Tomato spotted wilt virus management with resistance-breaking strains

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Agriculture and Natural Resources

Overview

- Symptom recognition
- Background
- Plant resistance-breaking strain
- Management strategies

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Tomato spotted wilt virus (TSWV) Symptom Recognition

TSWV symptoms on tomato fruit

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Foliar symptoms of *TSWV*

Stage of crop development at the time of infection and stage of disease development influence symptoms

Beet curly top virus

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Alfalfa mosaic virus

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Tomato necrotic spot virus


Cut here
ACC 00936
SEB1, Sample extract pouch
Contains SEB1. Store at +4° C.
Contents: 3 ml
Lot No: 00039
agdia
FOR TESTING USE ONLY
Agdia
TSWV
SAMPLE

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Thrips vectors TSWV

Frankliniella occidentalis
(Western flower thrips)

Primary vector of TSWV in Central California

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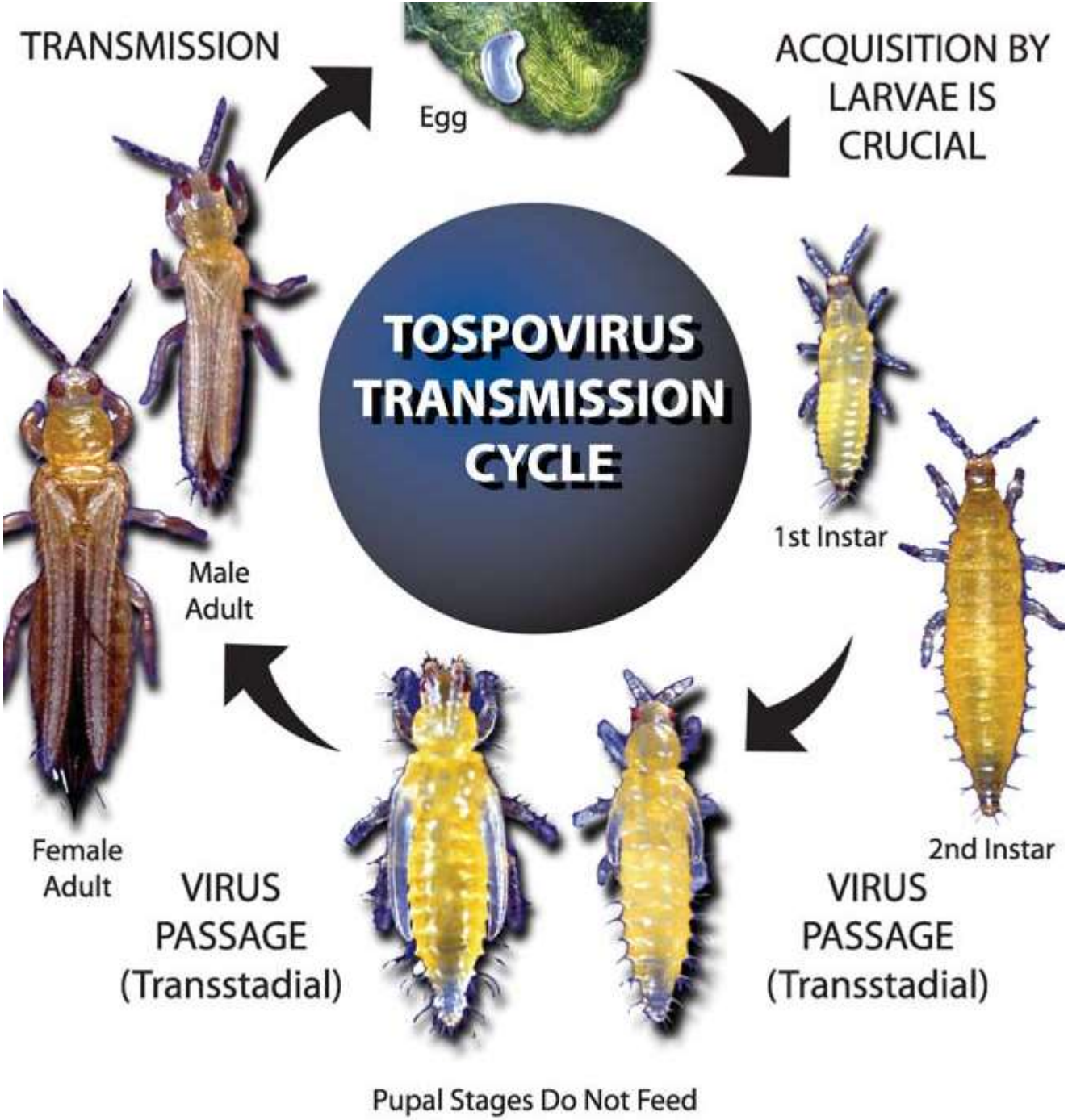

A. E.Whitfield, D. E. Ullman, and T L. German. 2005. **TOSPOVIRUS-THRIPS INTERACTIONS.** Annu. Rev. Phytopathol. 2005. 43:459–89

