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Integrated Pest Management: The strawberry perspective

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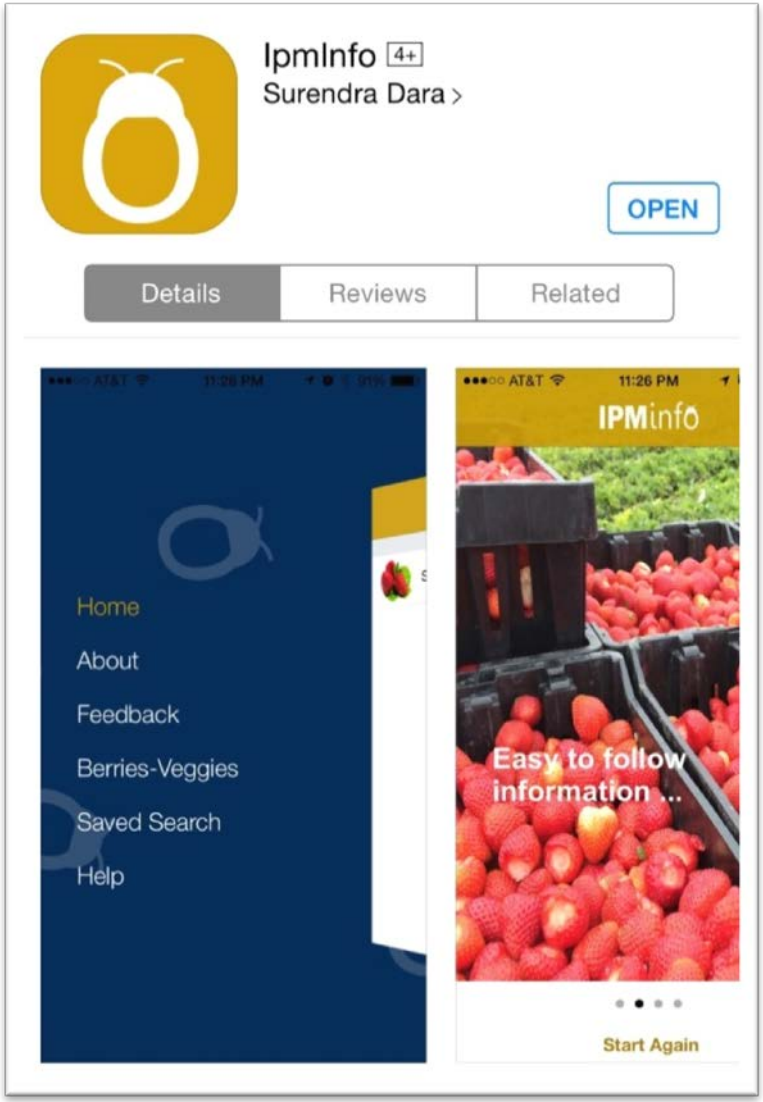
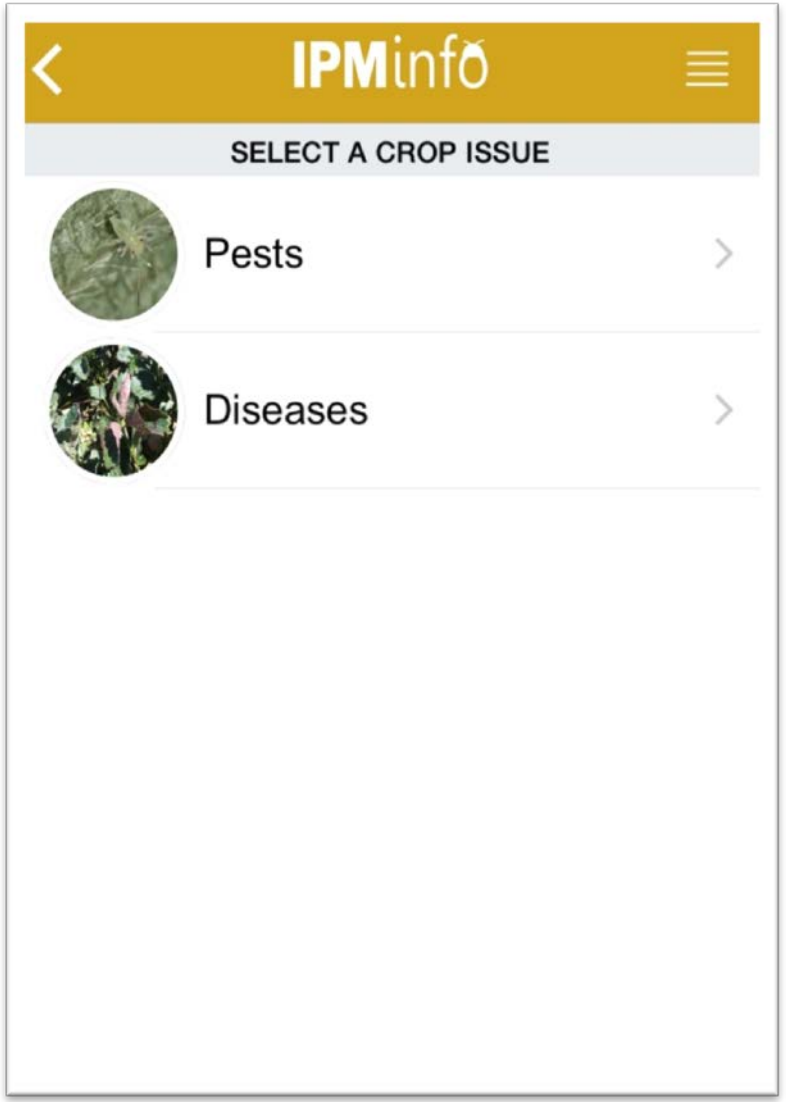
IPMinfo smartphone app for iOS devices





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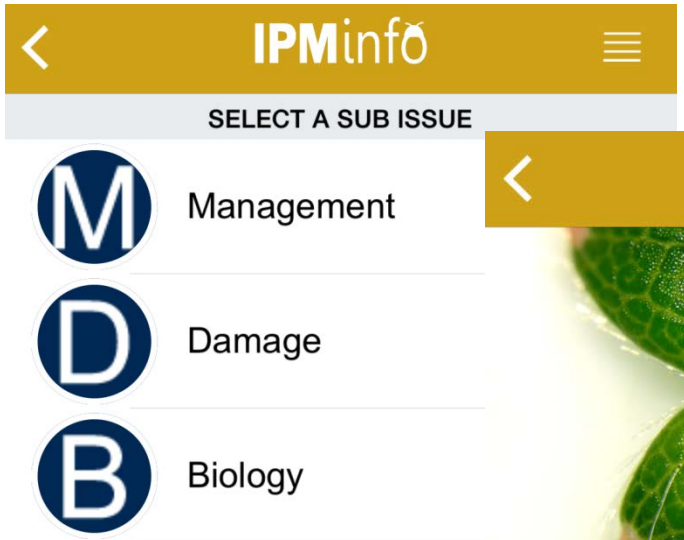


