What to know about new developments in curly top and spotted wilt virus of processing tomato

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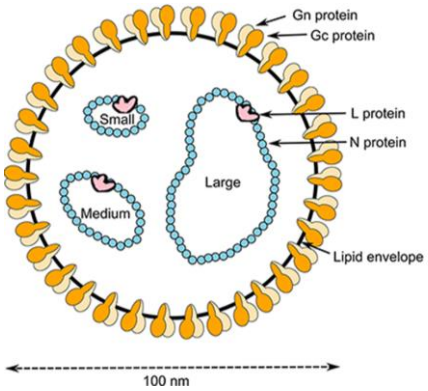
Why virus surveillance?

- Over 30 years of experience
- Virus landscape is always changing
- Strong network looking for virus symptoms
- Diagnostic tests for most CA tomato viruses
- Active in outreach efforts
- For tomatoes includes:
  - **Major viruses (TSWV and BCTV)**
  - Minor viruses (AMV, PZSV, ToNSV)
  - Exotic viruses (ToBRFV)
- We will always be fighting virus diseases!
- Need to adopt new technologies

Tomato spotted wilt virus



https://viralzone.expasy.org/
https://www.cabidigitallibrary.org/

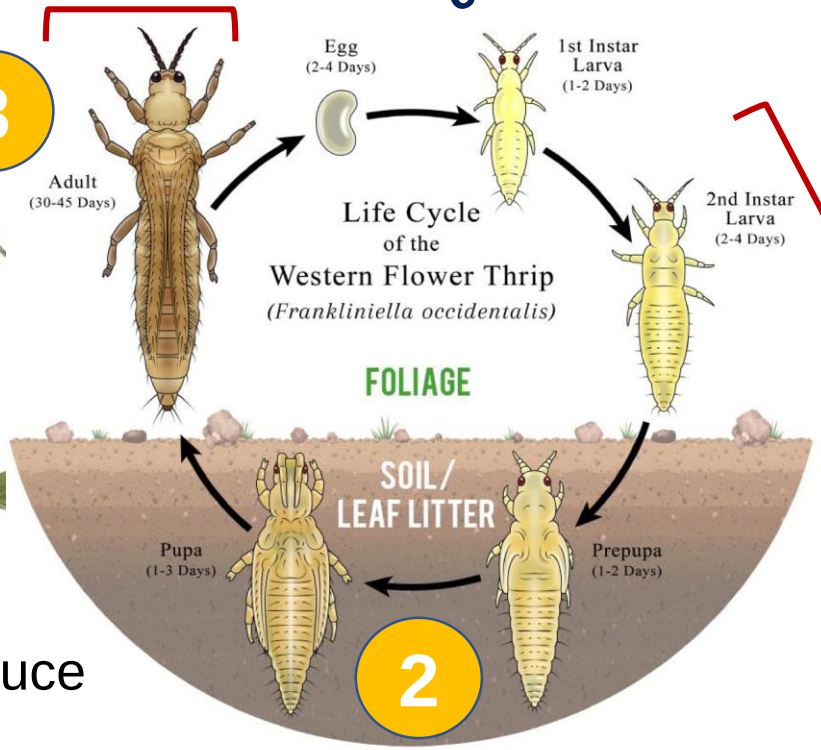
- TSWV has a single-stranded RNA genome divided in three segments protected by a protein shell.
- Major thrips vector in CA is Western flower thrips (*Frankiniella* spp)
- In tomatoes and peppers, spotted wilt can be managed by IPM approach, with a key tool being resistant varieties (tomato *Sw-5* gene, pepper *Tsw* gene)
- In 2016, a resistance breaking (RB) strain of TSWV emerged in fresh market tomatoes and has now become the dominant strain in Fresno

Tomato spotted wilt transmission

Transmission of the virus (only if they acquire as larvae)

Not spread by seed or contact or through eggs

tomato, pepper, lettuce and radicchio



https://laidbackgardener.blog/2020/12/30/thrips-the-no-see-sum-plant-pest/

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Acquisition of the virus

Weeds or volunteer plants

Tomato spotted wilt symptoms

Symptoms vary depending on stage of growth that plants are infected

Stunting, bronzing, necrosis and yellowing of leaves and ringspots and necrosis in fruits.

Spotted wilt update 2022

County	Total	TSWV		Negative	Observation
		RB	WT		
Colusa*	4	**2**	0	2	Samples with (-) results were showing leaf necrosis or scorching symptoms (Fusarium spp., associated symptoms?)
Sutter*	9	**7**	0	2	
Yolo*	64	**36**	0	**16**	
San Joaquin*	6	**1**	0	5	
Stanislaus*	1	**1**	0	0	
Merced	6	**6**	0	0	
Fresno	32	**29**	0	3	
Total	122	**82**	0	28	

Spotted wilt update 2022

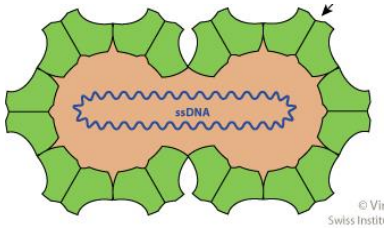
- RB-TSWV was detected in Northern Counties in **2021** and was the predominant strain detected in **2022**

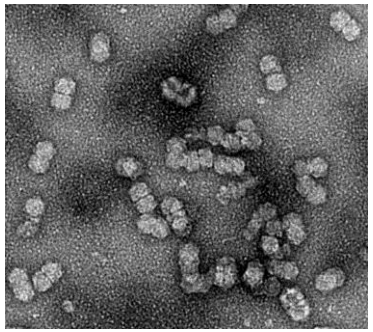
- Suggests RB-TSWV will become established

- RB-TSWV was detected in adult thrips captured on YSC in February

- Suggests that **overwintering pupae** from the previous season are sources for the next season

