The resistance-breaking strain of *Tomato spotted wilt virus* in the Central Valley of California: Survey, genetic variability, improved detection and screening for resistance

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Tomato spotted wilt diseases caused by *Tomato spotted wilt virus* (TSWV)

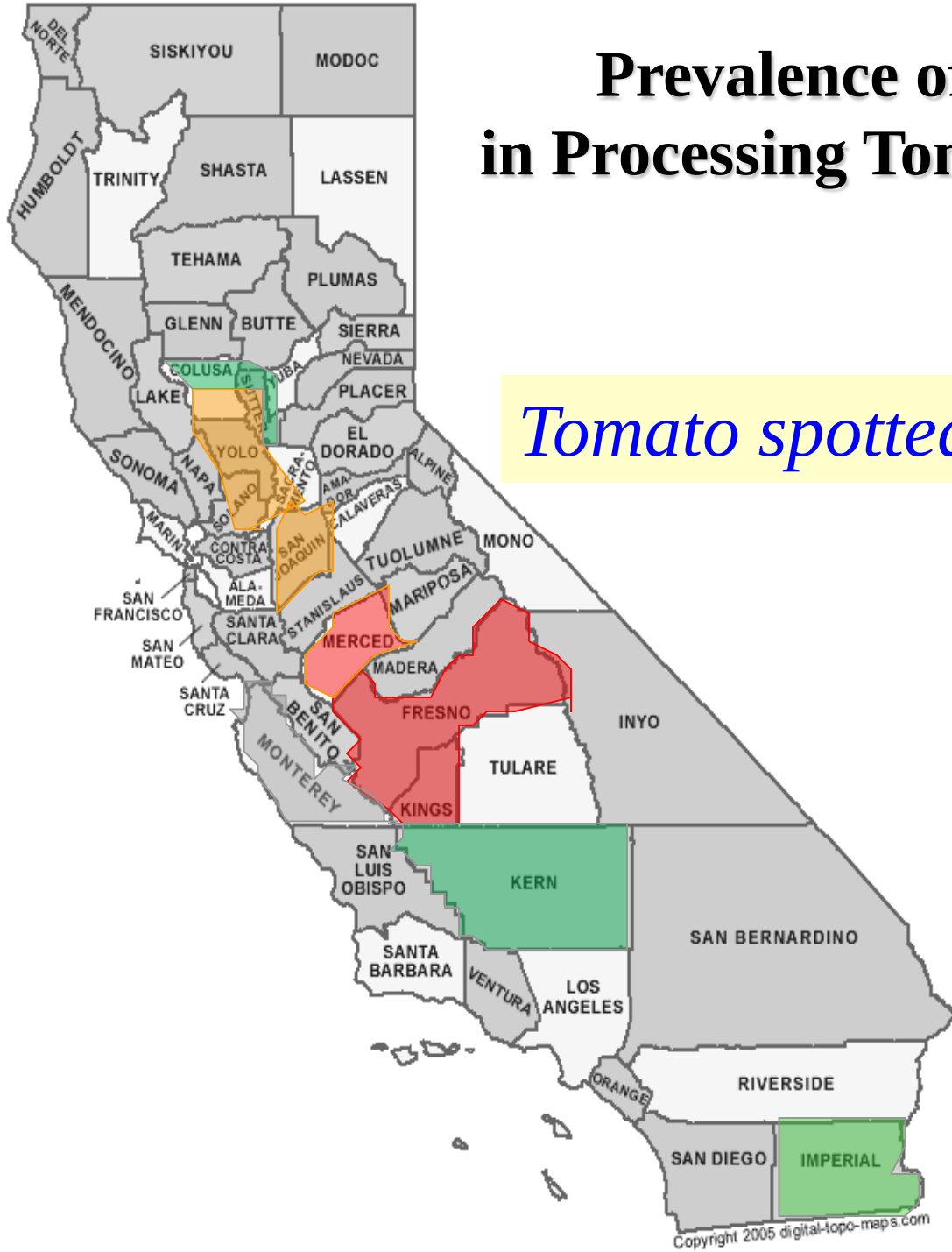
- Stunting: bronzing, necrosis and yellowing of leaves and ringspots and necrosis in fruits)
- Symptoms vary depending on variety and age at which plants are infected






Prevalence of Virus Diseases in Processing Tomatoes of California

Tomato spotted wilt virus (TSWV)



