Central Valley trial results on management of beet curly top and tomato spotted wilt virus





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University of **California** Agriculture and Natural Resources



Beet leafhopper Circulifer tenellus

 The only vector of the curly top viruses.



Photo by Lori Dunning



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 (21 May) Admire Pro 4 oz/A transplant water (22 May) Sivanto 2 fl oz directed foliar (22 May) Admire Pro 6.5 Drip (22 Jun) Admire Pro 10.5 oz/A transplant water (22 May) Sivanto 2 fl oz directed foliar (22 May) Admire Pro 6.5 Drip (22 Jun) Admire Pro 6.5 Drip (22 Jun)

Influence of Insecticide Applications on BCTV incidence, Five Points, 2015 22 June



Influence of Insecticide Applications on BCTV incidence, Five Points, 2015 12 Aug



BCTV smptomatic plants (%)

BCTV Symptom Development UC West Side Research and Extension Center, 2015



7 July 2015 WSREC



Influence of Insecticide Applications on yield, 2015



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/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 (10 Jun), Venom 6.0 oz drip (28 Jun) Admire Pro 4.0 oz transplant water (17 May), Platinum 3.67 oz drip (10 Jun), Venom 6.0 oz drip (28 Jun) Verimark 13.5 fl oz product/A tray drench (16 May), Platinum 3.67 oz drip (10 Jun), Venom 6.0 oz drip (28 Jun) **Untreated control**

Influence of Insecticide Applications on BCTV incidence, 2016



Influence of Insecticide Applications on BCTV incidence, 2016

BCTV Symptom Development UC West Side Research and Extension Center, 2016

Influence of Insecticide Applications on Yield and Quality, 2016

Verimark 13.5 fl oz/A tray drench (16 May), Platinum 3.67 oz drip (10 Jun), Venom 6.0 oz drip (28 Jun)

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Admire Pro 4.0 oz transplant water (17 May), Platinum 3.67 oz drip (10 Jun), Venom 6.0 oz drip (28 Jun)

Untreated control

70

	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
	Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May
Effect of	Radiant 10 fl oz/a 10 Jun
insecticides on	Dimethoate 1pt /a 28 Jun
beet curly top	BeLeaf 4.28 oz/a 12 Jul
<i>virus</i> incidence	Exirel 20.5 floz/a 26 Jul
in Fresno	Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May
County, CA	Admire Pro at 10 fl oz/a in transplant water 27 May
tomatoes <u>2022</u>	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
	Admire Pro at 10 fl oz/a in transplant water 27 May
	Radiant 10 fl oz/a 10 Jun
	Dimethoate 1pt 28 Jun
	Admire Pro 4.0 oz/A in transplant water 27 May
	Admire Pro 6.5 oz/A 10 Jun
	A21377X 5.13 fl oz/A 15 and 28 Jun
	A21377X 6.16 fl oz/A 15 and 28 Jun
	Movento 5.0 oz/A 10 and 24 Jun
	Sivanto Prime 28 oz/A drip at the first irrigation 3 Jun
	Sivanto Prime 7 oz/A in transplant water 27 May
	Sivanto Prime 21 oz/A 10 Jun

Admire Pro at 10 fl oz/a in transplant water 27 May, Radiant 10 fl oz/a 10 Jun, Dimethoate 1pt 28 Jun

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, BeLeaf 4.28 oz/a 12 Jul drip, Exirel 20.5 floz/a 26 Jul

Admire Pro 4.0 oz/A in transplant water 27 May, Admire Pro 6.5 oz/A 10 Jun

A21377X 6.16 fl oz/A 15 and 28 Jun

Admire Pro at 10 fl oz/a in transplant water 27 May, Radiant 10 fl oz/a 10 Jun, Dimethoate 1pt/a 28 Jun, BeLeaf Drip 4.28 oz/a 12 Jul, Exirel 20.5 floz/a 26 Jul

Movento 5.0 oz/A 10 and 24 Jun

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

Sivanto Prime 7 oz/A in transplant water 27 May, Sivanto Prime 21 oz/A 10 Jun

A21377X 5.13 fl oz/A 15 and 28 Jun

Untreated

Verimark transplant drench at the equivalent of 13.5 fl oz/a 26 May

Sivanto Prime 28 oz/A drip at the first irrigation 3 Jun

Effect of insecticides on *beet curly top virus* incidence in Fresno County, CA tomatoes **2022**

BCTV Symptom Development UC West Side Research and Extension Center, 2022

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

Insectio	cide 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.

