Evaluation of Delayed Dormant Copper to Reduce Inoculum of *Erwinia amylovora* in Bartlett Pears – Year 3

Rachel Elkins, Ken Johnson, Todd Temple, Steve Lindow and Broc Zoller

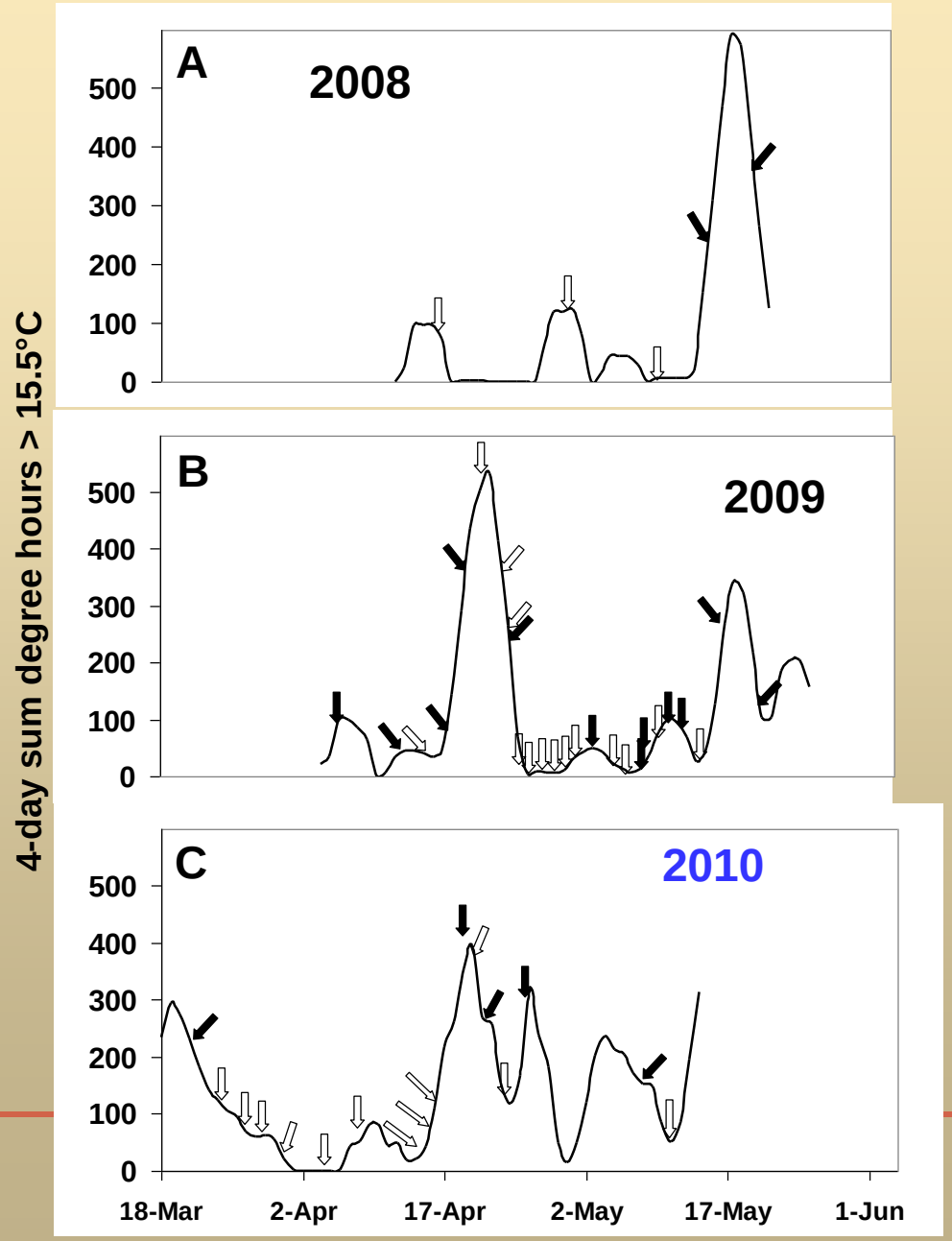
Why did we do this?