IPM for TSWV

-Planting TSWV- and thrips-free transplants

-Growing TSWV-resistant varieties

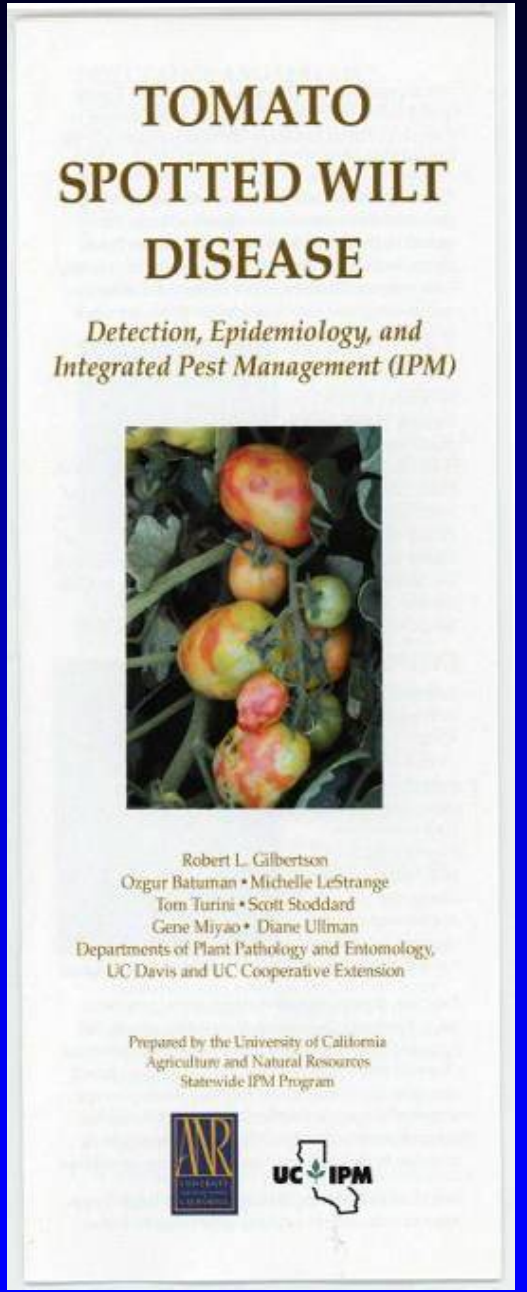
-Monitoring for thrips populations
(yellow sticky cards/degree-day model)

-Managing thrips with rotation of insecticides

-Roguing of TSWV-infected tomato plants (early)

-Prompt plowing fields after harvest

-Extensive sanitation including weeds, volunteers and other crops



Appearance of a resistance-breaking strain of *Tomato spotted wilt virus* in the Central Valley of California in 2016

- In the spring of 2016, typical and severe symptoms of TSWV were observed in Sw-5 fresh market tomatoes in Cantua Creek and Firebaugh (Fresno Co.)
- Immunostrip and RT-PCR/sequencing tests revealed only TSWV infection

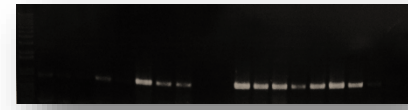
- Suggested the emergence/introduction of a resistance-breaking (RB) strain
- RB strains have been reported from Europe (Spain and Italy) and have been associated with specific amino acid substitutions in the viral movement protein (NSm), including 'YPT'

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 and sequencing

Amino acid (aa) sequence

MDTSKGKILLNTEGTSSFGTYESDSITESEGYD
LSARMIVDTNHHISNWKNDLFVGNGKQNA
NKVIKIYPTWDSRKQYMMISRIVIWVCP

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

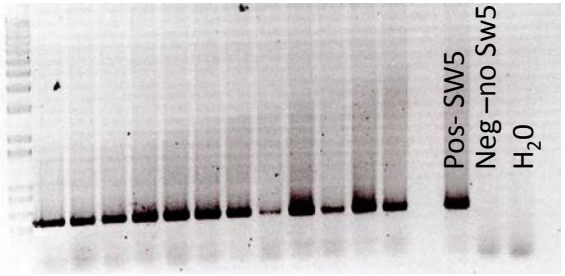
RB strain

MDTSKGKILLNTEGTSSFGTYESDSITESEGYD
LSARMIVDTNHHISNWKNDLFVGNGKQNA
NKVIKICPTWDSRKQYMMISRIVIWVCP

no aa substitution in 118 or 120 position (CPT)

