7th Annual Strawberry Production Meeting
Camarillo, August 28, 2008

Mites, Lygus and Other Strawberry Arthropods

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Two spotted spider mite

Tetranychus urticae

Carmine spider mite

Tetranychus cinnabarinus

Spider mites

- Usually found on the undersides of leaves
- Immatures look like adults, but are smaller
- Female two-spotted spider mites diapause in colder areas and turn reddish (so they can be confused with *Phytoseiulus persimilis* and the carmine spider mite)
- Two-spotted mites do not diapause in most years in coastal areas, and can continue to lay eggs

Diapausing two spot female

Spider mites

Damage

- Yellow spots on upper leaf surfaces
- Red to purple leaves at high densities
- Webbing

Damage

- Yellow spots on upper leaf surfaces
- Red to purple leaves at high densities
- Webbing

By the time these symptoms are observed, yield loss has already occurred

Damage depends on

- Variety
- Plant vigor
    - Nursery fumigation
    - Chilling of day neutral varieties
    - Horticultural practices
    - Summer plantings (less susceptible)
- Irrigation (water stress)
- Production area
- Time of season

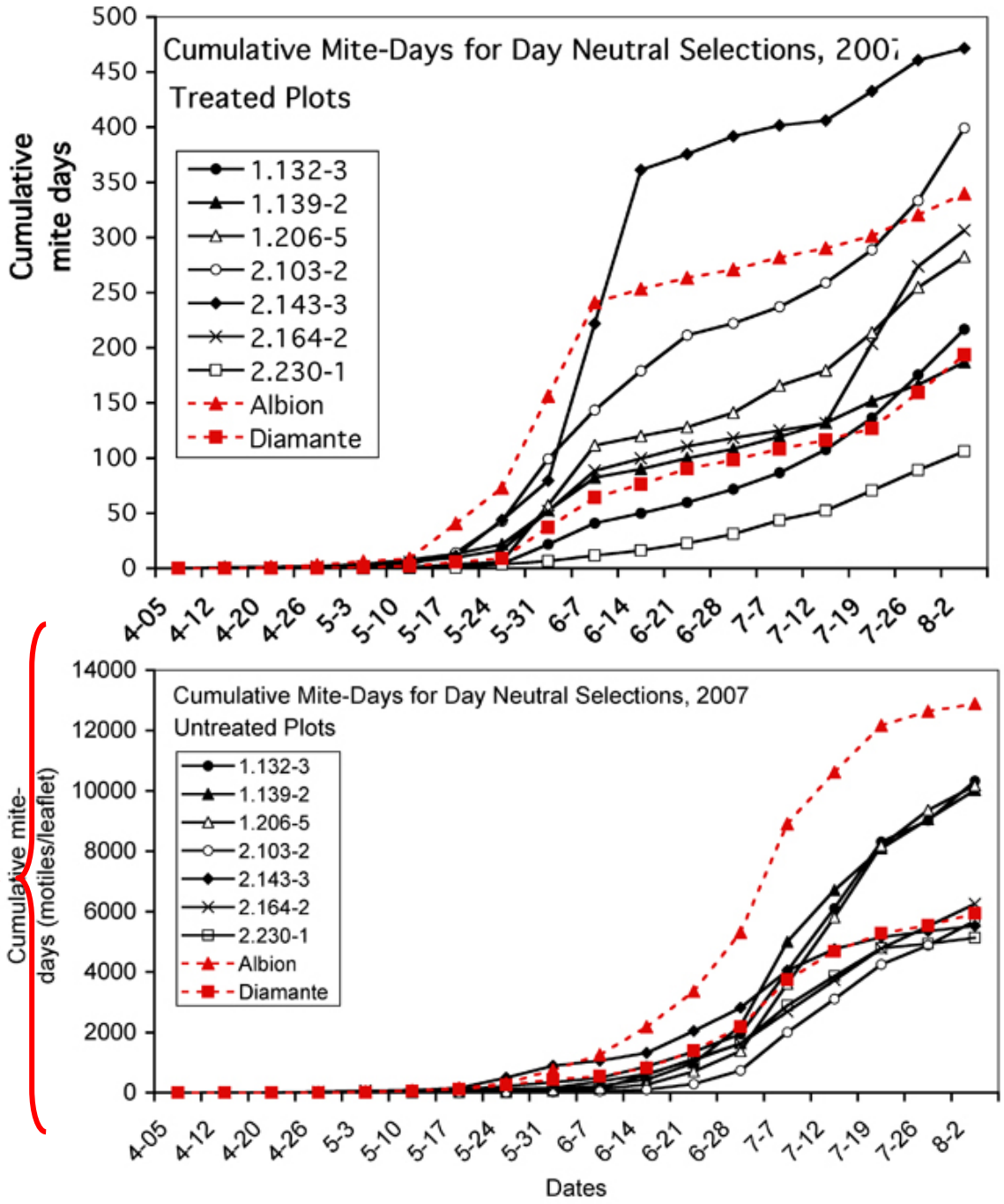

Varietal Susceptibility
Since 1989
with Dr. Doug Shaw


Selva

Varietal Mite Susceptibility, 2007

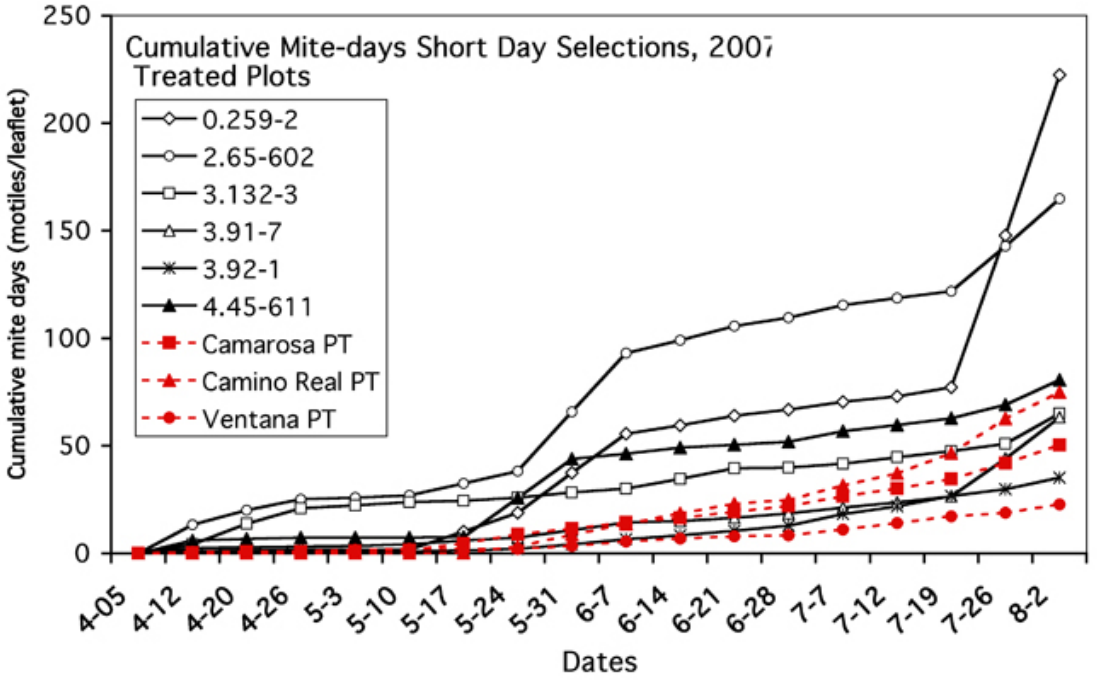
Day neutral selections

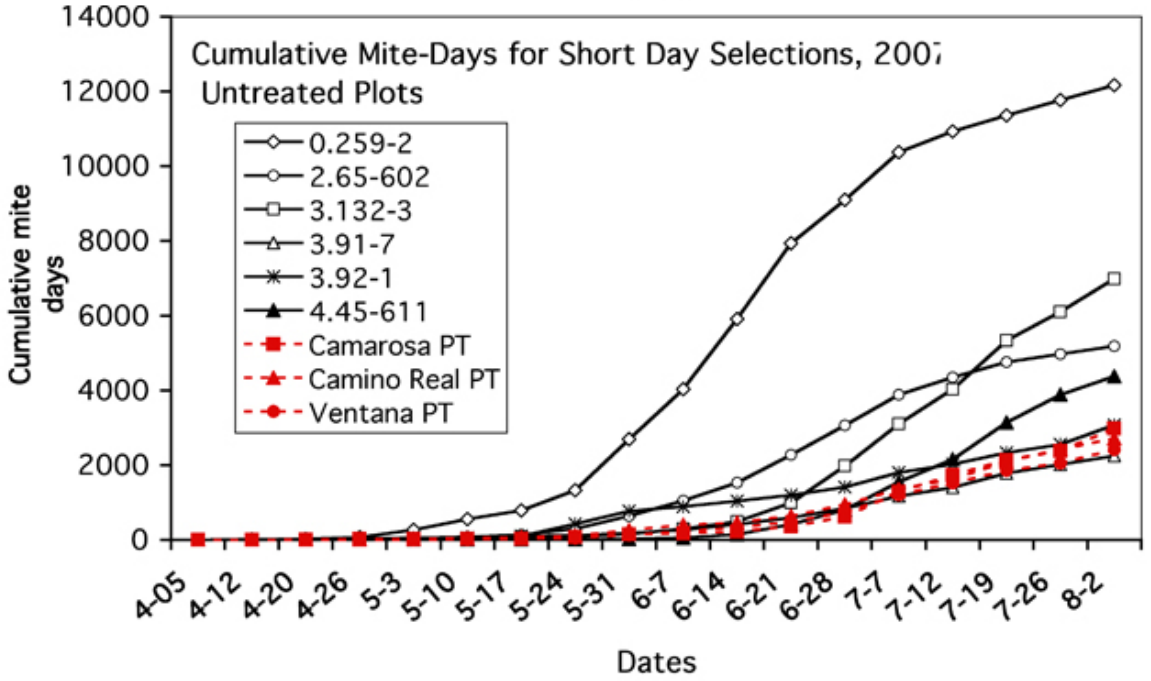
scale



Varietal Mite Susceptibility, 2007

Short day selections





Acaricides

Acaricide Classification

Product	Active Ingredient	Primary Target Site of Action	IRAC #
Kelthane	Dicofol	Unknown mode of action	Uncl.
Vendex	Fenbutatin oxide	Oxidative phosphorylation inhibitor	12B
Omite	Propargite	Oxidative phosphorylation inhibitor	12C
Agri-Mek	Abamectin	Chloride channel activator	6
Savey	Hexythiazox	Unknown mode of action (mite growth regulator)	10A
Zeal	Etoxazole	Unknown mode of action (mite growth regulator)	10B
Acramite	Bifenazate	Neuronal inhibitor (unknown mode of action)	25
Oberon	Spiromesifen	Inhibitor of lipid synthesis	23
