Integrative studies of vector-related virus epidemiology

Vaughn Walton, Daniel Dalton, Rick Hilton, Clive Kaiser, Brian Bahder, Kent Daane, Frank Zalom and Mysore Sudarshana

Department of Horticulture
Oregon State University
vaughn.walton@oregonstate.edu

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Integrative studies of vector-related virus epidemiology

- The deadly triangle
- Three grapegrowing regions
- Epidemiology trends
- Insect vectors
- Best management practices

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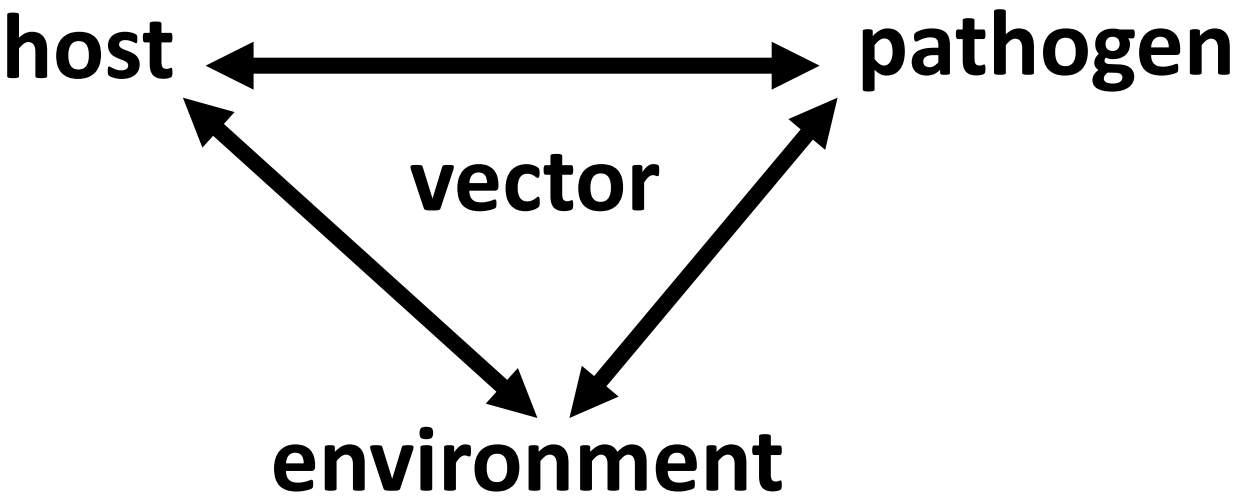
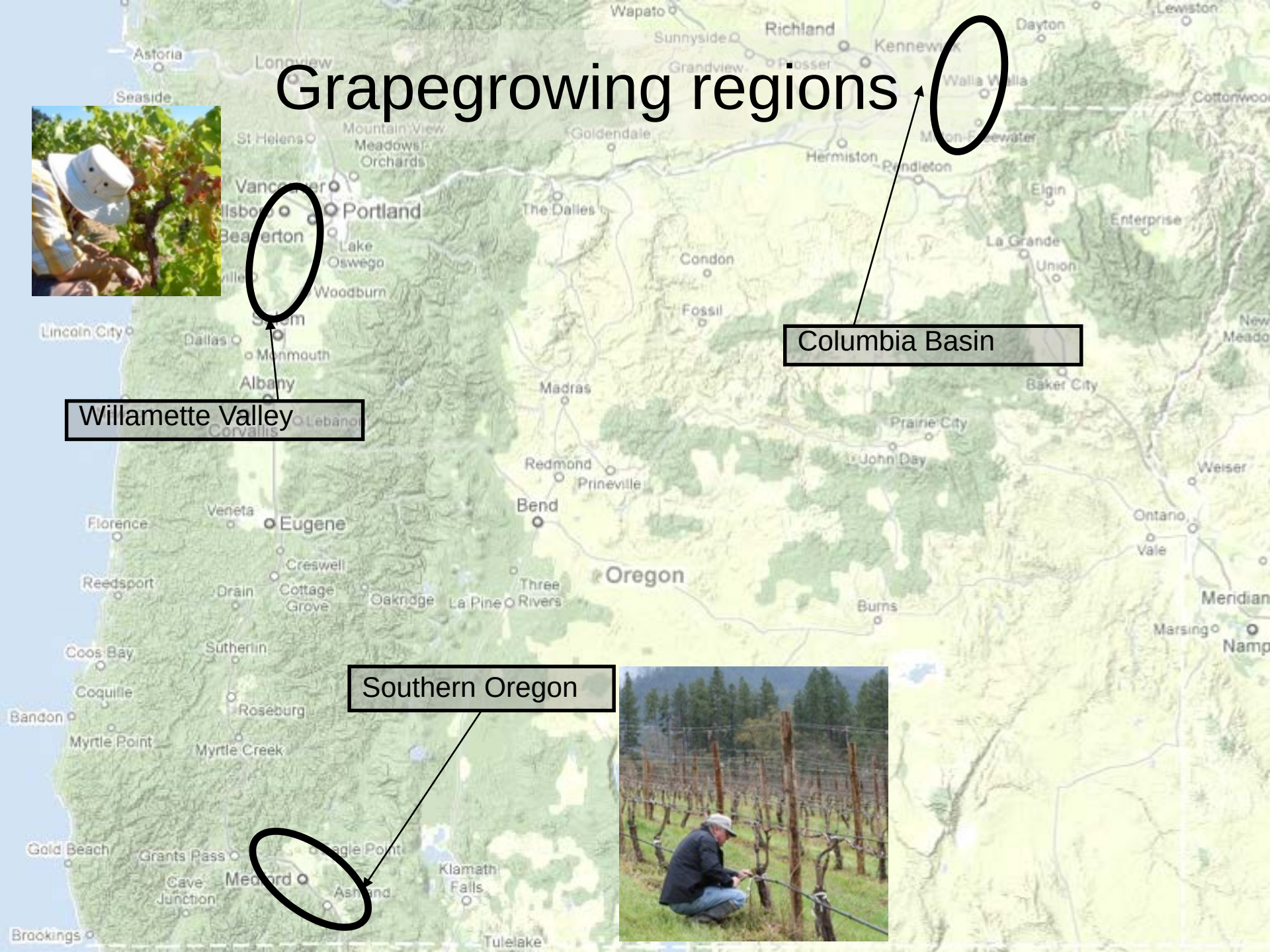
The Deadly Triangle