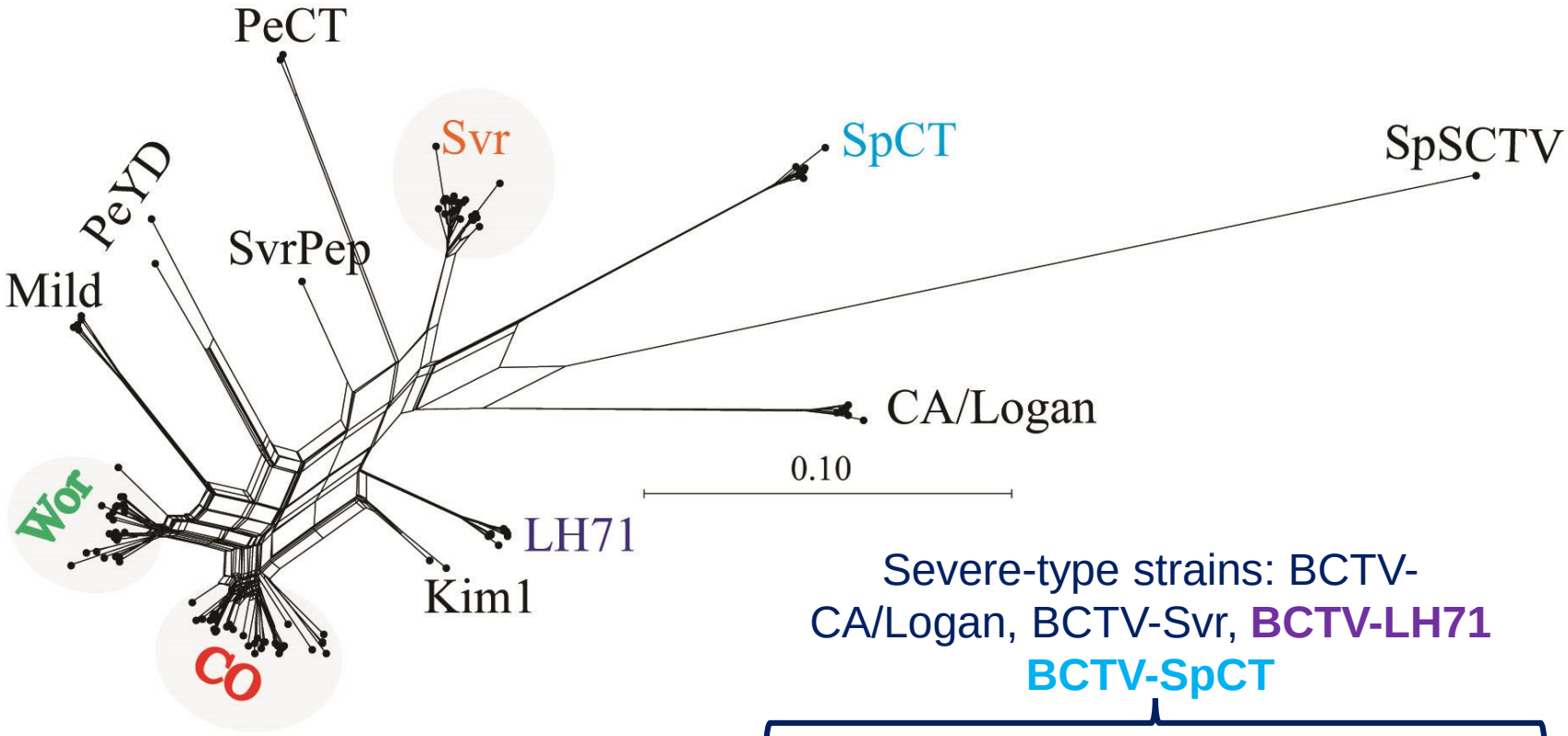
Beet curly top virus





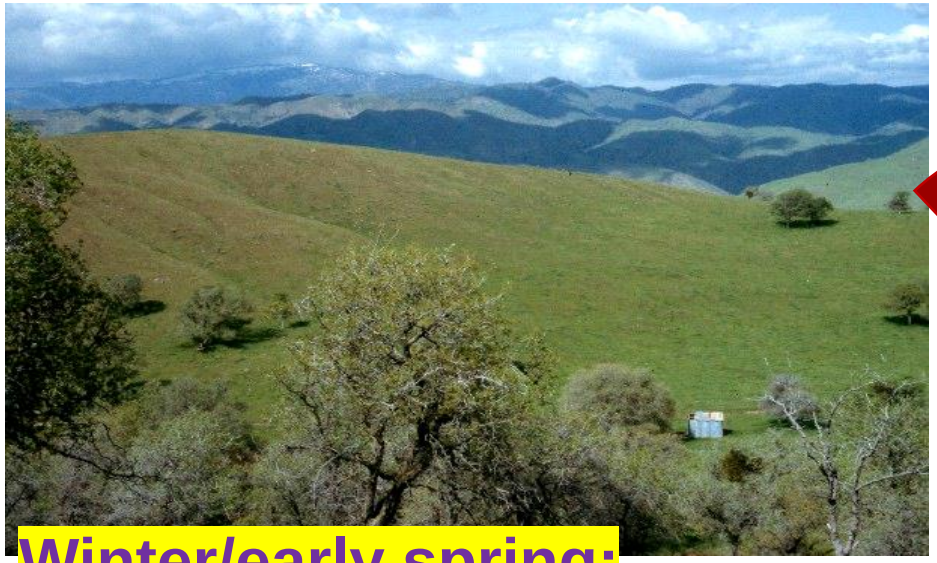
- BCTV has a circular single-stranded DNA genome protected by a protein shell that looks like 2 balls stuck together.
- Transmitted by the BLH but not passed to eggs or nymphs
- Tomato is not a host of BLHs
- BLH transmit during ‘tasting’ of tomatoes… introducing the virus into the plant phloem (food conducting system).
- Tomato is a dead- end host
- **Detection:** BCTV can be rapidly (5 hours) in tomato and beet leafhoppers by a multiplex PCR test

