Fire Blight Management using Biological and Chemical Control

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Materials registered for fire blight control

Biologicals:	Product effectiveness
BlightBan A506	poor to fair
Bloomtime	poor to good
Blossom Protect (expect 2011)	fair to good[#]

[#]limited data

Antibiotics:	
Streptomycin	poor to excellent*

*pathogen strains resistant to streptomycin are widespread

Oxytetracycline	fair to very good
Kasugamycin (expect 2012?)	very good to excellent

Antibiotic-like:	
Serenade Max plus NuFilm P	fair to good

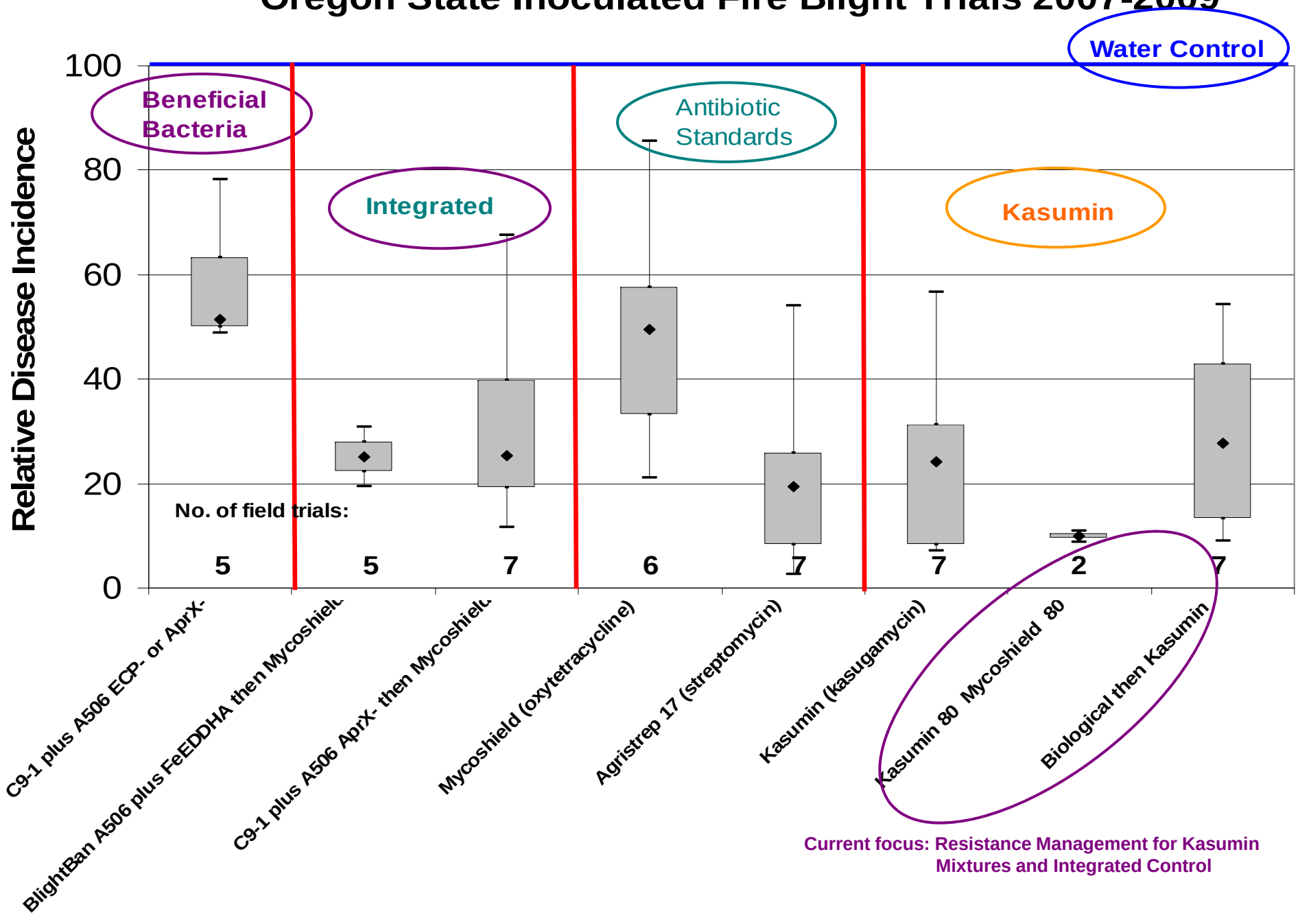
Fixed coppers:	
many	fair to excellent^

^generally limited to delayed-dormant applications owing to russet concerns

Why integrated control?

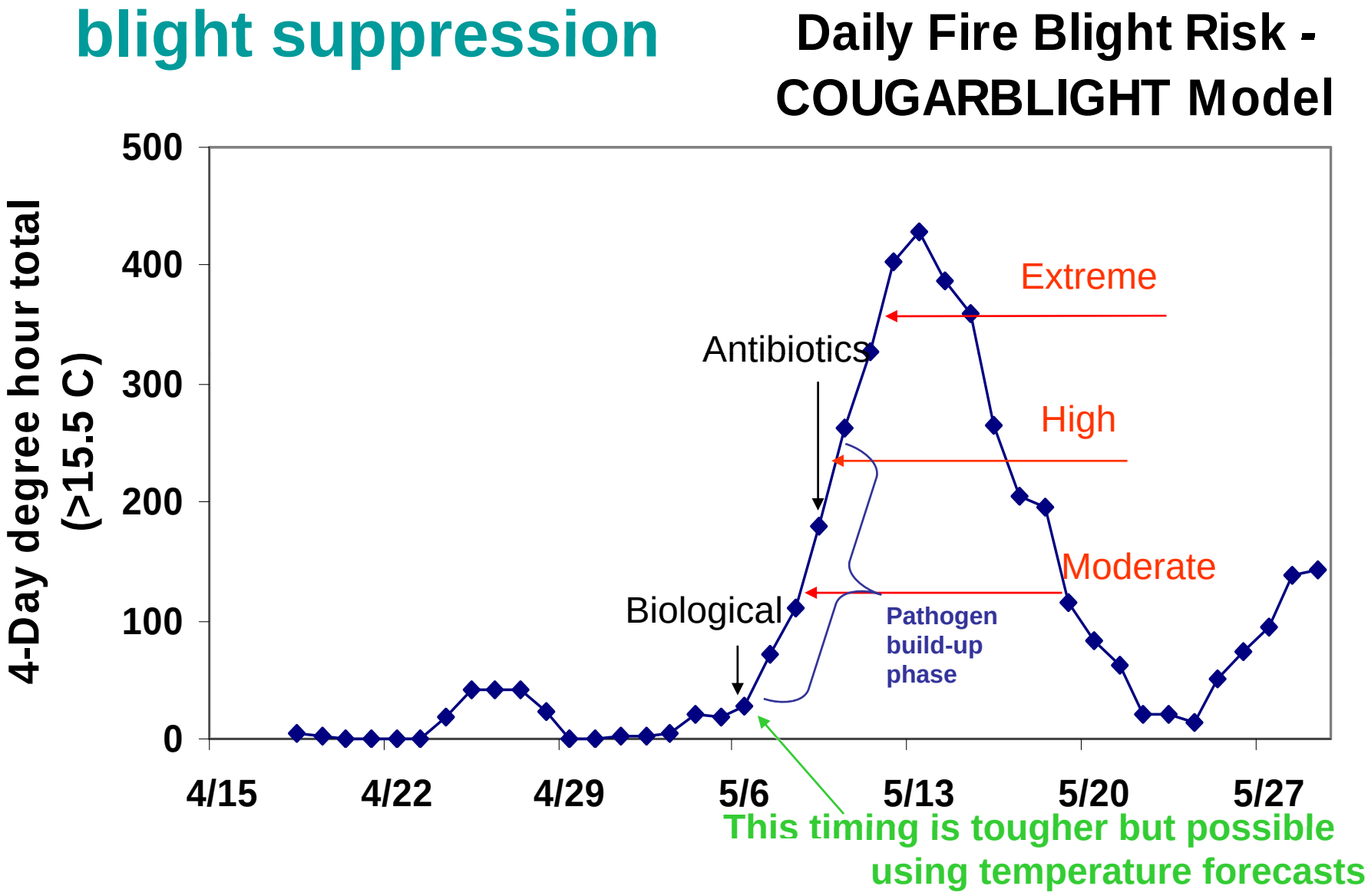
- ‘Integrated’ in this case means combining biological and chemical control
- It has been shown to improve disease suppression compared to either approach used by itself
- Integrated control may reduce the risk of selection of antibiotic-resistant strains
- The approach is compatible with forecasting models