The vector feeds on hosts, the pathogen is pathogenic to host

Grapegrowing regions

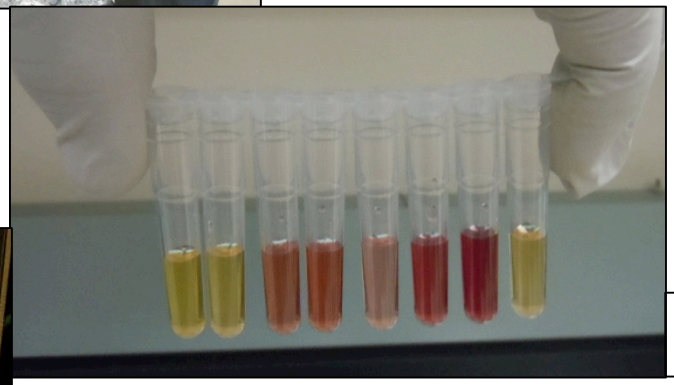


Sample preparation

1

2

1. Leaf collection
2. Tissue homogenization
3. Production of lysate
4. qPCR analysis



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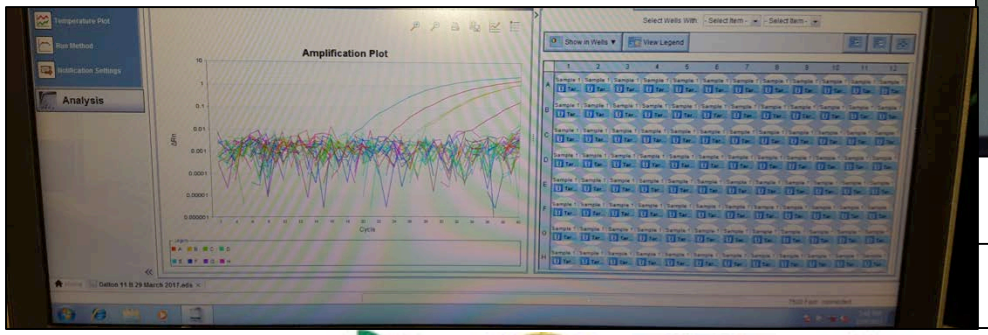

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Tissue collections, surrounding vegetation

Epidemiology trends

Regions surveyed in Oregon for GRBaV and incidence levels during 2016

Region	Site	Vines sampled in 2016	Positive for virus	% Infected
Southern Oregon	1	75	55	73.3%
	2	9	3	33.3%
	3	14	0	0.0%
	4	5	2	40.0%
	5	2	2	100.0%
	6	2	1	50.0%
	7	196	37	18.9%
	8	7	5	71.4%
	Nursery vines	32	0	0.0%
	Seedling vines from surrounding vegetation	14	1	7.1%
Willamette Valley	1	101	13	12.9%
	2	128	4	3.1%
	3	177	0	0.0%

Epidemiology trends

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	2	128	4	3.1%
	3	177	0	0.0%
S. Oregon total		356	106	29.8%
W. Valley total		406	17	4.2%
Total		**762**	**123**	**16.1%**

Epidemiology trends

Year	GRBaV-Positive	Count	% Infected	Rate of Spread
2014	3	193	1.6%	
2015	60	194	30.9%	19.90
2016	112	194	57.7%	1.87

Year	GRBaV-Positive	Count	% Infected	Rate of Spread
2014	16	188	8.5%	
2015	33	195	16.9%	1.99
2016	38	195	19.5%	1.15

Year	GRBaV-Positive	Count	% Infected	Rate of Spread
2013	54	180	30.0%	
2014	99	332	29.8%	0.99
2015	166	344	48.3%	1.62
2016	203	344	59.0%	1.22

