Annual Central Coast Strawberry Meeting
Watsonville, February 2, 2012

Recent Studies of Controls for Lygus

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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), save the products that will also kill adults for later

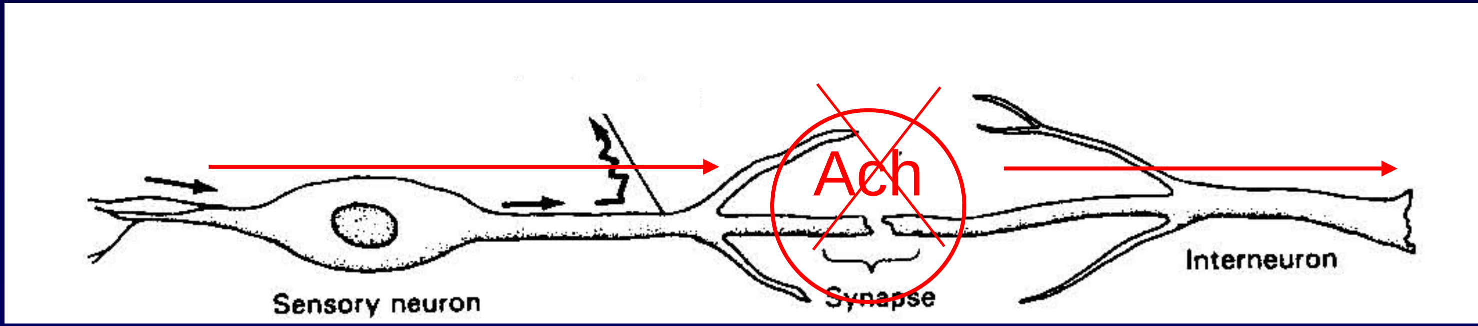
Registered insecticides

Pesticide	Chemical	Subgroup	Target Site of Activity	IRAC #
Malathion	malathion	organophosphate	acetylcholine esterase inhibitor	1B
Dibrom	naled	organophosphate	acetylcholine esterase inhibitor	1B
Diazinon	diazinon	organophosphate	acetylcholine esterase inhibitor	1B
Brigade, Bifenture, Athena	bifenthrin	pyrethroid	sodium channel modulator	3
Danitol	fempropathrin	pyrethroid	sodium channel modulator	3

- Nerve poisons
- Kill nymphs and adults
- Problems with resistance
- May be valuable as synergists in tank mixes

Malathion, Dibrom, Diazinon

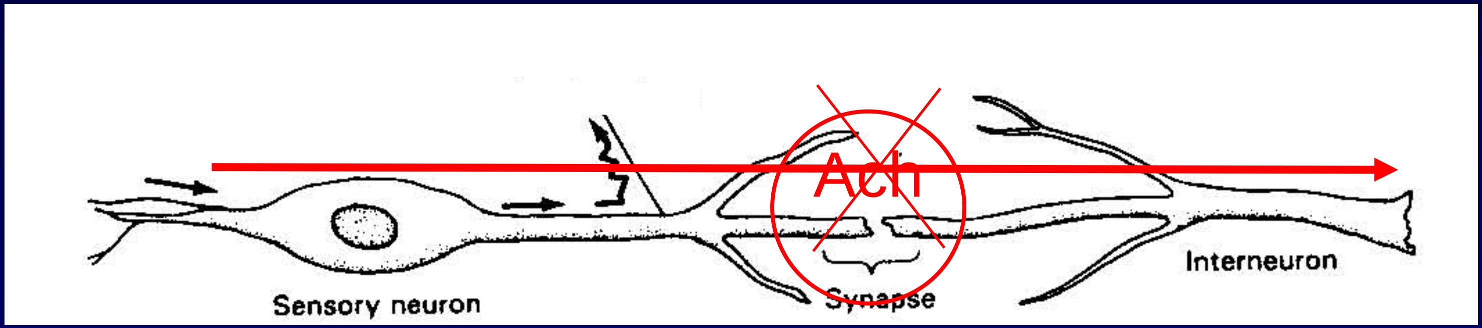
Organophosphates - Synaptic poisons



- acetylcholine transmits impulse across synapse
- acetylcholine is broken down by acetylcholinesterase to stop the signal
- organophosphate and carbamate insecticides inhibit acetylcholinesterase