Host Range of TSWV

Crop Hosts

- Radicchio
- Lettuce
- Celery
- Fava bean
- Tomato
- pepper
- Eggplant
- Potato

Weed Hosts

- Prickly lettuce (*Lactuca serriola)*
- Sowthistle *(Sonchus spp.)*
- Little mallow *(Malva parvaflora)*
- Mustard *(Brassica spp.)*
- London rocket *(Sisymbrium irio)*
- Wild Radish *(Raphanus raphanistrum)*
- Pineappleweed *(Chamomilla suaveolens)*
- Rough-seeded *buttercup* (Ranunculus muricatus)
- Nightshade *(Solanum spp.)*
- Jimsonweed (*Datura stramonium)*
- Field bindweed *(Convolvulus arvensis)*

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Annual Cycle TSWV/Western flower thrips in Central California

- Overwintering: in a small percentage of weeds and crops & TSWV pupating thrips
- Early season: reproduction of thrips and possible virus increase of TSWV on susceptible weeds and crops
- Mid season: movement to tomatoes and rapid increase in TSWV in areas with high levels of susceptible plants
- Late season: Highest pressure of the year

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TSWV Resistance

- SW5: Single dominant gene
- In widespread use in the Central San Joaquin Valley for ~7 years
- No documentation of resistance-breaking strains in CA prior to 2016
- Expression in SW5 varieties due to Wild type TSWV
  - There may be expression on up to 3% of plants
  - Unusual fruit symptoms in the absence of foliar symptoms may occur

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Detection of Resistance-breaking TSWV strain in Fresno Co. in 2016

- **Mid-Apr 2016, severe and typical symptoms of TSWV in Sw-5 fresh market tomatoes in Cantua Creek (Fresno Co.)**
- **May 2016, severe TSWV in Sw5 fresh market tomatoes in Firebaugh (Fresno Co.)**
- **July 2016, moderate TSWV in Sw5 processing tomatoes in Huron area**

All samples were Immunostrip positive

Virology – O. Batuman, R. Gilbertson

- RT-PCR/sequencing tests revealed only TSWV infection
- Raised the issue of the emergence/introduction of a resistance-breaking (RB) strain
- RB strains have been reported from Europe (Spain and Italy) and have been associated with specific amino acid substitutions in the viral movement protein (NSm)

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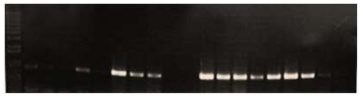
Identification of TSWV RB strain

Typical tospovirus symptoms

Test for TSWV with immunostrips

Confirm TSWV by RT-PCR



Confirm RB strain by RT-PCR of NSm gene

Amino acid (aa) sequence

MDTSKGKILLNTEGTSSFGTYESDSITESEG
YDLSARMIVDTNHHISNWKNDLFVGNGK
QNANKVIKIYPTWDSRKQYMMISRIVIWV
C

aa substitution C to Y in 118 position or T to N in 120 position

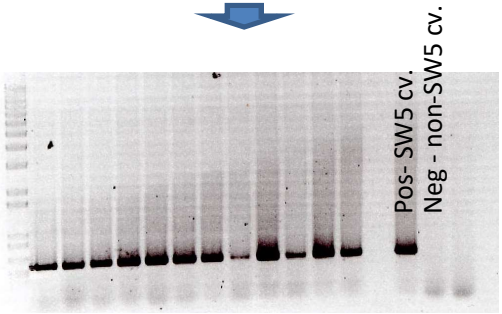
RB strain

MDTSKGKILLNTEGTSSFGTYESDSITESEG
YDLSARMIVDTNHHISNWKNDLFVGNGK
QNANKVIKICPTWDSRKQYMMISRIVIWV
C

no aa substitution in 118 or 120 position (CPT)

WT strain

Confirm tomato is a resistant variety by PCR for SW-5



From Gilbertson presentation at UC West Side Research Extension Center on 14 Dec 2017

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Resistance Breaking *Tomato spotted wilt virus, 2017*

- Detected in Sowthistle in Jan and Feb 2017 in Huron and Cantua Creek
- Resistance breaking strains associated with weedy areas early 2017 in Fresno Co.

- By Oct., 2017 over larger area in Fresno Co., detected in Merced and Brentwood.
- By the end of 2017, the resistance breaking TSWV strain was detected in lettuce, celery and peppers.

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Collaboration with Ag Seeds and TS&L, 2017

- Evaluation of variety trial in area affected by resistance-breaking TSWV on 17 Jul 2017
- Tomato spotted wilt virus incidence observed among entries at **one site** were from undetectable levels to 52% of plants expressing TSWV

