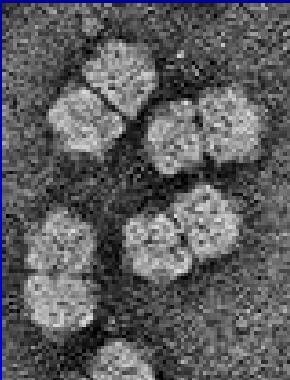


The unusual outbreak of curly top in 2021: What we know and what we can expect in 2022



Robert L. Gilbertson
Distinguished Professor
Department of Plant Pathology
University of California Davis

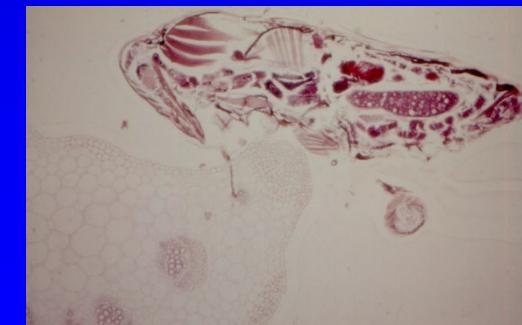
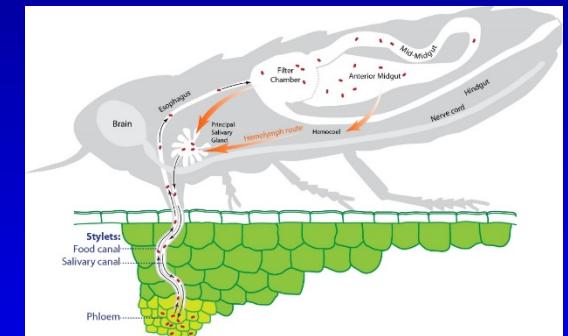
Goal of this presentation

- **Background information on curly top disease and beet curly top virus (BCTV)**
- **Update on what we know about the unusual outbreak of BCTV in the Northern Counties in 2021**
- **What to expect in 2022**
- **This is a complicated disease and it is important to know your enemy!**
- **In this case, it is really BCTV that is the enemy- the BLH causes little damage to tomatoes!**



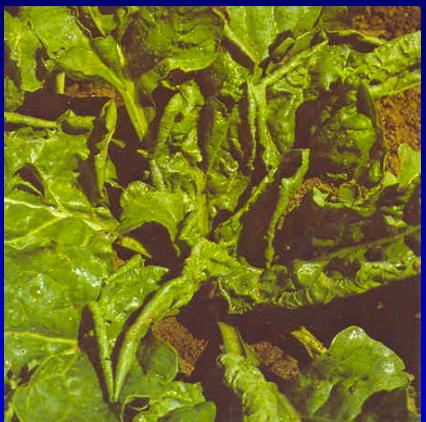
Background information on BCTV and curly top disease

- BCTV is a small plant virus composed of a **circular single-stranded DNA genome** protected by a **protein shell** that looks like 2 balls stuck together
- BCTV is **composed of 11 strains**
- Transmitted by the **BLH** but not passed to nymphs
- In CA, the major crop impacted is **tomato**
- **BLHs do not reproduce on tomato**
- BCTV only **infects the food conducting system (phloem)** and **BLH transmit** during ‘tasting’ of tomatoes but then move on (**tomato is a deadend host**)
- BCTV can be **rapidly (5 hours)** and **specifically detected in tomato and beet leafhoppers** by a **multiplex PCR test**



Beet curly top virus is composed of multiple strains

G. Curtovirus BCTV strains



BCTV-Logan
BCTV-CFH
BCTV-Worland

G. Curtovirus Species



BCTV



BSCTV



BMCTV

G. Curtovirus BCTV strains



BCTV-CA/Logan
BCTV-Svr (BSCTV)*
BCTV-Wor (BMCTV)*
BCTV-Mld (BMCTV)
BCTV-PeCT
BCTV-SpCT
BCTV-PeYD
BCTV-CO**
BCTV-LH71**

2001

2014

Symptoms of curly top of tomato

- **Early infection**

- Severe stunting

- Off color upcurled/rolled leaves with **vein swelling and purpling** (diagnostic)