Beet curly top virus (BCTV) strains

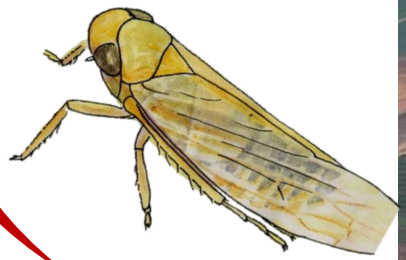


Severe-type strains: BCTV-CA/Logan, BCTV-Svr, **BCTV-LH71** **BCTV-SpCT**

mild-type strains:
BCTV-CO
BCTV-Wor

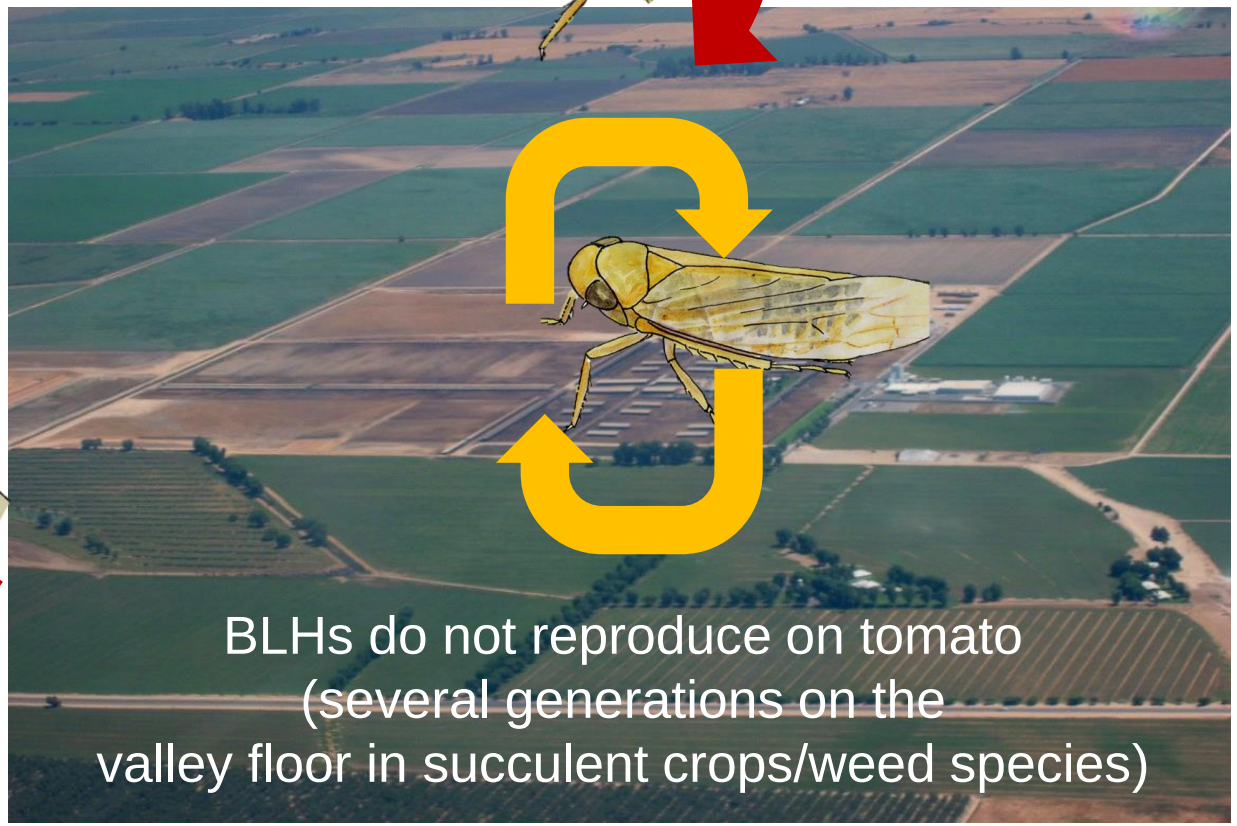


Winter/early spring: females overwinter and breed on annual and perennial weeds that show few symptoms



Fall: adult leafhoppers Migrate to overwintering in the foothills

Spring: New adults (some viruliferous) migrate to the valley floor and search for preferred host



Curly top disease symptoms

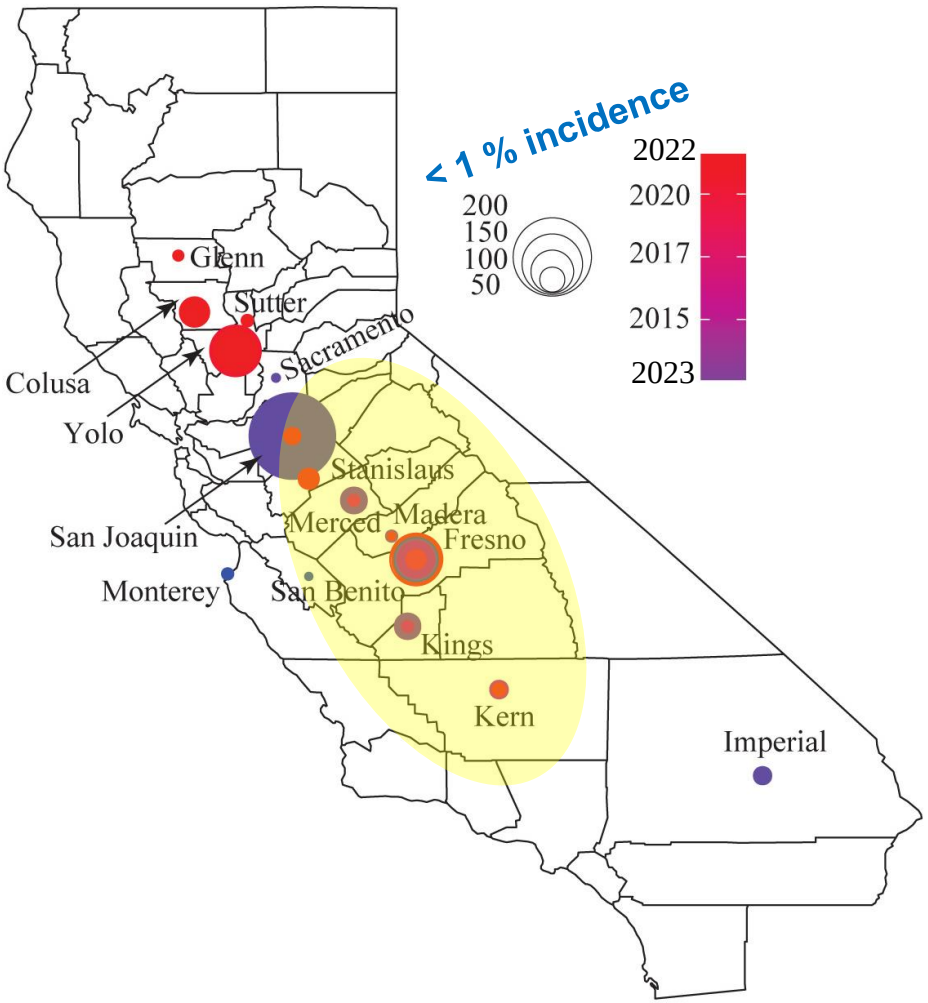
- **Early infection (~1 mo after planting)**
  - Stunted light green plants with upcurled/rolled leaves with vein swelling and purpling (diagnostic)
  - These plants often die, whereas those infected later may collapse.
  - May be confused with early spotted wilt

