Annual Central Coast Strawberry Meeting
Watsonville, February 4, 2010

Recent Studies for Lygus and Thrips Control

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Lygus

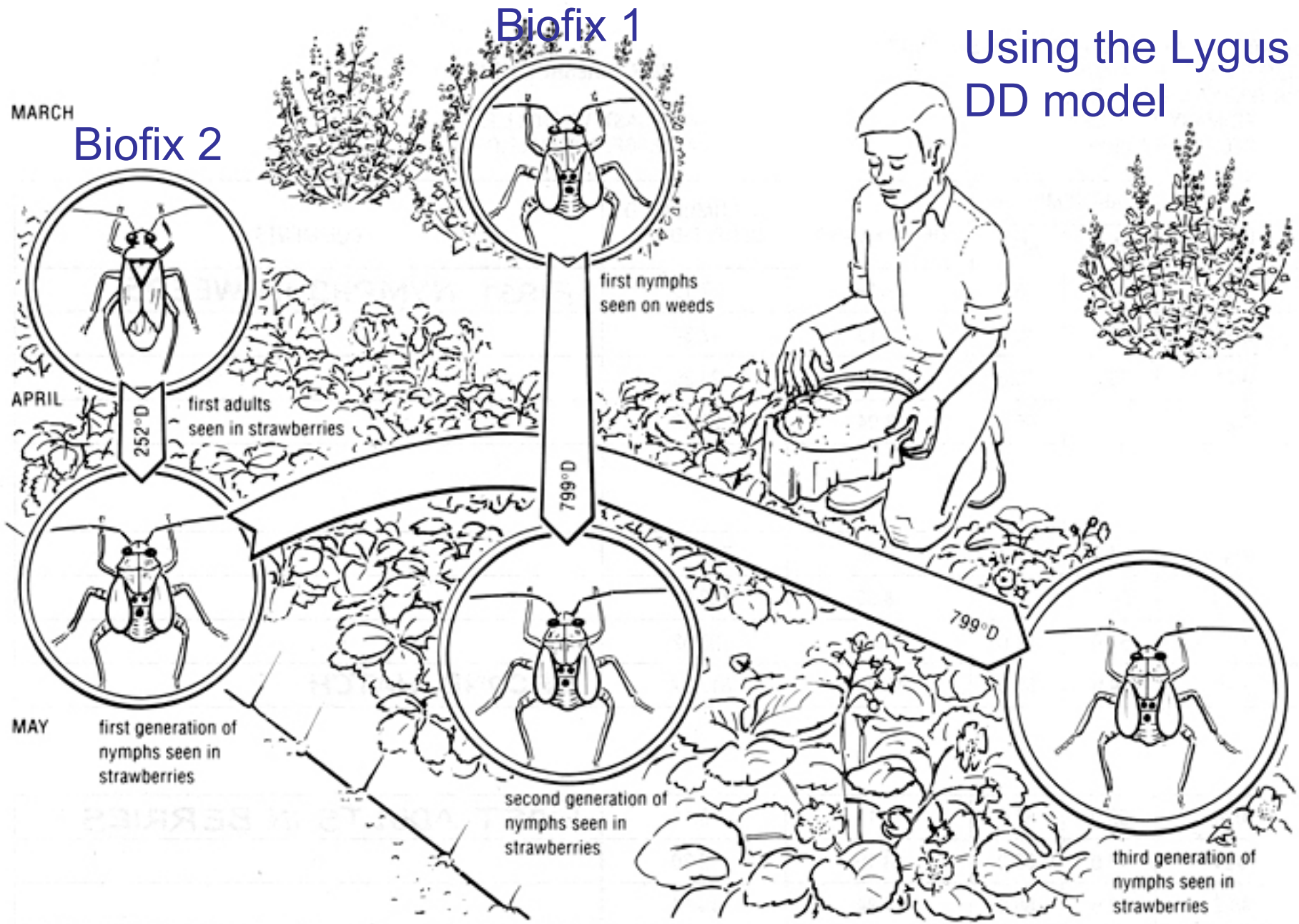
Monitoring…..

- Monitor weeds *and other alternative hosts (e.g. second year fields, cover crops trap crops)* in late winter to establish a biofix (presence of first nymphs), and until large nymphs are found
- Destroy the weeds and other hosts before adults emerge that will infest nearby strawberries

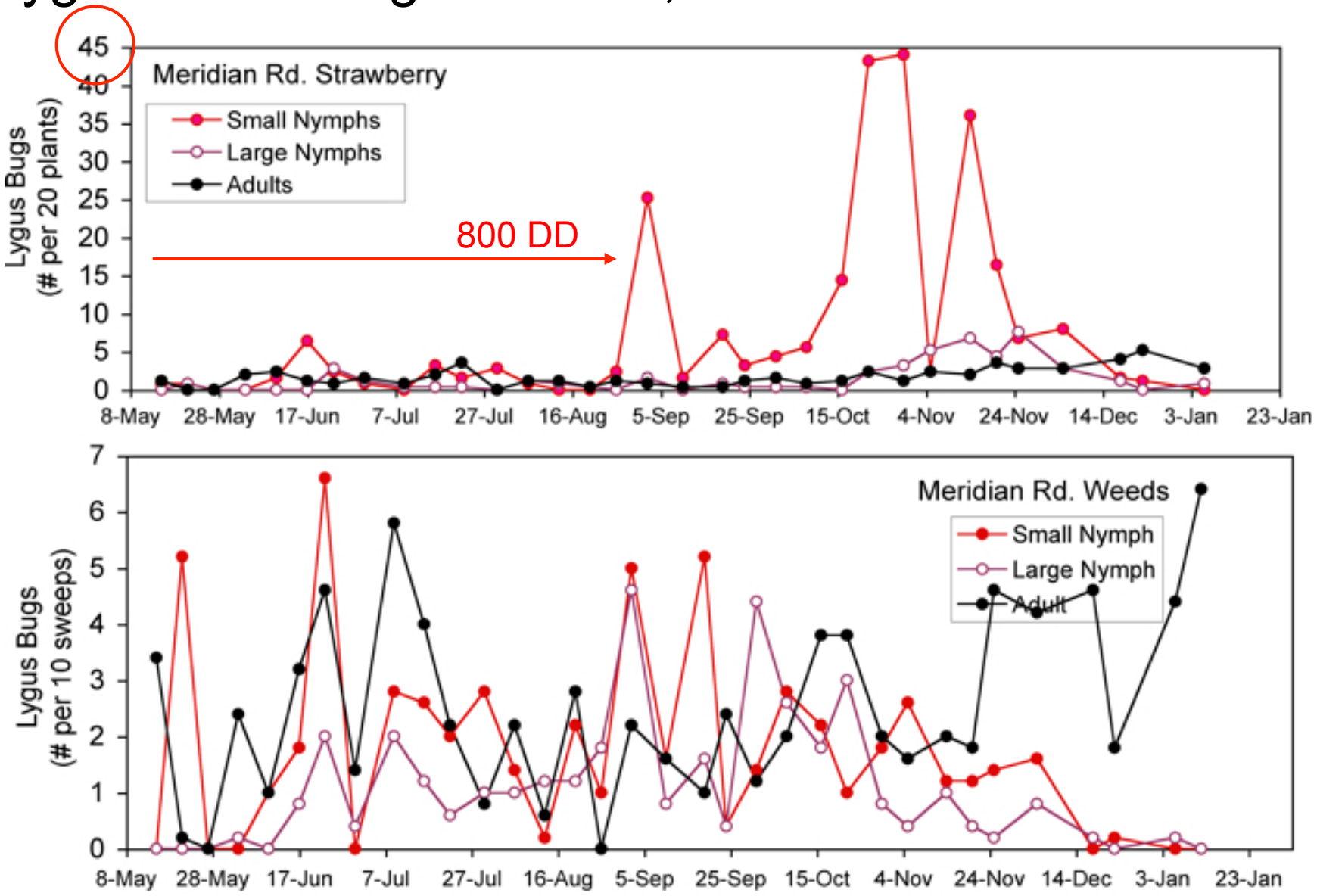
Monitoring…..

