

# IPM Tools for Insect Pest Management in Strawberries

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UCCE, Camarillo, 1 September, 2015



@calstrawberries @calveggies



strawberriesvegetables



berriesnveggies.tumblr.com

eNewsletters: [ucanr.edu/strawberries-vegetables](http://ucanr.edu/strawberries-vegetables) and [ucanr.edu/pestnews](http://ucanr.edu/pestnews)

Download the free iOS app "IPMinfo" about strawberry pests and diseases

# Lygus bug on strawberry

Lygus bug or western tarnished plant bug  
(*Lygus hesperus*)



# Lygus bug



Photos by Rodney Cooper, USDA-ARS

# Lygus bug

1<sup>st</sup> instar



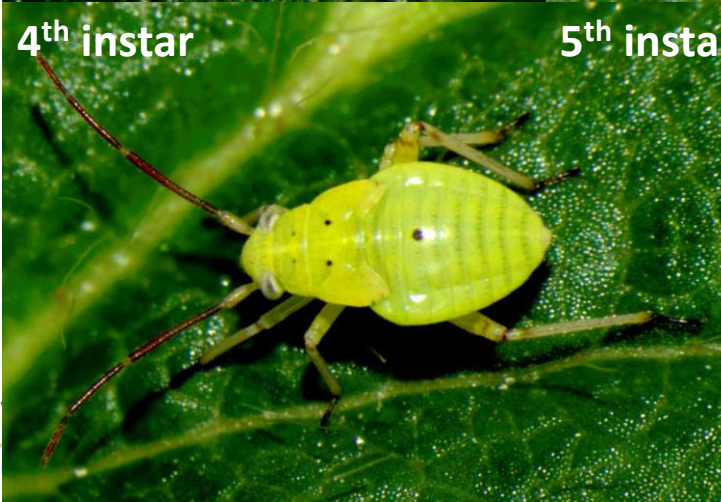
2<sup>nd</sup> instar



3<sup>rd</sup> instar



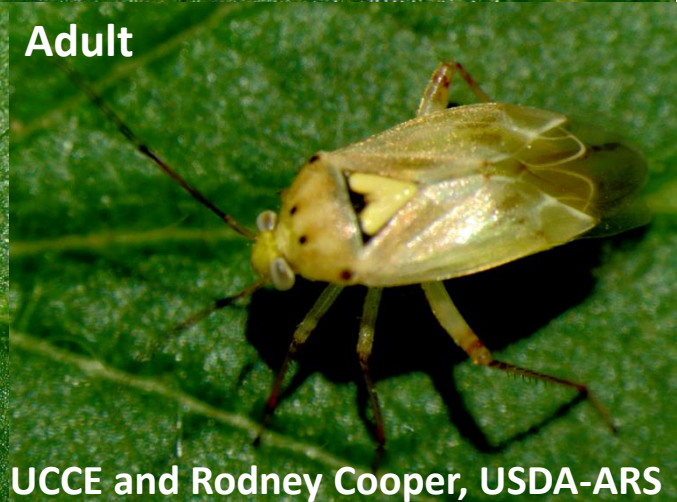
4<sup>th</sup> instar



5<sup>th</sup> instar

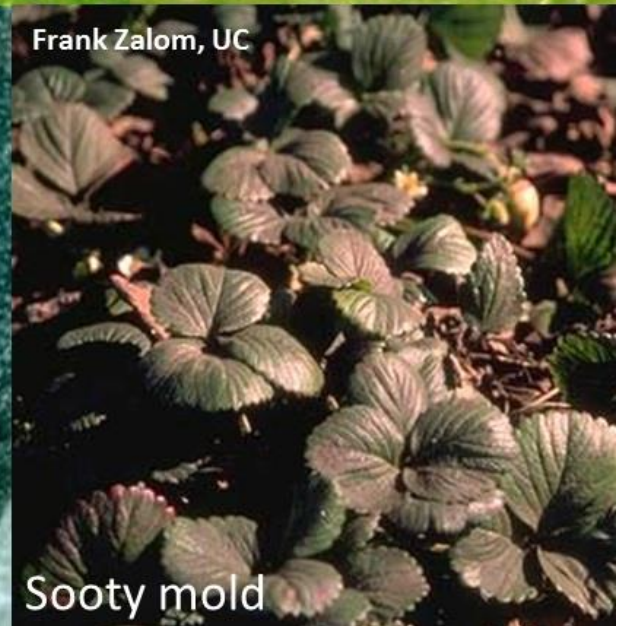


Adult



Photos by Surendra Dara, UCCE and Rodney Cooper, USDA-ARS

# Greenhouse whitefly



# Western flower thrips



# Pallidosis-related decline

## Transmitted by others

Pollen



OR

Nematodes



OR

Thrips



OR

Aphids



AND

## Whitefly-transmitted

Greenhouse whiteflies



*Apple mosaic*  
*Fragaria chiloensis latent*  
Strawberry necrotic shock

*Arabis mosaic*  
*Raspberry ringspot*  
*Strawberry latent ringspot*  
*Tomato black ring*  
*Tomato ringspot*

Strawberry necrotic shock

*Strawberry chlorotic fleck*  
*Strawberry crinkle*  
*Strawberry latent C*  
*Strawberry mild yellow edge*  
*Strawberry mottle*  
*Strawberry pseudo mild yellow edge*  
*Strawberry vein banding*

*Beet pseudo-yellows*  
Strawberry pallidosis associated



Mild or no symptoms

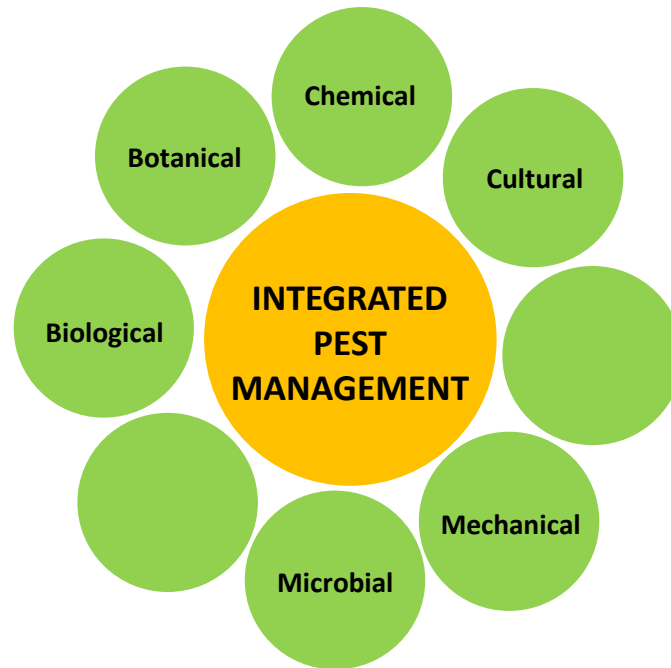


Variable degrees of  
symptoms of  
pallidosis-related decline



Mild or no symptoms

# IPM tools for strawberries





# 2014 Strawberry IPM trial

Evaluation of botanical, chemical, mechanical, and microbial insecticides for a sound IPM program