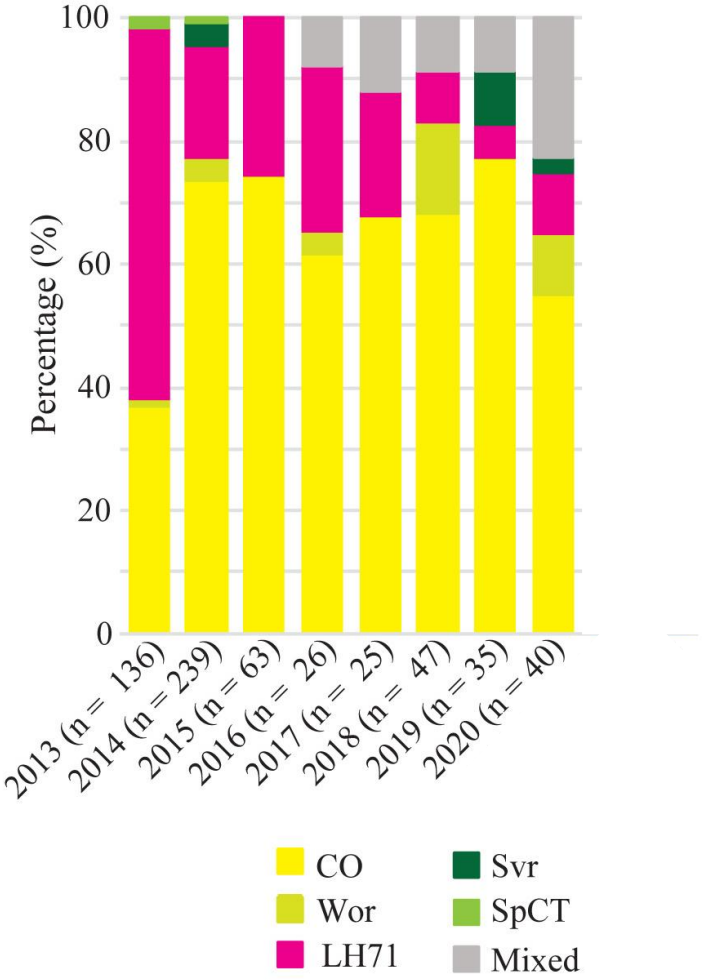
Curly top disease symptoms

Late infections (>1 mo after planting)

- Symptoms in newer growth
- Fruits are small and ripen prematurely
- Importance of sample collection for PCR testing!

BCTV strains infecting tomato plants since the major 2013 curly top outbreak and to 2020



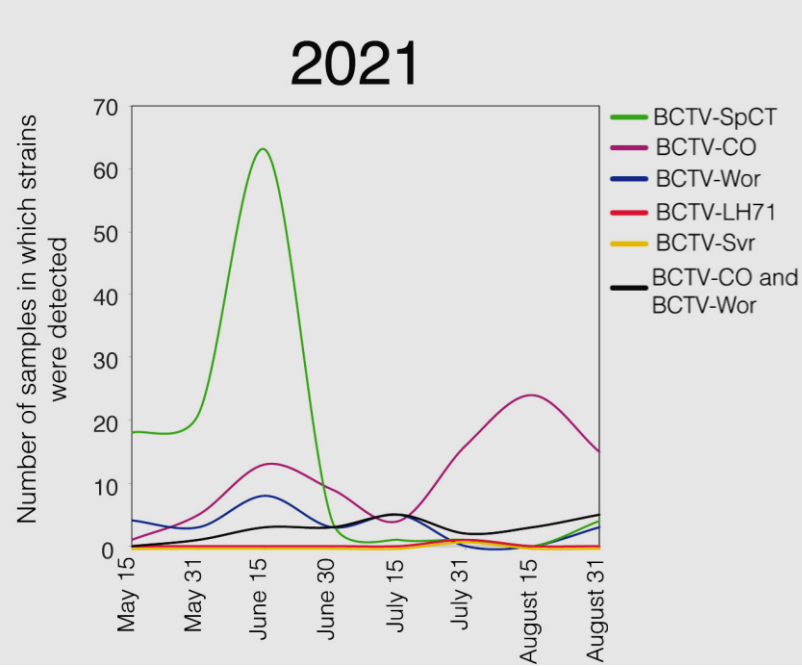


The 2021 curly top outbreak in the Northern Counties was highly unusual

- In 2021, processing tomato fields in Colusa, Glenn, Sutter and Yolo Counties had much higher incidences, as high as 15-20%.
- Associated with proximity to foothills and unusual hot dry winds in **April and May**.
- New strain of BCTV associated with curly top outbreaks in Northern California: BCTV-Spinach curly top (BCTV-SpCT)

