Recent research on *Tomato spotted wilt virus* in the Central San Joaquin Valley

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Overview

- Tomato spotted wilt virus
 - Background
 - Symptom recognition/ Biology
 - Plant resistance-breaking strain
 - Varietal evaluations
 - Integrated pest management strategies

Symptoms of TSWV on Tomato Fruit









Foliar TSWV expression







TSWV and stage of crop development









Thrips vectors TSWV



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

Host Range of TSWV

Crop Hosts

- Lettuce
- Celery
- Radicchio
- Fava bean

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)

- Tomato
- Pepper
- Eggplant
- Potato
- Nightshade (Solanum spp.)
- Jimsonweed (Datura stramonium)
 - Field bindweed (Convolvulus arvensis)

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Annual Cycle TSWV/Western flower thrips in Central California

Mar-Apr: thrips and TSWV increase on weeds and winter crops

Dec-Feb: TSWV and thrips overwinter at low levels

May-Jul: rapid increase of TSWV levels on tomatoes and other hosts

Late-Oct to Nov: Decline in thrips populations and plants supporting TSWV Aug-Oct: TSWV levels are highest

TSWV Resistance

- SW5: Single dominant gene
- In widespread use in the Central San Joaquin Valley for ~7 years
- 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
- No documentation of resistance-breaking strains in CA prior to 2016





Sw-5 Resistance-breaking strain



13 Apr 2016, Sw-5 fresh market tomatoes in Cantua Creek (Fresno Co.)

Modified from Gilbertson UC West Side Research Extension Center presentation on 14 Dec 2017

Resistance breaking

Wild type

aa substitution C to Y in 118 position (C118Y) or T to N in 120 position (T120N)

no aa substitution in 118 or 120 position (CPT)

Typical tospovirus symptoms





Amino acid (aa) sequence MDTSKGKILLNTEGTSSFGTYESDSITESEG YDLSARMIVDTNHHISNWKNDLFVGNGK QNANKVIKI<mark>YPT</mark>WDSRKQYMMISRIVIWV

C MDTSKGKILLNTEGTSSFGTYESDSITESEG YDLSARMIVDTNHHISNWKNDLFVGNGK QNANKVIKI<mark>CPT</mark>WDSRKQYMMISRIVIWV

Sw-5 Resistance-breaking strain, 2016

- First detection mid-Apr 2016, 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 Sw-5 processing tomatoes in Huron area

Detection of RB TSWV , 2017



Detection of RB TSWV, Late 2017

- Merced and Santa Clara **County by Oct**
- Late season reports in \bullet lettuce (Merced), and peppers and celery (Fresno)



Norte

Humboldt

Trinity

Mendocino

Marin

Sonoma

San Francisco

Siskiyou

Shasta

Butte

Sutter

Solano

Contra

Costa

Yuba

Sacramento

San

Joaquin

Tehama

Glenn

Napa

Colusa

Modoc

Lassen

Plumas

Sierra Nevada

Placer

Alpine

Mono

Tuolumne

El Dorado

alavera

Stanislau

Detection of RB TSWV, 2018



Collaboration with Ag Seeds and TS&L

Evaluation of commercial variety trial in area affected by resistance-breaking TSWV





- Company representatives provide trial maps
- UC personnel check fields for 10% incidence or more Advisors evaluate disease incidence
- In at least three trials, 3 shoots per variety in at least 6 varieties sampled and strain identified



34 entries repeated over locations (6 trials)

AB 0311	H1293	HM5235	N6420
BP 13	H1428	HM58801	N6426
BP 16	H1662	HM58841	N6428
BQ273	H5508	HM58871	SV8011TM
BQ400	H5608	HM5900	SVTM1082
BQ401	HM3887	HM7885	UG 15212
BQ403	HM3888	N6366	UG 16609
DRI319	HM4885	N6416	UG 19406
H1015	HM4909		

Rating scale

- 0 symptomless
- 1 shoot symptoms only
- 2 mild fruit and shoot symptoms
- 3 severe fruit and leaf symptoms
- 4 stunted plants, no fruit or symptomatic fruit only







2018 Observations (34 entries x 5 replications) Percentage TSWV (grouped by presence of Sw5)



Disease Incidence (34 entries x 6 replications) 16 LSD (0.05) for total incidence = 11.55714 TSWV incidence (%) CV (%) = 93.333% 12 10 8 6 4 2 0 N6426 N6416 N6366 BP 16 BQ400 N6420 H1293 H5608 DRI319 H1428 N6428 BQ403 BQ401 BQ273 H5508 H1662 16609 H1015 UG 19406 13 SVTM1082 SV8011TM HM4909 HM5235 HM4885 JG 15212 HM3888 HM58871 HM5900 AB 0311 HM58801 HM7885 HM58841 HM3887 ВР Ю П moderate mild moderately severe severe