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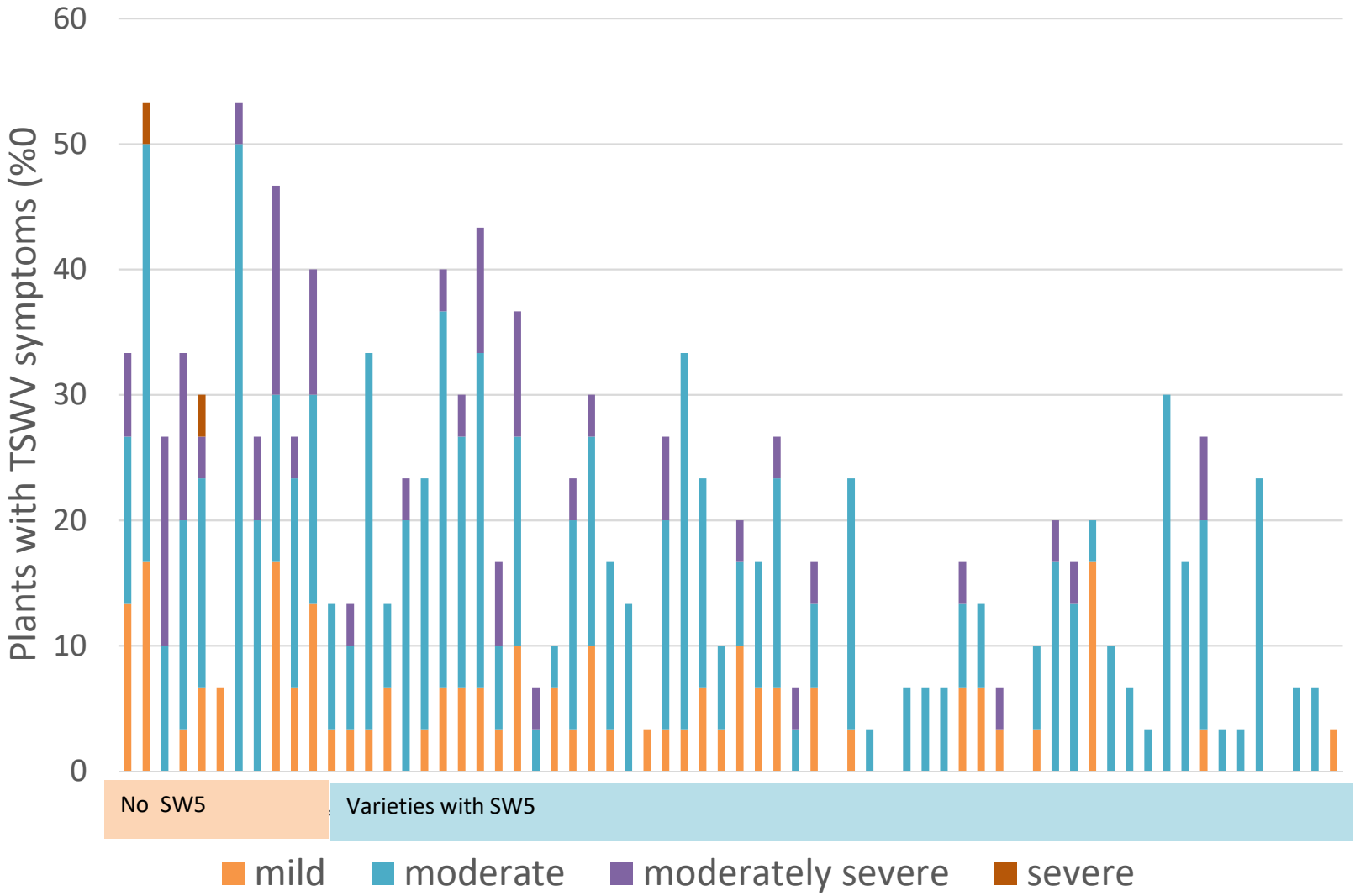
2017 Preliminary Observations (NO REPLICATION)

Percentage TSWV in 80 Treatment Trial

(No resistance and resistance grouped)



Variety Trial: Strain Determination

Variety	SW5 in variety	Strain detected
H1015 -no SW5	-	CPT
BQ273 -SW5	+	YPT
N6402 -SW5	+	YPT
HM3887 -SW5	+	YPT
DRI319 -SW5	+	YPT
H1292 -SW5	+	YPT
BP13 -SW5	+	YPT

CPT=wild type strain
YPT= resistance-breaking strain

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TSWV Field Research, 2018

- Monitoring of weeds & crops for resistance breaking strain
- Evaluation of commercial trials for varietal response in Central Valley
- Evaluation of lines with alternative mechanisms of resistance at the West Side Research and Extension Center

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Successful TSWV Management Program Depends Upon Multiple Approaches

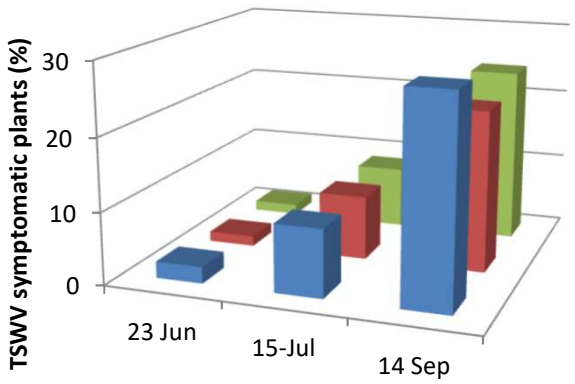
- Minimize host densities during winter
- Site selection
- Planting time: early season = lower risk
- Clean transplants
- Use of TSWV-resistant varieties
- Management of thrips

Management of Thrips

- Thrips degree day model is available online
- Radiant, Lanate and dimethoate deliver relatively consistent control
- Drip or transplant water-applied neonicotinoids have not reduced TSWV incidence in most trials
- Verimark transplant treatment reduced TSWV incidence 3/6 trials