- These plants **often die**

- May be **confused with early spotted wilt**

- **Late infections**

- Symptoms of in **young growth**

- Fruits **small and ripen prematurely**



Prevalence of Virus Diseases in Processing Tomatoes of California



Curly top disease

Curly top disease cycle: Dependent on a migratory insect



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



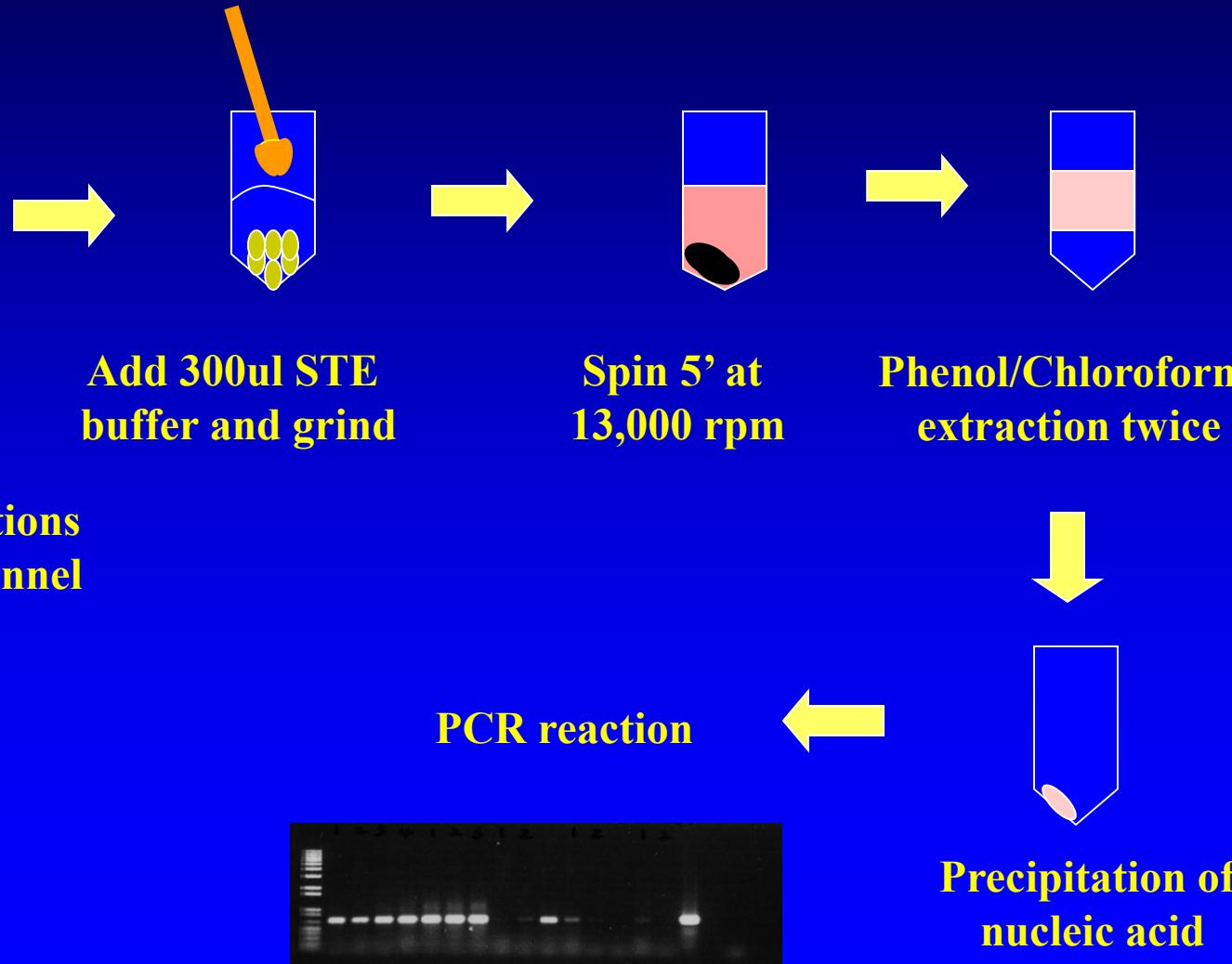
Fall: adult leafhoppers
Migrate to overwintering
in the foothills