Variety Trial: Strain Determination 2017

Variety	SW5 in	Strain
	variety	detected
H1015	-	wt
BQ273	+	Rb
N6402	+	Rb
HM3887	+	Rb
DRI319	+	Rb
H1292	+	Rb
BP13	+	Rb

Strain identification Sw-5 resistance breaking (Rb) Wild type (wt)

Variety Trial: Strain Determination 2018

Variety	SW5	Strain detected (rb or wt)		
		Five Pts	Huron	Merced
S6366	-	Rb	Rb	Rb
UG19406	-	Rb	Rb	Rb
BQ413	+	Rb	Rb	Rb
UG16609	+	Rb	Rb	Rb
HM5900	+	Rb	Rb	Rb
H1293	+	Rb	Rb	Rb
N6420	+	Rb	Rb	Rb
BOS811	+	Rb	Rb	Rb
AB311	+	Rb	Rb	Rb

Strain identification Sw-5 resistance breaking (Rb) Wild type (wt)

Evidence of Persistence of Sw5breaking TSWV in Central San Joaquin Valley

- Presence in winter weeds and lettuce
- Detection in non-Sw5 tomatoes and in crops lacking Sw5

Evaluation of acyl sugar lines, 2018 UC West Side Field Station

Line Name	Line Description	BCTV Infection	TSWV Infection
Sun 6366	Susceptible Control, no Sw-5	LOW	HIGH
Heinz 5608	Resistant Control, +Sw-5	MODERATE	MODERATE
AS Benchmark + Sw-5	Acylsugar + Sw-5	HIGH	LOW
AL6/AS + Sw-5	QTL6 which increases acylsugar with Sw-5	LOW	LOW
AL6/AS +Sw-5 x FA2/FA7-AS7/AS	Cross, multiple QTL to increase AS amount + fatty acid QTL + Sw-5	MODERATE	LOW
AL6/AL10/AS +Sw-5	Acylsugar QTL6 and QTL10 combination that increases acylsugar production	LOW	HIGH
FA7/AS	Benchmark + FA7, no Sw-5	MODERATE	MODERATE
FA2/FA7/AS	Benchmark + FA2 & FA7, no Sw-5	MODERATE	HIGH

Trial conducted in collaboration with Diane Ullman) Martha Mischler (Cornell) and Robert Gilbertson

Field Trial at UC West Side Research and Extension Center

Observations from the only Central Valley Trial



- Disease pressure was moderate to high for BCTV and TSWV
- Plants were infected by BCTV or TSWV; very few mixed infections
- Sw-5 commercial line (H5608) had moderate TSWV infection,
- Sun 6366 (no Sw-5) had high incidence
- Some evidence that acylsugars (AL6/AS) can protect Sw-5

Modified from Gilbertson UC West Side Research Extension Center presentation on 15 Aug 2018

Management of Thrips

- 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 3/7 trials
- Thrips degree day model is available online

University of California TSWV Field Risk Index and Thrips Projections

Home



Thrips Population Projections for Tomato

About thrips population projections

We currently provide projections for Western Flower Thrips populations for five areas in the California central valley. Clicking on each of the links in the menu on the left will open a new tab/window in your browser which will display the information for the area you have chosen. Each page has the same layout. The image below shows a screenshot with some explanation of what each area of the page does. If you have trouble reading the descriptions, clicking on the image will open it in full screen mode. Use your browser's "back" button to return to this page.

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Further information on the thrips projection model

The model was developed in collaboration with Dr Len Coop of Oregon State University's Integrated Plant Protection Center (IPPC). The IPPC developed and hosts the <u>USPEST</u> web service which is a multi pest multi model tool that provides information on pest development and disease risk for the contiguous 48 US states using a network of weather stations.

Use the menu on the left side of the screen to see the current status and population development projections for each area.



url: http://ucanr.edu/sites/TSWVfieldriskindex/Thrips_Population_Projections/

Clicking on each of the links in the menu on the left will open a new tab/window in your browser which will display the information for the area you have chosen.

TSWV Management Now

- 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.

Insecticides Evaluatated in Programs

Group #	Chemical sub- group	Primary target site of action	Trade name	Active ingredient
1A	Carbamate	Acetylcholineesterase inhibitors	Lannate LV	methomyl
1B	Organophosphate	Acetylcholinesterase inhibitors	Dimethoate 4EL	dimethoate
4A	Neonicotinoid	Nicotinic acetylcholine receptor (nAChR) competitive modulators	Admire, Platinum, Venom	Imidacloprid, Thiamethoxam, Dinotefuran
5	Spinosyns	Nicotinic acetylcholine receptor allosteric activators	Radiant Entrust	spinetoram spinosad
28	Diamide	Ryanodine receptor modulators Nerve and muscle action	Cyazypyr, Exeril, Verimark	cyantraniliprole

IRAC Mode of Action Classification Scheme Jul 2017

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