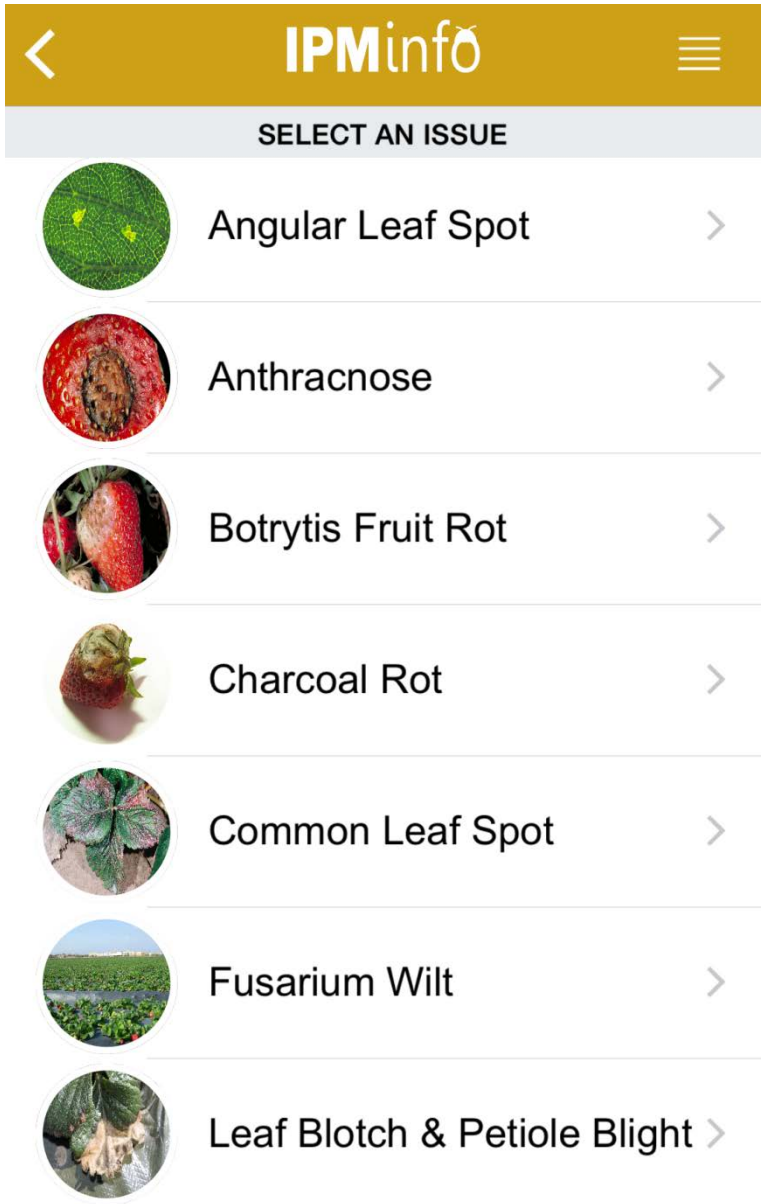
Strawberries

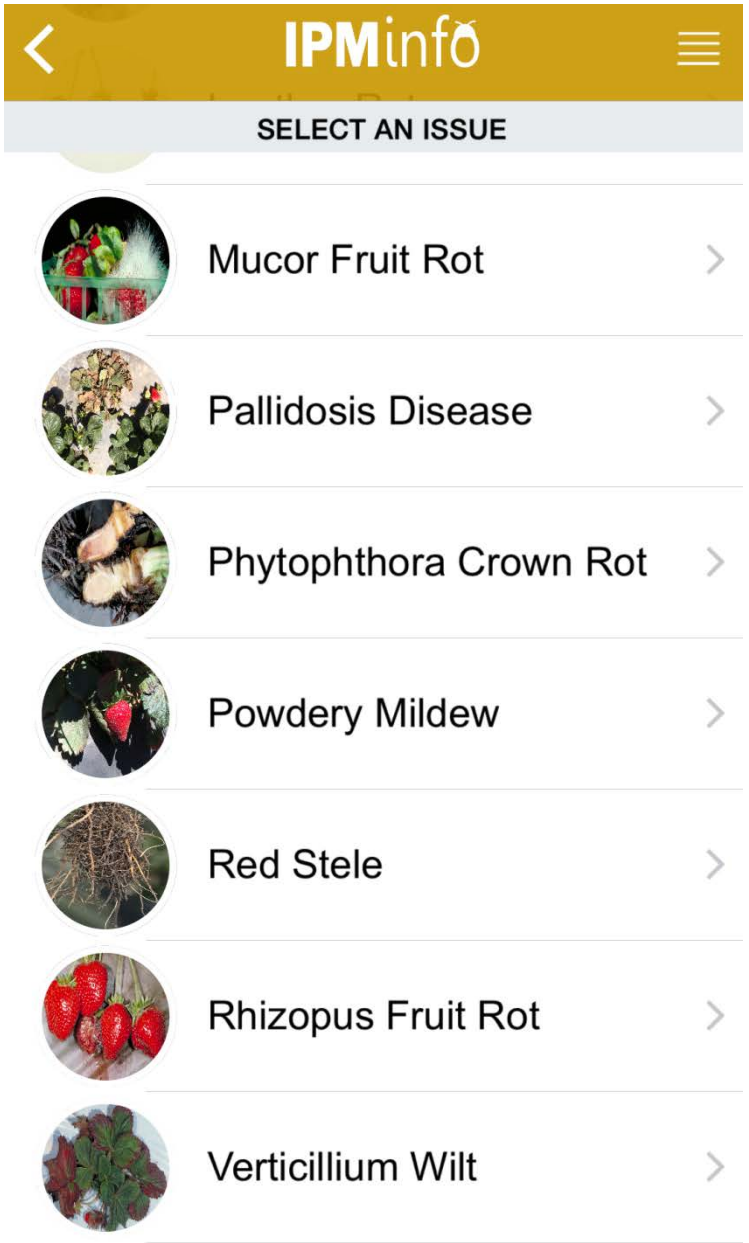
Lygus Bugs

Biology

Life cycle includes eggs, five nymphal instars, and adults. Depending on temperature, it can take about 21 days from egg stage to adult emergence. Females start laying eggs in about 9 days and continue the process for 21 days. Eggs are mostly laid in the inflorescence. First instar nymphs are light colored. Second and third instars have a dark spot on the abdominal segment. Fourth and fifth instars have two spots on each of the first two thoracic segments. Developing wing pads are visible in the last two instars.

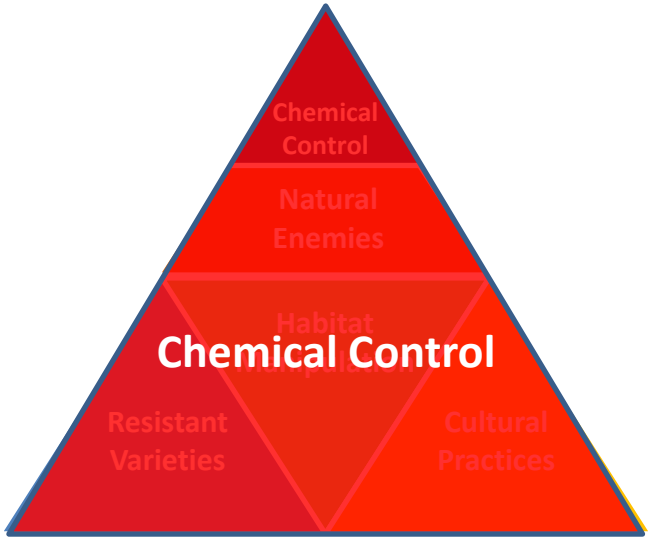
IPMinfo smartphone app for iOS devices





Integrated Pest Management

"Integrated pest management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment." UC IPM



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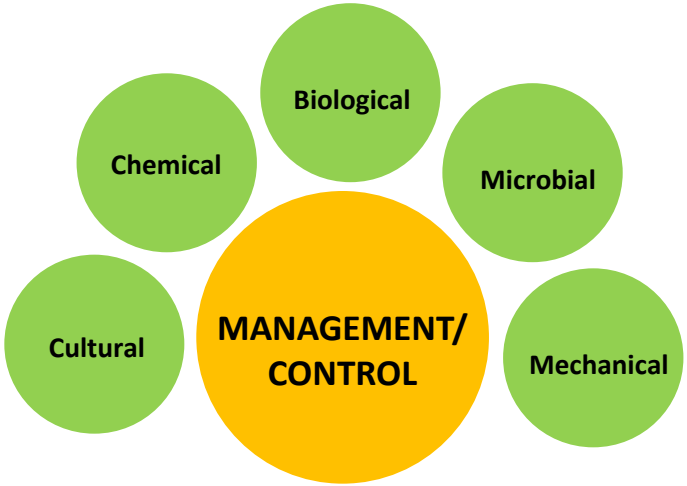
IPM and its components



