University of California
Agriculture and Natural Resources

Micro-sprinklers in strawberry production
Role of beneficial microbes on strawberry health and yield
Miticide evaluation for spider mite management
Role of lygus bug in fruit deformity
IPM study with an emphasis on lygus bug management

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Santa Maria Strawberry Meeting 10 November, 2015

@calstrawberries @calveggies **strawberriesvegetables** **berriesnveggies.tumblr.com**

eNewsletters: ucanr.edu/strawberries-vegetables and ucanr.edu/pestnews
Download the free iOS app "IPMinfo" about strawberry pests and diseases

Irrigation needs for strawberries

- 24-29” for a typical fall planted crop
- Drip irrigation throughout the production season
- Overhead sprinkler irrigation during the initial few weeks

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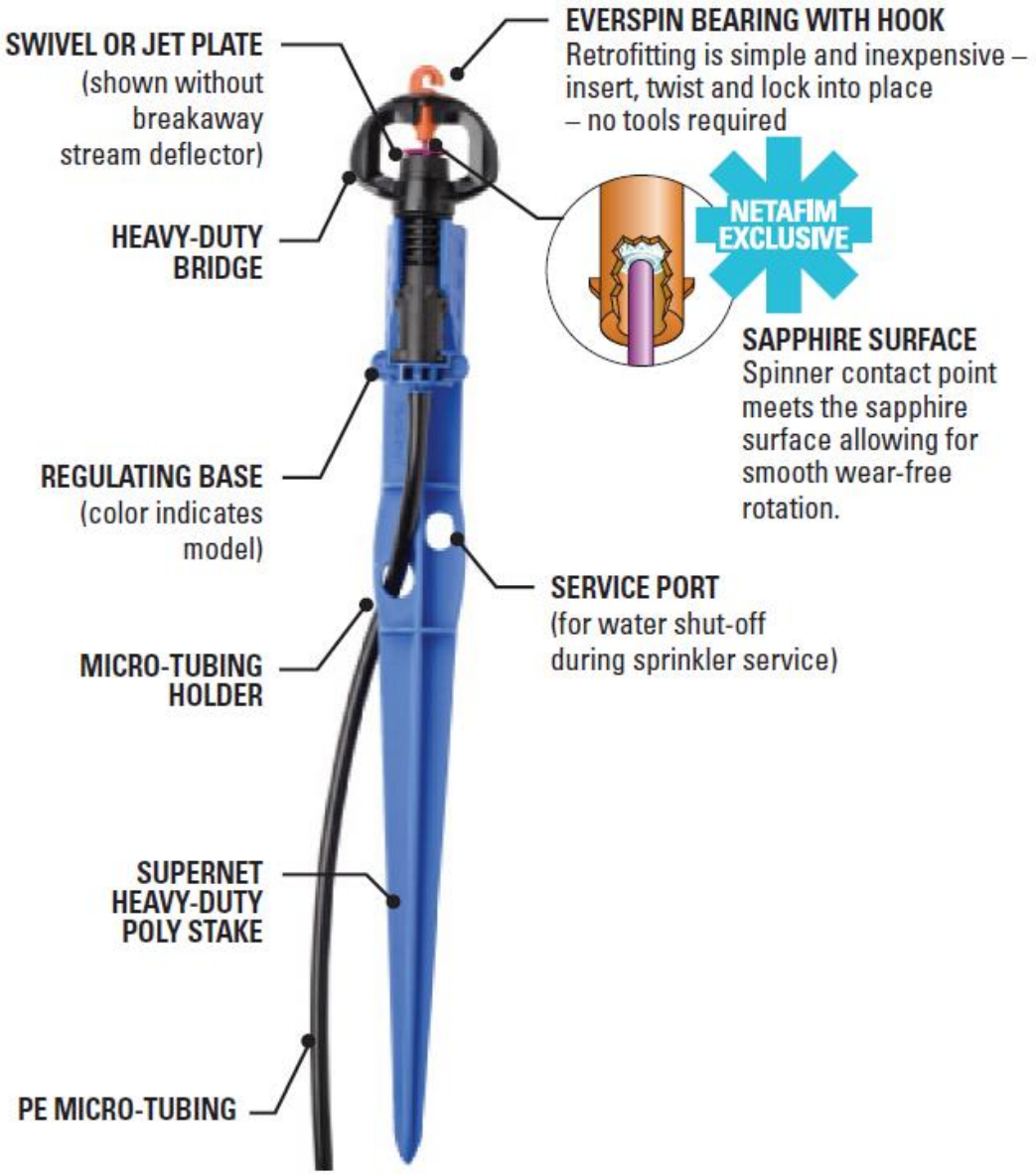
Micro-sprinkler



