

Entomology Research in Strawberries

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Pests studied:

Lygus bug

Greenhouse whitefly

Spider mites

Cyclamen mite

Corn earworm

Pests studied:

- ★ Lygus bug
- ★ Greenhouse whitefly
- ★ Spider mites
- ★ Cyclamen mite
- Corn earworm

Lygus

Lygus hesperus

Lygus elisus



Source of Lygus on Central Coast

Infested second year plantings

Weedy hosts around fields

**Alternate crops and cover crops
(snow peas, fava beans, etc.)**



Lygus Research, 2006



Registered and Candidate Lygus Insecticides

Pesticide	Chemical	Subgroup	Target Site of Activity	IRAC #
Lannate	methomyl	carbamate	acetylcholine esterase inhibitor	1A
Malathion	malathion	organophosphate	acetylcholine esterase inhibitor	1B
Dibrom	naled	organophosphate	acetylcholine esterase inhibitor	1B
Brigade	bifenthrin	pyrethroid	sodium channel modulator	3
Danitol	fempropathrin	pyrethroid	sodium channel modulator	3
Actara	thiamethoxam	neonicotinoid	nicotinic Ach receptor agonists/ antagonist	4A
Prevam	borax	borax	nonspecific inhibitor	uncl
Warrior	cyhalothrin	pyrethroid	sodium channel modulator	3
Assail	acetamiprid	neonicotinoid	nicotinic Ach receptor agonists/ antagonist	4A
--	clothianidin	neonicotinoid	nicotinic Ach receptor agonists/ antagonist	4A
Venom	dinotefurr	neonicotinoid	nicotinic Ach receptor agonists/ antagonist	4A
--	flonicamid	flonicamid	nonspecific feeding blocker	9C
--	metaflumizone	semicarbazone	blocks sodium channel??	22??
Rimon??	novaluron	benzoylurea	inhibitor of chitin biosynthesis, type 0	15

Withdrawn

Registered

Not registered for use on strawberries

Lygus Control, Watsonville

Treatment	Rate	Lygus per 10 beat sheet samples (n=4)							
		May 20		May 27		June 3		June 10	
Untreated	--	1.00	± 1.15	1.25	± 1.50	2.25	± 1.50	1.00	± 1.15
Danitol	10 2/3 oz	0.50	± 1.00	2.00	± 3.37	2.25	± 2.63	1.00	± 0.82
Malathion	2.0 pts	0.75	± 0.96	3.25	± 1.26	2.25	± 2.63	2.50	± 3.79
Actara	4.0 oz	0.25	± 0.50	2.00	± 0.82	3.00	± 1.83	0.75	± 0.96
flonicamid	0.34 lb	0.25	± 0.50	0.25	± 0.50	1.25	± 0.96	1.00	± 0.82
novaluron (2X)	12.0 oz	0.00	± 0.00	0.00	± 0.00	1.00	± 1.15	2.25	± 3.86
Assail	1.7 oz	0.50	± 0.58	1.75	± 0.96	1.00	± 1.41	2.00	± 1.41

¹ Treatment dates, May 13, May 20

Registered

Not registered for use on strawberries

Lygus Product Evaluations, 2006

July 31

Percent Survival

Treatments	Rate (form/ac)	24 hr	48 hr
Control (water)	NA	100.0 ± 0.0	100.0 ± 0.0
Danitol 2.4EC	10.67oz	0.0 ± 0.0 *	0.0 ± 0.0 *
Actara 25G	4.0oz	20.0 ± 0.0 *	20.0 ± 0.0 *
Actara 25G + Danitol 2.4EC	4.0oz + 10.67 oz	0.0 ± 0.0 *	0.0 ± 0.0 *
Danitol 2.4EC + Provdo 1.6F	10.67oz + 3.8 oz	0.0 ± 0.0 *	0.0 ± 0.0 *
Assail 30SG	4.0oz	26.7 ± 11.6 *	66.7 ± 11.6 *
Assail 30SG	6.0oz	6.7 ± 11.6 *	8.3 ± 14.4 *
metaflumizone + Penetrator Plus	16.0oz + 0.5% v/v	80.0 ± 34.6	20.0 ± 34.6 *
metaflumizone + Penetrator Plus	29.5oz + 0.5% v/v	53.3 ± 23.1 *	38.3 ± 37.5 *

* Means significantly different from untreated by Student's *t* test at $p < 0.05$ following arcsine transformation.