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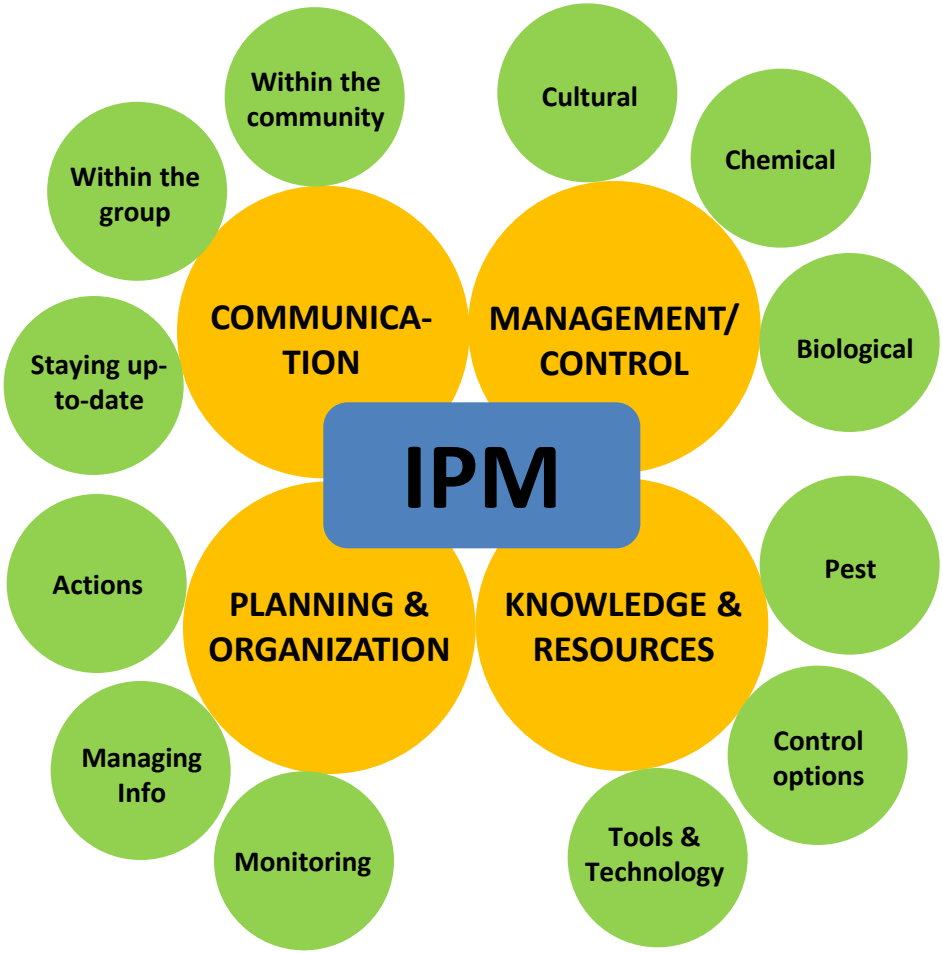

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Current pest management practices

- Chemical pesticides
- Biological control

Current pest management practices

- Low fences
- Watering the road ways

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Current pest management practices

- Bug vacuums

UC IPM Recommendations

- Cultural control
- Chemical control
- Biological control
- Microbial control

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IPM-Cultural Control

- Selection of the field
- Avoiding second year berries
- Managing weeds and alternate hosts that serve as sources of pest populations
- Adequate chilling of transplants
- Obtaining transplants from a clean source
- Irrigation management
- Nutrition management
- Regular monitoring

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IPM-Chemical Control

- Choosing the right chemical
- Rotating different modes of action to reduce the risk of resistance
- Reducing the number of chemical applications and using other alternatives
- Using softer chemicals to conserve natural enemies
- Test for resistance

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IPM-Biological and Microbial Control

- Timing chemical sprays to conserve released or native natural enemies
- Choosing the right species at the right time

Phytoseiulus persimilis

Neoseiulus californicus

- Multiple natural enemies for different life stages of pest

Peristenus stygicus on lygus nymph

Lygus adult killed by *Beauveria bassiana*

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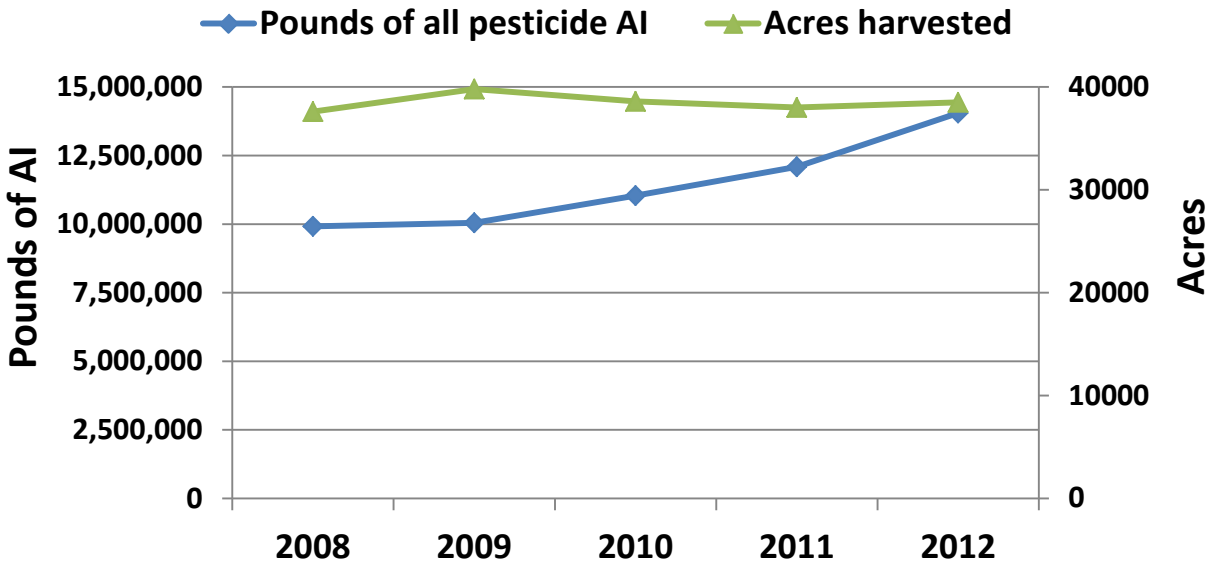
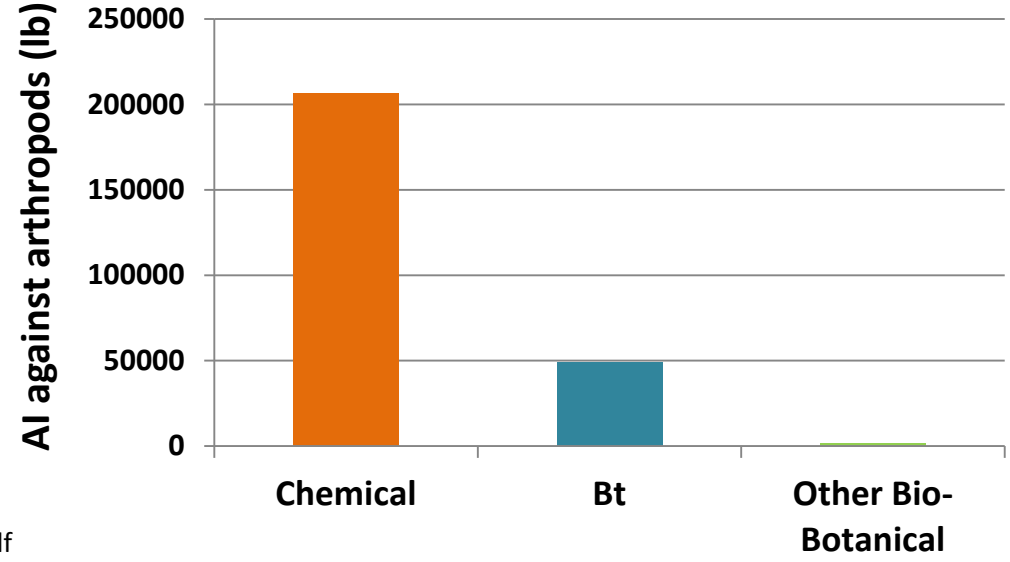
Pesticide use in California strawberries





http://www.cdpr.ca.gov/docs/pur/pur12rep/comrpt12.pdf

IPM field studies

Can we use non-chemical alternatives in conventional agriculture along with chemical pesticides to develop a sound IPM program?