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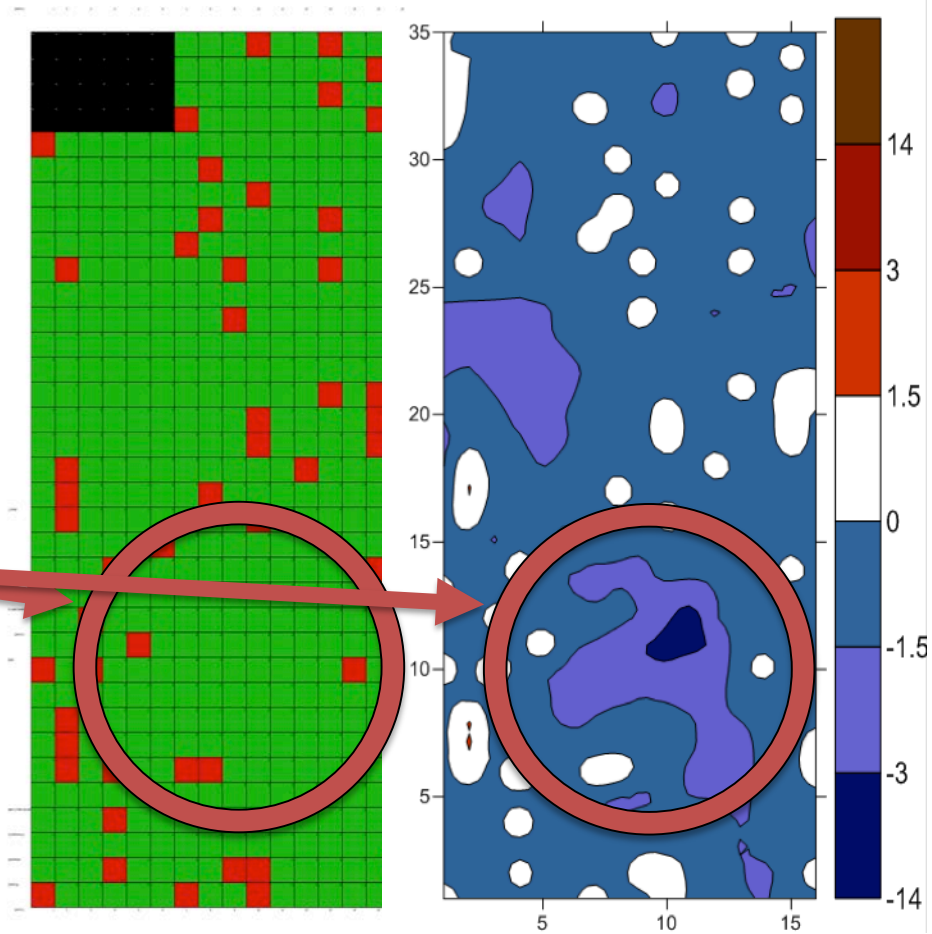
SADIE Analysis

- Spatial coordinates and count data are used to compare degree of regularity
- Apply data to Spatial Analysis by Distance Indices (SADIE) statistical program (Perry 1995)
- SURFER program produces contour maps showing patches and gaps
- Patch = higher than average counts
- Gap = lower than average counts

X	Y	Count
1	29	0
1	30	0
1	31	1
2	1	0
2	2	0
2	3	0
2	4	0
2	5	0
2	6	1
2	7	1
2	8	1
2	9	0
2	10	0

