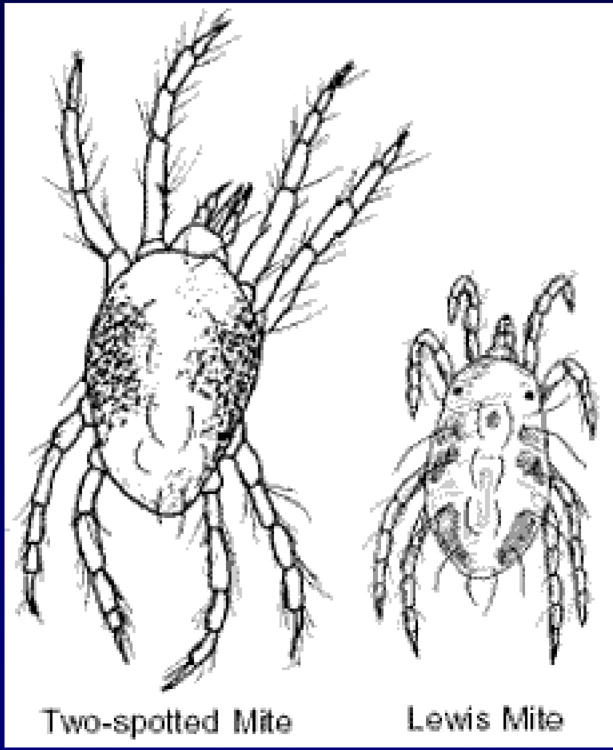
Panel Discussion of Entomology in Strawberries and Caneberries in 2011
Watsonville, September 13, 2011

General Entomology Topics (Everything Else)