Kanemite	Acequinocyl	Site III electron transport inhibitor	20B
Fujimite [1]	Fenpyroximate	Site I electron transport inhibitor	21
Ecotrol	Organic oils	Botanicals, exempt from tolerance	Uncl.
GC Mite	Organic oils & extracts	Botanicals, exempt from tolerance	Uncl.

[1] Not registered for use on strawberries

Two-spotted mite control, Watsonville, 2007

Trade name and rate	Mean±SD mites per leaflet [1], weeks post treatment				
	Week 1 6-14	Week 2 6-21	Week 3 6-28	Week 4 7-5	Week 5 7-12
Untreated	34.40±14.0	86.60±42.5	200.60 ± 184.7	200.00±124.2	90.60±29.7
Acramite WP; 1.0 lb	11.80±10.5	13.40±17.1*	12.13 ± 14.1*	14.17±20.4*	18.60±15.5*
Kanemite; 25.0 oz	11.40±8.9	23.40±5.8*	10.91 ± 9.3*	36.93±25.2*	24.60±26.2*
Kanemite; 31.0 oz	5.03±0.6	8.00±2.4*	7.42 ± 1.9*	34.73±27.0*	26.93±7.9*
Fujimite 5EC; 1.0 pt.[2]	9.97±9.4	11.87±7.5*	19.37 ± 14.3*	33.40±21.1*	45.80±35.7
Fujimite 5EC; 2.0 pt.[2]	8.87±8.9	4.13±6.3*	3.07 ± 3.7*	10.90±16.1*	15.07±9.0*
Agri-mek; 16.0 oz	20.50±23.4	17.07±14.3*	18.43 ± 17.7*	27.67±23.4*	44.13±60.1
Agri-mek; 16.0 oz + LI7000; 0.25% v/v	8.87±11.3	14.67±10.0*	5.00 ± 2.8*	8.90±6.2*	7.28±5.8*
Oberon; 16.0 oz	5.33±4.9	2.17±1.0*	0.47 ± 0.5*	3.20±2.4*	10.18±9.9*
Ecotrol; 4.0 pt + Natural wet; 32.0 oz	6.62±8.7	23.60±27.4*	47.40 ± 28.1*	67.00±75.7*	50.80±45.9

[1] Means followed by an asterisk (*) are significantly different from the untreated control by Student t tests at $p<0.05$

[2] Not registered for use on strawberries

Two-spotted mite control, Watsonville, 2008

Treatment	Active ingredient	Rate (form./acre)
Untreated Control	na	na
Oberon 2 SC	Spiromesifen	12.0 oz
Oberon 2 SC	Spiromesifen	16.0 oz
QRD 416	extract of *Chenopodium*	4 qts
Zoro + Latron	Abamectin + spreader sticker	16.0 oz + 0.25% v/v
Zoro + Latron	Abamectin + spreader sticker	32.0 oz + 0.25% v/v
Agri-mek + Latron	Abamectin + spreader sticker	16.0 oz + 0.25% v/v
Ecotrol EC	Rosemary Oil	8.0 oz
Acramite 50WS	Bifenezate	16 oz
+ Dyne-Amic	+ non-ionic emulsifiers	+ 0.5% v/v
Acramite 4L SC	Bifenezate	16 oz
+ Dyne-Amic	+ non-ionic emulsifiers	+ 0.5% v/v