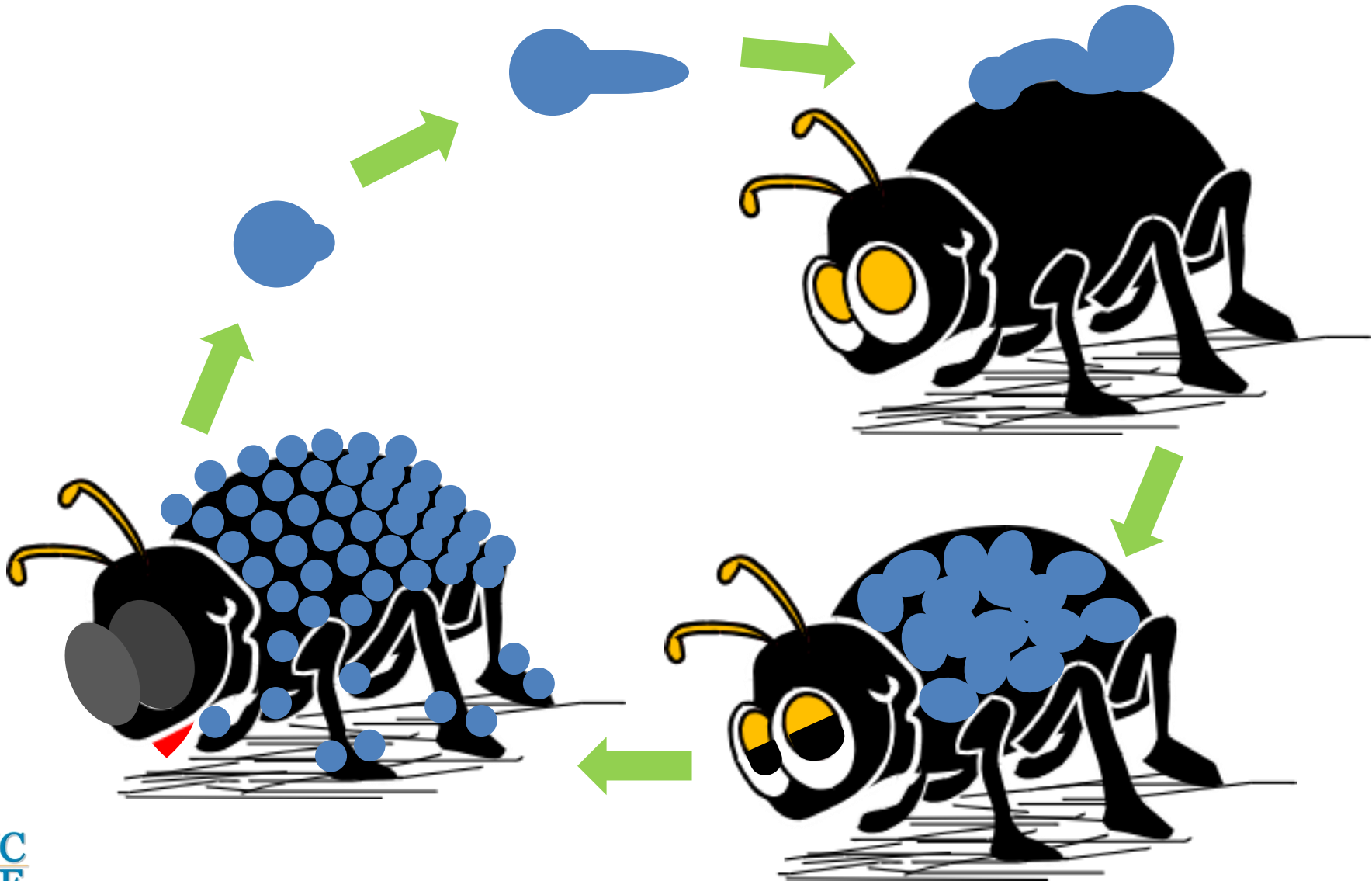
# Chemicals-Mode of action groups

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

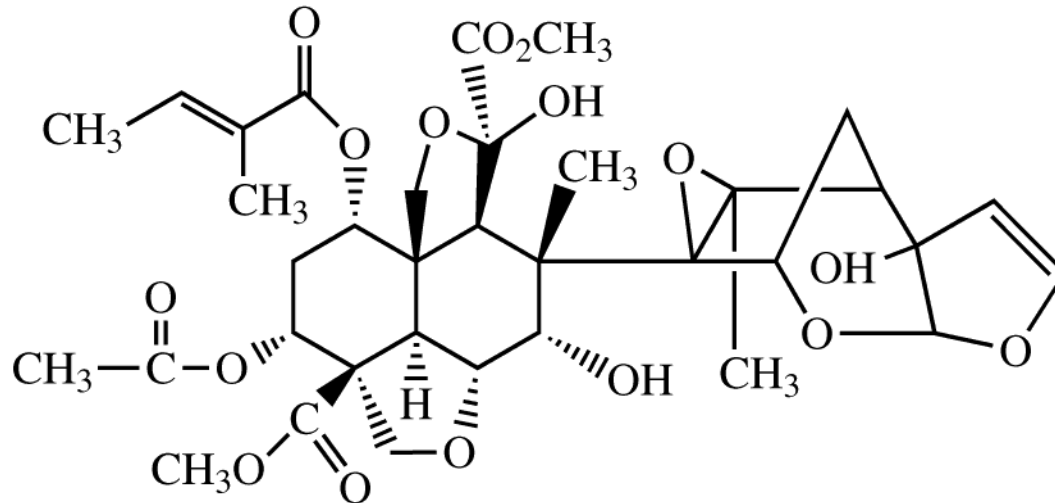
# Non-chemical alternatives

- 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>

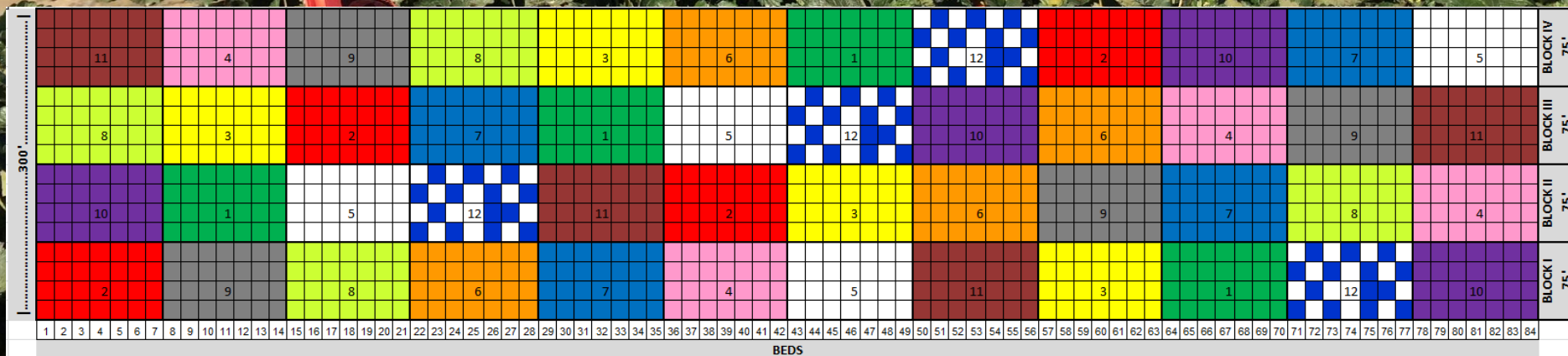
- Interferes with protein synthesis
- Affects molting and metamorphosis
- Disturbs mating and sexual communication
- Sterilizes adults
- Reduces reproductive ability
- Acts as antifeedant and repellent