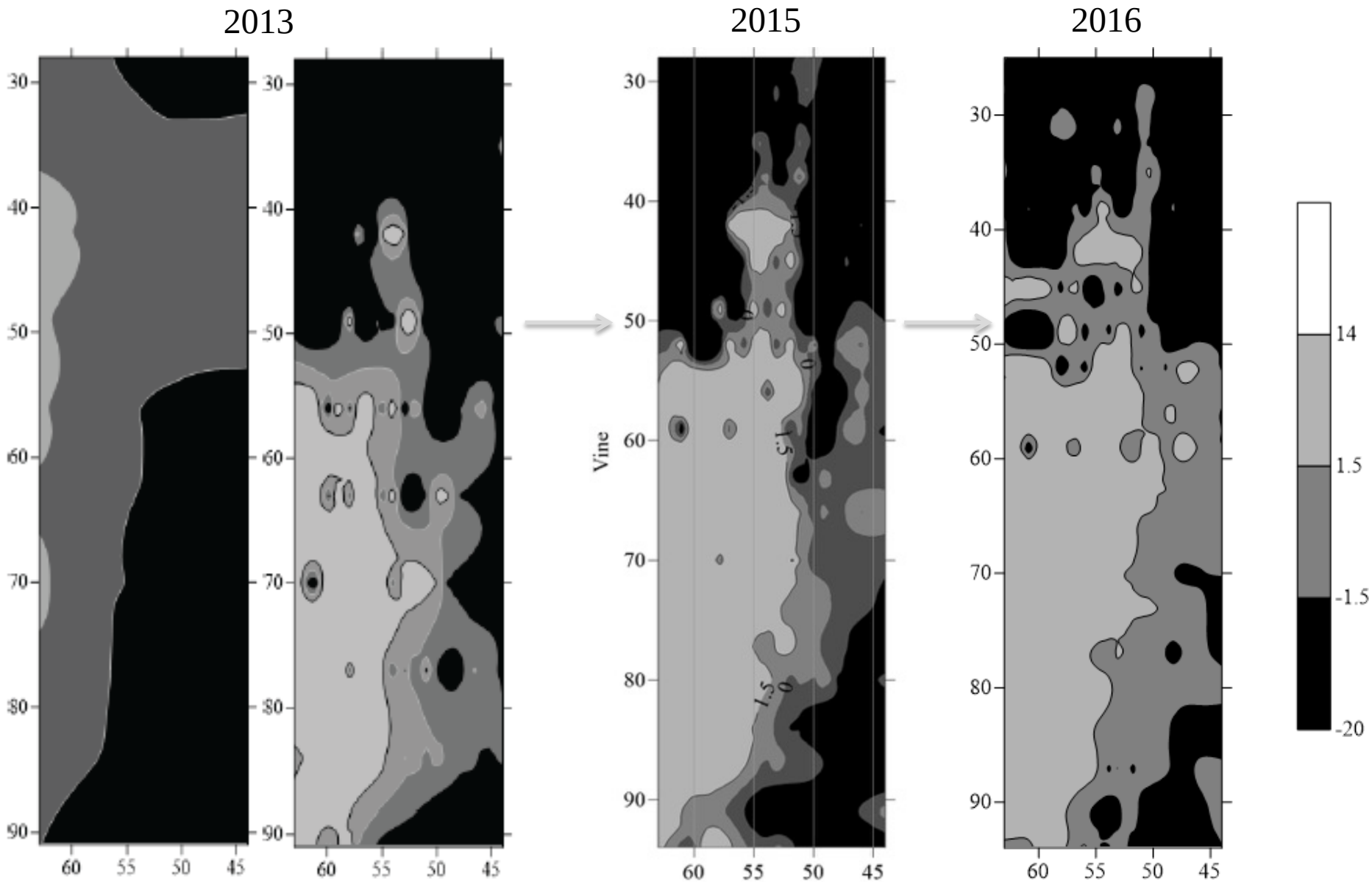
Significant Gap



Visual symptoms of virus in a vineyard block

Epidemiology trends

Vineyard 1, Willamette Valley



Leafroll | Red Blotch 30% | Red Blotch 48% | Red Blotch 59%

Transmission biology trials, OSU greenhouse, Corvallis OR

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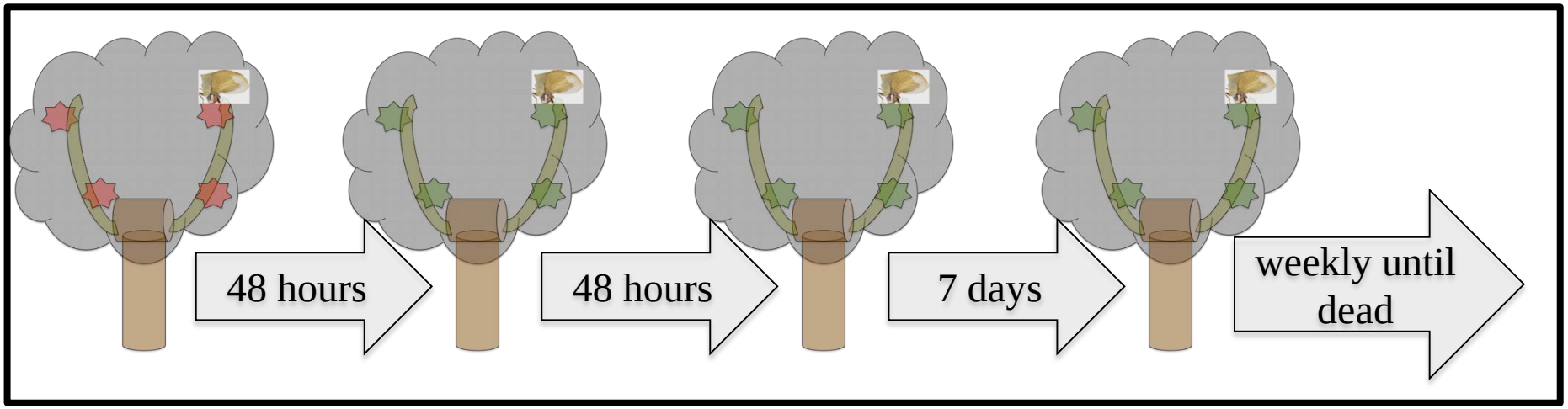
Transmission biology studies

Acquisition → Inoculation → Persistence of infectivity



Bug on Red
Blotch positive
vine

Bug on Red
Blotch negative
vine

Above: Schematic of *T. albidosparsus* greenhouse infestation study. Results have not been analyzed to date. N=130

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- **Insect vectors** **(Symptoms, field distribution, lifecycle)**
- **Best management practices**

