Bloom Period Management of Lygus bug in Alfalfa Seed

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Lygus biology & life cycle

Serious pest of alfalfa seed and other seed crops

- Overwinter as adults (late Oct. to Nov. in ID)
  - Plant crowns, litter, & debris
  - Fields, field margins
  - Natural areas
- Become active and mate in spring (~April)

Lygus biology & life cycle

- Females insert eggs in plant tissue
  - Hatch in 1-4 weeks
- Immatures (nymphs)
  - Develop through 5 instars in 1 to 2 months
  - 1 distinct and 2 to 3 overlapping generations per year in SW Idaho

Lygus biology & life cycle

- Prefer to feed on reproductive plant parts
  - Flowers, seeds
- Prefer reproductive stage alfalfa to nearly any other plant
  - *Lygus* + alfalfa grown for seed = the perfect storm

Lygus damage

Lygus bugs feed using needle-like mouthparts, injecting salivary enzymes into plant tissue

Two types of damage

- Physical damage from probing
- Chemical damage from digestive enzymes
  - Causes most damage
  - Kills plant tissue
  - Causes deformed growth
- Damage caused by adults and nymphs

Lygus damage

- Feed on developing flower buds, flowers, & immature pods
  - Drying (blasting) of flower buds
  - Flower, seed pod drop
- Reduction in seed yield possible with heavy infestations

Lygus damage to alfalfa seed

Most damage from feeding on immature seeds in developing pods

- Most (> 70%) damage caused by 4th and 5th instars and adults
- Damage is to green seed: stylets can't penetrate hard seed
- Without management, losses of 50% to nearly 100% are possible

Lygus management

Managed largely with insecticides

- A number of insecticides labeled for lygus control
  - Broad spectrum OP's, carbamates, pyrethroids
  - Several lower-risk insecticides available
- Usefulness of available compounds limited by
  - Efficacy and resistance management issues
  - Toxicity to beneficial insects
    - Natural enemies, but especially
    - Pollinators: ID-alfalfa leafcutting bee (ALCB)
- Need for effective, bee-safe insecticides

2013 *Lygus* Efficacy Trials in Alfalfa Seed

- Trial 1:
  - Pesticide rotations for lygus control in bloom period alfalfa seed
    - Assail 30WP (acetomiprid; 2007)
    - Beleaf (flonicamid: 2007)
    - Rimon (novaluran: 2006)
    - Transform SG (sulfoxaflor: 2014?)
    - Warrior
- Trial 2:
  - Grandevo for lygus control in bloom period alfalfa seed

Trial 2: Grandevo during bloom

❖ Grandevo (Marrone Bio Innovations)

- Insecticide class: microbial/ bio-insecticide, *Chromobacerium subtsugae* and fermentation products
- IRAC resistance group: unknown
- Mode of action: unknown, likely complex
- Route: ingestion, repellency, reduced fecundity
- Systemic in plant: no
- Insect stages affected: adult and immature insects, especially early instars.
- Activity spectrum: broad spectrum, chewing and sucking insects

Trial 1: Insecticides for Bloom Period Rotation

❖ Assail 70WP (United Phosphorus, Inc.)

- Insecticide class: neonicotinoid
- IRAC resistance group: 4A
- Mode of action: nerve poison. Mimics acetocholine and binds to nicotinic acetocholine receptors: over stimulation of nerve signals at synapse
- Route: ingestion and contact
- Systemic in plant: Yes, especially foliar applications
- Insect stages affected: adult and immature insects, especially early instars
- Activity spectrum: Sucking insects (aphids, plant bugs), some activity on chewing insects

Trial 1: Insecticides for Bloom Period Rotation

❖ Transform WG (Dow AgroSciences, LLC)

- Insecticide class: neonicotinoid
- IRAC resistance group: 4C, only member of this subgroup
- Mode of action: nerve poison. Mimics acetocholine and binds to nicotinic acetocholine receptors: over stimulation of nerve signals at synapse
- Route: ingestion
- Systemic in plant: translaminar
- Insect stages affected: adult and immature insects, especially early instars.
- Activity spectrum: sucking insects only (aphids, plant bugs)

Trial 1: Insecticides for Bloom Period Rotation

❖ BeLeaf 50SG (FMC Corp)

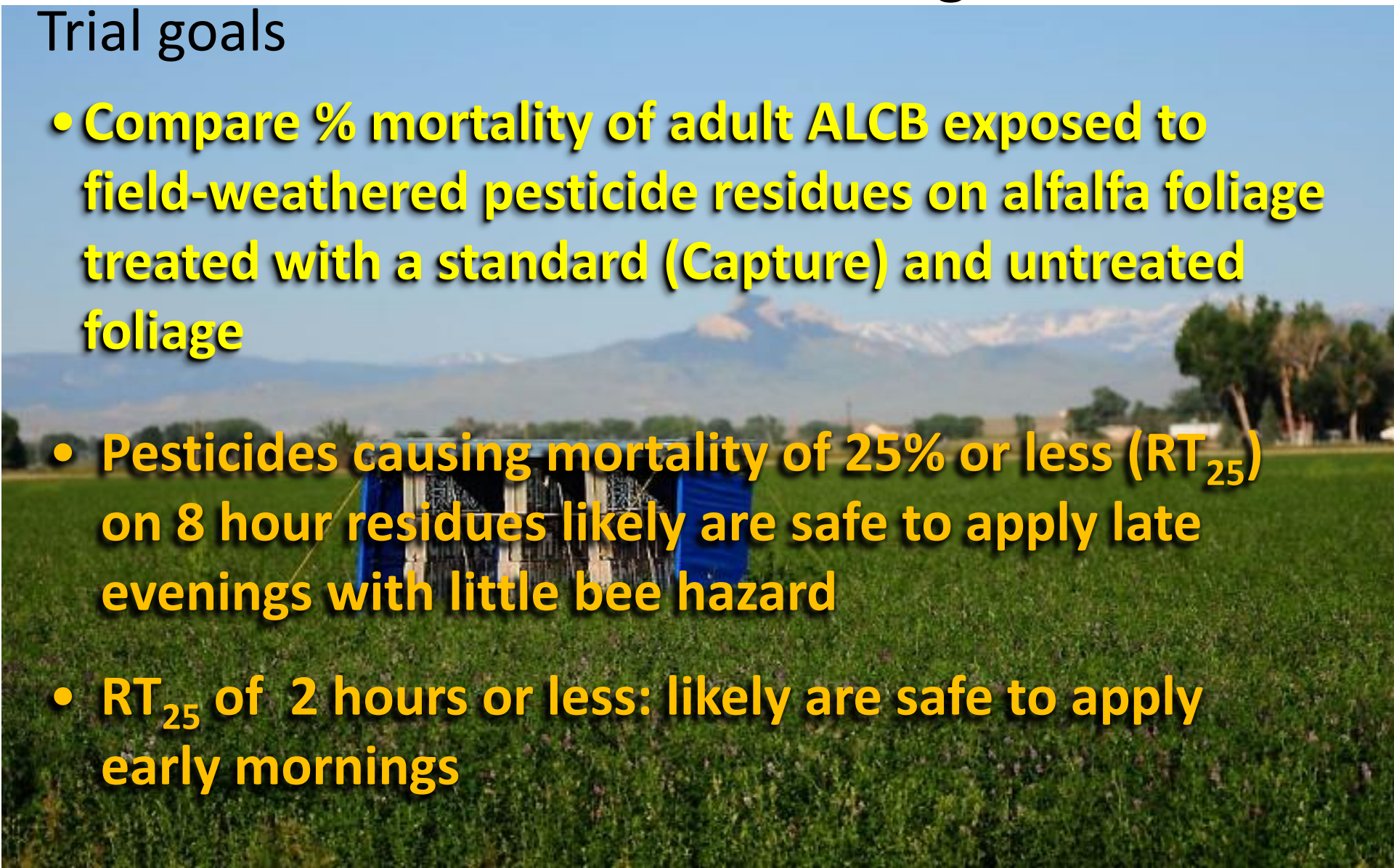
- Insecticide class: pyridinecarboxamide, feeding inhibitor
- IRAC resistance group: 9C
- Mode of action: nerve poison. Blocks pre-synaptic potassium channels resulting in uncontrolled acetocholine release at synapse
- Route: ingestion
- Systemic in plant: translaminar
- Insect stages affected: adult and immature insects, especially early instars.
- Activity spectrum: sucking insects only (aphids, plant bugs). Slow acting

Trial 1: Insecticides for Bloom Period Rotation

❖ Rimon 0.83EC (Chemtura Corp.)

- Insecticide class: benzoylphenylurea, insect growth regulator (CSI/IGR)
- IRAC resistance group: 15
- Mode of action: disrupts cuticle (chiton) synthesis, prevents molting (growth from one insect stage (instar) to the next)
- Route: ingestion and contact
- Systemic in plant: No
- Insect stages affected: immatures, especially early instars. Some activity against eggs. No adult activity
- Activity spectrum: broad, especially chewing insects, but some activity on sucking insects (aphids, plant bugs, etc.). Slow acting. Toxic to bee larvae

Residual toxicity (RT) of insecticides to adult alfalfa leafcutting bees



Trial goals

- **Compare % mortality of adult ALCB exposed to field-weathered pesticide residues on alfalfa foliage treated with a standard (Capture) and untreated foliage**
- **Pesticides causing mortality of 25% or less (RT_{25}) on 8 hour residues likely are safe to apply late evenings with little bee hazard**
- **RT_{25} of 2 hours or less: likely are safe to apply early mornings**

ALCB Residual toxicity trial

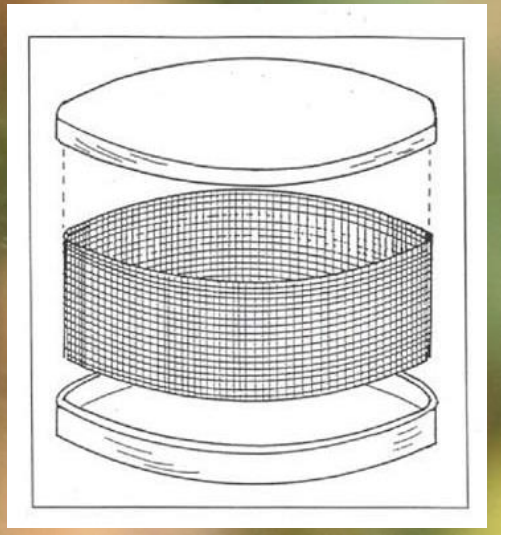
Trial methods

- **Experimental design**
  - 4 rows x 30ft
  - Randomized complete block
  - Treatments: insecticides at labeled rates
  - 4 replications
- **Application**
  - Foliar spray, CO_2 backpack sprayer hand held boom
  - 30 gal/a @ 30 psi

ALCB Residual toxicity trial

Trial methods

- **Sampling**
  - Hand collected foliage from plots at 2, 8, 24, 48 and 96 hours after treatment (~ 400 cm^3)
  - Collect live bees from domiciles in grower fields
  - Confine bees on field-weathered foliage (20-30/rep)
  - Determine mortality after 24 hrs.
- **Statistical analysis**
  - Analysis of Variance of % mortality adjusted for control mortality



RT_{25} (hrs) for selected insecticides to adult beneficial insects

Pesticide	Beneficial Insect			
	ALCB	Bigeyed bug	Damsel bug	Minute pirate bug
Assail	**4**	4	4	~96
Beleaf	**2**	2	2	2
Capture	**>96**	>96	>96	~96
Carzol	**4**	96	48	>96
Grandevo*	**?**	?	?	?
Rimon	**4**	4	4	4
Transform	**2**	?	?	?