Malathion, Dibrom, Diazinon

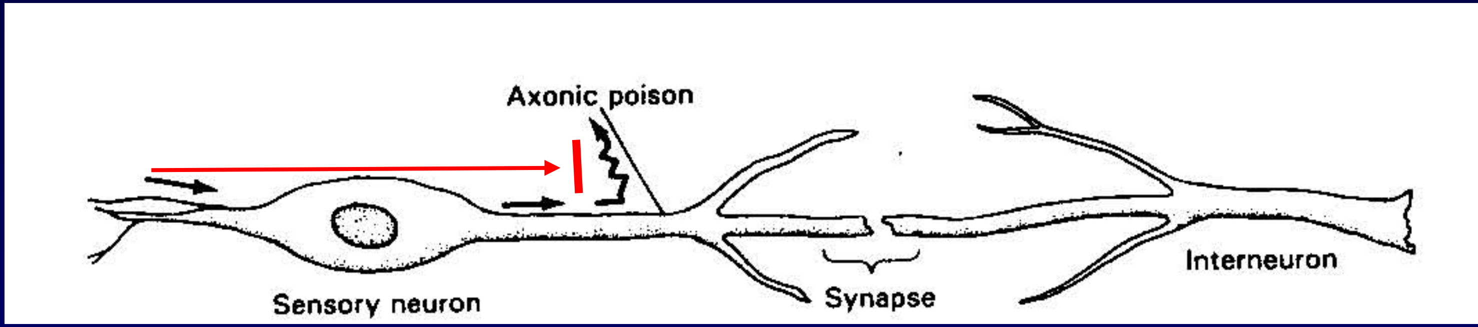
Organophosphates - Synaptic poisons



- organophosphate and carbamate insecticides inhibit acetylcholinesterase
- causes a build-up of acetylcholine and nerves continue to fire
- insect death preceded by tremors, convulsions, and paralysis

Danitol, Brigade, Bifenture, Athena

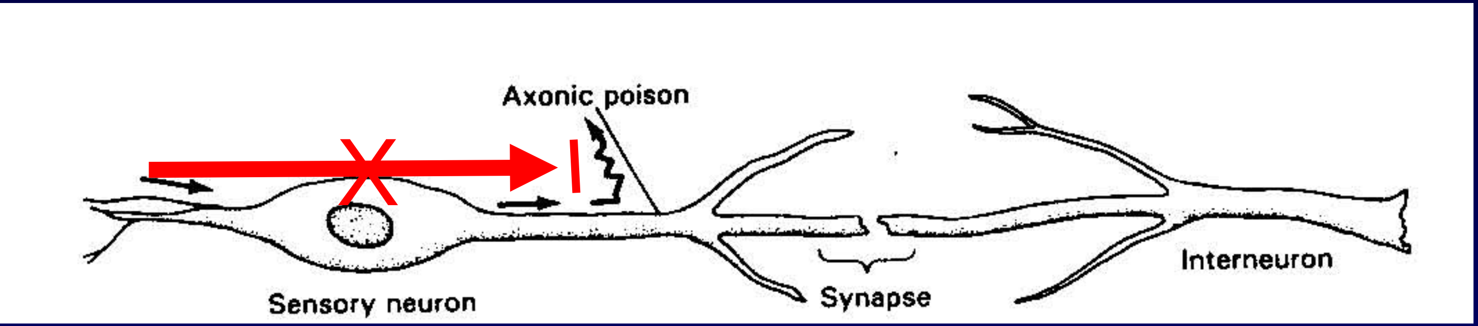
Pyrethroids - Axonic poisons



- pyrethroids act on tiny channels through which sodium is pumped to cause excitation of neurons
- bind to a protein in nerves called the voltage-gated sodium channel

Danitol, Brigade, Bifenture, Athena

Pyrethroids - Axonic poisons



- pyrethroids act on tiny channels through which sodium is pumped to cause excitation of neurons
- bind to a protein in nerves called the voltage-gated sodium channel
- they prevent the sodium channels from closing, resulting in continual nerve impulse transmission, tremors, and eventually, death.

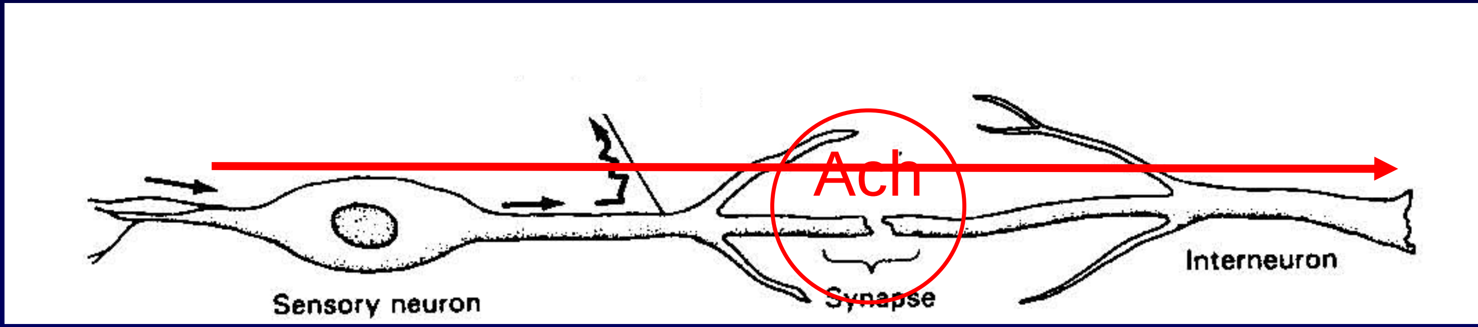
Registered insecticides

Pesticide	Chemical	Subgroup	Target Site of Activity	IRAC #
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	sodium tetraborohydrate decahydrate	__	nonspecific inhibitor	uncl

