Organic Processing Tomato Production Meeting
Woodland, CA February 16, 2007

Potato Aphid and Stink Bug Management

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Potato aphid

Macrosiphum euphorbiae

Varietal resistance - Mi gene
OMRI approved pesticides
and adjuvants

Organic insecticide efficacy - potato aphids:

First trial - Do adjuvants improve efficacy of organically acceptable products?

- Completely randomized design.
- 4 replicates of all treatments.
- 50 gpa (1st spray), 100 gpa (2nd spray); buffered to pH 5.0
- Pretreatment sample on July 7, 2005.
- Treatments applied on July 8 and 15.
- Potato aphids sampled at 3, 10 and 17 days after first application by proportion infested leaves per plot.
- Data analyzed by 1 way ANOV following arcsine transformation, and compared by paired t-tests.

What are they?

Insecticide	Active ingredient
Agroneem	Azadirachtin
Neemix	Azadirachtin
Pyganic	Pyrethrin
Ecotrol	Rosemary oil and Peppermint oil
GC-Mite	Cottonseed oil, Clove oil and Garlic extract

What are they?

Adjuvant	Active ingredient	Adjuvant type
Organocide	Sesame oil	sticker / extender / synergist
Trilogy	Neem oil	sticker / extender
Natural Plant Wash	Potassium soap	spreader / penetrant
A-plus	Vegetable oil	sticker / extender
Biolink spreader sticker	alkylphenol ethoxylate, polysaccharide	spreader / sticker / extender
Green Cypress Spreader	Jojoba oil	sticker / extender
Biolink Surfactant Penetrant	Yucca and Garlic extracts	penetrant/ spreader sticker

Mean (± SD) proportion potato aphid infested leaves, 2005.

			% Leaves infested with potato aphids							
			Pre-treat		Post treat 1		Post treat 2			
	Rate		7/5		7/11		7/18		7/25	
Insecticide	Prod/ac	Adjuvant	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Untreated	na	na	38.8	3.8	40.0	5.4	61.3	4.3	36.3	5.2
Warrior (1)	3.84 oz		30.0	4.1	13.8	7.7	6.3	4.7 *	5.0	2.9 *
Warrior (2)	3.84 oz				45.0	7.9	6.3	2.4 *	1.3	1.3 *
		Organocide	30.0	4.5	35.0	2.9	40.0	7.4 *	28.8	11.3
		Trilogy	35.0	3.5	42.5	9.7	48.8	3.8	22.5	6.0
		Natural Plant Wash	28.8	2.4	22.5	3.2	36.3	3.8 *	22.5	7.5
Agroneem	64 oz		27.5	6.6	47.5	10.3	42.5	8.5 *	13.8	5.2 *
Agroneem	64 oz	A-plus	36.3	7.2	32.5	9.2	32.5	1.4 *	18.8	5.2 *
Agroneem	64 oz	Natural Plant Wash	37.5	4.3	33.8	7.7	27.5	2.5 *	21.3	3.2
Agroneem	64 oz	Biolink spreader sticker	42.5	3.2	31.3	4.3	33.8	2.4 *	25.0	2.0
Neemix	7 oz		33.8	3.2	31.3	7.5	38.8	6.6 *	21.3	5.5
Neemix	7 oz	Trilogy	28.8	3.8	23.8	7.5	30.0	7.1 *	11.3	3.2 *
Neemix	7 oz	Natural Plant Wash	32.5	2.5	52.5	13.6	33.8	5.5 *	23.8	6.6
Neemix	7 oz	Biolink spreader sticker	35.0	3.5	33.8	10.9	32.5	7.5 *	21.3	8.0
Pyganic 5.0	13.5 oz		25.0	2.0	32.5	6.3	33.8	5.5 *	26.3	3.2
Pyganic 5.0	13.5 oz	Organocide	35.0	4.1	32.5	5.2	28.8	2.4 *	11.3	6.6 *
Pyganic 5.0	13.5 oz	Natural Plant Wash	32.5	4.3	32.5	4.3	27.5	9.7 *	17.5	3.2 *
Pyganic 5.0	13.5 oz	Biolink spreader sticker	28.8	1.2	41.3	18.9	23.8	5.5 *	26.3	8.8
Ecotrol EC	1% v/v		33.8	2.4	35.0	2.0	52.5	3.2	36.3	7.7
Ecotrol EC	1% v/v	Green Cypress Spreader	33.8	3.8	27.5	4.3	20.0	6.1 *	12.5	6.0 *
Ecotrol EC	1% v/v	Natural Plant Wash	31.3	2.4	33.8	5.9	31.3	6.3 *	25.0	11.4
Ecotrol EC	1% v/v	Biolink spreader sticker	30.0	2.0	33.8	9.0	26.3	6.6 *	16.3	2.5 *

Treatment Comparisons

Agroneem vs. Agroneem + Adjuvant	df	7/18 T=	7/18 P=	7/25 T=	7/25 P=
Oil (A-plus)	6	0.687	0.2880	-1.107	0.5176
Potassium Soap (Natural Plant Wash)	6	-1.657	0.1487	1.238	0.2621
Spreader Sticker (Biolink Spreader/Sticker)	6	-1.007	0.3526	2.032	0.0884

Neemix vs. Neemix + Adjuvant	df	7/18 T=	7/18 P=	7/25 T=	7/25 P=
Oil (Trilogy)	6	-0.923	0.3915	-1.567	0.1682
Potassium Soap (Natural Plant Wash)	6	-0.597	0.7781	0.295	0.5723
Spreader Sticker (Biolink Spreader/Sticker)	6	-0.622	0.5567	0.011	0.9917

Pyganic vs. Pyganic +Adjuvant	df	7/18 T=	7/18 P=	7/25 T=	7/25 P=
Oil (Organocide)	6	-0.847	0.4293	-2.046	0.0868
Potassium Soap (Natural Plant Wash)	6	-0.517	0.6235	-1.937	0.1009
Spreader Sticker (Biolink Spreader/Sticker)	6	-1.283	0.2468	0.035	0.9731

Ecotrol vs. Ecotrol +Adjuvant	df	7/18 T=	7/18 P=	7/25 T=	7/25 P=
Oil (Organic Spreader)	6	-4.78	**0.0031**	-2.44	**0.0505**
Potassium Soap (Natural Plant Wash)	6	-3.083	**0.0216**	-0.788	0.4605
Spreader Sticker (Biolink Spreader/Sticker)	6	-3.613	**0.0112**	-2.464	**0.0489**

Organic insecticide efficacy - potato aphids:

Second trial - Will increased volume improve efficacy?