- **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**

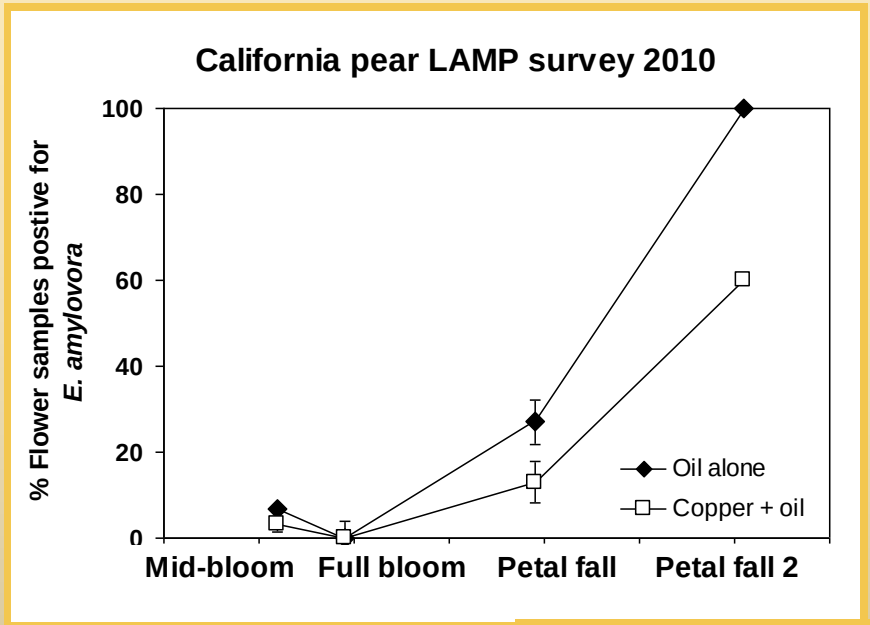
Summary of LAMP assay results from 100-flower cluster samplesa collected from commercial pear and apple orchards in the Pacific Northwest region of the United States from 2008 to 2010

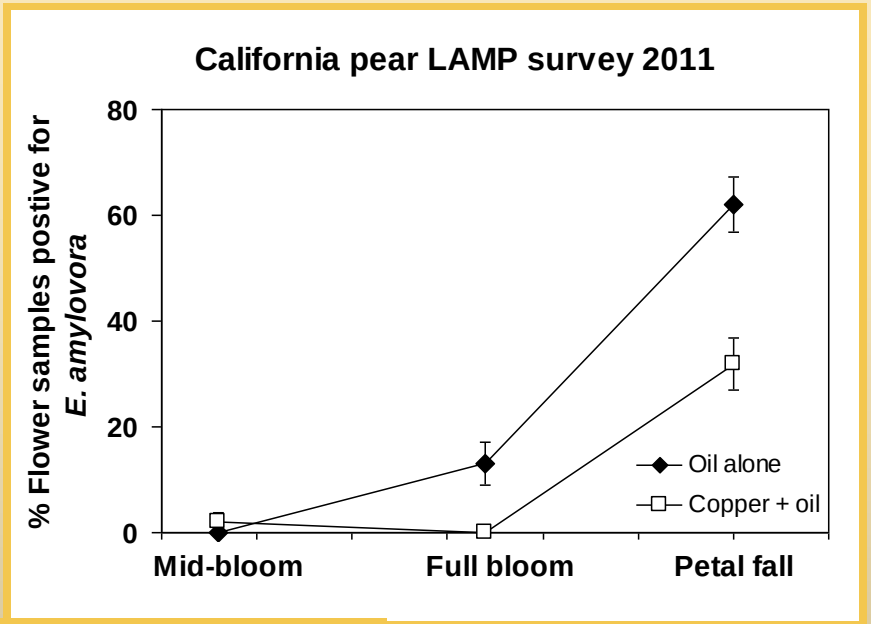
					No. of positive LAMP of total samples						
Year	State	Production area	Host	No. of orchards	Mid-bloom	Full bloom	Petal fall	Media isolation[b]	Mean Log (CFU) per flower[c]	No. of orchards with fire blight	Disease severity in orchards with fire blight[d]
2008	OR	Rogue Valley	Pear	3	0 of 15	0 of 14	n.s.[e]	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	