- This unusual strain, BCTV-SpCT, was involved in early infections (April-May)

- However, later outbreaks (after late June) were caused by BCTV-CO



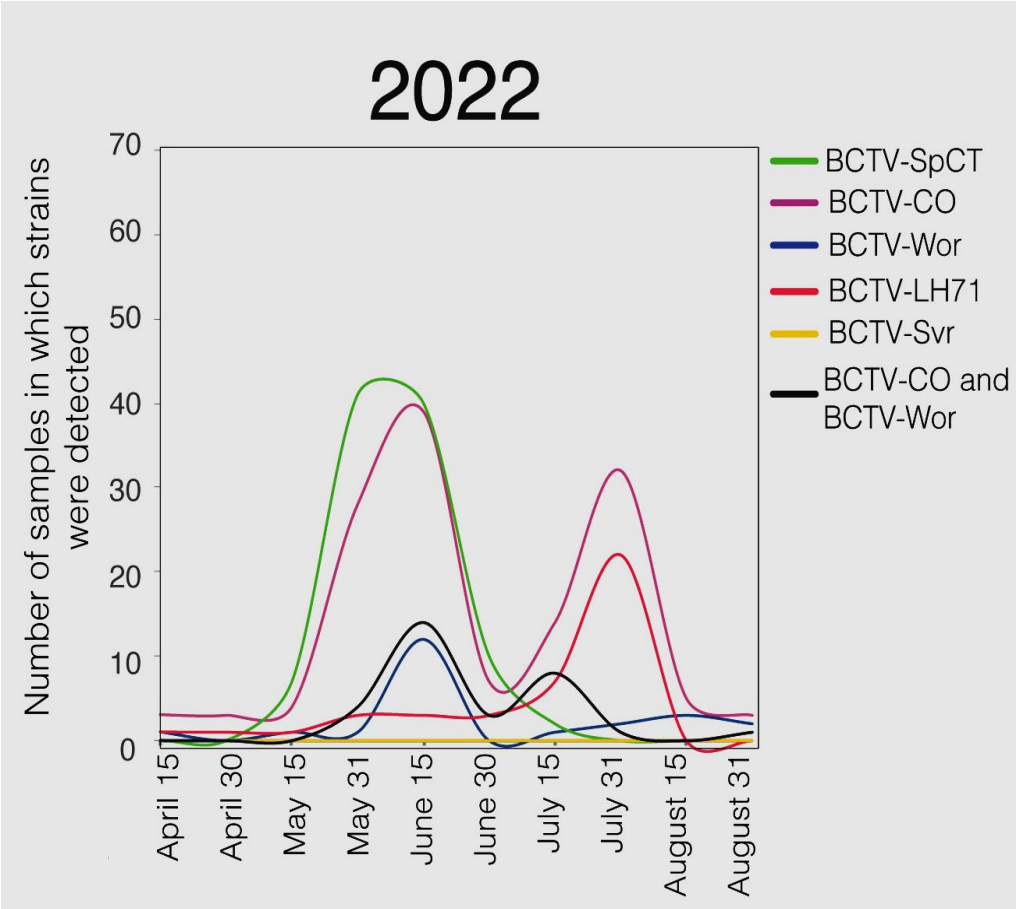
Curly top monitoring in 2022

County	No. of samples	Multiplex PCR for mild and severe type BCTV strains				PCR with BCTV strain-specific primers					
		mild-type	severe-type	mixed	Negative	BCTV-SpCT	BCTV-CO	BCTV-Wor	BCTV-LH71	CO+Wor	Other mixed
Colusa	62	22	35	1	4	34	13	3	0	5	1
Yolo	102	23	61	2	16	54	14	7	4	2	1
Glenn	9	8	0	0	1	0	8	0	0	0	0
Stanislaus	30	29	0	0	1	0	28	0	0	1	0
Sutter	1	0	1	0	0	1	0	0	0	0	0
San Joaquin	26	25	1	0	0	1	14	0	0	7	0
Fresno	157	65	47	8	37	4	45	6	27	9	7
Madera	2	2	0	0	0	0	1	1	0	0	0
Kern	12	10	2	0	0	1	9	0	1	1	0
Total	401	184	147	11	59	95	132	17	32	25	9

- Curly top re-appeared in the Northern counties (Colusa and Yolo) in 2022.

