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Vectors and Spread of Grapevine Red Blotch-associated Virus in California

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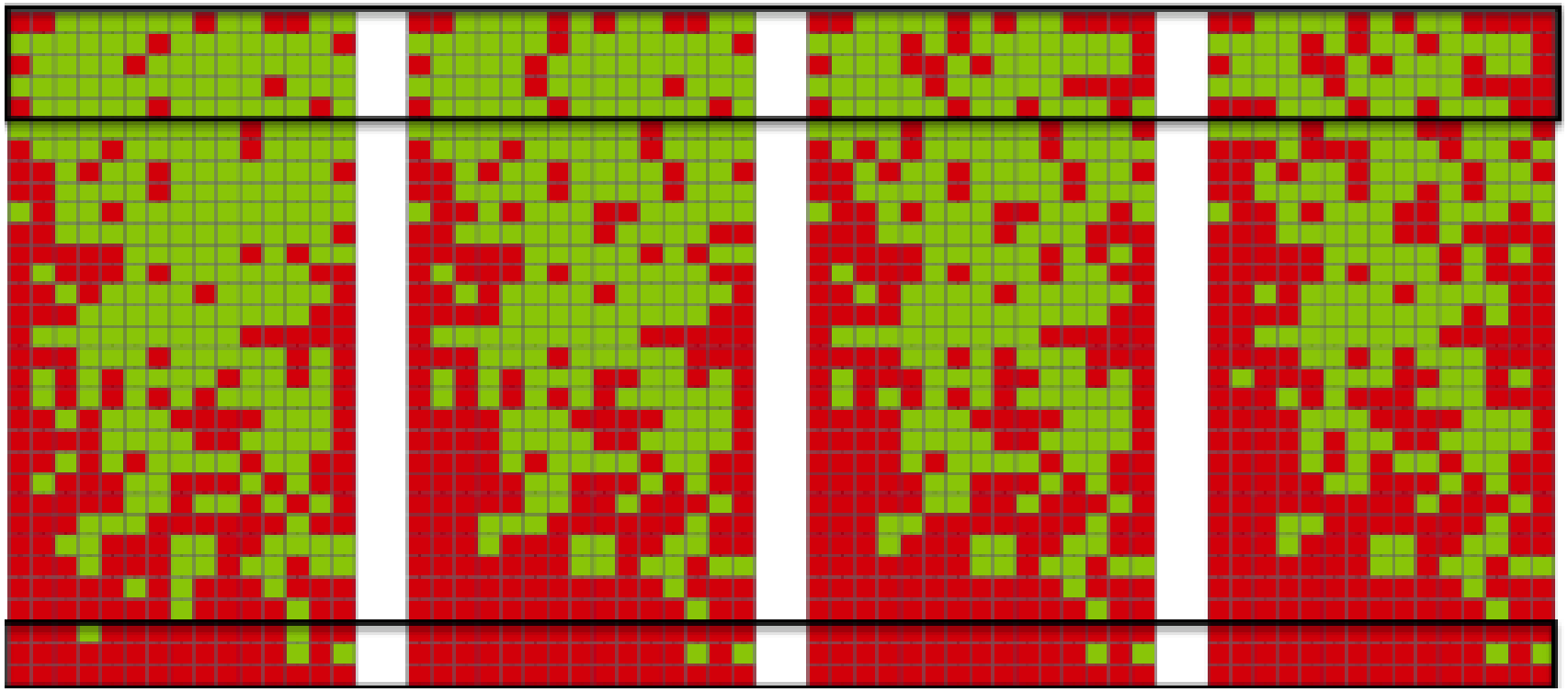
Is red blotch disease spreading?

That the disease was associated with a virus and that spread occurs was not universally accepted, however…

- Observed patterns of incidence that would suggest spread was occurring
- Year-to-year increase in new GRBaV infections was documented
- All known geminiviruses are insect transmitted