RT_{25} ≤ 2: apply when bees are not foraging

RT_{25} ≤ 8: apply during late evening or night

***Grandevo causes little or no bee mortality but may repel bees for several days**

Rimon Impact on Bee Return

Labeled for bloom period lygus bug control in alfalfa seed

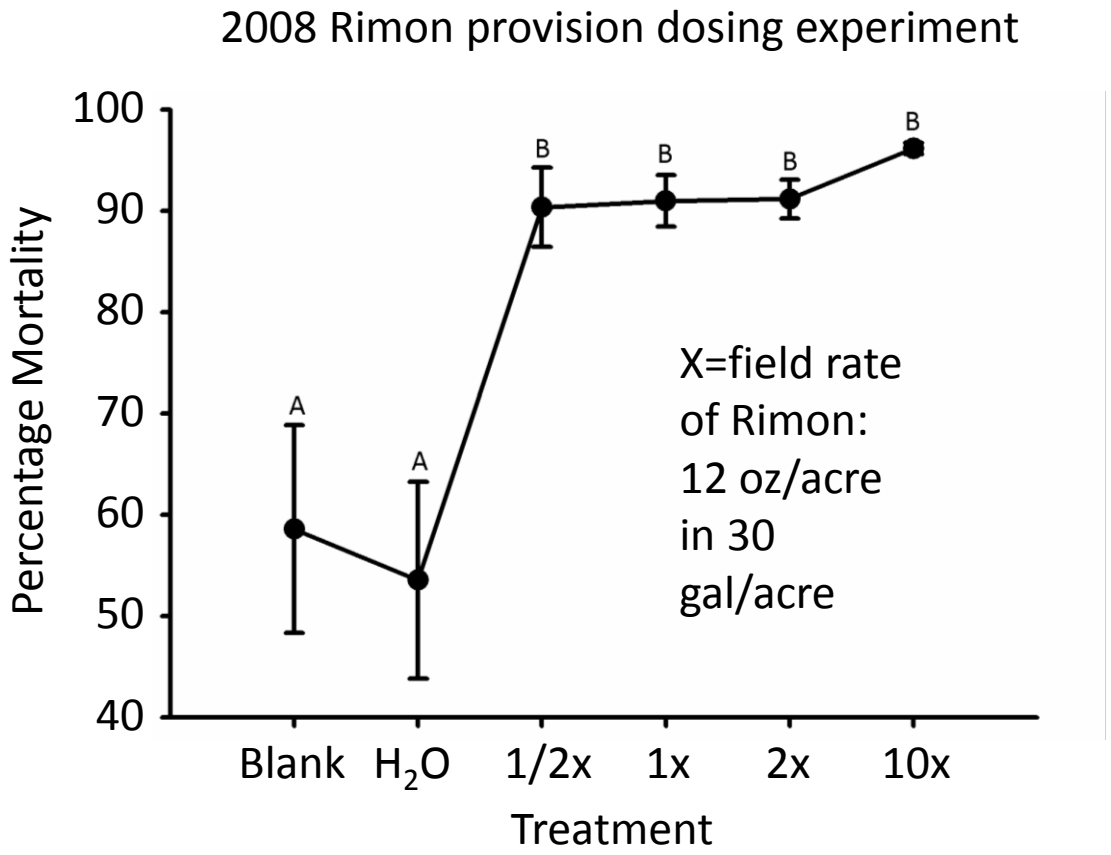
- Effective lygus control
- Safe to adult ALCB
- Toxic to ALCB larvae
- Can reduce alfalfa leafcutting bee (ALCB) return

- Directly, by contact of eggs and larvae with contaminated provisions and nesting material
- Indirectly, through adult ingestion of Rimon in nectar or on leaf material

Rimon Impact on Bee Return

Rimon is directly toxic to ALCB eggs on dosed provisions in the laboratory (Hodgson et al. 2011)

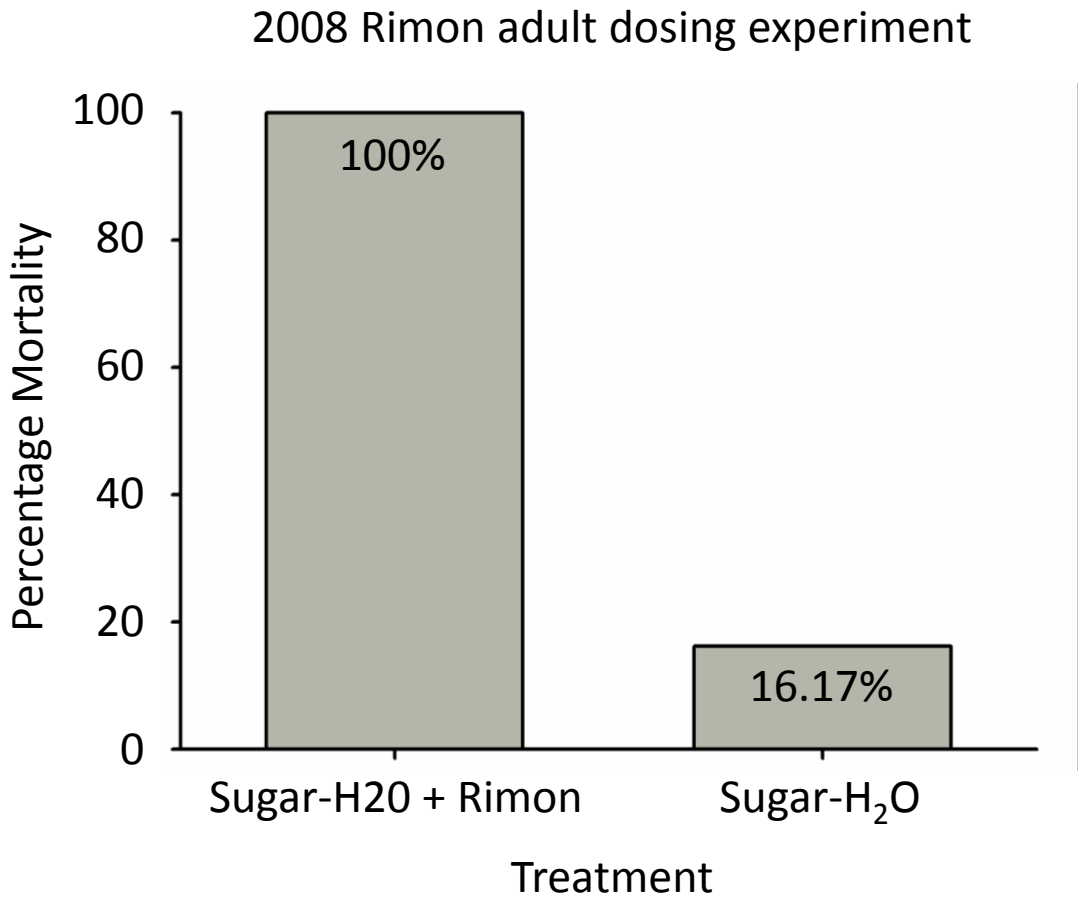
> 90 % mortality of ALCB eggs on Rimon-treated provisions



Rimon Impact on Bee Return

Rimon also is indirectly toxic to ALCB eggs via adult consumption of Rimon in the laboratory (Hodgson et al. 2011)

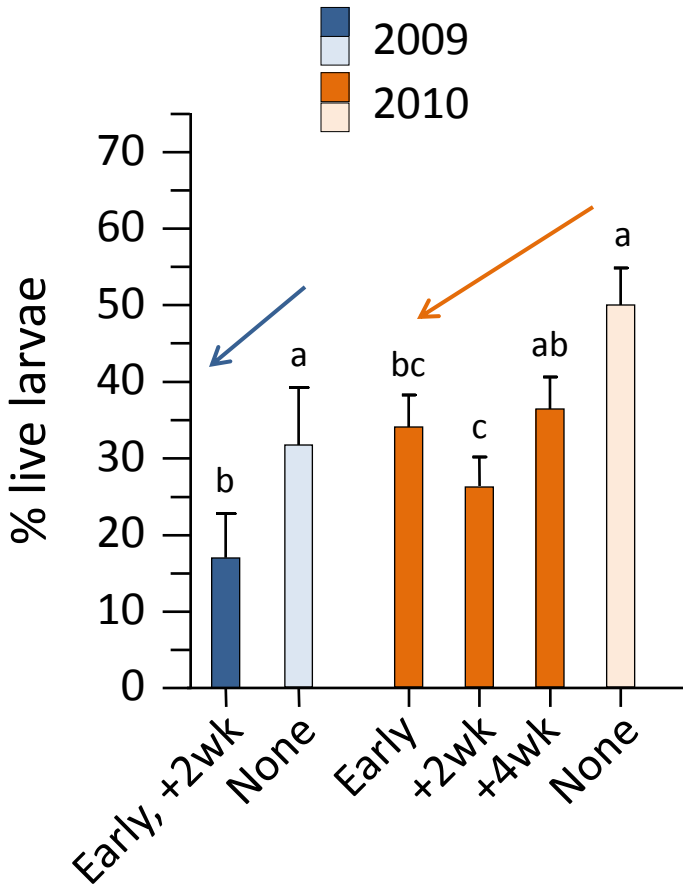
Adults fed Rimon dosed sucrose lay a high percentage of unviable eggs

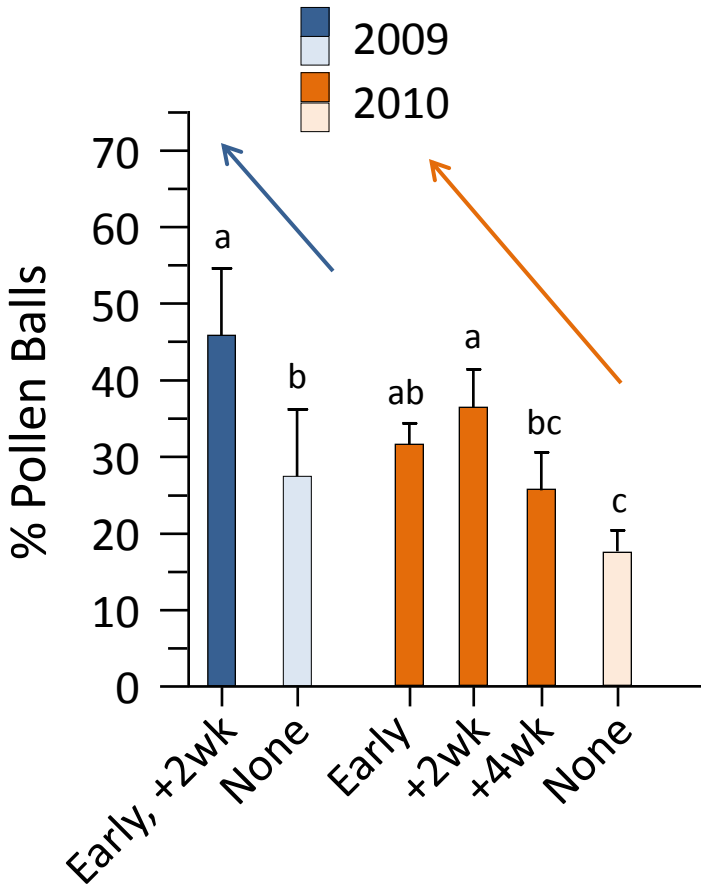


Rimon Impact on Bee Return

Results of lab studies have been confirmed in the field, but effects are not as strong