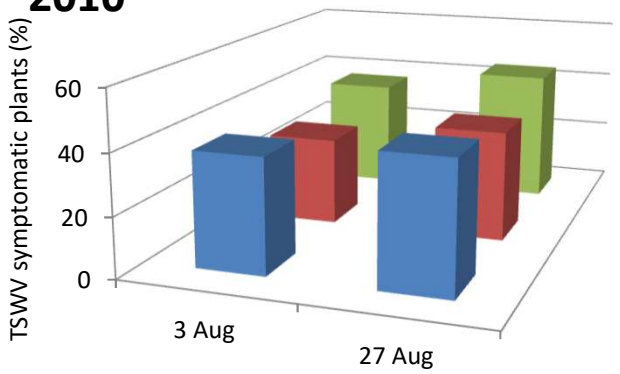
Influence of Drip-Applied Insecticides

2009



- thiamethoxam 193 g (3 Jun)
- thiamethoxam 193 g (3 Jun), dinotefuron 294 g (7 Jul)
- Untreated

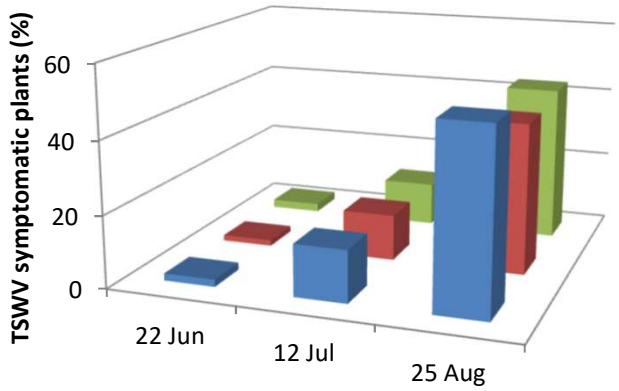
2010



- thiamethoxam 193 g (25 May), dinotefuron 294 g (30 Jun)*
- thiamethoxam 193 g (25 May), dinotefuron 294 g (30 Jun)
- Untreated

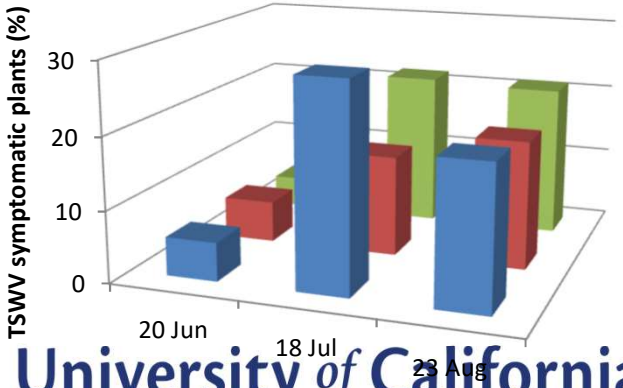
* Weekly injections of acibenzolar-s-methyl 35g/ha

2011



- thiamethoxam 193 g (22 Jun), dinotefuron 294 g (12 Jul)
- thiamethoxam 193 g (22 Jun), dinotefuron 294 g (22 Jul)
- Untreated

2012



- thiamethoxam 193 g (7 Jun), dinotefuron 294 g (27 Jun)
- thiamethoxam 193 g (7 Jun), cyantraniliprole 177 g (27 Jun)
- Untreated