- Pretreatment sample - count all aphids on moderately infested leaves *in situ*
- Tag individual leaves
- Apply treatments to runoff - complete coverage
- Completely randomized design
- 4 replicates of all treatments
- Recount number of live aphids on tagged leaves at 3 days after first application
- Data analyzed by 1 way ANOV following arcsine transformation, and compared by paired t-tests.

Mean (± SE) % potato aphid mortality at 3 DAT. (Individual leaves sprayed to runoff)

Insecticide	Rate Prod /ac	Adjuvant	Rate Prod /ac	% Mortality Mean ± SE	
Untreated				23.24 ± 8.41	
Warrior	3.84 oz			100.00 ± 0.00	*
		Organocide	0.78%	54.41 ± 13.62	
		Trilogy	1%	39.92 ± 14.06	
		Natural Plant Wash	1%	40.50 ± 22.52	
Agroneem	64 oz			44.34 ± 14.76	
Agroneem	64 oz	A-plus	0.13%	58.82 ± 9.21	
Agroneem	64 oz	Natural Plant Wash	1%	77.08 ± 10.42	*
Agroneem	64 oz	Biolink spreader sticker	0.05%	60.35 ± 10.95	
Neemix	7 oz			32.61 ± 22.96	
Neemix	7 oz	Trilogy	1%	57.75 ± 14.09	
Neemix	7 oz	Natural Plant Wash	1%	72.49 ± 12.23	*
Neemix	7 oz	Biolink spreader sticker	0.05%	32.51 ± 13.98	
Pyganic	13.5 oz			88.40 ± 1.74	*
Pyganic	13.5 oz	Organocide	0.78%	92.71 ± 4.30	*
Pyganic	13.5 oz	Natural Plant Wash	1%	81.49 ± 14.64	*
Pyganic	13.5 oz	Biolink spreader sticker	0.05%	100.00 ± 0.00	*
Pyganic	13.5 oz	Biolink surfactant & penetrant	0.5%	79.12 ± 18.07	*
Ecotrol EC	1% v/v			35.97 ± 8.67	
Ecotrol EC	1% v/v	Green Cypress Organic Spreader	0.13%	48.44 ± 10.33	
Ecotrol EC	1% v/v	Natural Plant Wash	1%	87.50 ± 9.47	*
Ecotrol EC	1% v/v	Biolink spreader sticker	0.05%	29.16 ± 2.37	
Ecotrol EC	1% v/v	Biolink surfactant & penetrant	0.5%	73.71 ± 8.40	*
GC-Mite	1% v/v			82.08 ± 11.25	*
GC-Mite	1% v/v	Biolink spreader sticker	0.05%	81.41 ± 3.97	*
	2% v/v	Natural Plant Wash (2X rate)		81.82 ± 11.88	*

Stink bugs


Redshouldered Stink Bug


Consperse Stink Bug
nymph
adult


Says Stink Bug
nymph
adult

Stink Bug Damage

- Stink bugs feed directly on tomato fruit
- Cosmetic damage for fresh market
- Damaged fruit unsuitable for whole peeled or chopped
- Vector a yeast which can can cause post harvest rot

Stink Bug Seasonal Movement

Emerging population reproduces on mustard, wild radish and cheeseweed

First generation moves into tomatoes

After harvest, stink bugs move to blackberry and under tree bark in riparian areas to overwinter

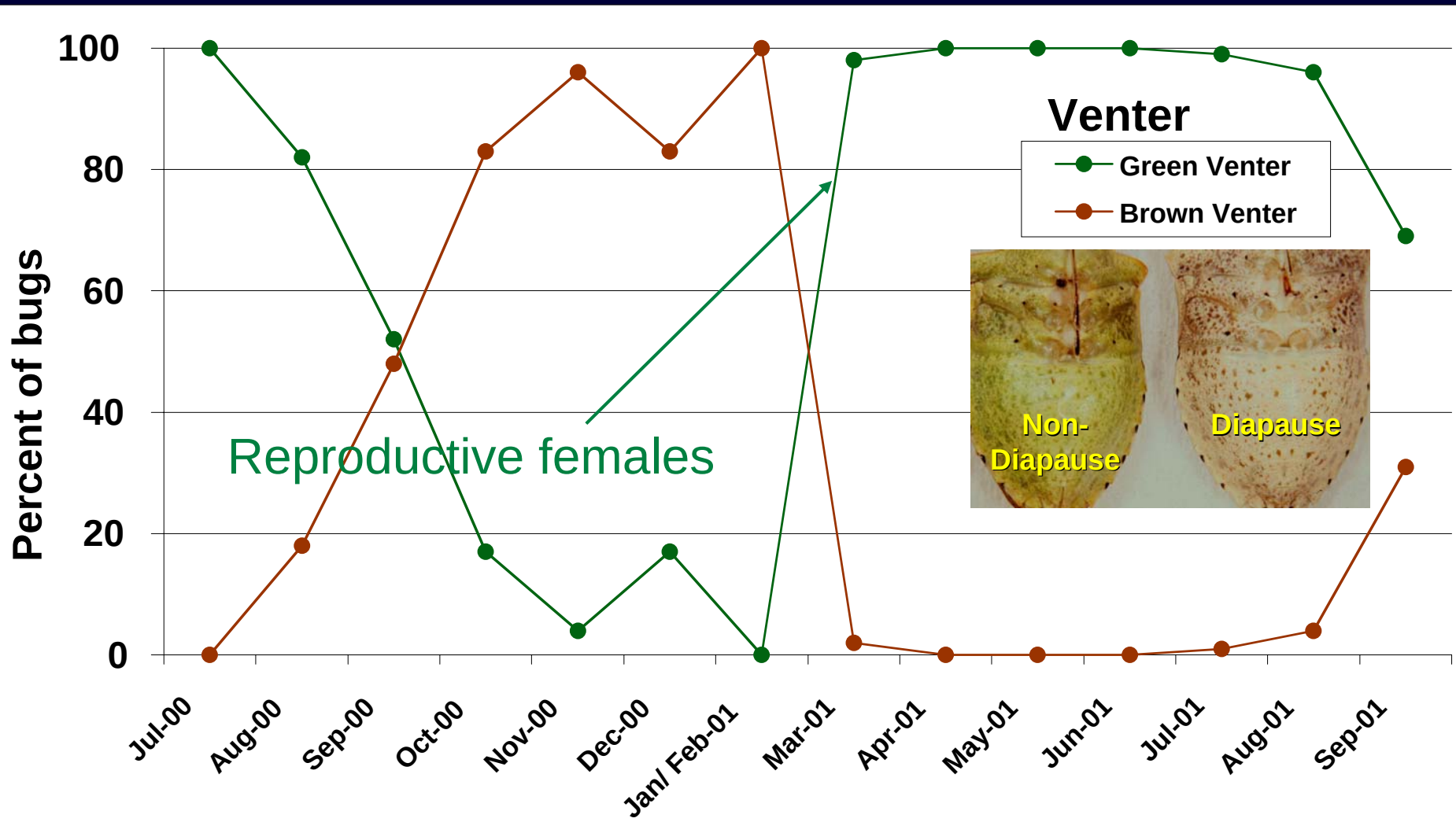
Habitat survey/ relative abundance of stink bugs, 2000-01