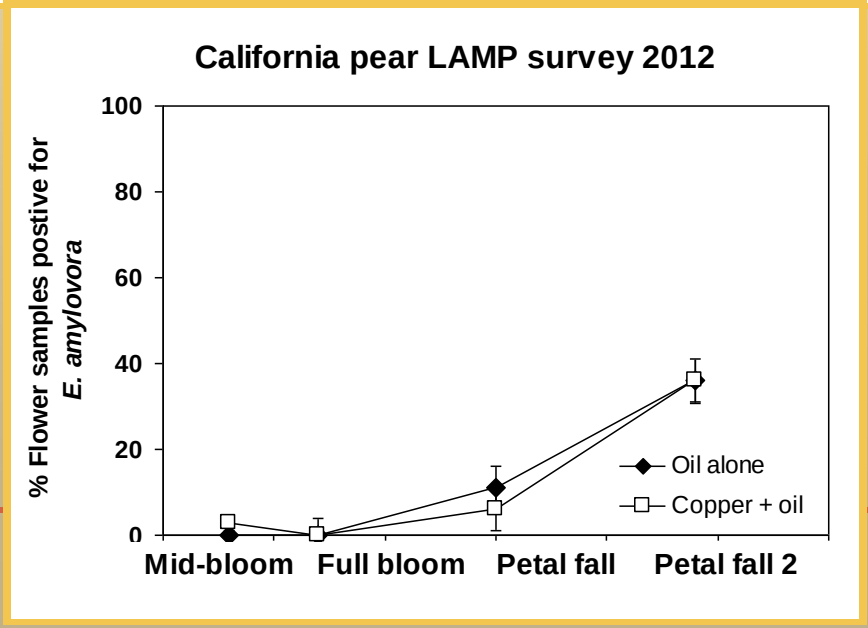
LAMP detection of *E. amylovora* over 3 years and correlation with Cougarblight model



Percent LAMP detection of *E. amylovora* over 3 years in California







Average number positive LAMP samples per 300 flower clusters and average Log 10 *E. amylovora* per flower at mid-bloom, full bloom, and petal fall in Lake and Sutter Counties, CA, 2011

	Bloom Stage							
	Mid Bloom		Full Bloom		Petal Fall		Total	
Treatment[1]	3/31-4/19/2011		4/8-22/2011		4/26-5/26/2011			
	No.	Log10	No.	Log10	No.	Log10	No.	Log10
Copper + oil	0.02	<0.01	0.00	<0.01	0.32	0.81	0.09	0.21
Oil alone	0.00	<0.01	0.13	1.80	0.62	0.85	0.22	0.30
P-value[2]	0.34	0.34	0.02	0.06	0.02	0.84	0.01	0.30
Treated	n=41	n=41	n=39	n=39	n=28	n=28	n=108	n=108
Untreated	n=38	n=38	n=37	n=37	n=29	n=29	n=104	n=104

[1] Additional positive LAMP samples (treated: Mid=1, PF=2 and untreated: Mid=4, FB=2, PF=1) not included due to lack of dilution plate confirmation.

[2] Means analyzed using T-test, P< 0.05. Data normalized with (SQRT+1) transformation.

- **6 orchard blocks in Yuba County (Sacramento Valley) (2010-2012).**
- **7 orchard blocks in Lake County.**
- **treated vs. untreated blocks (4-5 acres); treated 2010-2012.**
- **Badge 2X 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 late May – early June (only holdovers in 2010).**

(4 new blocks in Sacramento County also treated – no results)

2012 Trial (Year 3)

Average number positive LAMP samples per 300 flower clusters and average Log^{10} *E. amylovora* per flower at mid-bloom, full bloom, petal fall and rat tail from orchard blocks treated with delayed dormant copper from 2010-2012 in Lake and Yuba Counties, CA. 2012

	Bloom Stage									
	Mid Bloom		Full Bloom		Petal Fall		Rat Tail		Total	
Treatment[1]	3/22-4/19		3/29-4/16		4/30/2013		4/27/1930			
	No.	Log^{10}	No.	Log^{10}	No.	Log^{10}	No.	Log^{10}	No.	Log^{10}
Copper + oil	0.03	<0.01	0.00	0.00	0.00	0.00	0.24	0.35	0.10	0.10
Oil alone	0.00	0.00	0.00	0.00	0.33	0.17	0.24	0.24	0.10	0.14
P-value[2]	0.32	0.32	----	----	0.37	0.37	1.00	0.51	0.98	0.68
Treated	n=33	n=33	n=18	n=18	n=3	n=3	n=33	n=33	n=87	n=87
Untreated	n=33	n=33	n=17	n=17	n=3	n=3	n=33	n=33	n=86	n=86

[1] Additional positive LAMP samples (treated: Mid=3, PF=1, Rat tail=1 and untreated: Mid=1, Rat=1) not included due to lack of dilution plate confirmation.

