Processing Tomato Pest Management Research in Fresno County

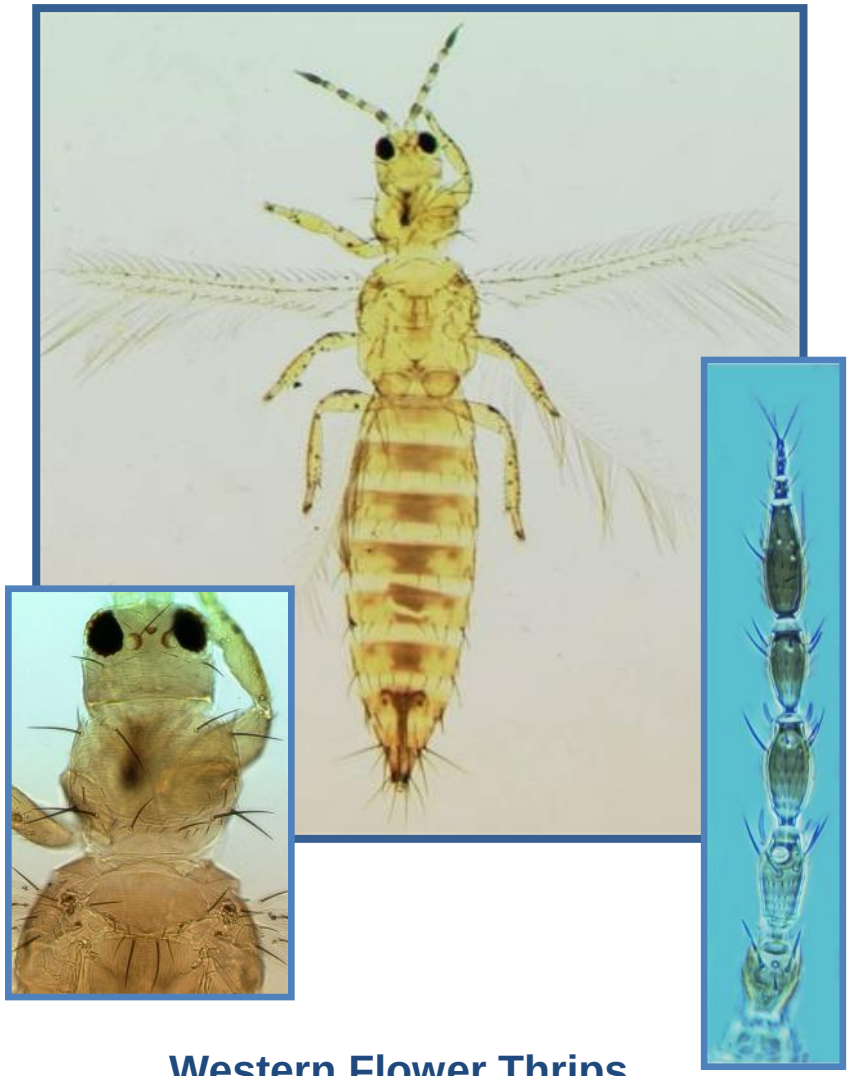
Tom Turini
Vegetable Crops Farm Advisor
University of California Cooperative Extension
Fresno County

Overview

- Thrips Control
- Powdery Mildew Control
- Herbicide Carryover Research Update

Thrips Control Comparisons

Thrips control is part of a processing tomato program due to Tomato spotted wilt virus



Western Flower Thrips
Frankiniella occidentalis

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
3A	Pyrethroids	Sodium channel modulators	Mustang	Zeta-cypermethrin
			Warrior with Zeon	Lambda-cyhalothrin
4A	Neonicotinoids	Nicotinic acetylcholine receptor agonists	Admire, Assail, Platinum, Venom	Imidacloprid, acetamiprid, thiamethoxam, dinotefuron
5	Spinosyns	Nicotinic acetylcholine receptor allosteric activators	Radiant Entrust	spinetoram spinosad
6	Avermectins	Chloride channel activators	Agri-Mek SC	abamectin
9C	Flonicamid	Selective homopteran feeding blockers	Beleaf	flonicamid
21	Pyrazole		Torac	tolfenpyrad
23	Tetronic and Tetramic acid derivatives	Inhibitors of acetyl CoA carboxylase.	Movento	spirotetramat
28	Diamide	Ryanodine receptor modulators	Cyazypyr	cyantraniliprole