Chemicals-Mode of action groups

4A	Neonicotinoids
4C	Sulfoximines
6	Chloride channel activators
9C	Selective homopteran feeding blockers
15	Inhibitors of chitin biosynthesis

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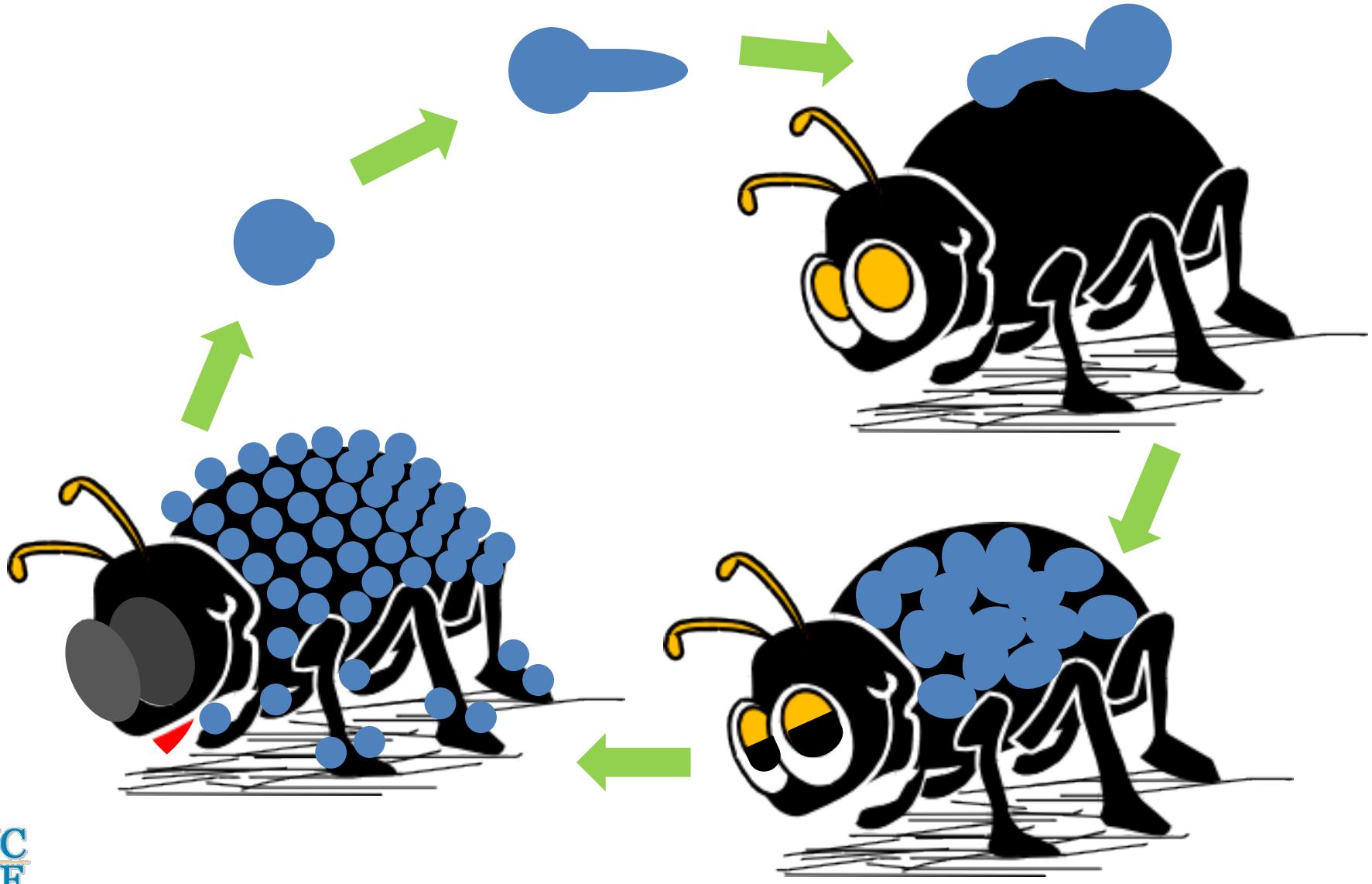
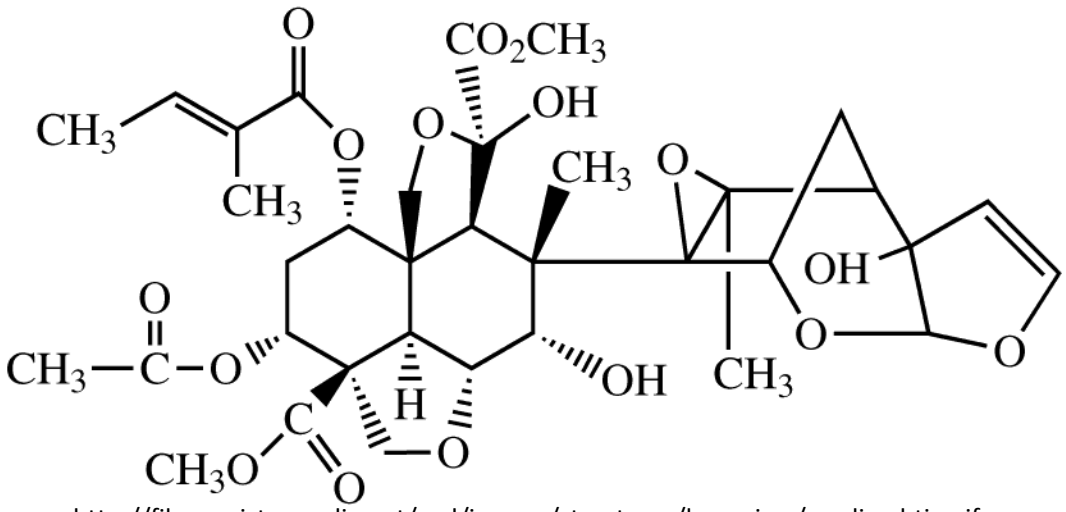
Non-chemical alternatives

- Entomopathogenic fungi, *Beauveria bassiana* and *Metarhizium brunneum*
- Botanical insect growth regulator, azadirachtin
- Diatomaceous earth

Entomopathogenic fungus mode of action



Azadirachtin mode of action



http://files.meistermedia.net/cpd/images/structures/largeview/azadirachtin.gif

- Interferes with protein synthesis
- Affects molting and metamorphosis
- Disturbs mating and sexual communication
- Sterilizes adults
- Reduces reproductive ability
- Acts as antifeedant and repellent

Diatomaceous earth mode of action

- Powder form of fossilized remains of diatoms (contains silicon dioxide)
- Absorbs waxy layer of insect cuticle causing water loss
- Causes death due to desiccation