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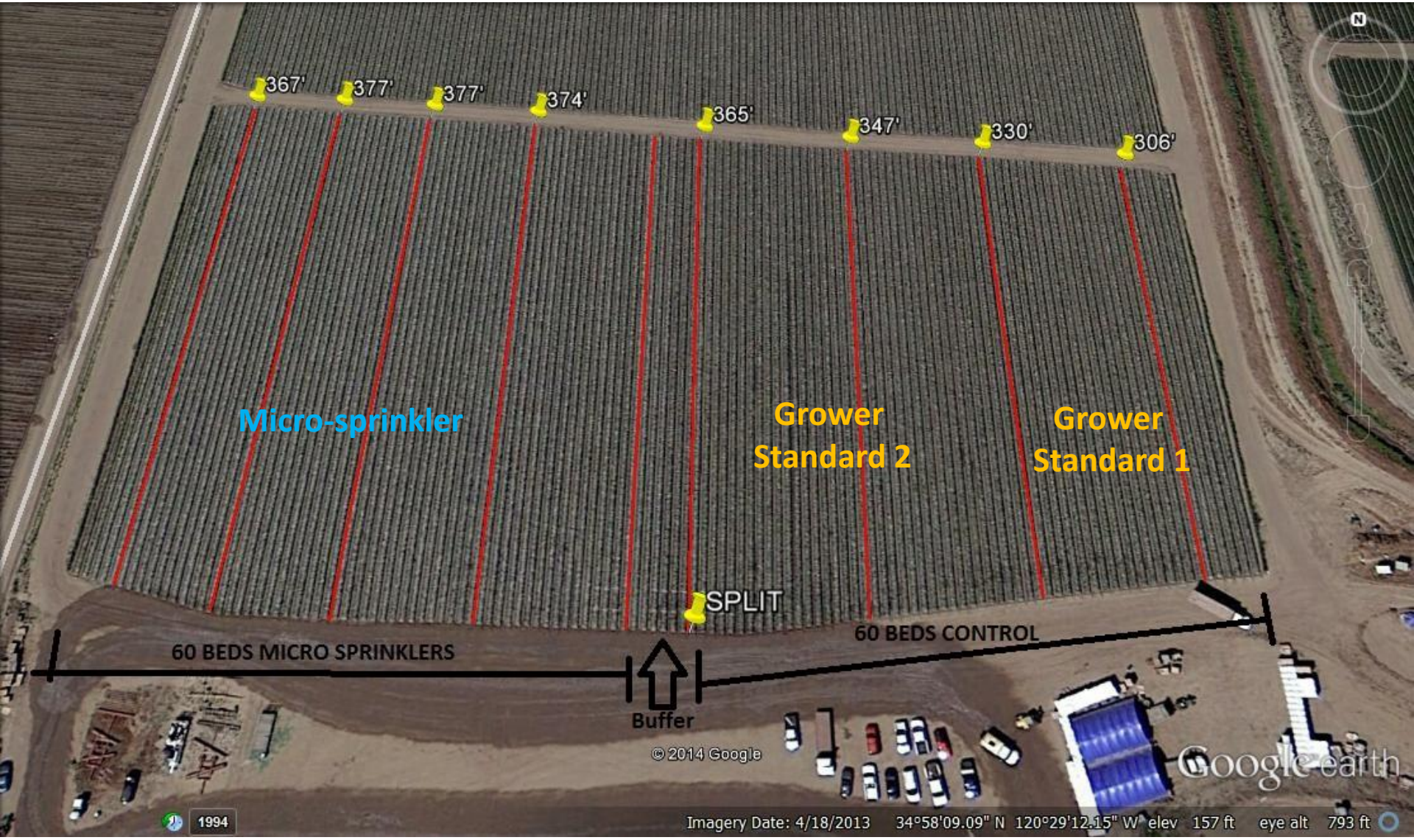
Experimental field