Registered

Not registered for use on strawberries

Lygus Product Evaluations, 2006

August 3

Treatments	Rate (form/ac)	Percent Survival	
		24 hr	48 hr
Control (water)	NA	100.00 ± 0.00	40.00 ± 20.00
Danibl 2.4EC	10.67 oz	0.00 ± 0.00 *	0.00 ± 0.00 *
clothianidin	1.5oz	0.00 ± 0.00 *	0.00 ± 0.00 *
clothianidin	2.0oz	0.00 ± 0.00 *	0.00 ± 0.00 *
Venom 70SG	42.8g	6.67 ± 11.5 *	6.67 ± 11.5 *
Venom 70SG	57.1g	13.33 ± 23.09 *	13.33 ± 23.09
Venom 70SG	85.6g	20.00 ± 20.00 *	13.33 ± 11.55
novaluron 0.83EC	9.0oz	72.22 ± 48.11	82.22 ± 16.78 *
novaluron 0.83EC	12.0oz	46.67 ± 46.19 *	6.67 ± 11.55 *
Assai B0SG	4.0oz	13.33 ± 11.55 *	20.00 ± 0.00
Assai B0SG	6.0oz	6.67 ± 11.55 *	13.33 ± 11.55

* Means significantly different from untreated by Student's *t*-test at $p < 0.05$ following arcsine transformation.

Registered

Not registered for use on strawberries

Lygus Product Evaluations, 2006

August 31

Treatments	Rate (form/ac)	Percent Survival	
		24 hr	48 hr
Control (water)	NA	82.22 ± 16.78	40.00 ± 40.00
Danibl 2.4EC	10.67 oz	0.00 ± 0.00 *	0.00 ± 0.00 *
clothianidin	1.5oz	0.00 ± 0.00 *	0.00 ± 0.00 *
clothianidin	2.0oz	0.00 ± 0.00 *	0.00 ± 0.00 *
Venom 70SG	85.6g	26.67 ± 46.19 *	18.89 ± 20.09
novaluron 0.83EC	9.0oz	31.27 ± 22.47 *	0.00 ± 0.00 *
novaluron 0.83EC	12.0oz	20.00 ± 0.00 *	0.00 ± 0.00 *
AssaiB0SG	4.0oz	13.33 ± 11.5 *	0.00 ± 0.00 *
AssaiB0SG	6.0oz	0.00 ± 0.00 *	6.67 ± 11.5 *

* Means significantly different from untreated by Student's *t*-test at $p < 0.05$ following arcsine transformation.

Registered

Not registered for use on strawberries

Lygus Product Evaluations, 2006

September 7

Treatments	Rate (formac)	Percent Survival	
		24 hr	48 hr
Control (water)	NA	88.89 ± 19.24	54.44 ± 23.65
Venom 70SG	57.1g	13.33 ± 23.09 *	26.67 ± 23.09 *
Venom 70SG metaflumizone	85.6g 16.0oz	32.22 ± 13.47 *	32.22 ± 13.47
+ PenetatorPlus metaflumizone	+ 0.5% v/v 29.5oz	80.00 ± 20.00	60.00 ± 0.00
+ PenetatorPlus	+ 0.5% v/v	30.00 ± 17.32 *	17.78 ± 16.78 *

* Means significantly different from untreated by Student's *t*-test at $p < 0.05$ following arcsine transformation.