# 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

# 2014 Strawberry IPM trial

Goodwin Berry Farms, Santa Maria



# 2014 Strawberry IPM trial

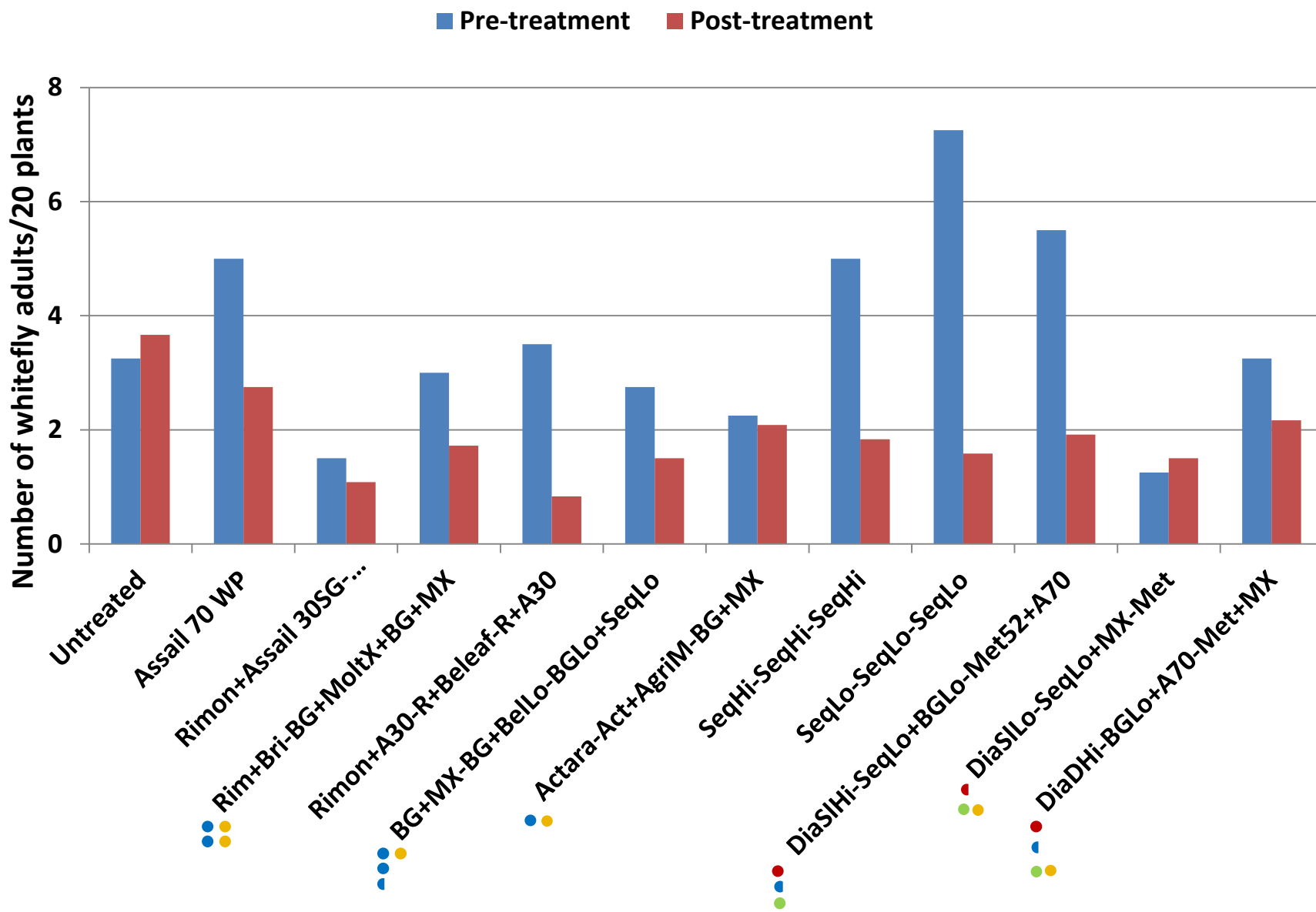
	1 <sup>st</sup> application (Rate/acre)	2 <sup>nd</sup> application (Rate/acre)	3 <sup>rd</sup> application (Rate/acre)
1	Untreated	Untreated	Untreated
2	Assail 70 WP (3 oz) <b>4A*</b>	Assail 70 WP (3 oz) <b>4A</b>	Assail 70 WP (3 oz) <b>4A</b>
3	Rimon 0.83 EC (12 fl oz) <b>15</b> + Assail 30SG (6.9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