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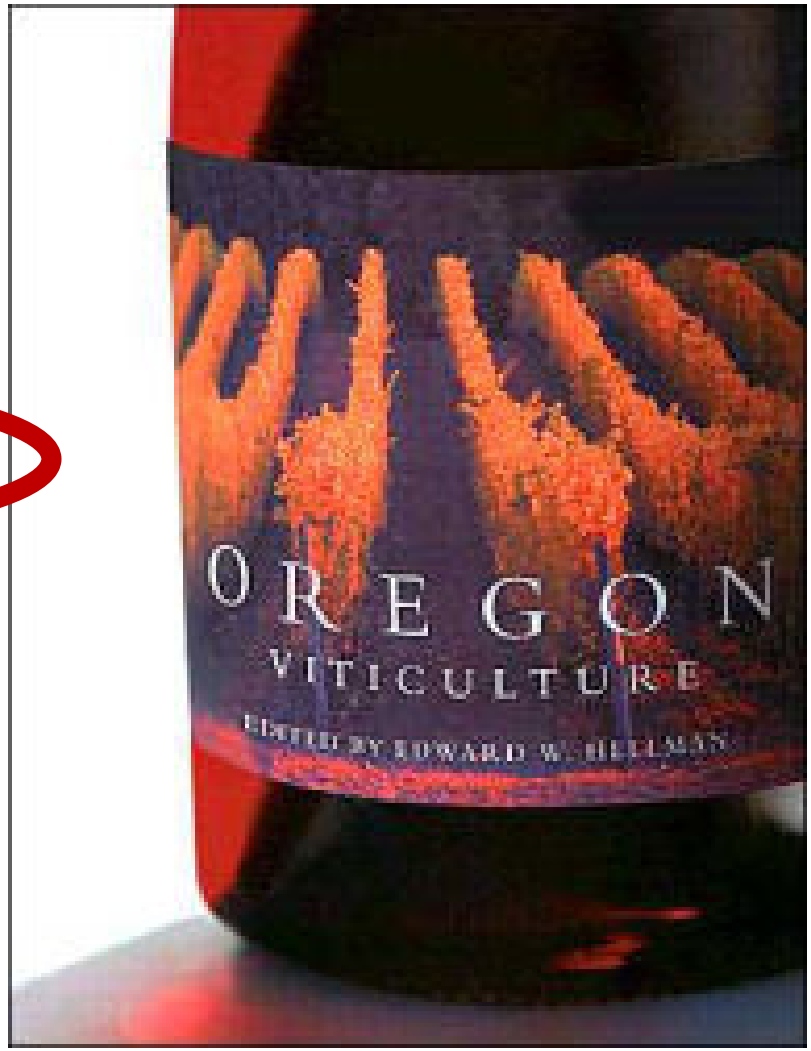
Oregon Viticulture

— edited by Ed Hellman, pub. in 2003

❑ Ch. 24 Management of Insect and Mite Pests

- Grape phylloxera
- Black vine weevil
- Spider mites
- Leafhoppers
- Sharpshooters
- Threecornered alfalfa hopper
- Branch and twig borer
- Variegated cutworm
- Other lepidoptera
- Grape mealybug
- Thrips
- Grasshoppers
- Yellowjackets




Tortistilus wickhami
Van Buskirk

Insect Surveys 2016

February 2016 revelation of threecornered alfalfa hopper (*Spissistilus festinus*) as vector of GRBaV

Searched all sticky cards from 2009-2015

OSU and SOREC insect collections (1920's- present)

Found

Tortistilus wickhami

Tortistilus albidosparsus

Spissistilus festinus

Region	*S. festinus*	*T. albidosparsus*	*T. wickhami*
So. Oregon	X	X	X
Willamette Valley		X	X
E. Oregon			

Insect surveys 2016

T. wickhami, mostly in Southern Oregon

Insect surveys 2016

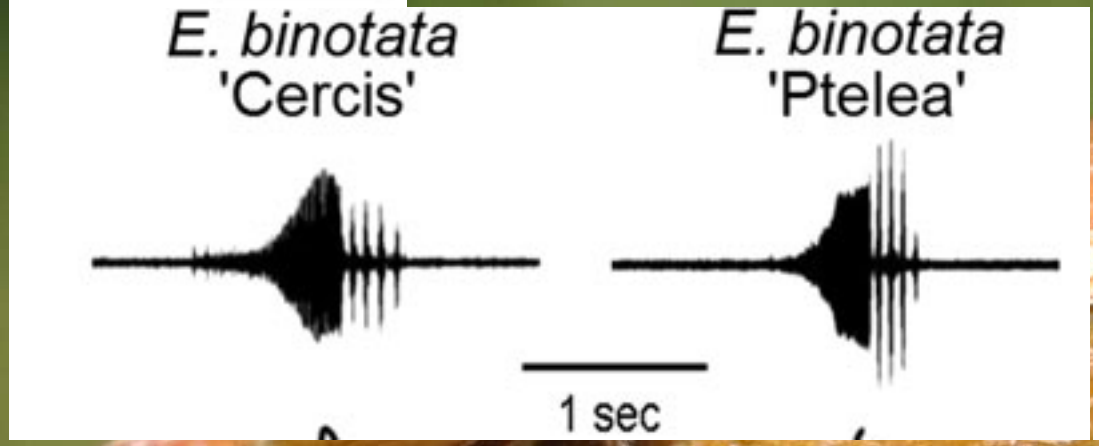
T. albidosparsus, mostly in Willamette Valley