Month	Habitat list	Reproductive		Diapause		5th nym	Total bugs
		F	M	F	M		
July	Tomatoes	53	7			S	60
August	Tomatoes	93	39	26	3	S	161
September	Tomatoes, Hedgerow, Elderberry, Sugarbeet	28	5	19	12	S	64
October	Hedgerow, Elderberry, Sugarbeet	5		14	11		30
November	Sugarbeet, Leaf litter	1		21	8		30
December	Blackberry, Mallow, Leaf litter	7		23	10		40
Jan.-Feb.	Blackberry, Mallow, Leaf litter			15	15		30
March	Mustard, Wild radish, Russian thistle, Mallow	38	11		1		50
April	Mustard , Wild radish, Russian thistle, Mallow	25	15				40
May	Wheat, Alfalfa, Mustard, Wild radish, Mallow, Mullein	20	13			13	46
June	Tomatoes	30	12				42
July	Tomatoes	38	44	1		S	83
August	Tomatoes	75	14	1	3	S	93
September	Tomatoes	31	9	12	6	S	58

S= stink bugs collected in shake samples in tomatoes.

Total bugs = 70% females, 28% males and 2% 5th instar nymphs

Venter color corresponds to reproductive status



Stink Bug Control on Organic Farms

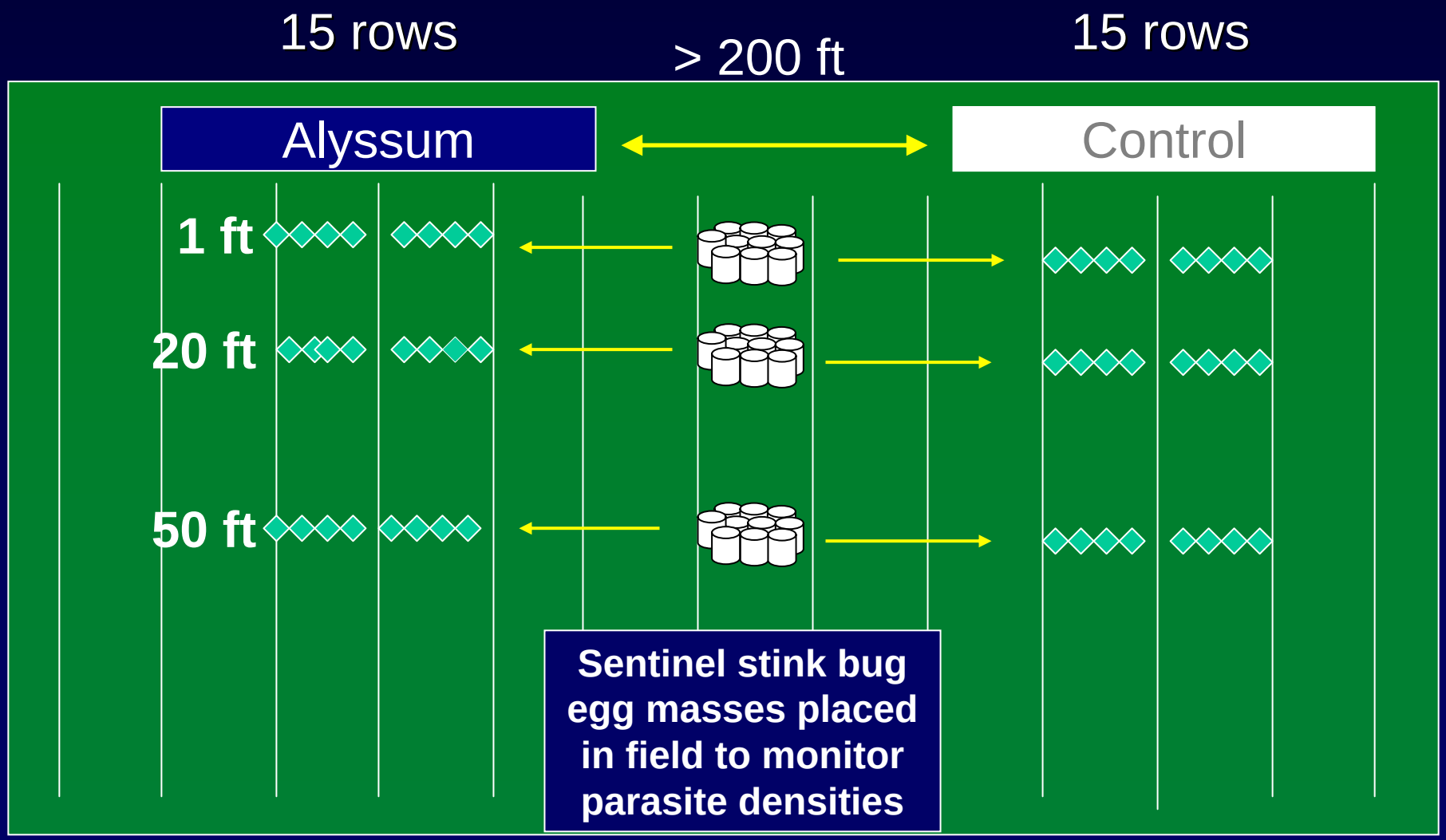
- Conservation of Natural Enemies with Insectary Plants
- Pest Habitat Management - border weed control
- OMRI approved insecticides