[2] Means analyzed using T-test, P<0.05. Data normalized with (SQRT+1) transformation.

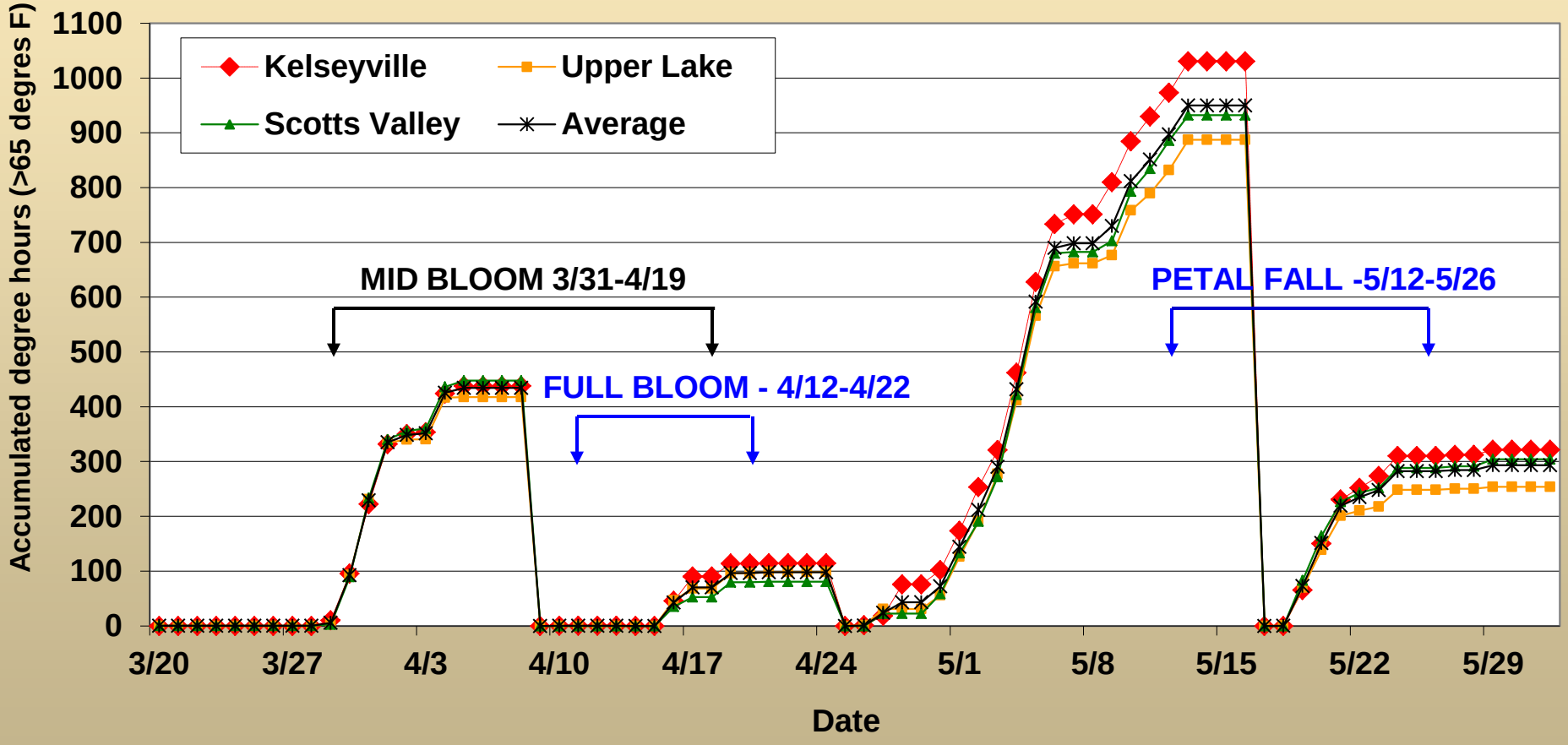
Average number positive LAMP samples per 300 flower clusters and average Log^{10} *E. amylovora* per flower at mid-bloom and petal fall/rat tail in Lake County, CA, 2012.