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Lygus bug management study

	1st application (Rate/acre)	2nd application (Rate/acre)	3rd application (Rate/acre)
1	Untreated	Untreated	Untreated
2	Assail 70 WP (3 oz) **4A***	Assail 70 WP (3 oz) **4A**	Assail 70 WP (3 oz) **4A**
3	Rimon 0.83 EC (12 fl oz) **15** + Assail 30SG (6.9 oz) **4A**	Rimon 0.83 EC (12 fl oz) **15** + Sequoia SC (4.5 fl oz) **4C**	Rimon 0.83 EC (12 fl oz) **15** + Assail 30SG (6.9 oz) **4A**
4	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**	BotaniGard ES (2 qrt) + Molt-X (8 fl oz)	BotaniGard ES (2 qrt) + Molt-X (8 fl oz)
5	Rimon 0.83 EC (12 fl oz) **15** + Assail 30SG (6.9 oz) **4A**	Rimon 0.83 EC (12 fl oz) **15** + Beleaf 50 SG (2.8 oz) **9C**	Rimon 0.83 EC (12 fl oz) **15** + Assail 30SG (6.9 oz) **4A**
6	BotaniGard ES (2 qrt) + Molt-X (8 fl oz)	BotaniGard ES (2 qrt) + Low Beleaf 50 SG (1.4 oz) **9C**	Low BotaniGard ES (1 qrt) + Low Sequoia (3 oz) **4C**
7	Actara (4 oz) **4A**	Actara (4 oz) **4A** + Agri-Mek SC (3.5 fl oz) **6**	BotaniGard ES (2 qrt) + Molt-X (8 fl oz)
8	High Sequoia (4.5 oz) **4C**	High Sequoia (4.5 oz) **4C**	High Sequoia (4.5 oz) **4C**
9	Low Sequoia (3 oz) **4C**	Low Sequoia (3 oz) **4C**	Low Sequoia (3 oz) **4C**
10	High Diafil 610 Slurry (70 lb)	Low BotaniGard ES (1 qrt) + Low Sequoia (3 oz) **4C**	Met52 EC(16 fl oz) + Assail 70 WP (3 oz) **4A**
11	Low Diafil 610 Slurry (35 lb)	Low Sequoia (3 oz) **4C** + Molt-X (8 fl oz)	Met52 EC(16 fl oz)
12	High Diafil 610 Dust (70 lb)	Low BotaniGard ES (1 qrt) + Assail 70 WP (3 oz) **4A**	Met52 EC (16 fl oz) + Molt-X (8 fl oz)

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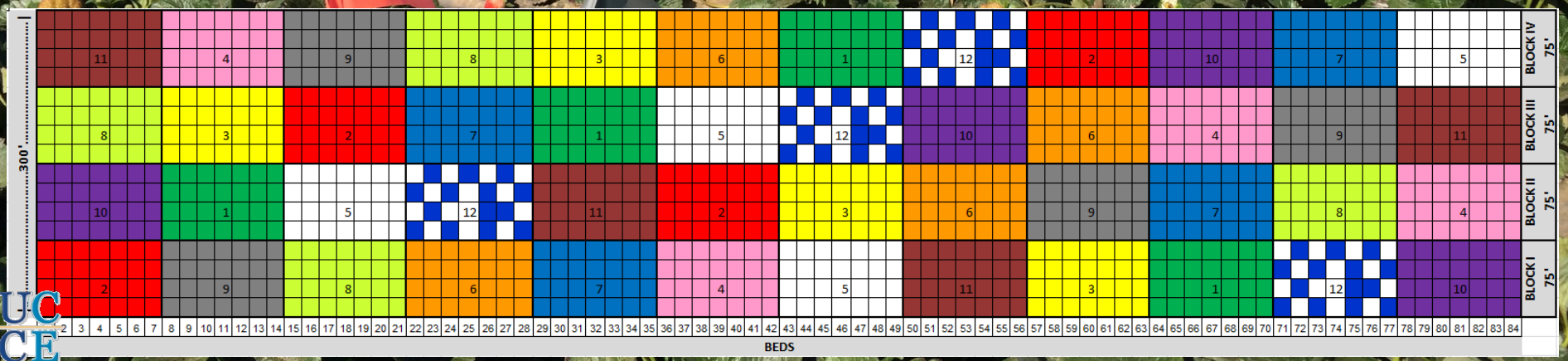
*MoA group

4A Neonicotinoids
4C Sulfoximines
6 Chloride channel activators
9C Selective homopteran feeding blockers
15 Inhibitors of chitin biosynthesis