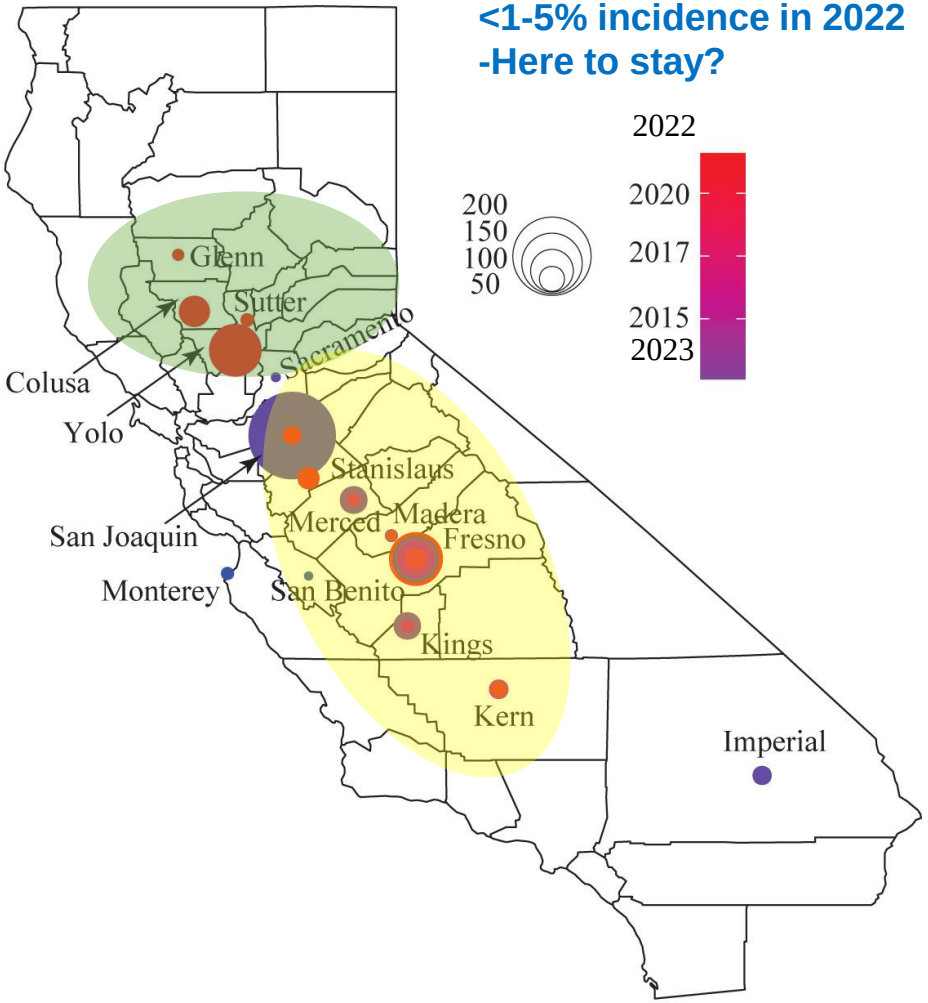
- It was observed in many fields but at low incidences and did not cause economic loss

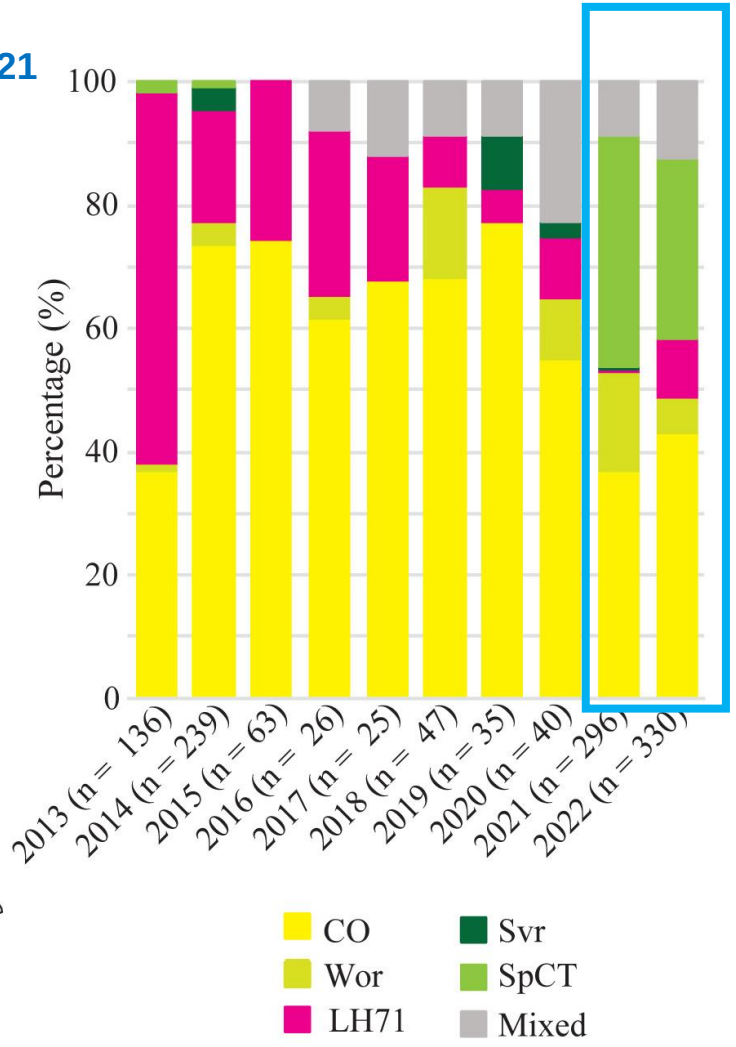
- BCTV-SpCT and BCTV-CO were predominant strains with early outbreaks