	Bloom Stage							
	Mid Bloom		Full Bloom		Petal Fall/Rat Tail		Total	
Treatment[1]	4/19/2012		No Data		4/27-4/30/2012			
	No.	Log^{10}	No.	Log^{10}	No.	Log^{10}	No.	Log^{10}
Copper + oil	0.07	<0.01	----	----	0.00	0.00	0.03	<0.01
Oil alone	0.00	0.00	----	----	0.06	0.03	0.03	0.01
P-value[2]	0.33	0.33	----	----	0.32	0.32	1.00	0.19
Treated	n=15	n=15	no data	no data	n=18	n=18	n=33	n=33
Untreated	n=15	n=15	no data	no data	n=18	n=18	n=33	n=33

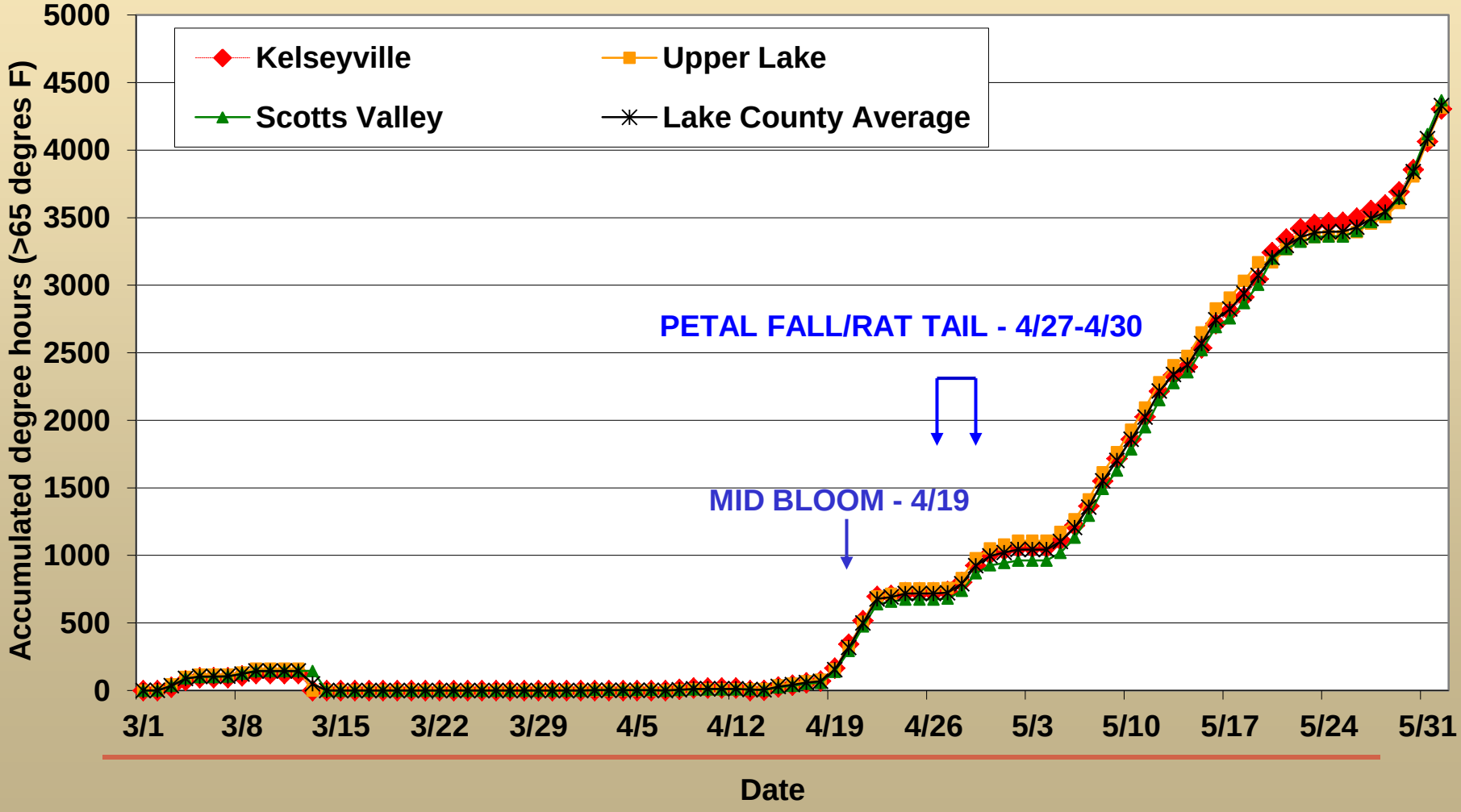
[1] Additional positive LAMP samples (treated: Mid=3, PF/RT=1 and untreated: Mid=1) not included due to lack of dilution plate confirmation.