Oregon State Inoculated Fire Blight Trials 2007-2009



Current focus: Resistance Management for Kasumin Mixtures and Integrated Control

Timing ‘integrated” treatments for blossom blight suppression



ONLINE COUGARBLIGHT MODEL

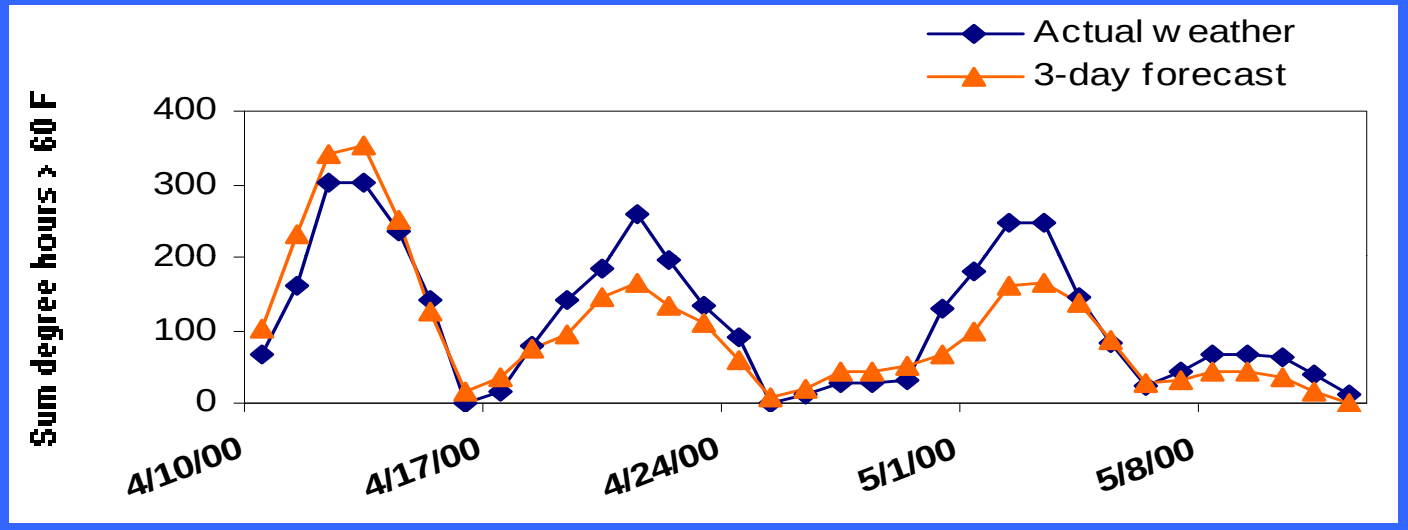
Date	Max T	Min T	Precip	°h/day	4-day °h total	Fire blight risk
4 17	63.4	35.7	0.00	5	5	
4 18	57.9	44.9	0.00	0	5	
4 19	58.1	35.6	0.00	0	5	
4 20	71.6	35.6	0.00	74	79	very low risk
4 21	69.2	38.1	0.00	42	116	low risk
4 22	69.6	46.7	0.00	52	168	low risk
4 23	57.4	46.8	0.37	0	168	low risk
4 24	57.9	34.6	0.06	0	94	very low risk
4 25	57.9	34.6	0.00	0	52	very low risk
4 26	64.7	35.2	0.00	14	14	
4 27	72.1	42.5	0.00	74	88	very low risk
4 28	77.4	43.1	0.00	146	234	low risk unless blighted in ‘97
Forecast using:	Corvallis OR NWS 5-DAY FORECAST					
4 29	77.0	42.0	0.00	146	380	*5D_fcst* moderate risk
4 30	82.0	45.0	0.00	228	594	*5D_fcst* high risk if nearby in ’97
5 1	68.0	53.0	0.00	50	570	*5D_fcst* high risk if nearby in ’97
5 2	68.0	47.0	0.00	33	457	*5D_fcst* moderate risk
5 3	70.0	54.0	0.00	70	381	*5D_fcst* moderate risk