- Nerve poisons
- Insect growth regulator
- Contact poison with little residual activity

Actara, Assail

Neonicotinoids - Synaptic poisons

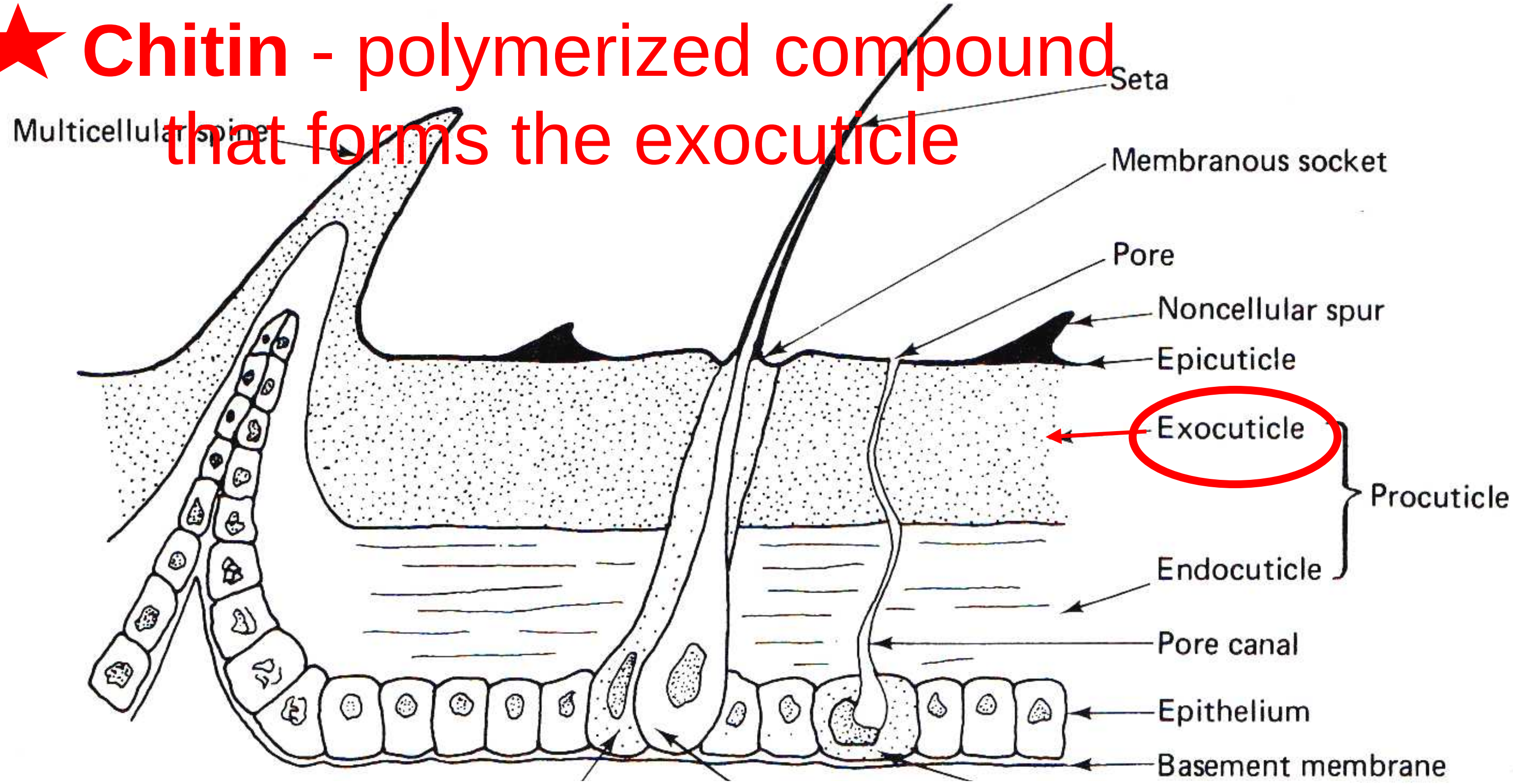


- mimic acetylcholine and nerves continue to fire
- closer mimics to the insect acetylcholine than mammalian acetylcholine so fairly non-toxic to mammals
- insect death preceded by tremors, convulsions, and paralysis