Companion Planting
Sweet Alyssum

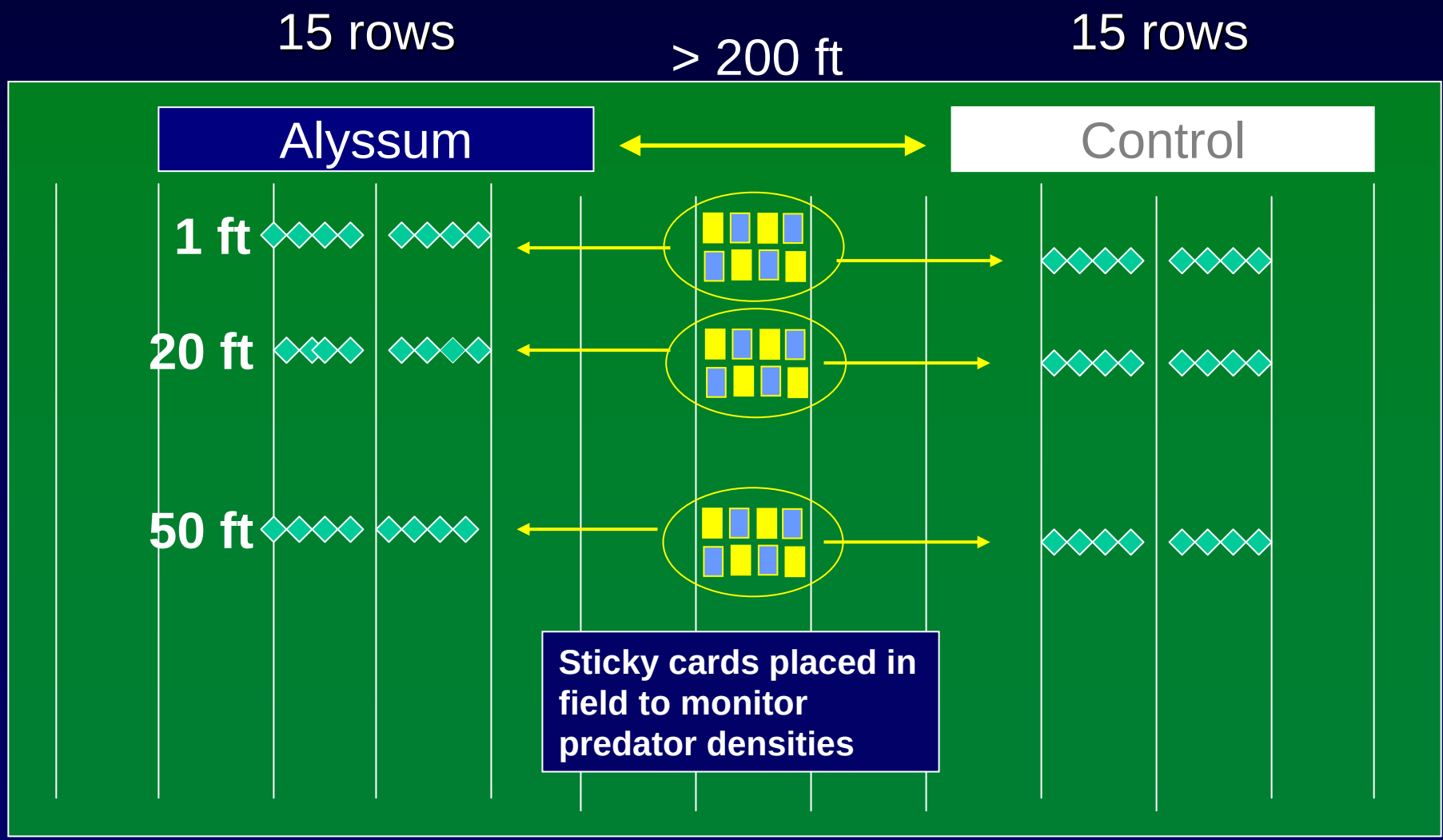
- Assess the ability of sweet alyssum to enhance egg parasitism of stink bugs
- Three field sites on organic farms
- One border (15 rows) sweet alyssum
- One border (15 rows) bare ground
- Monitored with sentinel egg masses and sticky cards

Companion Plantings:

Experimental Design
Parasitoid Monitoring

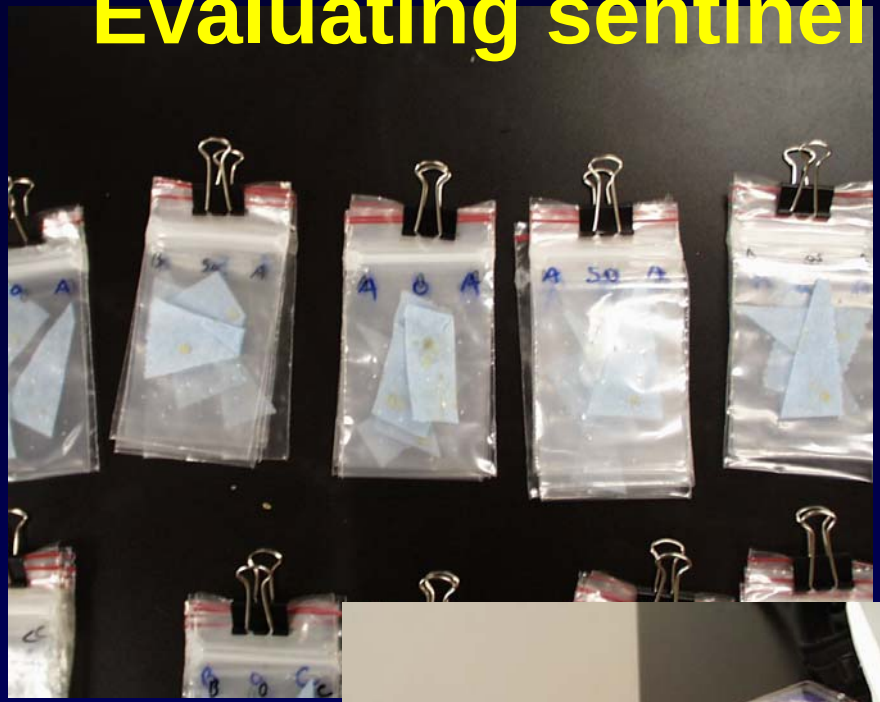


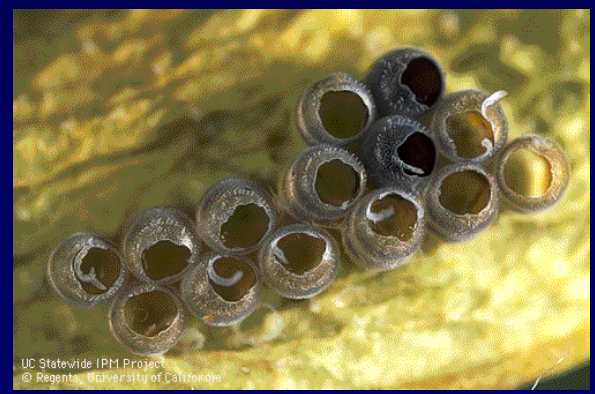
Experimental Design
Predator Monitoring



Stink bug colonies - sources of sentinel egg masses

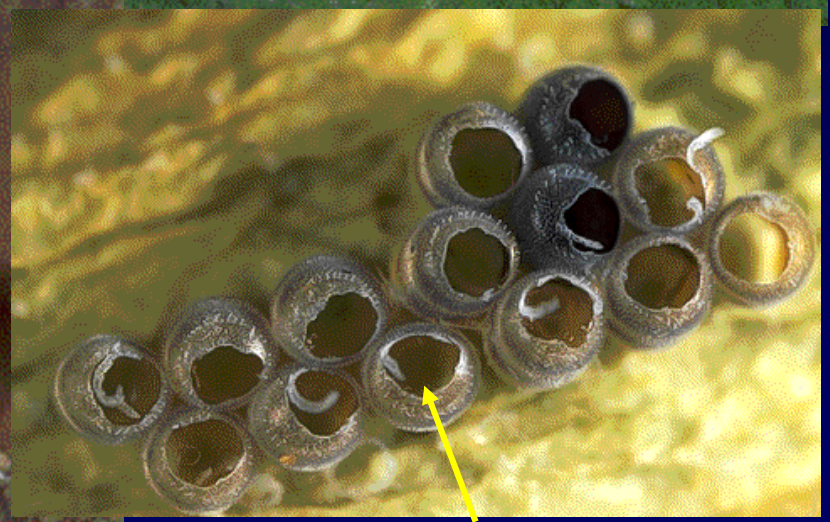
Evaluating sentinel egg masses





Parasitized eggs

Stink bug egg parasitIsm



Parasitoids emerged from these eggs

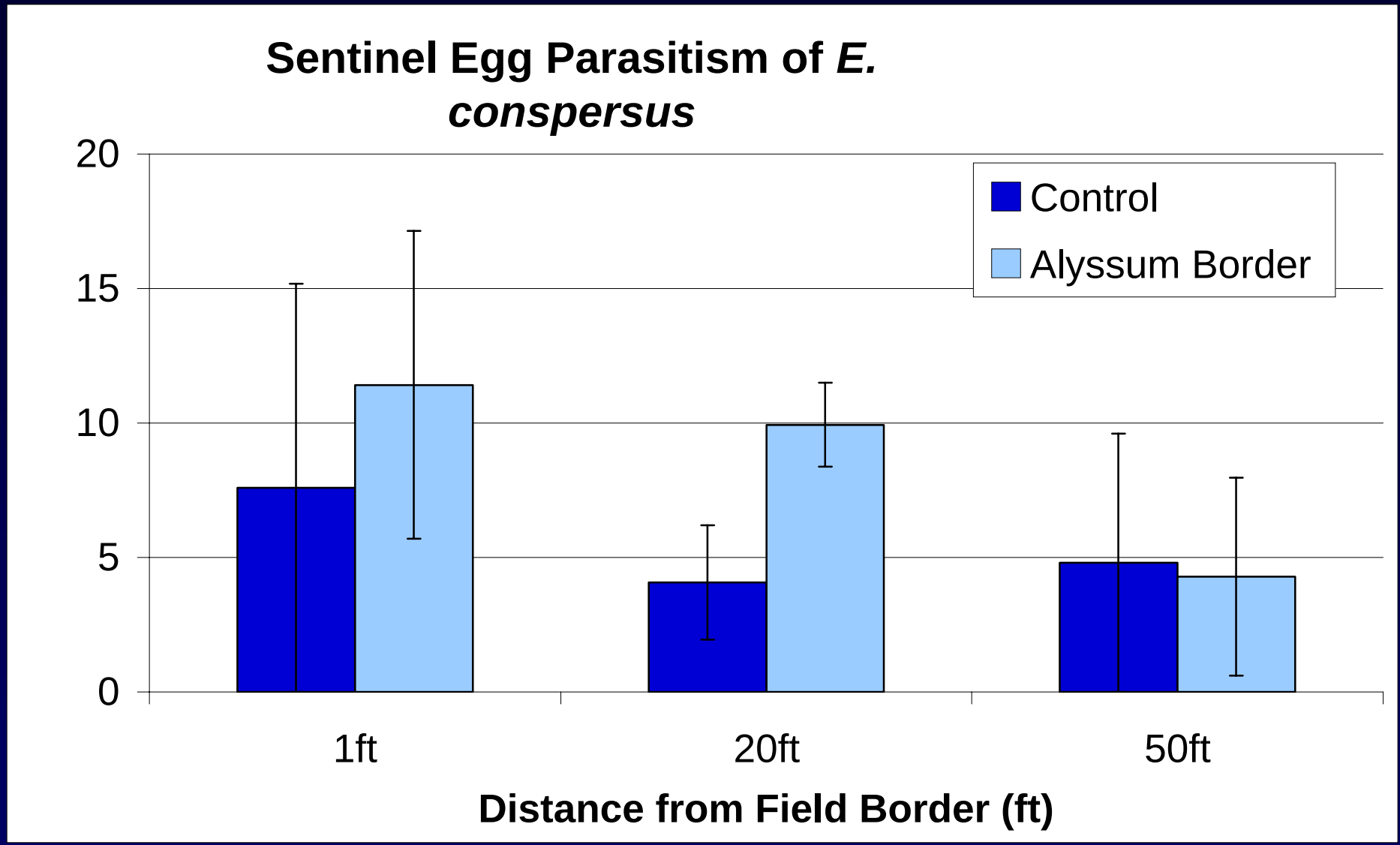
Egg Parasitoids Recovered from Sentinal Egg Masses