above 60°F

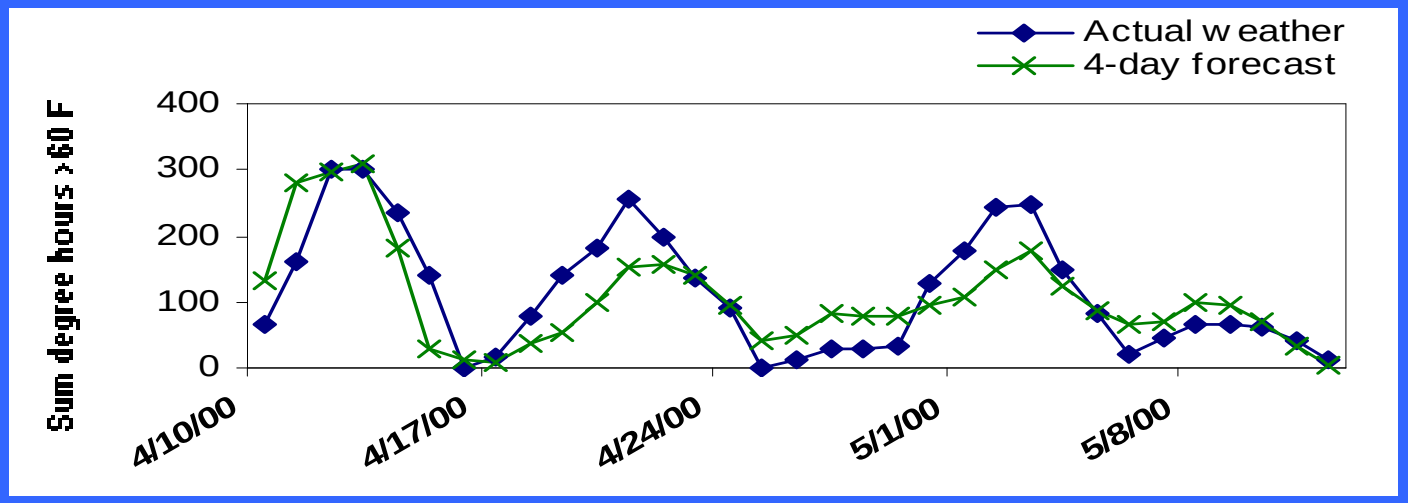
How far out can we forecast temperature and future fire blight risk?

COUGARBLIGHT – Yakima 2000

3-day risk forecast



4-day risk forecast



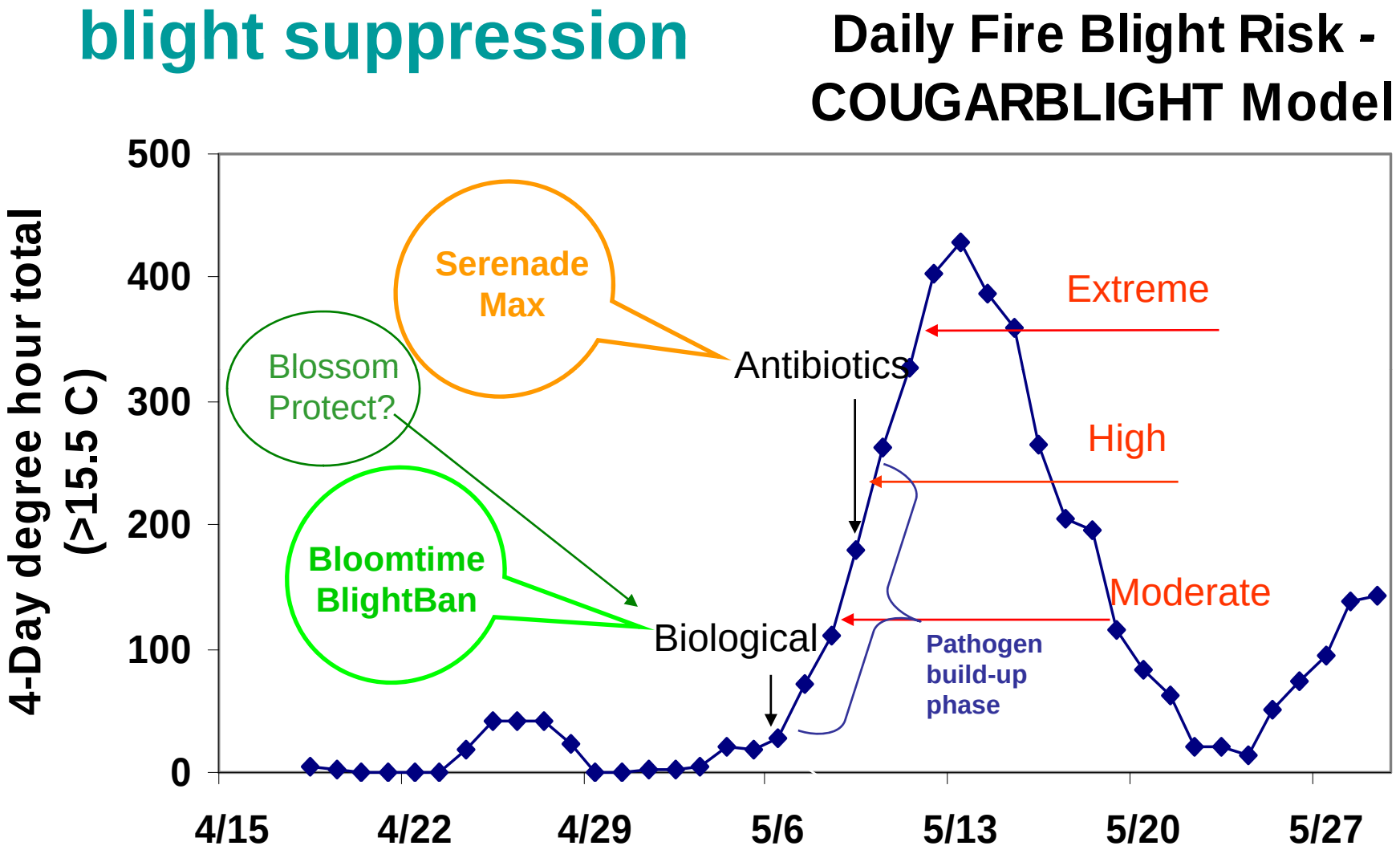
EVALUATION OF KASUMIN FOR SUPPRESSION OF FIRE BLIGHT OF PEAR, 2009
BARTLETT PEAR, Corvallis, Oregon

K.B. Johnson, T. N. Temple, and A.R. Hubbard, Oregon State University

Pear

Treatment	Rate per 100 gallons water	Date treatment applied* 16 April 30% bloom	18 April 70% bloom	21 April Full bloom	Number of blighted clusters per tree**		Percent blighted floral clusters ***	
Water control	------	**X**[§]	**X**	X	**485**	**a**[#]	**44.0**	**a**[#]
Mycoshield 200 ppm	16 oz.	---	X	X	90	b	9.3	b
C9-1^{Kr} then	*10^8 CFU/ml*	X	X	---				
Mycoshield 200 ppm	16 oz.	---	---	X	66	bc	7.0	bc
C9-1then	*10^8 CFU/ml*	X	X	---				
Mycoshield 200 ppm	16 oz.	---	---	X	50	bc	5.1	bc
Kasumin 80 ppm &	52 fl. oz.	---	X	X				
Mycoshield 80 ppm	6.4 oz.	---	X	X	45	bc	4.8	bc
C9-1 then	*10^8 CFU/ml*	X	X	---				
Kasumin 100 ppm	64 fl. oz.	---	---	X	42	bc	4.0	bcd
C9-1^{Kr}	*10^8 CFU/ml*	X	X	---				
then Kasumin 100 ppm	64 fl. oz.	---	---	X	38	bc	3.5	bcd
Kasumin 100 ppm	64 fl. oz.	---	X	X	33	bcd	3.5	bcd
Kasumin 80 ppm &	52 fl. oz.	---	X	X				
Mycoshield 100 ppm	8 oz.	---	X	X	31	cd	3.3	bcde
C9-1^{Kr} then	*10^8 CFU/ml*	X	X	---				
Kasumin 80 ppm &	52 fl. oz.	---	---	X				
Mycoshield 80 ppm	6.4 oz.	---	---	X	23	de	3.0	cde
Kasumin 100 ppm &	64 fl. oz.							
Mycoshield 100 ppm	8 oz.	---	X	X	23	de	2.5	de
Agri-mycin 100 ppm	8 oz.	---	X	X	11	e	1.1	e