UC Davis Oakville Station

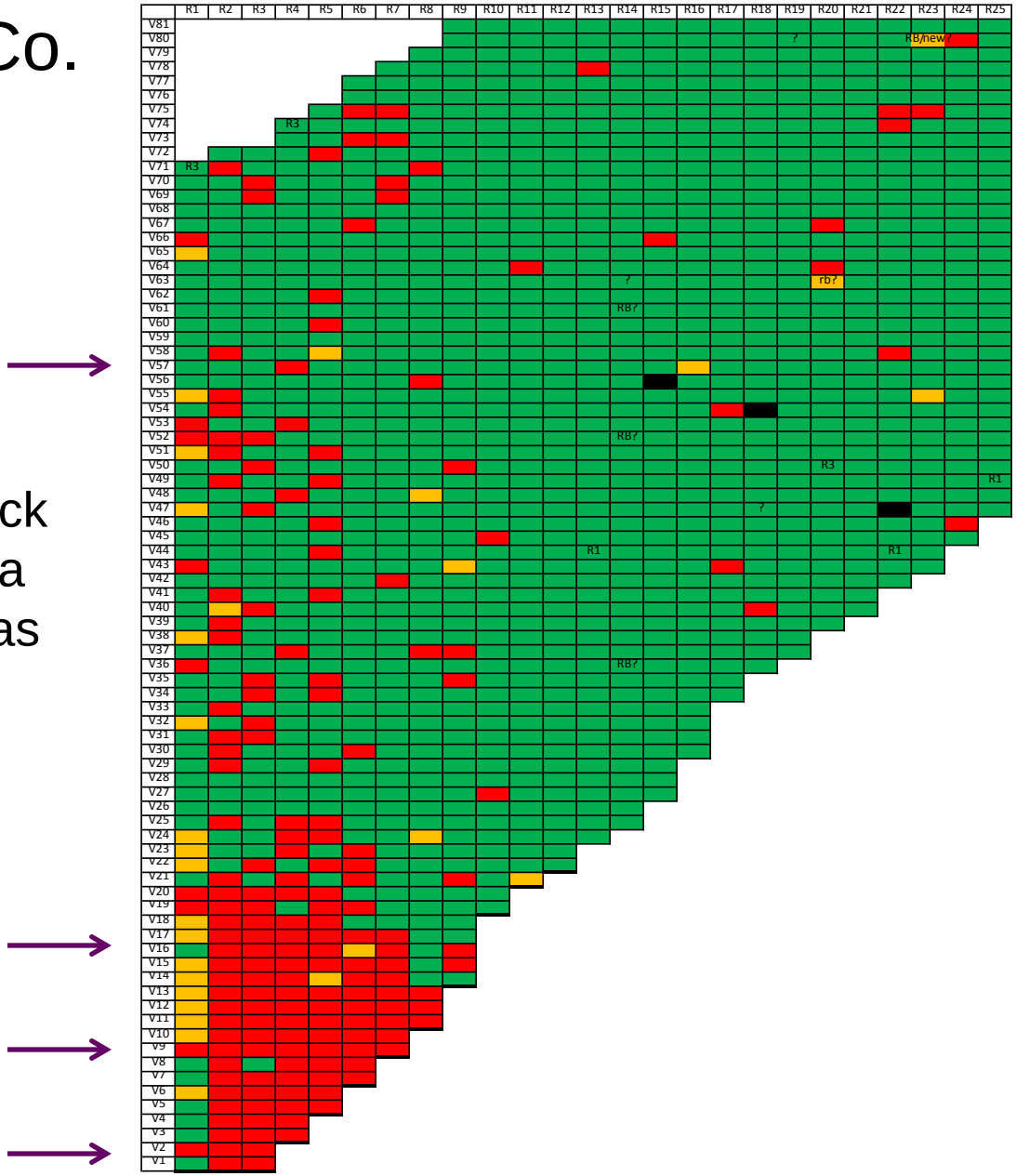


2011	2012	2013	2014
44%	+5.4%	+4.8%	+5.4%

Red squares are infected vines, green squares are healthy vines, all vines located within black rectangles were tested using qPCR

Santa Barbara Co.