WT strain

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



Detection of the RB-TSWV strain from weeds during the winter survey in 2017

WEED SAMPLES						
Scientific name	**Common name**	**Botanic family**	**Total of samples**	**TSWV +**	**CPT**	**YPT**
Amaranthus sp.	Amaranthus	Amaranthaceae	1	0	xxx	xxx
Lactuca sativa	Lettuce	Asteraceae	1	0	xxx	xxx
Lactuca sp.	Prickly lettuce	Asteraceae	2	0	xxx	xxx
Matricaria sp.	Pineapple weed	Asteraceae	5	0	xxx	*Sonchus* sp.
	Sowthistle	Asteraceae	39	6 (15%)	2 (34%)	4 (66%)
Brassica sp.	Mustard	Brassicaceae	1	0	xxx	xxx
Beta vulgaris	Sugar beet	Chenopodiaceae	5	0	xxx	xxx
Chenopodium sp.	Chenopodium	Chenopodiaceae	3	0	xxx	xxx
Cucumis sp.	Cucumis	Cucurbitaceae	4	0	xxx	xxx
Medicago sativa	Alfafa	Fabaceae	5	0	xxx	xxx
Malva sp.	Malva	Malvaceae	2	0	xxx	xxx
Solanacearum sp.	Solanacearum	Solanaceae	1	0	xxx	xxx
TOTAL			69	6 (15%)	2 (34%)	4 (66%)

Detection of the TSWV-RB strain in tomato varieties with and without the *Sw-5* gene in 2017

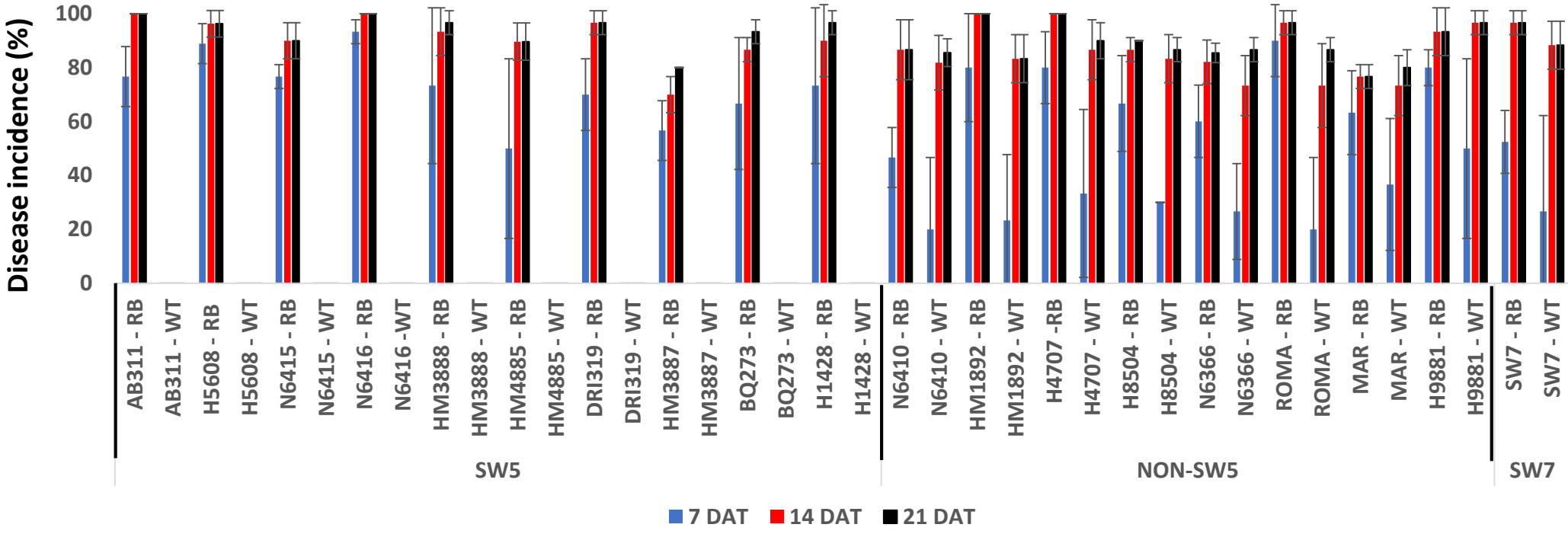
TOMATO – Sw-5			
COUNTY	**TOTAL**	**YPT**	**CPT**
FRESNO	94	91 (97%)	3 (3%)
MERCED	9	9 (100%)	0 (100%)
CONTRA COSTA	2	2 (100%)	0 (100%)
TOTAL	105	102 (97%)	3 (3%)