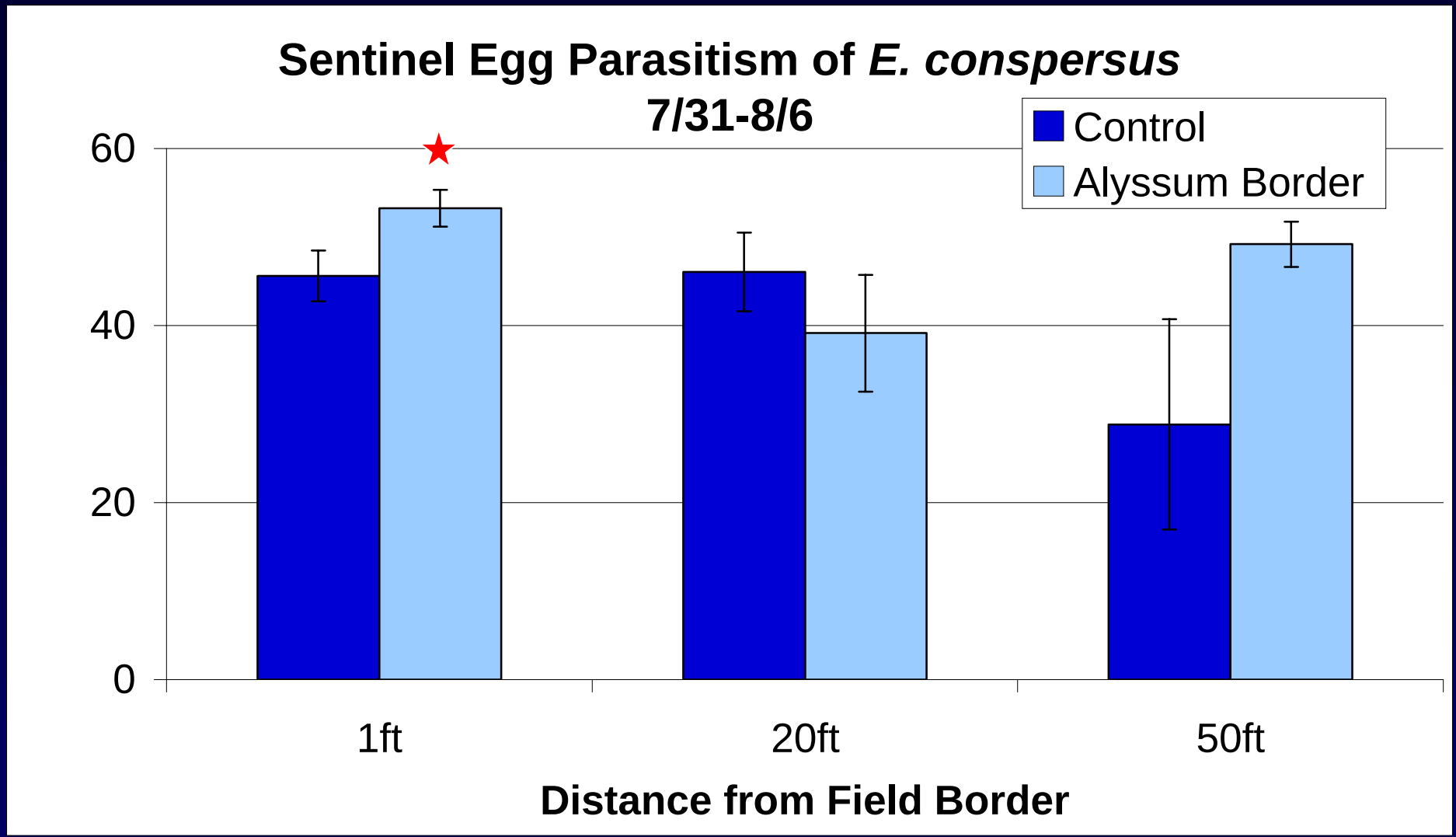
Scelionidae

- *Gryon obesum* (52%)
- *Trissolcus hullensis* (25%)
- *Trissolcus utahensis* (13%)
- *Trissolcus euschsti* (8%)

Encyrtidae

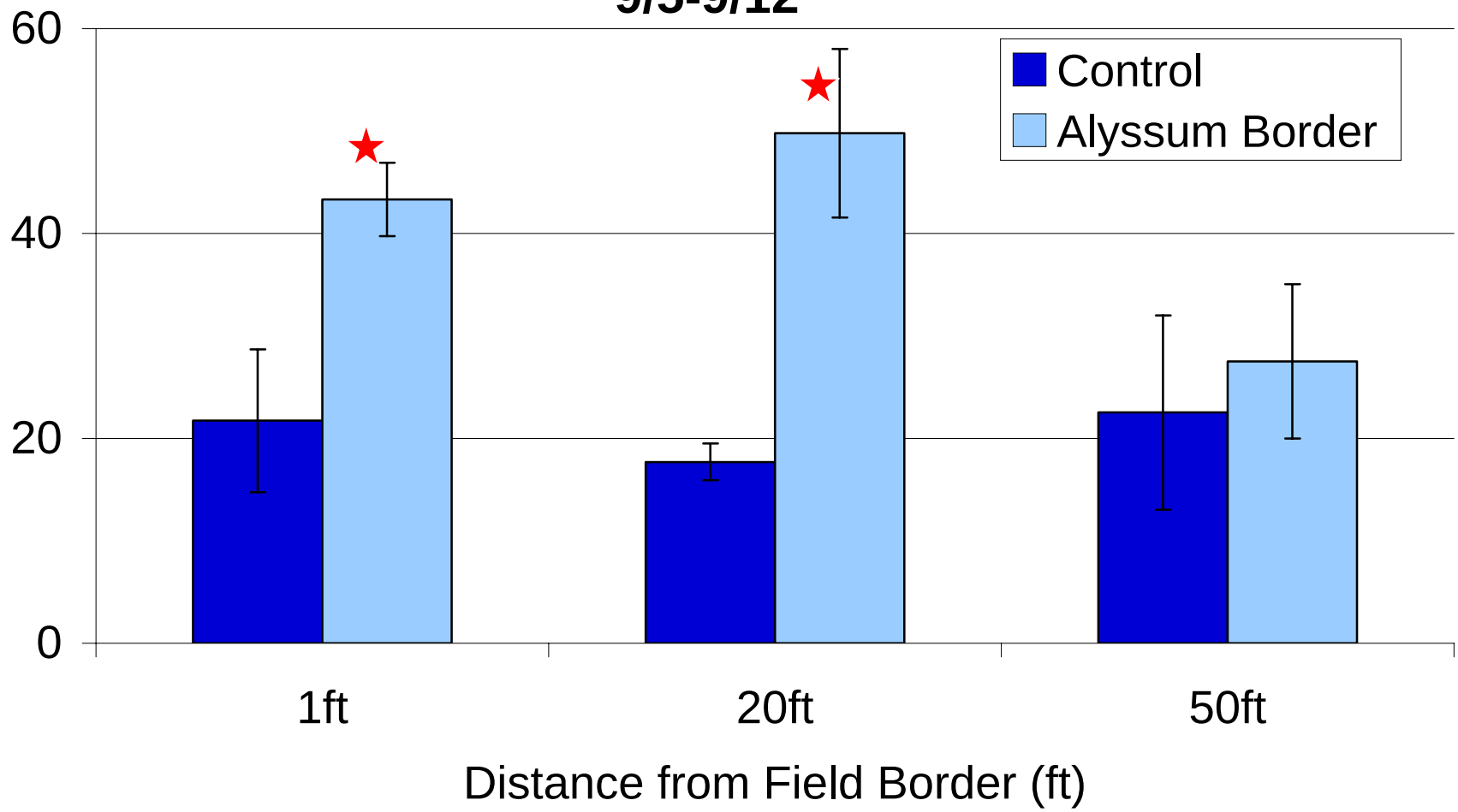
- *Oencyrtus johnsoni* (2%)