Spring: New adults, some with
BCTV migrate to the
valley floor and search for
preferred host



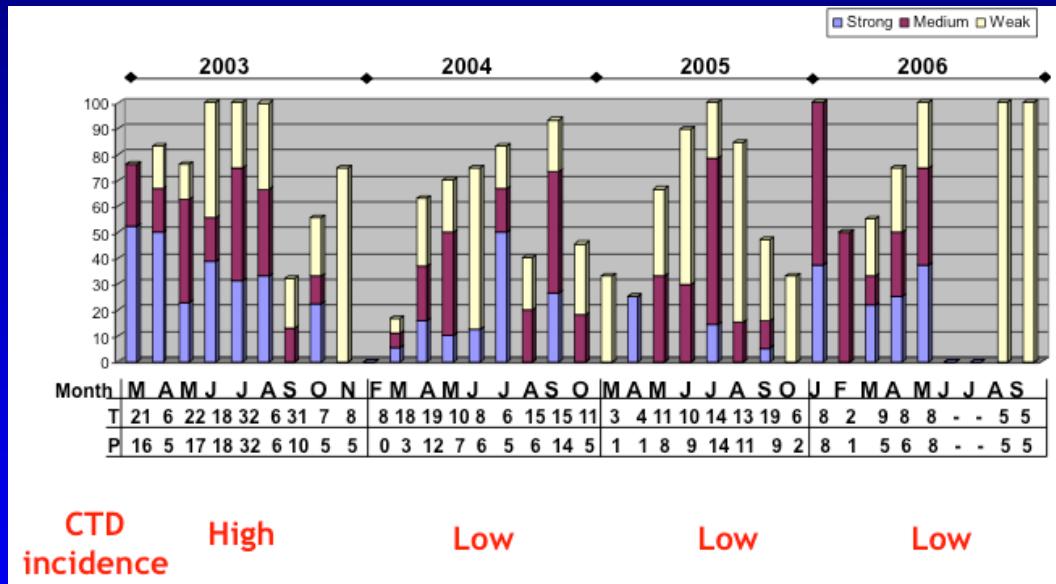
Multiple generations on the
valley floor

PCR Detection of BCTV in beet leafhoppers

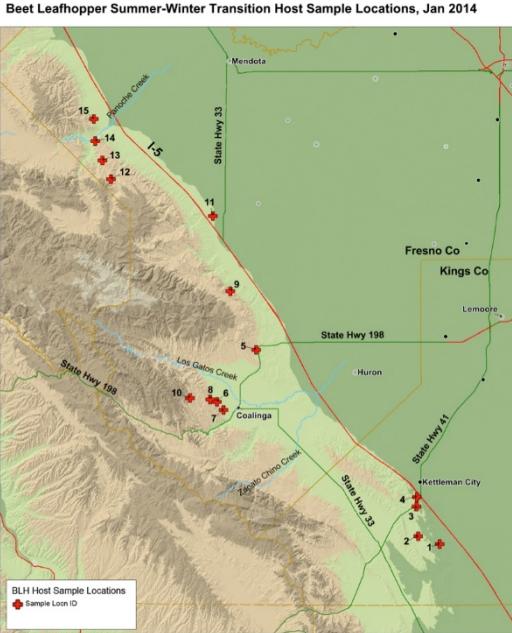


Model for predicting curly top outbreaks: Bad years are correlated with high populations of virus-carrying leafhoppers early in the growing season