Rimon

Insect growth regulator - Chitin synthesis inhibitor

★ **Chitin** - polymerized compound that forms the exocuticle



Gives the cuticle its strength and resilience

Rimon

Insect growth regulator - Chitin synthesis inhibitor

incomplete metamorphosis,
nymphs must ‘molt’ in order to grow

Rimon

Insect growth regulator - Chitin synthesis inhibitor

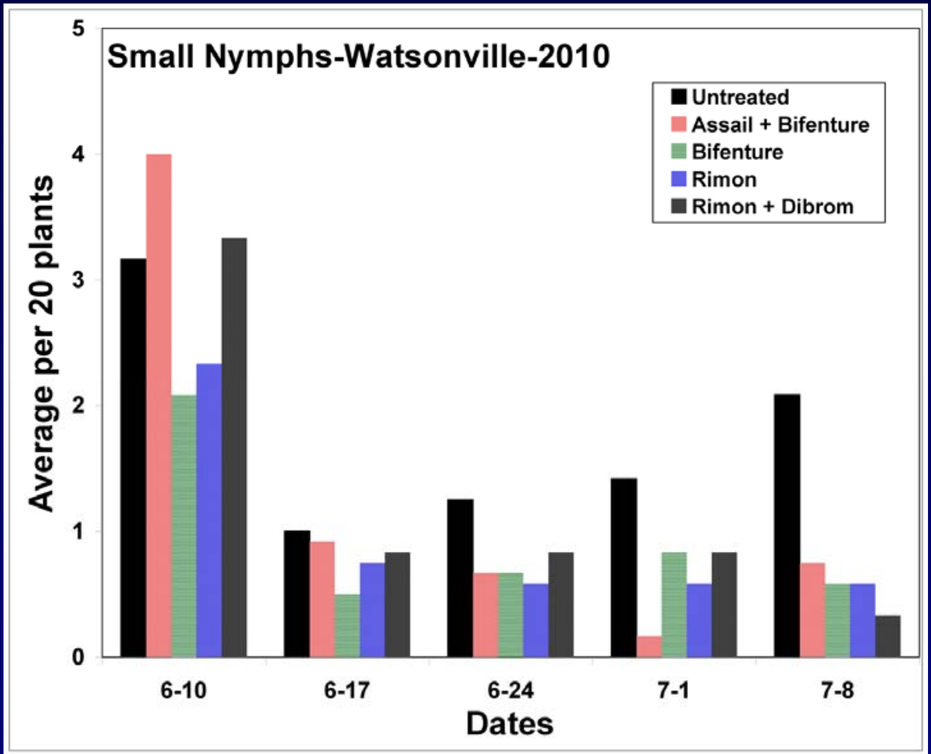
- blocks the production of chitin
- insect poisoned cannot make chitin and so cannot molt
- insect remains in same life stage and eventually dies

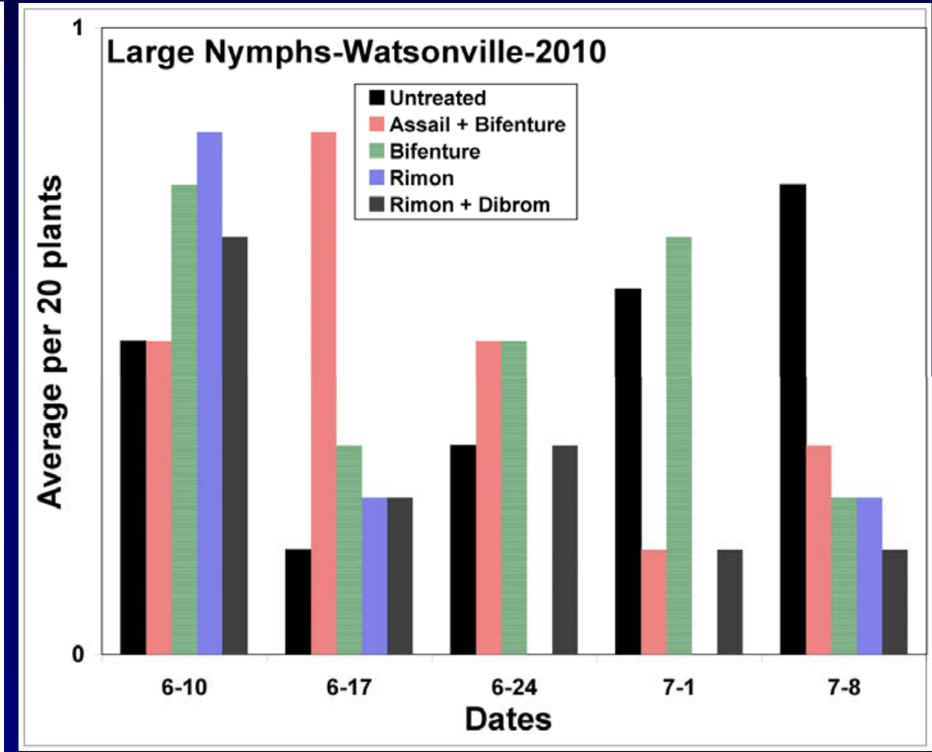
Lygus Control, Watsonville, 2010

- 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

Lygus Control - 2010

Results





Rimon affects molting

Lygus Control - 2010

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

Treatment	Rate (form/ac)	Mean ± SE fruit damaged/plant 7/8/10	Mean ± SE fruit damaged/plant 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 DyneAmic at 0.25% v/v