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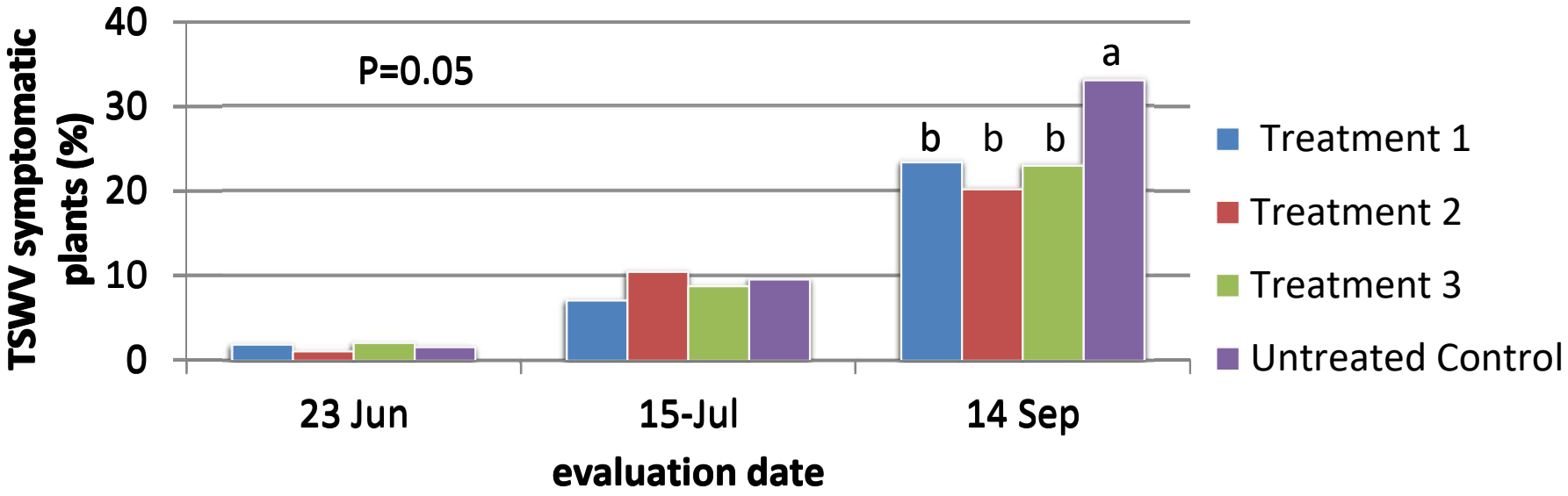
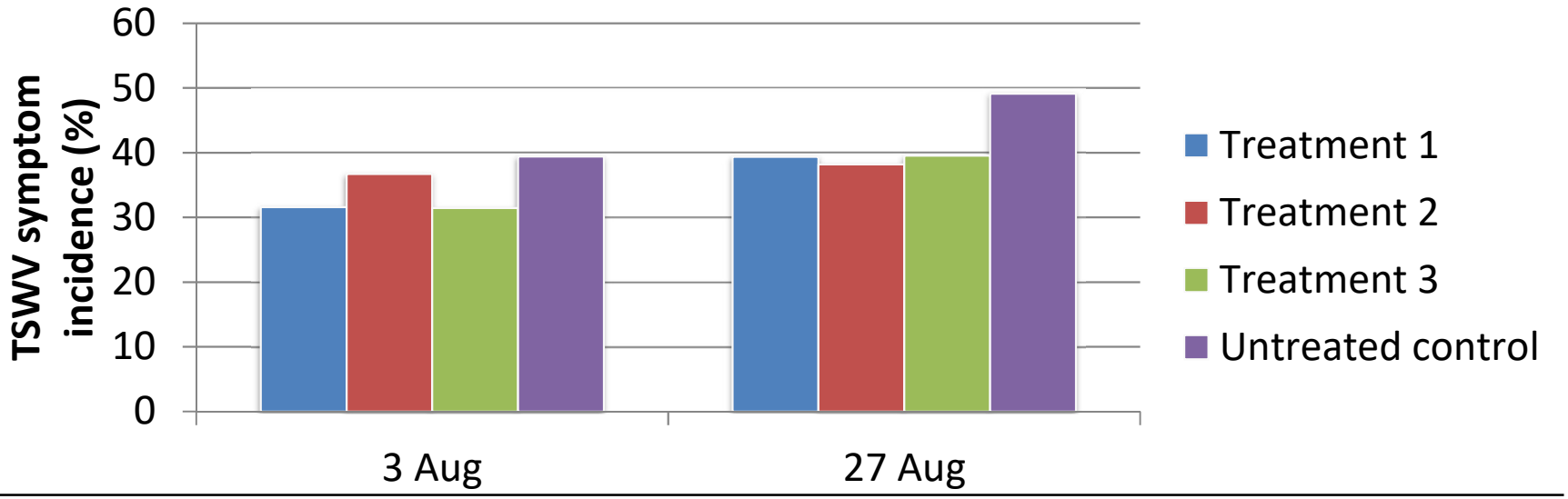
Foliar Treatment Impact on TSWV Symptomatic Plant Incidence 2009



	date of application, rate		
	17 Jun	1 Jul	15-Jul
Treatment 1	Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz
Treatment 2	Radiant 10 fl oz	Dimethoate 4EL 1 pt	
Treatment 3		Dimethoate 4EL 1 pt	Radiant 10 fl oz
Untreated control			

Foliar Treatment Impact on TSWV Symptomatic Plant Incidence 2010



	date of application, quantity ai/ha				
	drench	9 Jun	23 Jun	7 Jul	16 Jul
Treatment 1	Verimark 13.5 fl oz	Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz	Dimethoate 4EL 1 pt
Treatment 2		Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz	Dimethoate 4EL 1 pt
Treatment 3		Radiant 10 fl oz	Dimethoate 4EL 1 pt		
Untreated control					

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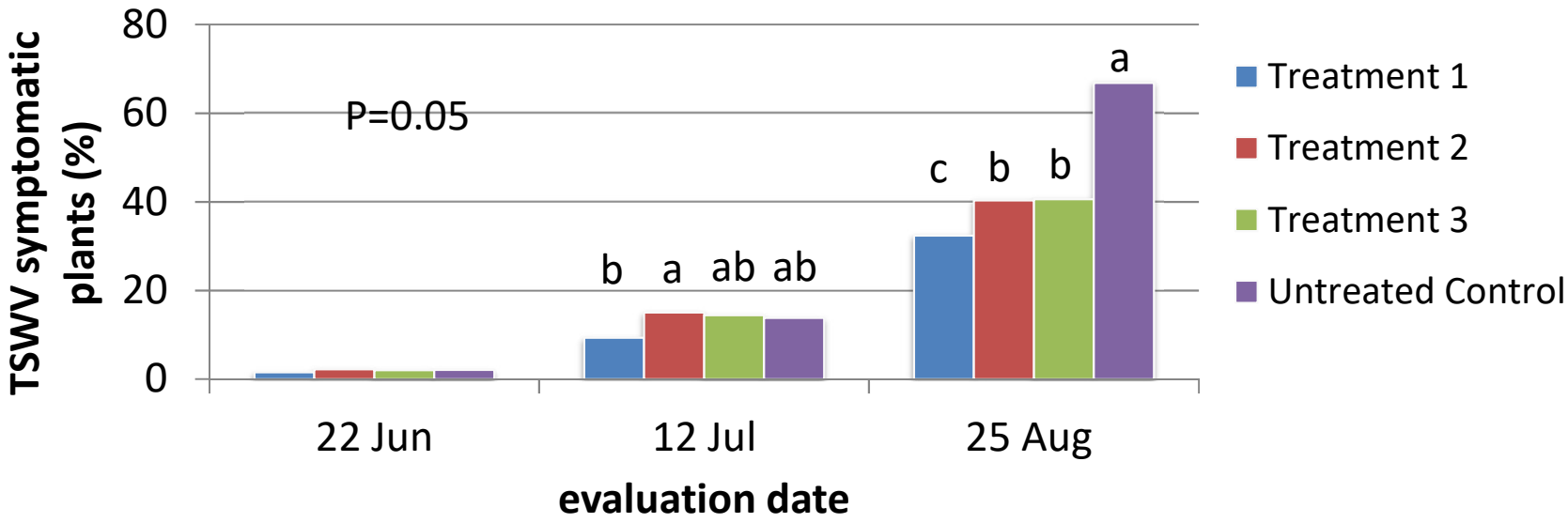
Foliar Treatment Impact on TSWV Symptomatic Plant Incidence 2011