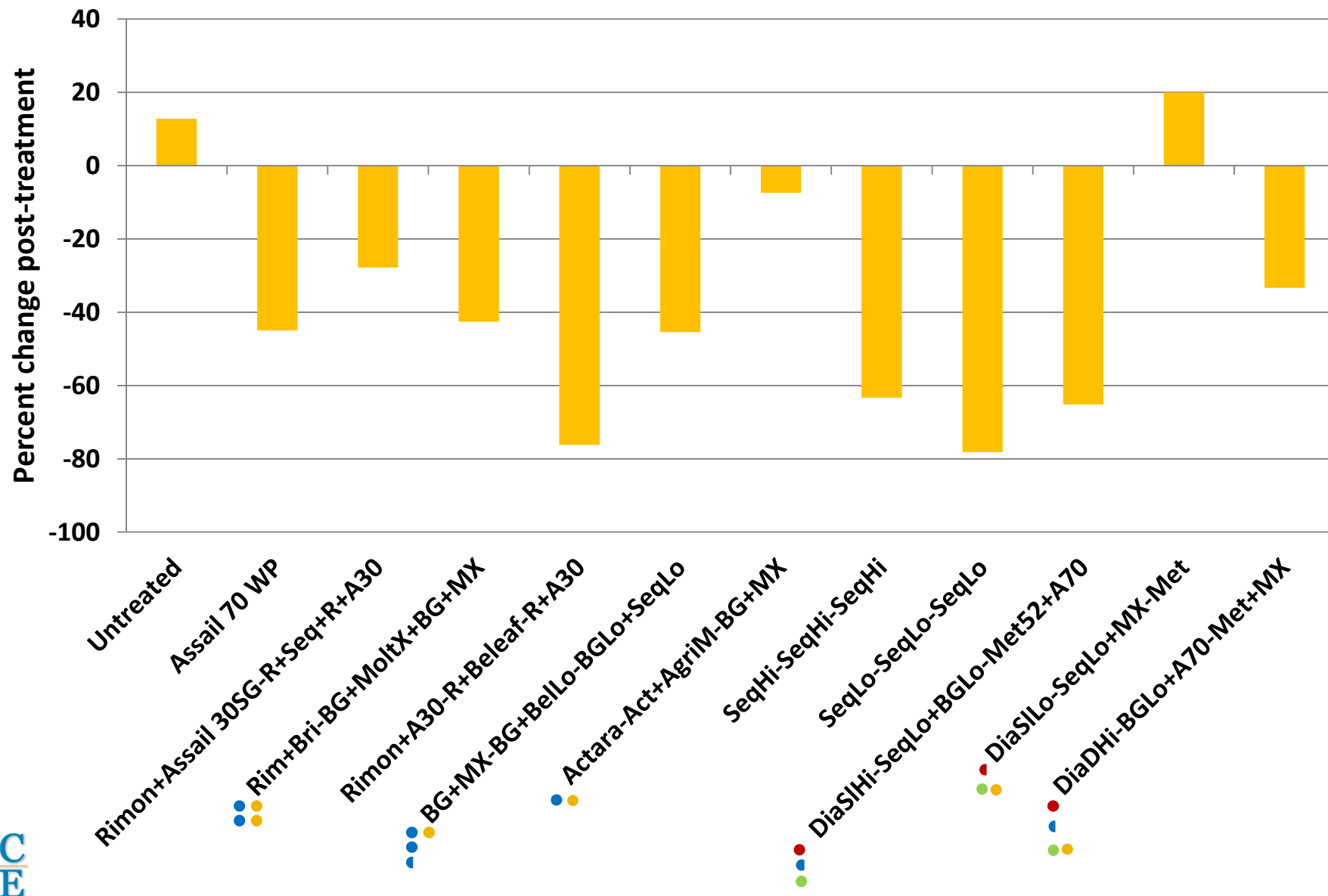
# Treatments and sampling



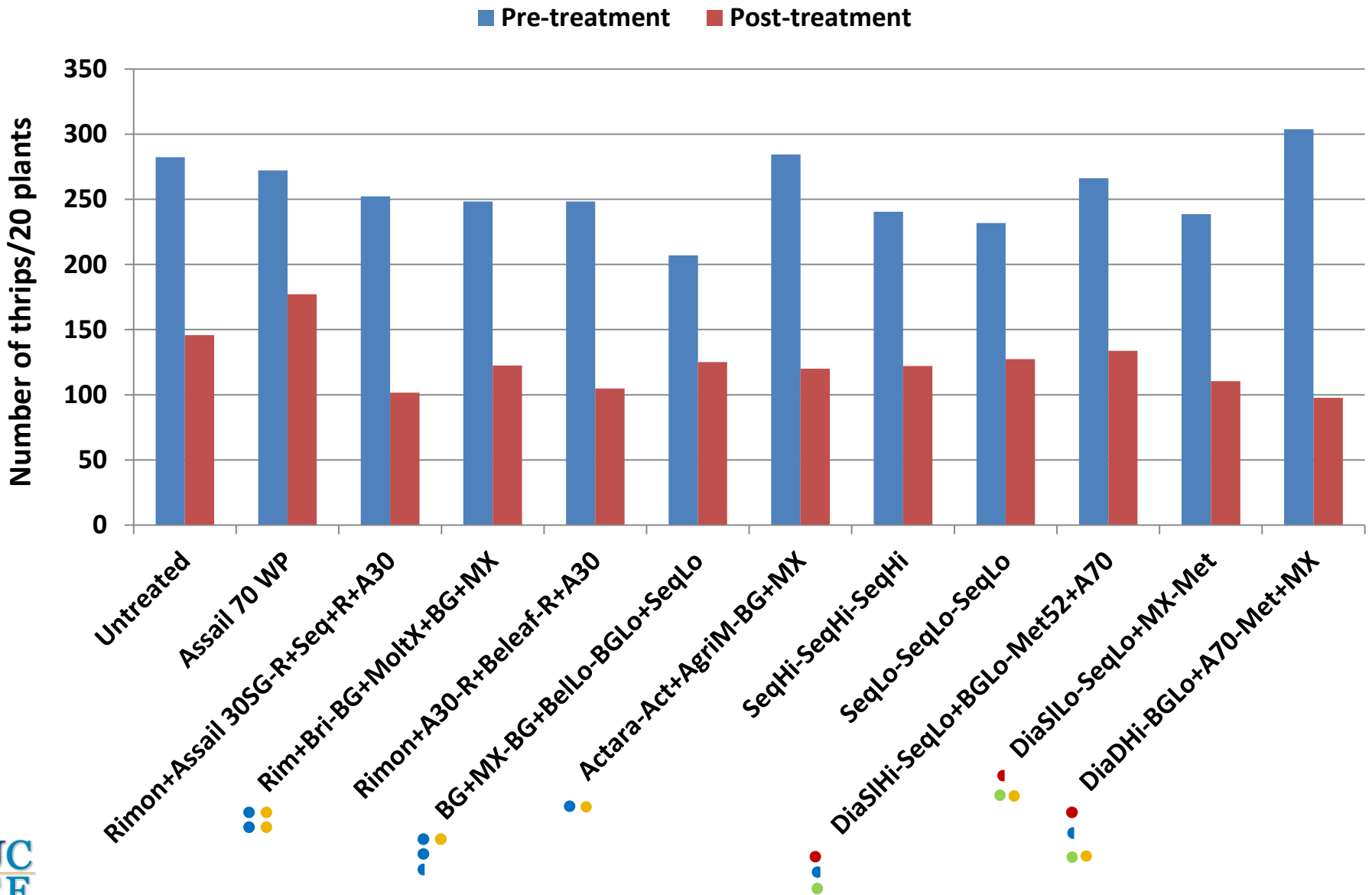
# 2014 Strawberry IPM trial-Whitefly adults