Registered

Not registered for use on strawberries

Lygus Product Evaluations, 2006

OMRI Approved Products

July 31

Treatments	Rate (form/ac)	Percent Survival	
		24 hr	48 hr
Control (water)	NA	100.0 ± 0.0	100.0 ± 0.0
CedarGard	2%v/v	36.7 ± 32.2 *	26.7 ± 23.1 *
Ecotrol + Natural Wet	2.0oz + 0.125%v/v	86.7 ± 11.6	73.3 ± 23.1 *
Pyganic + Natural Wet	18.0oz + 0.125% v/v	46.7 ± 50.3 *	60.0 ± 34.6 *
Ecotrol + Pyganic + Natural Wet	2.0oz + 18 oz + 0.125%v/v	73.3 ± 11.6 *	80.0 ± 20.0

* Means significantly different from untreated by Student's *t*-test at $p < 0.05$ following arcsine transformation.

Lygus Product Evaluations, 2006

OMRI Approved Products

August 3 and August 31

Treatments	Rate (form/ac)	Percent Survival	
		24 hr	48 hr
Control (water)	NA	100.0 ± 0.00	40.0 ± 20.0
EcoPCO EC/X (Pyrethrin)	16.0oz	66.7 ± 11.6 *	20.0 ± 0.0
CedarGuard	2%v/v	53.3 ± 46.2 *	26.7 ± 30.6

Treatments	Rate (form/ac)	Percent Survival	
		24 hr	48 hr
Control (water)	NA	82.22 ± 16.78	40.00 ± 40.00
EcoPCO EC/X (Pyrethrin)	16.0oz	86.67 ± 23.09	20.00 ± 20.00
CedarGuard	2%v/v	6.67 ± 11.55 *	0.00 ± 0.00 *

* Means significantly different from untreated by Student's *t*-test at $p < 0.05$ following arcsine transformation.

Lygus Nymph Control, Novaluron, 2005

Treatment	Rate (form/ac)	Mean \pm SD percent survival ¹			
		24 hr		48 hr	
Untreated	water	100.0	\pm 0.0	85.0	\pm 14.0
Nova luron	12.0 oz	73.0	\pm 11.6 *	33.0	\pm 23.0 *
Nova luron	9.0 oz	47.0	\pm 11.6 *	20.0	\pm 0.0 *

Treatment	Rate (form/ac)	Mean \pm SD caste skins ²					
		24 hr			48 hr		
Untreated	water	0.80	\pm 0.84	A	2.80	\pm 1.64	A
Nova luron	12.0 oz	0.00	\pm 0.00	A	0.67	\pm 1.15	B
Nova luron	9.0 oz	0.33	\pm 0.58	A	0.00	\pm 0.00	B

Nymphs treated were 1st or 2nd instar; 5 lygus nymphs/petri dish; Treated August 9, 2005

¹ ANOVA statistics: $F= 108.78$, $df=2,10$, $P<0001$ @ 24 hrs; $F= 11.03$, $df=2,10$, $P= 0.0050$ @ 48 hrs

² ANOVA statistics: $F= 1.52$, $df=2,10$, $P=0.2753$ @ 24 hrs; $F= 8.48$, $df=2,10$, $P= 0.0106$ @ 48 hrs

* Means significantly different from untreated by Student's t test at $p<0.05$ following arcsine transformation.

** Means significantly different from untreated by LSD at $p<0.05$.

Greenhouse Whitefly



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Sources of Whiteflies

Summer strawberry plantings
Infested second year plantings
Other infested crops or host



Source of Whiteflies on Central Coast

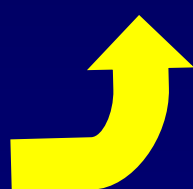
New plantings next to second year plantings



