Evaluation of Delayed Dormant Copper to Reduce Inoculum of *Erwinia amylovora* in Bartlett Pears: 2010-2013

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- **Old recommendation (green tip)**
- **Based on counting strikes only (early-mid 1900's)**
- **New interest due to resistance to antibiotics, new copper materials (e.g. Badge X2)**
- **LAMP available to determine presence of bacteria on blossoms *rapidly***
- **BEGAN 2010; 2013 THE FINAL YEAR**

Why did we do this?

Summary of LAMP assay results from 100-flower cluster samples collected from commercial pear and apple orchards in the Pacific Northwest region of the United States from 2008 to 2010

Year	State	Production area	Host	No. of orchards	No. of positive LAMP of total samples			Media isolation[b]	Mean Log (CFU) per flower[c]	No. of orchards with fire blight	Disease severity in orchards with fire blight[d]
					Mid-bloom	Full bloom	Petal fall				
2008	OR	Rogue Valley	Pear	3	0 of 15	0 of 14	n.s.[e]	No	-	0	-
		Hood River Valley	Pear	3	0 of 15	3[f] of 15	7[f] of 15	Yes	1.6	2	Light to moderate
2009	OR	Rogue Valley	Pear	3	3 of 20	0 of 20	2 of 20	Yes	3.3	1	Light
		Hood River Valley	Pear	6	6 of 30	6 of 30	7 of 25	Yes	3.3	2	Light
		Hood River Valley	Apple	2	0 of 8	2 of 8	4 of 8	Yes	2.2	1	Light
		Walla Walla Valley	Apple	4	0 of 20	4 of 20	11 of 20	Yes	3.3	3	Light
	CA	Lake County	Pear	4	2 of 15	2 of 15	1 of 15	Yes	1.2	1	Light
	WA	Okanogan Valley	Pear	1	0 of 4	0 of 6	2 of 4	Yes	3.8	1	Light
		Wenatchee Valley	Pear	2	0 of 10	0 of 10	0 of 10	No	-	0	-
		Columbia Basin	Apple	3	0 of 15	0 of 15	0 of 10	No	-	3	Light to moderate
	UT	Utah County	Apple	6	11 of 19[f]	19 of 25[f]	10 of 18[g]	Yes	3.4	7	Moderate to heavy
2010	OR	Rogue Valley	Pear	2	0 of 12	0 of 12	0 of 12	No	1.5	0	-
	CA	Sutter County	Pear	6	4 of 30	0 of 30	0 of 30	Yes	2.0	0	-
	CA	Lake County	Pear	5	0 of 30	0 of 30	20 of 40	Yes	-	0	-
	WA	Okanogan Valley	Pear	1	2 of 3	0 of 5	n.s.	No	-	1	Light
		Yakima Valley	Apple	9	0 of 30	2 of 30	n.s.	Yes	1.6	6	Light
		Summary		60	28 of 276 10%	38 of 285 13%	64 of 227 28%		2.8	28	

- **6 orchard blocks in Yuba County (Sacramento Valley)**
- **6 orchard blocks in Lake County.**
- **4 orchard blocks in Sacramento County (not 2011)**
- **Treated vs. untreated blocks (4-5 acres Badge X2 applied at bud swell (just before green tip – slightly earlier than old literature/recommendations), 6 lbs./acre, air blast sprayer.**
- **Blossom samples mid-bloom, full bloom, petal fall and rat tail to OSU for LAMP.**
- **Russet and frost damage samples pre-harvest to UCB.**
- **Blight counts in mid April – June.**