Lower % live larvae and higher % pollen balls in Rimon-treated fields





Rimon Treatment

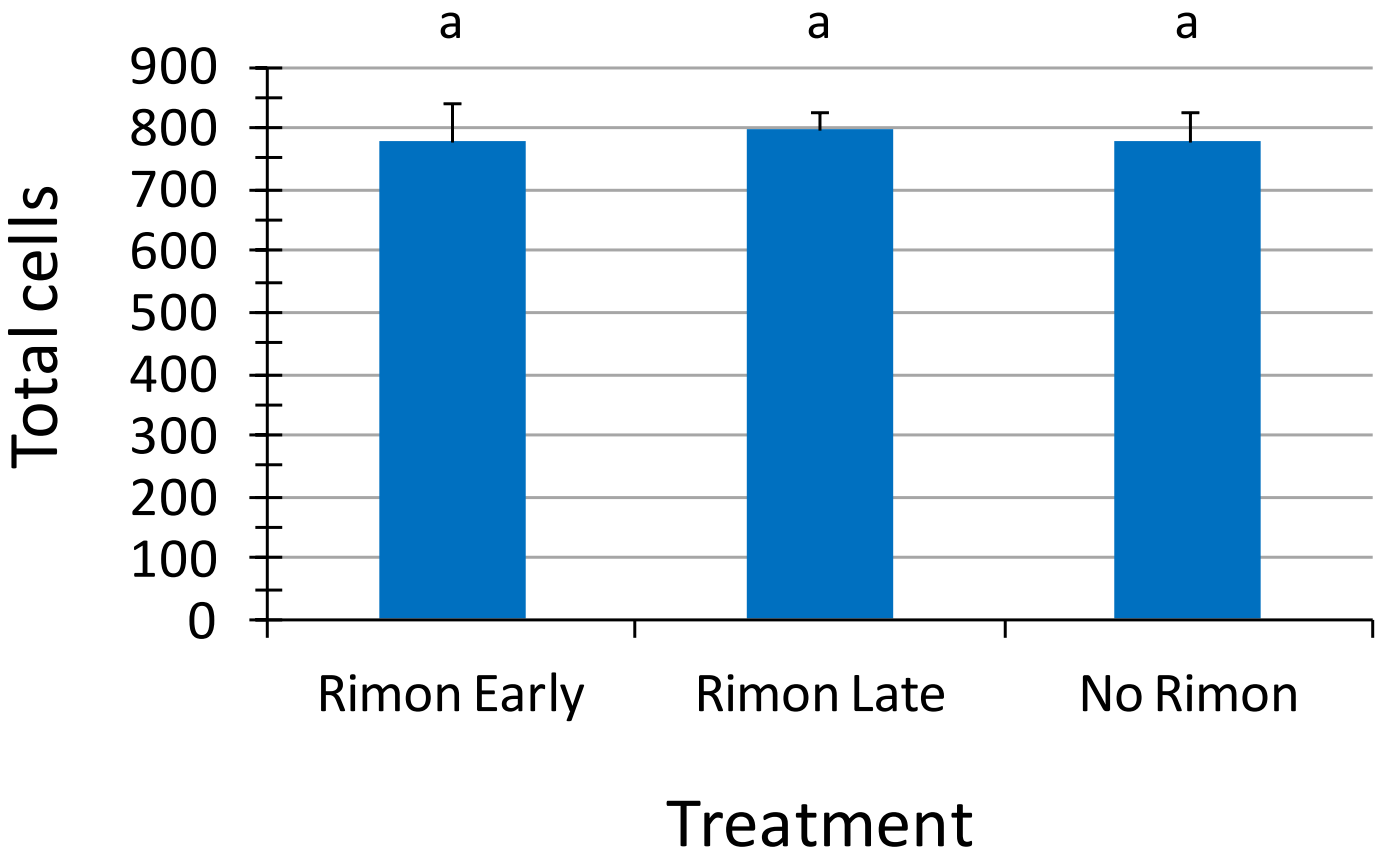
2011 Rimon Bee Return Study

Impact of Rimon application timing on bee return: will later application reduce negative impacts?

- Three bloom period treatments
  - Rimon applied early: as soon as bees actively flying
  - Rimon applied late: three weeks later
  - No Rimon control: grower standard practice
- Rimon applications
  - Single application per treatment @ high rate (12 oz) in 20-30 gpa (made by growers)
  - Made regardless of lygus numbers