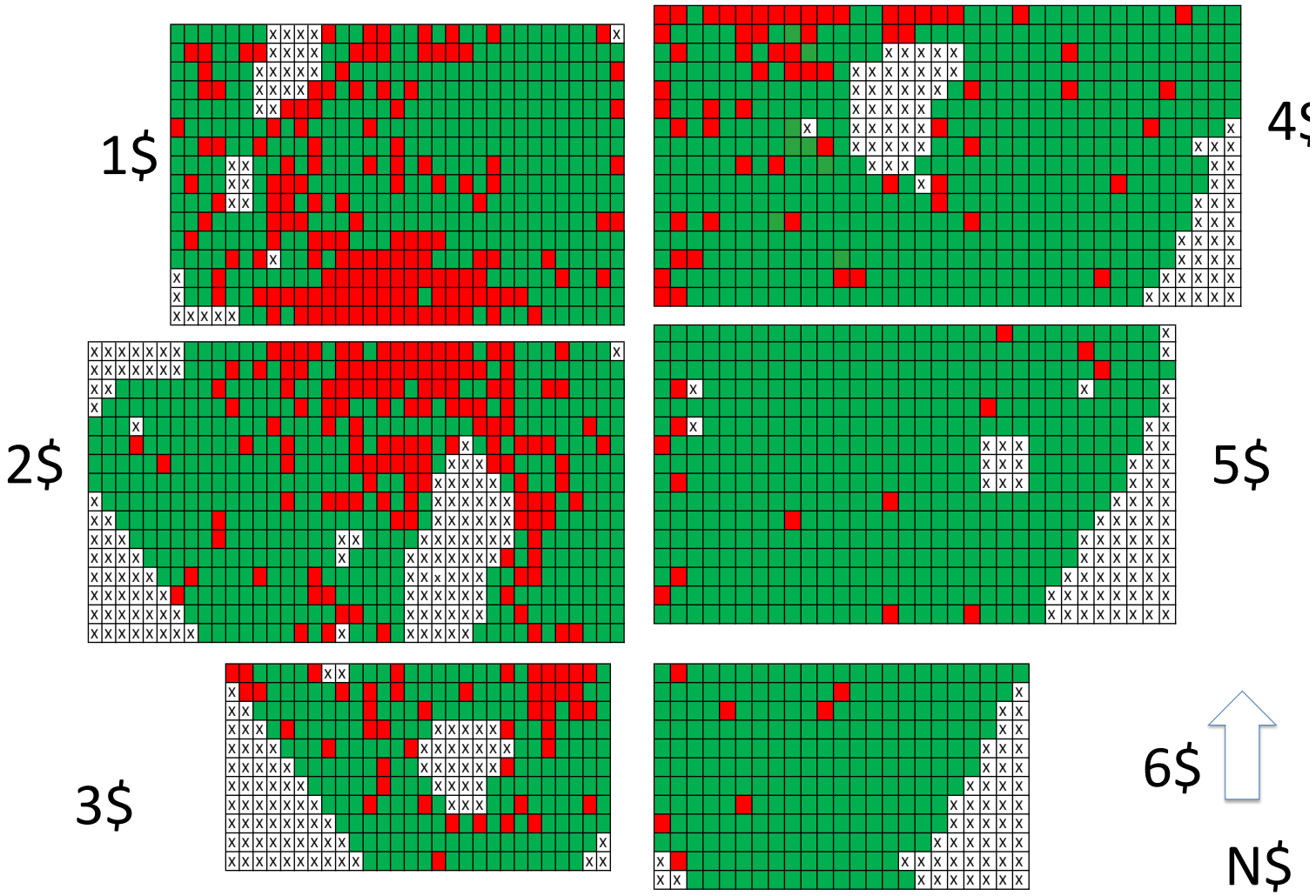
Symptoms in the block began to show after a neighboring block was planted with GRBaV nursery transplants



Amador Co. - self-rooted Zinfandel

(F. Zalom)

Number of infected vines increased by 18% from 2015 to 2016



Source of cuttings - a Zinfandel block planted in 1928

Is an insect involved?

A 2013 study at Washington State University implicated the Virginia Creeper Leafhopper, *Erythroneura ziczac* as a vector in a greenhouse study…

- Poojari et al. (2013)

… but no other labs were able to repeat the study results.

(C. Preto)

VCLH as a vector?

Nice story, but problematic -

- VCLH were not present in some vineyards where disease spread was suspected
- VCLH was present in vineyards with red blotch, but disease not spreading
- VCLH feeds primarily on mesophyll, but monopartite geminiviruses are phloem limited

Vector Transmission Bioassays

- 2014: 100 transmission bioassays
- 2015: 125 new transmission bioassays

No transmission detected

VCLH as a vector?

All 3 *Erythroneura* species tested positive for presence of GRBaV after feeding on infected plants, but they had lower virus concentration and a lower percentage tested positive than other Hemiptera tested

Fewer positive Lower virus conc.

Species	No. positive/ No. tested	Mean (Ct ± SE)	Mean virus Qty./µl±SE
E. elegnatula	2/20	28.9±0.81	1.79E+01
E. variabilis	1/20	32.1±0.0	1.00E+01
E. ziczac	1/20	26.5±0.0	1.55E+01
Spissistilus festinus	15/20	16.1±0.34	1.86E+05
GRBaV-infected[1]	5/5	14.1±0.63	1.34E+06
Healthy grapevine[1]	0/5	No Ct	N/A
Buffer control[1]	0/5	No Ct	N/A

VCLH as a vector?