Frank Zalom
Department of Entomology
University of California, Davis

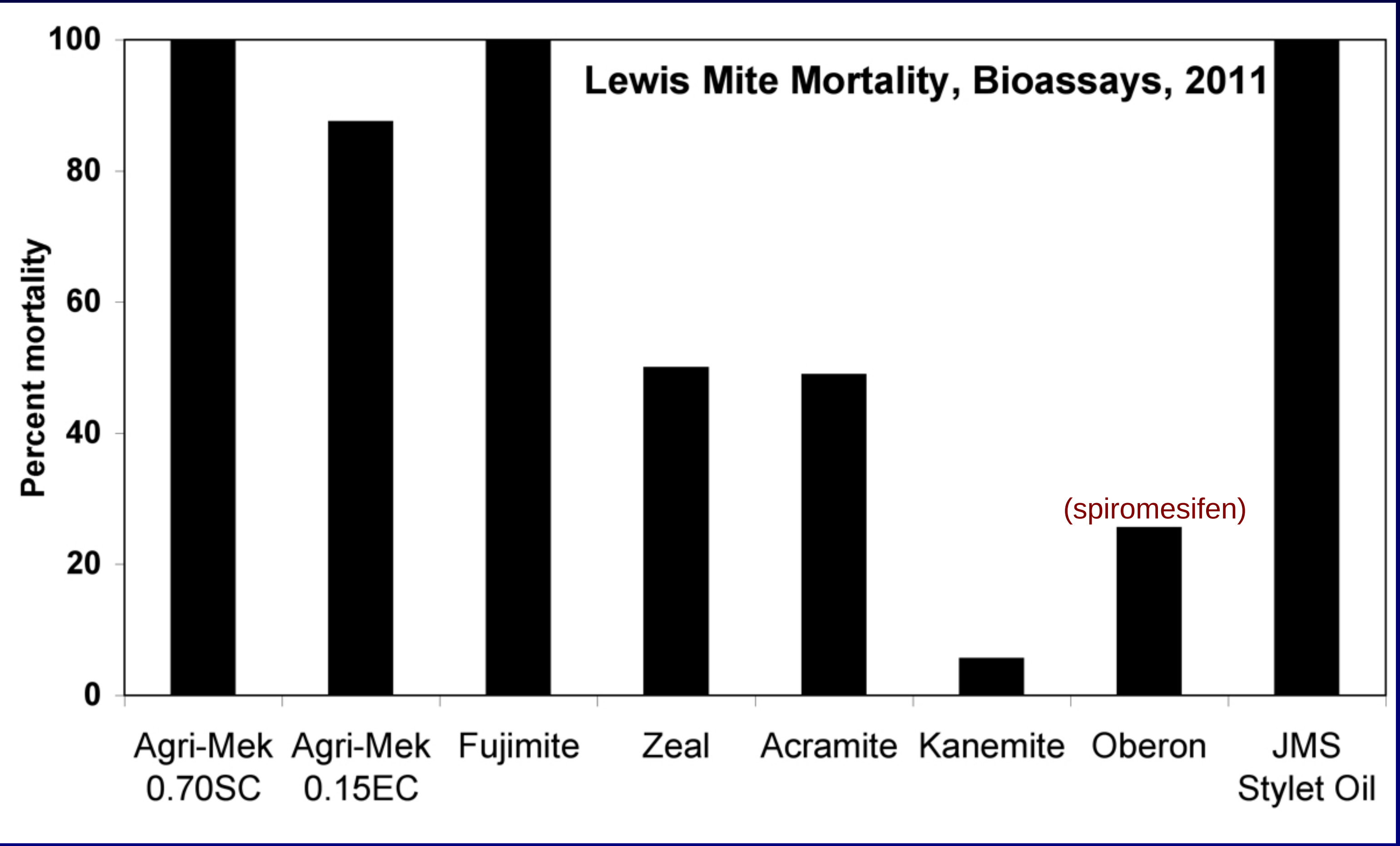
Lewis Mite



Eotetranychus lewisi

Tetranychus urticae

Lewis Mite - Lab Bioassays



Mortality at 24 hours

Eotetranychus vs Tetranychus

Willamette Spider Mite
Eotetranychus willamettei

Pacific Spider Mite
Tetranychus pacificus

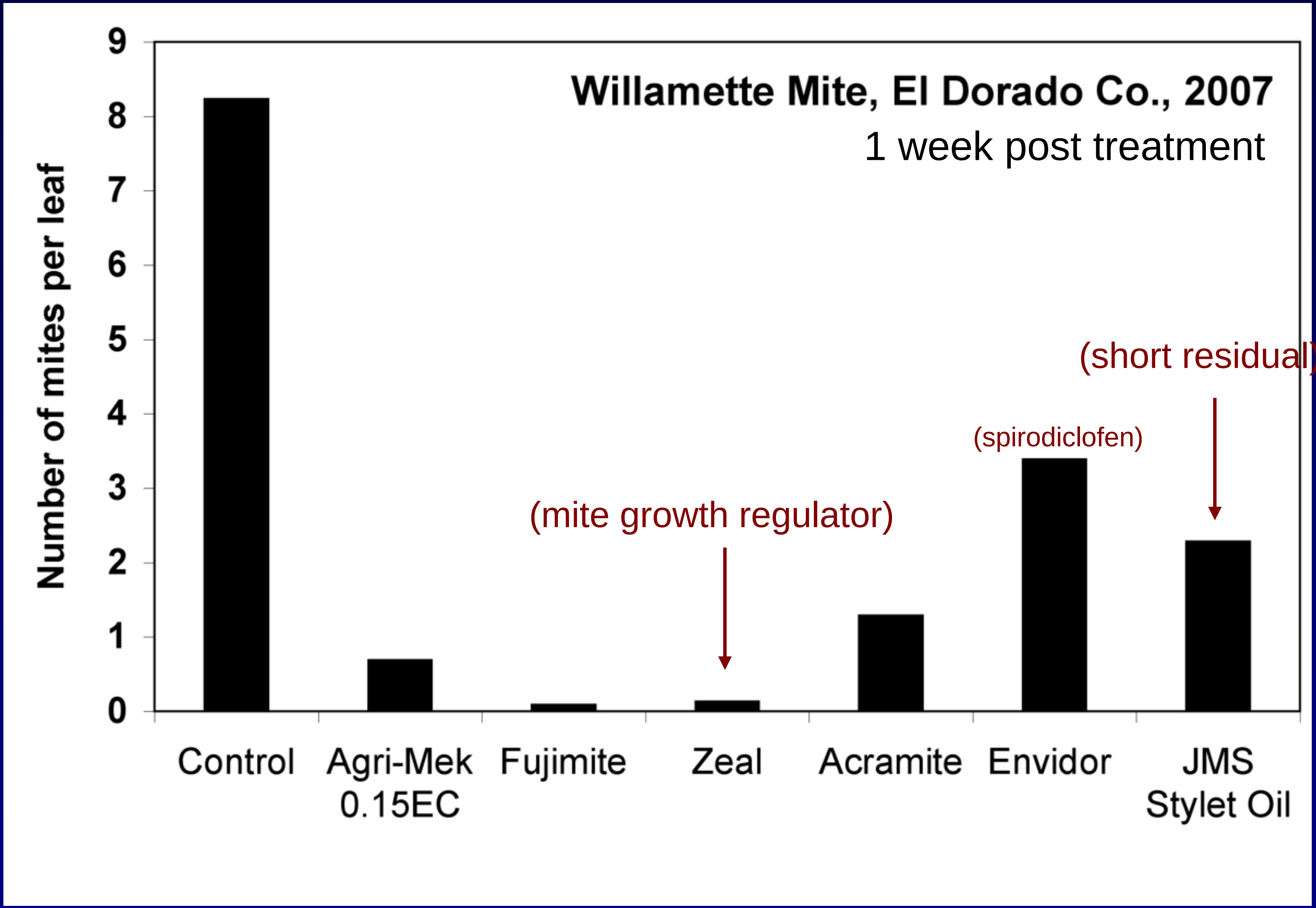
grapes

Eotetranychus lewisi

strawberries

Tetranychus urticae

Willamette Mite - Grapes



Predator mites - Phytoseiidae

Phytoseiulus persimilis

Neoseiulus californicus

Predator mites - Phytoseiidae

Are there differences between species?

- Food requirements - specialists vs generalists
- Temperature - adapted to cooler vs warmer conditions
- Water - require free water vs obtaining water from food
- Adaptation to crop - e.g. smooth leaves vs hairy leaves

Predator mites - Phytoseiidae

Are there differences?

	Pros	Cons
Specialists	Obligatory mite predators Good if mites are always present in the crop	May leave or decline if pest mites low May cannibalize their eggs or young
Generalists	Feed on mites + other small arthropods, pollen, nectar, etc. Will persist in the crop	May not provide control of rapidly increasing pest populations

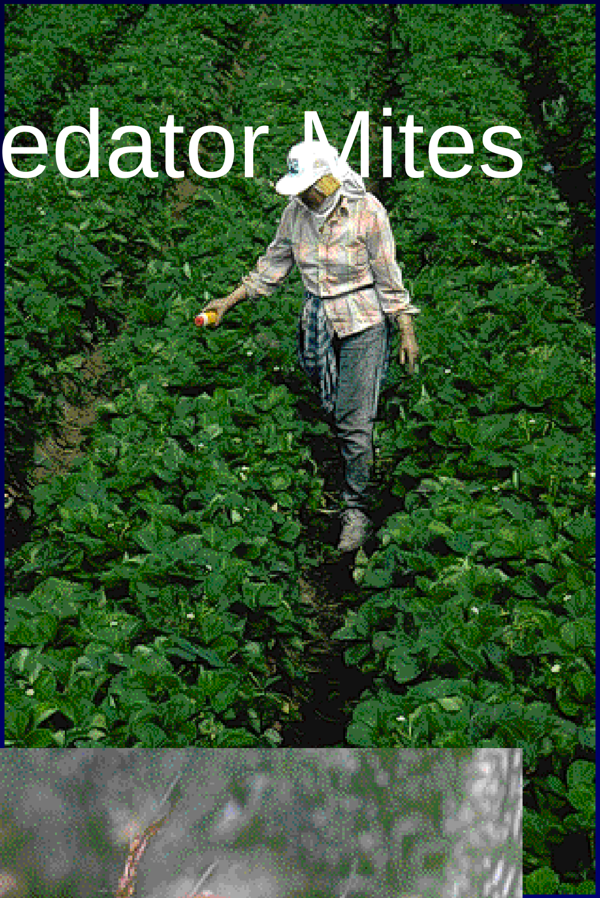
Predator mites - Phytoseiidae

Are there differences?

Type	Characteristics	Examples
I	Feed on *Tetranychidae* only; rapid feeding; rapid movement	*Phytoseiulus persimilis*
II	Feed on mites only; slower rate of feeding; slower dispersal	*Galendromus occidentalis*
III	Generalist predators that can feed on plant products	*Amblyseius californicus* *Neoseiulus cucumeris*
IV	Pollen feeders that are also generalist predators	

Integrating Pesticides and Predator Mites

Acaricide selectivity -



Integrating Pesticides and Predator Mites

Residual bioassays up to 37 days after application

Direct and indirect effects of -

- Acaramite = Bifenazate
- Agri-mek = Abamectin
- Kanemite = Acequinocyl
- Oberon = Spiromesifen
- Zeal = Etoxazole
- Fujimite = Fenpyroximate

Predator mite bioassays - persistence

Active ingredient, trade name, formulation and concentration.