2014 Strawberry IPM trial

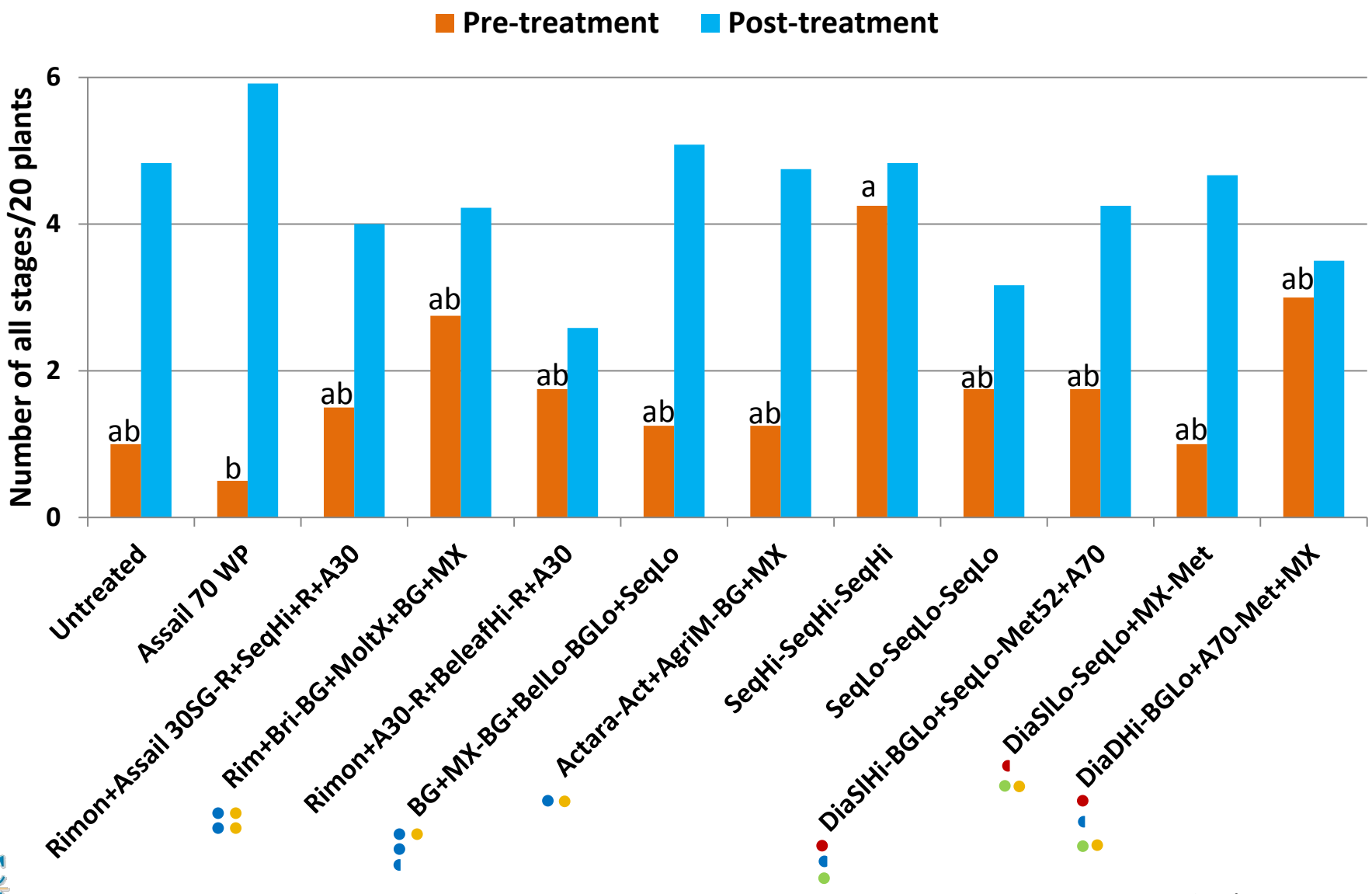
Goodwin Berry Farms, Santa Maria



Treatments and sampling

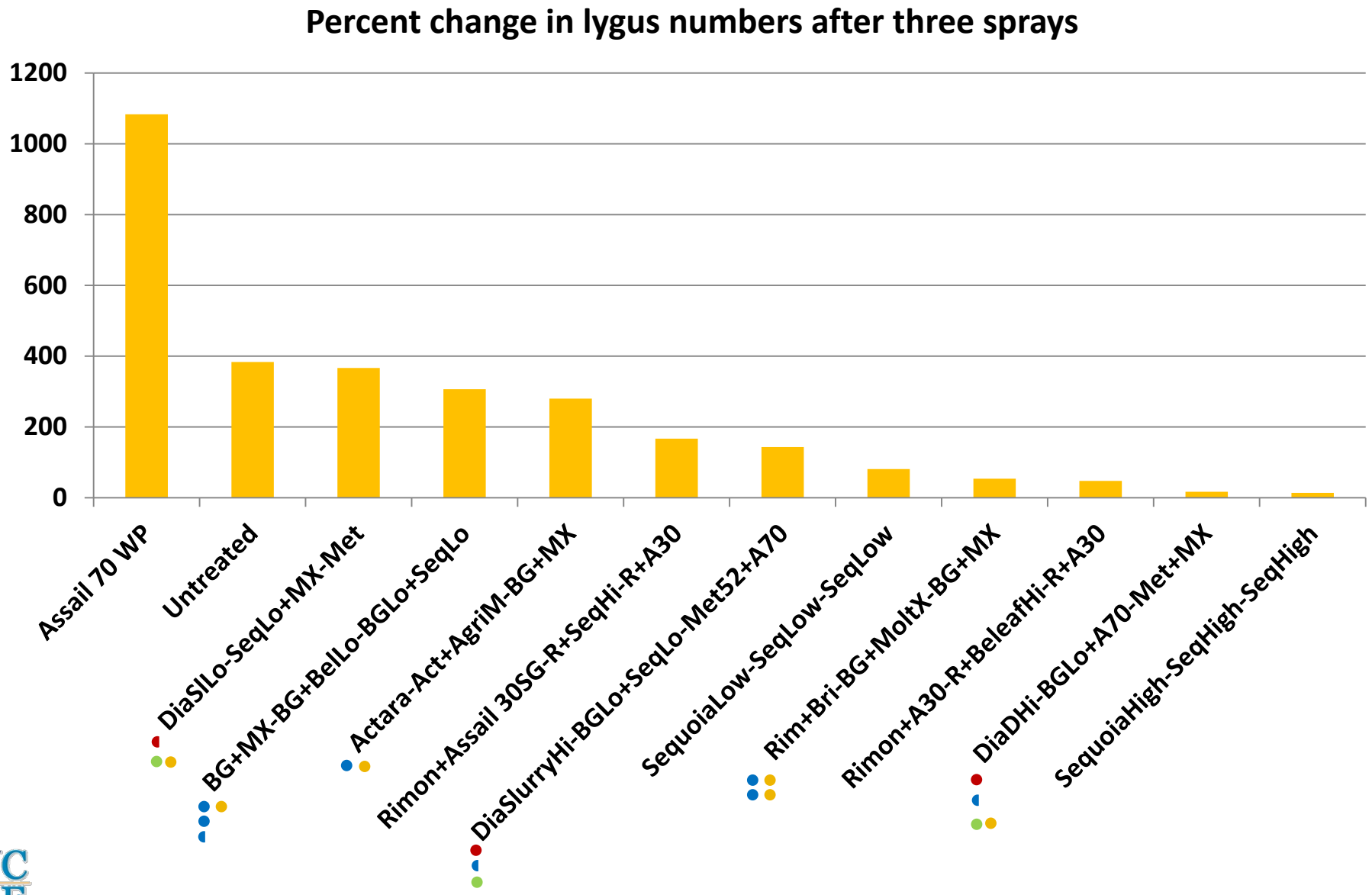
- Treatments applied on 4, 12, and 20 June, 2014
- Spray volume was 110 gpa for all treatments, but diatomaceous earth slurry (70 gpa)
- Sampled 5-6 days after each application

Strawberry IPM Trial 2014-Lygus bug



Tukey's HSD $P < 0.05$

Strawberry IPM Trial 2014-Lygus bug



Strawberry IPM Trial 2014-Lygus bug

Rank	%Change	I Spray	II Spray	III Spray
I	14	Sequoia High	Sequoia High	Sequoia High
II	17	Diafil Dust High	BotaniGard Low + Assail 70WP	Met52 + Molt-X
III	48	Rimon + Assail 30SG	Rimon + Beleaf 50SG	Rimon + Assail 30SG
IV	54	Rimon + Brigade	BotaniGard ES + Molt-X	BotaniGard ES + Molt-X
V	81	Sequoia Low	Sequoia Low	Sequoia Low
VI	143	Diafil Slurry High	Sequoia Low + BotaniGard ES Low	Met52 + Assail 70WP
VII	167	Rimon + Assail 30SG	Rimon + Sequoia High	Rimon + Assail 30SG
VIII	280	Actara	Actara + Agri-Mek	BotaniGard ES + Molt-X
IX	307	BotaniGard ES + Molt-X	BotaniGard ES + Beleaf 50SG Low	BotaniGard ES Low + Sequoia Low
X	367	Diafil Slurry Low	Sequoia Low	Met52 + Molt-X
XI	383	Untreated	Untreated	Untreated
XII	1083	Assail 70WP	Assail 70WP	Assail 70WP