2014-16: Recipient plants were tested monthly for 1.5 years post inoculation:

- *Erythroneura ziczac*: 0/10 positive for GRBaV
- *Erythroneura elegantula*: 0/10 positive for GRBaV
- *Erythroneura variabilis*: 0/10 positive for GRBaV

2015-16: Recipient plants were tested monthly post inoculation, results at 5 month:

- *Erythroneura ziczac*: 0/15 positive for GRBaV
- *Erythroneura elegantula*: 0/15 positive for GRBaV
- *Erythroneura variabilis*: 0/15 positive for GRBaV

Vector Transmission Bioassays

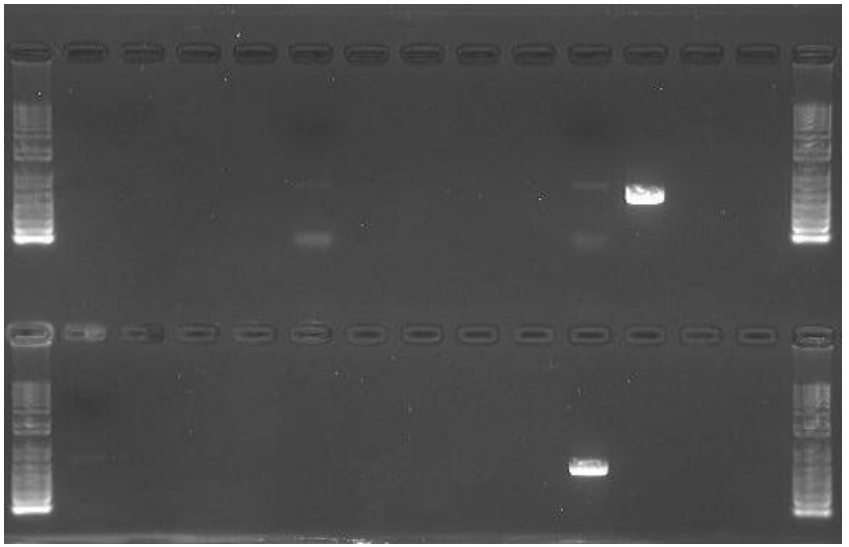
Species considered as likely candidates at end of 2015

- 1 treehopper (Membracidae)
- 2 leafhoppers (Cicadellidae)
- 1 jumping plant louse (Psyllidae)
- 1 planthopper (Cixiidae)

Vector Transmission Bioassays

5 month PCR test in February, 2016 -

- Membracidae 3/15 { 8/15 at 6 months
- Cicadellidae 0/50
- Cicadellidae 0/20
- Psyllidae 0/10
- Cixiidae 0/10