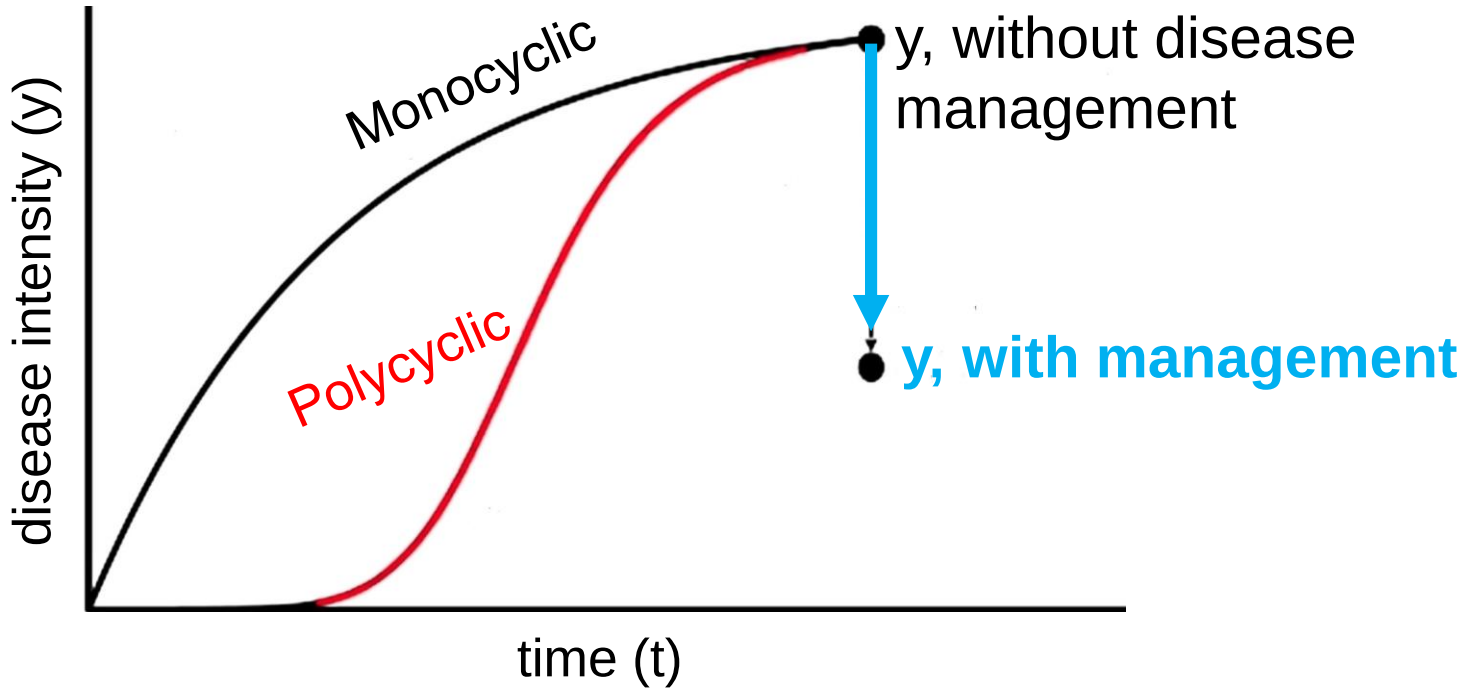
SpCT strain become an important fraction of the 2021 and 2022 BCTV population

-15 – 20% incidence in 2021
<1-5% incidence in 2022
-Here to stay?





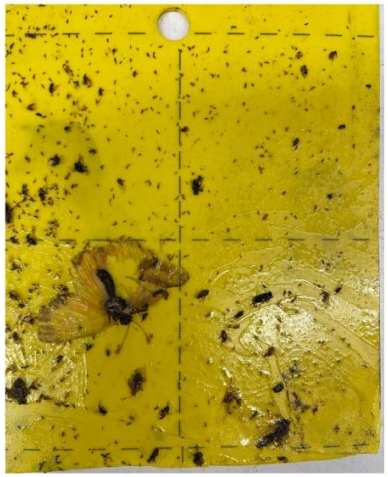
Curly top and tomato spotted wilt are monocyclic disease



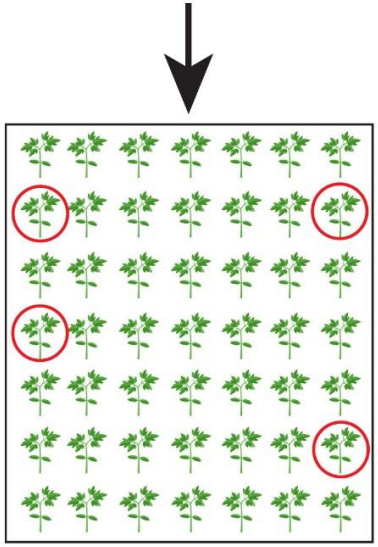
- Primary inoculum plays a key role in monocyclic diseases.
- IPM should focus in reducing the primary infections!

Two key data to predict curly top outbreaks

Low BLH population

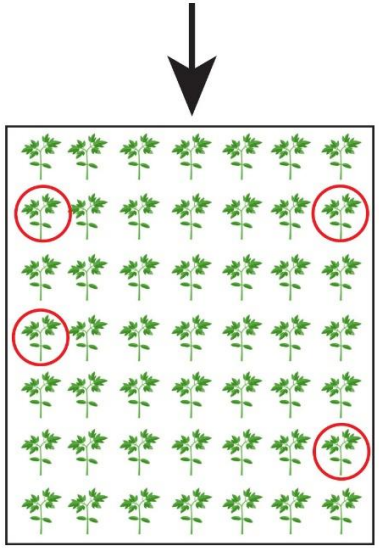


+++ Strong



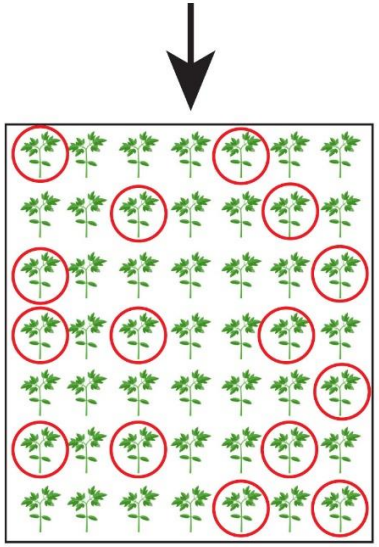
High BLH population

+ Weak

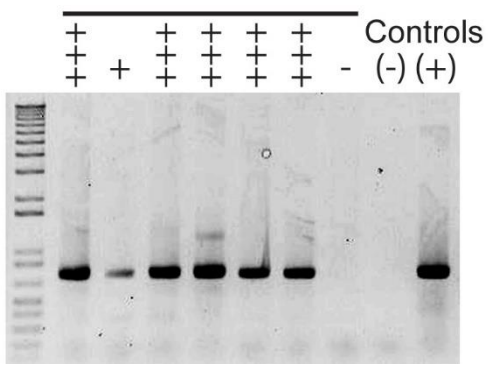


High BLH population

+++ Strong



PCR test BLHs



BCTV detection in beet leafhoppers from yellow sticky cards (2022) in Fresno

Date	# of yellow sticky card	# of hoppers per card	BCTV detection
3/26/22	2	1	NO
4/2/22	5	>1000	NO
4/11/22	4	55	Weak (+)
4/15/22	6	>1000	Weak (+)
4/22/22	6	136	Weak (+)
5/2/22	3	74	Weak (+)
5/24/22	1	53	NO
6/3/22	1	50	NO
6/17/22	2	52	NO