Two-spotted mite control, Watsonville, 2008

Trade name and rate	Mean+SD mites per leaflet [1], weeks post treatment		
	Week 1	Week 2	Week 3
	6-4	6-9	6-18
Untreated	11.50 ± 5.7	12.00 ± 6.8	35.00 ± 17.6
Oberon; 12.0 oz	5.67 ± 4.3	5.03 ± 5.6	0.83 ± 0.2*
Oberon; 16.0 oz	6.00 ± 5.6	1.07 ± 0.7	0.90 ± 0.2*
QRD 416; 4 qts[4]	9.00 ± 1.0	14.00 ± 6.0	22.60 ± 11.5
Zoro + Latron; 16.0 oz + 0.25% v/v[2,3]	7.65 ± 3.6	25.20 ± 22.9	9.10 ± 11.7*
Zoro + Latron; 32.0 oz + 0.25% v/v	7.00 ± 1.2	8.77 ± 7.0	22.40 ± 15.9
Agri-mek + Latron; 16.0 oz + 0.25% v/v[2,3]	11.40 ± 3.0	9.30 ± 4.7	3.65 ± 3.3*
Ecotrol EC; 8.0 oz[3]	4.35 ± 1.2	14.40 ± 3.4	6.05 ± 3.3*
Acramite 50WS + Dyne-Amic; 16 oz + 0.5% v/v	7.00 ± 3.0	9.97 ± 8.6	4.87 ± 0.6*
Acramite 4L SC + Dyne-Amic; 16 oz + 0.5% v/v	2.50 ± 1.2	5.93 ± 4.3	4.40 ± 4.0*

[1] Means followed by an asterisk (*) are significantly different from the untreated control by Student t tests at $p<0.05$

[2] Second application applied two weeks post treatment

[3] n= 2, all others, n=3

[4] Not registered for use on strawberries

Two-spotted mite control, Watsonville, 2008

Trade name and rate	Mean+SD mites per leaflet [1], weeks post treatment		
	Week 4	Week 5	Week 6
	6-25	7-2	7-9
Untreated	41.80 ± 30.3	40.40 ± 16.6	84.00 ± 62.7
Oberon; 12.0 oz	2.07 ± 0.1	8.60 ± 5.8	13.40 ± 5.2
Oberon; 16.0 oz	1.33 ± 1.2	0.80 ± 0.4	2.97 ± 1.8
QRD 416; 4 qts[4]	58.60 ± 24.7	54.00 ± 43.7	102.00 ± 77.4
Zoro + Latron; 16.0 oz + 0.25% v/v[2,3]	33.60 ± 28.8	61.50 ± 75.1	59.10 ± 68.3
Zoro + Latron; 32.0 oz + 0.25% v/v	43.00 ± 44.9	31.20 ± 11.7	55.80 ± 24.2
Agri-mek + Latron; 16.0 oz + 0.25% v/v[2,3]	7.70 ± 3.5	9.10 ± 10.9	22.75 ± 28.9
Ecotrol EC; 8.0 oz[3]	15.30 ± 7.2	35.10 ± 4.7	41.10 ± 24.2
Acramite 50WS + Dyne-Amic; 16 oz + 0.5% v/v	15.20 ± 12.3	14.40 ± 3.6	19.20 ± 6.5
Acramite 4L SC + Dyne-Amic; 16 oz + 0.5% v/v	10.18 ± 8.9	5.33 ± 4.0	22.03 ± 19.2

[1] Means followed by an asterisk (*) are significantly different from the untreated control by Student t tests at $p<0.05$

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[4] Not registered for use on strawberries

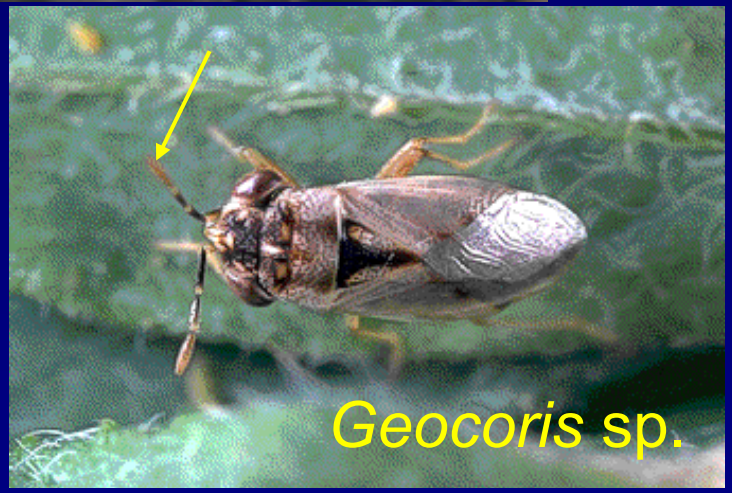
Lygus

Identification

Can be confused with other insects such as *Calocoris, Geocoris,* and other bugs


Calocoris sp.


False Chinch Bug


Geocoris sp.