PCR results at 5 months

Spissistilus festinus

Confirmed by Marc Fuchs, Cornell University

Red Blotch Symptoms

Two of the three recipient plants also exhibited mild red blotch leaf symptoms

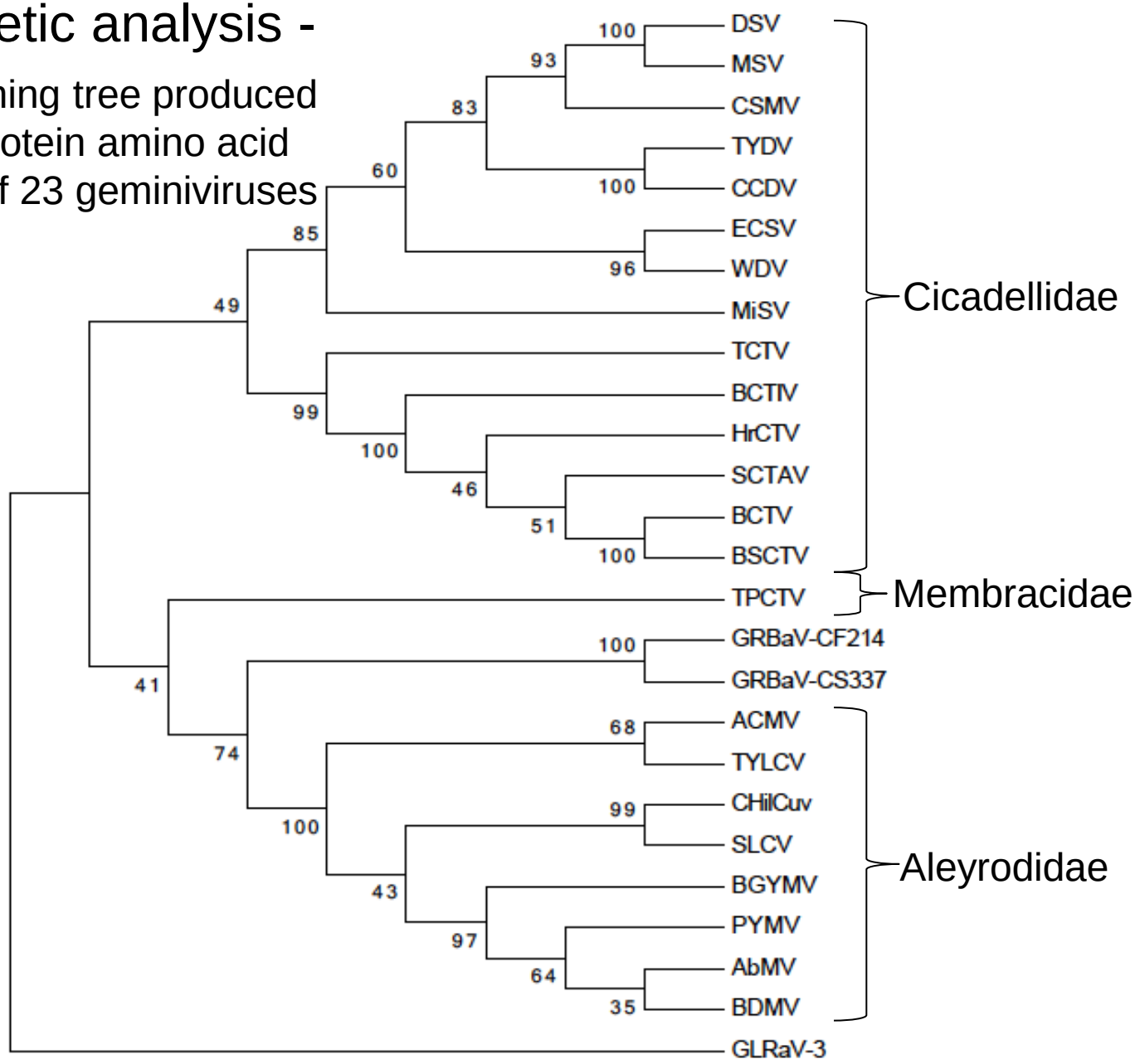
Recipient plant

Negative control

B. Bahder, UC Davis

Phylogenetic analysis -

Neighbor-joining tree produced using coat protein amino acid sequences of 23 geminiviruses



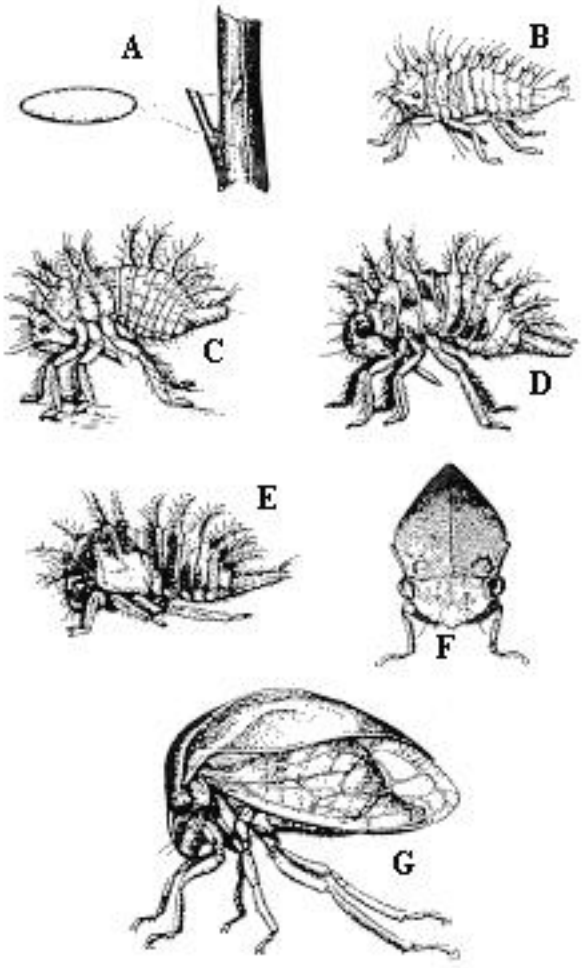
Three-cornered alfalfa hopper

Spissistilus festinus (Say)

K. Garvey, UC Davis

Spissistilus festinus (Say)