- Used PCR detection method and leafhoppers provided by the CTVCB)
- Suggested that bad outbreaks of curly top in tomato were correlated with **high populations of leafhoppers carrying high levels of BCTV early in the growing season (i.e., February-April)**



Survey for BCTV reservoirs



CTVCB
winter
survey and
samplings

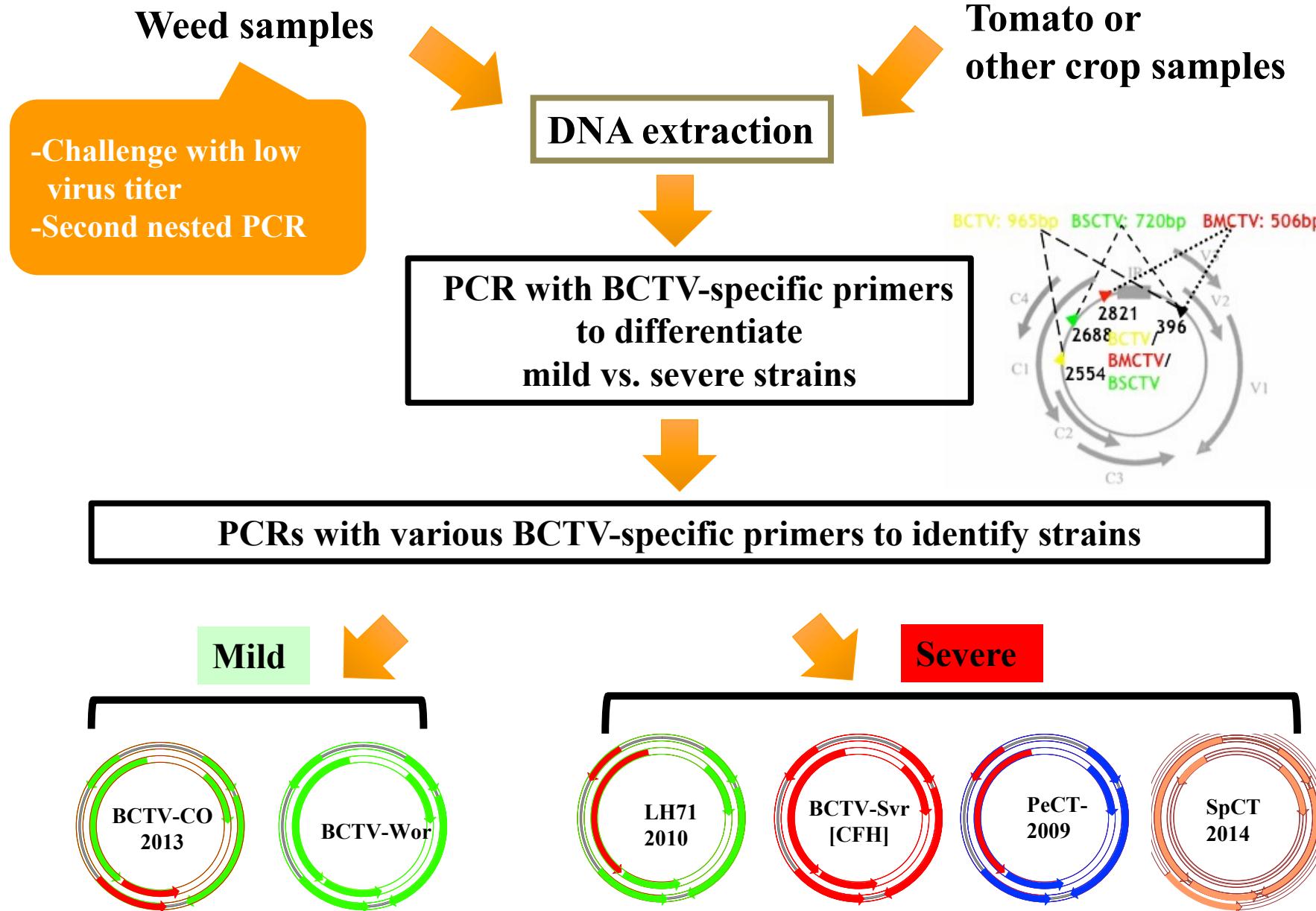
Weeds and crops on
the valley floor



- BLH perennial hosts
- No symptoms, low virus titer?

Virus detection by PCR and
nested PCR

Flow chart for BCTV identification and characterization in plants



Detection of BCTV in perennial plants and weed species in the foothills: Fresno (CTVCB samples)

Fresno - weeds							
Host	total n°	Positive	High titer	mild	severe	mixed	negative
Russian thistle	76	12 (16%)	2	7	1	4	64 (84%)
Plantago	54	15 (28%)	3	10	5	0	39 (72%)
Filaree	40	6 (15%)	2	5	1	0	34 (85%)
Pepper grass	33	3 (9.0%)	0	3	0	0	30 (91%)
Thistle	18	4 (22%)	0	3	1	0	14 (86%)
Brassia	13	1 (8.0%)	0	0	1	0	12 (92%)
Kochia scoparia	10	0 (0.0%)	0	0	0	0	10 (100%)
Goose foot	9	3 (34%)	0	2	1	0	6 (66%)
Lambsquarter	6	3 (50%)	0	3	0	0	3 (50%)