- Monitor Fall planted strawberries in spring to determine when the first adults appear to establish the second biofix (presence of first adults in Fall planting)
- Monitor strawberries during the season to establish age structure of the population
- It is most effective to treat nymphs soon after they start to hatch in strawberries

Using the Lygus DD model



Lygus Monitoring 2009 - Bi, et al.



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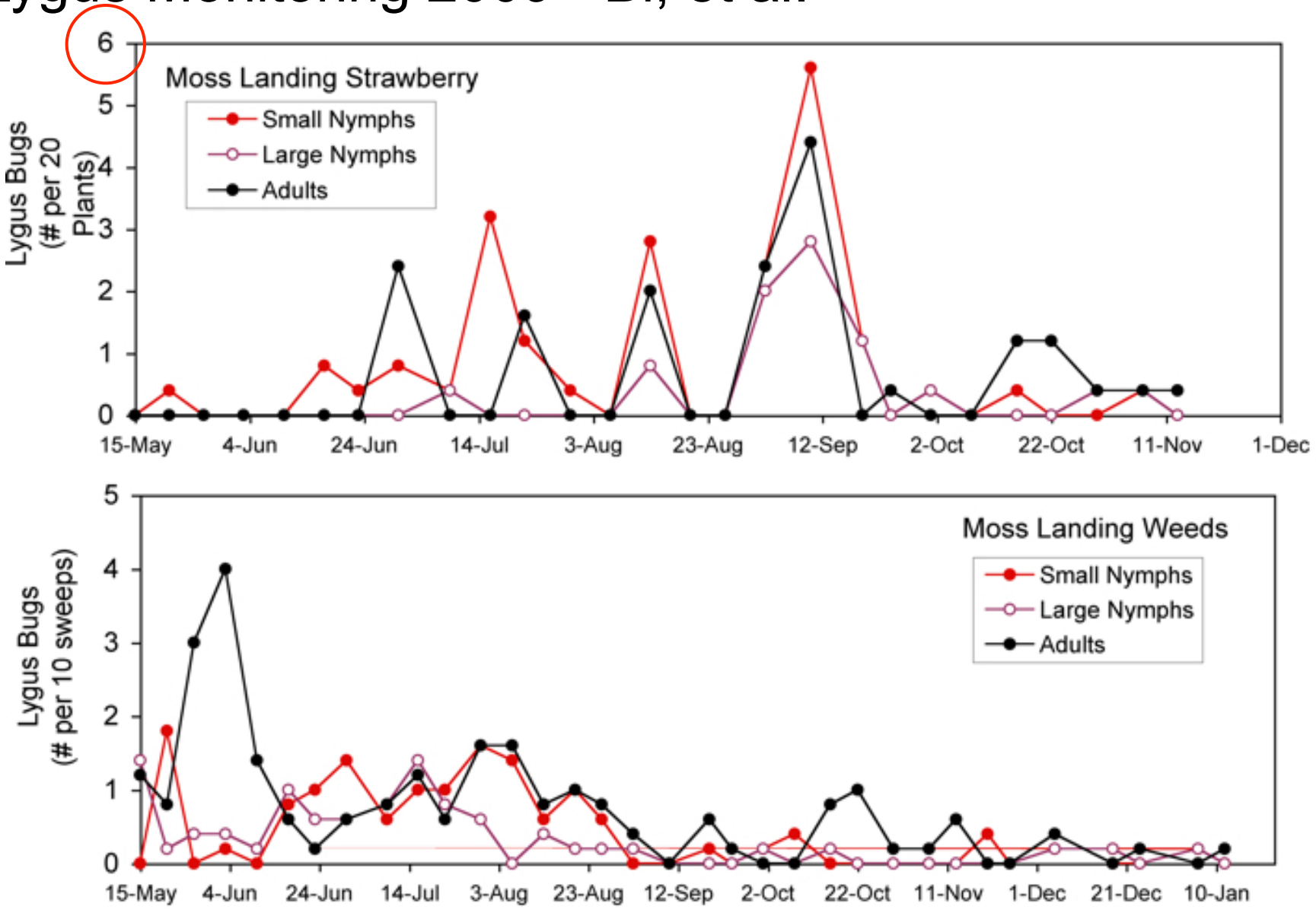