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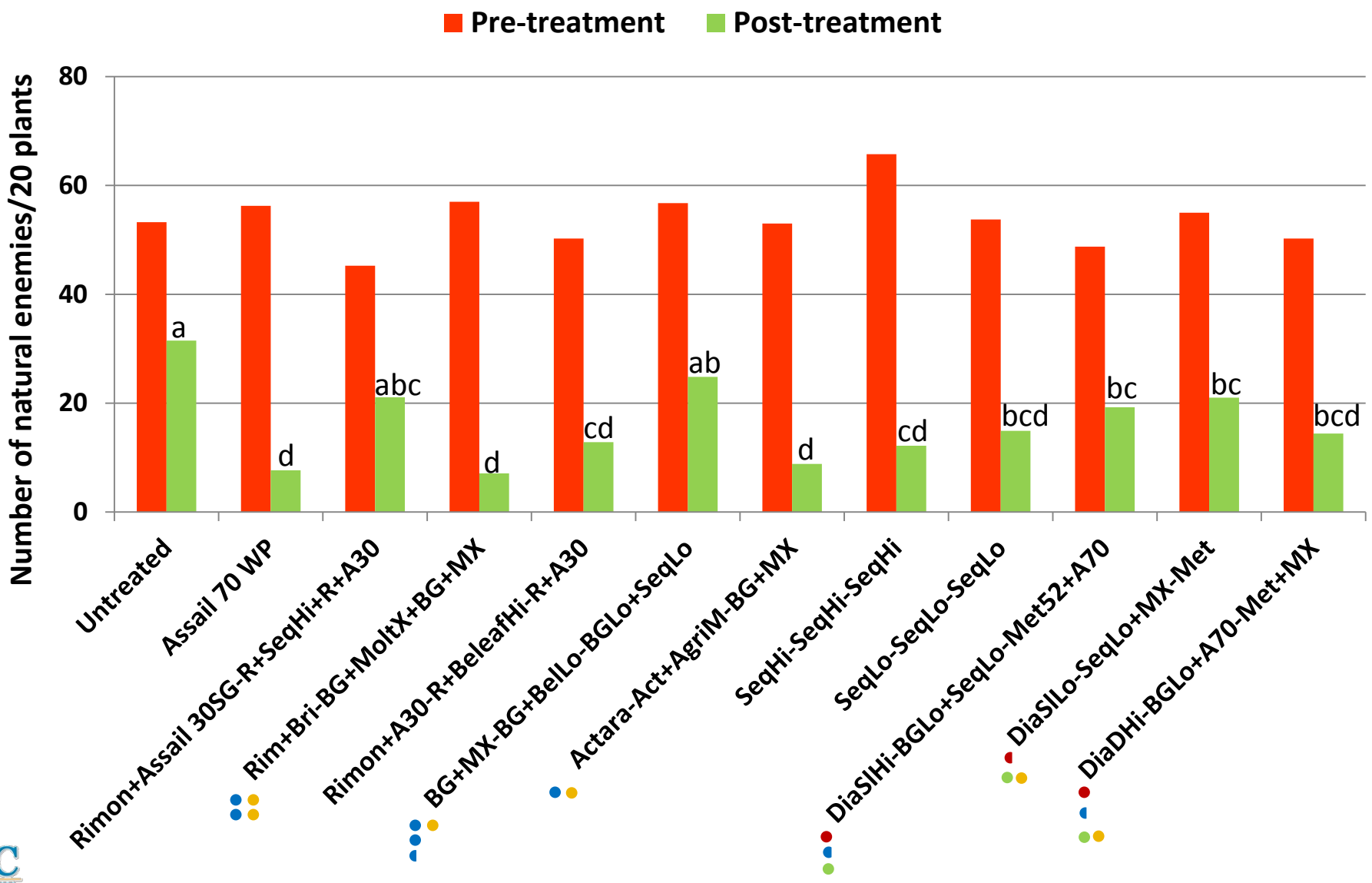
Strawberry IPM Trial 2014-Natural Enemies



Tukey's HSD $P < 0.05$

Strawberry IPM Trial 2014

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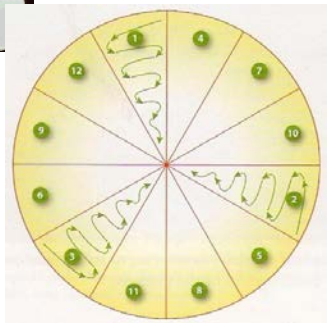
Strawberry Miticide Trial 2013

Treatments

1. Untreated
2. Acramite 50 WS (bifenazate) 1 lb
3. Agri-Mek SC (abamectin) 4.29 fl oz
4. BotaniGard ES (*B. bassiana*) 1qrt + Acramite 0.75 lb
5. Eco-Mite 1% (rosemary and cotton seed oils)
6. Fujimite 5 EC (fenpyroximate) 2 pt
7. Fujimite XLO 2 pt
8. Grandevo *(C. subtsugae)* 2 lb
9. Venerate (*Burkholderia* spp.) 2 gal
10. Nealta (cyflumetofen) 13.7 fl oz

Spraying 150 gal/acre at 70 psi with hollow cone nozzle

Plot size 14’ longX44” wide bed replicated 4 times



Treated on May 16 and 25, 2013

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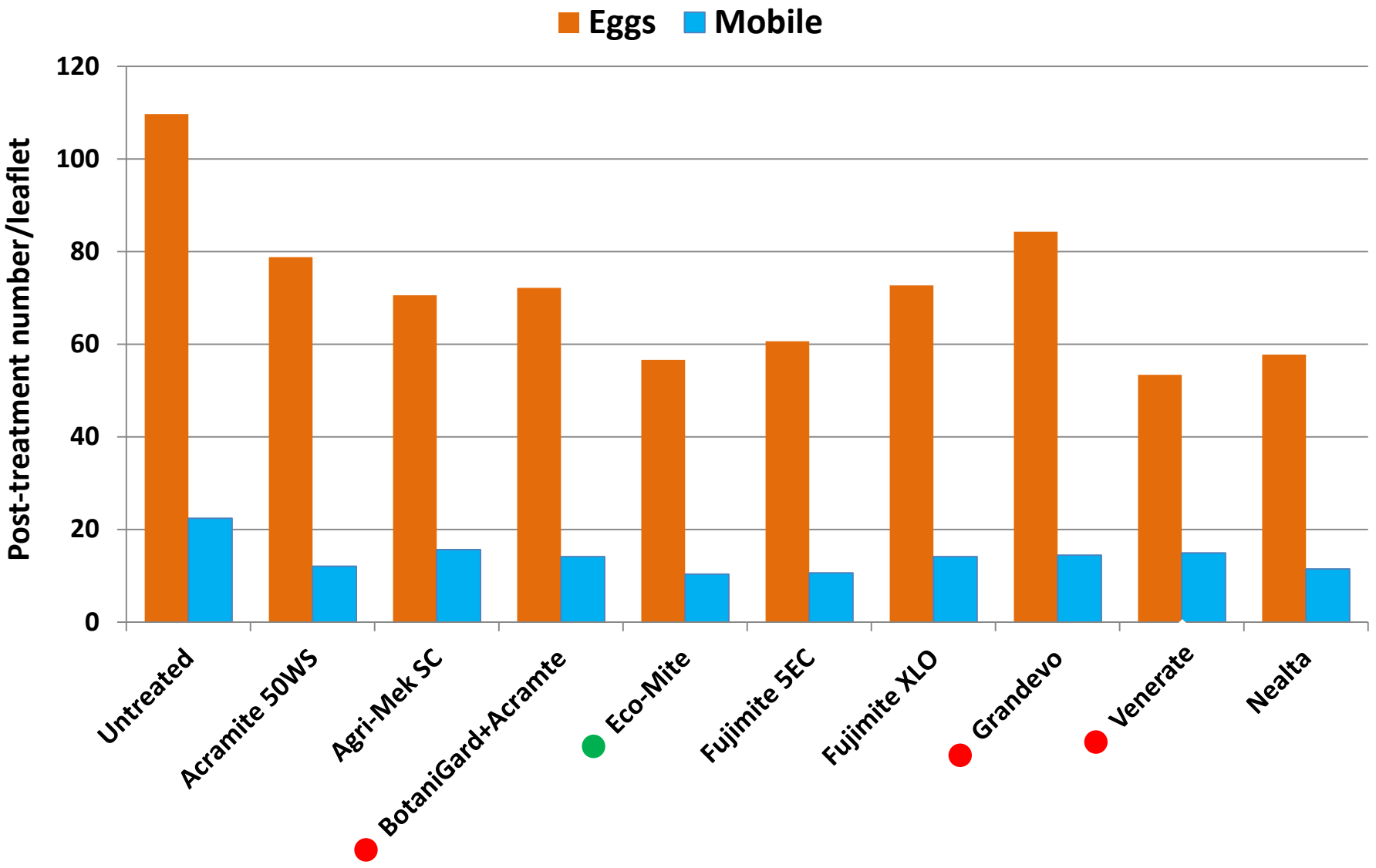
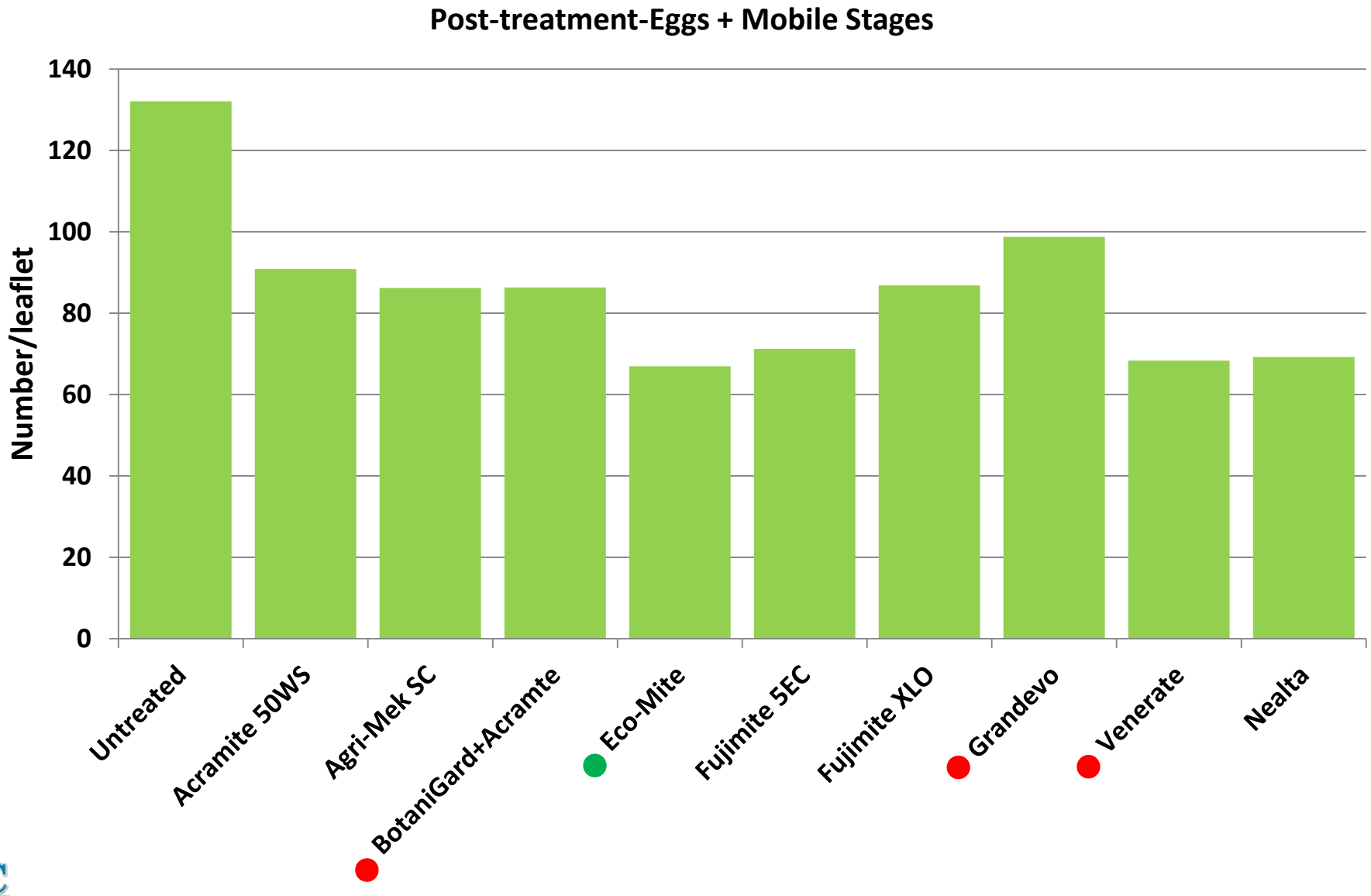
Strawberry Miticide Trial 2013-TSSM