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

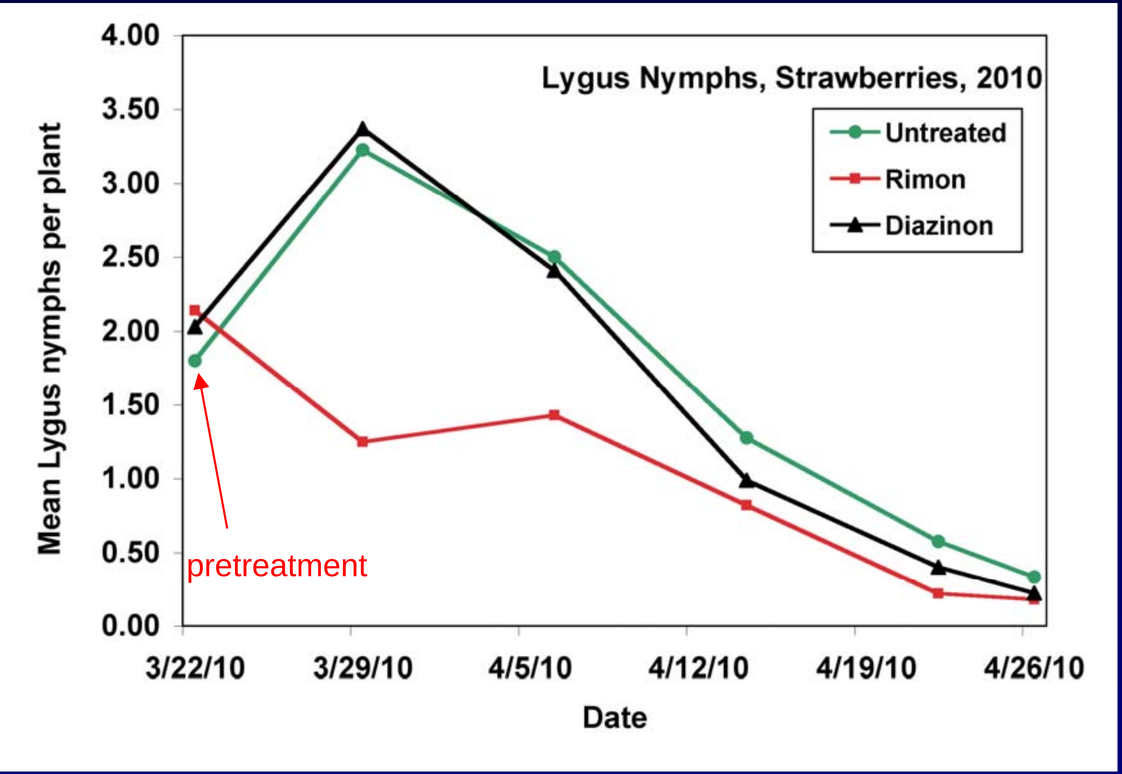
Treatments:

- 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)

Monitoring for small nymphs to time treatments is very important

Rimon spring spray, Watsonville, 2010

- Rimon is best used early season as it only affects Lygus nymphs and there is more synchronization of the Lygus generations at that time
- Later application is best when tank mixed with another product
- Timing is critical

Yet to be registered insecticides

Pesticide	Chemical	Subgroup	Target Site of Activity	IRAC #
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

- Nerve poison
- Feeding blocker
- Affects insect’s energy metabolism
- ??

Belay and Beleaf - 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
Brigade	bifenthrin	16 oz
Athena	bifenthrin + abamectin	17.0 oz
Actara 25WG	thimethoxam	4.0 oz

Treatments include Dyne-amic

Belay and Beleaf - Small Nymphs, 2010

	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

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

Belay and Beleaf - Total Lygus (Nymphs + Adults)

Treatment	Mean ± SE total Lygus (nymphs + adults) per plant			
	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

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

Pre-treat count = 0.61Lygus per plant; F=0.6700, df=12,36, P=0.7636

Belay and Beleaf - Damage at 27 and 35 days

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

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

Lygus Control - Insecticides - 2011

tolyfenpyrad and sulfoxaflor - 2011

Treatment	Chemical name	Rate (form/ac)
Untreated		
Brigade WSB	bifenthrin	16 oz
Actara 25 WG +	thiamethoxam +	4 oz +
Brigade	bifenthrin	16 oz
Rimon 0.83 EC	novaluron	12 oz
Rimon + Brigade	novaluron + bifenthrin	12 oz + 16 oz
Beleaf 50SG	flonicamid	2.8 oz
Belay 2.13 EC	clothianidin	4.0 oz
Belay 2.13 EC	clothianidin	6.0 oz
tolfenpyrad 15 SC	tolfenpyrad	27 oz
tolfenpyrad 15 EC	tolfenpyrad	27 oz
sulfoxaflor (L)	sulfoxaflor	2.85 oz
sulfoxaflor (M)	sulfoxaflor	4.28 oz
sulfoxaflor (H)	sulfoxaflor	5.7 oz