mixed	6	1 (17%)	1	1	0	0	5 (83%)
London Rocket	5	3 (60%)	0	0	2	1	2 (40%)
Atriplex	3	0 (0.0%)	0	0	0	0	3 (100%)
Weed ID	2	0 (0.0%)	0	0	0	0	2 (100%)
vol. Tomato	2	0 (0.0%)	0	0	0	0	2 (100%)
Suaeda nigra	2	0 (0.0%)	0	0	0	0	2 (100%)
Halogeten	1	1 (100%)	0	1	0	0	0 (0.0%)
Total	280	52 (19%)	8	35	12	5	228 (81%)

New BCTV strains associated with the 2013 outbreak

Mild phenotype strains

BCTV-Wor



Sugar beet

BCTV-CO**



Severe phenotype strains

BCTV-Svr



BCTV-LH71**



Tomato



N. benthamiana



The 2021 curly top outbreak was highly unusual

- The incidence of curly top in Northern Counties has been very low
- In 2021, **curly top symptoms** appear in processing tomato fields in **Colusa, Glenn, Sutter and Yolo Counties** with incidences ranging from **<1%-15 or 20%**
- Field visits and sampling: 6/1 and 7/20
- Associated with **proximity to foothills** and **unusual hot dry winds** in April and May (?)
- The strain initially involved was **BCTV-SpCT** (spinach curly top), detected in CA in 2014 but only in a **small number of plants!**
- However, later outbreaks (after late June) were caused by **BCTV-CO**