Active ingredient	Product	% a.i. and formulation	Concentration (ppm)
Fenpyroximate	Fujimite	5 SC	62.5
Etoxazole	Zeal	72 WP	80.9
Acequinocyl	Kanemite	15 SC	181.5
Bifenazate	Acramite	50 WS	200.7
Spiromesifen	Oberon	23 SC	142.6
Abamectin	Agri-mek	15 EC	93.0

Amount of solution applied was 10.6±0.53 μl/cm2.

The chemicals evaluated were mixed with distilled water

Predator mite bioassays - persistence

- Strawberry plants were grown and treated in the field
- Acaricides applied at 100 ml per plant to runoff
- Five 20 mm leaf disks per Petri dish arena
- Three adult female *P. persimilis* or G. *occidentalis* per disk
- *T. urticae* active stages and eggs provided for food
- Evaluated mortality and fecundity @ 3 days and fertility @ 6 days)
- Five replicates of each treatment and control
- Procedures repeated with treated leaflets removed from the plants at 3, 6, 10, 14, 17, 24, 30 and 37 days after application

IOBC Persistence Categories

Based on persistence - number of days after treatment that total effects are greater than 30%

A = short lived (<5 d)
B = slightly persistent (5-15 d)
C = moderately persistent (16-30 d)
D = persistent (>30 d)

Direct Effects - Mean ± SD percent *G. occidentalis* and *P. persimilis* female mortality 72 h after exposure to treated strawberry leaflets

	Mean ± SD % mortality									
	G. occidentalis					*P. persimilis*				
	Days after treatment					Days after treatment				
Product	3	6	10	>14	IOBC	3	6	10	>14	IOBC
Control	0a	0a	0a	0a	A	0a	0a	0a	0a	A
Acramite	0a	0a	0a	0a	A	0a	0a	0a	0a	A
Zeal	26.4±6.6b	0a	0a	0a	A	0a	0a	0a	0a	A
Oberon	0a	0a	0a	0a	A	0a	0a	0a	0a	A
Agri-mek	33.0±10.4b	0a	0a	0a	A	26.4±12.3b	26.4±12.3b	0a	0a	A
Fujimite	100c	100b	100b	0a	B	100c	100c	100b	0a	B
Kanemite	100c	0a	0a	0a	A	100c	0a	0a	0a	A

Within columns means (±SD) followed by the same letter do not differ significantly at *P*=0.05 by LSD. IOBC categories: A = short lived (<5 d), B = slightly persistent (5-15 d), C = moderately persistent (16-30 d), D = persistent (>30 d)

Indirect Effects - Mean ± SD *P. persimilis* fecundity (eggs/female/day) recorded 72 h after exposure to to treated strawberry leaflets

	Days after treatment							
Product	3	6	10	14	17	24	30	37
Control	4.2±0.34a	4.1±0.34a	4.1±0.23a	4.0±0.27a	3.8±0.32a	4.3±0.17a	4.3±0.08a	4.0±0.25a
Acramite	0.0±0.00c	1.9±0.10b	1.6±0.14b	2.9±0.21b	4.4±0.20a	4.5±0.21a	4.4±0.09a	4.0±0.33a
Zeal	1.8±0.23b	1.5±0.23bc	1.2±0.24b	3.1±0.24b	4.4±0.18a	4.4±0.18a	4.4±0.06a	4.0±0.10a
Oberon	0.1±0.03c	0.8±0.16cd	1.1±0.07b	4.1±0.23a	4.1±0.18a	4.2±0.15a	4.0±0.33a	4.0±0.26a
Agri-mek	1.2±0.13b	1.7±0.40b	1.7±0.30b	3.3±0.18b	4.1±0.24a	4.1±0.12a	4.1±0.12a	4.2±0.24a
Fujimite	0.3±0.13c	0.4±0.18d	0.2±0.05c	1.7±0.05c	1.3±0.11b	1.3±0.16b	4.2±0.20a	4.1±0.15a
Kanemite	1.4±0.25b	3.9±0.23a	3.9±0.28a	4.1±0.26a	4.4±0.18a	4.4±0.12a	4.3±0.10a	4.3±0.12a

Within columns means (±SD) followed by the same letter do not differ significantly at *P*=0.05 by LSD.

Indirect Effects - Mean ± SD *P. persimilis* fertility (percent egg hatch) recorded 72 h after exposure to to treated strawberry leaflets

Product	Days after treatment							
	3	6	10	14	17	24	30	37
Control	96.7±1.4a	98.3±0.8a	98.0±1.0a	97.8±1.3a	97.4±1.3a	99.0±1.0a	100±0.0a	97.8±1.4a
Acramite	0.0±0.0b	99.0±1.0a	100±0.0a	97.9±3.4a	62.5±3.4c	99.1±0.9a	99.2±0.8a	98.5±0.9a
Zeal	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0d	0.0±0.0b	0.0±0.0b	0.0±0.0b
Oberon	0.0±0.0b	0.0±0.0b	3.9±2.4b	97.7±1.1a	76.7±5.3b	97.3±1.1a	99.2±0.8a	97.4±1.4a
Agri-mek	0.0±0.0b	99.1±0.9a	99.2±0.9a	98.6±0.6a	97.0±0.9a	98.1±1.2a	99.2±0.8a	97.9±1.3a
Fujimite	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0d	0.0±0.0b	0.0±0.0b	0.0±0.0b
Kanemite	99.2±0.8a	100±0.0a	99.1±0.8a	99.2±0.8a	99.0±0.6a	98.7±0.8a	99.1±0.6a	97.2±1.4a

Within columns means (±SD) followed by the same letter do not differ significantly at *P*=0.05 by LSD.

Total effects of pesticides - *E*

Mortality, fecundity and fertility analyzed by ANOVA with means separated by LSD ($p < 0.05$)

$$E\ (\%) = 100\% - (100\% - M) \times R$$

Where

M = Abbott corrected mortality (Abbott, 1925)

R = reproduction per treated female (eggs/female x % fertility) / reproduction per untreated female

Total effects (*E*) of acaricide residues on *P. persimilis* recorded 72 h after exposure to strawberry leaflets treated with the labeled dose of formulated products.

	Days after treatment								
Treatment	3	6	10	14	17	24	30	37	IOBC
Acramite	100	54	61	29	26	0	0	0	B
Zeal	100	100	100	100	100	100	100	100	D
Oberon	100	100	99	0	12	0	0	0	B
Agri-mek	100	70	59	19	3	2	1	2	B
Fujimite	100	100	100	100	100	100	100	100	D
Kanemite	100	5	6	0	0	0	0	0	A

IOBC categories: A = short lived (<5 d), B = slightly persistent (5-15 d), C = moderately persistent (16-30 d), D = persistent (>30 d)

Total effects (*E*) of acaricide residues on *G. occidentalis* recorded 72 h after exposure to strawberry leaflets treated with the labeled dose of formulated products.