Treatments applied September 30, 2011, to first year 'Albion' field
All include Dyne-amic

tolyfenpyrad and sulfoxaflor - Small Nymphs

Treatment	Mean ± SE small Lygus bug nymphs per plant			
	10/6/11	10/13/11	10/20/11	10/27/11
Untreated	0.08 ± 0.01	0.16 ± 0.06	0.06 ± 0.04	0.04 ± 0.01
Brigade	0.02 ± 0.02*	0.06 ± 0.02	0.02 ± 0.02	0.08 ± 0.04
Actara + Brigade	0.03 ± 0.02	0.10 ± 0.06	0.08 ± 0.04	0.05 ± 0.04
Rimon	0.01 ± 0.01*	0.06 ± 0.02	0.05 ± 0.02	0.11 ± 0.04
Rimon + Brigade	0.03 ± 0.01*	0.04 ± 0.03	0.05 ± 0.01	0.06 ± 0.02
Beleaf	0.03 ± 0.01*	0.03 ± 0.00*	0.04 ± 0.02	0.09 ± 0.05
Belay (L)	0.03 ± 0.01*	0.03 ± 0.01*	0.02 ± 0.02	0.02 ± 0.02
Belay (H)	0.02 ± 0.01*	0.01 ± 0.01*	0.03 ± 0.01	0.09 ± 0.02
tolfenpyrad SC	0.02 ± 0.01*	0.03 ± 0.03*	0.01 ± 0.01	0.08 ± 0.04
tolfenpyrad EC	0.01 ± 0.01*	0.06 ± 0.03	0.05 ± 0.01	0.12 ± 0.03
sulfoxaflor (L)	0.00 ± 0.00*	0.04 ± 0.01	0.05 ± 0.04	0.06 ± 0.04
sulfoxaflor (M)	0.02 ± 0.01*	0.04 ± 0.01	0.01 ± 0.01	0.05 ± 0.01
sulfoxaflor (H)	0.05 ± 0.01	0.08 ± 0.02	0.04 ± 0.01	0.04 ± 0.02

* Means are significantly different from control at *P*<0.05 using Dunnett's test.

tolyfenpyrad and sulfoxaflor - Total Lygus

Treatment	Mean ± SE Total Lygus bugs (adults + nymphs) per plant			
	10/6/11	10/13/11	10/20/11	10/27/11
Untreated	0.11 ± 0.01	0.21 ± 0.06	0.17 ± 0.05	0.23 ± 0.05
Brigade	0.08 ± 0.02	0.13 ± 0.04	0.11 ± 0.03	0.23 ± 0.03
Actara + Brigade	0.05 ± 0.03	0.15 ± 0.06	0.11 ± 0.04	0.14 ± 0.03
Rimon	0.06 ± 0.02	0.09 ± 0.02	0.08 ± 0.02	0.19 ± 0.02
Rimon + Brigade	0.04 ± 0.02	0.06 ± 0.05	0.10 ± 0.04	0.10 ± 0.03
Beleaf	0.08 ± 0.02	0.06 ± 0.01	0.09 ± 0.02	0.17 ± 0.07
Belay (L)	0.04 ± 0.03	0.06 ± 0.01	0.03 ± 0.01	0.07 ± 0.02
Belay (H)	0.02 ± 0.01	0.01 ± 0.01	0.12 ± 0.04	0.12 ± 0.03
tolfenpyrad SC	0.09 ± 0.03	0.07 ± 0.07	0.06 ± 0.05	0.11 ± 0.07
tolfenpyrad EC	0.03 ± 0.01	0.10 ± 0.04	0.09 ± 0.02	0.19 ± 0.04
sulfoxaflor (L)	0.06 ± 0.03	0.10 ± 0.02	0.09 ± 0.06	0.15 ± 0.06
sulfoxaflor (M)	0.02 ± 0.01	0.11 ± 0.04	0.07 ± 0.03	0.16 ± 0.03
sulfoxaflor (H)	0.08 ± 0.01	0.12 ± 0.02	0.10 ± 0.03	0.09 ± 0.03

Pre-treat count = 0.061 small Lygus nymphs per plant, 0.022 large Lygus nymphs per plant, and 0.015 Lygus adults per plant, for a total of 0.098 Lygus per plant

Percent fruit damage at 3, 4 and 5 weeks

Treatment	Percent fruit damaged per plot		
	10/20/11	10/27/11	11/3/2011
Untreated	16.09 ± 1.22	8.64 ± 2.84	24.35 ± 7.33
Brigade	11.66 ± 1.03	9.85 ± 3.94	9.57 ± 4.91
Actara + Brigade	9.79 ± 0.25	8.45 ± 0.17	11.55 ± 2.78
Rimon	7.77 ± 1.29	4.24 ± 1.34	9.31 ± 1.19
Rimon + Brigade	5.17 ± 0.78	4.19 ± 0.97	7.23 ± 0.33
Beleaf	10.73 ± 2.28	8.99 ± 1.06	12.83 ± 1.30
Belay (L)	9.59 ± 3.04	5.78 ± 2.52	6.31 ± 2.80
Belay (H)	13.17 ± 2.16	4.91 ± 1.32	11.36 ± 3.99
tolfenpyrad 15 SC	10.74 ± 1.10	7.03 ± 2.60	11.73 ± 2.40
tolfenpyrad 15 EC	12.08 ± 1.97	4.76 ± 1.88	8.16 ± 0.91
sulfoxaflor (L)	12.37 ± 2.86	7.42 ± 1.86	7.06 ± 2.16
sulfoxaflor (M)	10.57 ± 2.04	7.77 ± 1.79	10.03 ± 3.00
sulfoxaflor (H)	10.53 ± 2.28	7.59 ± 1.21	10.25 ± 2.72