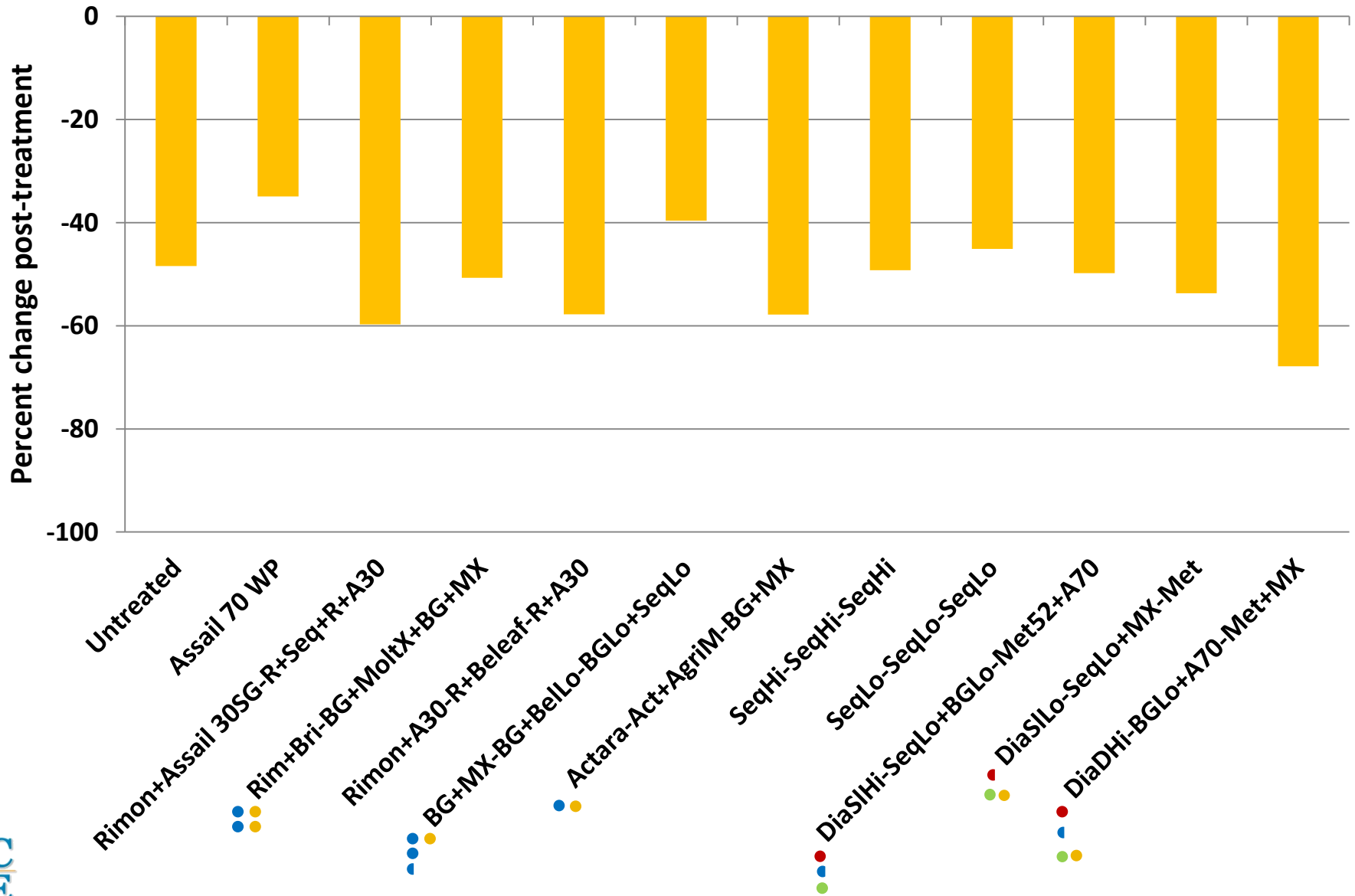
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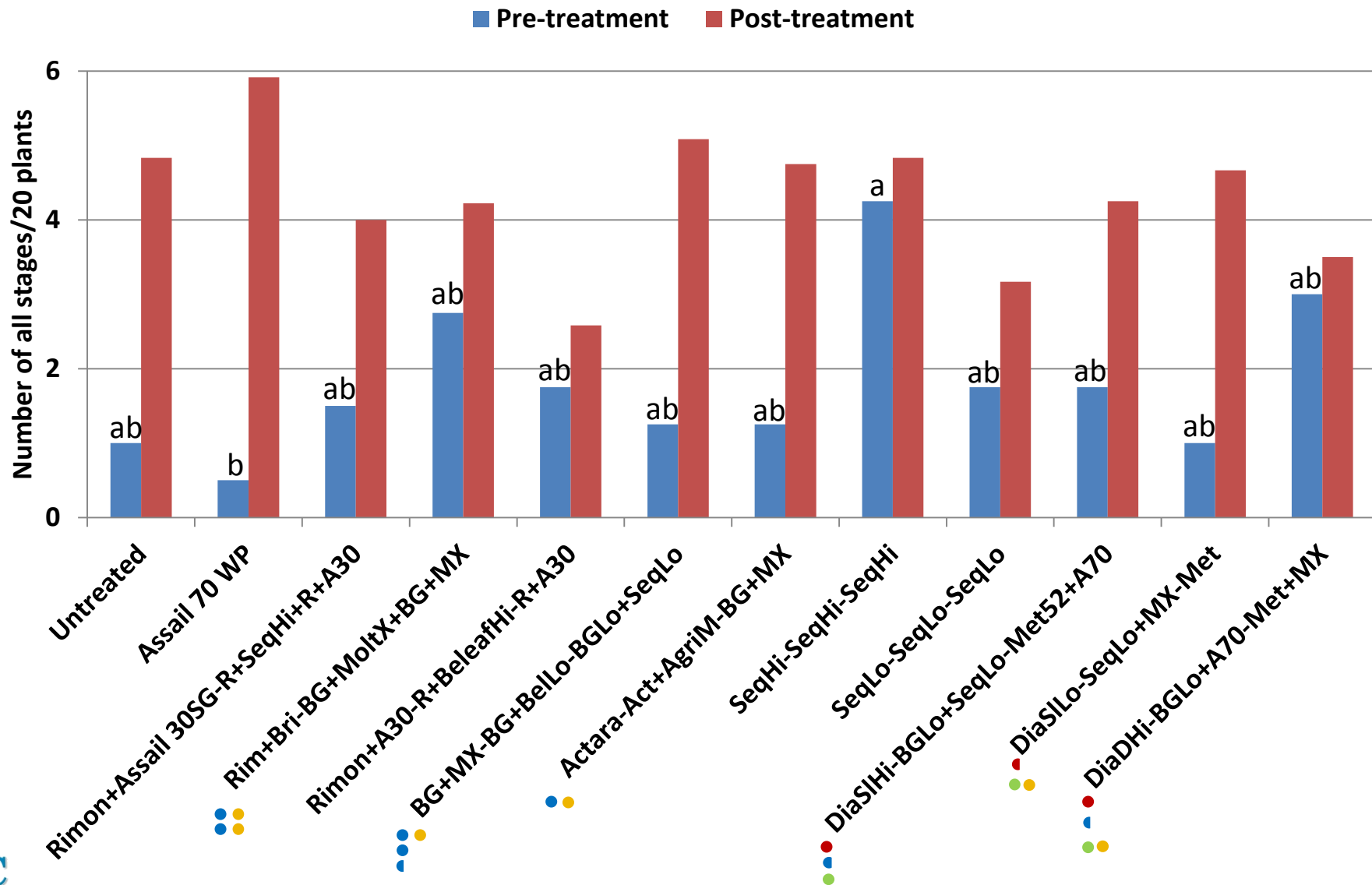
# 2014 Strawberry IPM trial-Thrips