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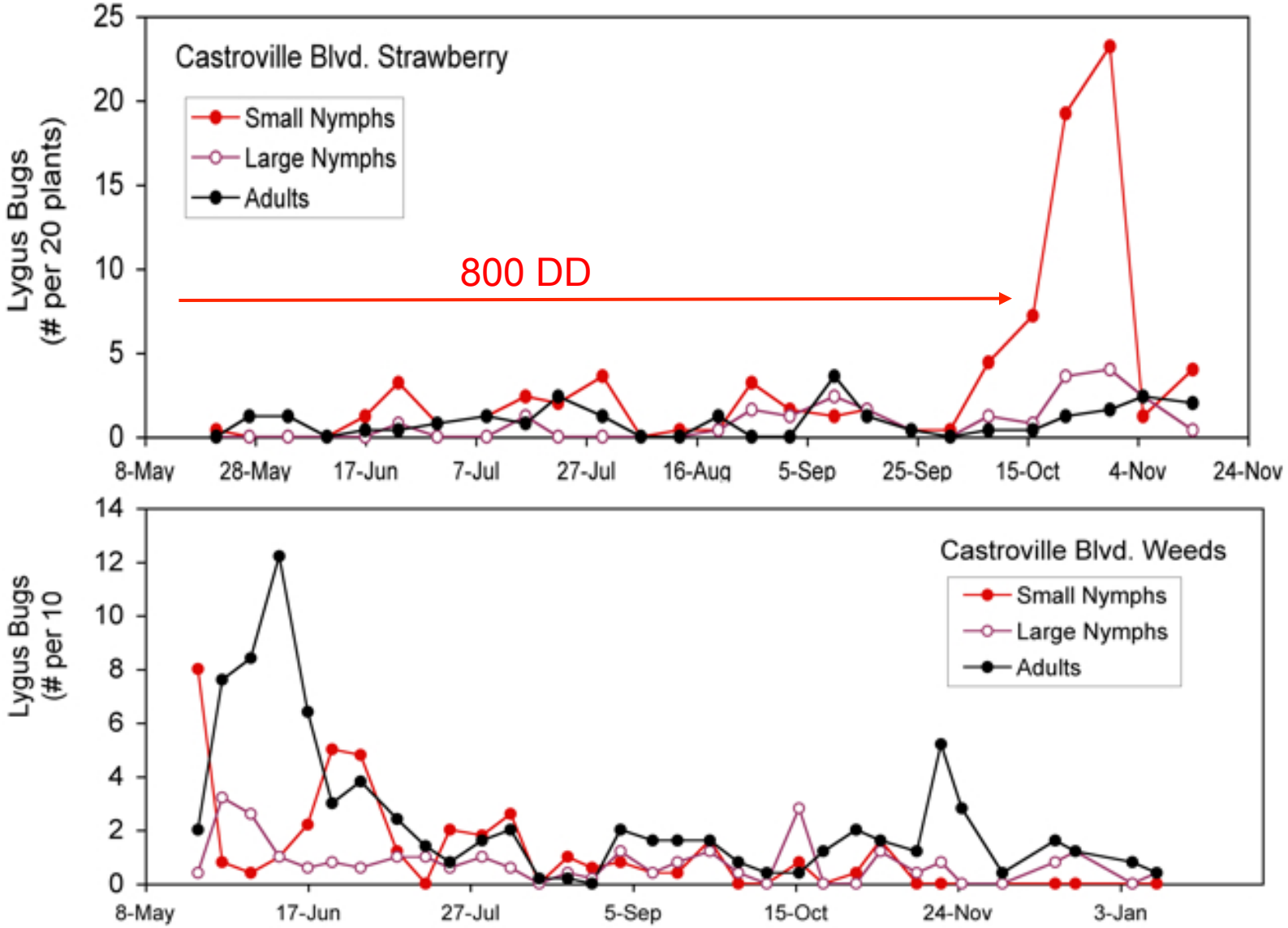
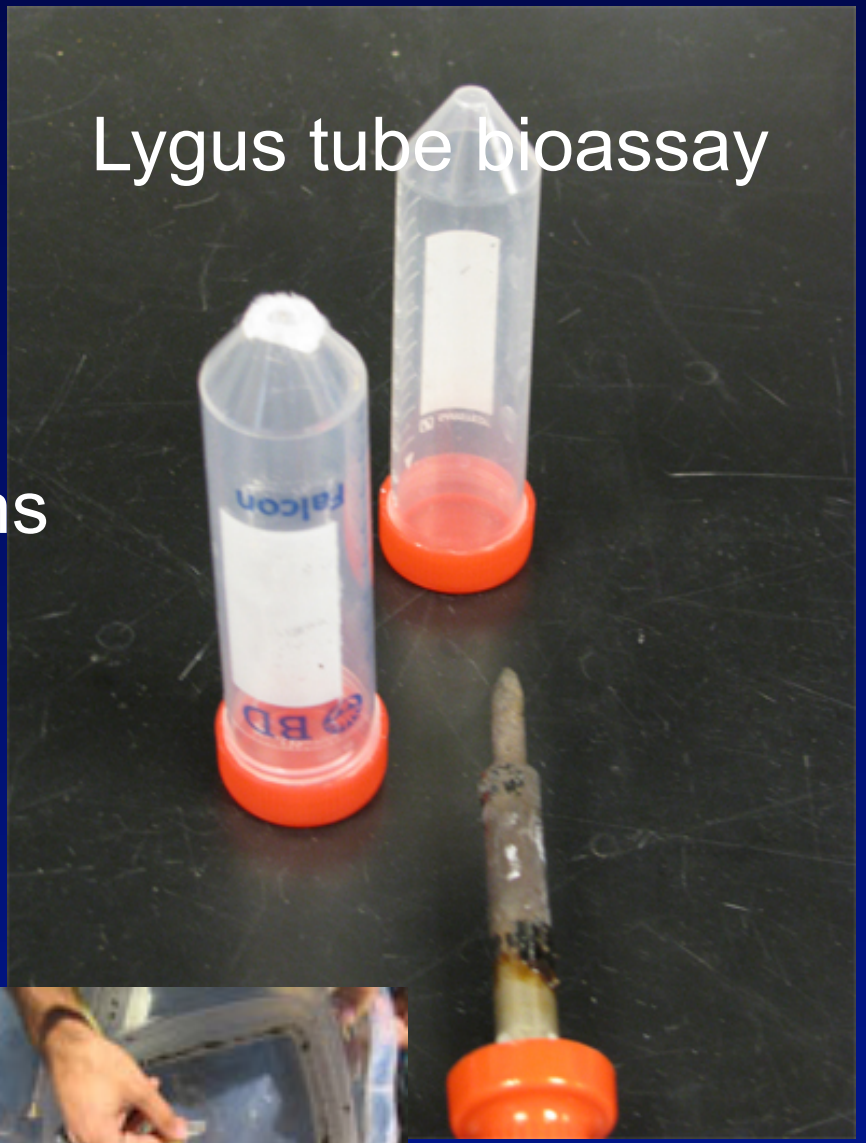


Lygus Resistance

Field collect Lygus adults
Aspirate into tubes
Challenge with insecticide
at a series of concentrations