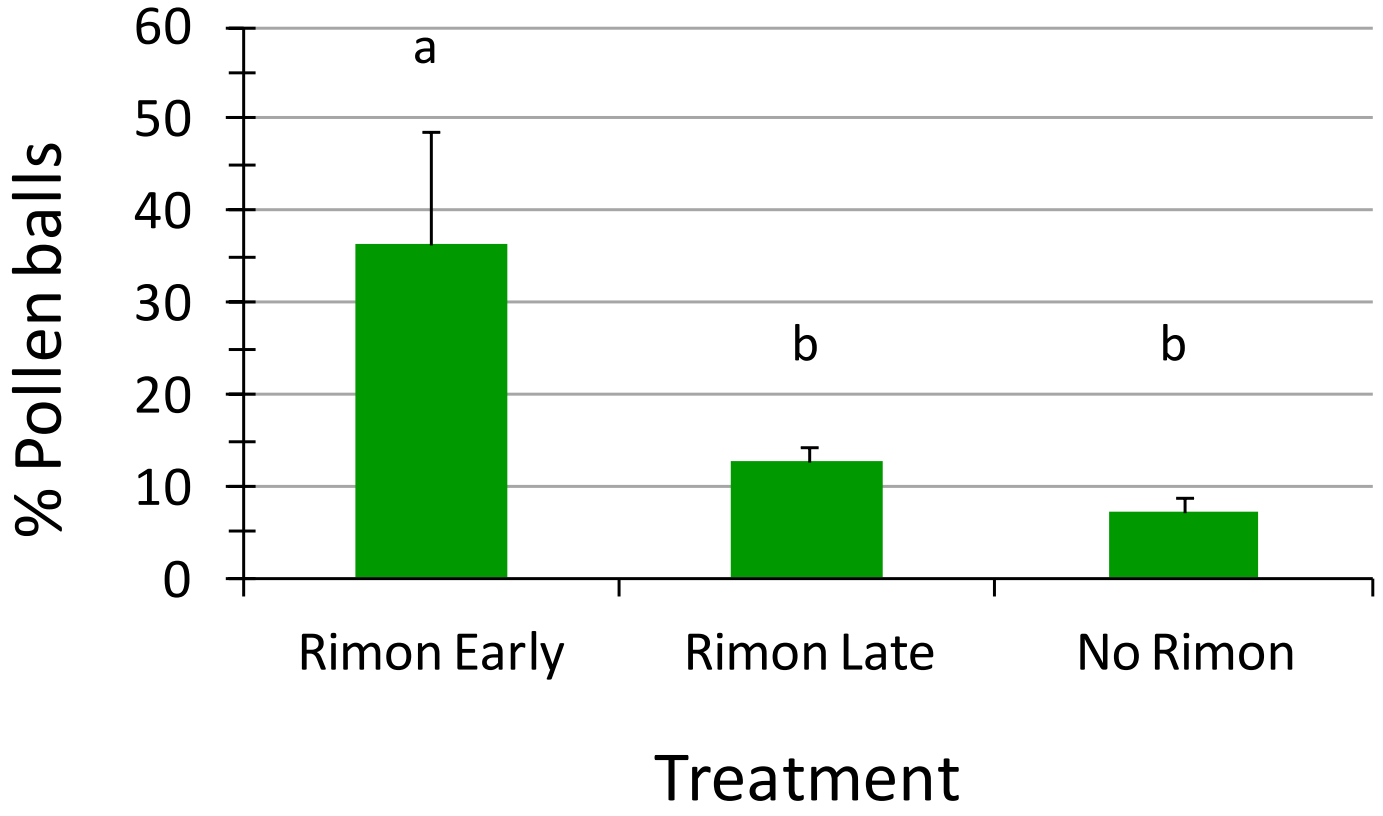
Rimon Impact on Bee Return

Impact of application timing on total number of cells per sample



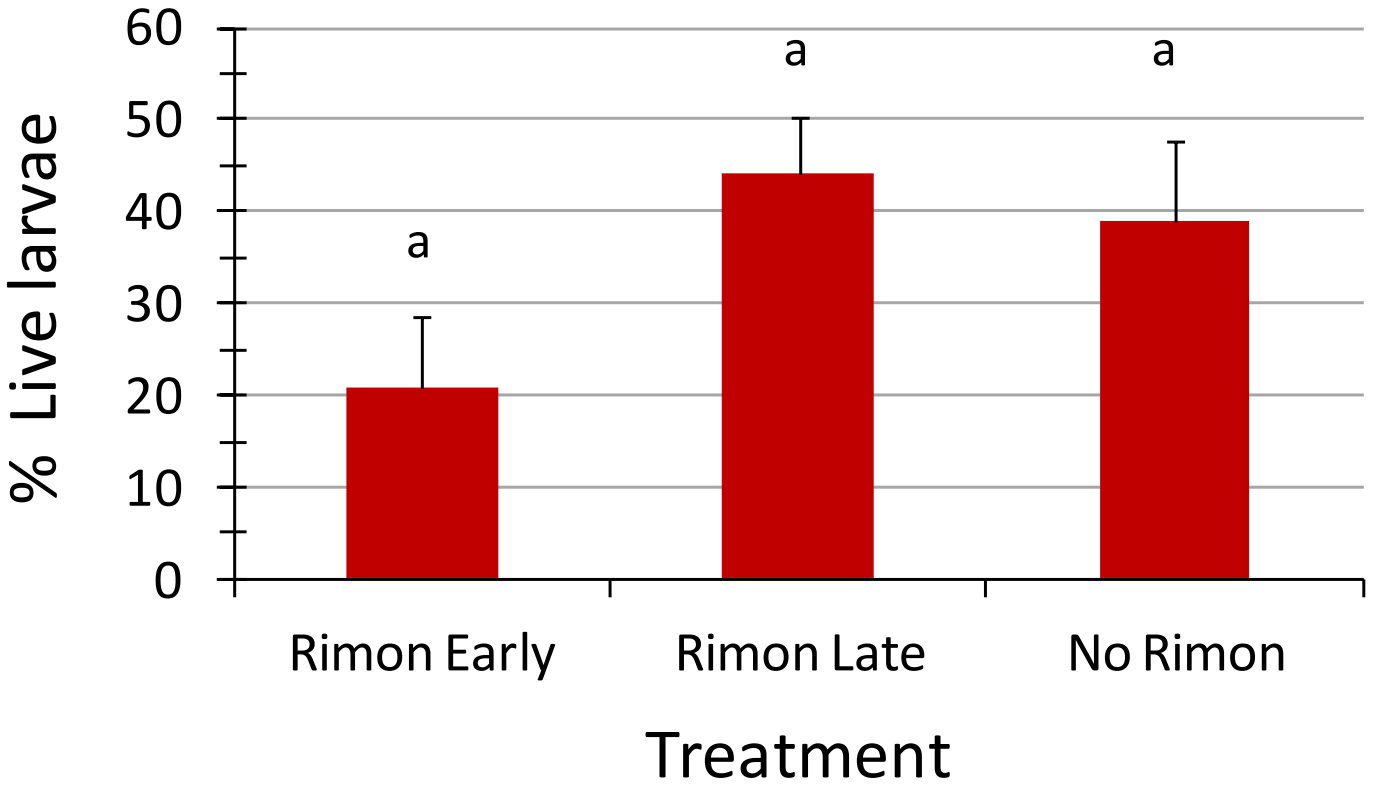
Rimon Impact on Bee Return

Impact of application timing on mean percentage pollen balls per sample



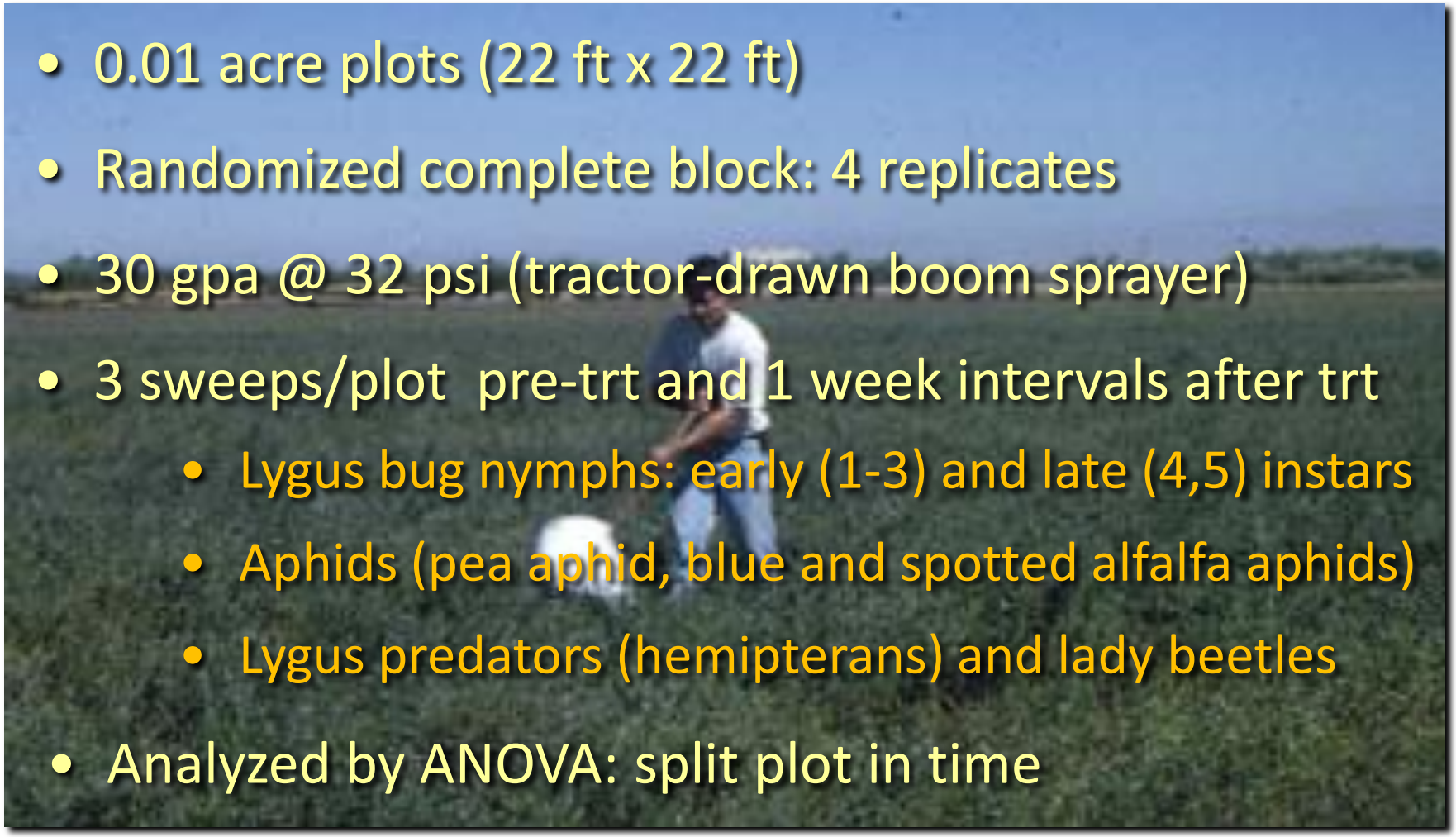
Rimon Impact on Bee Return

Impact of application timing on mean percentage live larvae per sample



2013 Idaho *Lygus* pesticide trials

Pesticide trial methods



- 0.01 acre plots (22 ft x 22 ft)
- Randomized complete block: 4 replicates
- 30 gpa @ 32 psi (tractor-drawn boom sprayer)
- 3 sweeps/plot pre-trt and 1 week intervals after trt
  - Lygus bug nymphs: early (1-3) and late (4,5) instars
  - Aphids (pea aphid, blue and spotted alfalfa aphids)
  - Lygus predators (hemipterans) and lady beetles
- Analyzed by ANOVA: split plot in time

Idaho pesticide efficacy trials

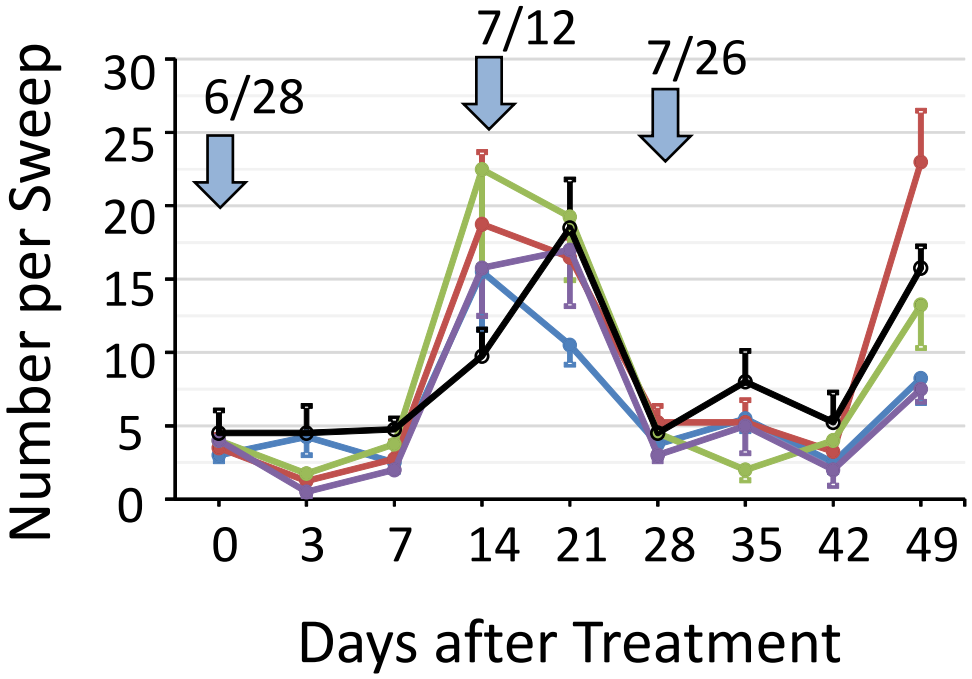
Trial 1. Insecticide rotations for bloom period lygus control

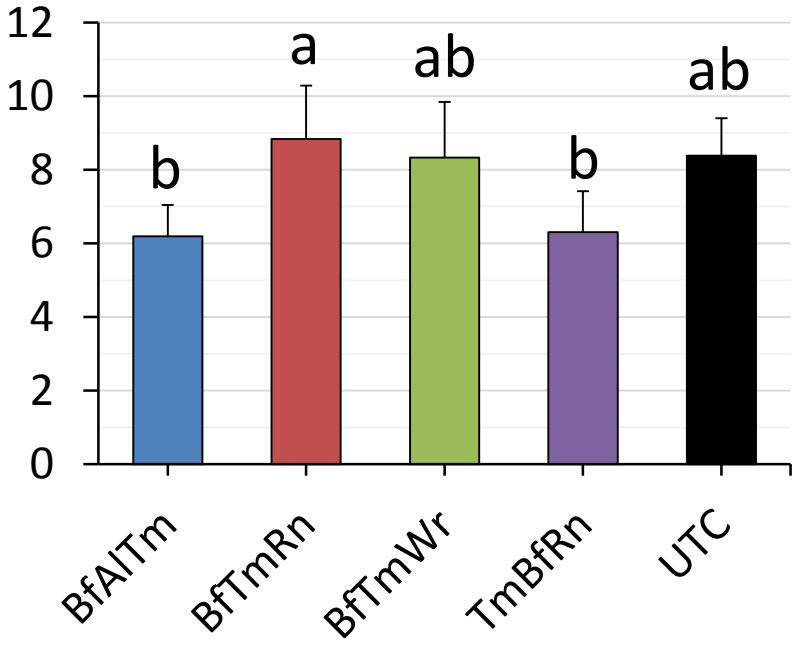
No.	Treatment	ai	IRAC group	Rate
1	Transform BeLeaf Rimon	sulfoxaflor flonicamid novaluron	4C, neonicotinoid 9C, feeding blocker 15, Chiton synthesis inhib.	1.5 oz 2.8 oz 12 oz
2	BeLeaf Transform Rimon			2.8 oz 1.5 oz 12 oz
3	Beleaf Transform Warrior	lambda cyhalothrin		2.8 oz 1.5 oz 1.9 oz
4	Beleaf Assail Transform	acetomiprid	4A, neonicotinoid	2.8 oz 2.3 oz 1.5 oz
5	UTC	n/a	n/a	n/a

Applications at 2 week intervals

Bloom-Period Insecticide Trial 1

Mean number of *Lygus* adults per sample on each sample day and over all sample days on treated and untreated plots



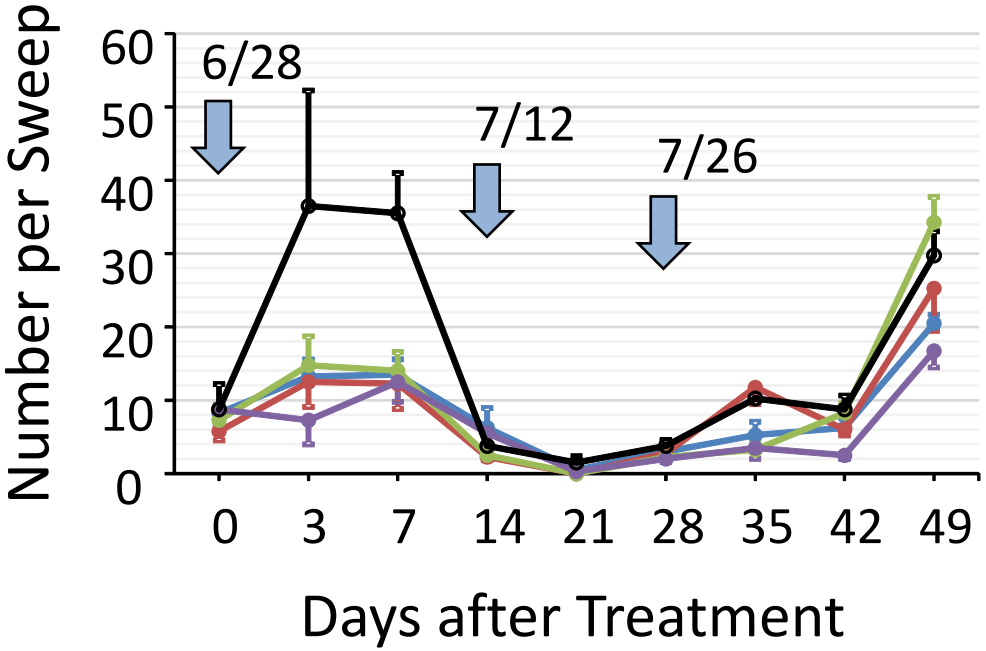


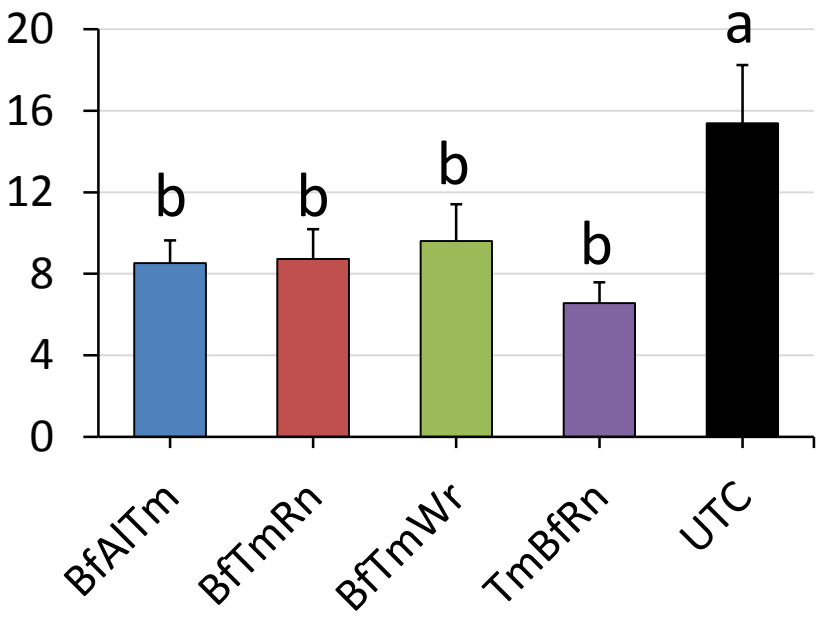
Bf/Al/Tm Bf/Tm/Rn Bf/Tm/Wr

Tm/Bf/Rn UTC

Bloom-Period Insecticide Trial 1

Mean number of small *Lygus* nymphs per sweep on each sample day and over all sample days on treated and untreated plots