		date of application, quantity ai/ha			
	Trans. drench	24-Jun	6-Jul	14-Jul	21-Jul
Treatment 1	Verimark 13.5 fl oz	Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz	Dimethoate 4EL 1 pt
Treatment 2		Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz	Dimethoate 4EL 1 pt
Treatment 3		Radiant 10 fl oz	Dimethoate 4EL 1 pt		
Untreated Control					

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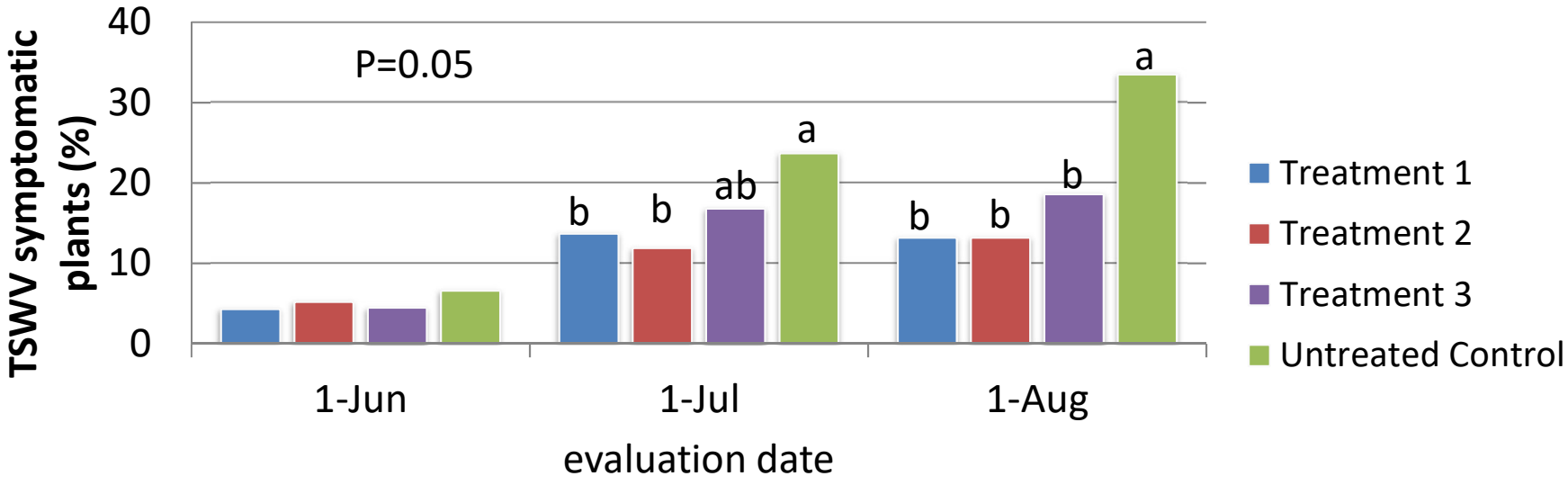
Foliar Treatment Impact on TSWV Symptomatic Plant Incidence 2012



	date of application, quantity ai/ha					
	drench	12-Jun	22-Jun	29-Jun	9-Jul	18-Jul
Treatment 1	Verimark 13.5 fl oz	Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz
Treatment 2		Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz	Dimethoate 4EL 1 pt	Radiant 10 fl oz
Treatment 3		Radiant 10 fl oz	Dimethoate 4EL 1 pt			
Untreated Control						