Timing ‘integrated” treatments for blossom blight suppression



2009 Organic fire blight control in pears

Treatment	Rate per 100 gallons water	Date treatment applied* 13 April 10% bloom	16 April 30% bloom	18 April 70% bloom	21 April Full bloom	25 April petal fall	Number of blighted clusters per tree****	
Water control	------	---	**X**[§]	**X**	**X**	---	**485**	**a**[#]
BlightBan C9-1 plus	*5x10^7 CFU/ml*	---	---	X	---	---		
BlightBan A506 then	*5x10^7 CFU/ml*	---	---	X	---	---		
Serenade Max plus	64 oz.	---	---	---	X	---		
Nu-Film-P	6 oz.	---	---	---	X	---	178	b
Westbridge Yeast BCYP-B plus buffer A	1.34 lbs. 9.35 lbs.	---	X	X	---	---	120	cd
Westbridge Yeast BCYP-B plus buffer A	1.34 lbs 9.35 lbs	X	X	X	X	---	129	bc
BlightBan C9-1 plus	*5x10^7 CFU/ml*	---	X	X	---	---		
BlightBan A506 then	*5x10^7 CFU/ml*	---	X	X	---	---		
Serenade Max plus	64 oz.	---	---	---	X	X		
Nu-Film-P	6 oz.	---	---	---	X	X	101	de
Mycoshield 200 ppm	16 oz.	---	---	X	X	---	90	de
BlightBan C9-1 then	*1x10^8 CFU/ml*	---	X	X	---	---		
Mycoshield 200 ppm	16 oz.	---	---	---	X	---	50	e
Agri-mycin 100 ppm	8 oz.	---	---	X	X	---	11	f

low frequency integrated

yeast – we don't understand this stuff

high frequency integrated

conventionalintegrated

2009 Organic fire blight control in apples

Treatment	Rate per 100 gallons water	Date treatment applied* 13 April 10% bloom	16 April 30% bloom	18 April 70% bloom	21 April Full bloom	25 April petal fall	Number of blighted clusters per tree****	Percent blighted floral clusters ***
Water control	------	---	**X**[§]	**X**	**X**	---	**133 a**[#]	**44.1 a**[#]
BlightBan C9-1 plus	*5x10^7 CFU/ml*	---	---	X	---	---		
BlightBan A506 then	*5x10^7 CFU/ml*	---	---	X	---	---		
Serenade Max plus	64oz.	---	---	---	X	---		
Nu-Film-P	6 oz.	---	---	---	X	---	78 a	31.8 ab
Westbridge Yeast BCYP- B plus buffer A	1.34 lbs. 9.35 lbs.	---	X	X	---	---	68 ab	27.5 ab
Westbridge Yeast BCYP-B plus buffer A	1.34 lbs 9.35 lbs	X	X	X	X	---	108 a	26.0 ab
BlightBan C9-1 plus	*5x10^7 CFU/ml*	---	X	X	---	---		
BlightBan A506 then	*5x10^7 CFU/ml*	---	X	X	---	---		
Serenade Max plus	64 oz.	---	---	---	X	X		
Nu-Film-P	6 oz.	---	---	---	X	X	43 ab	21.6 bc
Rex Lime Sulfur &	2 gal.	---	X	X	X[##]	---		
Crocker's Fish oil	2 gal.	---	X	X	X[##]	---	58 ab	16.1 bc
BlightBan C9-1 then	*1x10^8 CFU/ml*	---	X	X	---	---		
Mycoshield 200 ppm	16 oz.	---	---	---	X	---	23 b	11.2 bc
Fireline 200 ppm	16 oz.	---	---	X	X	---	7 c	2.4 c
Agri-mycin 100 ppm	8 oz.	---	---	X	X	---	5 c	2.3 c

low frequencyi ntegrated

yeast – we don't understand this stuff

high frequency integrated

lime sulfur and fish oil

conventional integrated

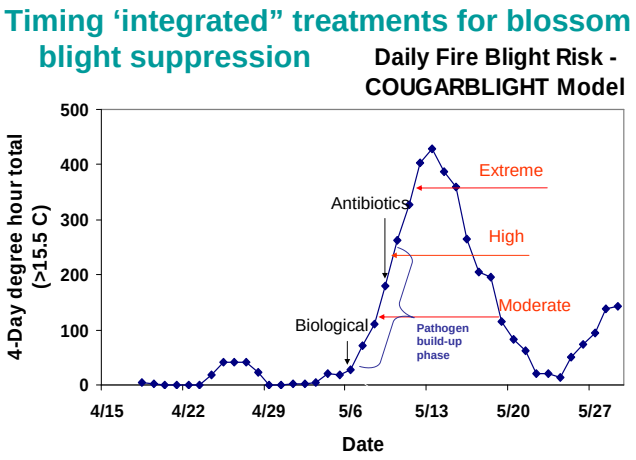
Bloom thinning: Lime sulfur (plus fish oil)

- As used for bloom thinning in apples, it appears to be providing a benefit to fire blight suppression
- It's not compatible in mixture with any of the other fire blight control products
- We are recommending that other products should follow 1-2 days after the last LS + FO treatment.