Sentinel Egg Parasitism of E. conspersus
20
15
10
5
0
Control
Alyssum Border
1ft
20ft
50ft
Distance from Field Border (ft)



★ **Mean is significantly different from the control at $p < 0.05$.**

Sentinel Egg Parasitism of *E. conspersus* 9/5-9/12



★ **Mean is significantly different from the control at $p < 0.05$.**

Number of Predators Captured On Yellow Sticky Cards

Mean of 3 cards placed at 5, 20, and 50 ft from border

	Mean (SEM) captured on yellow sticky cards			
	6/18 - 6/25		8/6 Š 8/13	
Species	Alyssum	Control	Alyssum	Control
G. atricolor	0.67 ± 0.67	0.33 ± 0.33	0.00 ± 0.00	0.33 ± 0.33
H. convergens	0.33 ± 0.33	0.33 ± 0.33	0.00 ± 0.00	0.00 ± 0.00
J. wickhami	2.33 ± 0.88*	0.00 ± 0.00	3.00 ± 1.53	4.67 ± 0.33
C. carnea	0.00 ± 0.00	1.33 ± 0.67	0.00 ± 0.00	0.00 ± 0.00
Total	3.33 ± 1.45	2.00 ± 0.58	3.00 ± 1.53	5.00 ± 0.58

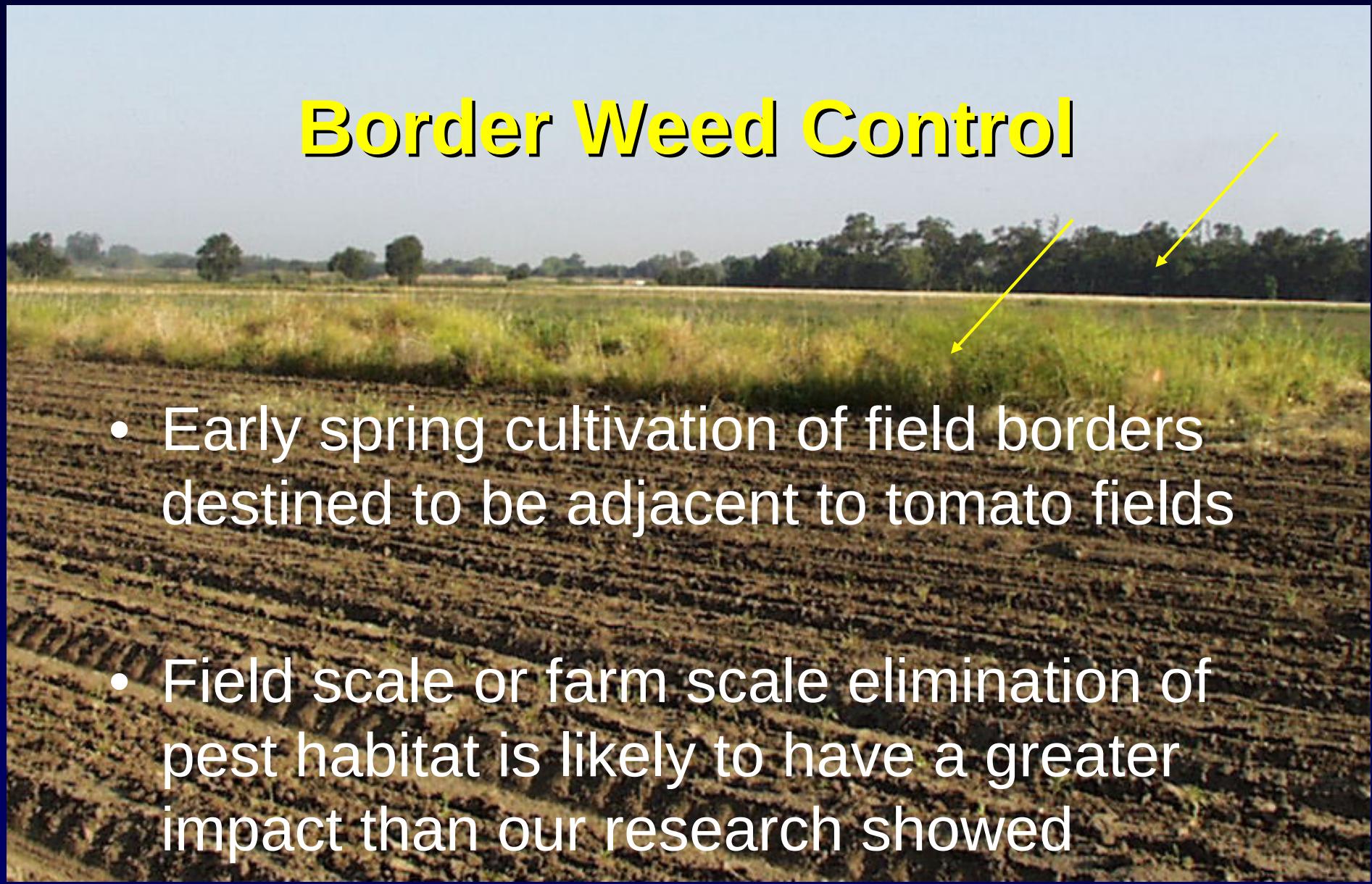
* Mean is significantly different from the control at $p < 0.05$.

★ **Mean is significantly different from the control at $p < 0.05$.**

Conclusions

- Nectar plants such as alyssum have the potential to enhance parasitism of stink bug egg masses.
- Significant differences in parasitism was detected in 2 of three sample periods.
- Sentinel egg mass parasitism was significantly greater 1 ft and 20 ft from alyssum borders for the final sampling period.
- No significant differences in parasitism were observed further than 20 ft from the border and only for the first sample.
- Stink bug predators were not very abundant in tomatoes, but *Jalysus* and Syrphid fly densities were significantly greater associated with the alyssum border when compared to the control.