Treatment	Days after treatment								IOBC
	3	6	10	14	17	24	30	37	
Acramite	100	67	52	0	0	0	0	0	B
Zeal	100	100	100	100	100	100	100	100	D
Oberon	100	67	33	0	0	0	0	0	B
Agri-mek	60	0	0	0	0	0	0	0	A
Fujimite	100	100	100	100	100	100	100	100	D
Kanemite	100	48	30	23	6	0	0	0	B

IOBC categories: A = short lived (<5 d), B = slightly persistent (5-15 d), C = moderately persistent (16-30 d), D = persistent (>30 d)

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 $P<0.05$.

Issues:

- Lannate no longer labeled for strawberries
- Number of applications per season restricted by Dow Agrosciences for spinosyns (Entrust, Success and Radiant) in the Monterey Bay area

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:

Spinosyns are important rotational products for -

- Lepidoptera
  - Corn earworm
  - Beet armyworm
  - Cutworms
  - *Light brown apple moth*
- Spotted wing drosophila

Especially for organic producers (Entrust)

Western Flower Thrips Studies, 2009-10

- 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, 2009-10

'Resistant' site -
Susceptible site - } Two sites

Fields treated with Success rotated with Dibrom

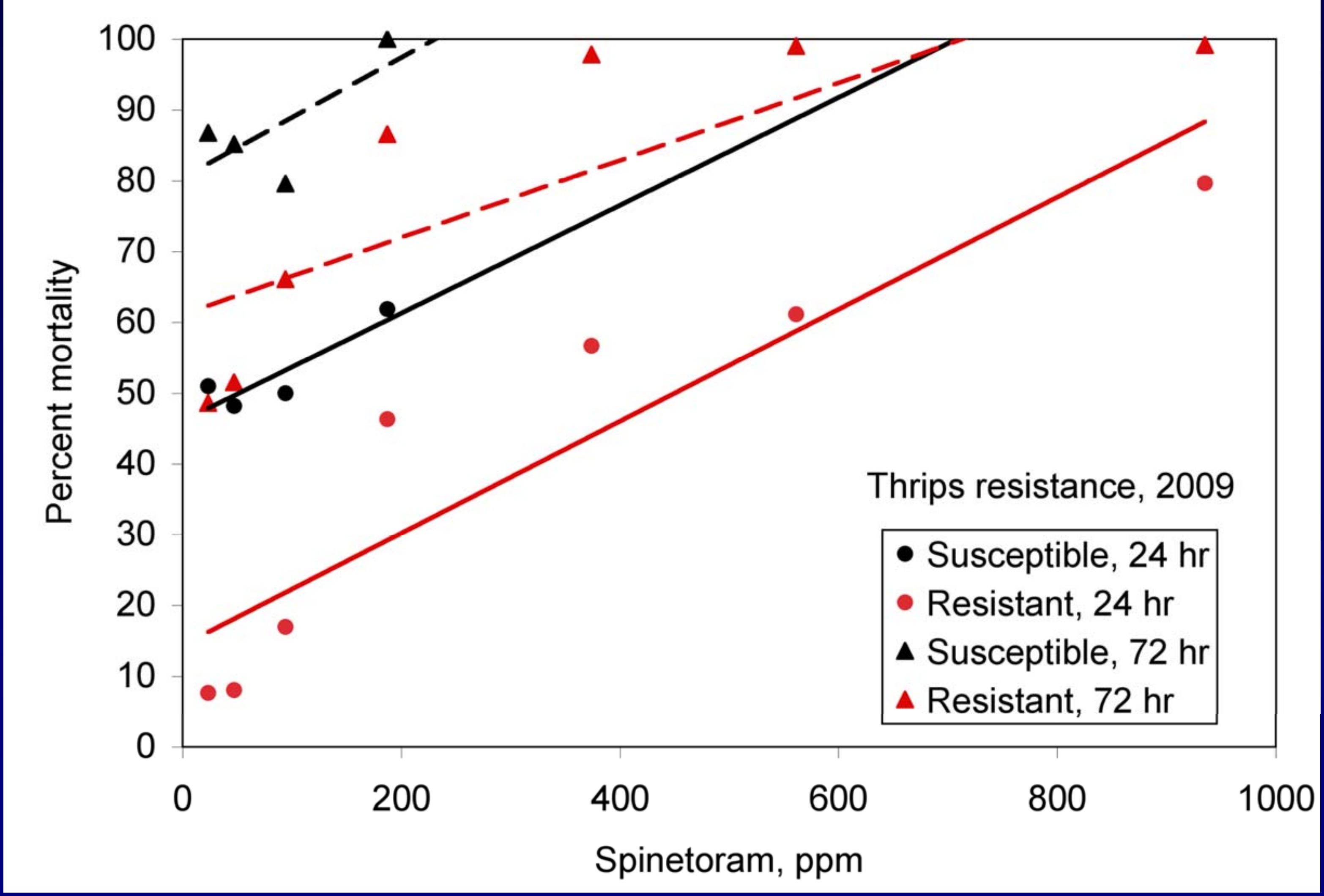
Treatment dates -

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

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

Is thrips resistance real?

Thrips Susceptibility of Fields, Pretreatment



Thrips susceptibility to spinetoram - 'susceptible' site

Sampling date	n	hrs	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
		24	0.81 ± 0.07	63.15 (47.86-81.85)
Jul. 23	899	48	0.83 ± 0.07	23.01 (14.86-32.48)
		72	0.91 ± 0.09	9.55 (5.72-13.98)
		24	0.69 ± 0.03	48.23 (38.81-59.35)
Sept. 4	2625	48	0.81 ± 0.04	25.98 (20.53-32.21)
		72	0.71 ± 0.03	7.57 (5.62-9.88)
		24	0.53 ± 0.03	8.32 (4.55-14.39)
Oct. 21	1321	48	0.47 ± 0.03	1.35 (0.66-2.47)
		72	0.50 ± 0.03	0.34 (0.16-0.63)

(label rate is 28 - 187 ppm)

Thrips susceptibility to spinetoram - 'resistant' site

Sampling date	n	hrs	Slope ± SE	LC_{50}, µg ai/ml (95% CI)
Jun. 17	708	24	1.45 ± 0.11	289.63 (222.95-387.50)
		48	1.53 ± 0.11	80.23 (60.07-102.79)
		72	1.61 ± 0.14	45.55 (31.90-59.71)
Jul. 17	770	24	1.24 ± 0.11	533.71 (390.65-797.61)
		48	1.42 ± 0.13	206.77 (153.12-262.37)
		72	1.07 ± 0.11	44.26 (25.74-64.41)
Aug. 27	883	24	0.99 ± 0.07	851.26 (640.41-1179.86)
		48	1.20 ± 0.11	344.03 (255.82-443.85)
		72	1.54 ± 0.17	236.92 (175.50-295.86)
Oct. 1	1207	24	1.25 ± 0.10	279.50 (210.69-355.86)
		48	1.11 ± 0.08	92.52 (59.79-130.18)
		72	1.54 ± 0.14	86.83 (53.19-121.77)