A late planted field provides insight into the source of the BCTV-SpCT

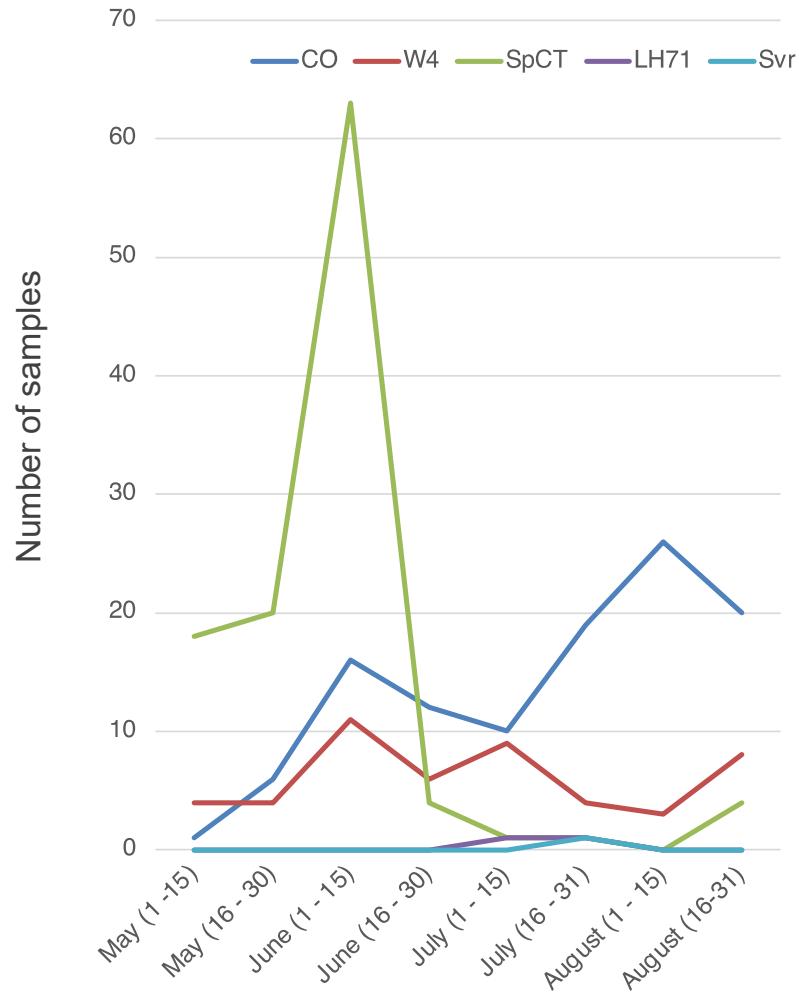
- A July 20 visit to a field **partially replanted** revealed **high incidences of curly top (~20)**
- Most likely caused by leafhoppers of a **valley floor generation that acquired BCTV from local weeds**
- Samples from this field were **all infected with BCTV-CO** not BCTV-SpCT, suggesting BCTV-SpCT came from elsewhere



Detection of strains of BCTV associated with outbreaks of curly top disease
in processing tomatoes in 2021

County	BCTV strains				
	CO	Wor	LH71	Svr	SpCT
Fresno	13	4	1	0	1
Yolo	27	22	0	0	70
Stanislaus	27	3	0	0	3
Colusa	15	6	0	0	33
Gleen	1	1	0	0	2
Sutter	10	9	0	0	1
San Joaquin	17	2	1	1	1
Total	110	47	2	1	111