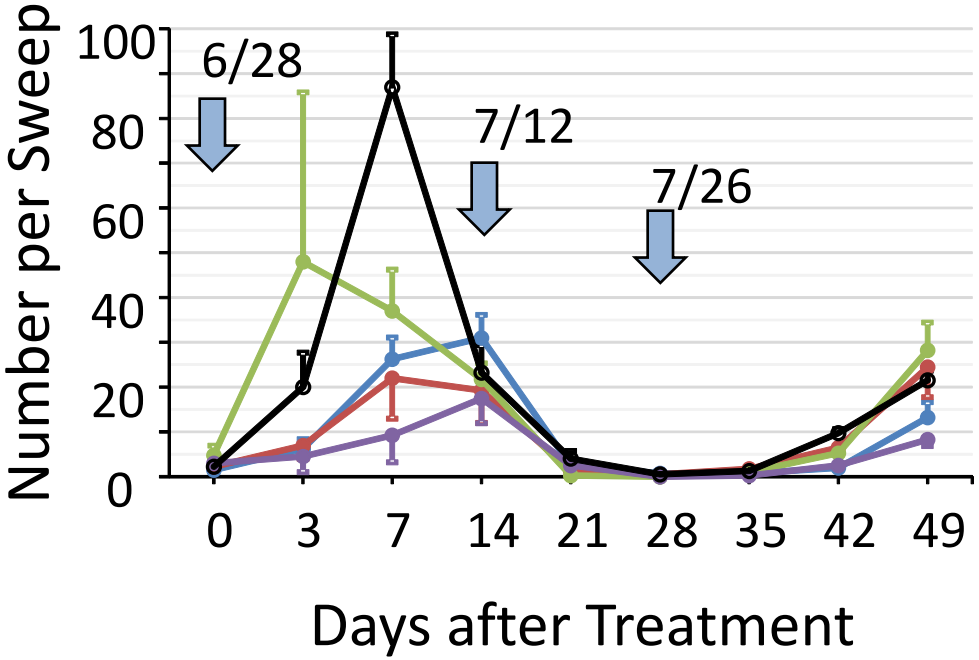


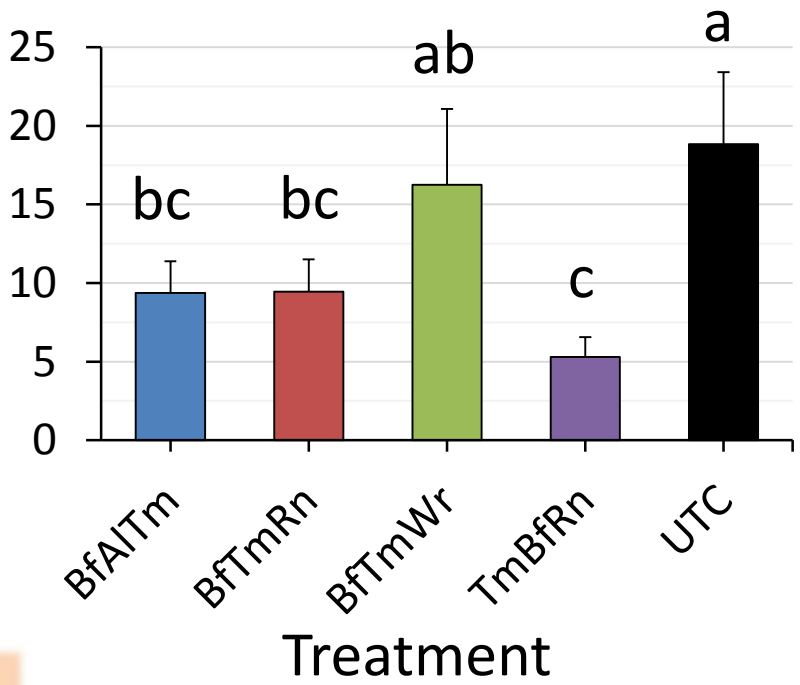
Bf/Al/Tm Bf/Tm/Rn Bf/Tm/Wr

Tm/Bf/Rn UTC

Bloom-Period Insecticide Trial 1

Mean number of large *Lygus* nymphs per sweep on each sample day and over all sample days on treated and untreated plots

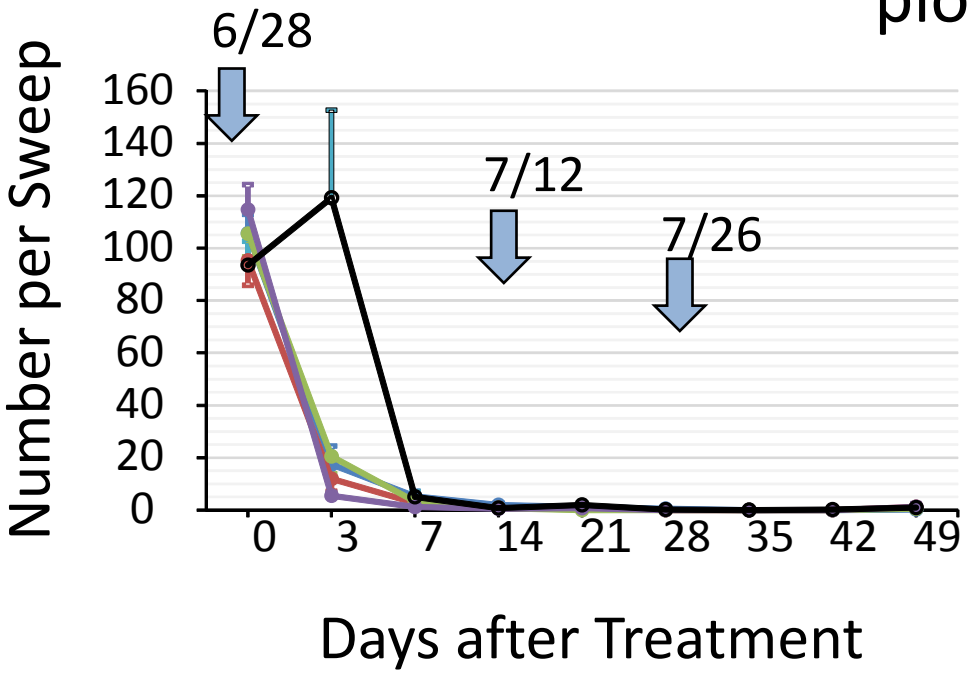


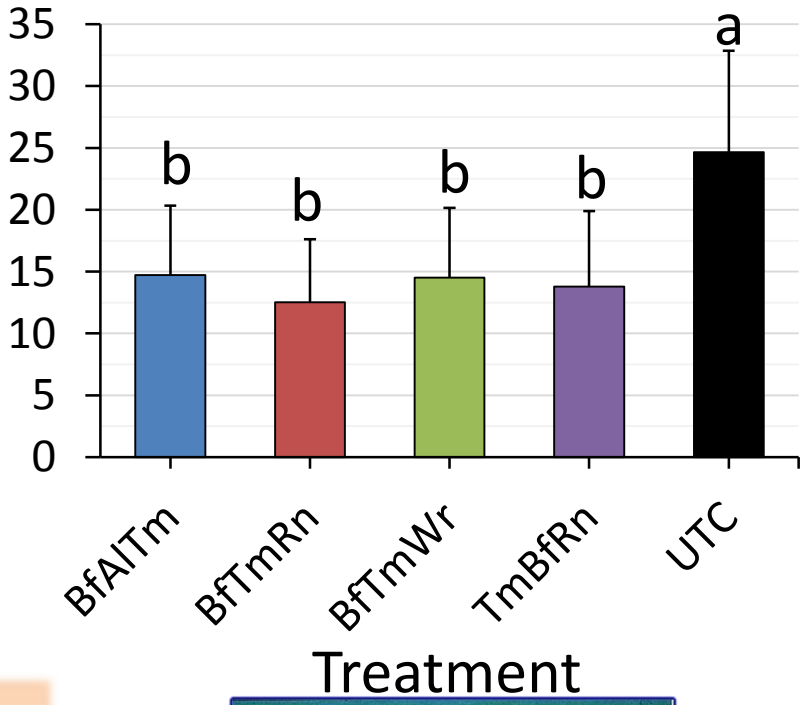


Bf/Al/Tm Bf/Tm/Rn Bf/Tm/Wr Tm/Bf/Rn UTC

Bloom-Period Insecticide Trial 1

Mean number of pea and blue alfalfa aphids per sweep on each day and over all sample days on treated and untreated plots

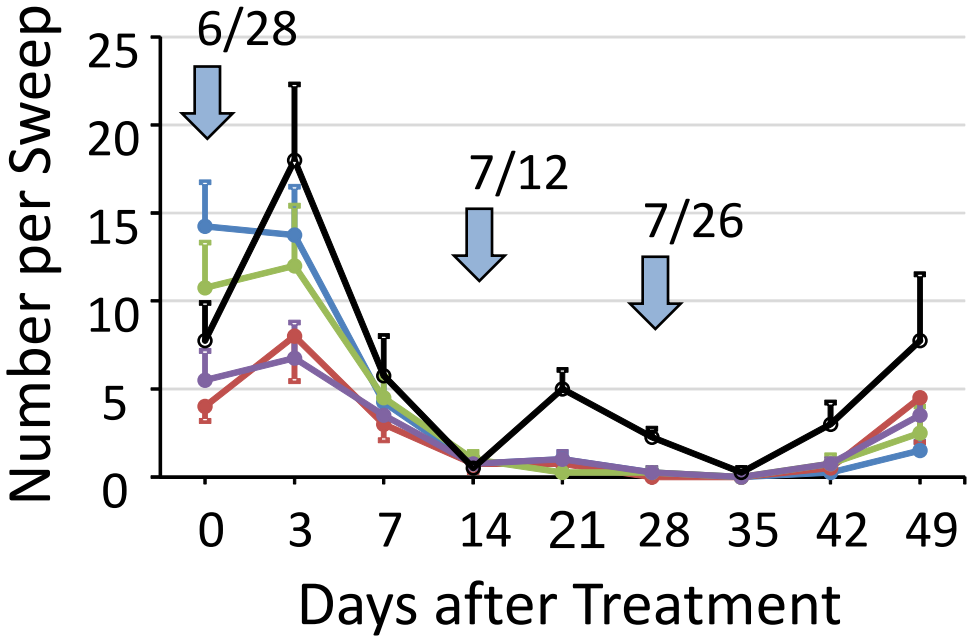


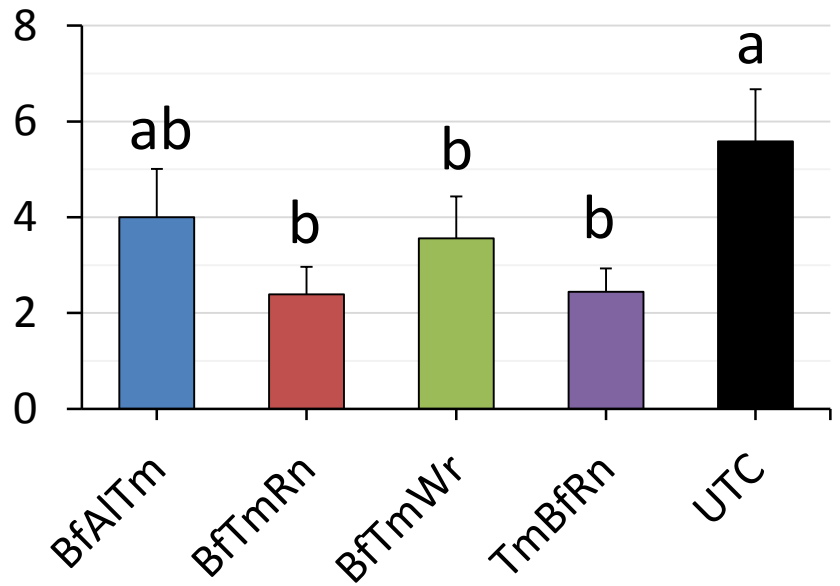


Bf/Al/Tm Bf/Tm/Rn Bf/Tm/Wr Tm/Bf/Rn UTC

Bloom-Period Insecticide Trial 1

Mean number of spotted alfalfa aphids on each sample day and over all sample days on treated and untreated plots