Life Cycle

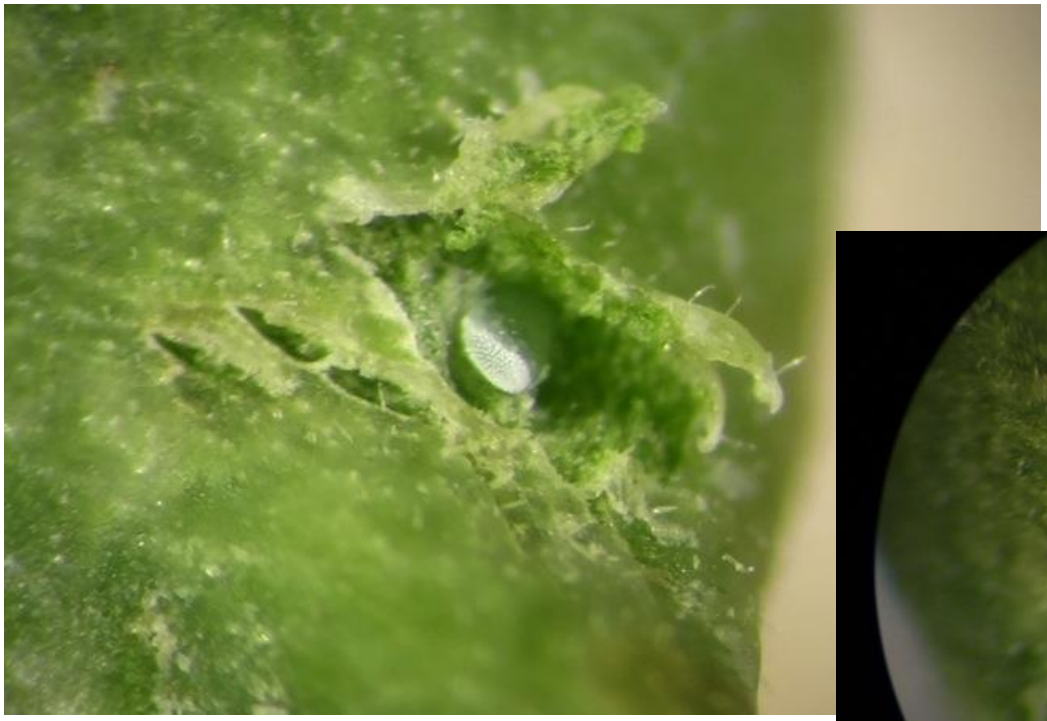


A, egg; B-F, nymphs; G, adult

C. Preto, UC Davis

Spissistilus festinus (Say)

Oviposition scars and eggs



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Spissistilus festinus (Say) - from literature

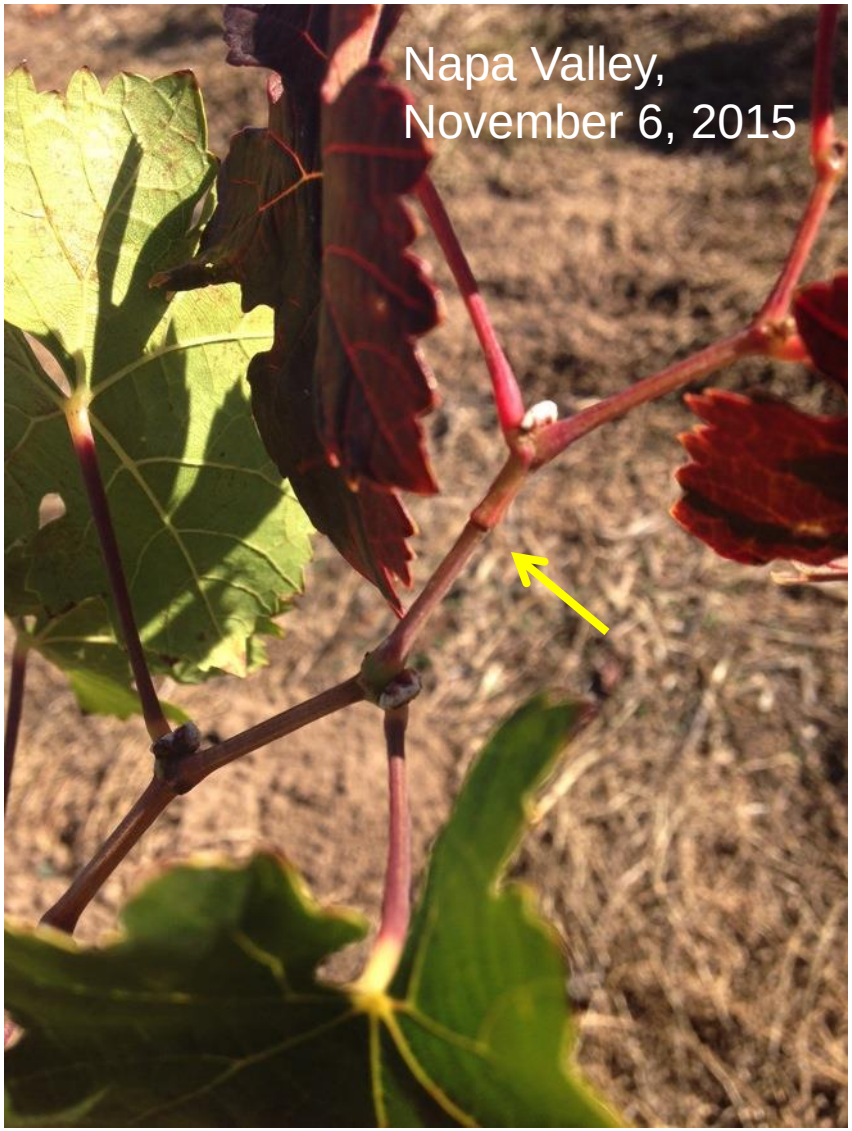
Host preference - leguminous plants (alfalfa, peanut, soybean, bean, cowpea, and sweet clover