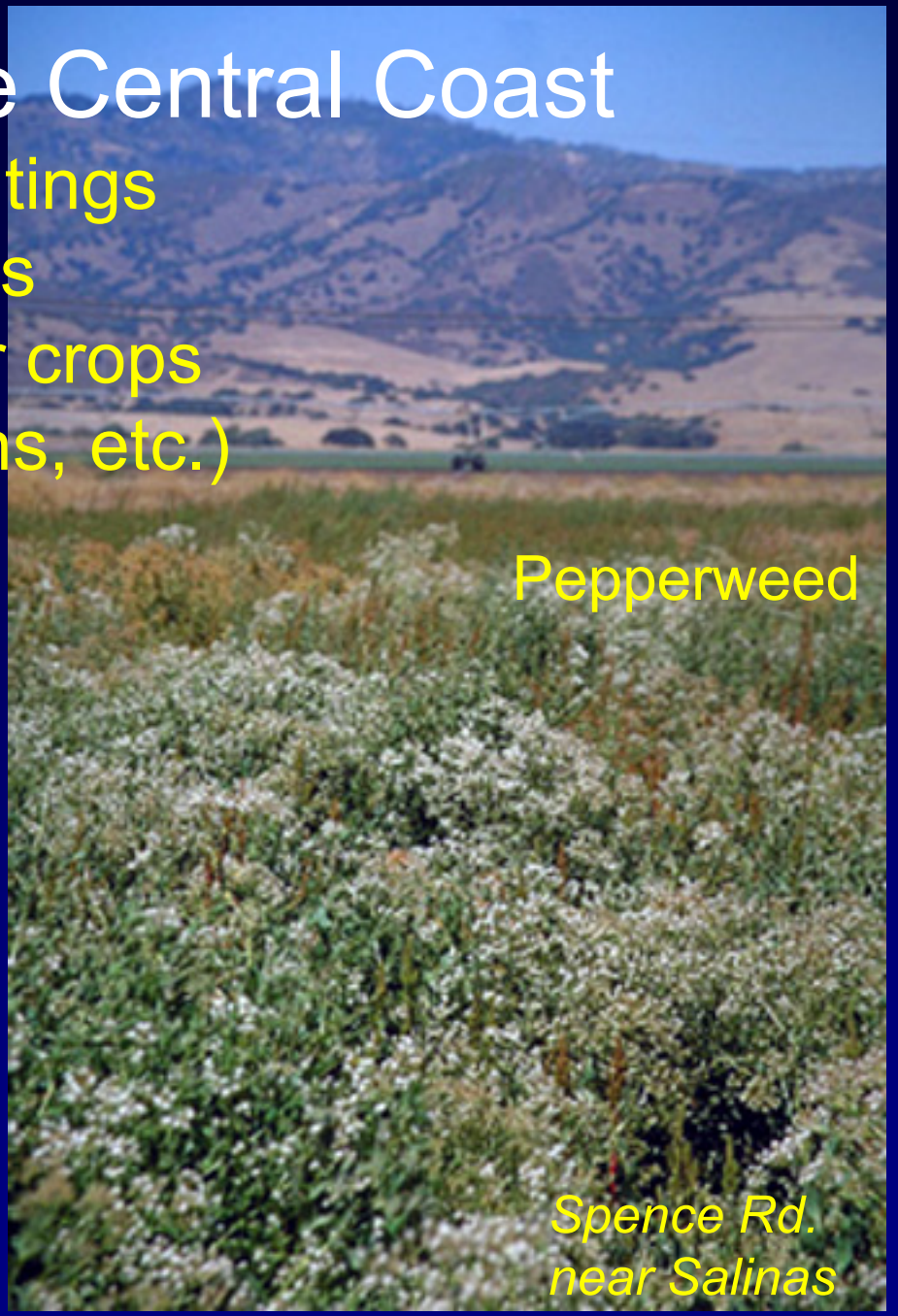
Lygus Sources on the Central Coast

Infested second year plantings

Weedy hosts around fields

Alternate crops and cover crops

(snow peas, fava beans, etc.)



Lygus Sources - Ventura Co.

Infested Summer plantings (for Fall plantings)

Infested Fall plantings (for Summer plantings)

Weedy hosts around fields

Alternate crops

Project initiated with Oleg Daugovish and Chris Martin in mid-June, 2008

Season-long monitoring of strawberry plantings, and adjacent weeds or potential host crops for Lygus age structure.

Lygus Sources - Ventura Co.

Monitoring for -

- Small nymphs
- Large nymphs
- Adults

What are bridge hosts for strawberries?
What are Lygus reproductive hosts?
Validation of degree-day model for Lygus.

Monitoring, Monitoring, Monitoring…..

Important to determine if and when (in terms of degree-days) to make a control action

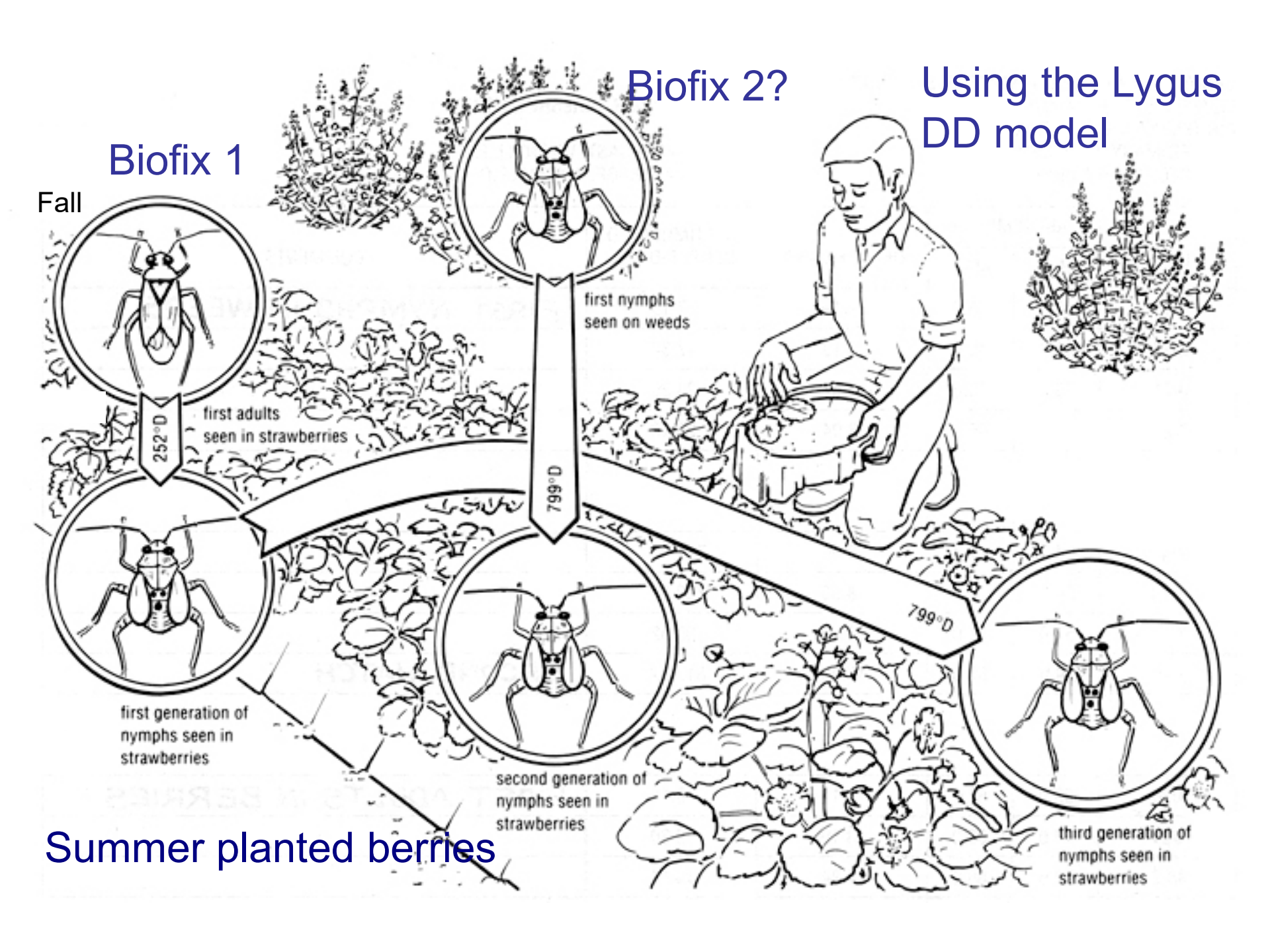
- Monitor weeds and other host crops to establish a biofix and for control of nymphs by destroying those hosts before adults emerge
- For Fall planted berries, monitor in early spring to determine when the first adults appear (to establish the second biofix)
- For Summer planted berries, start monitoring when flowering begins to establish a biofix
- Continue monitoring during the season.