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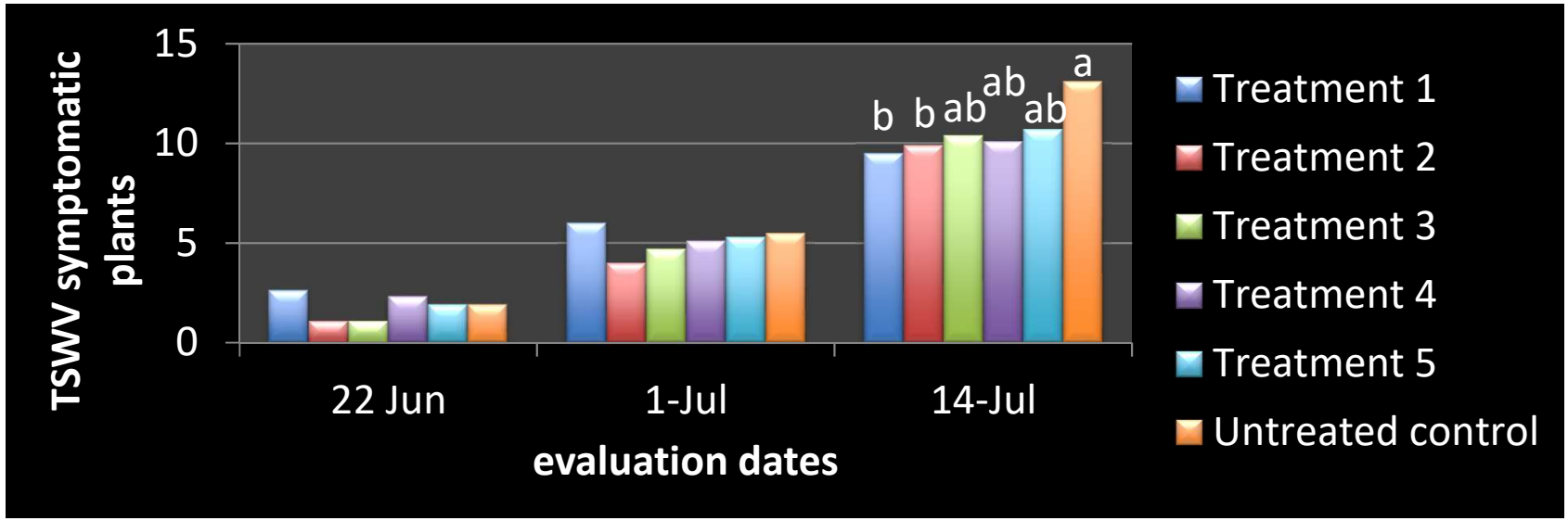
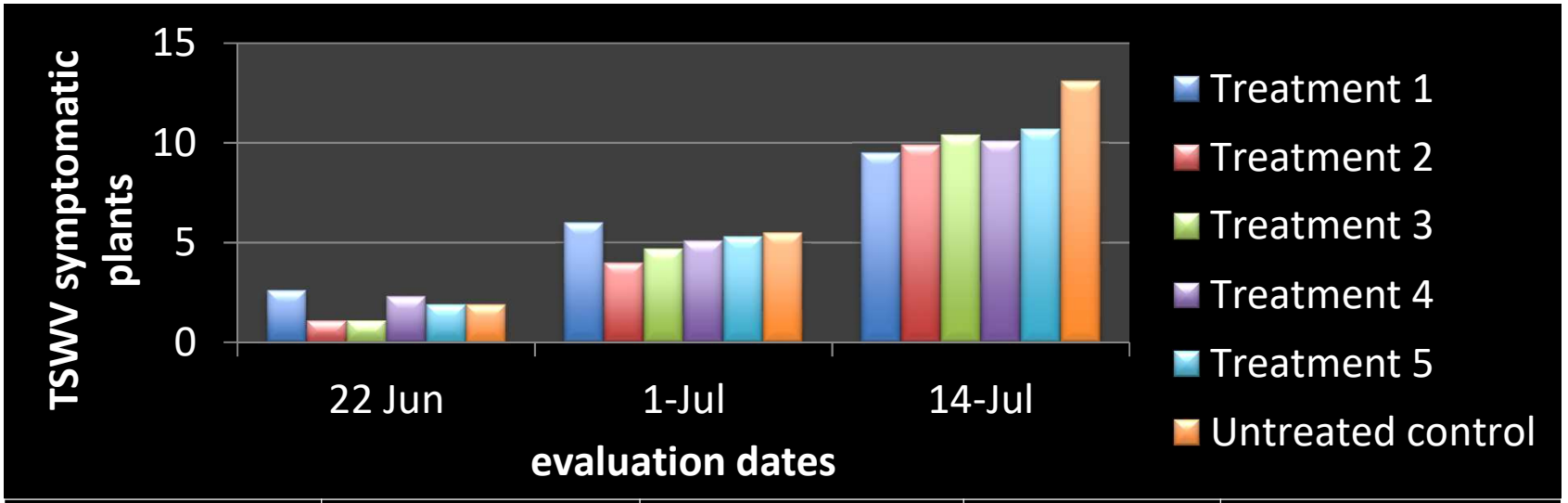
Impact of Insecticides on TSWV Symptomatic Plant Incidence, 2015