Protocol: 2010-2013

Percent LAMP detection of *E. amylovora* over 4 years in California
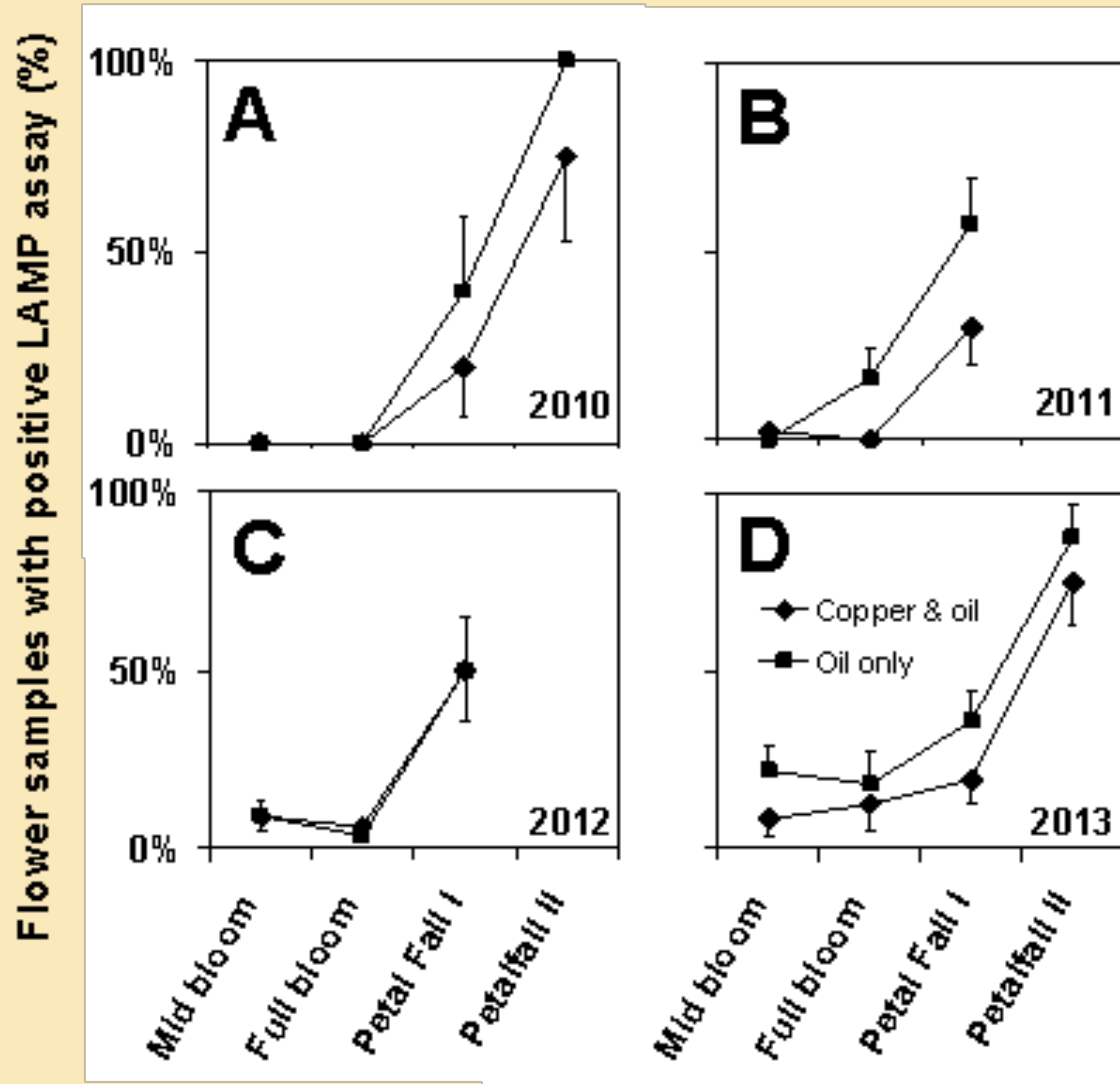
Combined average number positive LAMP samples per flower and average Log^{10} *E. amylovora* detected in all bloom stages in Lake and Yuba Counties, CA, 2010 - 2013

Treatment	2010		2011		2012		2013	
	Spray dates not available		Treatment applied 36 (Yuba) to 37 (Lake) days prior to Mid-bloom		Treatment applied 28 (Yuba) to 59 (Lake) days prior to Mid-bloom		Treatment applied 25 (Yuba) to 35 (Lake) days prior to Mid-bloom	
	No./ flower	Log^{10}	No./ flower	Log^{10}	No./ flower	Log^{10}	No./600 flowers	Log^{10}
Copper + oil	1.0	1.6	0.1	0.2	0.1	0.1	0.3	1.1
Oil alone	1.1	1.7	0.2	0.3	0.1	0.1	0.4	1.9
P-value[1]	0.11	0.69	0.01	0.3	0.98	0.68	0.04	0.01

[1] Multiple-Variable analysis with Spearman Rank Correlation test.