  Future efforts will generate the support data for this recommendation ☺

Comments on spraying biologicals:

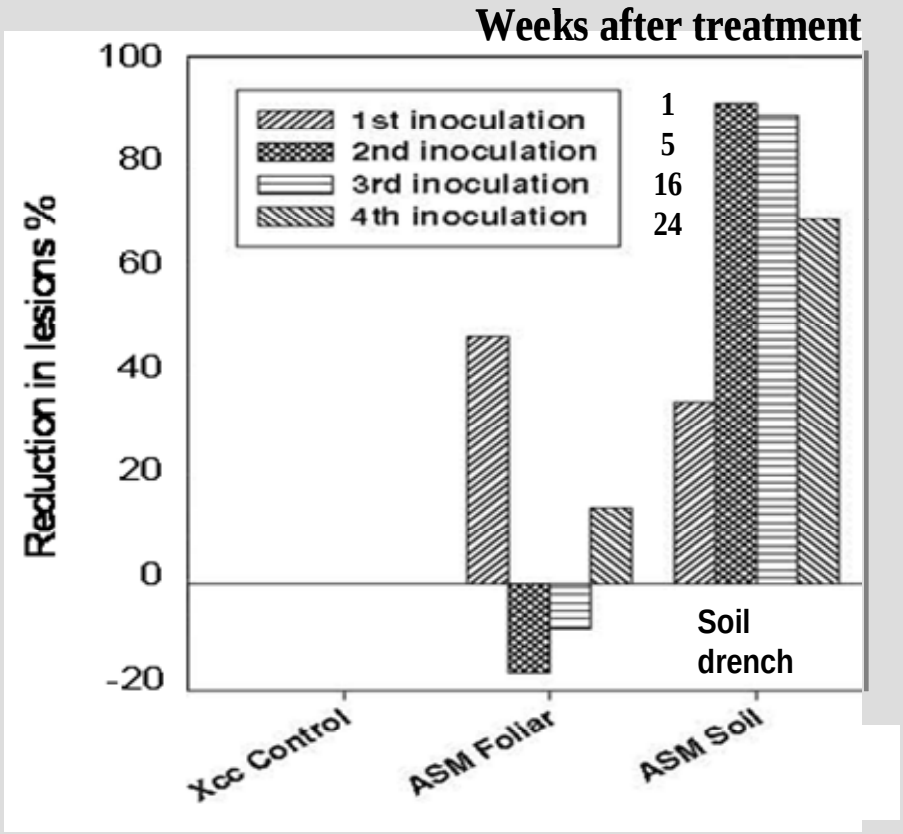
- They are living organisms
- Thus, to the degree that you can afford to increase the volume of water applied to a tree (up to 200 gallons per acre), it will help their establishment
- Similarly, spraying early in the morning on days with max temps > 60 F promotes good establishment
  - Early morning: promotes slow drying
  - Warmish days: promotes growth of biologicals

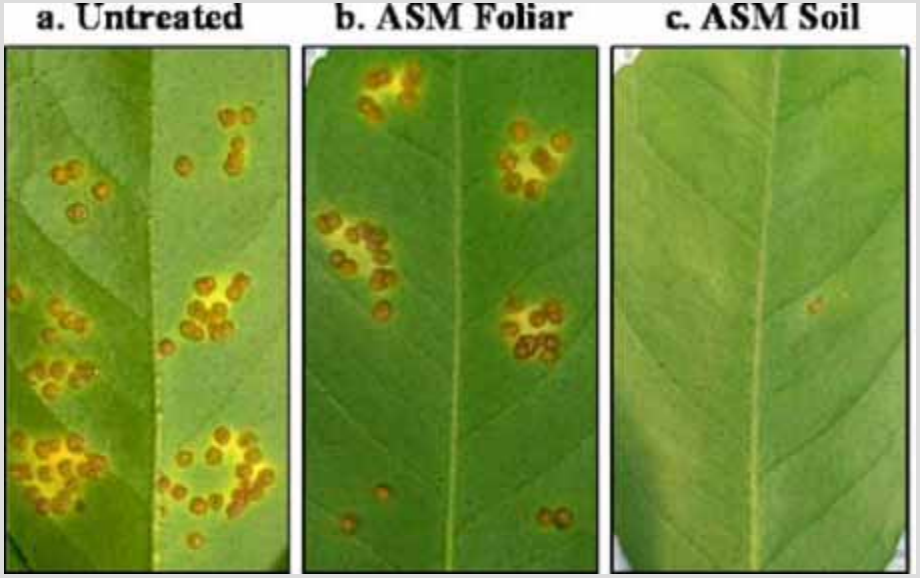


The problem:

SAR induction via soil treatment

Induction of SAR via drench provides long lasting protection in citrus





From : M. I. Francis & A. Redondo & J. K. Burns & J. H. Graham. 2009. Soil application of imidacloprid and related SAR-inducing compounds produces effective and persistent control of citrus canker. European J. Plant Pathology 124:283–292.

Other SAR related literature

Foliar sprays of Actigard suppresses fire blight of apple

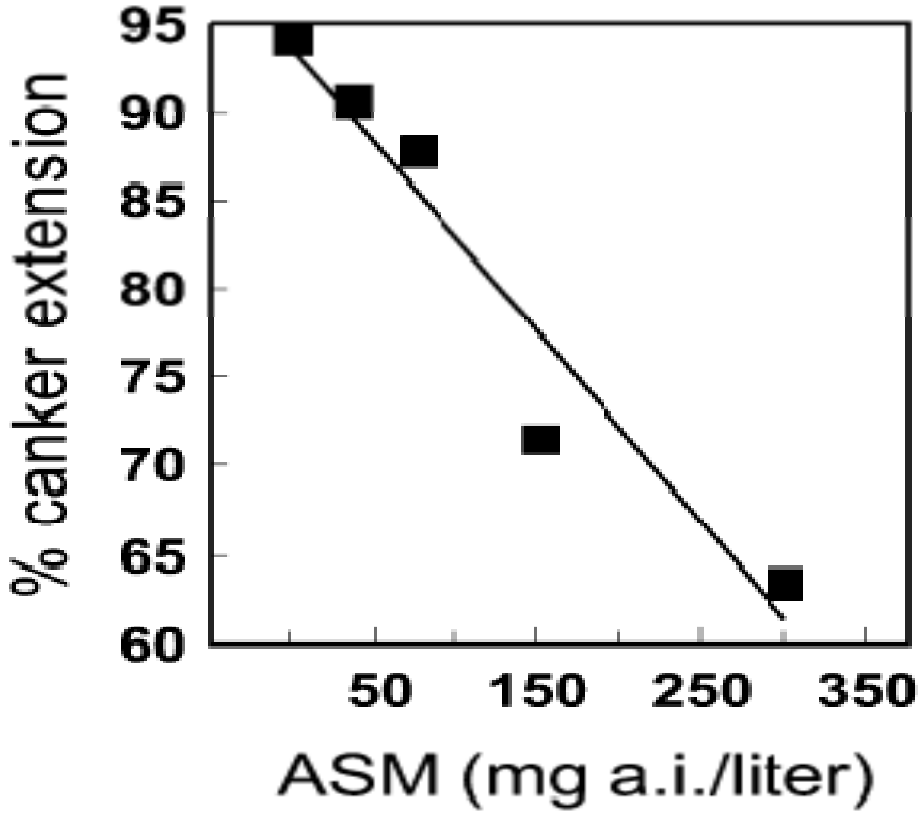
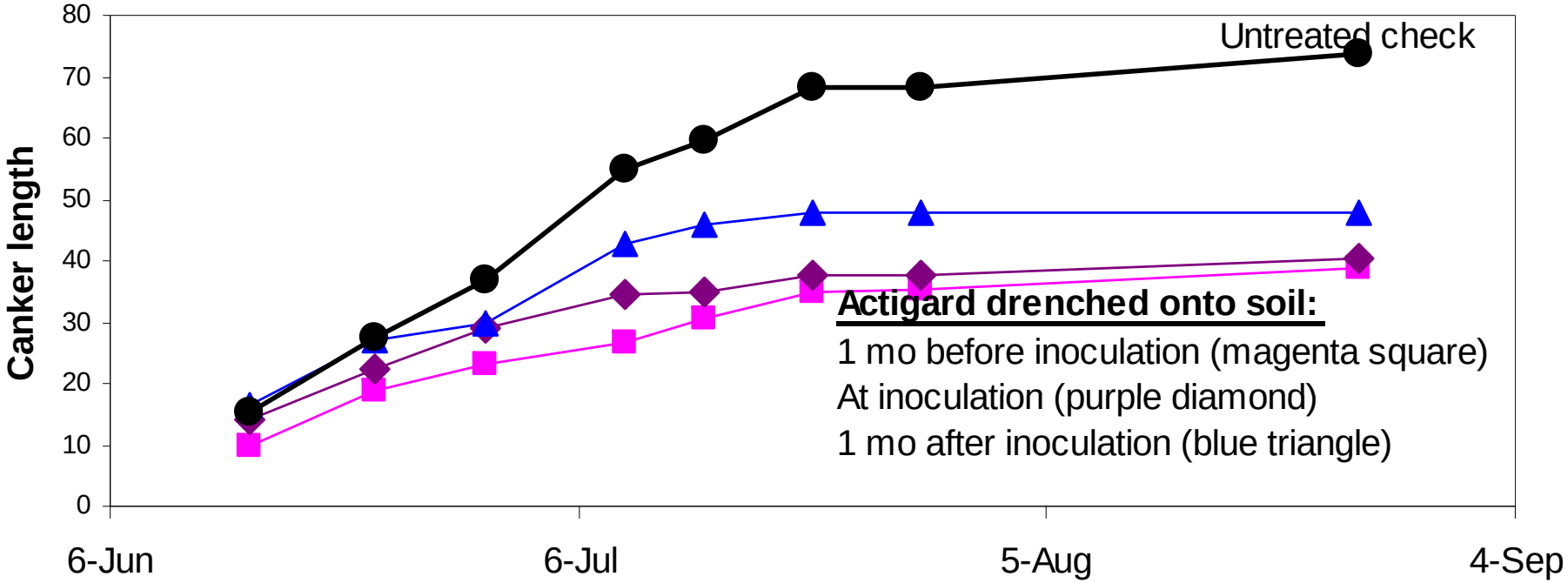