# 2014 Strawberry IPM trial-Thrips

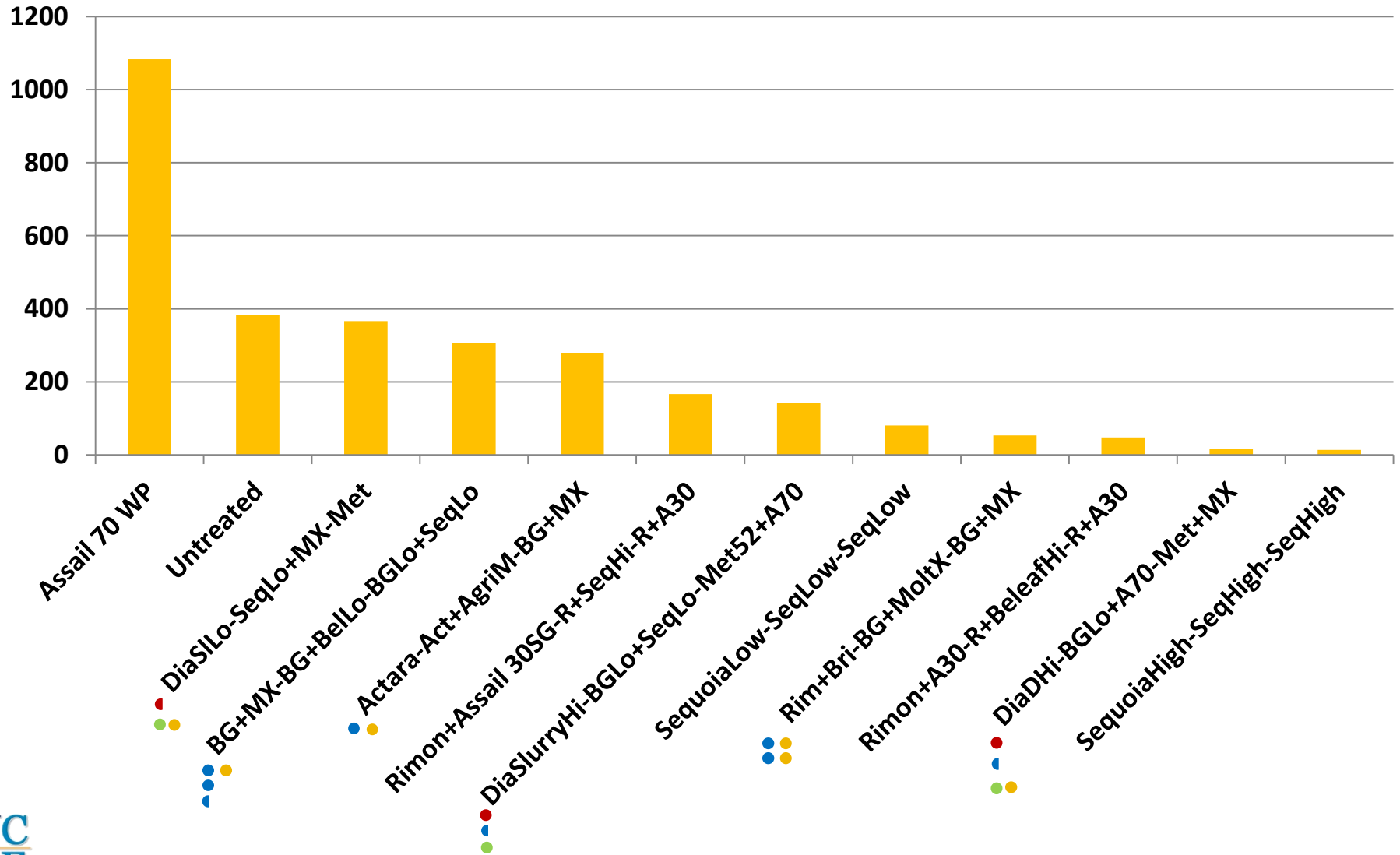


# 2014 Strawberry IPM trial



# 2014 Strawberry IPM trial-Lygus bug

Percent change in lygus numbers after three sprays



# 2014 Strawberry IPM trial-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



# 2014 Strawberry IPM trial-Lygus bug

Rank	%Change	I Spray	II Spray	III Spray	Cost/ac
I	14	Sequoia High	Sequoia High	Sequoia High	\$143.82
II	17	<del>Diafil Dust High</del> Sequoia High	BotaniGard Low + Assail 70WP	Met52 + Molt-X	<del>\$385.74</del> \$216.16
III	48	Rimon + Assail 30SG	Rimon + Beleaf 50SG	Rimon + Assail 30SG	\$178.42
IV	54	Rimon + Brigade	BotaniGard ES + Molt-X	BotaniGard ES + Molt-X	\$333.39
V	81	Sequoia Low	Sequoia Low	Sequoia Low	\$95.88
VI	143	Diafil Slurry High	Sequoia Low + BotaniGard ES Low	Met52 + Assail 70WP	\$378.22
VII	167	Rimon + Assail 30SG	Rimon + Sequoia High	Rimon + Assail 30SG	\$195.43
VIII	280	Actara	Actara + Agri-Mek	BotaniGard ES + Molt-X	\$180.60
IX	307	BotaniGard ES + Molt-X	BotaniGard ES + Beleaf 50SG Low	BotaniGard ES Low + Sequoia Low	\$178.42
X	367	Diafil Slurry Low	Sequoia Low	Met52 + Molt-X	\$218.12
XI	383	Untreated	Untreated	Untreated	0
XII	1083	Assail 70WP	Assail 70WP	Assail 70WP	\$126.63

# Acknowledgements

## **Growers**

Francisco Bautista

## **Technicians**

Andrew Reade

Anthony Reade

Michael McNulty

Ryan Sheppard

## **Industry collaborators**

Bayer CropScience

Bioworks

Chemtura

Dow AgroSciences

Imerys

Monsanto BioAg

Syngenta

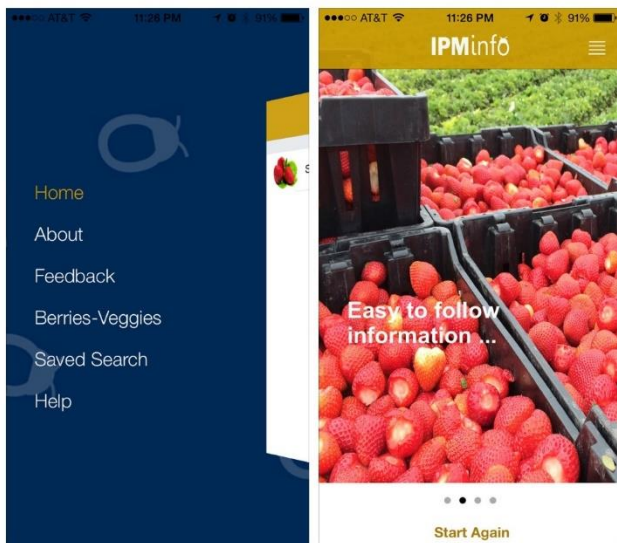
# IPMinfo app for Apple devices

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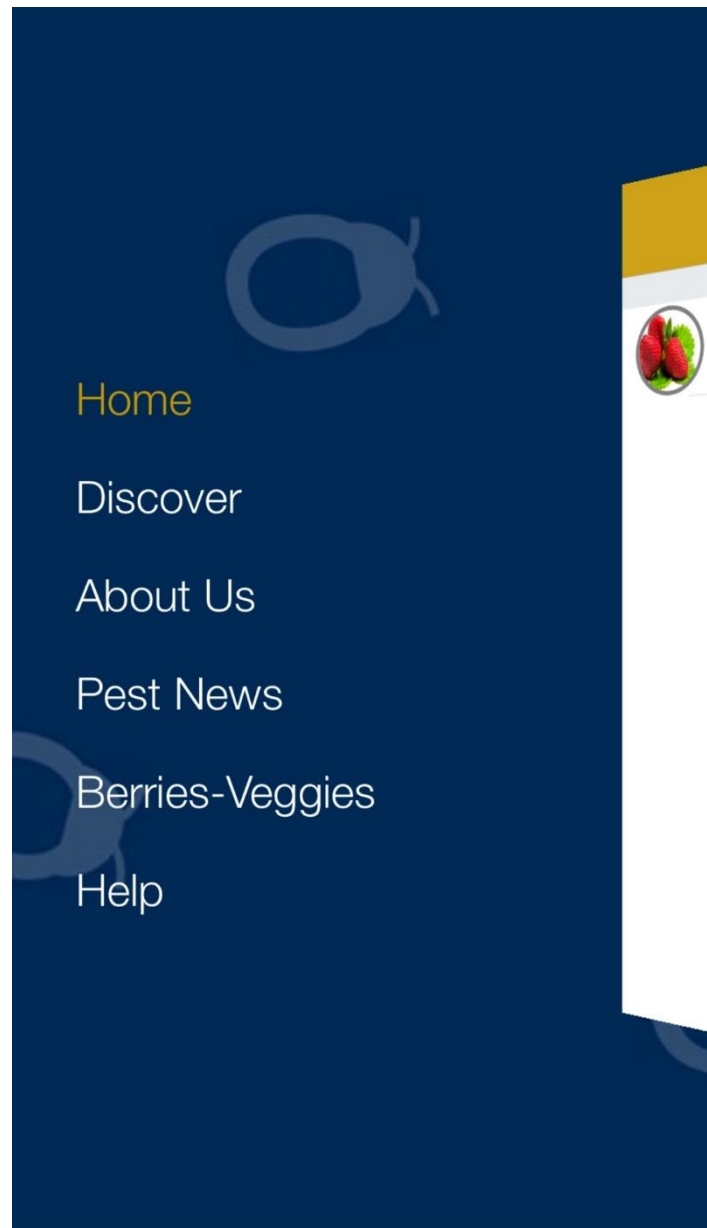