Average number positive LAMP samples per 300 flower clusters and average Log ^{10} of colony forming units for *E. amylovora* detected in all bloom stage samples collected from orchards treated with and without delayed dormant copper from 2010-2013 in Lake and Yuba Counties, CA.
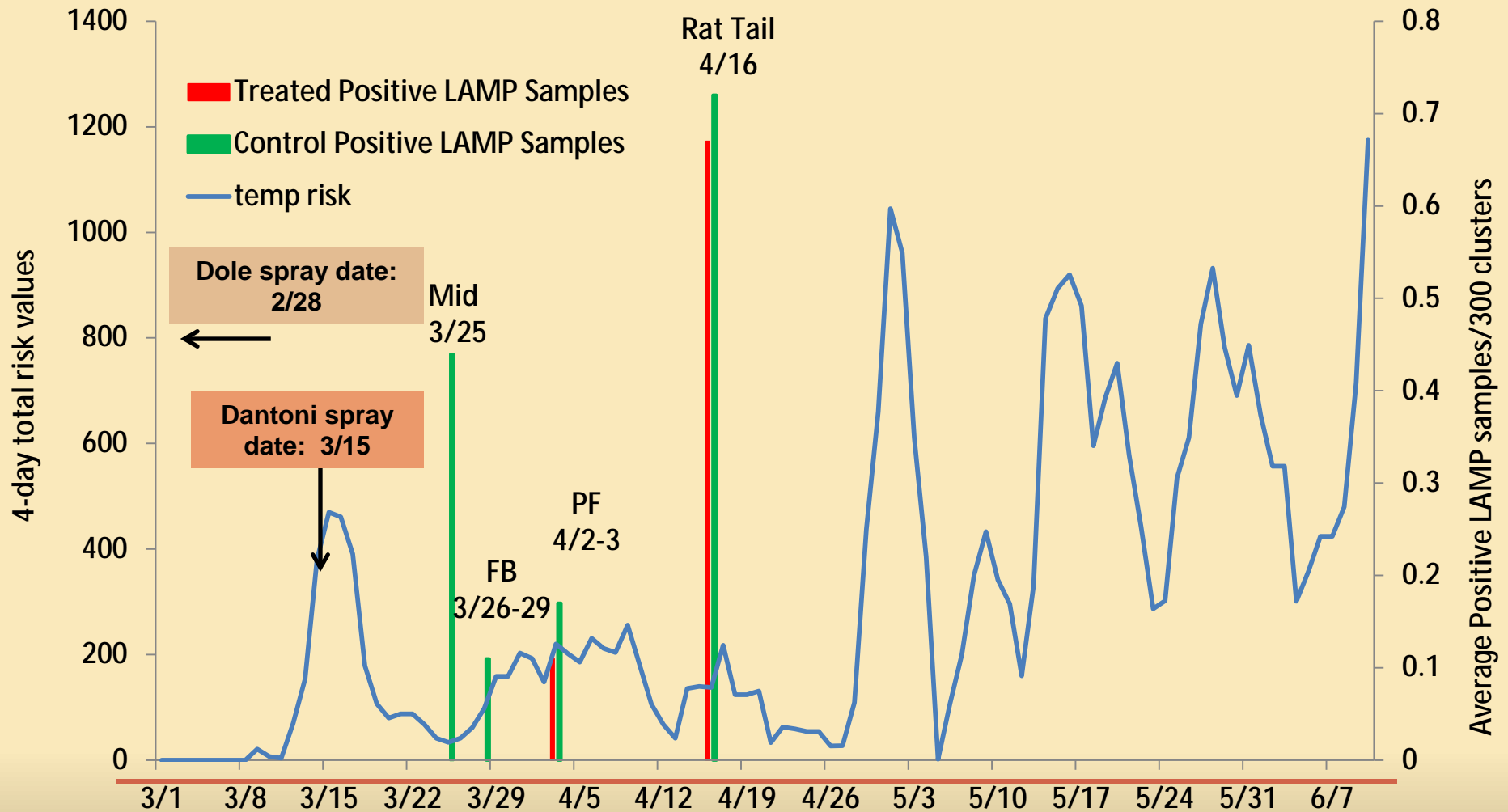
Treatment	Bloom Stage										Total (all years)	
	Mid Bloom		Full Bloom		Petal Fall		Petal Fall II		Rat Tail			
	No./test sample	Log^{10}	No./test sample	Log^{10}	No./test sample	Log^{10}	No./test sample	Log^{10}	No./test sample	Log^{10}	No./test sample	Log^{10}
Copper + oil	0.04	<0.00	0.04	<0.01	0.21	0.36	0.60	1.54	0.47	0.16	0.16	0.13
Oil alone	0.07	<0.01	0.11	0.07	0.43	0.41	1.00	3.68	0.51	0.16	0.26	0.20
P-value	0.22	0.18	0.05	0.07	0.003	0.60	0.14	0.03	0.72	0.80	0.001	0.10

|												
Treated	n=111	n=111	n=100	n=100	n=80	n=80	n=5	n=5	n=61	n=61	n=357	n=357
Untreated	n=108	n=108	n=97	n=97	n=81	n=81	n=5	n=5	n=61	n=61	n=352	n=352