Lygus Resistance

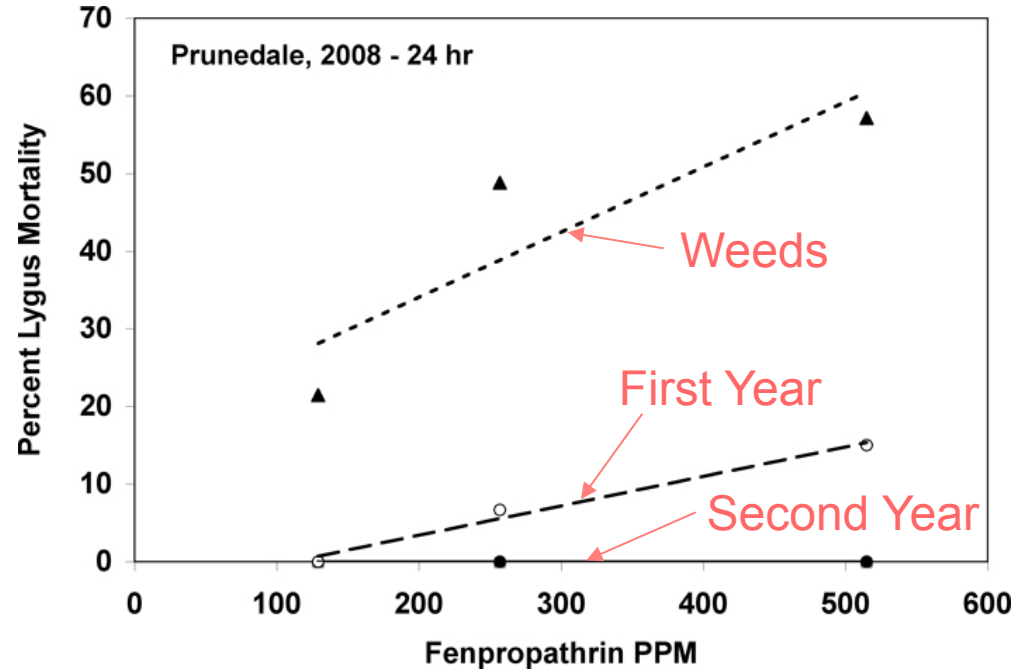
Danitol

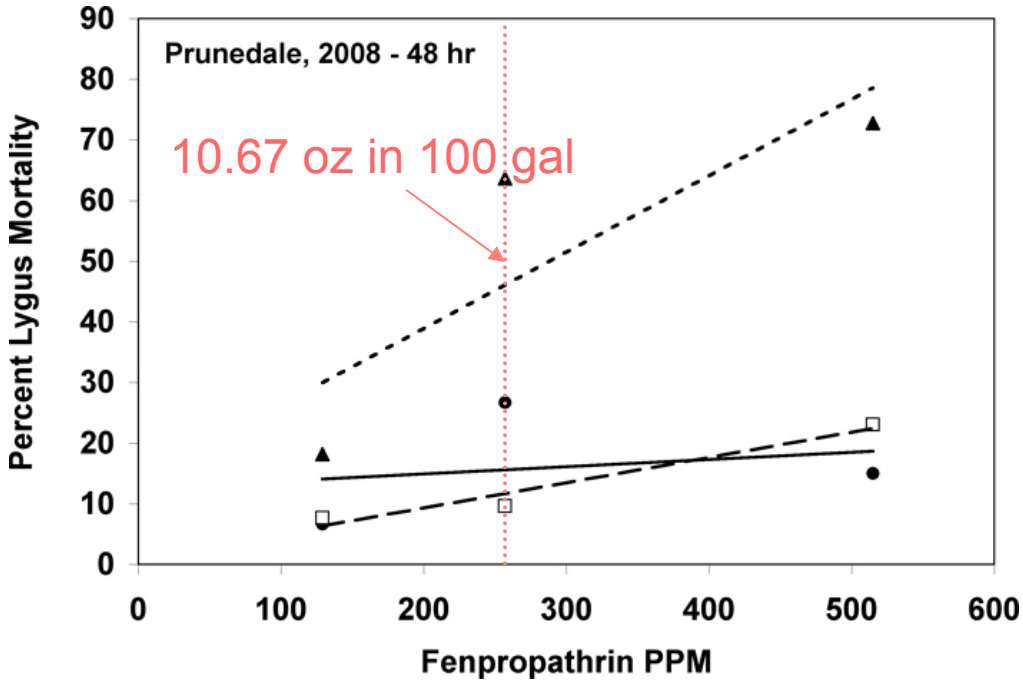
Prunedale, July 18, 2008

Lygus collected from -

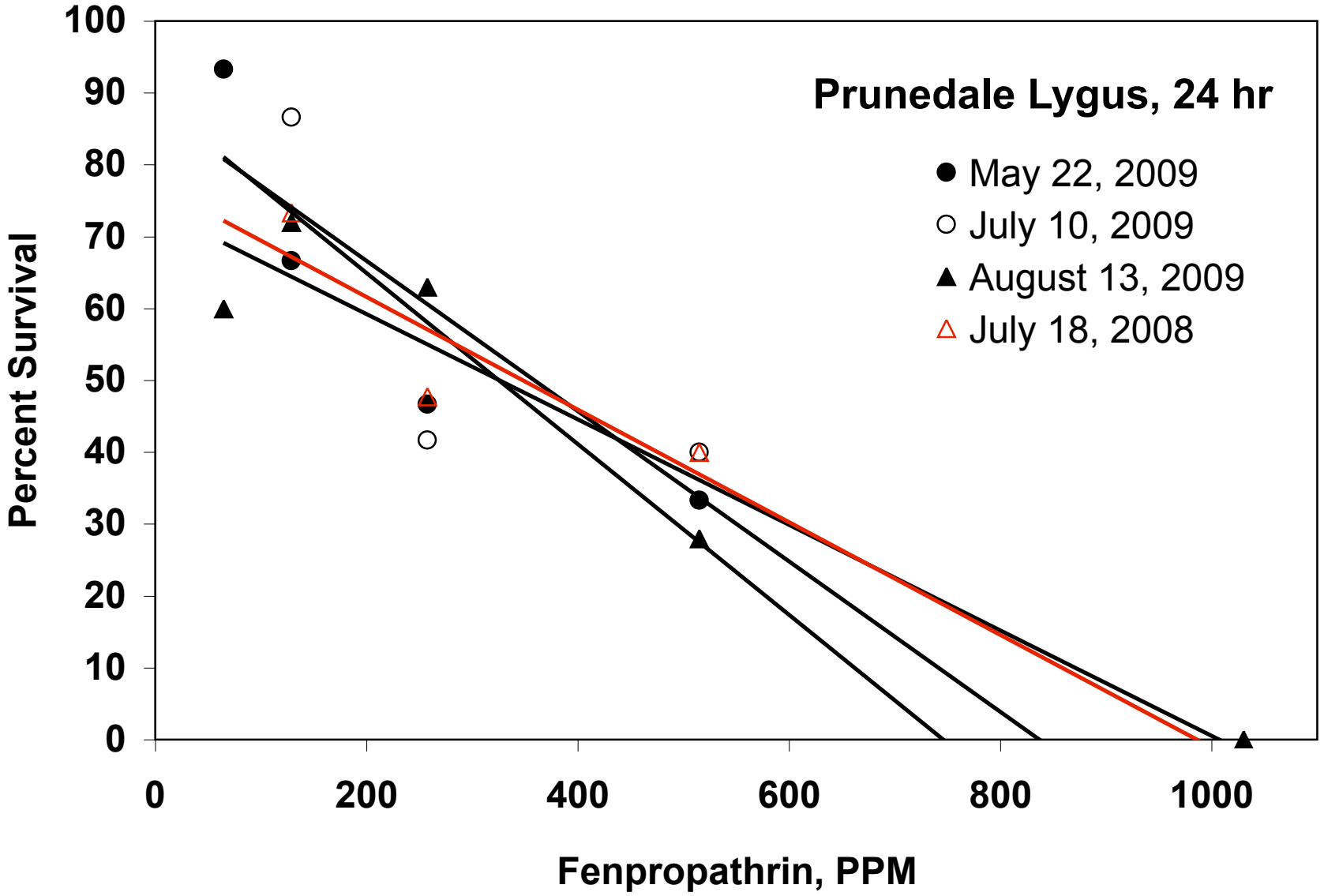
- Weeds
- First Year Field
- Second Year Field

2007 sprays -
1 Brigade + 2 Danitol
2008 sprays -
3 Brigade + 1 Danitol





Lygus Resistance - Is it seasonal?