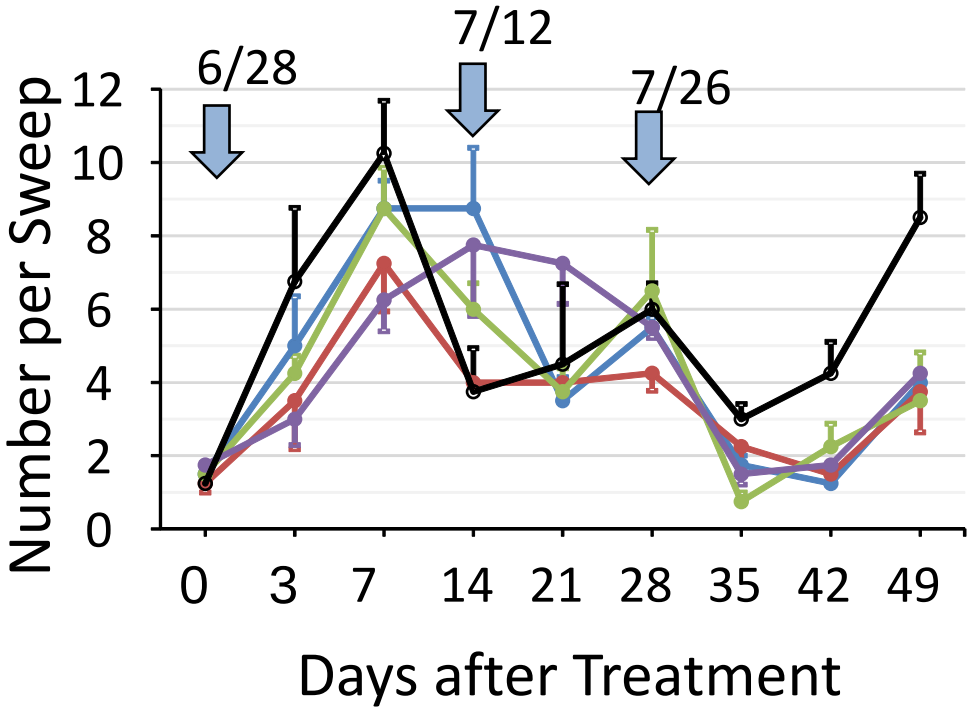


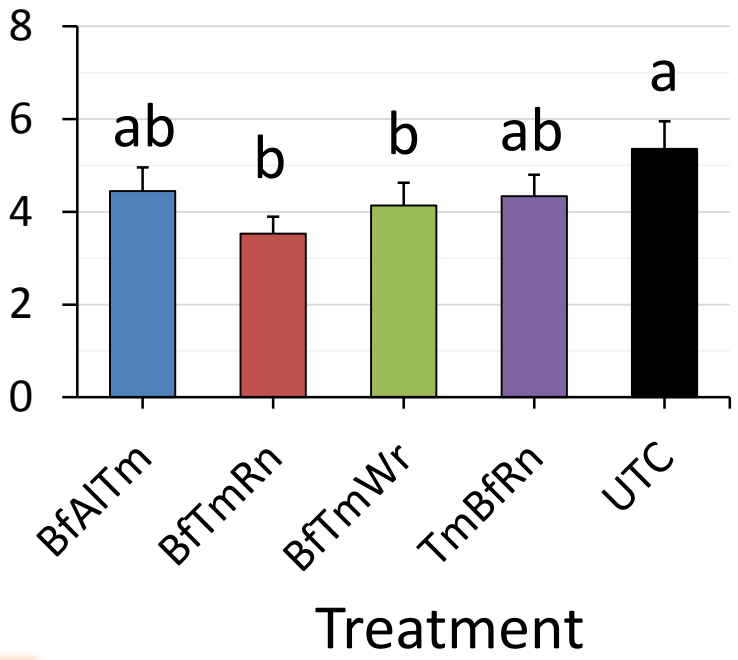
Bf/Al/Tm Bf/Tm/Rn Bf/Tm/Wr

Tm/Bf/Rn UTC

Bloom-Period Insecticide Trial 1

Mean number of lygus predators per sweep on each sample day and over all sample days on treated and untreated plots



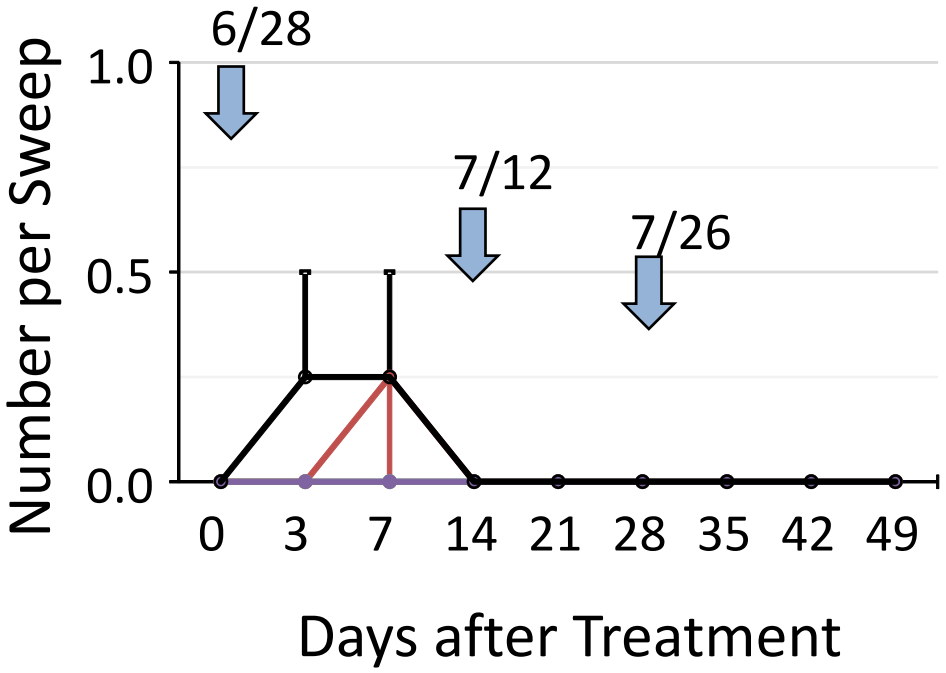


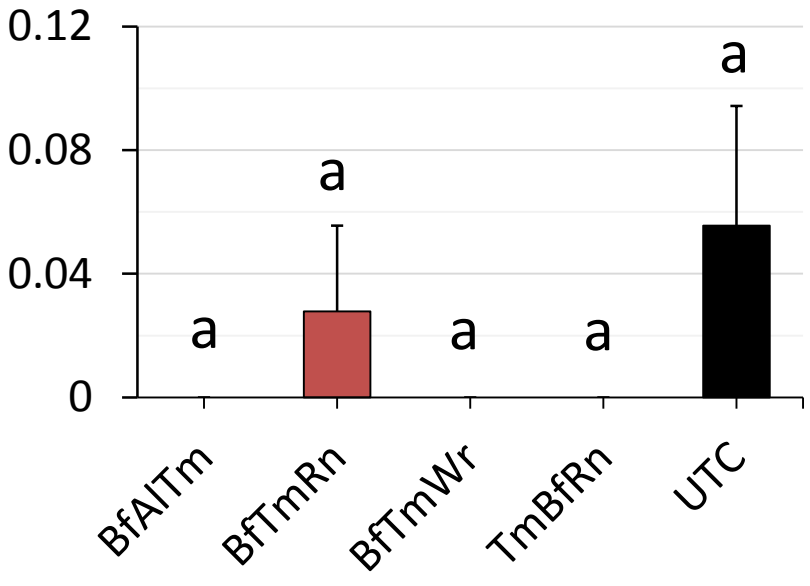
Bf/Al/Tm Bf/Tm/Rn Bf/Tm/Wr

Tm/Bf/Rn UTC

Bloom-Period Insecticide Trial 1

Mean number of lady beetles per sweep on each sample day and over all sample days on treated and untreated plots





Bf/Al/Tm
Bf/Tm/Rn
Bf/Tm/Wr
Tm/Bf/Rn
UTC

Idaho pesticide efficacy trials

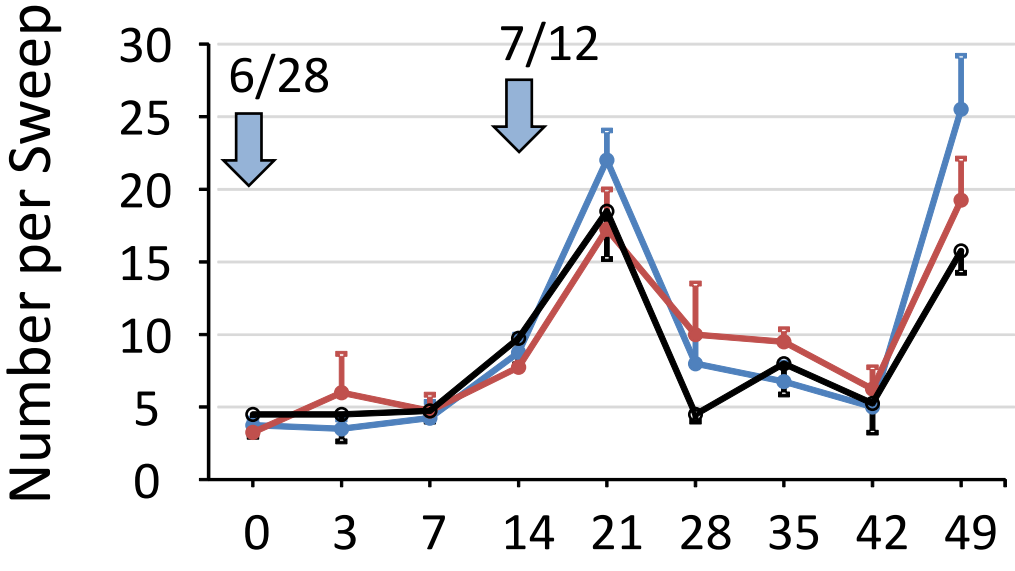
Trial 2. Grandevo for bloom period lygus control

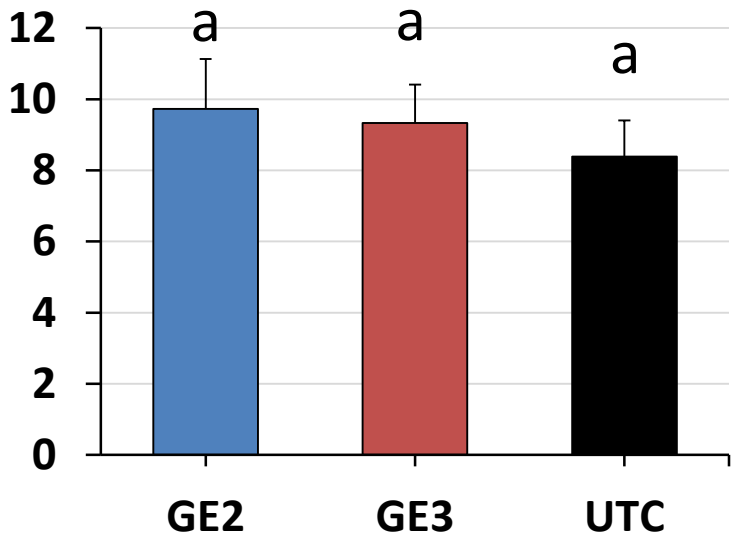
No.	Treatment	ai	IRAC group	Rate
1	Grandevo	*Chromobacterium subtsugae strain PRAA4-1 and fermentation products*	unknown	2 lb.
2	Grandevo			3 lb.
5	UTC	n/a	n/a	n/a

2 Grandevo applications/ treatment, 2 week apart

Bloom-Period Insecticide Trial 2

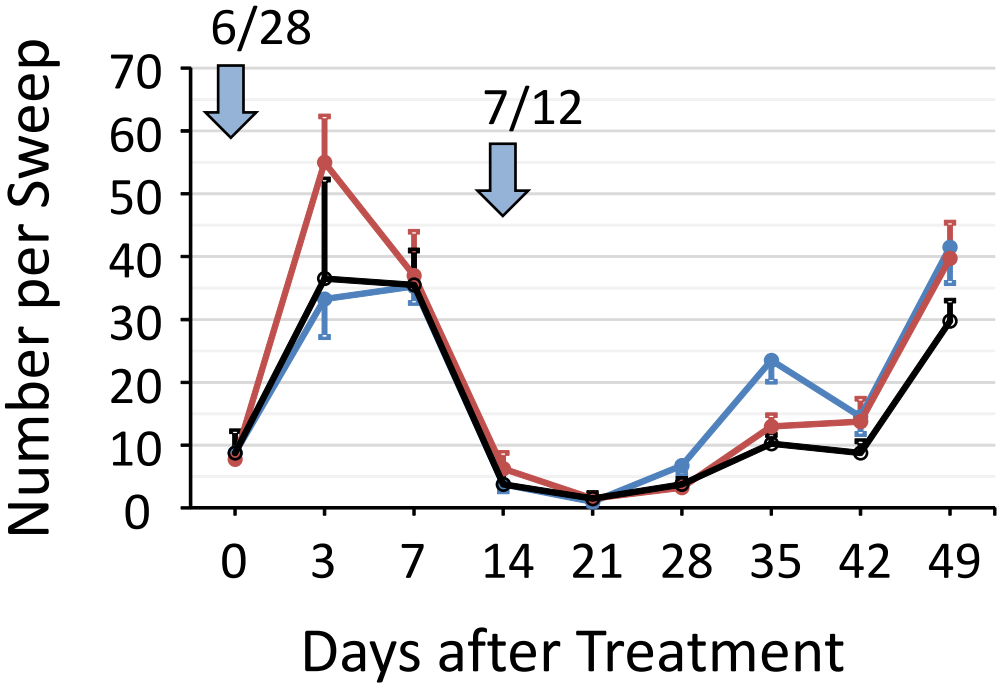
Mean number of *Lygus* adults per sample on each sample day and over all sample days on treated and untreated plots