Other hosts include - tomato, melon, cotton, wheat, barley, oat, Bermuda grass, and Johnson grass, as well as some trees and shrubs

“Overwinter as eggs in plant tissues or as adults protected by clumps of grasses; overwintering adults are active…”

Damage - complete girdling of stems of the host plant; the girdle is the result of many punctures made in a ring around the stem of the plant

Spissistilus festinus (Say) - Damage



F. Zalom

Spissistilus festinus (Say)

Feeding and oviposition on grapes?

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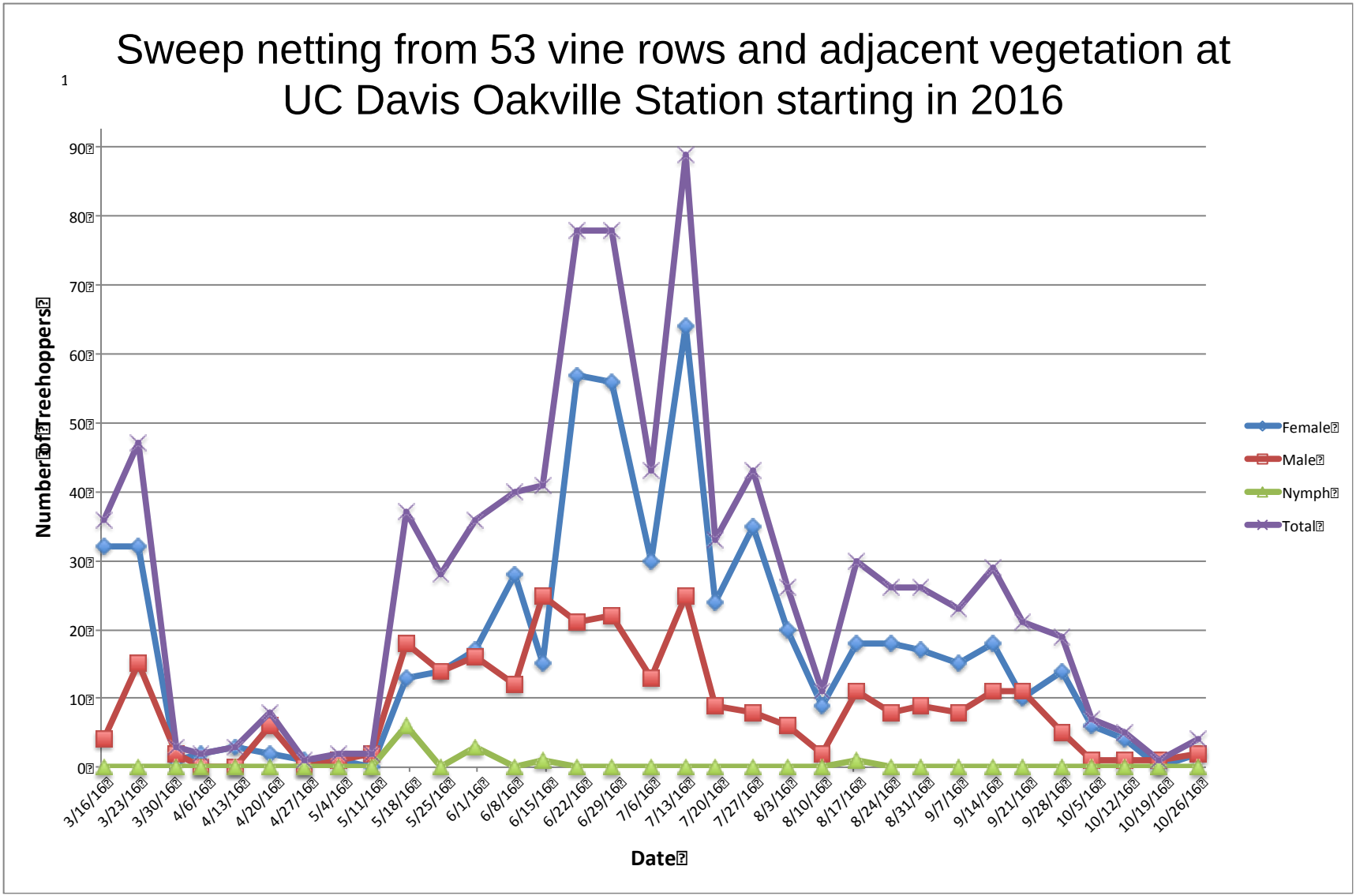
Spissistilus festinus (Say) – Seasonal phenology