Relationship between accumulated degree hour (base >65°F) for Yuba County, California, March 1 to May 24, 2013 and positive (shown in blue) LAMP samples.
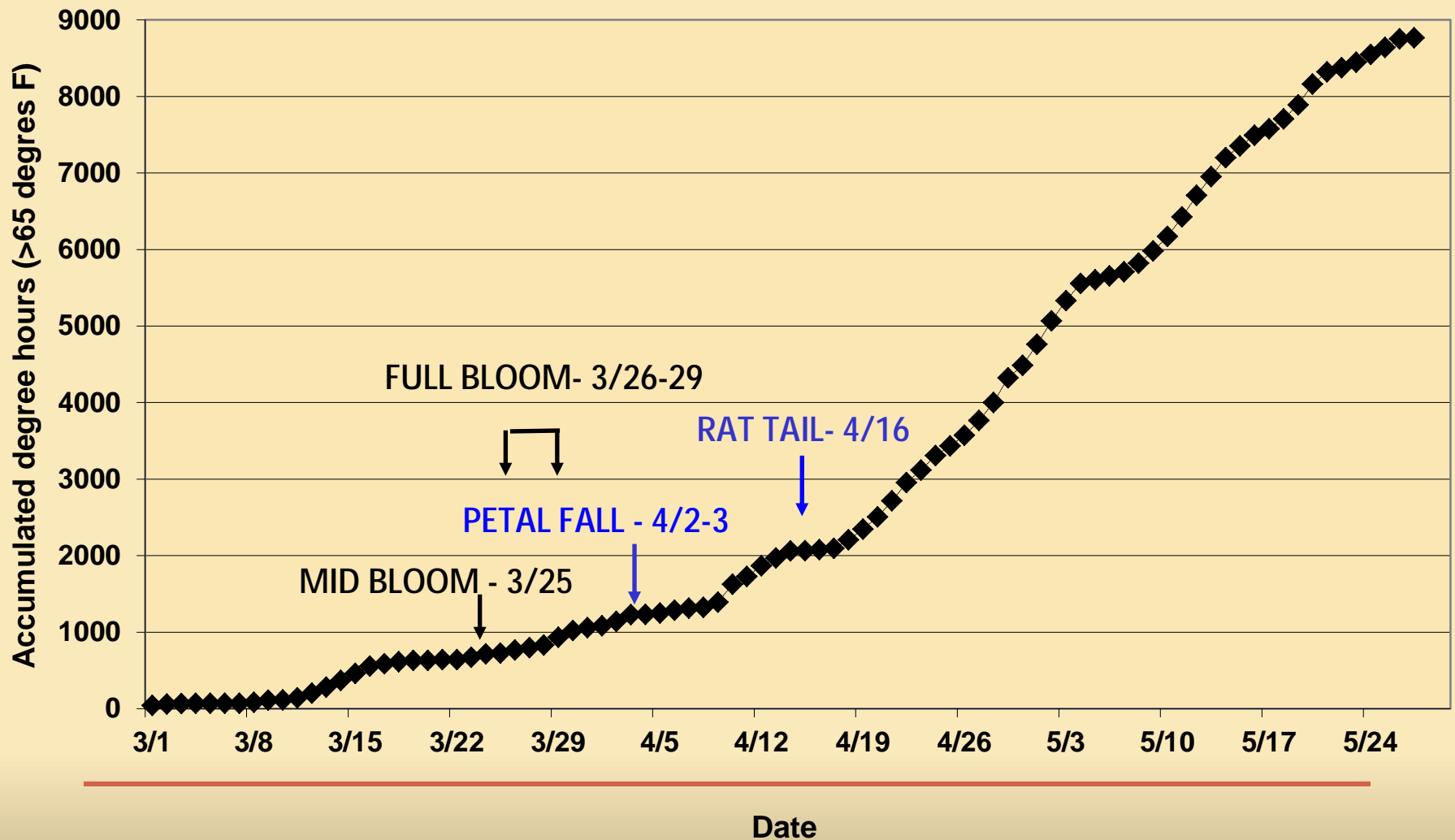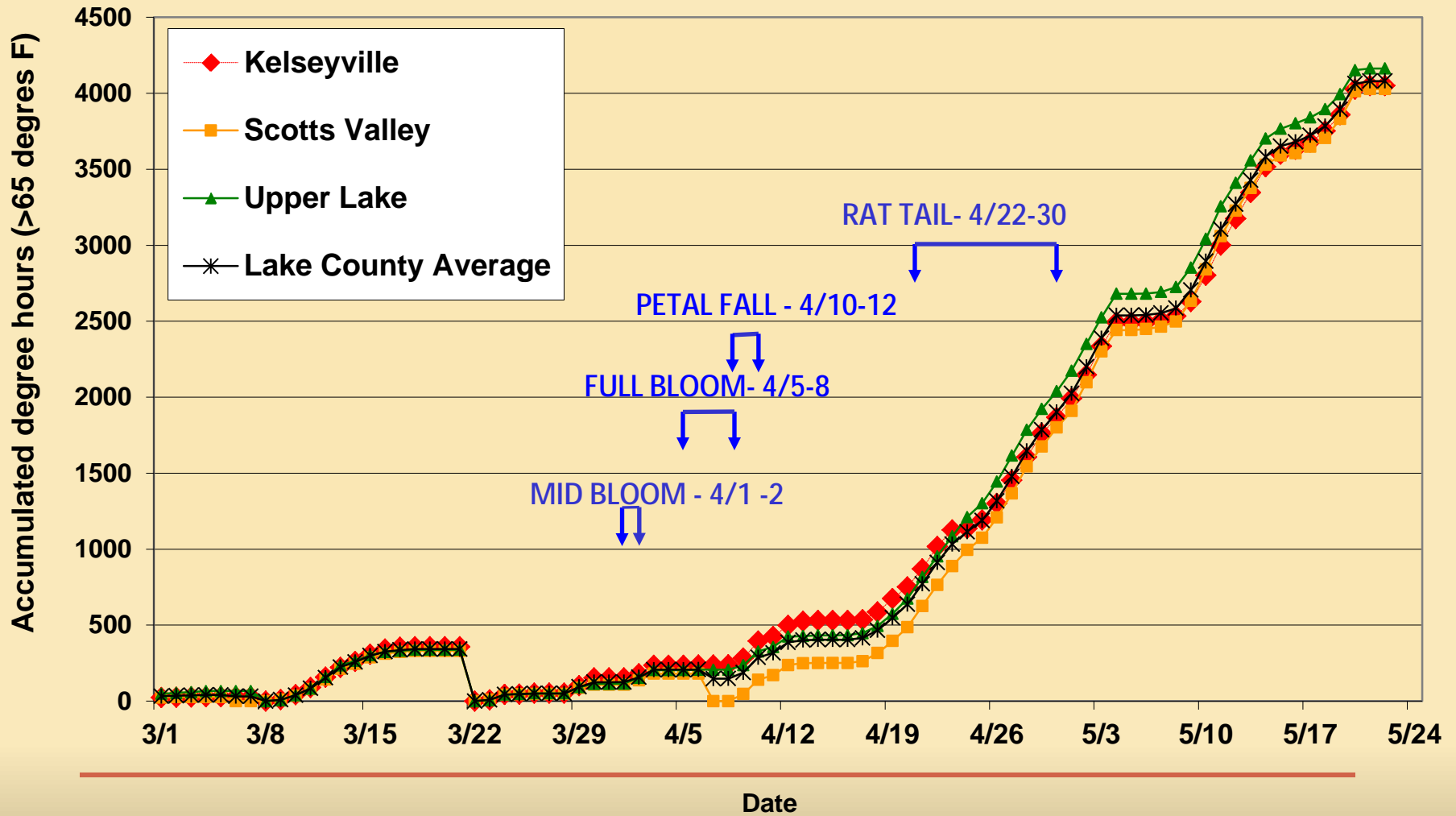