TOMATO – non-Sw-5			
COUNTY	**TOTAL**	**YPT**	**CPT**
FRESNO	33	13 (40%)	20 (60%)
VENTURA	2	0 (0%)	1 (100%)
YOLO	1	0 (0%)	1 (100%)
TOTAL	36	13 (36%)	22 (64%)

Detection of the RB-TSWV strain in other crops in 2017

OTHER CROPS				
COUNTY	**TOTAL**	**CROP**	**YPT**	**CPT**
FRESNO	3	CELERY	1 (33%)	2 (67%)
SAN JOAQUIM	6	PEPPER	0 (0%)	6 (100%)
MERCED	2	LETTUCE	1 (50%)	1 (50%)
TOTAL	11		2 (18%)	9 (82%)

Response of tomato varieties with and without the Sw-5 gene to inoculation with the wild-type and RB strains of TSWV

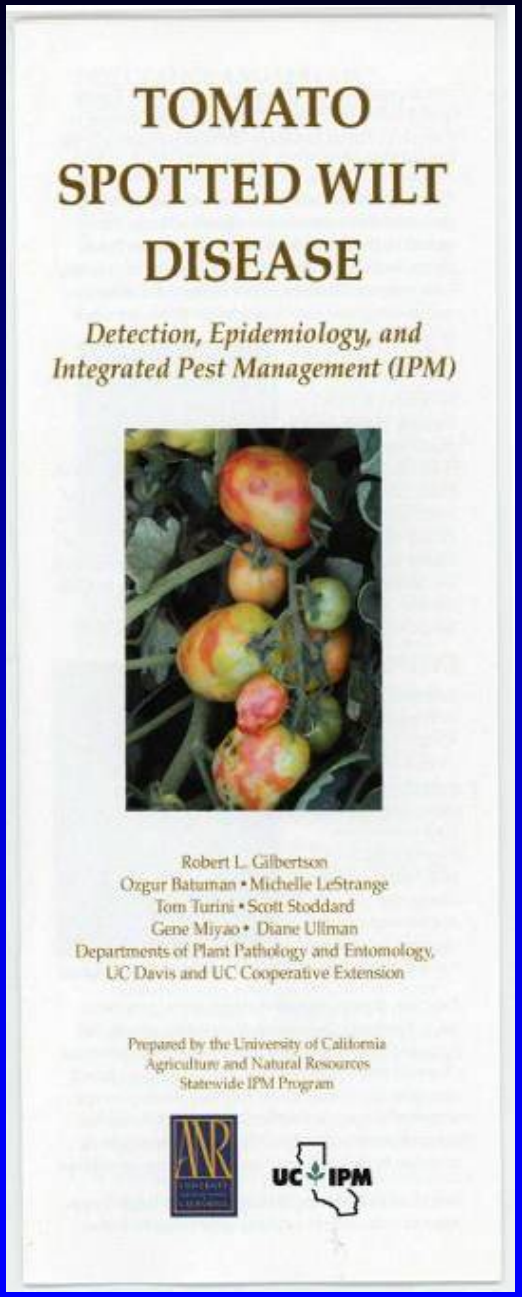


Conclusions

- The RB-TSWV strain overwintered in weeds in 2017
- In Fresno County, the RB-TSWV was detected in most (97%) Sw-5 samples and in 40% of non-Sw-5 samples; the wild-type TSWV strain was in 60% of non-Sw-5 varieties
- The RB-TSWV strain spread to Merced and Contra Costa Counties
- The RB-TSWV strains was also detected in celery and lettuce
- RB-TSWV strain infected and caused typical spotted wilt symptoms in all of the major Sw-5 processing tomato varieties tested

Future Directions

- **Continued monitoring** of the spread of the RB-TSWV
- Develop a **more rapid diagnostic test** for RB-TSWV
- **Compare RB and wild-type strains for thrips transmission** and other properties
- **Search for sources of resistance** to the RB-TSWV strain
- **Assess the IPM program** for RB-TSWV management



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