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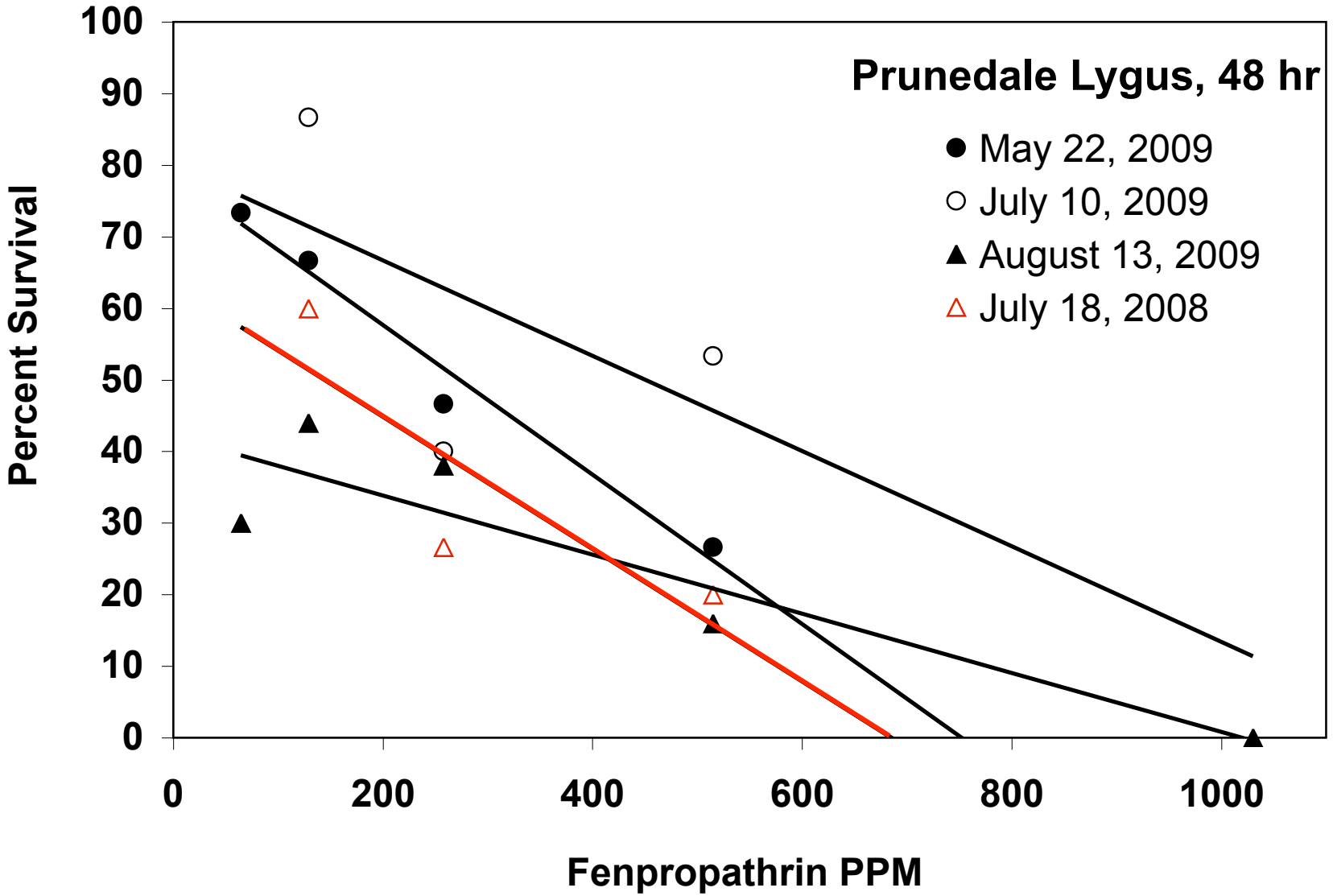

Lygus Resistance

Danitol - Probit statistics

Prunedale, August 13, 2009

24 hour

Host	n	X^2	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
First year	180	40.7	3.32 ± 0.51	2551.0 (1923.0 – 3504.2)
Second year	130	51.8	2.65 ± 0.44	2197.9 (1480.5 – 4124.1)
Weeds	128	31.6	1.46 ± 0.35	213.3 (109.9 – 397.4)

48 hour

Host	n	X^2	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
First year	180	28.8	6.45 ± 1.71	2903.4 (1923.4 – 3535.6)
Second year	130	18.9	8.41 ± 2.17	2612.3 (2066.2 – 3120.0)
Weeds	128			119.6

Lygus Resistance

Danitol - Probit statistics

Prunedale, August 13, 2009

LC50 is 10 times greater than in weeds

24 hour

Host	n	X^2	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
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Weeds	128			119.6

Lygus Control - Admire Injection

Second year berries

Treatment date - March 18, 2009 (immediately before flowering)

Admire rate - 14 oz./acre

Line pressure 5-6 psi

Plot size - 5 beds wide by 90' (98 plants) long

Sampled damaged fruit from middle bed starting 23 days after treatment

Lygus Control - Admire Injection

Treatment	Mean ± SD Percent Catfaced Green Fruit 4/10/2009 (23 days)	4/23/2009[1] (30 days)	4/30/2009 (37 days)
Untreated	28.88 ± 12.91	20.31 ± 2.69	20.99 ± 2.59
Admire	16.37 ± 6.83	16.35 ± 0.99	22.75 ± 5.28

[1]ANOVA statistics - *F*=5.6685; df=1,5; *P*=0.0756

Treatment	Mean ± SD % Catfaced Red Fruit 4/10/2009 (23 days)	4/23/2009[1] (30 days)	4/30/2009 (37 days)
Untreated	20.93 ± 13.39	20.31 ± 2.70	20.99 ± 2.59
Admire	11.73 ± 2.68	13.05 ± 5.66	20.12 ± 8.51