Degree-day Accumulations (> 54°F) Required for Each Stage of Lygus Development

Developmental stage	DD (°F)	DD (°C)
Eggs:	252.0	140.0
Nymphs:	371.0	206.1
Egg to Adult:	623.0	346.1
Pre-Oviposition:	176.0	97.8
(Egg to Egg):	799.0	443.9

Lygus Phenology Model after *Sevacherian et al.*

URL - http://ipm.ucdavis.edu/WEATHER/ddretrieve.html

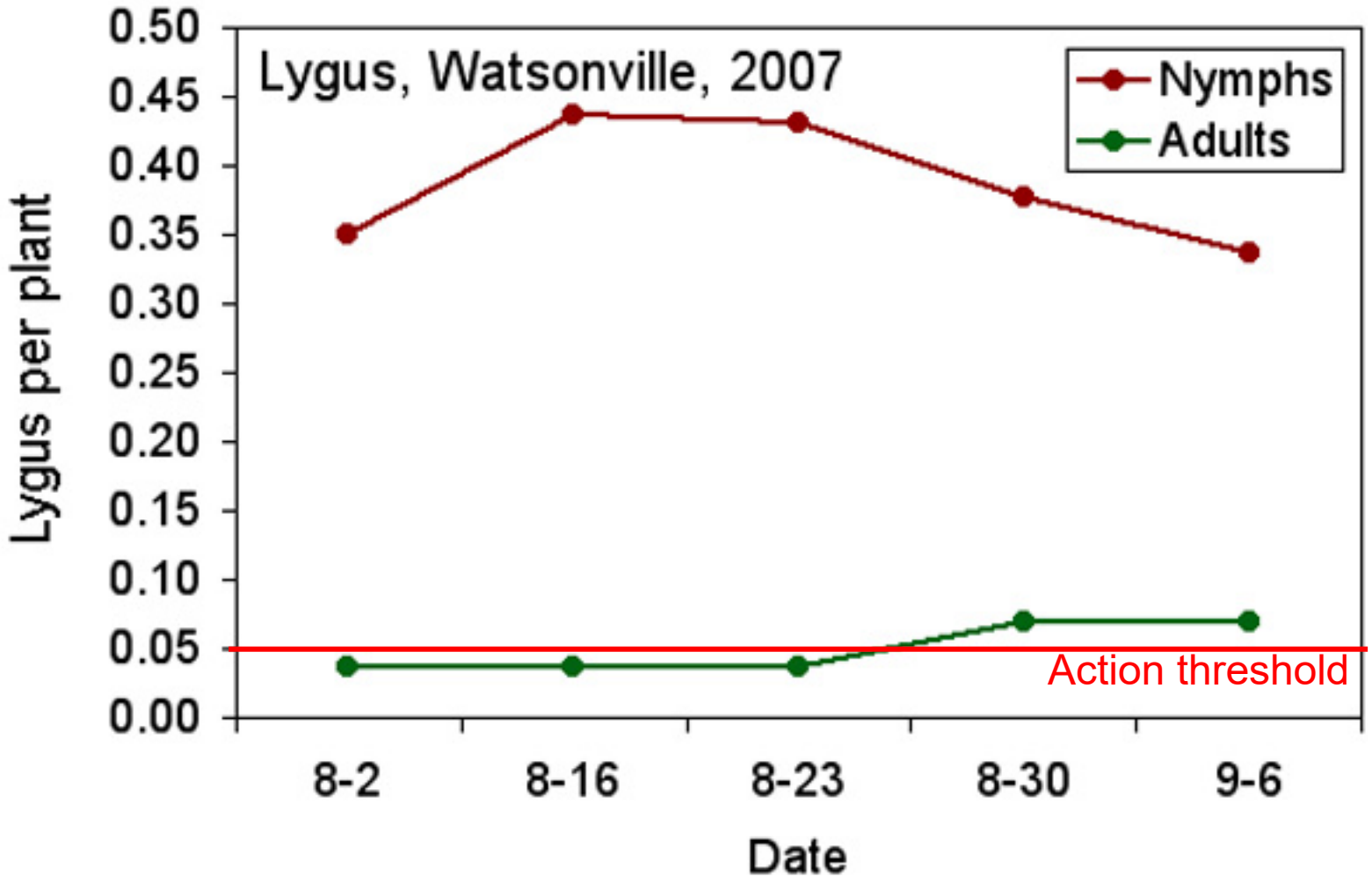

Biofix 2?
Using the Lygus DD model
Biofix 1
Fall
first nymphs seen on weeds
252°D
first adults seen in strawberries
799°D
799°D
first generation of nymphs seen in strawberries
second generation of nymphs seen in strawberries
third generation of nymphs seen in strawberries
Summer planted berries

Lygus Bug Control, Watsonville, 2007

Product	Chemical name	Rate per ac. (form)	Label
Untreated	--	--	--
Danitol	Fenpropathrin	10.67 oz	Yes
Assail-L + Dyneamic	Acetamiprid + Surfactant	5.0 oz + 0.25% v/v	No
Assail-H + Dyneamic	Acetamiprid + Surfactant	7.0 oz + 0.25% v/v	No
Assail-L + Danitol + Dyneamic	Acetamiprid + Fenpropathrin + Surfactant	5.0 oz + 10.67 oz + 0.25% v/v	No
Rimon	Novaluron	12.0 oz	No
Rimon (2 applications)	Novaluron	12.0 oz	No
Actara 25 WG	Thiamethoxam	4.0 oz	Yes
Actara 25 WG + Danitol	Thiamethoxam + Fenpropathrin	4.0 oz + 10.67 oz	Yes
Actara 25 WG + Dibrom	Thiamethoxam + Naled	4.0 oz + 1	Yes
Clothioanidan	Clothioanidan	2.0 oz	No
Beleaf 50% SG	Flonicamid	2.8 oz	No
Dibrom	Naled	1 pt	Yes

Not registered for use on strawberries
Application date - August 10, 2007
n=3 replicates
10 flowers/plot; washed through filter paper in ETOH, counted under dissecting microscope

Lygus Present in Untreated Plots, 2007



Lygus Bug Control, Watsonville - *adults*

Treatment	Mean ± SE adults per plant[1]				
	Pre 8-2-07	8/16/07	8/23/07	8/30/07	9/6/07
Untreated	0.06 ± 0.02	0.04 ± 0.01	0.04 ± 0.01	0.07 ± 0.01	0.06 ± 0.02
Danitol	0.05 ± 0.03	0.02 ± 0.01	0.03 ± 0.01	0.03 ± 0.01*	0.05 ± 0.03
Assail-L	0.06 ± 0.02	0.02 ± 0.02	0.00 ± 0.00	0.05 ± 0.02	0.06 ± 0.02
Assail-H	0.06 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01*	0.06 ± 0.01
Assail-L + Danitol	0.03 ± 0.02	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00*	0.03 ± 0.02
Rimon	0.03 ± 0.02	0.01 ± 0.01	0.03 ± 0.01	0.01 ± 0.01*	0.03 ± 0.02
Rimon (2 apps)	0.02 ± 0.01	0.03 ± 0.02	0.04 ± 0.01	0.00 ± 0.00*	0.02 ± 0.01
Actara	0.02 ± 0.01	0.04 ± 0.02	0.01 ± 0.01	0.04 ± 0.02	0.02 ± 0.01
Actara + Danitol	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.01 ± 0.01*	0.00 ± 0.00
Actara + Dibrom	0.03 ± 0.01	0.02 ± 0.02	0.02 ± 0.02	0.03 ± 0.01*	0.03 ± 0.01
Clothioanidan	0.04 ± 0.01	0.01 ± 0.01	0.03 ± 0.03	0.04 ± 0.01	0.04 ± 0.01
Beleaf	0.01 ± 0.01	0.00 ± 0.00	0.04 ± 0.02	0.00 ± 0.00*	0.01 ± 0.01
Dibrom	0.04 ± 0.03	0.03 ± 0.01	0.04 ± 0.02	0.03 ± 0.01*	0.04 ± 0.03

[1] Means followed by * are significantly different from untreated at p=0.05 when compared by Students t-test following Log(mean+0.1)*10 transformation.