Fig. 4. Relationship of rate of acibenzolar-*S* methyl (ASM) to extension of fire blight in 1- year-old shoots of Fuji apple trees inoculated with *Erwinia amylovora* in 2000. Treatments were applied weekly for 3 weeks, and inoculations were made 7 days after the first application. Line depicts a linear trend ($y = -0.11x + 94$; $R2 = 0.93$**). Data from Maxson-Stein, K., He, S.-Y., Hammerschmidt, R., and Jones, A. L. 2002**.

These rates of Actigard are high relative to most labeled rates in tobacco and vegetable crops

- Actigard is registered for suppression of Pseudomonas canker of hazelnut (Italy) and it suppresses Pseudomonas canker of mango (Spain).

Fire blight canker expansion in Golden Russet Bosc pear



Inoculated control

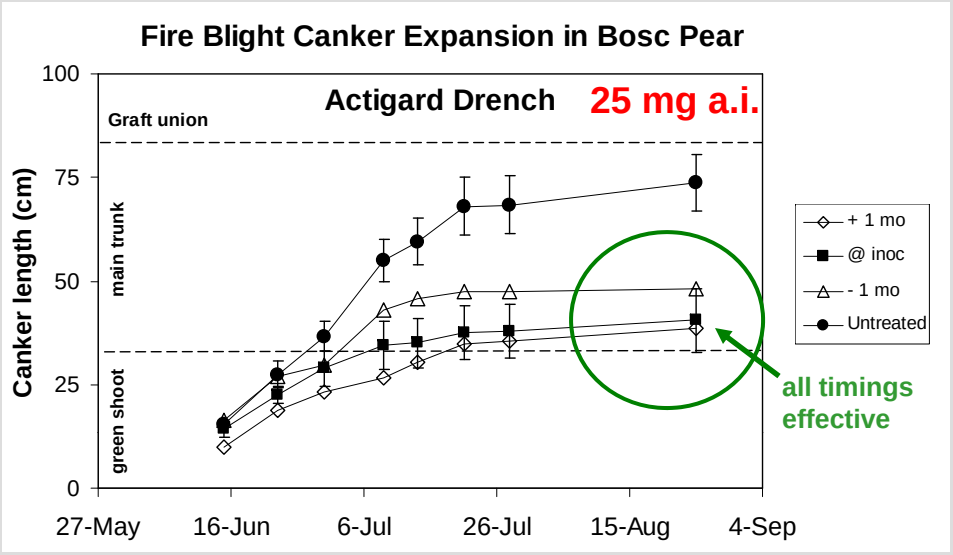
Actigard drenched on soil
1 mo before inoculation

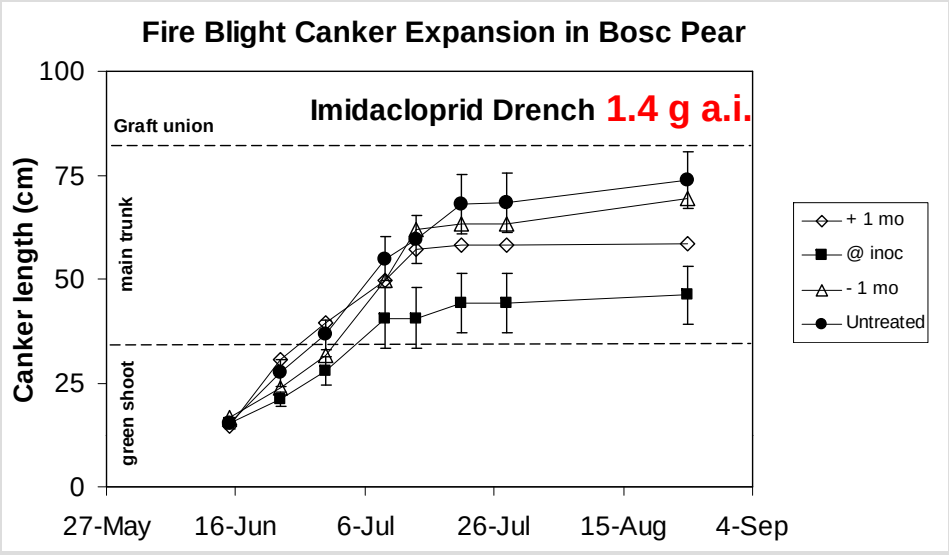
Actigard sprayed foliar
1 mo after inoculation