[1]ANOVA statistics - *F*=5.5986; df=1,5; *P*=0.0771

Lygus Damage - Reflective Mulch

Lygus Damage - Reflective Mulch

- Treatments
  - Metalized mulch
  - Black and silver
  - Clear
- Sample monthly

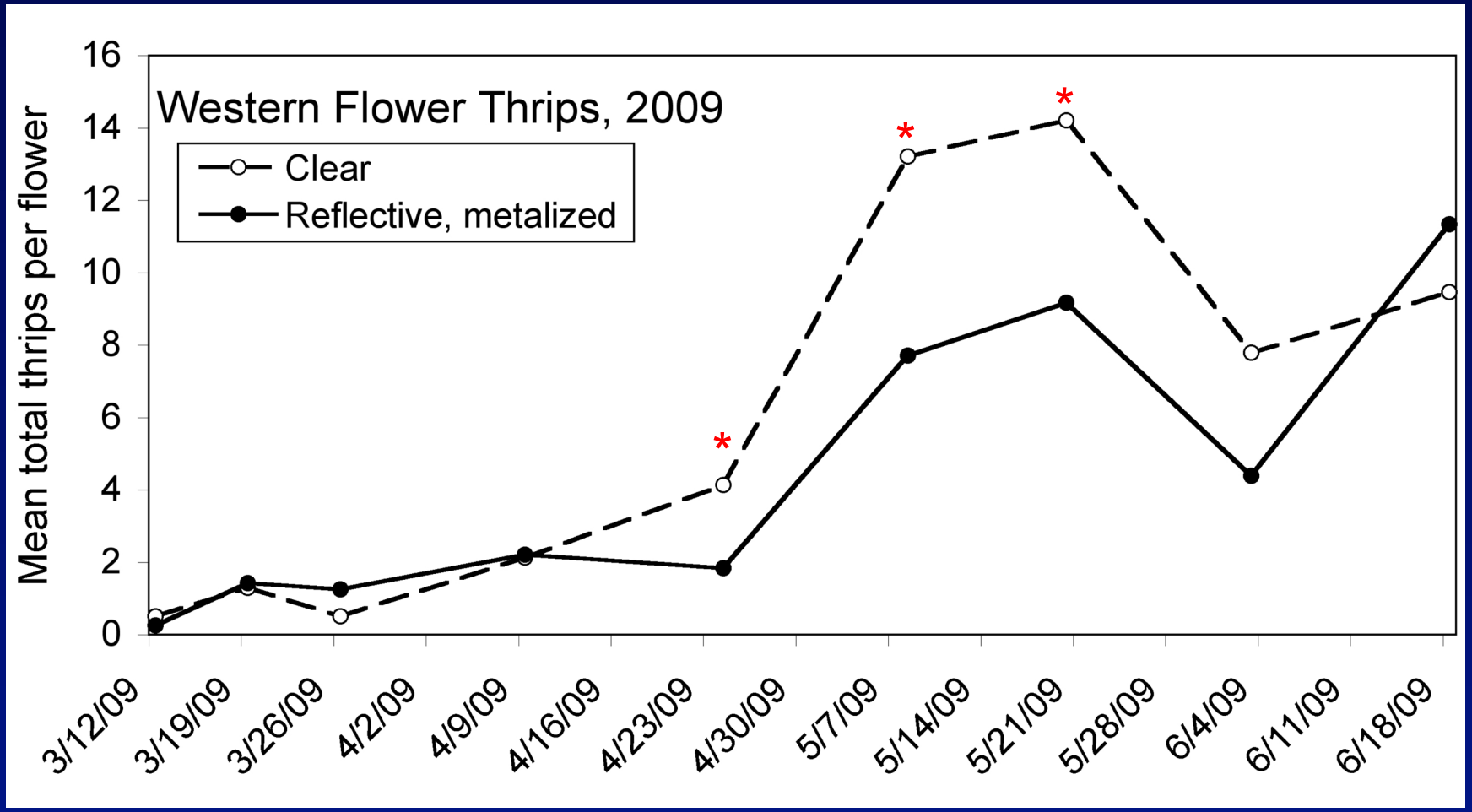
Lygus Damage - Reflective Mulch

Treatment	Mean ± SE Percent Damaged Fruit 4/23/09	5/15/09	7/16/09
Clear	8.84 ± 1.07	2.19 ± 1.35	4.22 ± 1.55
Black/ Silver	4.97 ± 0.87	0.00 ± 0.00	3.96 ± 1.26
Metallized	9.75 ± 3.27	2.98 ± 2.01	2.43 ± 0.75

Treatment	Mean ± SE Percent Damaged Fruit 8/6/09	8/25/09	9/17/09
Clear	10.42 ± 0.95	2.95 ± 2.21	3.71 ± 0.88
Black/ Silver	8.61 ± 2.71	1.89 ± 1.07	3.16 ± 0.86
Metallized	7.00 ± 0.99	2.18 ± 0.76	1.17 ± 0.60

No significant difference in damage for season

Lygus Control - Reflective Mulch



ANOVA statistics (n=4) -

4/24/09 - F=8.6763, P=0.0241

5/8/09 - F=11.6731, P=0.0142

5/20/09 - F=6.7501, P=0.0408

Lygus Control - Reflective Mulch

Fruit per plant for our 6 samples

Treatment	Mean ± SE Total Fruit/Plant/Sample
Clear	11.84 ± 0.14
Black/Silver	10.14 ± 0.26*
Metallized	11.61 ± 0.26

ANOVA statistics F=17.9608; df=2, 8; P=0.0029

* Mean significantly different than control at P=0.05 by Students t-test.

Lygus Control - Insecticides

Treatment	Rate (form/ac)
Assail[1]	6.4 oz
Assail[1] + Brigade	6.4 oz + 16 oz
Assail + Dyne-Amic[1] + Bifenture	6.4 oz + 16 oz
Rimon	12 oz
Rimon + Dyne-Amic[2]	12 oz
Beleaf + Dyne-Amic[2]	2.8 oz
Beleaf + Dyne-Amic[2] + Danitol	2.8 oz + 10.66 oz
Beleaf + Dyne-Amic[2] + Rimon	2.8 oz + 12 oz
Danitol + Dyne-Amic[2]	10.66 oz
Clutch (L) + Dyne-Amic[2]	5.6 oz
Clutch (H) + Dyne-Amic[2]	11.0 oz
Clutch (L) + Dyne-Amic[2] + Danitol	5.6 oz + 10.66 oz

[1]1.0% v/v

[2]0.25% v/v

Lygus Control - Insecticides

First year var. 'Albion'
Applied with 5 row wide tractor mounted sprayer
Volume = 100 gpa
Plot size = 5 rows x 50 feet
Application date = 9/4/2009
Pretreat Lygus counts

- Nymphs = 0.5 per plant
- Adults = 0.029 per plant

Products not registered

- Rimon - benzoylurea (growth regulator)
- Beleaf - flonicamid (feeding blocker)
- Clutch - neonicotioid (nerve poison)

Clutch and Beleaf are not registered for strawberries

Lygus Control - Nymphs

Treatment	Corrected percent reduction of Lygus nymphs per plant 9/10/09	9/17/09
Assail*	42.67	15.49
Assail + Brigade*	5.33	43.19
Assail + Bifenture*	52.89	53.99
Rimon	26.22	24.41
Rimon*	57.33	29.11
Beleaf	51.56	0.00
Beleaf + Danitol*	28.89	7.98
Beleaf + Rimon*	36.00	33.80
Danitol*	44.89	17.37
Clutch (L)*	60.89	35.21
Clutch (H)*	52.89	20.66
Clutch (L) + Danitol *	74.22	24.41

* Dyne-Amic

Lygus Control - Total Lygus

Treatment	Corrected percent reduction of Lygus nymphs and adults per plant 9/10/09	9/17/09	10/2/09
Assail*	41.35	9.46	2.12
Assail + Brigade*	8.86	37.84	10.58
Assail + Bifenture*	54.43	46.85	0.00
Rimon	26.58	19.82	5.29
Rimon*	56.54	29.73	0.00
Beleaf	52.32	0.00	0.00
Beleaf + Danitol*	31.22	7.21	0.00
Beleaf + Rimon*	34.18	31.98	3.97
Danitol*	45.57	11.71	23.55
Clutch (L)*	53.16	19.82	3.97
Clutch (H)*	59.92	31.08	23.81
Clutch (L) + Danitol *	41.35	9.46	2.12

* Dyne-Amic

Lygus Control - Damage Reduction

Treatment	Percent reduction of catfacing corrected for damage in untreated		
	9/24/09	10/2/09	Average
Assail*	17.54	13.85	15.70
Assail + Brigade*	19.54	28.73	24.13
Assail + Bifenture*	26.25	18.82	22.54
Rimon	18.89	15.11	17.00
Rimon*	8.72	15.36	12.04
Beleaf	18.22	10.23	14.22
Beleaf + Danitol*	9.98	24.87	17.43
Beleaf + Rimon*	42.58	4.27	23.42
Danitol*	26.00	19.21	22.60
Clutch (L)*	31.58	12.44	22.01
Clutch (H)*	22.85	19.42	21.14
Clutch (L) + Danitol *	36.30	20.72	28.51

* Dyne-Amic

Western Flower Thrips

Frankliniella occidentalis

Type I Bronzing

Bronzing

3 types identified

Causes of Type 3 Bronzing

Koike, S.T., F.G. Zalom, and K.D. Larson. 2009. Bronzing of strawberry fruit as affected by production practices, environmental factors, and thrips. HortScience. 44(6): 1-6.

Causes of Type 3 Bronzing

Elevated temperature and solar radiation

Mitigated by:

- overhead sprinkling
- certain foliar pesticides
- lignin

Koike, S.T., F.G. Zalom, and K.D. Larson. 2009. Bronzing of strawberry fruit as affected by production practices, environmental factors, and thrips. HortScience. 44(6): 1-6.