IPMinfo  
Surendra Dara

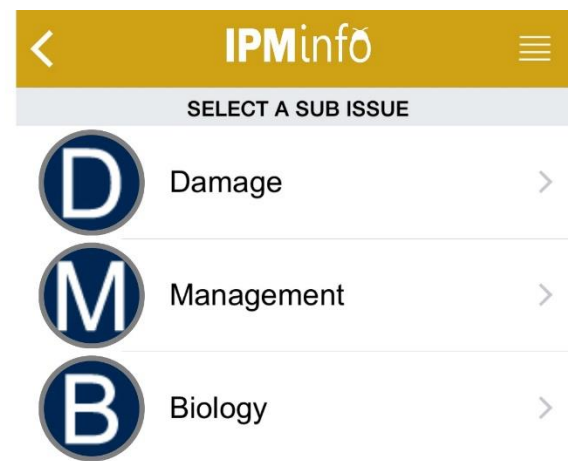
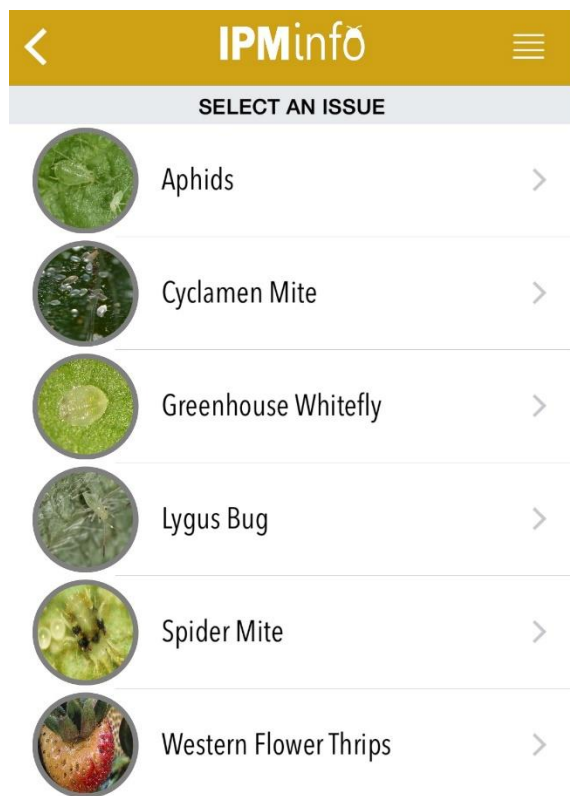
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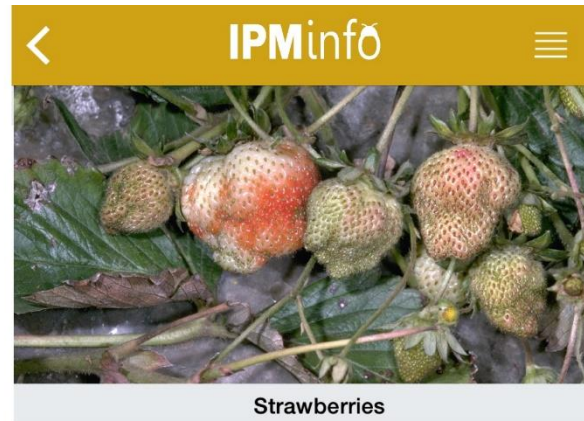
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# IPMinfo app for Apple devices



# IPMinfo app for Apple devices



## *Lygus Bug*

### Management

- Cultural control - Lygus bugs thrive on flowering weed hosts like wild mustard and wild radish and migrate to strawberries when the weeds dry out. Managing weeds and alternate hosts in winter before lygus bugs moves to strawberries is important.
- Biological control - Several species of natural enemies feed on various stages of lygus bugs. Big-eyed bugs (*Geocoris* spp.), damsel bugs (*Nabis* spp.), minute pirate bug (*Orius tristicolor*), parasitic wasp (*Anaphes iole*), different spiders are among the common species of natural enemies. Providing refuge and use of safer insecticides help conserve natural enemies.
- Microbial control - Recent studies show promise for controlling lygus bugs with entomopathogenic fungus, *Beauveria bassiana*.
- Chemical control - Various groups of chemicals are registered for managing lygus bugs. Rotating different modes of action is ideal to reduce the risk of resistance development.

For additional information, refer to  
<http://www.ipm.ucdavis.edu/PMG/r734300111.html>