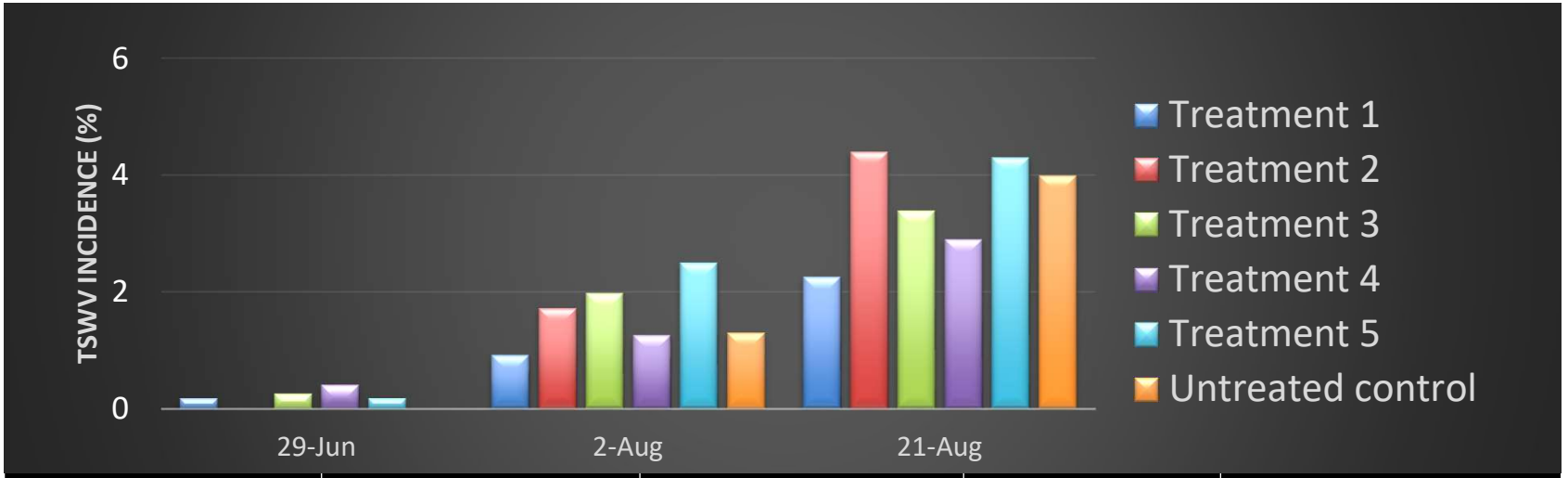
	Transplants 21 May	22 May transplant water	22 May foliar	22 June
Treatment 1	Verimark 13.5 fl oz			
Treatment 2		Admire 4.0 fl oz	Sivanto 2.0 fl oz	Admire 6.5 fl oz
Treatment 3		Admire 10.0 fl oz		
Treatment 4			Sivanto 2.0 fl oz	Admire 6.5 fl oz
Treatment 5				Admire 6.5 fl oz

Impact of Insecticides on TSWV Symptomatic Plant Incidence, 2016



	transplant trt 16 May	transplant water 17 May	10 Jun	28 Jun
Treatment 1	Verimark 13.5 fl oz			
Treatment 2		Admire Pro 4.0 fl oz	Verimark 10 fl oz drip	Verimark 10 fl oz drip
Treatment 3			Sivanto 10.5 fl oz Platinum 3.67 oz (drip)	Venom 6.0 oz drip
Treatment 4		Admire Pro 4.0 fl oz	Platinum 3.67 oz (drip	Venom 6.0 oz drip
Treatment 5	Verimark 13.5 fl oz		Platinum 3.67 oz (drip	Venom 6.0 oz drip

Impact of Insecticides on TSWV Symptomatic Plant Incidence, 2017



	transplant trt 17 May	transplant water 18 May	Foliar 1 Jun	23 Jun drip applied
Treatment 1	HGW86-885 13.5 fl oz			
Treatment 2	HGW86-906 13.5 fl oz			
Treatment 3	HGW86-885 13.5 fl oz			Platinum 11 fl oz
Treatment 4		Admire Pro 4.0 fl oz		Platinum 11 fl oz
Treatment 5		Admire Pro 4.0 fl oz SP2700 7.8 fl oz	SP2700 7.8 fl oz	Platinum 11 fl oz

Influence of Insecticides on TSWV, 2017

	yield[z]	fruit quality (%)[y]					laboratory analysis[x]		
Treatment, application (date applied)[w]	(tons/ acre)	red	grn	sun burn	rot	TSW	color	solids	pH
HGW86-885 13.5 fl oz tray drench (17 May)[v]	61.08	74.43	1.28	4.09	1.28	4.98	25.0	4.78	4.503
HGW86-906 13.5 fl oz tray drench (17 May)	52.23	71.56	2.35	5.35	2.35	1.21	24.3	4.83	4.508
HGW86-885 13.5 fl oz tray drench (17 May) Platinum 11 fl oz buried drip application (23 Jun)[u]	57.49	72.21	1.51	5.05	1.51	3.53	24.5	4.85	4.523
Admire Pro 8.7 fl oz in transplant water (18 May)[t] Platinum 11 fl oz buried drip application (23 Jun)	56.78	74.18	2.05	3.20	2.05	4.28	24.5	5.03	4.525
Admire Pro 8.7 fl oz + SP2700 7.8 fl oz in transplant water (18 May) SP2700 7.8 fl oz (1 Jun)[s] Platinum 11 fl oz buried drip application (23 Jun)	60.75	70.92	2.74	5.11	2.74	3.39	25.0	4.90	4.523
Untreated control	65.71	67.72	2.75	6.34	2.75	6.47	25.0	4.63	4.518
$LSD_{0.05}$ [r]	8.898	NS[q]	NS	NS	NS	3.059	NS	0.329	NS
CV (%)	10.01	6.47	49.82	49.82	65.85	51.02	4.55	4.52	0.95

Main Points

- Plant-resistance breaking TSWV is present in the Central San Joaquin Valley production area.
- Any TSWV foliar symptoms present in more than 3% of the plants should be checked for the resistance breaking strain
- Current management depends upon IPM, heavily reliant upon sanitation and site selection.
- Insecticides may reduce incidence but should not be relied upon without other approaches.

Acknowledgements

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