4-day Cougarblight total temperature risk values and average positive LAMP samples per 300 flower clusters at varying bloom stages for 6 orchards, Yuba County, CA, USA, 2013
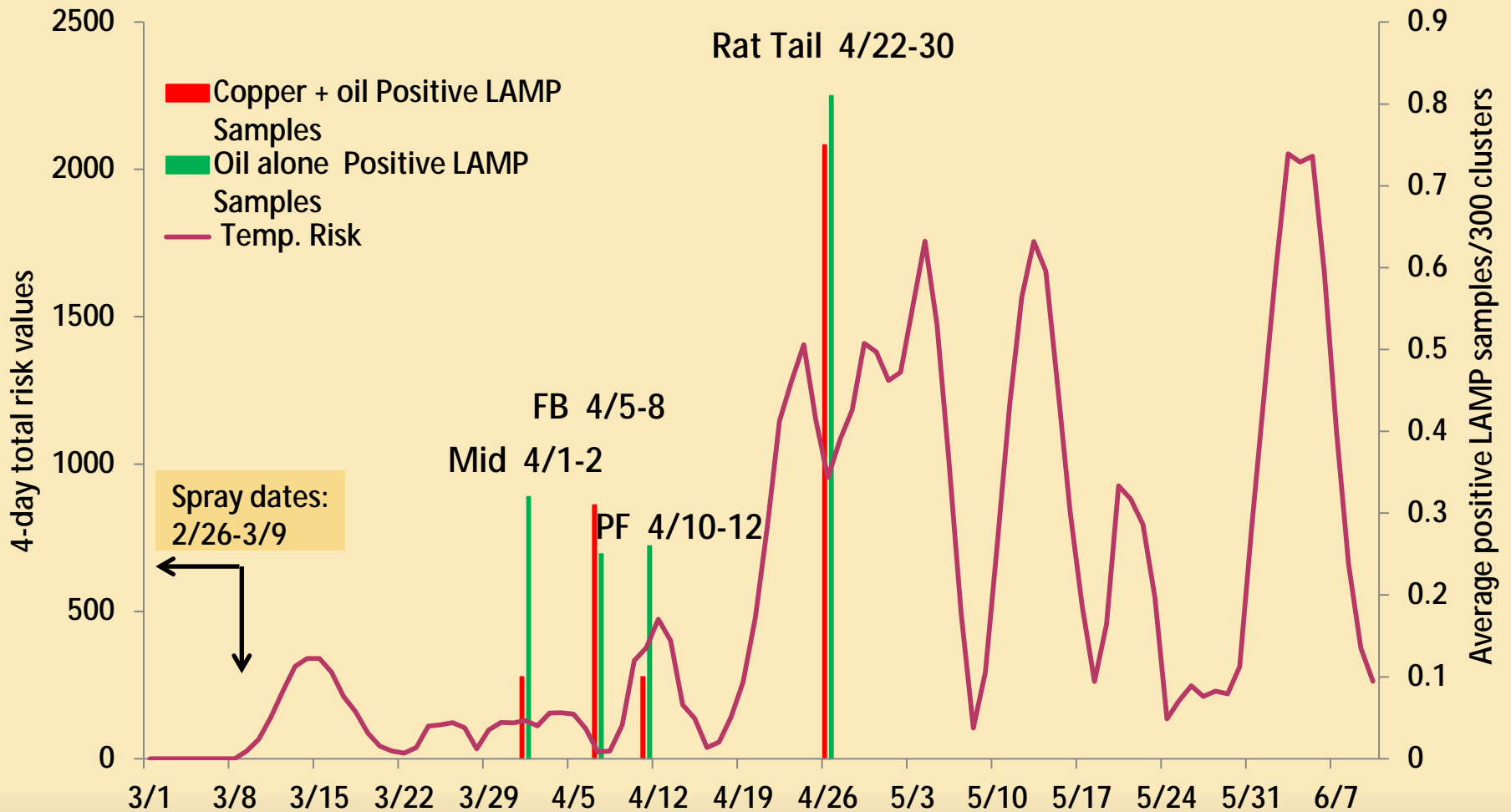
Weather data source: uspest.org/wea disease degree-day/phenology model program/Ken Johnson, OSU.