From IRAC, 2012

Thrips Efficacy (3-5 days after treatment) 2007-2012

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	Trt 3 Jul'12 Smpled 3 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)	18.3 c (2)
Radiant 6.0 fl oz + Prev-Am 1qt					6.0 c (1)	
Torac 21 fl oz						15.0 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)				
Entrust 7 fl oz						20.0 bc (3)
HGW86 13.5 fl oz + Brigade			2.3 ef (2)			
Hero 11.2 fl oz			3.5 def (3)	3.7 c (6)		
Torac + Agri-Mek						26.8 bc (4)
HGW86 13.5 fl oz				10.0 ab (11)		
HGW86 20.5 fl oz					10.5 bc (5)	31.8 ab (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)			
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)	34.5 a (6)
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)	37.0 a (8)

Thrips Efficacy (3-5 days after treatment) 2007-2012

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	Trt 3 Jul'12 Smpled 3 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)	18.3 c (2)
Radiant 6.0 fl oz + Prev-Am 1qt					6.0 c (1)	
Torac 21 fl oz						15.0 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)				
Entrust 7 fl oz						20.0 bc (3)
HGW86 13.5 fl oz + Brigade			2.3 ef (2)			
Hero 11.2 fl oz			3.5 def (3)	3.7 c (6)		
Torac + Agri-Mek						26.8 bc (4)

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

Consistent Control

- Radiant
- Lannate
- Dimethoate
- Beleaf (moderate)

Promising based on 1 season of data

- Torac
- Entrust (organic spinosad)

Over 4 Years of Fresno Co. Insecticide Programs Comparisons:

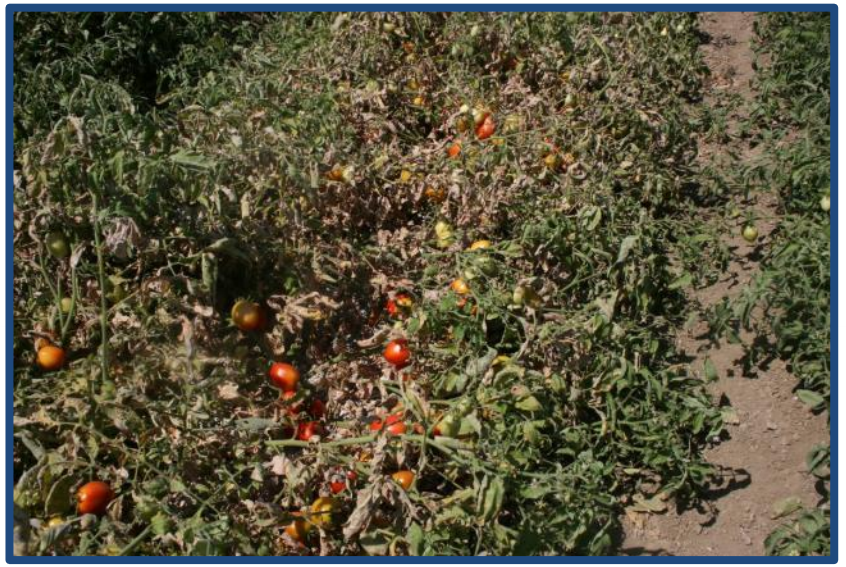
- Foliar treatments with Radiant and dimethoate reduced thrips densities and TSWV incidence
- Drip-injected neonicotinoid insecticides did not reduce thrips densities or TSWV incidence

Powdery Mildew in Tomato

Tomato Powdery Mildew

Leveillula taurica
(Oidiopsis sicula)

Oidium neolycopersici



Powdery Mildew Efficacy Comparisons : Fresno County 2009-2013

Efficacy Comparisons in Fresno County

- Backpack sprayer @ 50 gal/A and 40 psi
- First application before disease was observed or at very early stages of disease development (<1 leaf with mildew/100 sampled)
- Randomized complete block design with 4 replications
- Evaluated by 0-10 ratings of 10 mid-canopy leaves per plot and by amount of plant death

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)	**Powdery mildew rating**				**Necrosis rating**			
	22 Aug		1 Sep		25 Aug		2 Sep	
Luna Sensation 7.6 fl oz+Dyne-Amic (D)	0.5	c	1.3	b	1.5	ef	2.0	c
Quadris Top 8 fl oz + D	0.6	c	1.9	b	1.3	f	1.8	c
Quadris Top 8 l oz + D (1,3) Bravo Weather Stik 2.75 pt (2,4)	1.5	c	2.2	b	2.8	cde	3.3	c
Torino 3.4 oz + D	1.1	c	2.3	b	1.3	f	2.0	c
Vivando 15 fl oz + Widespread Max 0.03%	1.7	c	4.6	a	2.0	def	3.3	c
Cabrio 16 oz + D (1,3) Rally 4 oz/A + D (2,4)	3.4	b	5.0	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)	3.8	b	5.4	a	4.0	bc	6.5	ab
Flint 3.0 oz + D	4.0	b	6.1	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)	3.4	b	6.2	a	3.5	bcd	5.0	b
Regalia at 0.5% + Cabrio 8 oz + D	4.2	b	6.3	a	3.5	bcd	5.8	b
Regalia 0.5% + Rally 2.5 oz + D	3.7	b	6.3	a	3.7	bc	5.8	ab
Microthiol 10.0 lb	5.0	ab	6.5	a	2.8	bcde	6.3	ab
Regalia 1.0% + D	5.9	ab	6.8	a	4.8	ab	7.8	ab
Bravo Weather Stik 2.75 pt	5.9	ab	7.0	a	4.8	ab	7.3	ab
Untreated Control	7.0	ab	7.4	a	6.0	a	8.8	a