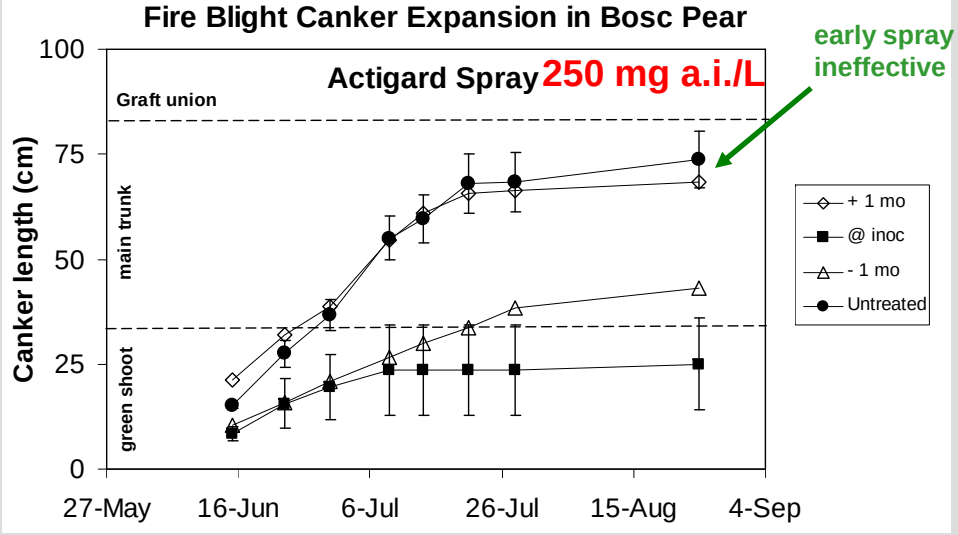
Untreated control

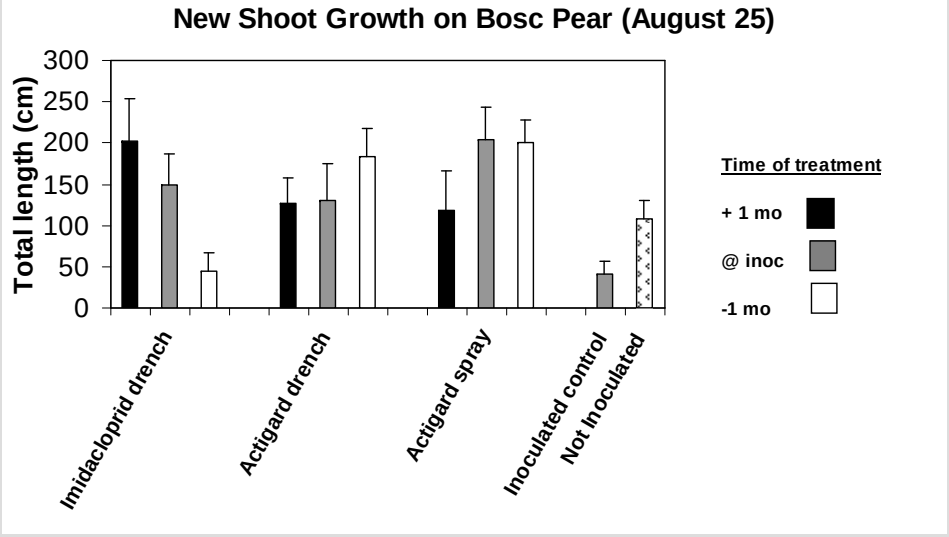
Actigard 50 mg a.i. + 1 mo

Pot study - greenhouse









Ken’s SAR induction projects for bacterial disease suppression

Fire blight: Rescue of pear (funded)

Fire blight: Protection of apple rootstock (funded)

P. syringae canker**:** Cherry establishment (funded)

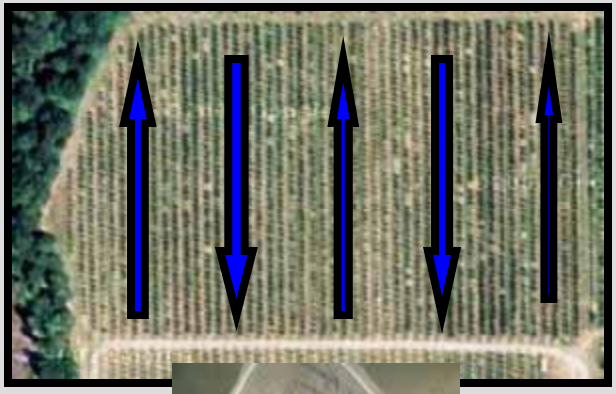
P. syringae canker**:** Lilac blight (bootleg research)

Xanthomonas blight: carrot seed production (funded)

PI: Dr. Bo Ming Wu (Madras)

Resistance to streptomycin 2009

LAMP-based scouting for early detection of the fire blight pathogen



Positive **Negative**

	2009 Percentage of Pop's Streptomycin Res or Sen 1	2	3	Blight ?
Zillah, WA	nd	nd	nd	no data
	nd	nd	nd	no data
	nd	nd	Res. (100%)	no data
Yakima, WA	nd	nd	nd	Y light
Wenatchee, WA	nd	nd	nd	N
	nd	nd	nd	N
Okanogan, WA	nd	nd	Res (100%)	Y light
Parkdale, OR apple	nd	nd	Sen (100%)	N
	nd	nd	Sen (100%)	Y light
Parkdale, OR pear	sen (100%)	nd	sen (100%)	N
	sen (100%)	nd	sen (100%)	N
	nd	nd	not det.	Y light
Hood River, OR	nd	nd	Sen (100%)	Y light
	nd	nd	nd	Y light
	nd	nd	nd	N
Medford, OR	Sen (100%)	nd	nd	N
	nd	nd	Res (100%)	N
	nd	nd	Res (100%)	Y light
	nd	nd	nd	N
Milton Freewater, OR	nd	Res (100%)	Sen (100%)	Y light
	nd	nd	nd	N
	nd	nd	Res (100%)	Y light
	nd	Sen (33%) Res (67%)	Res (100%)	Y light
Lake County, CA	sen (100%)	sen (100%)	sen (100%)	Y light
	nd	nd	nd	N
	nd	sen (100%)	nd	N

Red Bold are Resistant to Streptomycin and Green bold are sensitive to streptomycin.