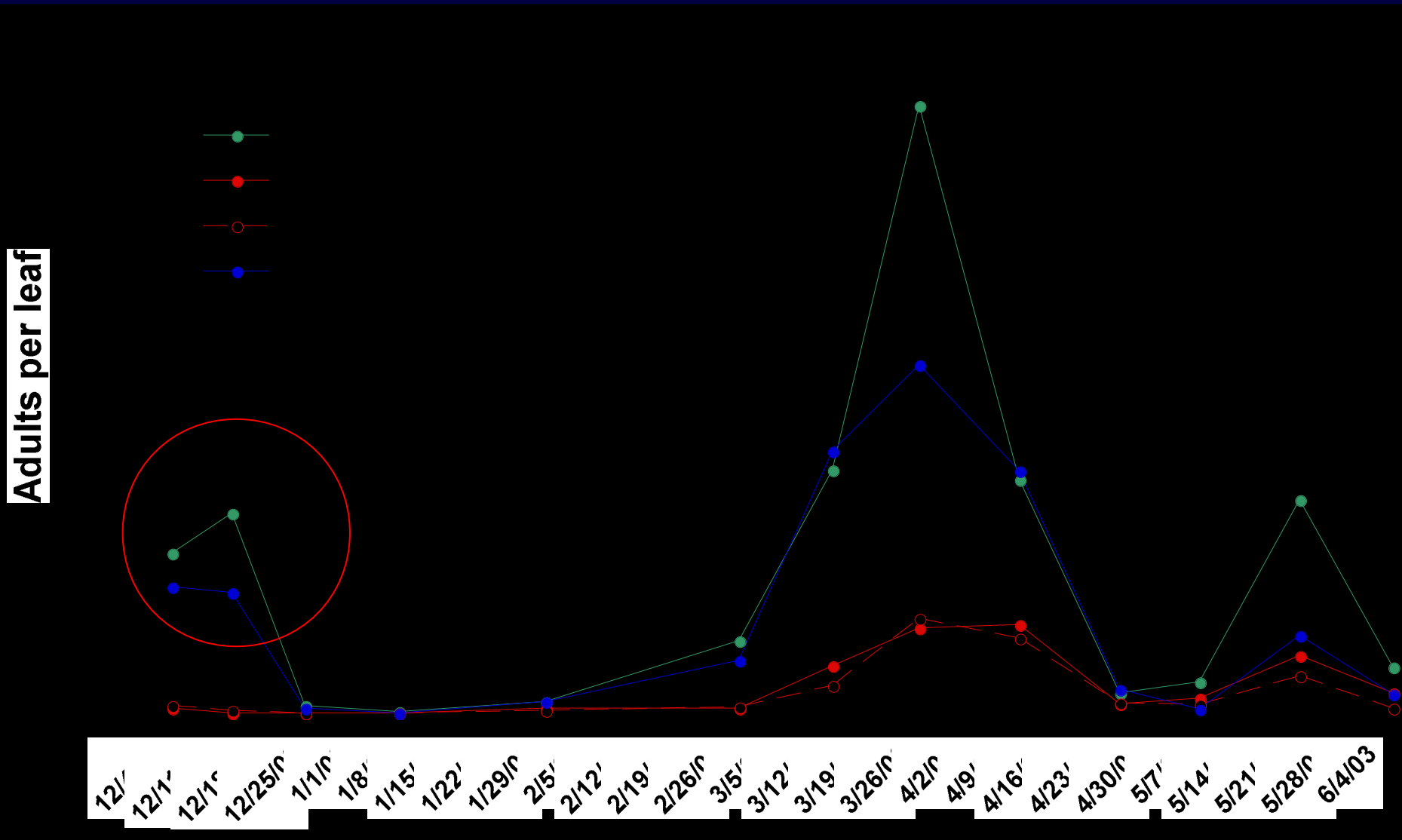
Infested
second year
planting



New
planting



Greenhouse Whitefly Control, Watsonville, 2003-04



Greenhouse Whitefly Control, Watsonville, 2006

Treatment	Rate
UTC	NA
Oberon2 SC	16 f oz
Esteem0.86EC	3.0fl oz
Actara 2 WG	4.0 oz
Admiral Pro (post plant)	14.0fl oz
Admiral Pro (post plant), then Oberon2 SC (3 wks later)	14.0fl oz (Ad), then 16 fl oz (Ob) 3 wks later
Ecotrd + BiolinkSpreader	4 pts (Ec) +0.05% (B) v/v
Ecotrd + BiolinkSpreader + Neomix4.5	4 pts (Ec) +0.05% (B) v/v + 70 fl oz (Ne)
Pyganic+ BiolinkSpreader	13.5 oz+0.05% (B) v/v
Neomix4.5 +Biolink Spreader	7.0 fl oz +0.05% (B) v/v