Border Weed Control



- Early spring cultivation of field borders destined to be adjacent to tomato fields
- Field scale or farm scale elimination of pest habitat is likely to have a greater impact than our research showed

Mean number of stink bugs per tray shake and percent damage at field borders in relation to availability of an adjacent host, 2003

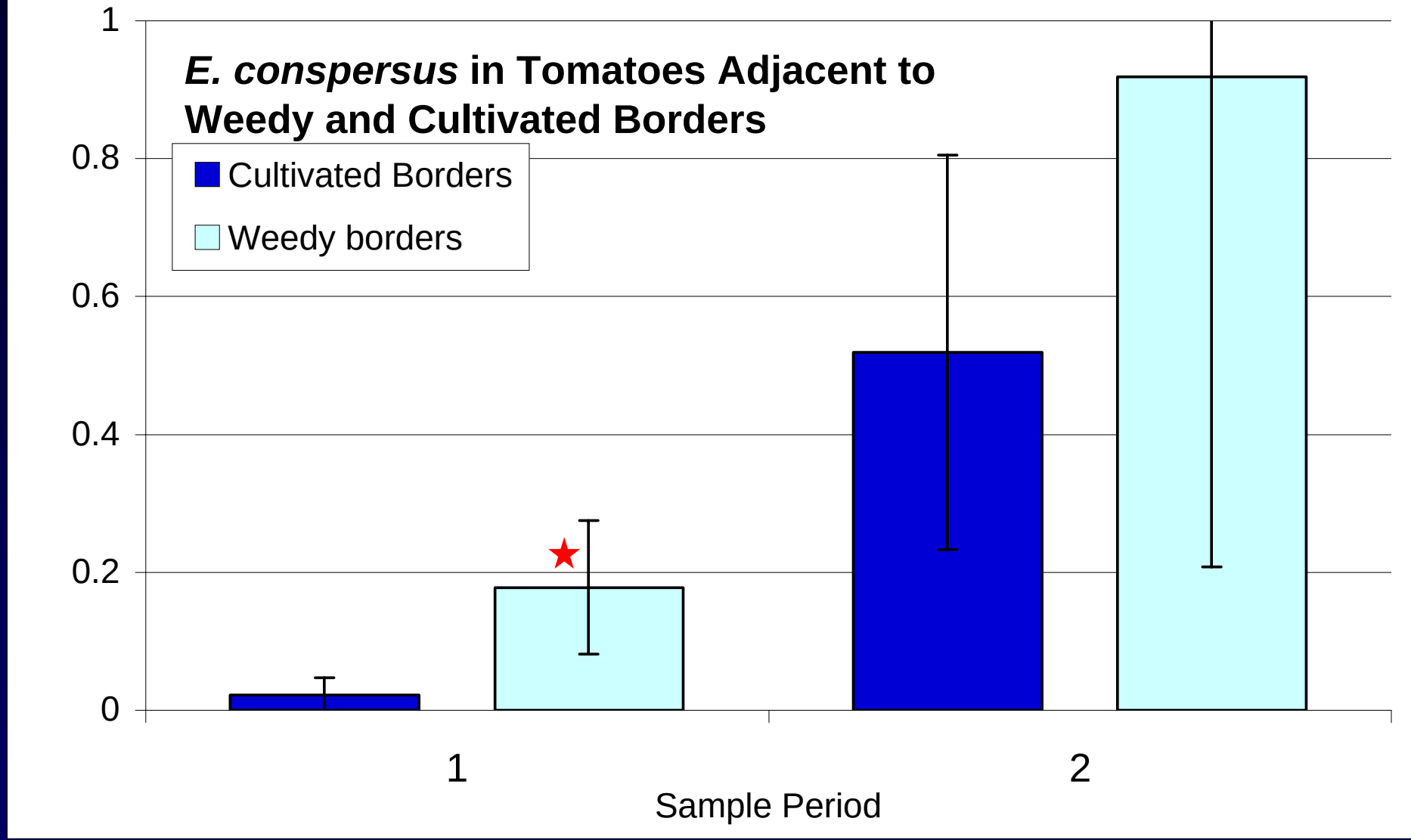
Treatment	Mean ± SE
Non-host border (1st sample period)	0.02 ± 0.01
Host border (1st sample period)	0.18 ± 0.06**
Non-host border (2nd sample period)	0.28 ± 0.15
Host border (2nd sample period)	0.48 ± 0.24
Non-host border (% fruit damage)	39.52% ± 6.73%
Host border (% fruit damage)	46.44% ± 4.32%

8 fields sampled, 8 monitoring sites < 60 feet (12 rows) from each field border

First sample - early July.

Second sample - late August to early September.

** Means significantly different from no host border by t-test at $p<0.05$.



Means represent 8 fields not treated with insecticides for 1st sample and 4 fields not treated with insecticides for 2nd sample.

★ **Mean is significantly different from the control at $p < 0.05$.**

Stink Bug Control with Organic Pesticides

- Stink bugs are difficult to control with any pesticides
- Difficult to achieve coverage
- Difficult to spray in fresh market staked tomatoes
- Best control is against nymphs (immatures)

Stink Bug Sampling:

Treatment threshold -
~ 1/3 bug per tray shake sample

Consperse stink bug pheromone trap

Insecticide efficacy - stink bugs:

Insecticide efficacy - stink bugs:

- Var. AB2 transplanted April 27, 2005
- Randomized complete block design with 3 replicates.
- Stink bug egg hatch began July 15 to July 18.
- Treatments applied on July 22.
- All treatments buffered to pH 5.0-5.5.
- Stink bugs sampled by 5 tray shakes per plot on August 10.
- Stink bug damage determined on August 19 by examining 90 randomly selected tomatoes per plot.
- Data analyzed by 1 way ANOV following arcsine transformation.
- Means separated by t-test following log(x+1) transformation (number of stink bugs) or arcsine transformation (stink bug damage).

Mean (± SE) number of stink bugs per 5 tray shake samples, 2005.

Treatment	Rate per acre	Mean ± SE	
Untreated	---	1.33 ± 0.07	
Danitol 2.4 EC	10.67 oz.	0.33 ± 0.17	*
Surround	75 lb.	0.20 ± 0.07	*
Pyganic	18 oz	1.33 ± 0.66	
Pyganic & Natural Plant Wash	18 oz & 2 gal	0.60 ± 0.34	

* Mean is significantly different from the untreated control at $p < 0.05$ by pairwise t- test

Mean (± SE) proportion of stink bug damaged fruit, 2005.

Treatment	Rate per acre	Mean	± SE	
Untreated	---	54.81	± 10.41	
Danitol 2.4 EC	10.67 oz.	30.74	± 3.99	*
Surround	75 lb.	28.15	± 6.59	*
Pyganic	18 oz	35.93	± 10.31	
Pyganic & Natural Plant Wash	18 oz & 2 gal	38.89	± 7.23	

- Mean is significantly different from the untreated control at $p < 0.05$ by pairwise t- test ANOV statistics - F=2.5736; df =14,44; p=0.0161

Surround

Kaolin clay

Organic Processing Tomato Production Meeting
Woodland, CA February 16, 2007

Potato Aphid and Stink Bug Management

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