Cumulative degree hours >65 degrees F. for Lakeport, CA from March 15 to April 30 for the years 2010-2013
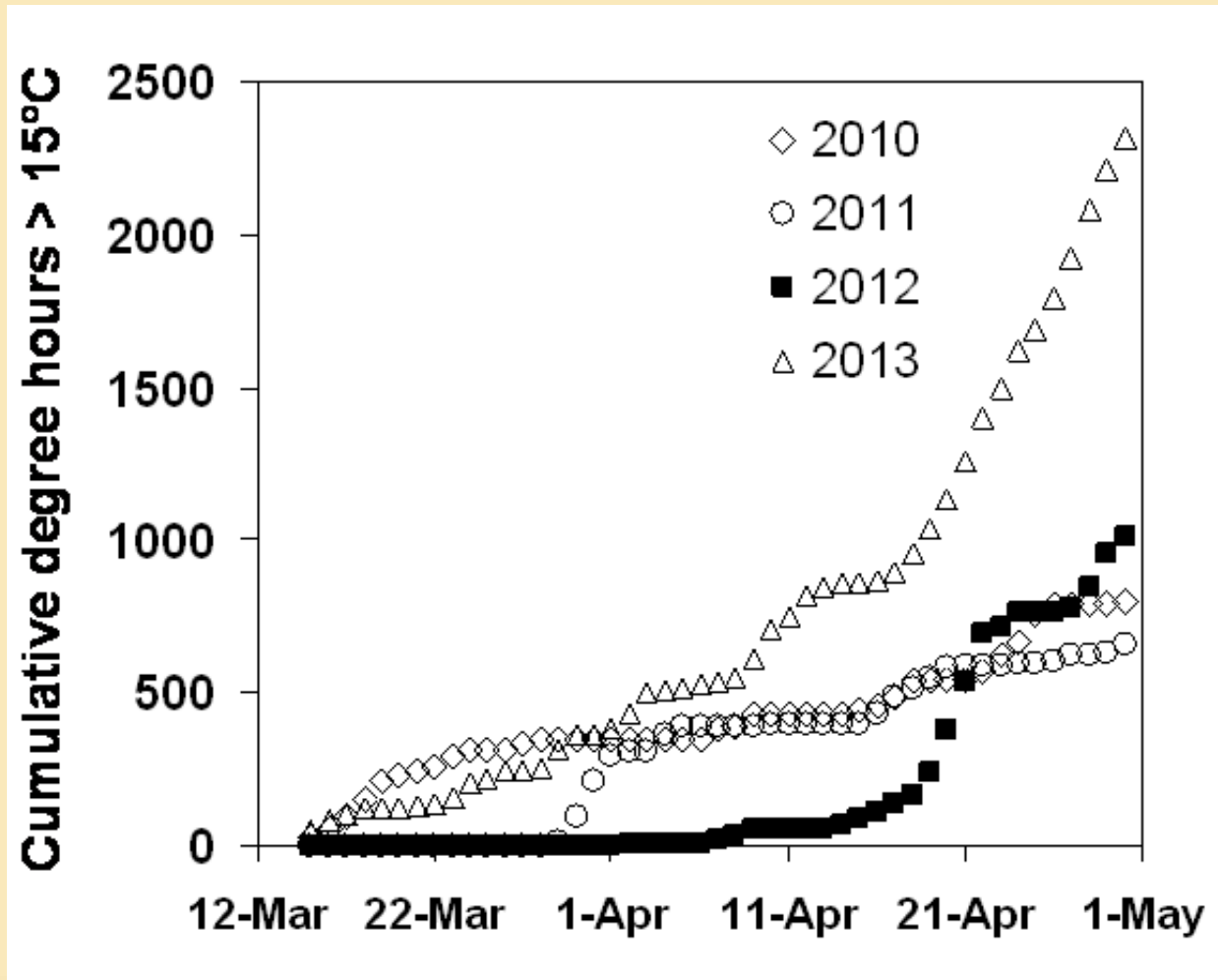
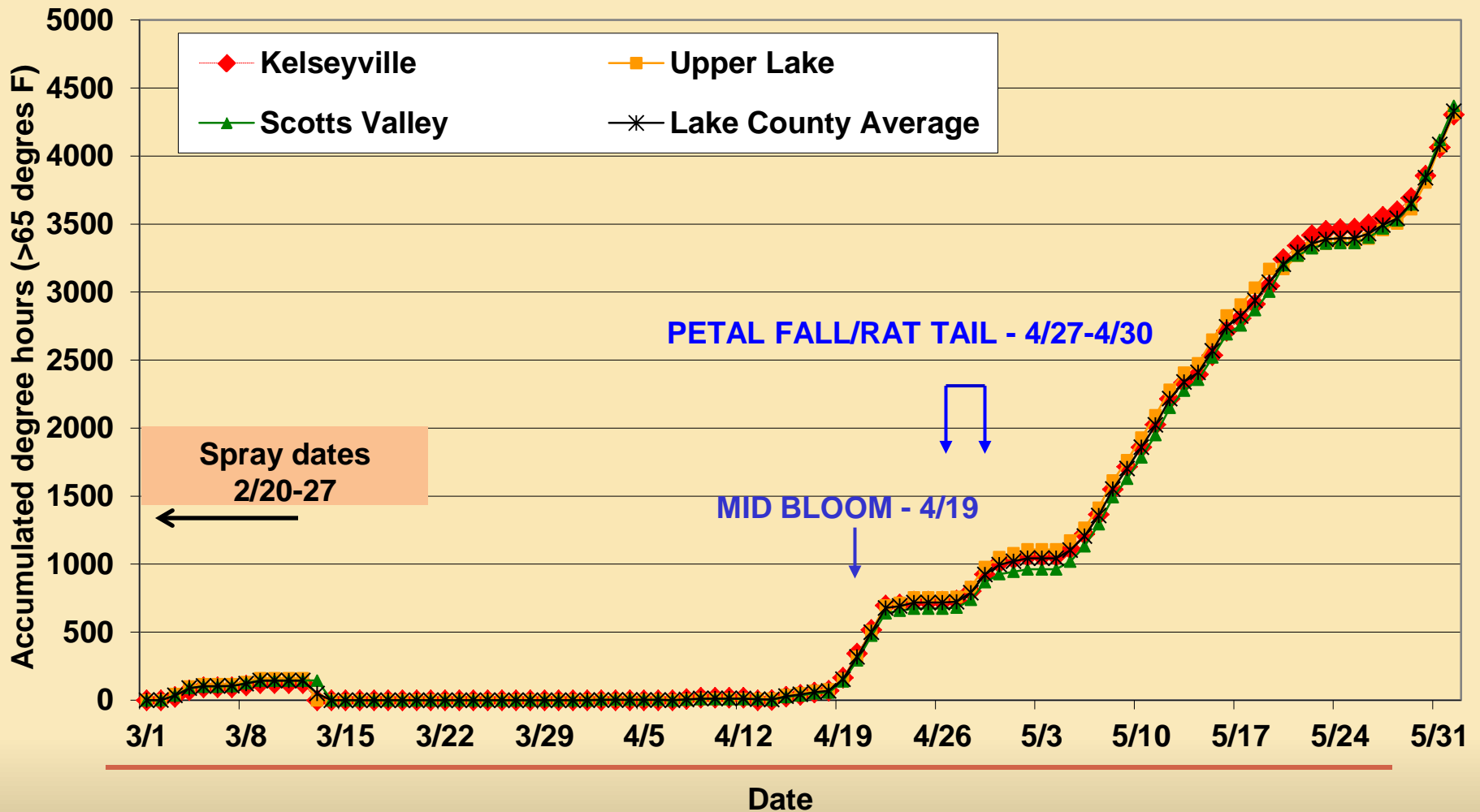# Relationship between accumulated degree hours (base ≥65°F) for Kelseyville, Scotts Valley (Lakeport) and Upper Lake, Lake County, California, March 1 to May 23, 2013 and positive LAMP samples.