## *Lygus Bug*

### Biology

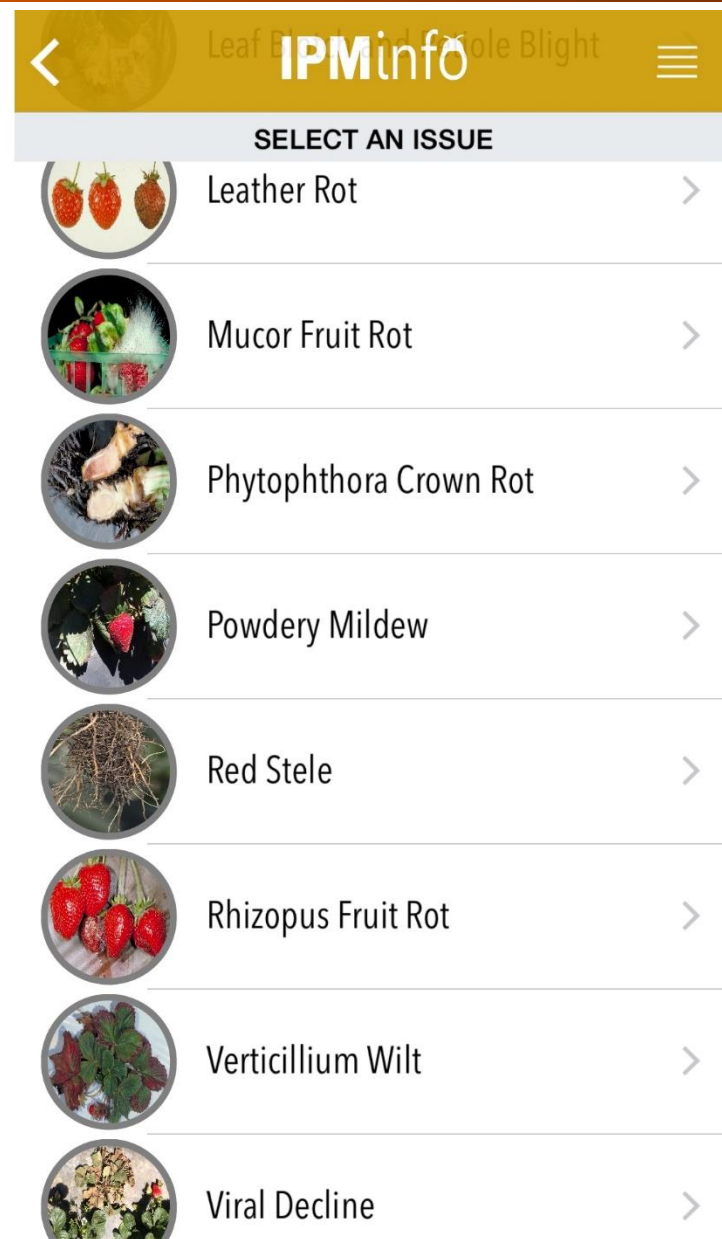
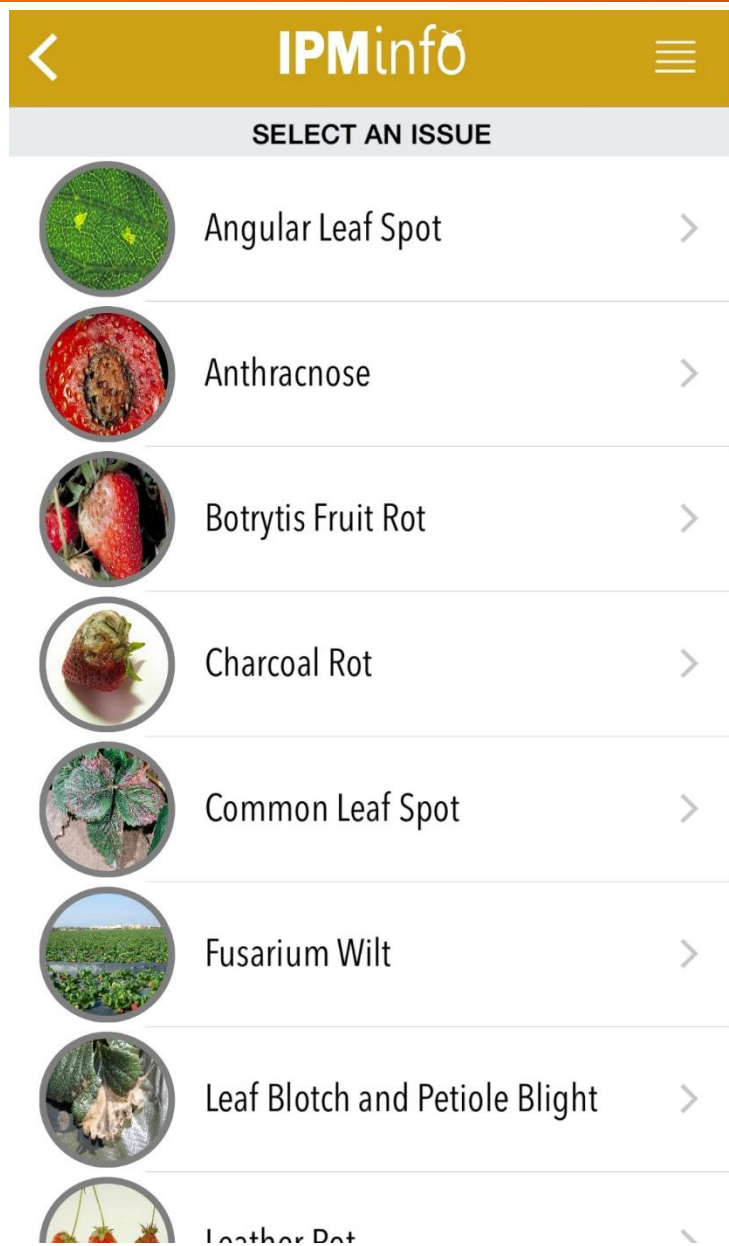
Life cycle includes eggs, five nymphal instars, and adults. Depending on temperature, it can take about 21 days from egg stage to adult emergence. Females start laying eggs in about 9 days and continue the process for 21 days. Eggs are mostly laid in the inflorescence. First instar nymphs are light colored. 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.

## *Lygus Bug*

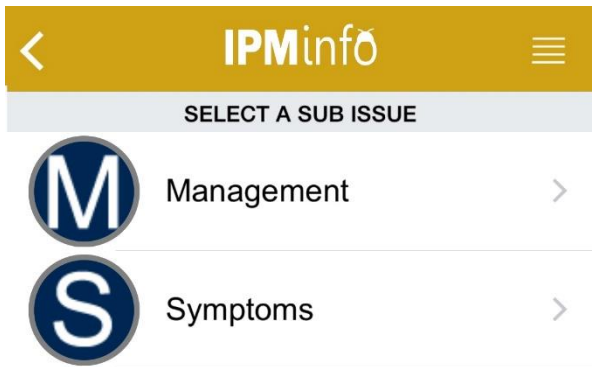
### Damage

Lygus bug punctures the plant tissue with its pointed mouthparts and feeds on the plant sap. Feeding causes damage to achenes (seeds) resulting in fruit deformation as the fruits develop. Deformed or cat-faced fruits are not marketable.

# IPMinfo app for Apple devices



# IPMinfo app for Apple devices



## ***Powdery Mildew***

### **Symptoms**

Typical symptoms include white, powdery fungal growth on the lower surface of the leaves, upward curling of the leaf edges, and dry, purplish patches on the upper leaf surface as the disease advances. In addition to leaves, flowers and fruit are also infected. Infected flowers fail to bear fruit or produce deformed fruit or die off. Infection hardens or desiccates developing fruit or gives a seedy appearance to mature fruit.

Pathogen overwinters as mycelium or spore-bearing structures called cleistothecia on transplants. Infected fields also serve as a source of inoculum which is dispersed by wind. Dry leaf surfaces, cool to warm temperatures and high humidity favor the infection.



## ***Powdery Mildew***

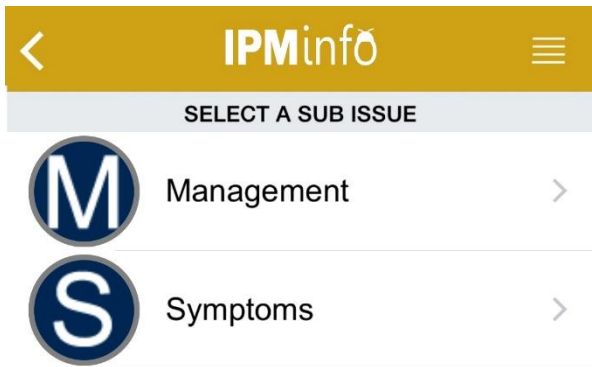
### **Management**

- Clean nursery stock is very important to prevent the introduction to the production fields.
- Avoid overhead irrigation during the periods of infection.
- Optimal fertilization without excessive nitrogen application is also important.
- Choose cultivars that are resistant to powdery mildew.
- Apply fungicides prior to the onset of symptoms for effective and sustainable suppression of the disease.

For additional information, refer to

<http://www.ipm.ucdavis.edu/PMG/r734100711.html>

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# Entomopathogenic fungi as endophytes



# Entomopathogenic fungi as endophytes