Treatment dates -

May 29 and June 8 - Success

June 16 and 29 - Dibrom

August 8 and 15 - Success

(label rate is 28 - 187 ppm)

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	0.82 ± 0.05	130.21 (94.67-171.33)
			48	0.94 ± 0.06	65.03 (43.89-88.75)
			72	0.87 ± 0.06	20.63 (12.41-30.48)
	Nov. 10	968	24	1.89 ± 0.19	526.04 (413.59-636.80)
			48	1.85 ± 0.20	311.46 (218.23-402.85)
			72	1.72 ± 0.21	169.86 (100.93-239.55)
2nd year berry	Jul. 22	1216	24	1.05 ± 0.06	434.19 (344.68-548.39)
			48	1.51 ± 0.13	285.26 (211.13-358.41)
			72	1.29 ± 0.10	142.10 (103.67-182.24)
	Nov. 10	1137	24	1.75 ± 0.16	581.38 (465.82-700.08)
			48	1.50 ± 0.15	321.56 (230.85-415.64)
			72	1.63 ± 0.18	197.99 (129.42-268.65)
Weeds	Jul. 22	1104	24	0.76 ± 0.04	3.43 (2.16-5.42)
			48	0.71 ± 0.04	0.89 (0.56-1.36)
			72	0.77 ± 0.05	0.33 (0.17-0.57)
	Nov. 10	1133	24	0.59 ± 0.08	25.06 (4.04-68.46)
			48	0.57 ± 0.05	3.15 (0.34-12.50)
			72	0.57 ± 0.05	0.42 (0.11-1.21)

Thrips insecticide efficacy - Watsonville, 2009

		Mean ± SE thrips per flower		
Treatment	Rate	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

		Mean (± SE) thrips per flower		
Treatment	Rate	7/13/09	7/23/09	7/30/09
Untreated	NA	35.63 ± 2.87	27.50 ± 4.80	9.21 ± 1.60
Radiant	10 oz	29.00 ± 0.13	20.96 ± 1.33	7.46 ± 0.81
Malathion 8	2 pts	32.75 ± 4.21	24.21 ± 4.56	12.42 ± 2.98
Oberon	16 oz	34.29 ± 3.71	21.42 ± 2.98	7.58 ± 0.96
Radiant + Assail	10 oz + 6.4 oz	22.75 ± 2.17	16.63 ± 2.15*	8.58 ± 1.16
Oberon + Malathion 8	16 oz + 2 pts.	30.96 ± 2.63	22.25 ± 0.78	8.84 ± 0.91
Oberon + Assail	16 oz + 6.4 oz	30.13 ± 2.73	20.96 ± 3.84	8.13 ± 1.18
Malathion 8 + Esteem	2.0 pts + 10 oz	23.63 ± 2.94	29.42 ± 1.95	12.25 ± 1.76

All treatments applied with Dyne-amic

Treatments applied July 3 and repeated July 10 with a backpack sprayer with drop nozzles at 100 gpa and 4 reps.

Thrips insecticide efficacy - Tank mixes

Treatment	Rate	Mean (± 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
Belay	5.6 oz	12.83 ± 2.82	17.11 ± 1.51	9.61 ± 1.21
Belay	11 oz	28.39 ± 14.06	15.06 ± 1.35	10.78 ± 0.53
Belay + 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

Belay and Beleaf are not registered for strawberries

Thrips insecticide efficacy - Tank mixes

		Mean ±SE thrips per flower		
Treatment	Rate (form/ac)	6/24/10	7/8/10	7/15/10
Untreated	--	45.83 ± 17.25	30.61 ± 4.15	32.67 ± 4.29
Assail + Bifenture	6.4 oz + 16.0 oz	23.67 ± 5.23	38.39 ± 6.50	36.06 ± 6.31

All treatments applied with Dyne-amic

Treatments applied June 17

Lygus

Lygus Monitoring

Determine when to make a control action….

- Monitor alternate hosts (including infested older strawberry plantings to determine when adults are present that may move into the newer strawberries
- Treat or destroy the alternate hosts before nymphs become adults, if practical, to avoid movement of adults to the newer strawberries
- Monitor the winter planted strawberries to determine when the first adults appear to establish the biofix
- Treat with appropriate products depending on the age structure of a population (e.g. Rimon is a growth regulator, so will only be effective on nymphs), spray the products that will also kill adults for later

Rimon spring spray, Watsonville, 2010

Timed to first nymphs

Second year 'Albion' with high infestation levels

Rimon treatment dates:

- March 23, 2010
- April 5, 2010

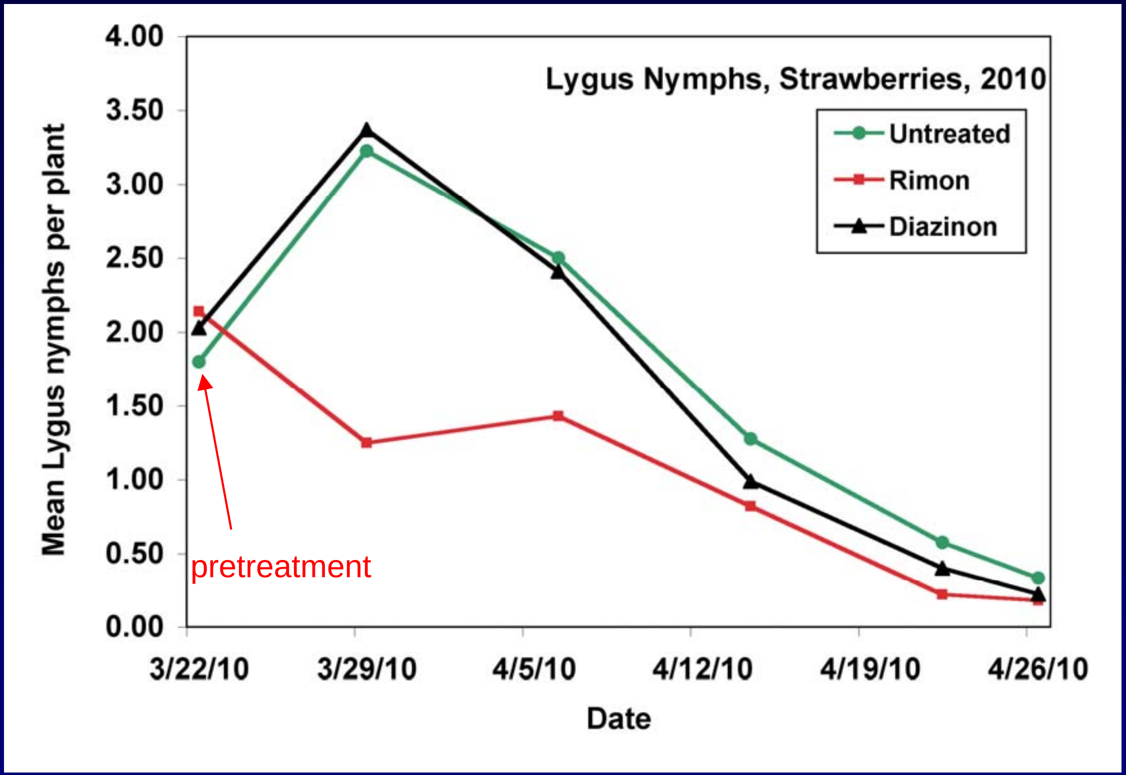
Treatments:

- Untreated control
- Rimon 0.83EC @ 12 oz per acre (2 applications)
- Diazinon AG500 @ 16 oz per acre (1 application)

Plot size - 12 rows wide x 175' long

Sampled 80 plants per plot

Rimon spring spray, Watsonville, 2010



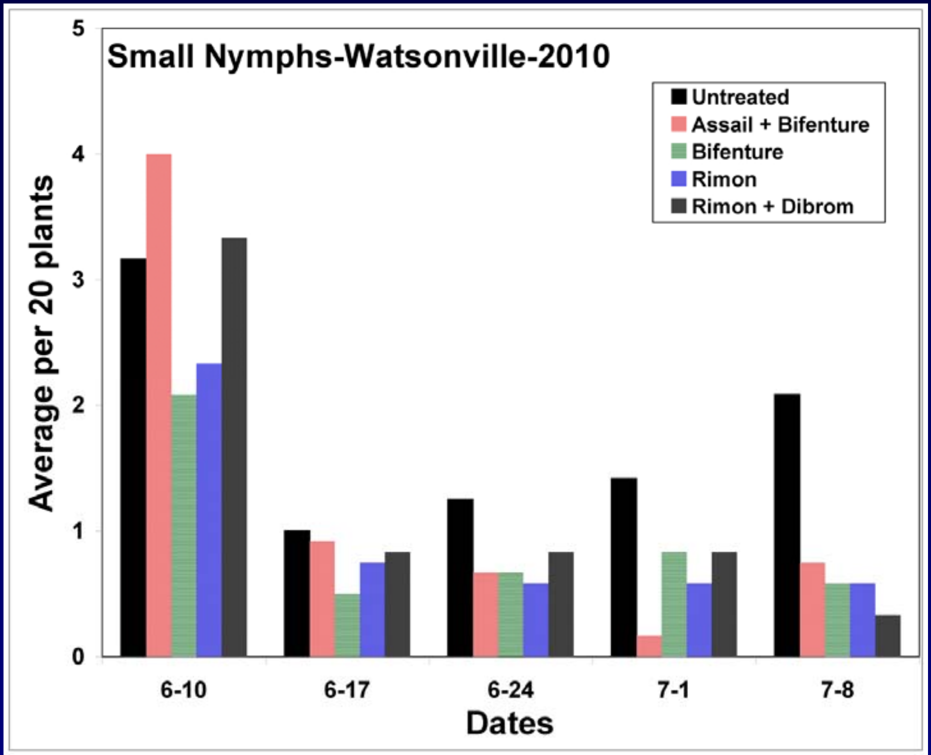
Problem with second year fields - they already have a resident Lygus population from the previous year, and because they have been sprayed the Lygus are more resistant to older insecticides like organophosphates (diazinon, malathion, Dibrom) and pyrethroids (Brigade and Danitol)

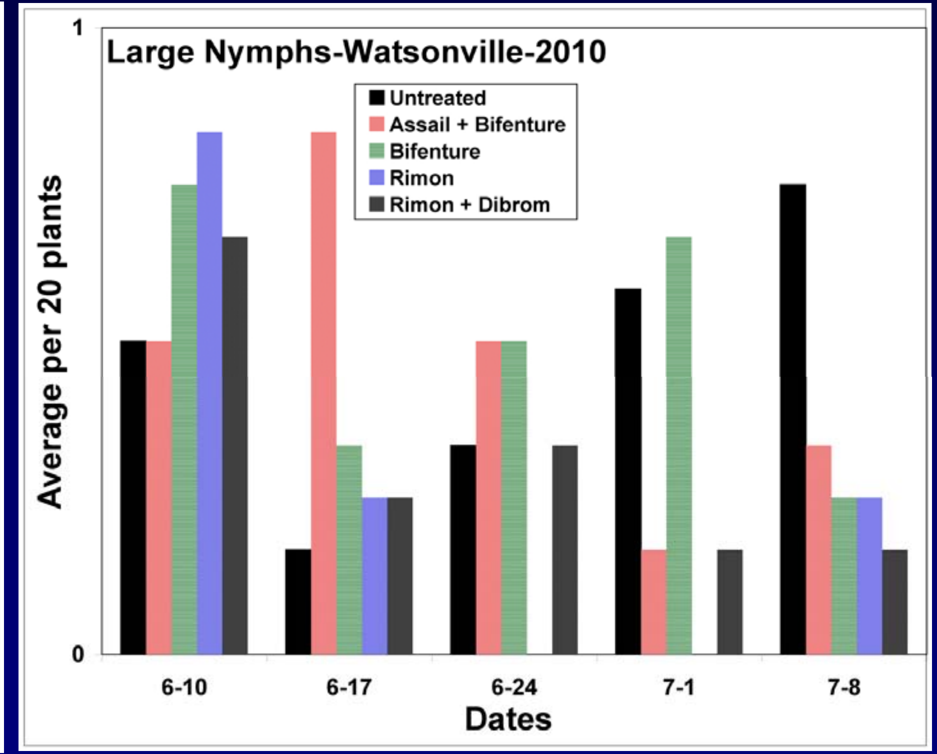
Rimon first year field, Watsonville, 2010

- Timed to nymphal hatch of first generation
  - First year 'Albion'
  - Rimon treatment dates:
    - June 11, 2010
    - June 18, 2010 (Rimon treatments only)
  - Treatments:
    - Untreated
    - Rimon @ 12 oz (2 applications)
    - Rimon @ 12 oz + Dibrom @ 16 oz (2 applications)
    - Bifenture 10DF @ 16 oz (1 application)
    - Assail 30SG @ 6.4 oz + Bifenture @ 16 oz (1 application)
  - Plot size - 6 rows wide x 67' long
  - Fruit > 0.75" were removed prior to treatment
  - Sampled 80 plants per plot for Lygus and fruit damage