Western Flower Thrips Control, Orange Co.

	Number of thrips per flower			
Treatment	Feb 18	Feb 27	Mar 4	Mar 16
Untreated	1.14±0.62	5.29±1.94	6.90±2.72	11.10 ±3.52
Lannate	0.47±0.46	0.73±0.35*	1.87±1.16*	6.87±3.10
Entrust	0.45±0.30	1.39±0.45*	2.98±0.81*	6.15±0.89*
Success	0.60±0.72	1.58±0.86*	3.70±2.29	7.87±2.14

* Treatment differs from untreated by pairwise t-test at $P<0.05$.

New concerns:

- Loss of the Lannate label for strawberries
- Restriction on number of applications per season by Dow Agrosciences for spinosyns (Entrust, Success and Radiant)

Western Flower Thrips Resistance, 2008

Mortality of a spinetoram susceptible population

@ 40 ppm - 100%

@ 200 ppm - 97.8%

@ 1000 ppm - 100%

(label rate is 28 - 187 ppm)

Mortality of a spinetoram resistant population

@ 40 ppm - 19.9%

@ 200 ppm - 57.3%

@ 1000 ppm - 90.6%

(label rate is 28 - 187 ppm)

Data from Dow Agrosciences

Western Flower Thrips Resistance, 2008

Mortality of a spinosad susceptible population

@ 40 ppm - 100%

@ 200 ppm - 100%

@ 1000 ppm - 100%

(label rate is 37 - 225 ppm)

Mortality of a spinosad resistant population

@ 40 ppm - 5.7%

@ 200 ppm - 8.2%

@ 1000 ppm - 13.4%

(label rate is 37 - 225 ppm)

Data from Dow Agrosciences

Spinosyn Product Restrictions -

Restriction on number of applications per season for spinosyns (Entrust, Success and Radiant) is a bigger issue than just thrips control:

An important rotational project for -

Lepidoptera

Corn earworm

Beet armyworm

Cutworms

Light brown apple moth

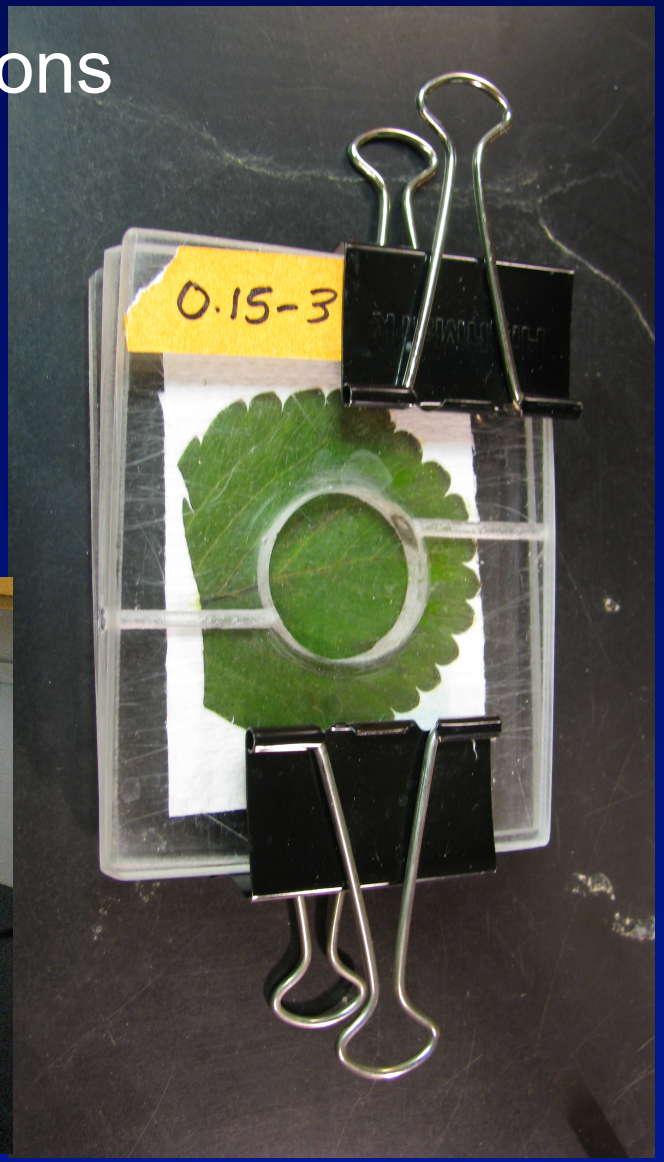
Spotted wing drosophila

Especially for organic producers (Entrust)

Western Flower Thrips Studies, 2009

- Bioassays of insecticide rotations and resistance development
- Field efficacy trials

With Mark Bolda, Jianlong Bi, Robert Yu Yi, and Jim Mueller (Dow Agrosciences)