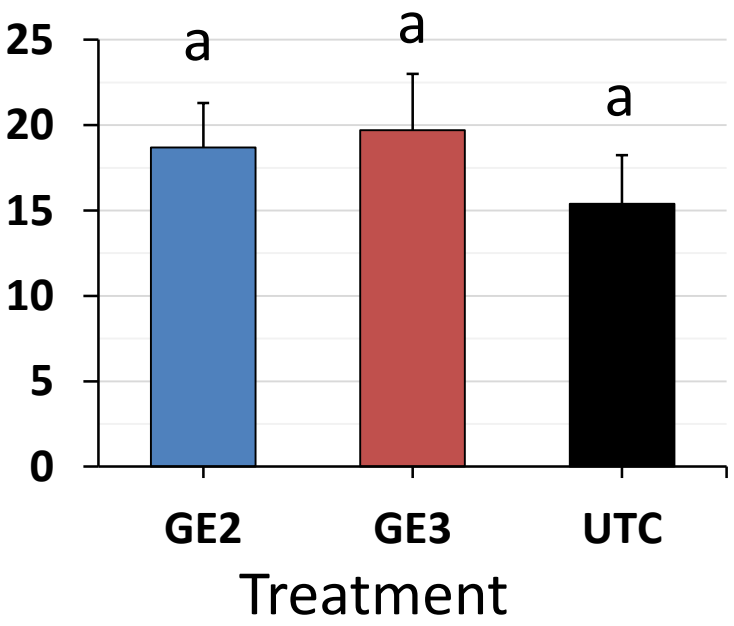




Bloom-Period Insecticide Trial 2

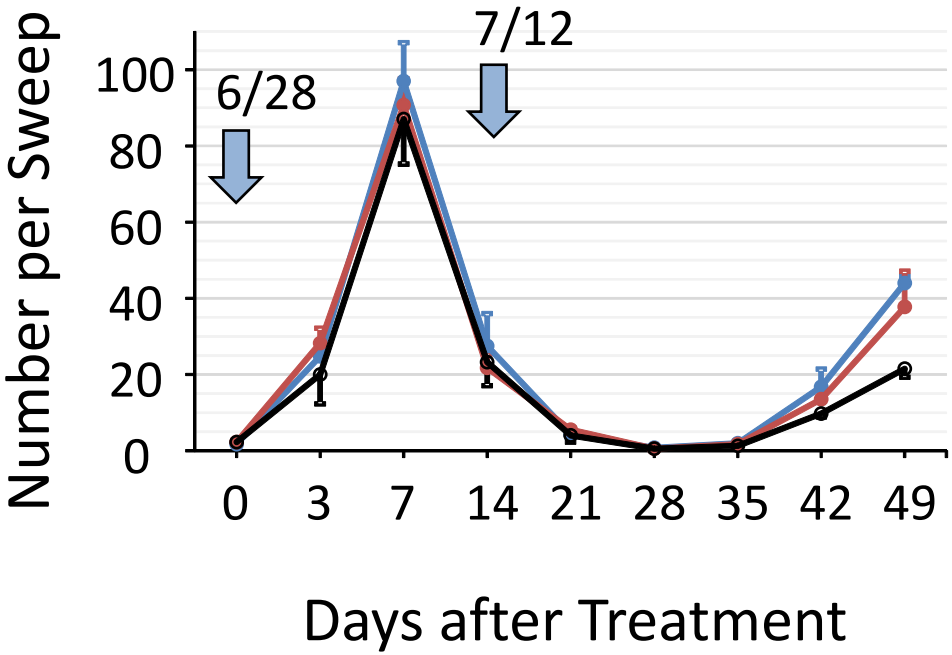
Mean number of small *Lygus* nymphs per sweep on each sample day and over all sample days on treated and untreated plots

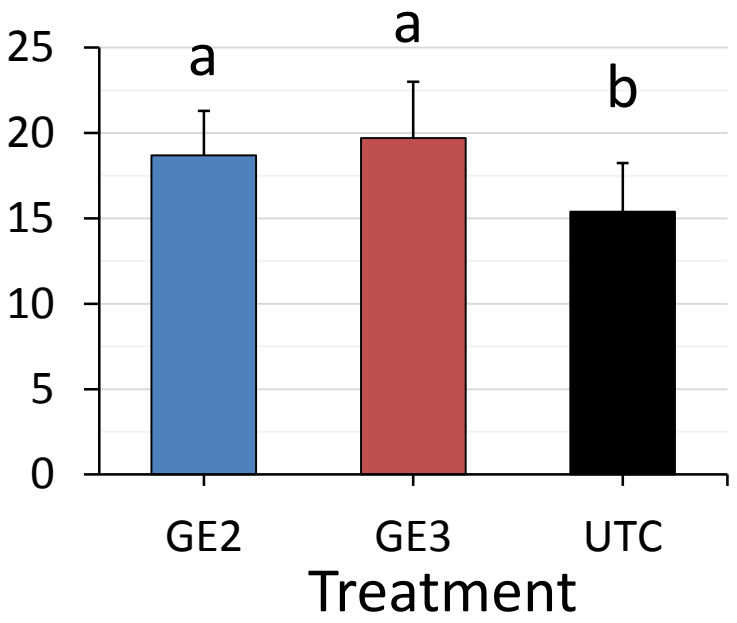




Bloom-Period Insecticide Trial 2

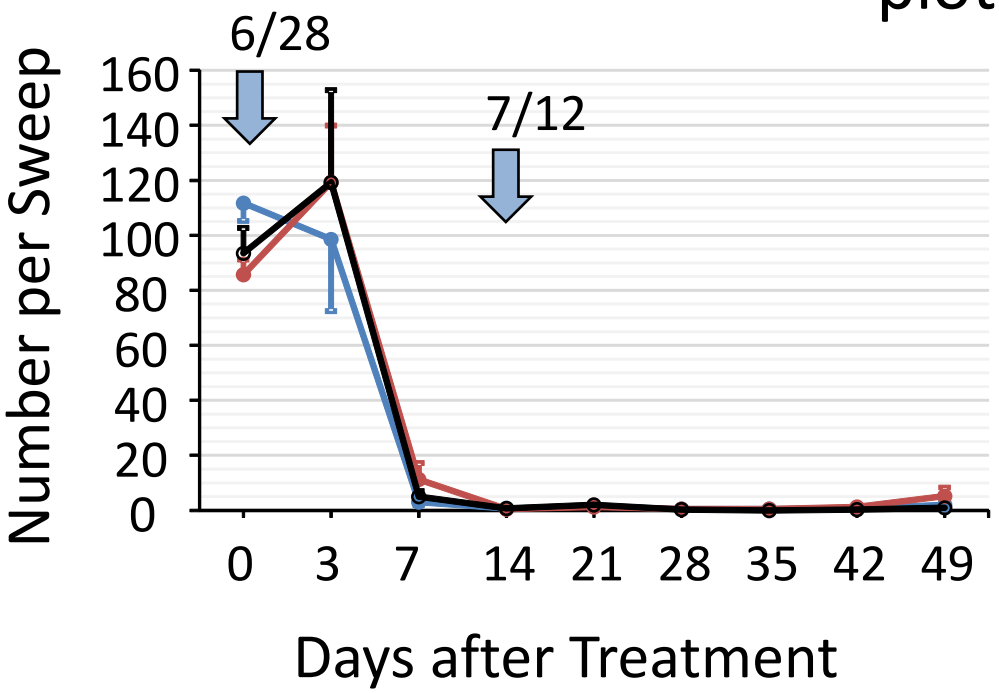
Mean number of large *Lygus* nymphs per sweep on each sample day and over all sample days on treated and untreated plots

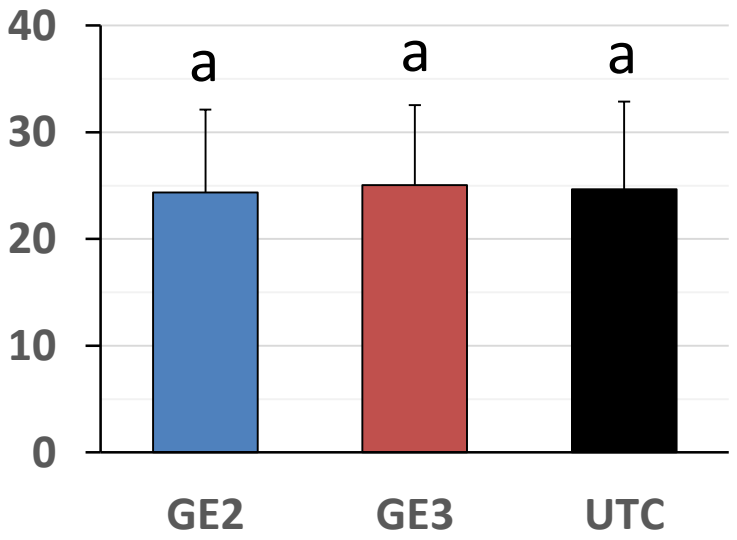




Bloom-Period Insecticide Trial 2

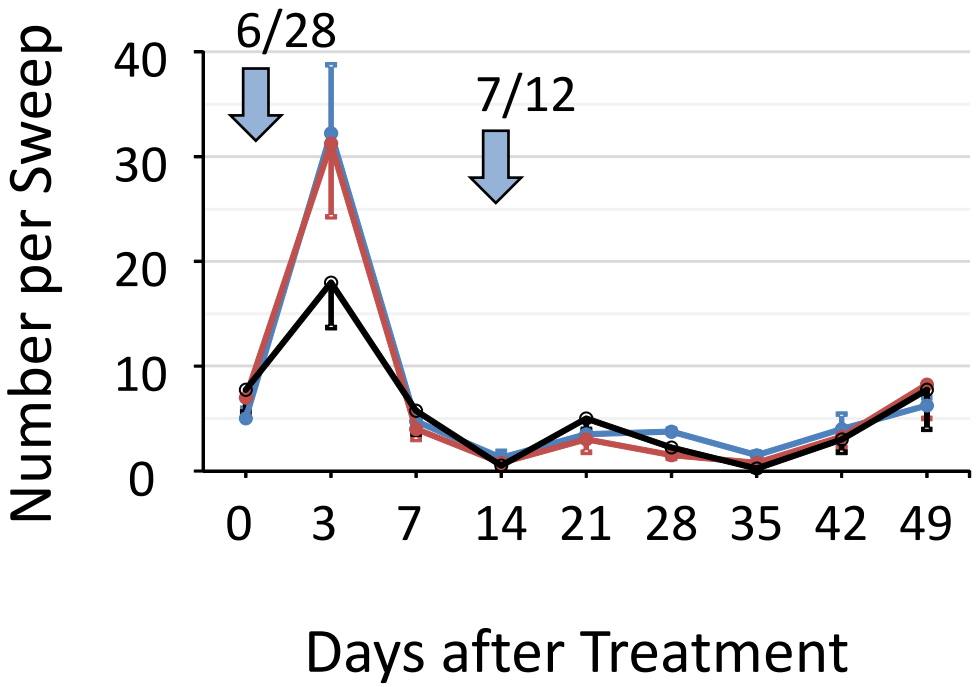
Mean number of pea and blue alfalfa aphids per sweep on each day and over all sample days on treated and untreated plots