Application date 2/14/2006

2nd Oberon treatment applied 3/10/2006

Greenhouse Whitefly Control, Watsonville, 2006

Rain

Treatment	2/23/06	3/4/06	3/10/06	3/18/06	3/24/06	3/31/06
UTC	1.40 ± 0.36	0.50 ± 0.40	0.73 ± 0.06	1.27 ± 0.64	1.73 ± 1.08	1.03 ± 1.19
Oberon	0.90 ± 0.78	0.43 ± 0.12	0.43 ± 0.21	0.80 ± 0.10	0.53 ± 0.06	0.40 ± 0.26
Esteem	0.80 ± 0.20	0.67 ± 0.38	1.23 ± 0.31	1.03 ± 0.29	1.27 ± 0.71	0.40 ± 0.17
Actara	0.43 ± 0.32	0.47 ± 0.64	0.70 ± 0.70	0.93 ± 0.32	0.63 ± 0.15	0.13 ± 0.15
Admire	0.77 ± 0.50	0.33 ± 0.32	0.40 ± 0.10	0.87 ± 0.35	0.63 ± 0.21	0.17 ± 0.15
Admire / Oberon ¹	1.20 ± 1.22	0.37 ± 0.06	0.80 ± 0.44	0.37 ± 0.15	0.47 ± 0.40	0.17 ± 0.12
Ecotrol	1.43 ± 0.29	0.60 ± 0.61	1.27 ± 0.70	2.07 ± 1.50	2.03 ± 0.84	1.47 ± 0.93
Ecotrol + Neemix	0.77 ± 0.31	0.57 ± 0.15	0.83 ± 0.50	1.07 ± 0.21	1.00 ± 0.35	0.83 ± 0.76
Pyganic	0.97 ± 0.40	0.97 ± 0.67	0.57 ± 0.06	1.87 ± 0.71	1.73 ± 1.31	1.47 ± 0.51
Neemix	0.80 ± 0.17	0.97 ± 0.40	0.37 ± 0.06	1.73 ± 0.40	1.00 ± 0.26	1.10 ± 0.72

Application date 2/14/2006

¹ Oberon applied 3/10/2006

Greenhouse Whitefly Control, Watsonville, 2006

Treatment	4/7/06	4/16/06	4/21/06	4/28/06	5/5/06
UTC	0.63 ± 0.67	0.93 ± 0.84	0.53 ± 0.31	0.53 ± 0.15	0.67 ± 0.29
Oberon	0.63 ± 0.25	0.50 ± 0.17	0.73 ± 0.40	0.43 ± 0.15	0.60 ± 0.10
Esteem	0.67 ± 0.42	0.87 ± 0.06	0.63 ± 0.67	0.30 ± 0.20	0.47 ± 0.06
Actara	0.87 ± 0.42	0.53 ± 0.06	0.53 ± 0.21	0.57 ± 0.38	1.80 ± 1.93
Admire	0.47 ± 0.23	0.40 ± 0.35	0.47 ± 0.15	0.23 ± 0.15	0.30 ± 0.26
Admire + Oberon	0.23 ± 0.06	0.63 ± 0.76	0.27 ± 0.15	0.23 ± 0.21	0.20 ± 0.17

Application date 2/14/2006

¹ Oberon applied 3/10/2006

Two spotted spider

Tetranychus urticae



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Two spotted spider

Research, 2006

Varietal susceptibility

Diamante thresholds

Chemical controls

Sublethal effects of acaricides on *P. persimilis*



Acaricide Classification

Product	Active Ingredient	Primary Target Site of Action	IRAC #
Kelthane	Dicofol	Unknown mode of action	Uncl.
Vendex	Fenbutath 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
Kanemite	Acequinocyl	Site III electron transport inhibitor	20B
Fujimite ¹	Fenpyroximate	Site I electron transport inhibitor	21
Oberon	Spiromesifen	Inhibitor of lipid synthesis	23
Acramite	Bifenazate	Neuronal inhibitor (unknown mode of action)	25
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