Rimon first year field, Watsonville, 2010

Results





Rimon affects molting

Rimon first year field, Watsonville, 2010

Mean number of fruit damaged at 27 and 35 days after first treatment, Watsonville, 2010

		Mean ± SE fruit damaged/plant	
Treatment	Rate (form/ac)	7/8/10	7/15/10
Untreated	NA	1.07 ± 0.18	2.43 ± 1.18
Assail + Bifenture *	6.4 oz + 16 oz	0.91 ± 0.52	1.01 ± 0.15
Bifenture *	16 oz	1.73 ± 0.28	1.52 ± 0.63
Rimon	12 oz	0.54 ± 0.36	0.77 ± 0.28
Rimon + Dibrom	12 + 1 pt	1.06 ± 0.59	0.52 ± 0.26

Application dates - all treatments 6/11/10 and 2nd Rimon treatment 6/18/10
* plus Dyne-amic at 0.25% v/v

Pesticide	Chemical	Subgroup	Target Site of Activity	IRAC #
Lannate	methomyl	carbamate	acetylcholine esterase inhibitor	1A
Malathion	malathion	organophosphate	acetylcholine esterase inhibitor	1B
Dibrom	naled	prganophosphate	acetylcholine esterase inhibitor	1B
Diazinon	diazinon	prganophosphate	acetylcholine esterase inhibitor	1B
Brigade, Bifenture, Athena	bifenthrin	pyrethroid	sodium channel modulator	3
Danitol	fempropathrin	pyrethroid	sodium channel modulator	3
Actara	thiamethoxam	neonicotinoid	nicotinic Ach receptor agonists/ antagonist	4A
Assail	acetamiprid	neonicotinoid	nicotinic Ach receptor agonists/ antagonist	4A
Rimon	novaluron	benzoylureas	inhibitor of chitin biosynthesis, type 0	15
Prevam	borax	borax	nonspecific inhibitor	uncl
Belay	clothianidin	neonicotinoid	nicotinic Ach receptor agonist/ antagonist	4A
Beleaf	flonicamid	flonicamid	nonspecific feeding blocker	9C
--	tolyfenpyrad	METI insecticide	Mitochondral complex I electron transport inhibitor	21A
--	sulfoxaflor	sulfilimine	--	uncl

Not registered

Registered

Not registered for use on strawberries, but under study

Lygus Control - Insecticides - 2010

Treatment	Chemical name	Rate (form/ac)
Untreated		
Rimon 0.83EC	novaluron	12 oz
Beleaf	flonicamid	2.8 oz
Beleaf + Brigade	flonicamid + bifenthrin	2.8 oz + 16 oz
Beleaf + Rimon	flonicamid + novaluron	2.8 oz + 12 oz
Danitol	fenpropathrin	10.66 oz
Belay (L)	clothianidin	4.0 oz
Belay (H)	clothianidin	6.0 oz
Belay (L) + Danitol	clothianidin + fenpropathrin	4.0 oz
Brigade	bifenthrin	16 oz
Athena	bifenthrin + abamectin	17.0 oz
Actara 25WG	thimethoxam	4.0 oz
Agri-flex SC	thiamethoxam + abamectin	10.66 oz

Treatments include Dyne-amic

Lygus Control - Insecticides - 2010

Second year var. 'Albion'
Applied with 5 row wide tractor mounted sprayer
Volume = 100 gpa
Plot size = 5 rows x 90 feet; counts from 40 middle plants
Application date = 8/27/2010
Monitored by weekly Lygus counts
+ damage at 27d and 35d
'Newer' classes of chemicals -
Rimon - benzoylurea (growth regulator)
Beleaf - flonicamid (feeding blocker)
Belay - neonicotioid (nerve poison)
Insecticide + miticide premixes -
Athena - bifenthrin + abamectin
Agri-flex SC - thiamethoxam + abamectin

Belay, Beleaf and Agri-flex are not registered for strawberries

Lygus Control - Small Nymphs

	Mean ± SE small nymphs per plant			
Treatment	9/2/10	9/9/10	9/16/10	9/23/10
Untreated	0.75 ± 0.11	1.16 ± 0.25	1.04 ± 0.15	0.44 ± 0.11
Rimon 0.83EC	0.54 ± 0.08	0.72 ± 0.11	0.82 ± 0.10	0.56 ± 0.07
Beleaf	0.29 ± 0.08*	0.69 ± 0.05	0.68 ± 0.16	0.68 ± 0.15
Beleaf + Brigade	0.27 ± 0.04*	0.63 ± 0.23*	1.18 ± 0.11	0.62 ± 0.23
Beleaf + Rimon	0.18 ± 0.05*	0.51 ± 0.24*	0.78 ± 0.44	0.59 ± 0.10
Danitol	0.60 ± 0.18	1.38 ± 0.16	1.17 ± 0.12	0.58 ± 0.04
Belay (L)	0.39 ± 0.13*	0.91 ± 0.22	1.04 ± 0.35	0.82 ± 0.22
Belay (H)	0.35 ± 0.04*	0.53 ± 0.09*	0.79 ± 0.29	0.64 ± 0.08
Belay (L) + Danitol	0.40 ± 0.04*	0.87 ± 0.05	0.92 ± 0.07	0.89 ± 0.16
Brigade	0.71 ± 0.09	1.31 ± 0.06	1.11 ± 0.18	0.73 ± 0.06
Athena	0.42 ± 0.19*	0.83 ± 0.24	0.57 ± 0.06	0.50 ± 0.06
Actara 25WG	0.48 ± 0.06	0.95 ± 0.17	0.78 ± 0.05	0.55 ± 0.05
Agri-flex SC	0.41 ± 0.12*	1.03 ± 0.07	1.49 ± 0.38	0.95 ± 0.02

Lygus Control - Total Lygus (Nymphs + Adults)