Resistance to streptomycin 2009

Utah

Utah

sample 1

date		LAMP	Pops
2-May	U1.1	Y	3.60E+03
2-May	U1.2	Y	3.10E+05
2-May	U1.3	N	nd
2-May	U1.4	N	nd
2-May	U1.5	N	nd
2-May	U1.6	Y	6.00E+04

sample 2

date		LAMP	Pops
3-May	U2.1	N	not det.
3-May	U2.2	Y	2.10E+05
3-May	U2.3	N	nd
3-May	U2.4	Y	nd
3-May	U2.5	Y	nd
3-May	U2.6	Y	8.70E+05

sample 3

date		LAMP	Pops
4-May	U3.1	N	nd
4-May	U3.2	Y	5.40E+05
4-May	U3.3	N	nd
4-May	U3.4	Y	nd
4-May	U3.5	N	nd
4-May	U3.6	Y	1.27E+06

sample 4

date		LAMP	Pops
5-May	U4.1	Y	3.00E+04
5-May	U4.2	Y	1.60E+06
5-May	U4.3	N	nd
5-May	U4.4	N	nd
5-May	U4.5	Y	nd
5-May	U4.6	Y	1.31E+06
pos contol not working			

sample 5

date		LAMP	Pops
6-May	U5.1	Y	2.70E+05
6-May	U5.2	Y	4.40E+05
6-May	U5.3	N	
6-May	U5.4	Y	7.00E+02
6-May	U5.5	Y	1.00E+02
6-May	U5.6	Y	1.50E+06
6-May	U5.7	Y	9.00E+02

sample 6

date		LAMP	Pops
7-May	U6.1	Y	6.40E+05
7-May	U6.2	Y	1.10E+05
7-May	U6.3	Y	1.30E+03
7-May	U6.4	N	nd
7-May	U6.5	Y	1.12E+06
7-May	U6.6	N	nd
7-May	U6.7	Y	4.00E+05

sample 7

date		LAMP	Pops
8-May	U7.1	Y	6.30E+03
8-May	U7.2	Y	1.80E+05
8-May	U7.3	Y	6.00E+02
8-May	U7.4	Y	8.00E+02
8-May	U7.5	N	
8-May	U7.6	Y	1.60E+06
8-May	U7.7	N	

sample 8

date		LAMP	Pops
9-May	U8.1	Y	5.70E+03
9-May	U8.2	Y	2.00E+04
9-May	U8.3	N	nd
9-May	U8.4	N	nd
9-May	U8.5	N	nd
9-May	U8.6	Y	6.95E+05
9-May	U8.7	N	nd

sample 9

date		LAMP	Pops
10-May	U9.1	Y	1.90E+05
10-May	U9.2	N	nd
10-May	U9.3	N	nd
10-May	U9.4	Y	1.80E+03
10-May	U9.5	Y	1.00E+04
10-May	U9.6	Y	4.20E+05

sample 10

date		LAMP	Pops
11-May	U10.1	Y	2.10E+05
11-May	U10.2	N	nd
11-May	U10.3	N	nd
11-May	U10.4	Y	1.60E+05
11-May	U10.5	N	nd
11-May	U10.6	Y	6.10E+05

sample 11

date		LAMP	Pops
12-May	U11.1	Y	8.20E+05
12-May	U11.2	N	
12-May	U11.3	Y	1.30E+03

sample 12

date		LAMP	Pops
13-May	U12.1	Y	6.60E+05

Red Bold pop's are Resistant to Streptomycin and Green Bold pop's are sensitive to streptomycin.

Resistance to streptomycin 2009

Utah

Bottom line:
if you want to use strep, use it only once and mix it with a full rate of oxytet

Utah

sample 1

date		LAMP	Pops
2-May	U1.1	Y	3.60E+03
2-May	U1.2	Y	3.10E+05
2-May	U1.3	N	nd
2-May	U1.4	N	nd
2-May	U1.5	N	nd
2-May	U1.6	Y	6.00E+04

sample 2

date		LAMP	Pops
3-May	U2.1	N	not det.
3-May	U2.2	Y	2.10E+05
3-May	U2.3	N	nd
3-May	U2.4	Y	nd
3-May	U2.5	Y	nd
3-May	U2.6	Y	8.70E+05

sample 3

date		LAMP	Pops
4-May	U3.1	N	nd
4-May	U3.2	Y	5.40E+05
4-May	U3.3	N	nd
4-May	U3.4	Y	nd
4-May	U3.5	N	nd
4-May	U3.6	Y	1.27E+06

sample 4

date		LAMP	Pops
5-May	U4.1	Y	3.00E+04
5-May	U4.2	Y	1.60E+06
5-May	U4.3	N	nd
5-May	U4.4	N	nd
5-May	U4.5	Y	nd
5-May	U4.6	Y	1.31E+06
pos contol not working			

sample 5

date		LAMP	Pops
6-May	U5.1	Y	2.70E+05
6-May	U5.2	Y	4.40E+05
6-May	U5.3	N	
6-May	U5.4	Y	7.00E+02
6-May	U5.5	Y	1.00E+02
6-May	U5.6	Y	1.50E+06
6-May	U5.7	Y	9.00E+02

sample 6

date		LAMP	Pops
7-May	U6.1	Y	6.40E+05
7-May	U6.2	Y	1.10E+05
7-May	U6.3	Y	1.30E+03
7-May	U6.4	N	nd
7-May	U6.5	Y	1.12E+06
7-May	U6.6	N	nd
7-May	U6.7	Y	4.00E+05

sample 7

date		LAMP	Pops
8-May	U7.1	Y	6.30E+03
8-May	U7.2	Y	1.80E+05
8-May	U7.3	Y	6.00E+02
8-May	U7.4	Y	8.00E+02
8-May	U7.5	N	
8-May	U7.6	Y	1.60E+06
8-May	U7.7	N	

sample 8

date		LAMP	Pops
9-May	U8.1	Y	5.70E+03
9-May	U8.2	Y	2.00E+04
9-May	U8.3	N	nd
9-May	U8.4	N	nd
9-May	U8.5	N	nd
9-May	U8.6	Y	6.95E+05
9-May	U8.7	N	nd

sample 9

date		LAMP	Pops
10-May	U9.1	Y	1.90E+05
10-May	U9.2	N	nd
10-May	U9.3	N	nd
10-May	U9.4	Y	1.80E+03
10-May	U9.5	Y	1.00E+04
10-May	U9.6	Y	4.20E+05

sample 10

date		LAMP	Pops
11-May	U10.1	Y	2.10E+05
11-May	U10.2	N	nd
11-May	U10.3	N	nd
11-May	U10.4	Y	1.60E+05
11-May	U10.5	N	nd
11-May	U10.6	Y	6.10E+05

sample 11

date		LAMP	Pops
12-May	U11.1	Y	8.20E+05
12-May	U11.2	N	
12-May	U11.3	Y	1.30E+03

sample 12

date		LAMP	Pops
13-May	U12.1	Y	6.60E+05

Red Bold pop's are Resistant to Streptomycin and Green Bold pop's are sensitive to streptomycin.