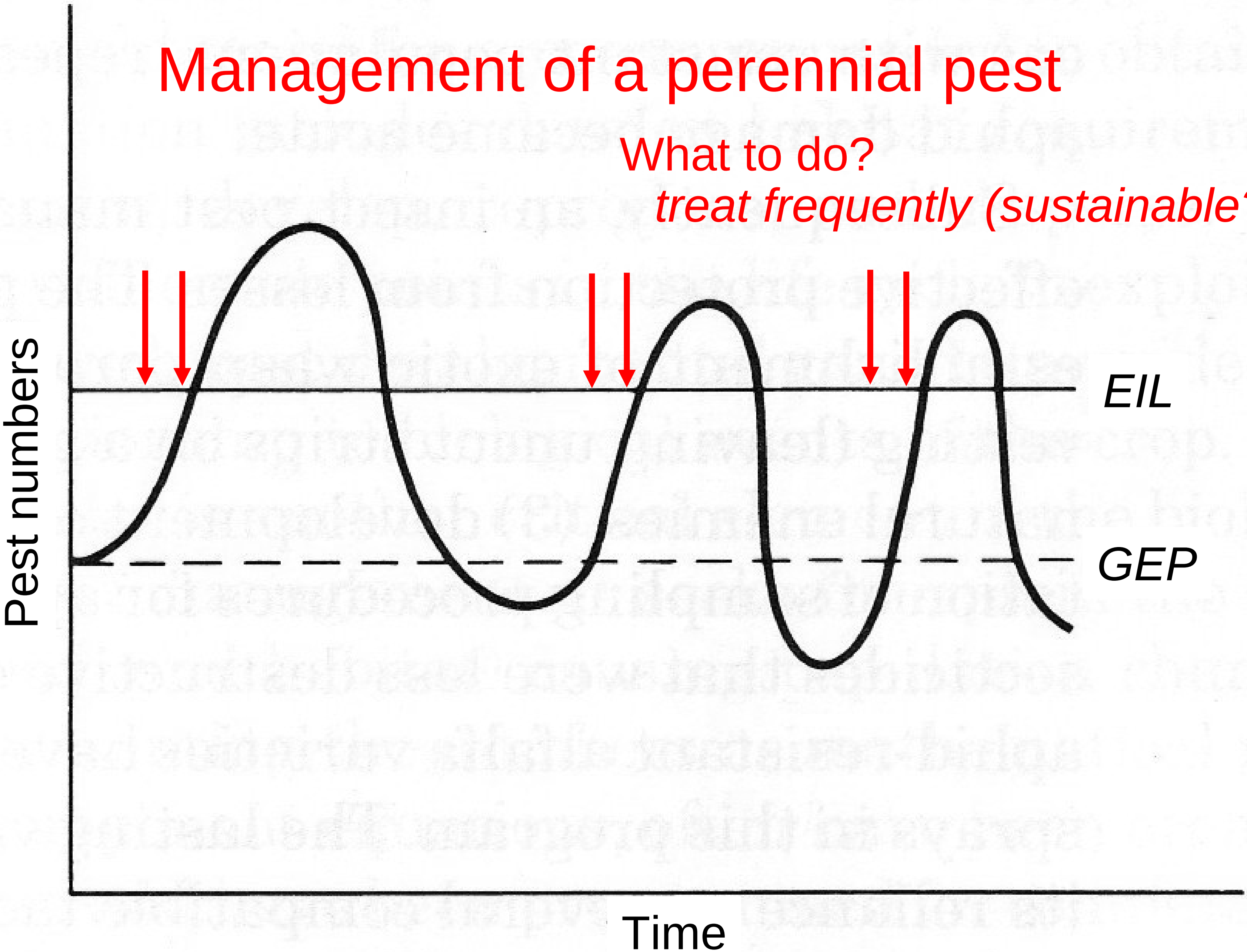
Percent fruit damage reduction at 3, 4 and 5 weeks