[2] Means analyzed using T-test, P<0.05. Data normalized with (SQRT+1) transformation.

Relationship between accumulated degree hour (base >65°F) for Kelseyville, Scotts Valley (Lakeport) and Upper Lake, Lake County, California, March 20 to June 1, 2011and positive (shown in blue) and negative (shown in black) LAMP samples.



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.



Comparison of average number of fire blight strikes in Lake and Sutter/Yuba Counties, CA, 2012.

Orchard	Dole (5/16-5/24)	Dantoni (5/11-6/1)	Combined Dole and Dantoni	Combined Dole, Dantoni and Henderson (6/10-6/18)
Treated	61.7	41.7	49.3	51.8
Control	28.3	54.1	44.2	42.5
P-value [1]	NS (0.93)	* (0.02)	NS (0.18)	NS (0.61)

Sample size (complete cases)	Treated n=18	Treated n=29	Treated n=47	Treated n=49
	Control n=18	Control n=29	Control n=47	Control n=49

[1] * Indicates significance at P< 0.05, NS indicates not significant at P>0.05 (Multiple-variable analysis with Spearman Rank Correlation test.)

Comparison of average number of fire blight strikes in Lake and Yuba Counties, CA, 2011.

Orchard	Lake County (5/24-6/8)	Yuba County (5/27-7/8)	Combined Lake and Yuba Counties
Treated	26.3	89.6	68.5
Control	49.3	97.1	81.1
P-value[1]	NS (0.60)	* (0.03)	* (0.04)
Sample size (complete cases)	n = 7	n = 14	n = 21

[1] * Indicates significance at P< 0.05 , NS indicates not significant P>0.05 (Multiple-Variable analysis with Spearman Rank Correlation test).

Average fruit russeting, percent russet severity and percent frost damage in Bartlett pears[3] harvested in Lake and Sutter/Yuba Counties CA, 2012.

Treatment[2]	Average Russeting	Russet Severity (greater than 7 %)	Russet Severity (less than 3 %)	Frost Damage (%)
Copper + oil	1.4	0.03	0.9	0.1
Oil alone	1.8	0.05	0.8	0.1
P-value[1]	0.32	0.25	0.33	0.88

[1] Means analyzed using T-test, P< 0.05.

[2] Treated and control: n=11.

[3] Samples rated August 2012

Average fruit russeting, percent russet severity and percent frost damage in Bartlett pears[3] harvested in Lake, Yuba and Sutter Counties CA, 2011.

Treatment[2]	Average Russeting	Russet Severity (greater than 7%)	Russet Severity (less than 3%)	Frost Damage (%)
Copper + oil	2.7	10.5	76.0	4.5
Oil alone	2.7	10.2	76.1	3.0
P-value[1]	0.96	0.95	0.98	0.53

[1] Means analyzed using T-test, P< 0.05.

[2] Treated and control: n=12.

[3] Samples rated August 12, 2011

Conclusions

- **2012 LAMP results differed from 2010 and 2011; however, fire blight strikes were significantly reduced (again) at one site.**
- **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**
- **Russet was reduced at one site in 2012; no problem in previous years**
- **Effort will continue one more year to assess strategy as a 'new" tool in fire blight IPM programs.**

Acknowledgements

- **Pear Pest Management Research Fund**
- **John Callis (Marysville), Joe Conant (Wheatland), Ken Barr, Dan Goff, Diane Henderson, Andy Scully (Lake County)**
- **Renee Koutsoukis and Lindow lab**
- **Mike Brown, Sarah Johnson, Makaila Rodrigues, Becky Suenram, Carolyn Shaffer and Steve Thomas (UCCE-Lake County)**

THANK YOU!!