4-day Cougarblight total temperature risk values and average positive LAMP samples per 300 flower clusters at varying bloom stages for 6 orchards, Lake County, CA, USA, 2013

Weather data source: uspest.org/wea disease degree-day/phenology model program/Ken Johnson, OSU.

Relationship between accumulated degree hour s (base >65°F) for Kelseyville, Scotts Valley (Lakeport) and Upper Lake, Lake County, California, March 1 to June 1, 2012 and positive LAMP samples (shown in blue.

Relationship between accumulated degree hours (base >65°F) for Yuba County, California, March 1 to June 1, 2012 and positive (shown in blue) and negative (shown in black) LAMP samples.
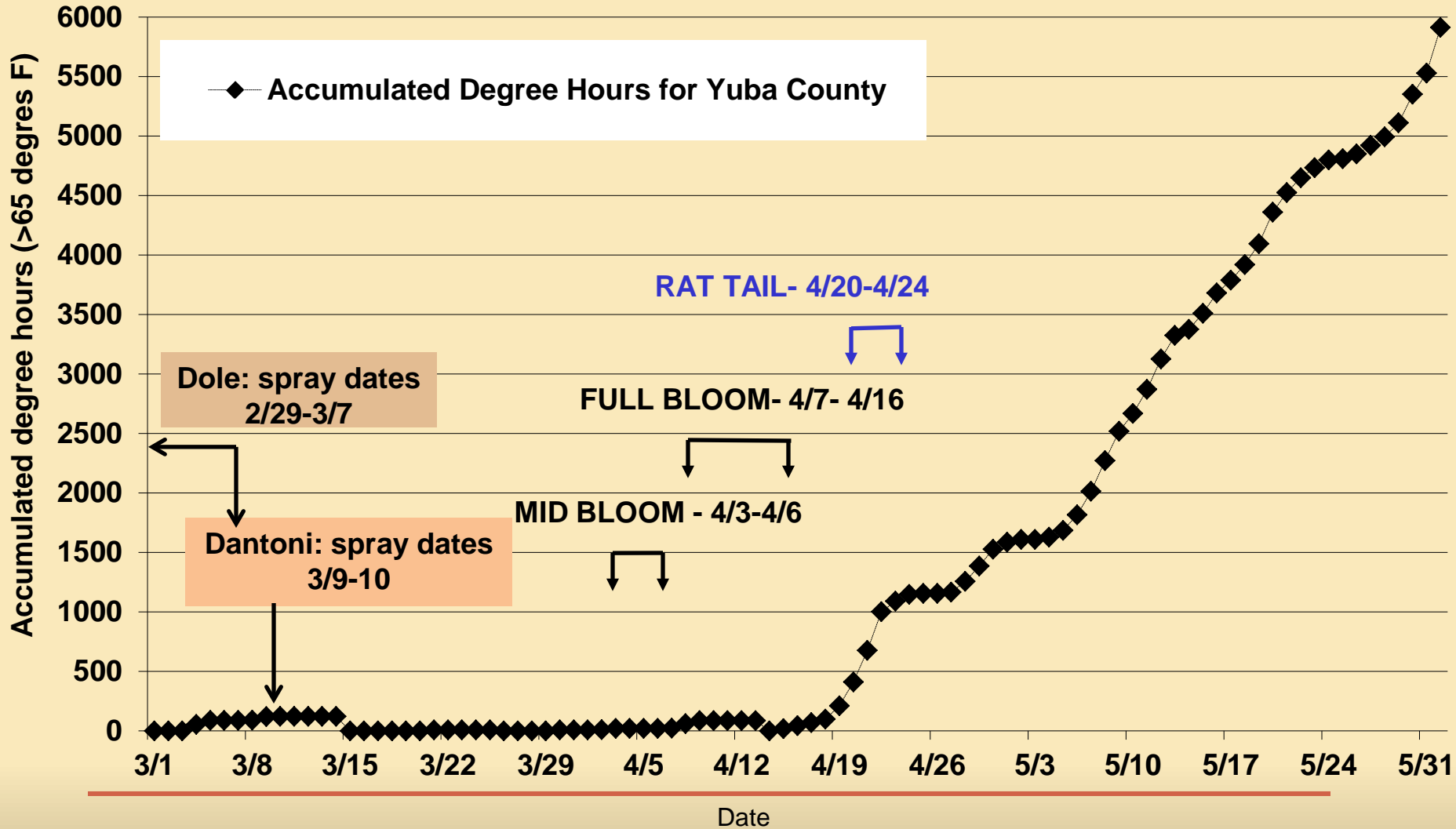
Average No. Positive LAMP Samples Per Flower
Avg. Log^{10} Colony Forming Units, *E. amylovora*
With and Without Delayed Dormant Copper

2010 and 2012-2013, Sacramento County, CA

	Bloom Stage									
	Mid Bloom		Full Bloom		Petal Fall		Rat Tail[2]		Total	
Treatment[1]	No. /flower	Log^{10}	No. /flower	Log^{10}	No. /flower	Log^{10}	No. /flower	Log^{10}	No. /flower	Log^{10}
Copper + oil	0.03	0.01	0.00	0.00	0.00	0.00	0.42	0.53	0.09	0.09
Oil alone	0.05	0.10	0.00	0.00	0.03	<0.00	0.46	0.26	0.10	0.07
P-value	0.56	0.30	~	~	0.32	0.32	0.58	0.31	0.84	0.59
Treated	n = 39	n = 39	n = 39	n = 39	n = 39	n = 39	n = 24	n = 24	n = 141	n = 141
Untreated	n = 39	n = 39	n = 39	n = 39	n = 39	n = 39	n = 24	n = 24	n = 141	n = 141

Average Fruit Russet and % Russet Severity
Bartlett pears, Sutter, Yuba & Lake Counties CA, 2010-2013

Year	No. Sections Sampled	Average Russeting		% of fruit with incidence of russet ≤ 3		% of fruit with incidence of russet ≥ 7	
		Copper + oil	Oil Alone	Copper + oil	Oil Alone	Copper + oil	Oil Alone
2010	5	2.2	2.2	91	95	9	5
2011	12	2.7	2.7	76	76	10	10
2012	11	1.4	1.8	88	84	3	5
2013	5	1.0	1.3	99	99	1	1

No significant differences in any year; Sacramento County as well.

- Delayed dormant copper significantly reduced inoculum in 3 of 4 years.

- 2012 LAMP results differed from 2010 and 2011 due to the long interval between treating and risk.

- LAMP continues to be a good tool to confirm bacterial presence (shows need to keep spraying at/past petal fall?)

- Degree-hour models highly accurate in assessing conditions for inoculum presence.

- No russet was detected from this timing, actually reduced 1 year at 1 site.

- Benefit is most with high overwintering inoculum. Benefit maximized when applied as close to bloom as possible.

Conclusions 2010 -2013

Acknowledgements

THANK YOU!!