2010 Treatments, 2, 17 and 31 Aug 2010	**Powdery mildew rating (0-10**		
	13 Aug	30 Aug	14 Sep
Luna Sensation 7.6 fl oz + Dyne-Amic 0.125%	0.1	0.1	0.3
Quintec 6.0 fl oz + Wetcit 0.25%	0.1	0.4	0.4
Quadris 6.2 fl oz + D 0.125%	0.1	0.2	0.4
Quintec 6.0 fl oz + D 0.125%	0.2	0.2	0.6
Quadris Top 8 fl oz + Actigard 0.75 oz + D 0.125%	0.1	0.1	0.6
Priaxor 8.2 fl oz + D 0.125%	0.2	0.3	0.7
Torino 3.4 fl oz + D 0.125%	0.1	0.2	0.8
Quadris Top 8 fl oz + Dyne-Amic 0.125%	0.1	0.2	0.8
Quadris Top 8 fl oz + Wetcit 0.25%	0.1	0.4	1.4
Sonata ASO at 4 quarts/A + D 0.125%	0.5	1.3	1.5
Fontellis16 fl oz + D 0.125%	0.2	0.5	1.6
Fontellis 24 fl oz + D 0.125%	0.4	1.0	1.7
BAS 639 14 fl oz + D 0.125%	0.1	0.6	1.9
BAS 500 7F 12.3 fl oz + D 0.125%	0.2	0.6	1.9
Cabrio 16 oz + D 0.125%	0.3	0.4	2.1
Untreated Control	0.8	1.6	2.3
Rally4.0 oz + Induce 0.25 %	0.4	1.1	2.5
LSD	0.3	0.5	1.0
CV (%)	91.07	63.8	57.92

Fungicide Efficacy Comparison in 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

Comparison of Conventional Fungicides 2012

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

Evaluations of Bio-Fungicides in a Conventional Program, 2012

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 Efficacy 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)
- Rally (3)
- Priaxor (7 + 11)
- Fontelis (7)
- Quintec (13)
- Luna Sensation (7 +11)
- Torino (U6)
- Vivando (U8) Not registered
- Mettle (3)

Evaluation of Herbicide Carryover Sub-Surface Drip Irrigated Tomato

Kurt Hembree and Tom Turini

Farm Advisors, UCCE Fresno County

Poor Root Development; Fresno Co. 2008-2013

Few fibrous roots

Field Observations

- Permanent beds with buried drip to depth of 10” (top 6-8” of soil is tilled between crops)
- Prowl H2O applied (w/in the previous 12 months)*
- More damage reported following dry winters
- Severity of damage is generally consistent within rows
- Following cotton in some fields
- Shallow planting depth in some fields

* In one field, no Prowl was used, but Treflan was used every year for 5 years before the report of symptoms.

Project Initiated in 2013

Objective: Quantify dinitroaniline herbicide carryover in processing tomatoes with sub-surface drip over 3-years and determine crop injury potential.

Experimental Design: 4 rep split-plot

Main plot: Sprinklers for 3 weeks, then drip drip throughout the season

Sub-plot: PPI Treflan or Prowl and no herbicide

PPI on 4/22 and sample soil on 4/23

Transplant 3.5” to 4.5” deep on 4/24

Apply 3” of water through sprinklers

- High winds the day of transplanting and the day after resulted in poor early appearance of sprinkler-irrigated plants

Experimental Details:

- Pre-plant herbicides were applied on 22 Apr
- Plants (cv. H 5608) were transplanted mechanically on 24 Apr
- Soil from each plot was analyzed for Treflan and Prowl after incorporation (23 Apr) and again before harvest (25 Aug) at depths of 0-3” and 3-6”
- Root and shoot dry weights were calculated from plant samples taken in May and stand was recorded
- The number of plants expressing curly top symptoms were recorded and soil temperature and moisture were monitored
- 40 row ft per plot were hand-harvested on 6 Sep

High winds resulted in poor uniformity in sprinkler irrigated plots and reduced stand.