Other vineyard treehoppers?

Napa County
May 17, 2016

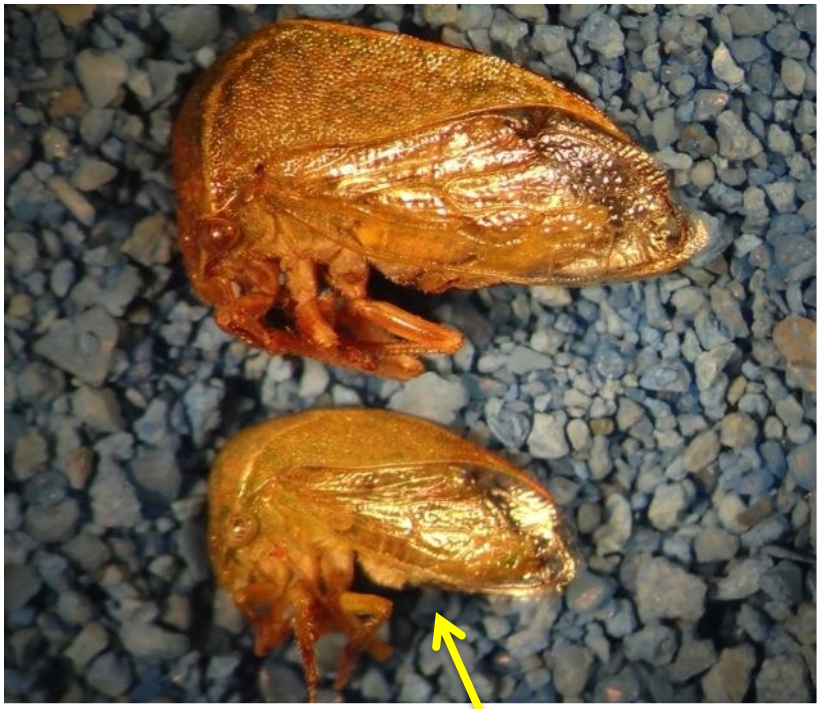
Other vineyard treehoppers?

Tortistilus spp.

B. Bahder

S. Sudarshana

Vector status, unknown, but being evaluated



Three cornered alfalfa hopper

Tortistilus vs *Spissitilus festinus*

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Virus and Vector Management Research

Armstrong Tract, Dept. of Plant Pathology, UC Davis

Virus and Vector Management Research

- Additional vectors
- Alternate plant hosts for vector and virus
- Virus development cycle in plants
- Vector transmission requirements
- Better methods for virus and vector detection
- 3CAH seasonal phenology and overwintering
- Cultural controls – vegetation management, cover crops, roguing, pruning
- Chemical controls – insecticides, antifeedants

Acknowledgements

- Cooperating growers and vineyard managers
- Casa Cristal Nursery, Knights Grapevine Nursery and Mercier Nursery
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- California Tree Fruit, Nut Crops and Grapevine Industry Board
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Zalom and Sudarshana lab members

S. Sudarshana

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