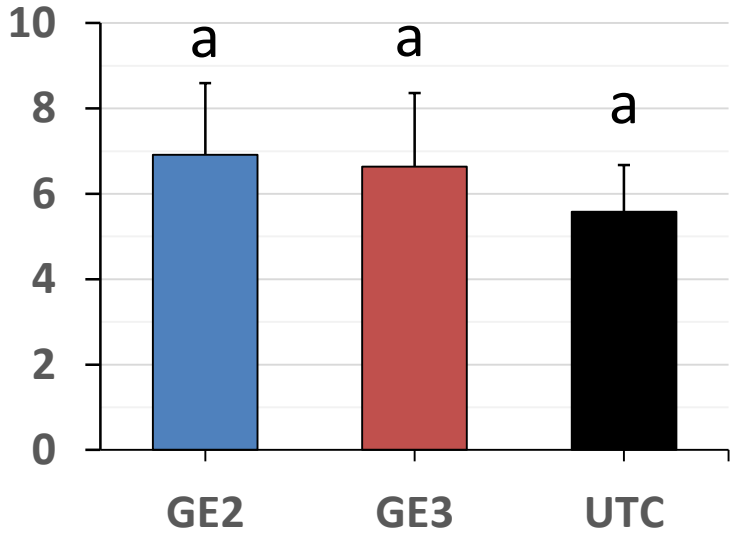




Bloom-Period Insecticide Trial 2

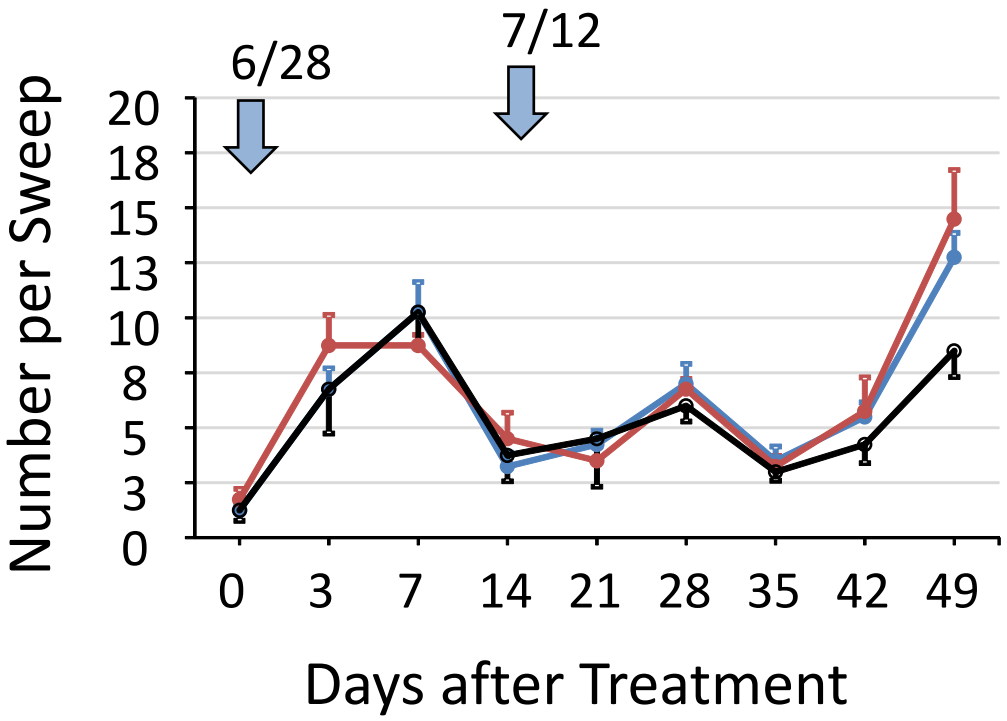
Mean number of spotted alfalfa aphids on each sample day and over all sample days on treated and untreated plots

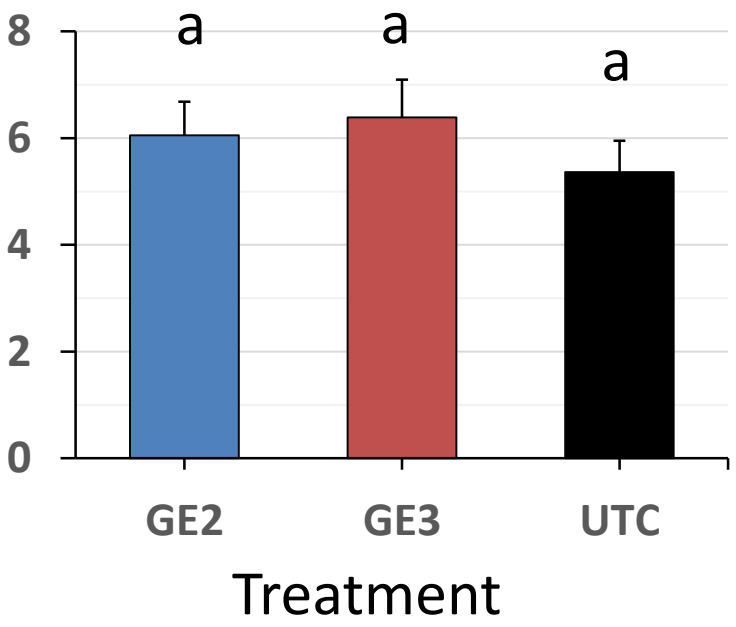




Bloom-Period Insecticide Trial 2

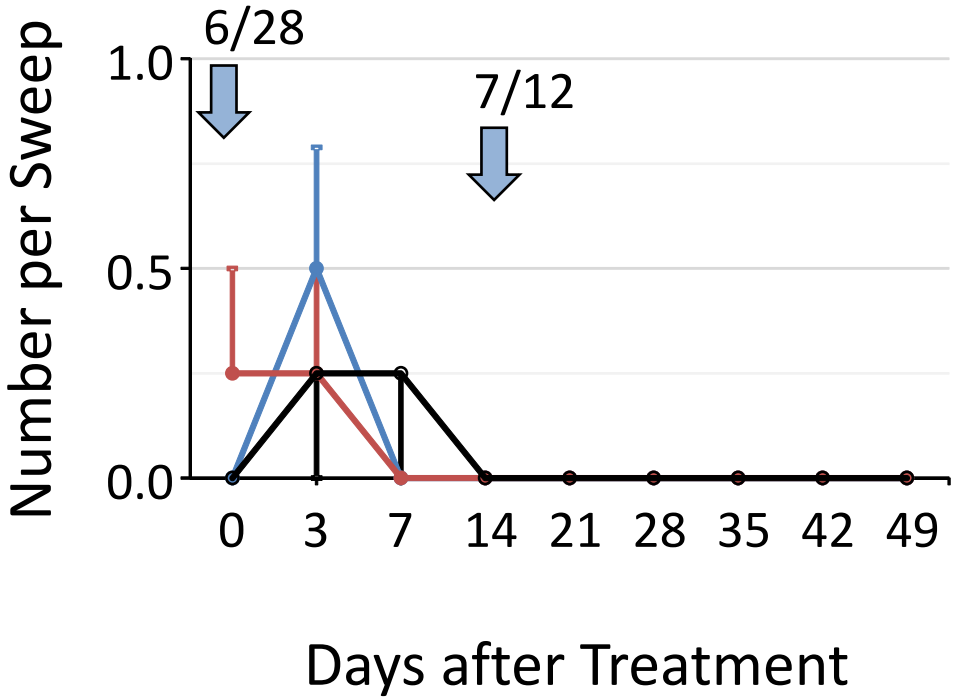
Mean number of lygus predators per sweep on each sample day and over all sample days on treated and untreated plots

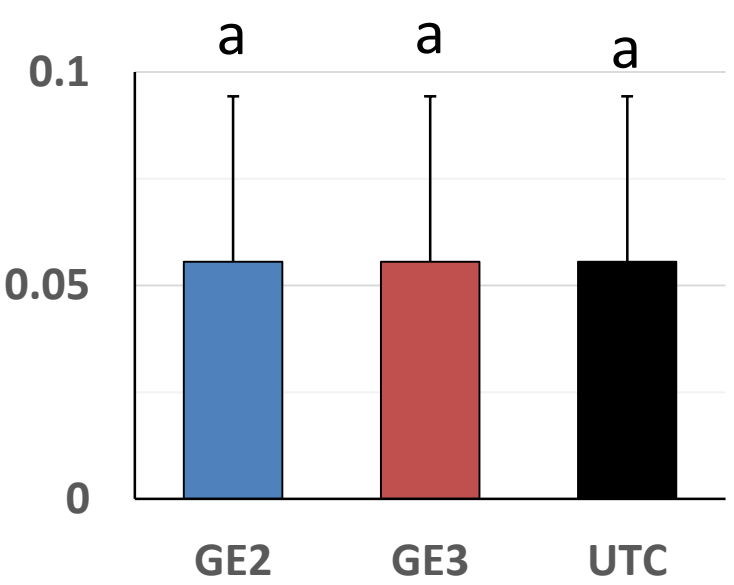




Bloom-Period Insecticide Trial 2

Mean number of lady beetles per sweep on each sample day and over all sample days on treated and untreated plots





Conclusions

Trial 1

- Lower nos. of small and large *Lygus* nymphs and aphids on all treated plots:
- Transform →BeLeaf → Rimon provided best control
  Beleaf → Transform → Warrior least control
- No major impact on *Lygus* predators from any rotation treatment

Trial 2

- Grandevo provided no control of *Lygus* adults, nymphs, or aphids at the 2 or 3 lb rates

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- WASGA/USDA-ARS Logan Bee lab

  For financial support

- ID Grower/cooperators

  For access to fields and bees and making applications for the Rimon trial

- Dairyland Seed (Lynn Nichols), Pioneer Hi- Bred (Brad Chambers)

  For their help organizing the Rimon trial

- Chemtura Corp. Dow AgroSciences

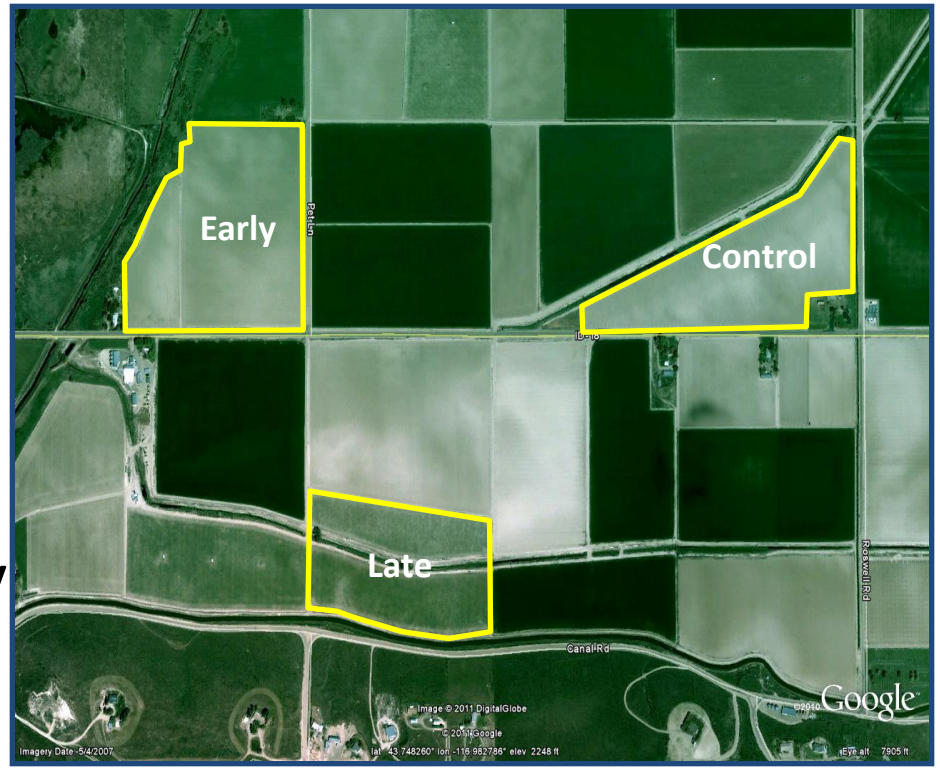
  For providing materials for the Rimon trial

Noemi Fernandez, Karen Barbour and Rebecca Blanscet

For their help conducting this work

2011 Rimon Bee Return Study

- Field selection
  - Four blocks of three fields each
    - Two blocks managed by one grower
    - Two blocks managed by different growers
    - Rimon and control treatments assigned randomly to fields where possible
      - Blocks managed by same grower, similar trts near each other



Residual Toxicity of Pesticides to Adult Beneficial Insects