ANOV statistics for each date:

8/16/07, df=12, 38, F=1.1109, P=0.3926
8/23/07, df=12, 38, F=1.2267, P=0.3177
8/30/07, df=12, 38, F=2.9658, P=0.0098
9/6/07, df=12, 38, F=1.591, P=0.1558

Not registered
Registered

Lygus Bug Control, Watsonville - *nymphs*

Treatment	Mean ± SE nymphs per plant[1]				
	Pre 8-2-07	8/16/07	8/23/07	8/30/07	9/6/07
Untreated	0.35 ± 0.04	0.43 ± 0.20	0.43 ± 0.06	0.38 ± 0.05	0.33 ± 0.02
Danitol	0.18 ± 0.06	0.07 ± 0.02	0.13 ± 0.04*	0.13 ± 0.03*	0.22 ± 0.03
Assail-L	0.26 ± 0.04	0.17 ± 0.04	0.23 ± 0.05	0.15 ± 0.04*	0.35 ± 0.23
Assail-H	0.21 ± 0.02	0.16 ± 0.11	0.21 ± 0.02*	0.27 ± 0.03	0.34 ± 0.09
Assail-L + Danitol	0.13 ± 0.03	0.18 ± 0.05	0.13 ± 0.03*	0.17 ± 0.02*	0.34 ± 0.13
Rimon	0.23 ± 0.04	0.10 ± 0.07	0.07 ± 0.03*	0.22 ± 0.05	0.27 ± 0.06
Rimon (2 apps)	0.24 ± 0.05	0.08 ± 0.00	0.18 ± 0.07*	0.21 ± 0.05*	0.41 ± 0.10
Actara	0.32 ± 0.09	0.13 ± 0.05	0.15 ± 0.01*	0.23 ± 0.03	0.23 ± 0.07
Actara + Danitol	0.17 ± 0.03	0.08 ± 0.01	0.08 ± 0.05*	0.07 ± 0.03*	0.13 ± 0.03
Actara + Dibrom	0.21 ± 0.02	0.17 ± 0.03	0.08 ± 0.03*	0.15 ± 0.03*	0.23 ± 0.02
Clothioanidan	0.21 ± 0.02	0.08 ± 0.02	0.11 ± 0.02*	0.14 ± 0.04*	0.20 ± 0.10
Beleaf	0.26 ± 0.03	0.09 ± 0.01	0.14 ± 0.03*	0.17 ± 0.07*	0.21 ± 0.07
Dibrom	0.29 ± 0.06	0.08 ± 0.02	0.18 ± 0.06*	0.17 ± 0.02*	0.23 ± 0.09

[1] Means followed by * are significantly different from untreated at p=0.05 when compared by Students t-test following Log(mean+0.1)*10 transformation.

ANOV statistics for each date:

8/16/07, df=12, 38, F=1.7839, P=0.1053
8/23/07, df=12, 38, F=3.4892, P=0.0037
8/30/07, df=12, 38, F=3.1341, P=0.0071
9/6/07, df=12, 38, F=0.7466, P=0.6956