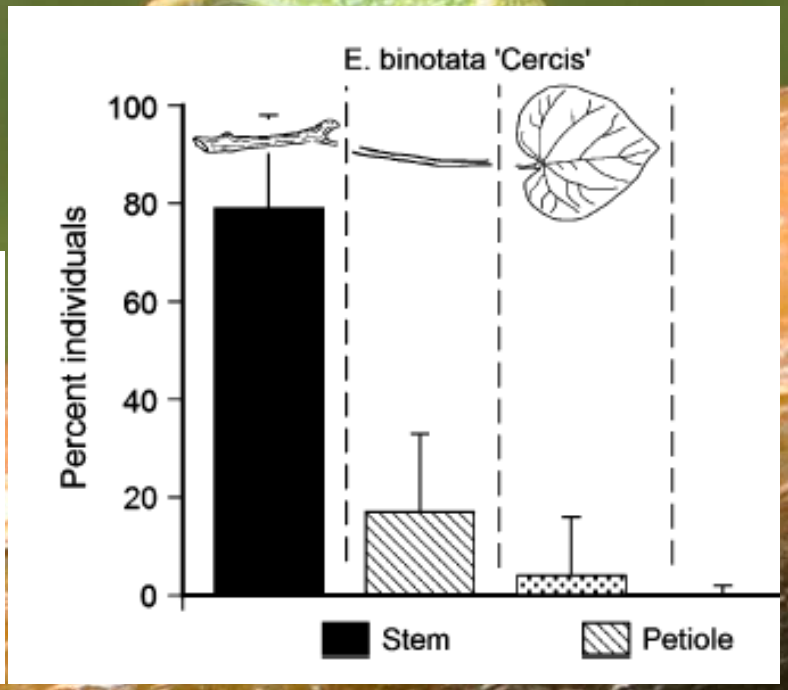
Results of sampling in 2016 in S. Oregon

Sampling method	*S. festinus*	*T. wickhami*	*T. albidosparsus*
Sweepnet	1	0	0
Sticky card	1	4	2 (in apple orchard)
Beat tray	0	≈ 4	0
Visual search	0	> 50	≈ 2

Rick Hilton data

Using substrate-borne vibrational signals transmitted through the leaves and stems of their host plant





Insect Surveys

T. albidosparsus

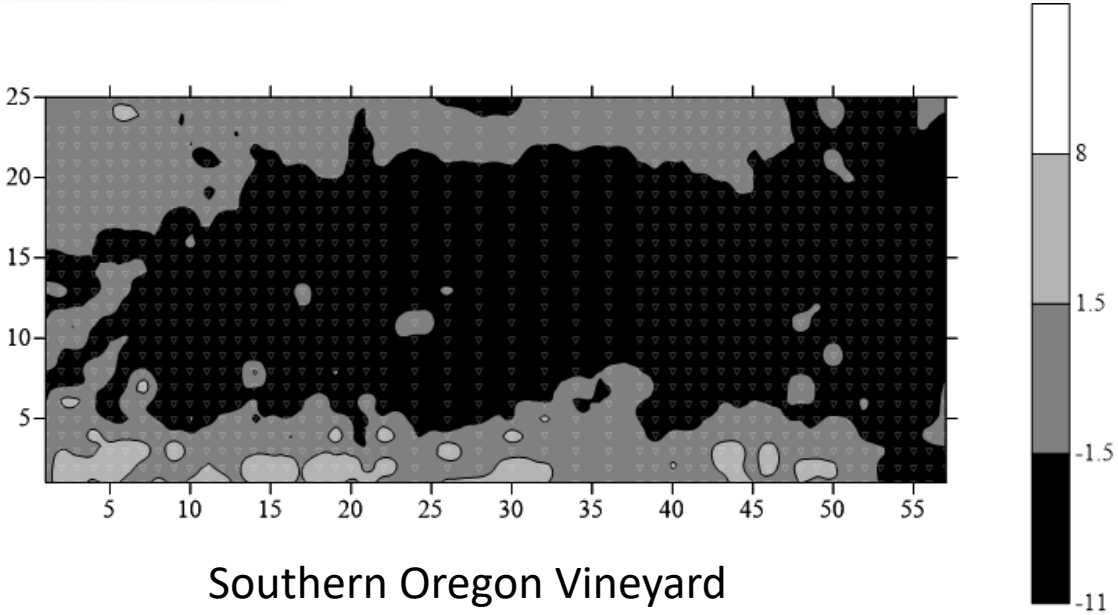
Treehopper feeding symptoms

T. wickhami

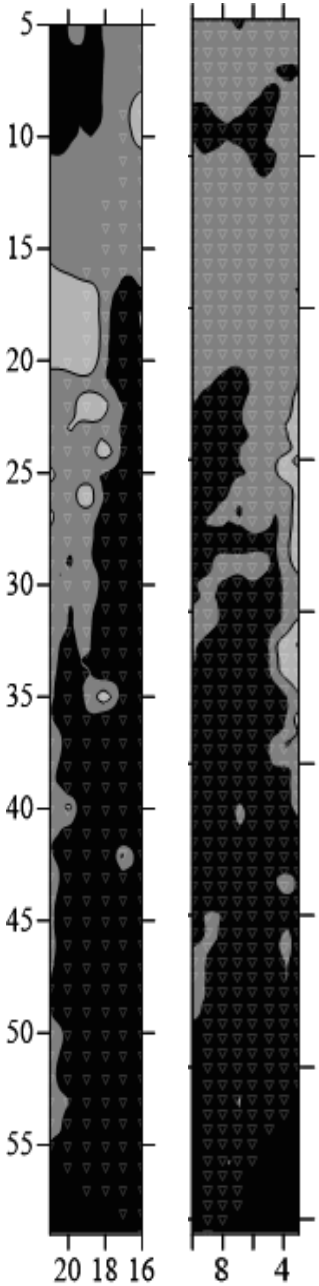
Treehopper feeding symptoms

- Girdling and discolored leaves (red cultivars) are seen in 1/5 cases
- Symptoms begin to appear about 5 days after feeding