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)	6.75ab	5.75 bcd
7	Success 4 fl oz (spinosad)	3.75 b	6.75 bcd
8	Sefina 14 fl oz (afidopyropen)	7.75 ab	9.50abc
9	Sivanto Prime 14 fl oz (flupyradifurone)	5.75ab	10.00abc
10	Exeril 20.5 fl oz (cyantrilaprole)	6.75ab	11.25ab
11	Untreated control	13.75a	15.75a
	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	1.00c	0.50b
2	Warrior II 1.6 fl oz	1.25c	0.50b
3	Baythroid 2.6 fl oz	1.00c	0.75b
4	Mustang 3.0 fl oz	1.50c	1.00b
5	Sefina 10.0 fl oz	2.00bc	1.00b
6	Sefina 14.0 fl oz	1.75bc	2.00ab
7	Beleaf 4.28 oz	4.00 abc	2.00ab
8	Admire Pro 1.6 fl oz	2.50bc	2.25ab
9	Exeril 20.5 fl oz	6.00ab	2.50ab
10	Sivanto Prime 14.0 fl oz	3.00 abc	3.75ab
11	Success 4.0 fl oz	4.75 abc	3.75ab
12	untreated	7.25a	4.75a
	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.

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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.

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

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

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

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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

1 shoot dieback

Symptom Categories

3 systemic symptoms through leaves and fruit

2 fruit symptoms with few foliar symptoms

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 (%)	
BP13	early	7.38398	e ^z	
SV8011TM	inter	7.75929	de	
SVTM1082	thin	8.34033	cde	
UG29814	inter	8.57453	cde	
H1662	thick	10.107	bcde	
BQ413	early	10.2285	bcde	
UG27713	thin	10.5225	abcde	
H1428	thick	10.5777	abcde	
SVTM9000	early	11.5547	abcde	
SVTM9007	thick	11.67	abcde	
N6441	inter	11.7315	abcde	
HM4521	inter	11.8613	abcde	
H1776	thick	12.7992	abcde	
H5608	thick	13.151	abcde	

entry	Use	TSWV (%)		
N6426	thick	13.2468	abcde	
UG4014	early	13.5282	abcde	
HM5235	inter	13.5476	abcde	
N6415	thick	14.2621	abcde	
H2401	thick	14.7516	abcde	No Sw5
BQ273	early	14.9422	abcde	
DRI319	thin	17.1124	abcde	
HM8163	pear	20.5663	abcde	
SVTM9011	early	21.4305	abcde	
AB0311	thin	21.7692	abcd	
N6420	pear	22.3952	abc	
H1293	pear	25.0618	ab	
HM7885	pear	25.8357	а	No Sw5

Insecticide Comparison Thrips vectors TSWV

Frankliniella occidentalis (Western flower thrips) Primary vector of TSWV in Central California

Pupal Stages Do Not Feed

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

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.

	6/9/2021	6/9/2021	6/9/2021
Insecticide trade name, rate per acre	adults ^z	nymphs	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

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

	8 Jun,
Insecticide trade name, rate per acre	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

	thrips counts per 10	
Insecticide trade name,	flow	vers
Formulated product per acre	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	Trade name, rate, application details and date	21-Jun	9-Jul	19-Jul	6-Aug
insecticides on thrips densities in	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 Rol oof 4 28 oz/a 12 Jul				
County. CA	Exirel 20.5 floz/a 26 Jul	9.75	0.75	10.50	12.25
2022 (thrips per 10 leaves)	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 Bel eaf 4 28 oz/a 12 Jul	5.75	0.75	10.00	12.23
	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 Evirel 20 5 floz/a 26 Jul	14.00	0.75	14 75	0 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 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

- Previous TSWV outbreaks and RB
- Uncontrolled vegetation near fields
- Late planted tomato fields (particularly in areas with many early planted fields)
- Highly susceptible varieties
- High thrips population densities

TSWV Management After Loss of Resistance

- Sanitation
 - Start with clean transplants
 - Manage weeds outside the field before planting
 - After planting tomatoes, consider treating weedy areas prior to discing or applying herbicide
- When possible, avoid planting near uncontrollable sources of virus
- Thrips management?
- Avoid use of highly susceptible varieties in high-risk areas

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