Over 48.8 % of the plants expressed curly top symptoms

Sprinkler/drip treatments were similar in quantities of herbicides detected.

Soil herbicide levels (ppm) in 2013 using HPLC

		4/23	4/23	4/23					
Irrigation	Herbicide	Treflan (0-3”)	Treflan (3-6”)	Prowl (0-3”)	(3-6”)	(0-3”)	(3-6”)	(0-3”)	(3-6”)
Drip	None	0.00 b	0.00	0.00 b	0.00 b	0.00	0.00	0.00 b	0.00
Sprinkler/drip	None	0.00 b	0.00	0.00 b	0.00 b	0.00	0.00	0.00 b	0.00
Drip	Treflan	**0.21 a**	**0.00**	0.00 b	0.00 b	**0.00**	**0.00**	0.00 b	0.00
Sprinkler/drip	Treflan	**0.18 a**	**0.00**	0.00 b	0.00 b	**0.00**	**0.00**	0.00 b	0.00
Drip	Prowl H2O	0.00 b	0.00	**1.85 a**	**0.21**	0.00	0.00	**0.20 a**	**0.04**
Sprinkler/drip	Prowl H2O	0.00 b	0.00	**2.28 a**	**0.31**	0.00	0.00	**0.21 a**	**0.05**
Statistical not. P=0.05	*CV (%) LSD*	*73.89 0.116*	*0.00 n.s.*	*73.70 1.29*	*122.32 0.192*	*0.00 n.s.*	*0.00 n.s.*	*70.92 0.131*	*293.94 n.s.*

Soil herbicide levels (ppm) in 2013 using HPLC (by irrigation)

	4/23	4/23	4/23	4/23	8/25	8/25	8/25	8/25
Irrigation	Treflan (0-3”)	Treflan (3-6”)	Prowl (0-3”)	Prowl (3-6”)	Treflan (0-3”)	Treflan (3-6”)	Prowl (0-3”)	Prowl (3-6”)
Drip	0.07	0.00	0.62	0.004	0.00	0.00	0.07	0.01
Sprinkler/drip	0.03	0.00	0.71	0.10	0.00	0.00	0.07	0.00
	LSD	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*

Herbicide/Irrigation Practice on Early Development

Sprinkler patterns related to high winds caused stand loss and less shoot growth

Tomato dry weight and stand (by irrigation)

Irrigation	Shoot (g) 30 DAT	Root (g) 30 DAT	Stand (no./plot)
Drip	36.37 a	9.34	68.5 a
Sprinkler fb drip	24.07 b	5.99	61.6 b

Herbicides did not significantly influence plant development.

Tomato dry weight and stand (by herbicide)

Herbicide	Shoot (g) 30 DAT	Root (g) 30 DAT	Stand (no./plot)
No herbicide	32.66	7.95	64.83
Treflan	30.57	6.05	64.75
Prowl H2O	27.44	4.99	65.50

Herbicide/Irrigation Practice Influence on Yield and Quality

No differences among treatments were documented: Curly top virus had substantial impact on yield, which was extremely variable.

Fruit yield, 50 count, and quality (by irrigation)

Irrigation	T/A Red	50 count weight (lb)	color	solids	pH
Drip	42.87	7.80	23.11	4.08	4.41
Sprinkler/drip	45.43	7.93	24.22	4.13	4.41

Fruit yield, 50 count, and quality (by herbicide)

Herbicide	T/A	50 count weight (lb)	color	solids	pH
No herbicide	38.60	7.77	24.17	4.15	4.42
Treflan	48.05	7.97	23.67	4.11	4.40
Prowl H2O	42.79	7.86	23.17	4.05	4.42

Summary

- Herbicides were not detected, or detected at extremely low levels deeper than 3” in the soil profile and did not negatively affect tomato shoot or root growth.
- Approximately 10% of the Prowl H2O detected before planting remained in the upper 3” by the end of the season; Treflan was not detected.
- Sprinkler irrigation did not influence depth of herbicides.

Project Outlook, 2014

- Additional sampling in March is scheduled to assess contribution of additional 6 months toward herbicide breakdown (rainfall levels will influence on results)

- Follow treatments imposed in 2013 with the same treatments on the same beds in 2014 and conduct similar assessments for plant development and yield as well as soil levels of herbicides

- CSU Fresno student will conduct greenhouse studies to quantify sensitivity of tomato to Treflan and Prowl H2O

Acknowledgements

California Tomato Research Institute
Growers and PCAs
West Side Research and Extension Center
Devon Rodriguez
Kurt Hembree
Robert Gilbertson
Ozgur Batuman
Diane Ullman
Michelle LeStrange
Brenna Aegerter
Industry Supporters