Mapping Treehopper Injury in Vineyards

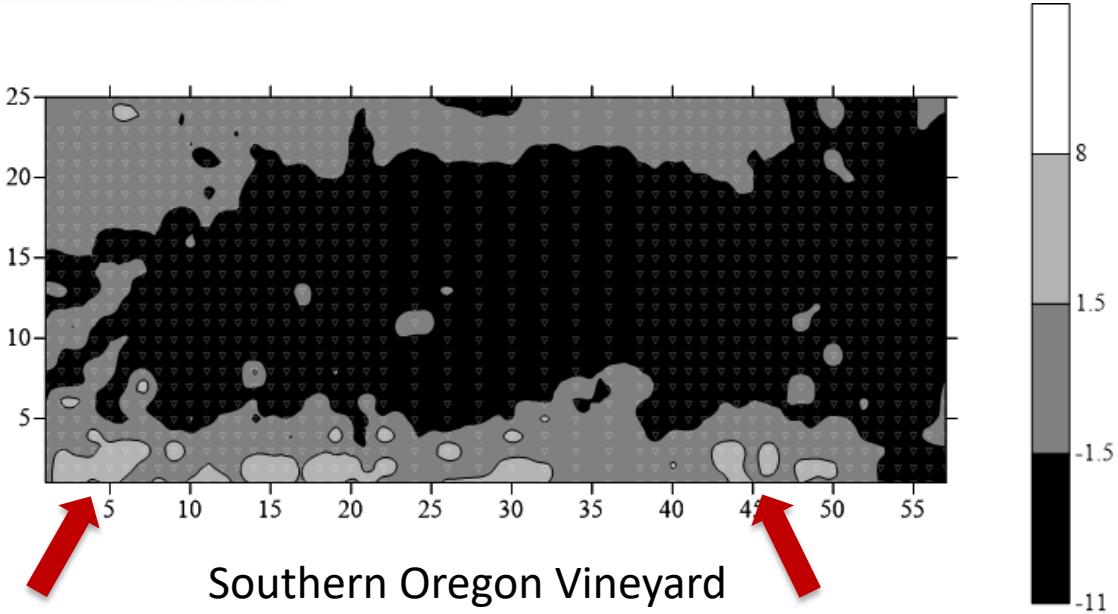


Southern Oregon Vineyard



Willamette Valley Vineyard

Mapping Treehopper Injury in Vineyards



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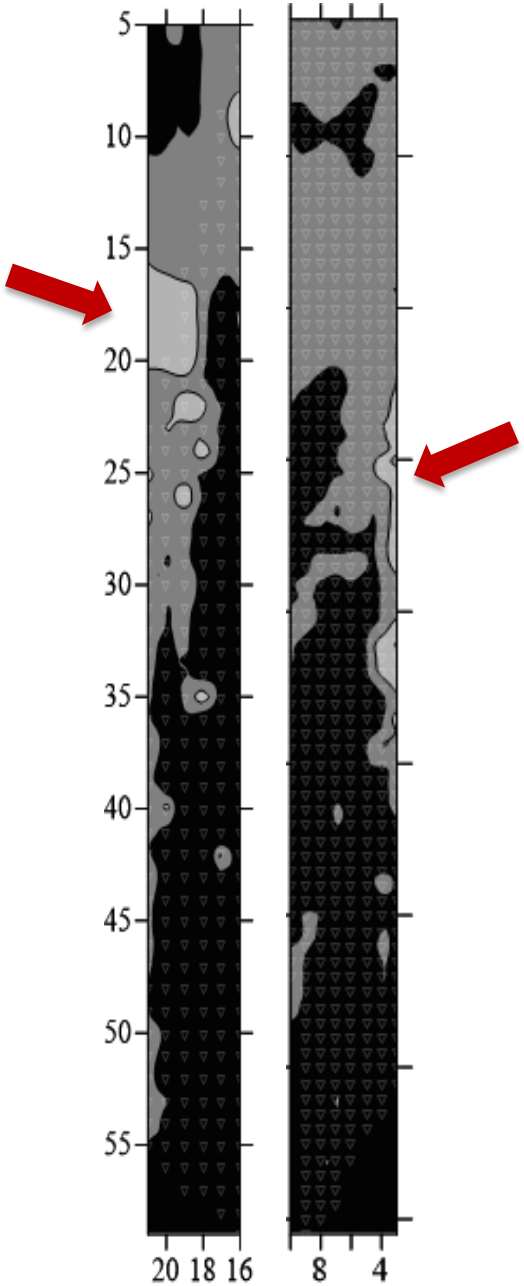
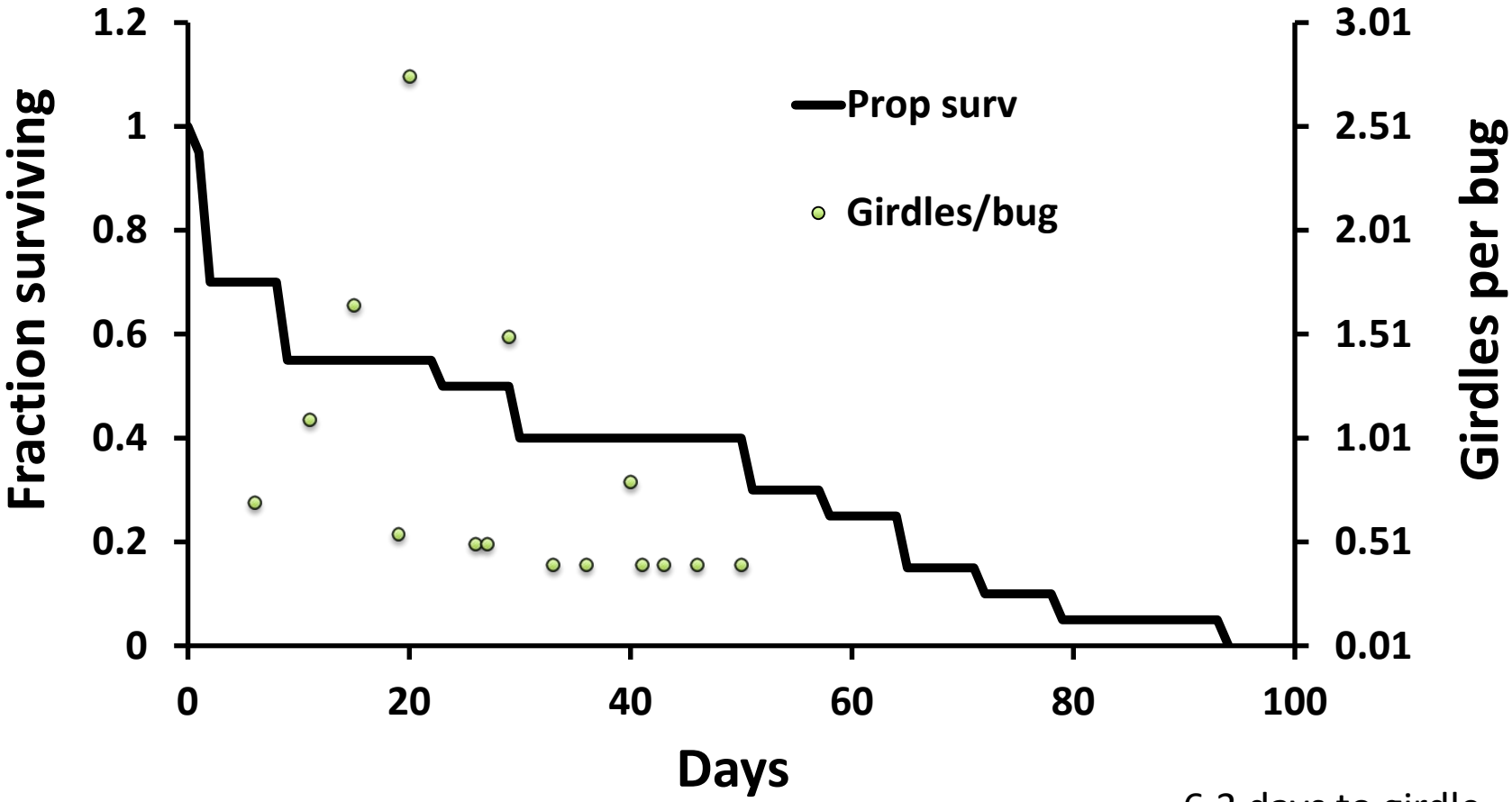


Willamette Valley Vineyard

T. wickhami survival and girdling trends



6.3 days to girdle

Surrounding non-crop vegetation

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Surrounding non-crop vegetation

Findings during 2016:
Oak
Hazelnut
Rose
Apple
Pear
Blackberry

Other literature and collections:
Almond
Ceanothus
Madrone
Manzanita
Walnut
Willow
Thistles — *Cirsium californicum, C. proteanum, C. arvense* (Canada thistle)

Surrounding non-crop vegetation

Cirsium californicum (Left) Cirsium arvense (Canada thistle, right)

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Surrounding non-crop vegetation

Dry summer, dry pastures, disturbed fields

Cirsium arvense (Canada thistle)

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Possible additional vectors (M. Fuchs , Cornell)

Colladonus reductus
(Variegated hopper)

Osbornellus spp.
(Variegated hopper)

Cixiidae (Planthoppers)

Other species from this genus known to vector phytoplasma, M. Fuchs has shown high virus levels using PCR

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Treehopper oviposition

T. wickhami ovipositing on grape cane, Willamette Valley

Current Best Management Practices

1. Use only healthy/clean stock when planting vines
2. Ask for virus test results from the supplier of nursery stock
3. When grafting vines be sure to have clean bud wood sourced
4. Employ regular monitoring of vine symptoms throughout the year
5. Monitor for symptoms of insect vector presence
6. If blocks test positive for the virus, do not use the bud wood for propagation nor provide it to other nurseries for propagation
7. Avoid planting or replanting vines in close proximity to vineyards that are positive for Red Blotch virus and that have insect vectors

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Thank you!

Especially to our
collaborating growers,
and Andy Swan,
Lora Stamper,
Alex Soohoo-Hui,
Shannon Davis,
Mukesh Bhattarai,
Ashley Li,
Trent Lawler,
Julia Vo

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