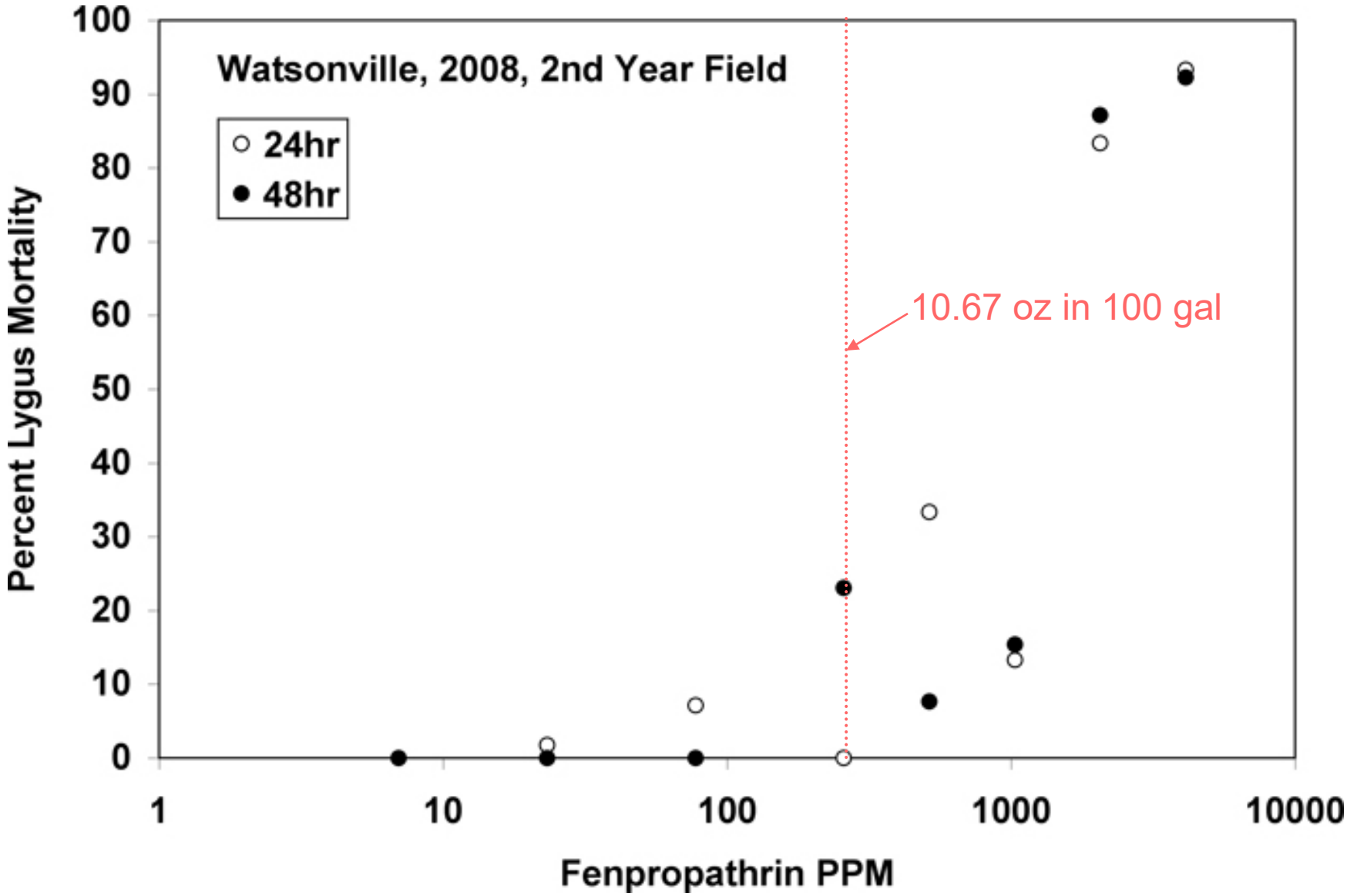
Not registered
Registered

Lygus Resistance

Field collect Lygus adults
Aspirate into tubes
Challenge with insecticide

Lygus tube bioassay

Lygus Resistance - Danitol



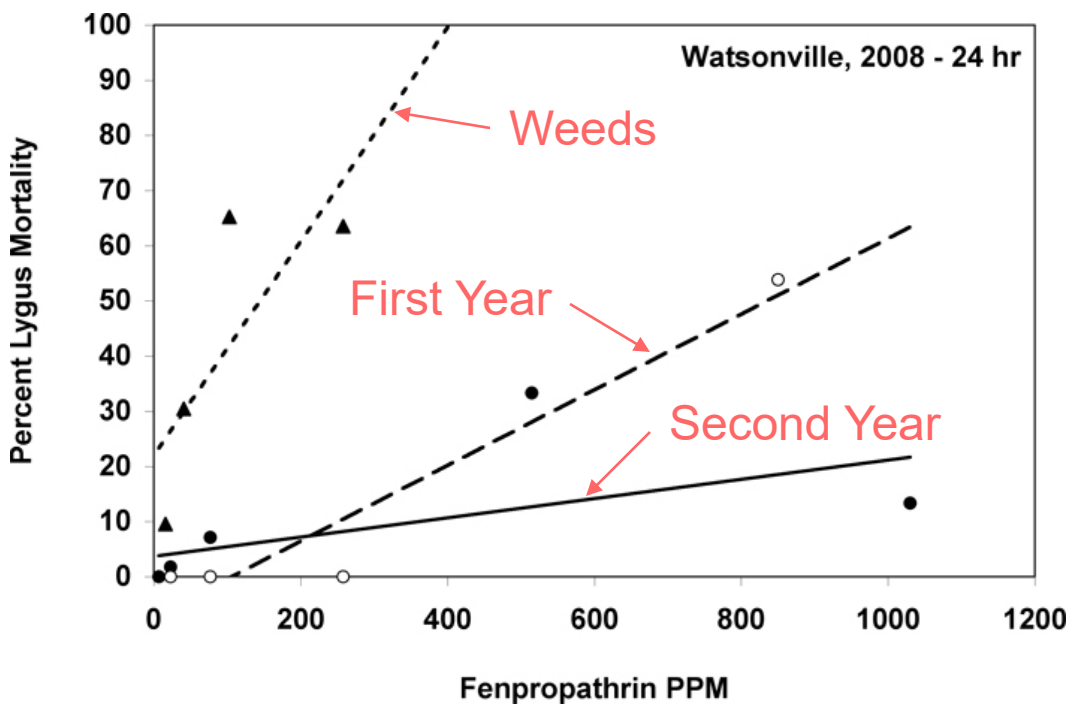
Lygus Resistance

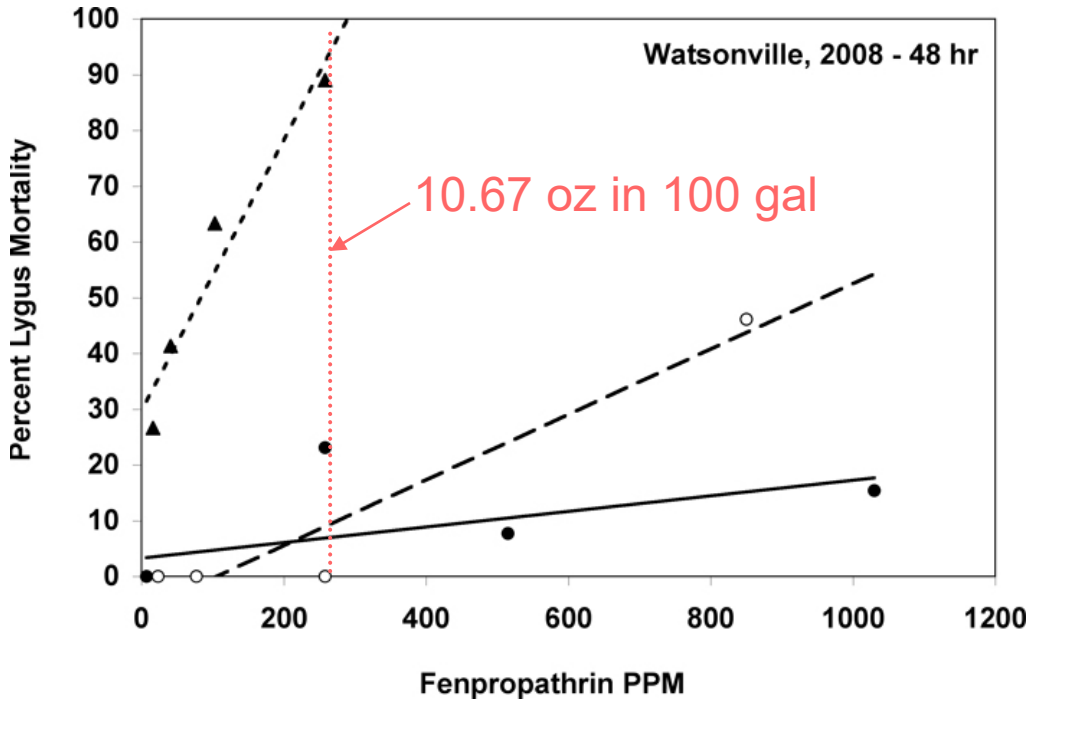
Danitol

July, 2008

Lygus collected from -

- Weeds
- First Year Field
- Second Year Field





Lygus Resistance

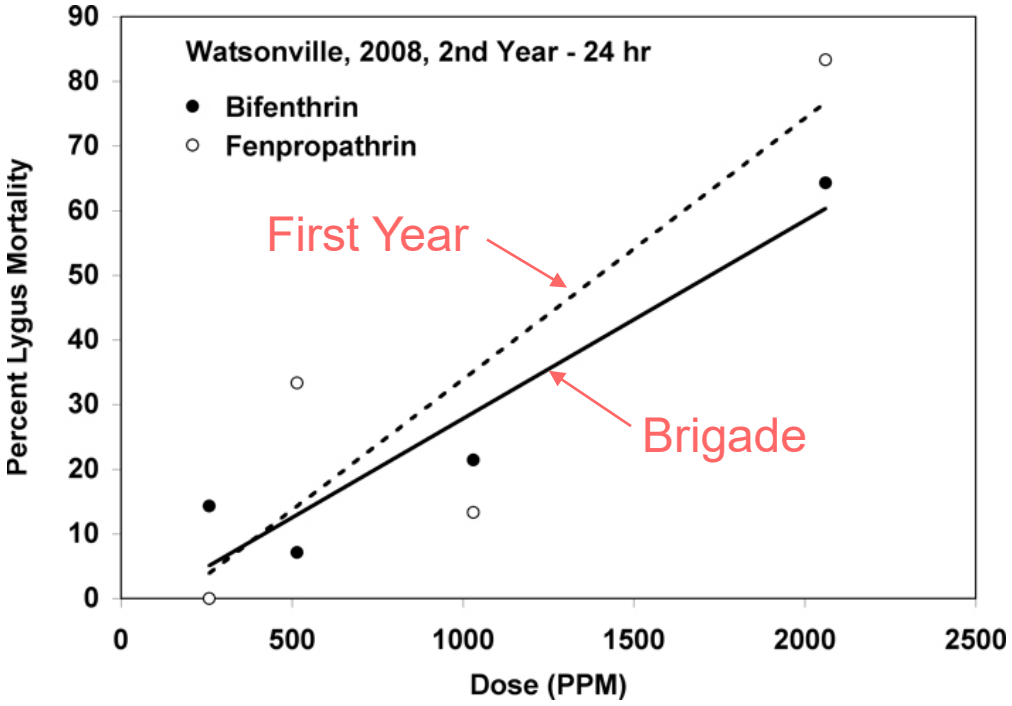
Danitol and Brigade

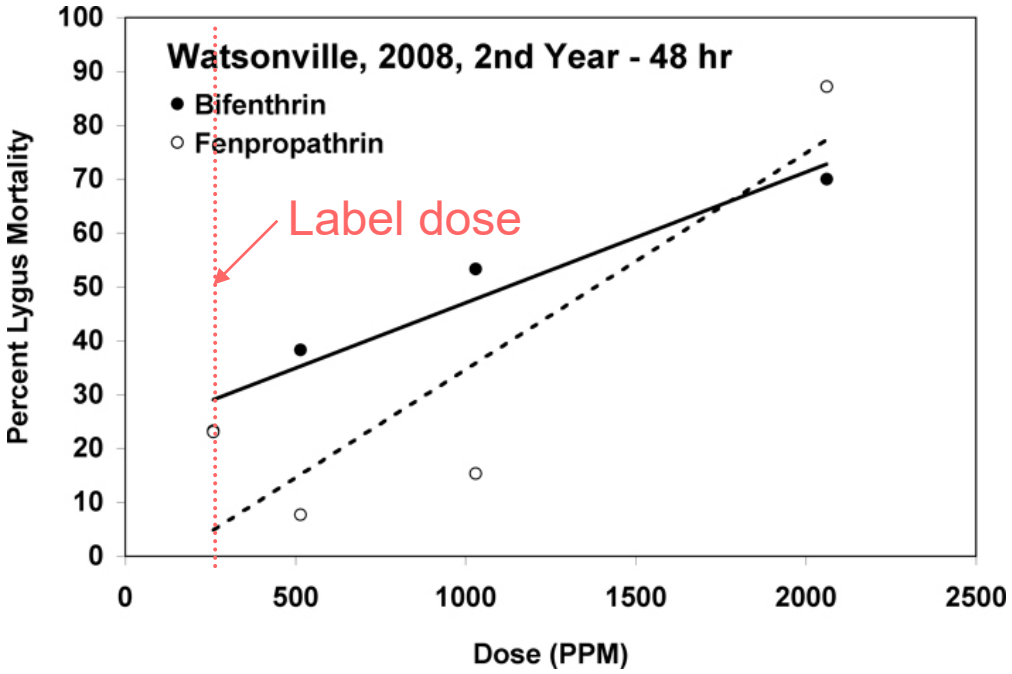
July, 2008

Label dose =

Danitol - 10.67 oz
Brigade - 32 oz

(Volume = 100 gal)





Corn Earworm

Helicoverpa zea

Corn Earworm Control, Orange County, 2007

Trade name	Chemical name	Rate form./acre
Untreated	--	--
Lannate	methomyl	1.0 lb
Intrepid	methoxyfenozide	12.0 oz
Rimon[1]	novaluron	12.0 oz
Synapse 24WG (NNI-0001)[1]	flubendiamide	2.0 oz
Synapse 24WG (NNI-0001)[1]	flubendiamide	3.0 oz
Radiant SG (GF-1587)	spinetoram	6.0 oz

[1] Not registered for use on strawberries

Application date 4/13/2007

Corn Earworm Control, Orange County, 2007

Treatment	Rate (form/A)	*H zea* damaged fruit per 20 plants
Untreated	--	12.75 ± 5.68
Lannate	1.0 lb	3.67 ± 0.58*
Intrepid	12.0 fl oz	4.67 ± 3.06*
Rimon[1]	12.0 fl oz	3.00 ± 1.41*
Synapse 24WG (NNI-0001)[1]	2.0 oz	3.00 ± 2.65*