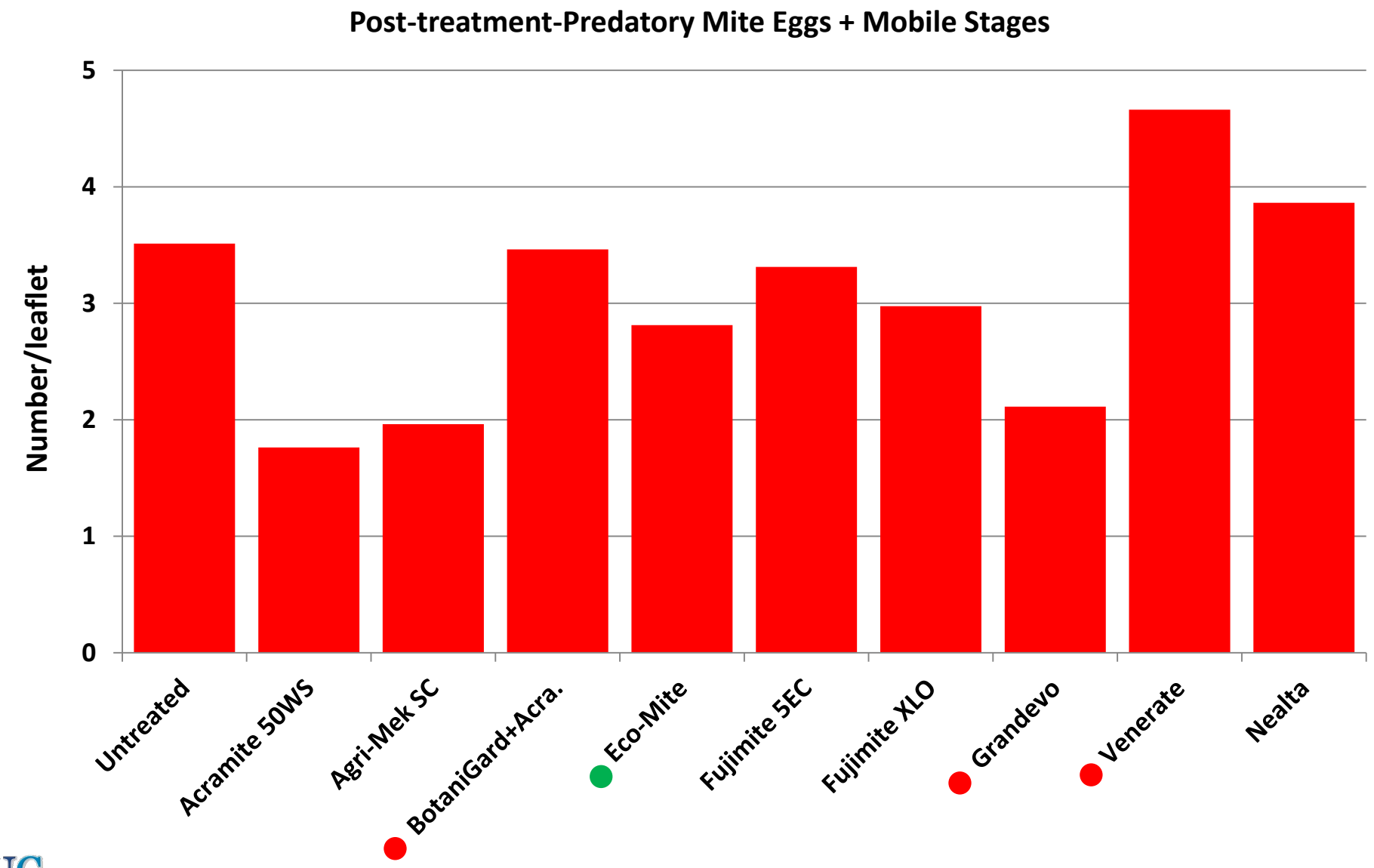


$P \geq 0.05$

Strawberry Miticide Trial 2013-TSSM



Strawberry Miticide Trial 2013-Predatory Mites



Conclusions

- Integrating various tools is critical in pest management.
- Botanical and microbial pesticides can be an important addition to chemical pest management options.

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