	Mean ± SE total Lygus (nymphs + adults) per plant			
Treatment	9/2/10	9/9/10	9/16/10	9/23/10
Untreated	0.64 ± 0.24	1.03 ± 0.15	1.37 ± 0.25	1.26 ± 0.19
Rimon 0.83EC	0.53 ± 0.18	0.73 ± 0.02	0.93 ± 0.15	1.09 ± 0.13
Beleaf	0.50 ± 0.08	0.49 ± 0.11*	0.89 ± 0.01	0.86 ± 0.12
Beleaf + Brigade	0.63 ± 0.31	0.47 ± 0.06*	0.83 ± 0.29*	1.46 ± 0.08
Beleaf + Rimon	0.52 ± 0.17	0.35 ± 0.05*	0.67 ± 0.21*	1.01 ± 0.54
Danitol	0.42 ± 0.07	0.80 ± 0.25	1.59 ± 0.21	1.45 ± 0.15
Belay (L)	0.50 ± 0.20	0.57 ± 0.18*	1.14 ± 0.23	1.34 ± 0.42
Belay (H)	0.68 ± 0.18	0.45 ± 0.07*	0.65 ± 0.08*	1.00 ± 0.29
Belay (L) + Danitol	0.84 ± 0.09	0.57 ± 0.02*	1.11 ± 0.03	1.21 ± 0.11
Brigade	0.89 ± 0.08	1.07 ± 0.08	1.53 ± 0.07	1.53 ± 0.20
Athena	0.57 ± 0.13	0.55 ± 0.12*	1.22 ± 0.10	1.86 ± 0.42
Actara 25WG	0.51 ± 0.07	0.74 ± 0.05	1.20 ± 0.19	1.08 ± 0.07
Agri-flex SC	0.66 ± 0.18	0.56 ± 0.21*	1.09 ± 0.20	0.80 ± 0.07

Pre-treat count - mean±SE = 0.60 ±0.153; *F*=0.6700, df=12,36, *P*=0.7636

Lygus Control - Damage at 27d and 35d

Treatment	Percent fruit damaged per plot 9/16/10			Percent fruit damaged per plot 9/23/10			Percent damage reduction 9/16/10	Percent damage reduction 9/23/10
Untreated	73.93	±	4.00	80.87	±	3.99		
Rimon 0.83EC	58.42	±	4.30*	44.87	±	4.11*	20.98	44.51
Beleaf	53.37	±	5.00*	52.14	±	4.30*	27.82	35.53
Beleaf + Brigade	47.19	±	4.77*	39.78	±	3.48*	36.18	50.81
Beleaf + Rimon	49.16	±	4.43*	51.82	±	4.25*	33.51	35.92
Danitol	49.20	±	4.88*	65.56	±	4.61*	33.45	18.93
Belay (L)	48.31	±	4.74*	63.02	±	3.88*	34.67	22.07
Belay (H)	52.91	±	4.89*	38.00	±	4.07*	28.45	53.01
Belay (L) + Danitol	55.88	±	4.85*	58.91	±	4.37*	24.43	27.16
Brigade	61.70	±	4.66*	50.98	±	3.67*	16.56	36.96
Athena	64.00	±	4.52	60.46	±	5.63*	13.45	25.23
Actara 25WG	69.35	±	4.06	70.14	±	4.85*	6.21	13.27
Agri-flex SC	40.89	±	3.44*	47.56	±	3.75*	44.70	41.19

*Means are significantly different from control at $P<0.05$ using Student-t test following arcsine transformation.

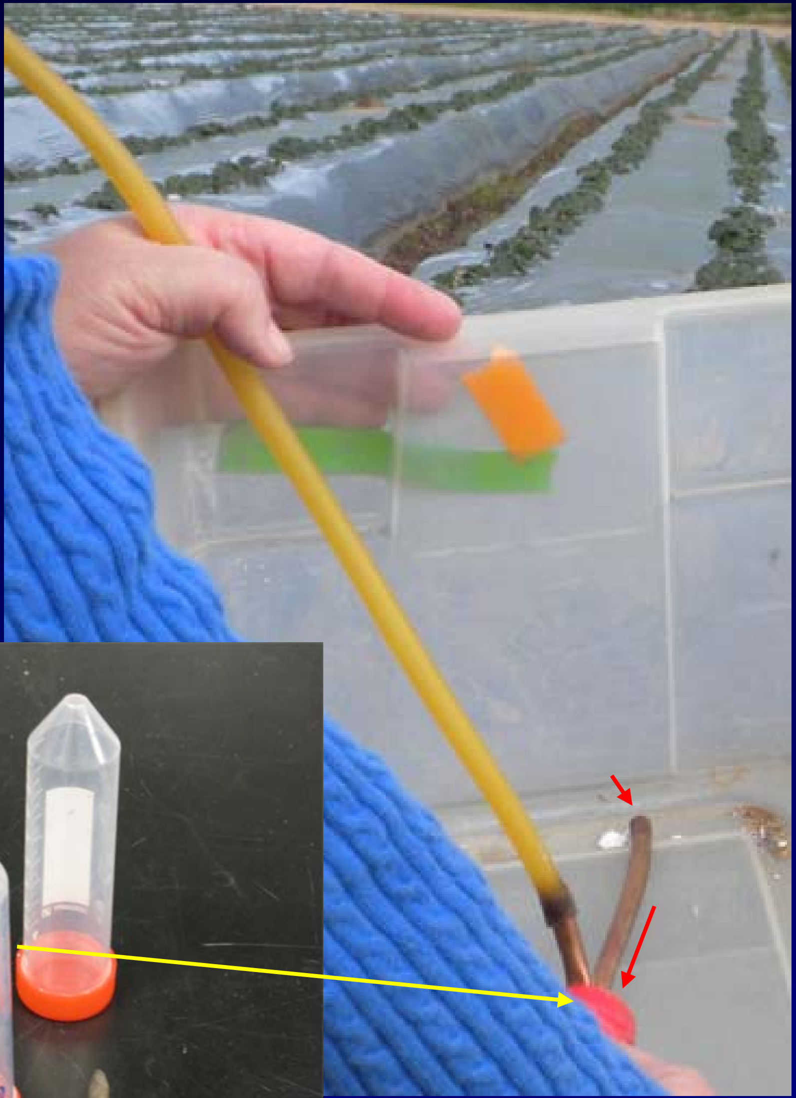
ANOVA statistics:

9/16/10, F=4.4884, df=12,455, $P<0.0001$

9/23/10, F=10.1919, df=12,455, $P<0.0001$

Lygus bioassays - 2011

Field collect Lygus adults
Aspirate into tubes
Treat with sulfoxaflor or tolyfenpyrad
Add a treated green bean and determine mortality at 24 hrs



Lygus bioassays - 2011

Treatment	Rate (form/ac)	Mean ± SE Mortality @ 24 hrs
Untreated	--	0.00 ± 0.00
Sulfoxaflor	2.85 oz	0.00 ± 0.00
Sulfoxaflor	4.28 oz	73.33 ± 17.64
Sulfoxaflor	5.7 oz	66.67 ± 17.64
Tolfenpyrad 15 EC	27 oz	100.00 ± 0.00
Tolfenpyrad 15 SC	27 oz	100.00 ± 0.00

Panel Discussion of Entomology in Strawberries and Caneberries in 2011
Watsonville, September 13, 2011

General Entomology Topics (Everything Else)

Frank Zalom
Department of Entomology
University of California, Davis