Western Flower Thrips Studies, 2009

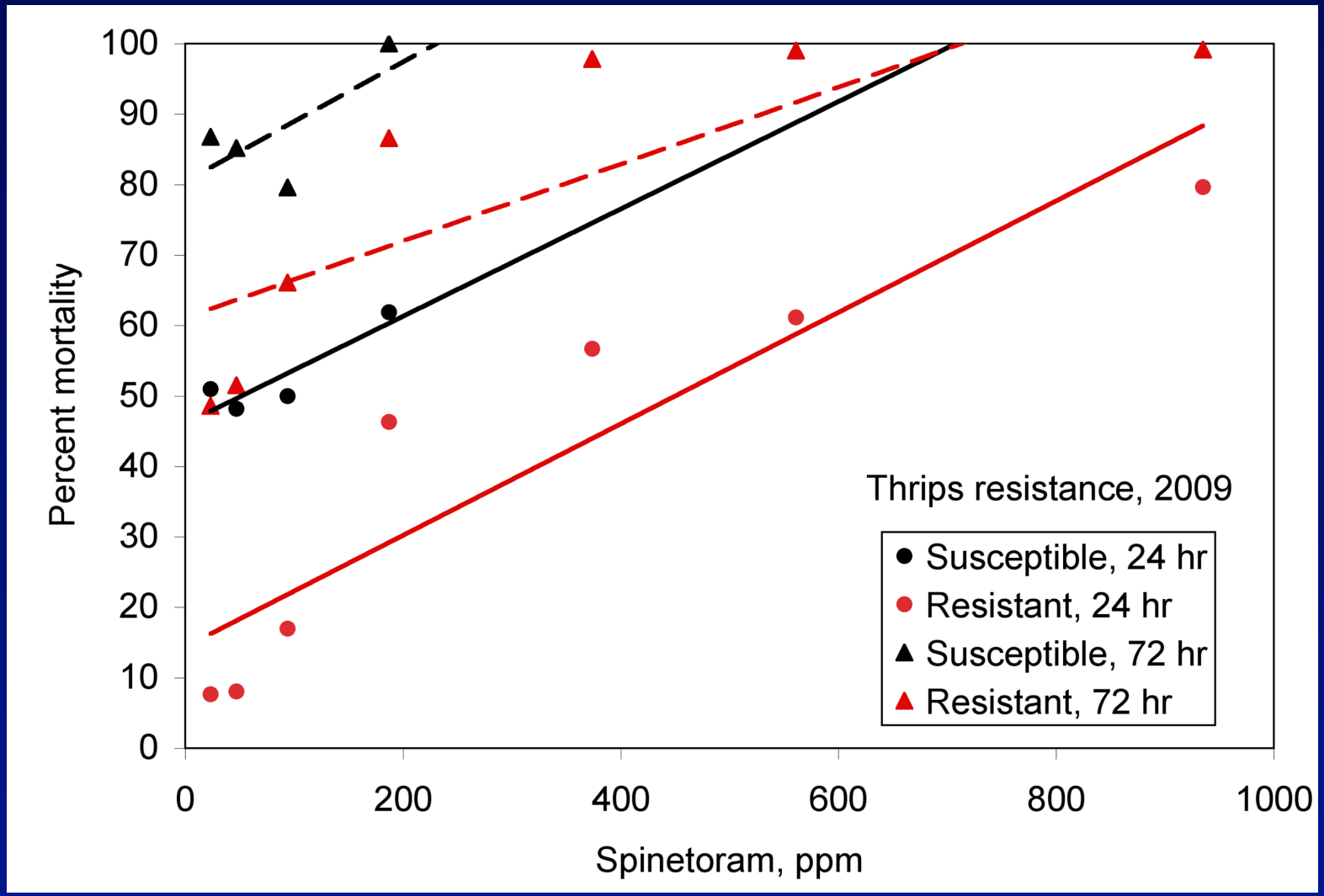
'Resistant' site -
Susceptible site -

Fields treated with Success or Radiant rotated with Dibrom

Treatment dates -
- May 29 and June 8 - Success
- June 16 and 29 - Dibrom
- August 8 and 15 - Success

Flowers collected monthly, June - November, and returned to the lab where thrips removed and placed on treated strawberry leaves for Munger cell dose response bioassays

Thrips Susceptibility of Fields, Pretreatment



Thrips susceptibility to spinetoram - 'susceptible' site

Sampling date	n	hrs	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
Jul. 23	899	24	0.810 ± 0.070	63.152 (47.863-81.845)
		48	0.827 ± 0.072	23.009 (14.864-32.477)
		72	0.905 ± 0.089	9.552 (5.719-13.984)
Sept. 4	2625	24	0.693 ± 0.026	48.229 (38.806-59.349)
		48	0.811 ± 0.036	25.981 (20.531-32.212)
		72	0.707 ± 0.033	7.573 (5.618-9.880)
Oct. 21	1321	24	0.531 ± 0.027	8.323 (4.550-14.386)
		48	0.474 ± 0.027	1.347 (0.658-2.471)
		72	0.497 ± 0.030	0.335 (0.155-0.631)

Thrips susceptibility to spinetoram - 'resistant' site

Sampling date	n	hrs	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
Jun. 17	708	24	1.454 ± 0.109	289.632 (222.953-387.499)
		48	1.534 ± 0.109	80.228 (60.069-102.790)
		72	1.614 ± 0.141	45.545 (31.895-59.707)
Jul. 17	770	24	1.237 ± 0.112	533.712 (390.645-797.613)
		48	1.419 ± 0.134	206.773 (153.115-262.367)
		72	1.067 ± 0.105	44.257 (25.743-64.406)
Aug. 27	883	24	0.992 ± 0.074	851.263 (640.411-1179.864)
		48	1.198 ± 0.109	344.027 (255.815-443.848)
		72	1.543 ± 0.171	236.922 (175.503-295.857)
Oct. 1	1207	24	1.246 ± 0.099	279.498 (210.693-355.859)
		48	1.112 ± 0.080	92.516 (59.785-130.184)
		72	1.542 ± 0.139	86.830 (53.186-121.767)

Treatment dates -

May 29 and June 8 - Success

June 16 and 29 - Dibrom

August 8 and 15 - Success

Thrips susceptibility to spinetoram - second year and weeds

Site	Sampling date	n	hrs	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
1st year berry	Jul. 22	1662	24	0.819 ± 0.052	130.213 (94.669-171.333)
			48	0.940 ± 0.063	65.027 (43.892-88.748)
			72	0.869 ± 0.064	20.630 (12.406-30.475)
	Nov. 10	968	24	1.885 ± 0.187	526.037 (413.586-636.796)
			48	1.852 ± 0.200	311.456 (218.226-402.846)
			72	1.716 ± 0.212	169.856 (100.933-239.553)
2nd year berry	Jul. 22	1216	24	1.048 ± 0.063	434.192 (344.679-548.389)
			48	1.506 ± 0.127	285.259 (211.132-358.411)
			72	1.293 ± 0.099	142.097 (103.668-182.241)
	Nov. 10	1137	24	1.751 ± 0.161	581.380 (465.822-700.084)
			48	1.497 ± 0.153	321.556 (230.851-415.635)
			72	1.625 ± 0.182	197.989 (129.418-268.645)
Weeds	Jul. 22	1104	24	0.762 ± 0.038	3.430 (2.162-5.419)
			48	0.707 ± 0.041	0.887 (0.559-1.364)
			72	0.770 ± 0.050	0.329 (0.173-0.567)
	Nov. 10	1133	24	0.593 ± 0.077	25.057 (4.041-68.464)
			48	0.565 ± 0.053	3.153 (0.341-12.496)
			72	0.566 ± 0.047	0.421 (0.107-1.207)

Thrips insecticide efficacy - MBA, 2009

Treatment	Rate	Mean ± SE thrips per flower		
		7/07/09	7/17/09	7/24/09
Control	-	21.67 ± 7.28	15.96 ± 4.50	17.54 ± 1.27
Altacor *	3.0 oz	24.33 ± 6.23	12.04 ± 1.61	15.17 ± 1.60
Beleaf	2.8 oz	19.00 ± 3.27	14.99 ± 2.72	23.21 ± 5.01
Assail *	6.4 oz	23.46 ± 4.99	12.54 ± 2.29	21.63 ± 2.65
Esteem	10.0 oz	26.46 ± 3.66	17.33 ± 3.00	18.54 ± 5.27

* Applied with Dyne-amic @ 1.0%

Treatments applied June 24 and July 10

Altacor and Beleaf are not registered for strawberries

Thrips insecticide efficacy - Tank mixes

Treatment	Rate	Means (± SE) thrips per flower		
		9/10/09	9/17/09	9/24/09
Untreated	-	19.39 ± 5.22	12.17 ± 2.18	8.33 ± 1.50
Assail + Brigade	6.4 oz + 16 oz	9.83 ± 0.82	11.26 ± 1.63	10.00 ± 2.96
Assail + Bifenture	6.4 oz + 16 oz	5.89 ± 1.11	15.33 ± 0.88	6.95 ± 1.11
Beleaf + Danitol	2.8 oz + 10.66 oz	19.78 ± 1.56	12.83 ± 2.38	9.11 ± 0.96
Beleaf + Rimon	2.8 oz + 12 oz	9.45 ± 1.48	16.89 ± 1.84	9.45 ± 0.72
Clutch	5.6 oz	12.83 ± 2.82	17.11 ± 1.51	9.61 ± 1.21
Clutch	11 oz	28.39 ± 14.06	15.06 ± 1.35	10.78 ± 0.53
Clutch + Danitol	5.6 oz + 10.66 oz	15.06 ± 4.02	13.11 ± 1.08	11.11 ± 1.28

All treatments applied with Dyne-amic
Treatments applied September 4

Clutch and Beleaf are not registered for strawberries

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