Low incidence of Curly top disease on tomato

Risk factors associated with curly top outbreaks in Fresno in 2022

Most of the Fresno samples can from fields with one of more **risk factors:**

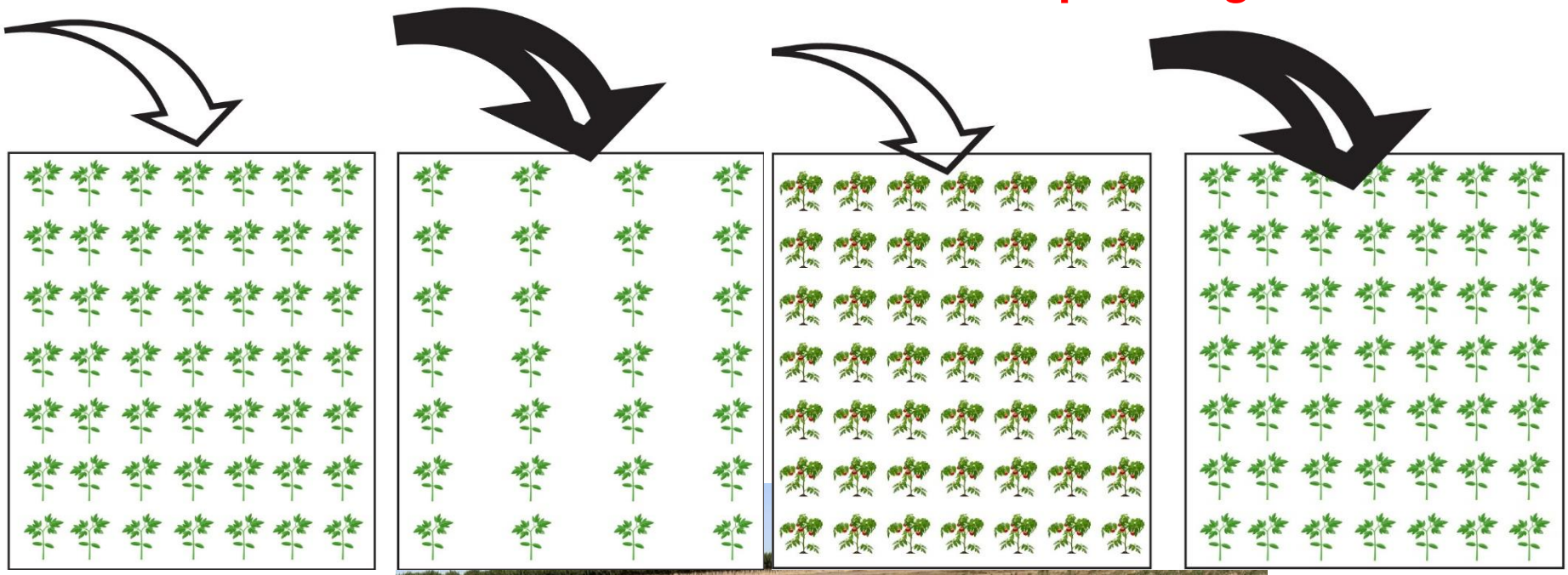
Near foothills

Hot spots for curly top outbreaks

Risk factors associated with curly top outbreaks in Fresno in 2022

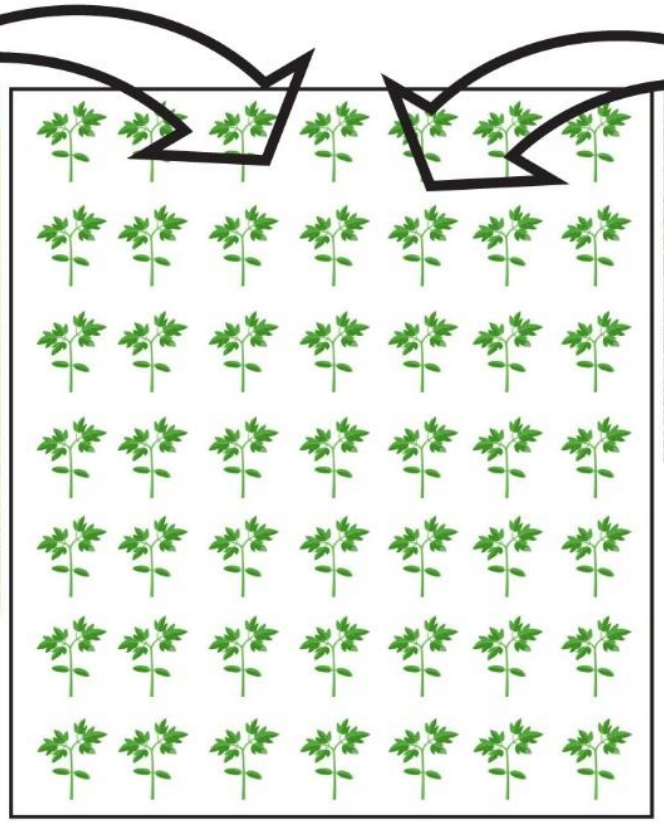
Sparsely planted

Late planting



Risk factors associated with curly top outbreaks in Fresno in 2022

Ditches



Fallow

An old virus learning new tricks: curly top outbreaks in cucurbits

- In 2022, curly top of cucurbits was more prevalent and occurred in more areas
- **Pumpkin and squash mostly, but also detected in melon in 2022**
- BCTV-CO was the predominant strain associated with curly top of cucurbits

Mild-type BCTV strains (-CO and -Wor) infecting new hosts

BCTV-CO and BCTV-Wor strains can infect and cause curly top symptoms in hemp and lettuce plants!

An unusual yellowing phenotype associated with curly top of tomato

- Not strain-associated
- Co-infection with Fusarium?
- Cultivar response?
- Leaf scorching symptoms further complicating diagnosis

Acknowledgements

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