.25	20.25	14.25
A21377X 6.16 fl oz/A 15 and 28 Jun	21.00	0.75	21.75	11.75
Untreated	19.00	1.50	20.50	10.75
Treatment Probability	0.27	0.08	0.24	0.26
Coefficient of Variation (%)	144.84	151.04	58.32	27.23

Effect of insecticides on tomato spotted wilt incidence in Fresno County, CA 2022

(% of plants with tomato spotted wilt virus symptoms)

Trade name, rate, application details and date	21-Jun	9-Jul
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May	2.87	10.31
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt /a 28 Jun BeLeaf 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	4.82	8.09
Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt 28 Jun DRIP BeLeaf 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	5.41	7.36
Admire Pro at 10 fl oz/a in transplant water 27 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt/a 28 Jun DRIP BeLeaf Drip 4.28 oz/a 12 Jul Exirel 20.5 floz/a 26 Jul	2.47	10.44
Admire Pro at 10 fl oz/a in transplant water 27 May Radiant 10 fl oz/a 10 Jun Dimethoate 1pt 28 Jun	2.38	7.50
Admire Pro 4.0 oz/A in transplant water 27 May Admire Pro 6.5 oz/A 10 Jun	4.43	3.99
Sivanto Prime 28 oz/A drip at the first irrigation 3 Jun	0.49	5.51
Sivanto Prime 7 oz/A in transplant water 27 May Sivanto Prime 21 oz/A 10 Jun	5.48	8.06
Movento 5.0 oz/A 10 and 24 Jun	2.30	11.72
A21377X 5.13 fl oz/A 15 and 28 Jun	1.87	5.72
A21377X 6.16 fl oz/A 15 and 28 Jun	3.83	6.48
Untreated	4.58	13.83
Treatment Probability	0.22	0.12
Coefficient of Variation (%)	93.81	66.54

2021-22 *Tomato spotted wilt virus* control study observations

- Varietal incidence differed:
  - Pear varieties included (HM8163, N6420, H1293, HM7885) had high incidence of TSWV.
  - Generally; BP13, SV8011TM, SVTM1082 and UG29814 were among entries with the lowest incidence.
- Verimark applied to transplants reduced thrips densities 14-days post plant.
- In recent Fresno County studies; neither drip-, transplant water- nor foliar-applied treatments reduced thrips population densities.

TSWV Management After Loss of Resistance - Identification of risk factors

- History of area – previous TSWV outbreaks and RB
- Uncontrolled vegetation near fields – known hosts
- Earlier planted tomato fields in vicinity
- Late season tomatoes
- Highly susceptible varieties
- High thrips population densities

TSWV Management After Loss of Resistance

- Sanitation : start with clean transplants, manage weeds inside the field and outside
- When possible, avoid planting near uncontrollable sources of virus
- Thrips management?
- Avoid use of highly susceptible varieties in high-risk areas
- Recognize risk in late season production and limit late fields to areas with lower risk

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