Synapse 24WG (NNI-0001)[1]	3.0 oz	4.33 ± 1.53*
Radiant SG (GF-1587)	6.0 fl oz	4.00 ± 2.65*

[1] Not registered for use on strawberries
Application date 4/13/2007
Harvest date 5/2/2007
ANOV statistics - F=4.0938, df=6,20, P=0.0140

Label rate = 6 to 10 oz.

Corn Earworm Control, Orange County, 2008

Trade name	Chemical name	Rate form./acre
Untreated	--	--
Altacor[1]	DPX-E2Y45	3.0 oz
Altacor[1]	DPX-E2Y45	6.0 oz
Rimon[1]	novaluron	12.0 oz
Intrepid	methoxyfenozide	10.0 oz
Synapse 24WG (NNI-0001)[1]	flubendiamide	2.0 oz
Synapse 24WG (NNI-0001)[1]	flubendiamide	3.0 oz
Radiant SG (GF-1587)	spinetoram	8.0 oz

[1] Not registered for use on strawberries

Application date 4/11/2008

Corn Earworm Control, Orange County, 2008

Treatment	Rate (form/A)	*H zea* damaged fruit per 20 plants
Untreated		3.31 ± 0.69
Altacor[1]	3.0 oz	1.08 ± 0.21*
Altacor[1]	6.0 oz	1.28 ± 0.39*
Rimon[1]	12.0 fl oz	1.72 ± 0.35*
Intrepid	10.0 fl oz	1.90 ± 0.23*
Synapse 24WG[1]	2.0 oz	1.60 ± 0.58*
Synapse 24WG[1]	3.0 oz	1.23 ± 0.64*
Radiant SG	8.0 fl oz	1.90 ± 0.47*

[1] Not registered for use on strawberries
Application date 4/11/2008
Data Collected 4/22/2008
ANOV statistics - F=6.4435, df=7,23 P=0.001

7th Annual Strawberry Production Meeting
Camarillo, August 28, 2008

Mites, Lygus and Other Strawberry Arthropods

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