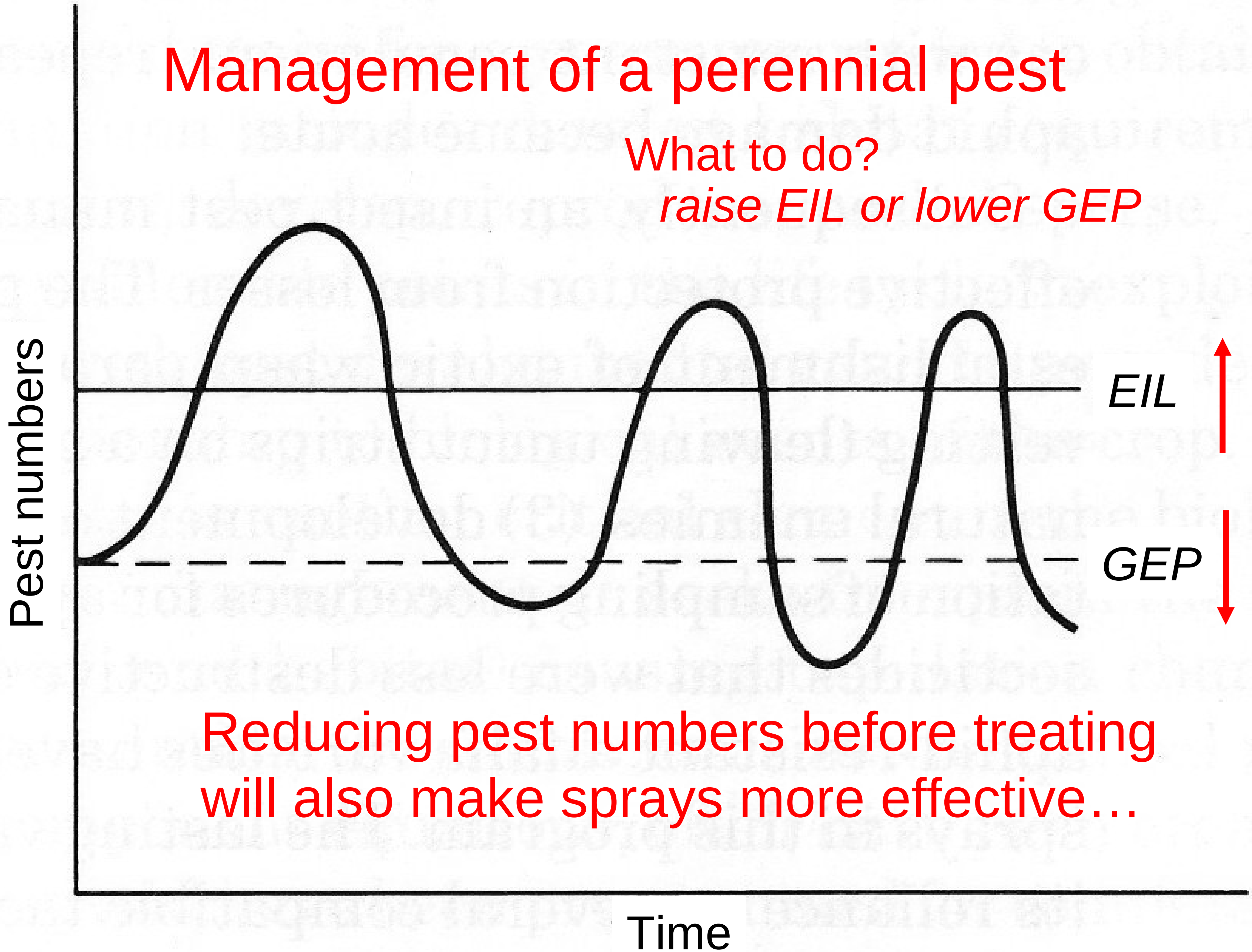
Treatment	Percent damage reduction 10/20/11	10/27/11	11/3/11	Average
Untreated				
Brigade	27.52	-14.11	52.57	21.99
Actara + Brigade	39.16	2.10	59.33	33.53
Rimon	51.72	50.90	70.30	57.64
Rimon + Brigade	67.87	51.44	47.30	55.54
Beleaf	33.34	-4.15	74.08	34.42
Belay (L)	40.39	33.02	53.34	42.25
Belay (H)	18.14	43.18	51.83	37.72
tolfenpyrad 15 SC	33.26	18.55	66.50	39.44
tolfenpyrad 15 EC	24.93	44.88	70.99	46.93
sulfoxaflor (L)	23.13	14.11	58.81	32.02
sulfoxaflor (M)	34.30	9.98	57.88	34.05
sulfoxaflor (H)	34.55	12.10	60.69	35.78

Management of a perennial pest

What to do?

treat frequently (sustainable?)




Management of a perennial pest
What to do?
raise EIL or lower GEP
EIL
GEP
Pest numbers
Time
Reducing pest numbers before treating
will also make sprays more effective…

Lygus Management

- Prevention - keep Lygus out of the field
  - Avoid sources -
    - second year fields harbor Lygus
    - destroy weeds in spring before nymphs become adults
- Reduce Lygus density -
    - vacuums?
    - reflective mulch?

Lygus Management

- Monitoring - determine when nymphs are present in nearby weeds and in the field
- Treat at the most effective time based on type of chemical
  - Rimon - against early season nymphs; tank mix later season
- Don’t overuse the same type of chemical

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