Mean \pm SD Number of Mites per Strawberry Leaflet, Watsonville, CA, 2006

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

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

Diamante Treatment Timing, 2006

Treatment	Treatment Schedule						Total mite - days	Total yield
	<i>Feb 2-09</i>	<i>March 3-13</i>	<i>April 4-2</i>	<i>May 5-11</i>	<i>June 6-9</i>	<i>July 7-14</i>		
All seas on	<i>Acramite</i>	<i>Kanem ite</i>	<i>Oberon</i>	<i>Acramite</i>	<i>Kanem ite</i>	<i>Oberon</i>	572	6513
Early Untreated,	<i>Acramite</i>	<i>Kanem ite</i>					4794	6416
then May-on Untreated,	--	--	--	<i>Acramite</i>	<i>Kanem ite</i>	<i>Oberon</i>	759	6457
then June	--	--	--	--	<i>Kanem ite</i>	--	2516	5779
Early & July Untreated,	<i>Acramite</i>	<i>Kanem ite</i>	--	--	--	<i>Oberon</i>	2292	6349
then July	--	--	--	--	--	<i>Oberon</i>	5338	5702

Cyclamen mite

Phytonemus pallidus

Eggs



Immatures



Adult



False Cyclamen Mites

Tarsonemus setifer

Tarsonemus confusus

No flange on femur IV of the male
Tarsonemus - flange present on
femur IV of the cyclamen mite



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Look for leaf damage
symptoms, and mites
primarily associated with
crinkled leaves, crown and
veins

Cyclamen mite bioassays, Watsonville, 2005

Treatment	Rate	Percent Survival 24 hr		Percent Survival 48 hr	
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Untreated	--	90.0 ± 11.6	90.0 ± 11.6	90.0 ± 11.6	90.0 ± 11.6
Agrimek	16 oz.	0.0 ± 0.0 *	0.0 ± 0.0 *	0.0 ± 0.0 *	0.0 ± 0.0 *
Fujimite ¹	2 pt.	0.0 ± 0.0 *	0.0 ± 0.0 *	0.0 ± 0.0 *	0.0 ± 0.0 *
Kanemite	31 oz.	45.0 ± 0.4 *	45.0 ± 0.4 *	10.0 ± 11.6 *	10.0 ± 11.6 *
Kelthane	4 lb.	30.0 ± 0.3 *	30.0 ± 0.3 *	30.0 ± 17.3 *	30.0 ± 17.3 *
Oberon	16 oz.	77.5 ± 20.6	77.5 ± 20.6	35.0 ± 47.3 *	35.0 ± 47.3 *
Acramite	1 lb.	75.0 ± 23.8	75.0 ± 23.8	77.5 ± 20.6	77.5 ± 20.6
Zeal	3 oz.	88.8 ± 13.2	88.8 ± 13.2	93.8 ± 12.5	93.8 ± 12.5

¹ Not registered for use on strawberries

Cyclamen mite bioassays, Watsonville

Treatment	Rate (form/A)	Percent Survival @ 24 hr Mean \pm SD
Control	--	75.0 \pm 19.2
Ecotrol	4 pts	75.0 \pm 19.2
GC Mite	1% v/v	10.0 \pm 11.6*
Danitol	10.66oz.	15.0 \pm 10.0 *

Mites collected August 7, 2006 from a CCOF certified organic strawberry field.

* Means are significantly different from the untreated control by pairwise t-test following arcsine transformation at $p < 0.05$, $n = 4$

Predator bioassays

Phytoseiulus persimilis

Contact and residual bioassays

Up to 37 days after application

Effects of -

Bifenazate

Etoxazole

Spiromesifen

Abamectin

Fenpyroximate

Acequinocyl



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Saenz de Cabazon Irigaray, F. J., F. G. Zalom, and P. B. Thompson. 2007. Residual toxicity of acaricides to *Galendromus occidentalis* and *Phytoseiulus persimilis* reproductive potential. *Biological Control*. 40:153-159.

Entomology Research in Strawberries

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