Variation of BCTV strains infecting tomato – 2021 season



Observations and expectations for 2022

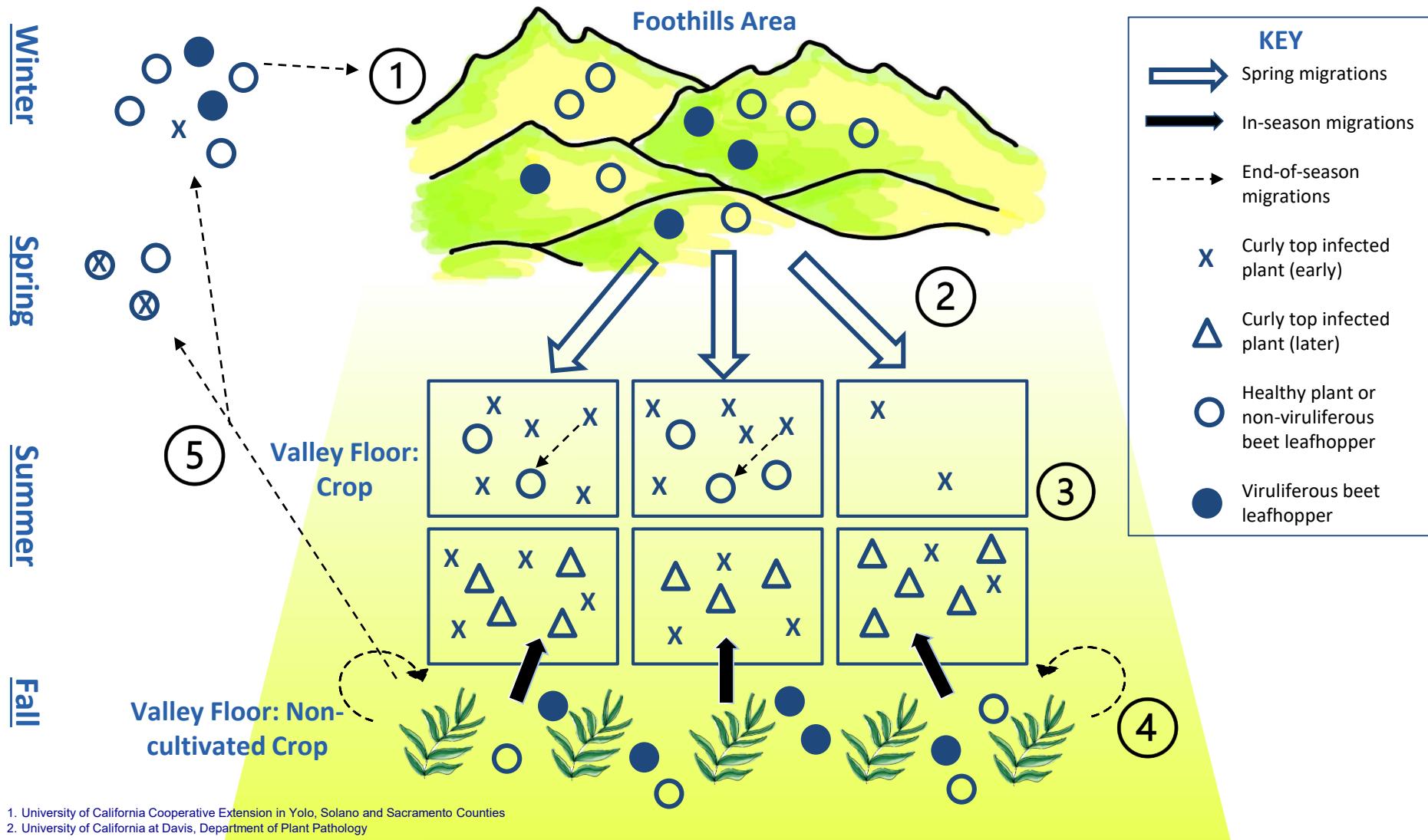
- An unusual outbreak caused by an unusual strain of BCTV
- Associated with foothills and unusual weather events
- Occurred over a wide areas but not in traditionally affected areas (Fresno and Kern Counties)
- Also affected cucurbits, especially squash but also cucumber and watermelon



➤ Unlikely to see the same ‘perfect storm’ in 2022?

Beet Leafhopper Migration and Beet Curly Top Virus Outbreak

By Margaret Lloyd¹, Bob Gilbertson² and Lena Pransky¹



1. University of California Cooperative Extension in Yolo, Solano and Sacramento Counties
2. University of California at Davis, Department of Plant Pathology

What can be done in 2022

- **Foothills survey to predict the potential for curly top in 2022**

- Survey for BLH and weed reservoirs
 - Test for BCTV and determine strains
 - Jan/Feb/March



- **Fields planted in areas with 2021 outbreaks**

- Verimark (cyaxypyrr) treatment of transplants
 - Monitor for BLH (sticky cards) and curly top
 - Throughout the growing season



- **Push for development of curly top resistant tomato varieties**

- **Don't forget RB-TSWV!**

Acknowledgements

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UCCE

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Cdfa Specially Crops Program