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Thanks to Manzanita field crew

Micro-sprinkler vs. Standard Aluminum

- Treatments: Micro-sprinklers and grower standard aluminum pipes (~2.5 ac each)
- Plots: Six 25’ long plots within each treatment

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Micro-sprinkler vs. Standard Aluminum

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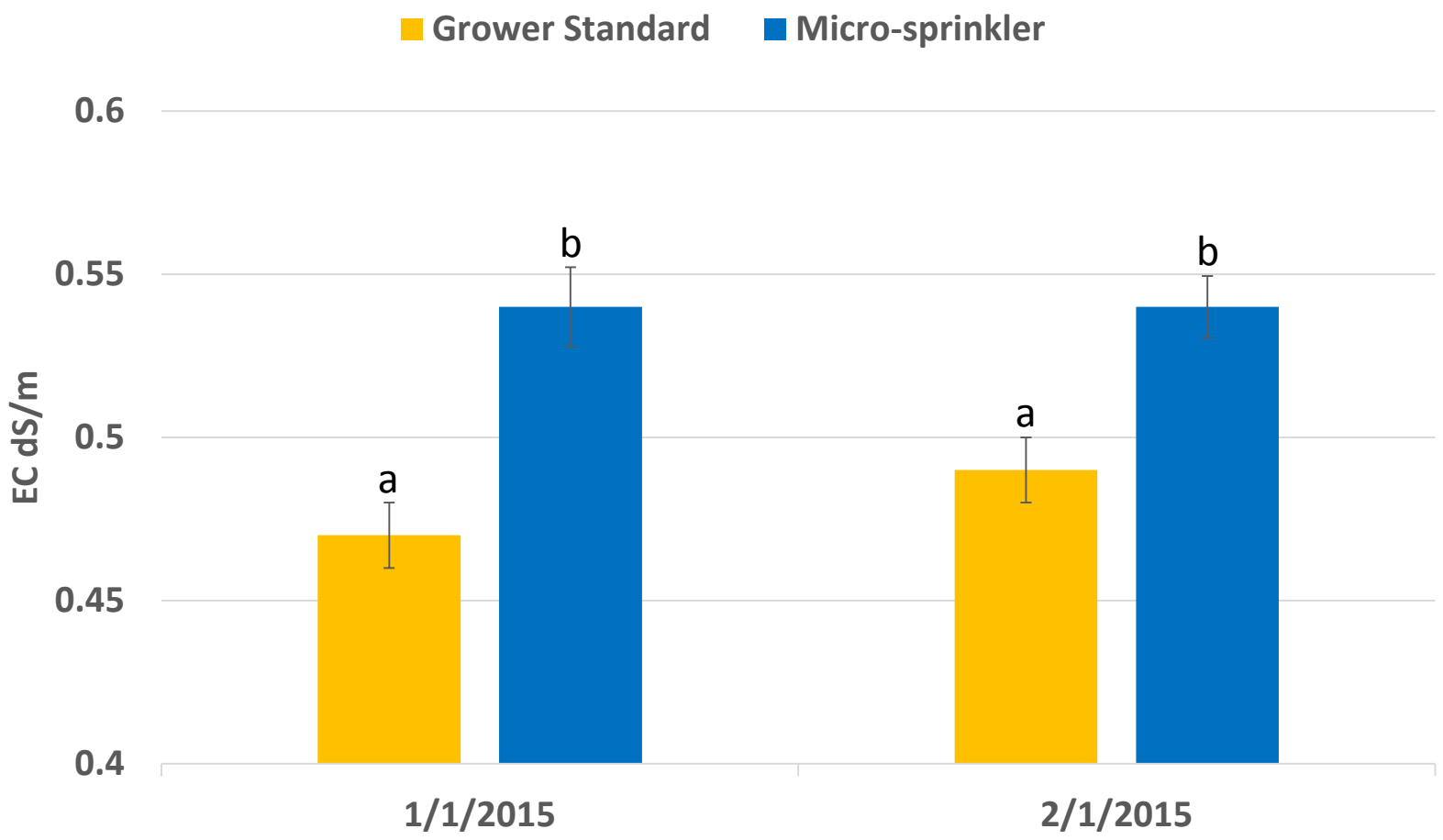
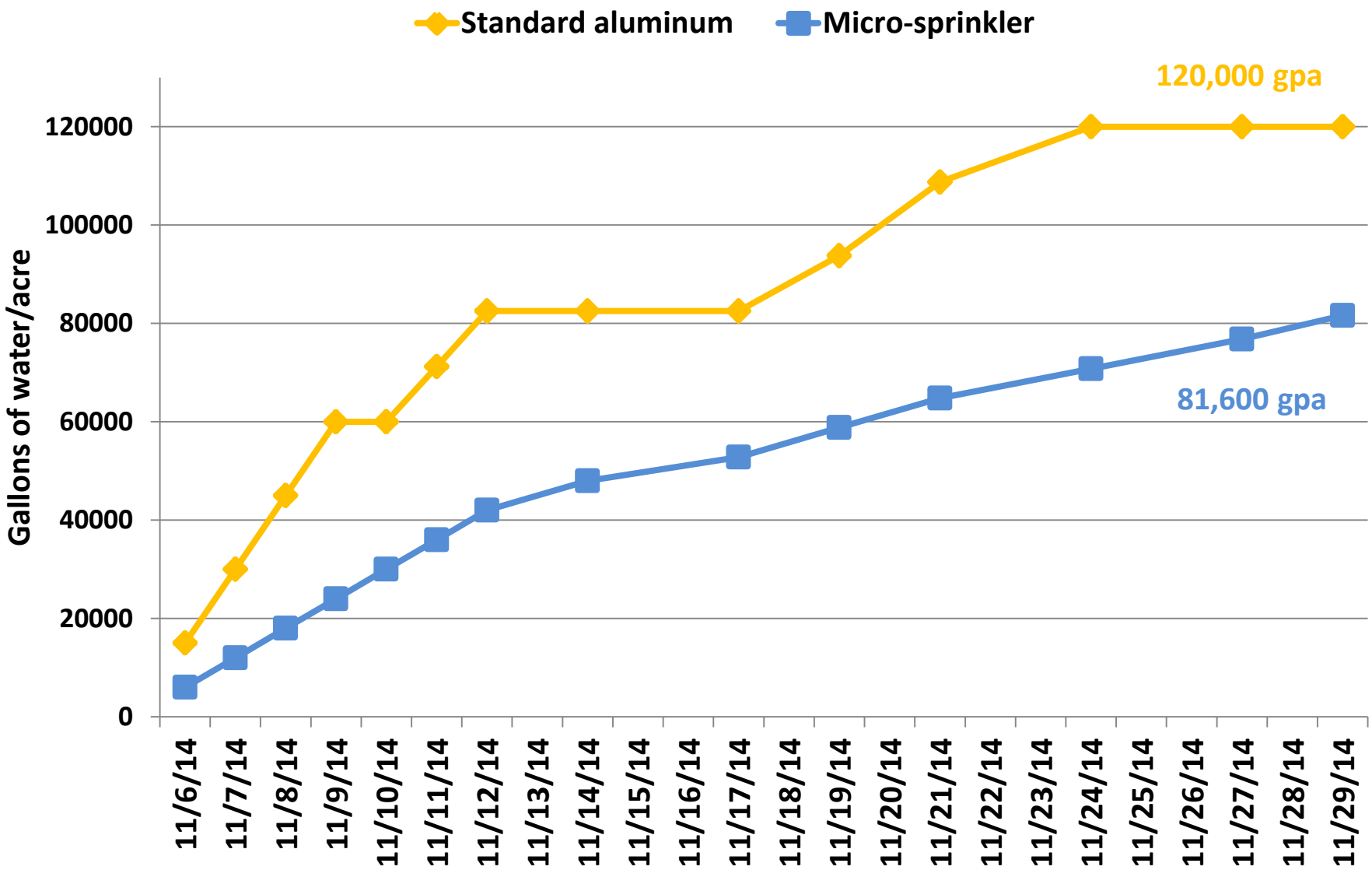
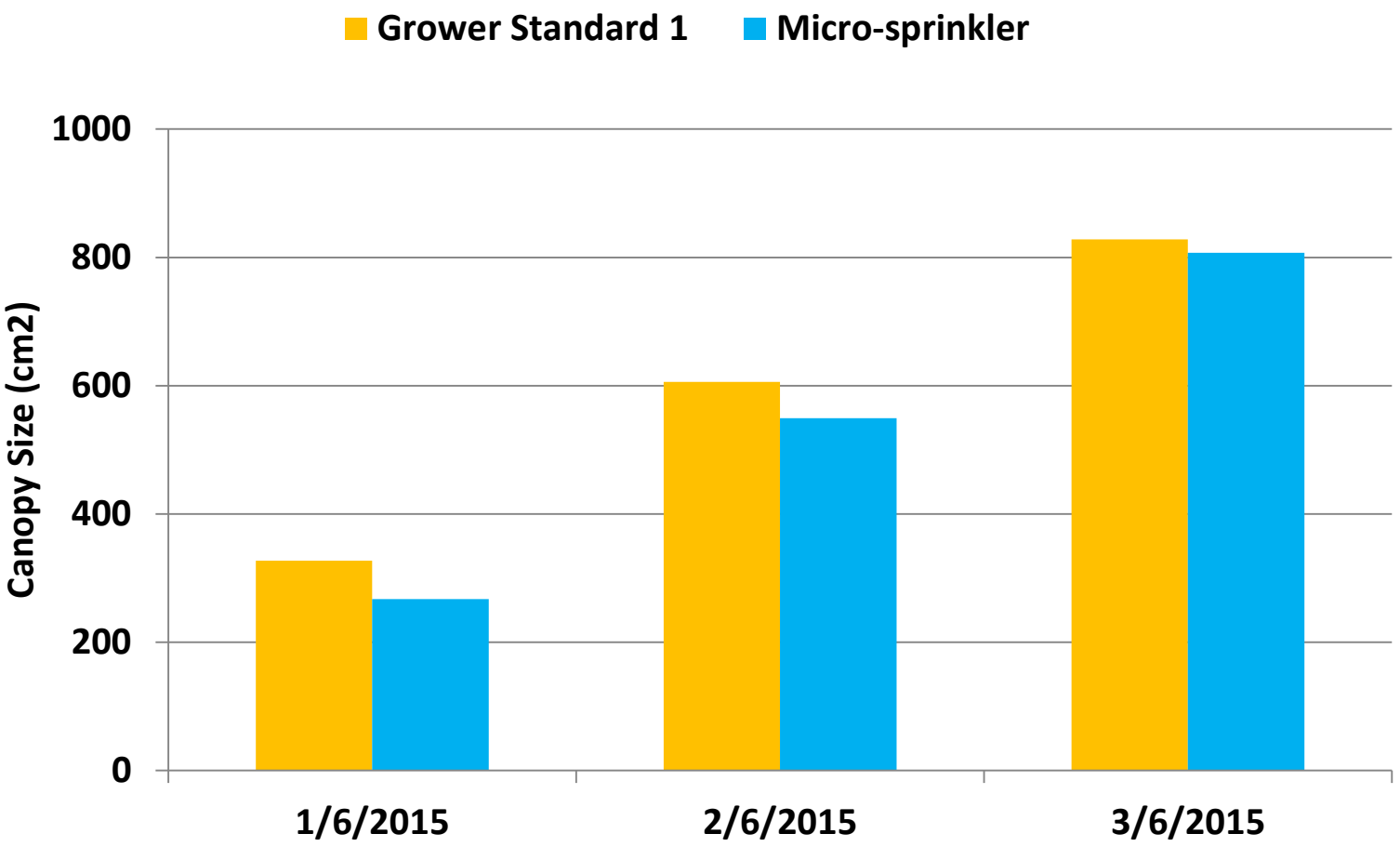
Electrical Conductivity



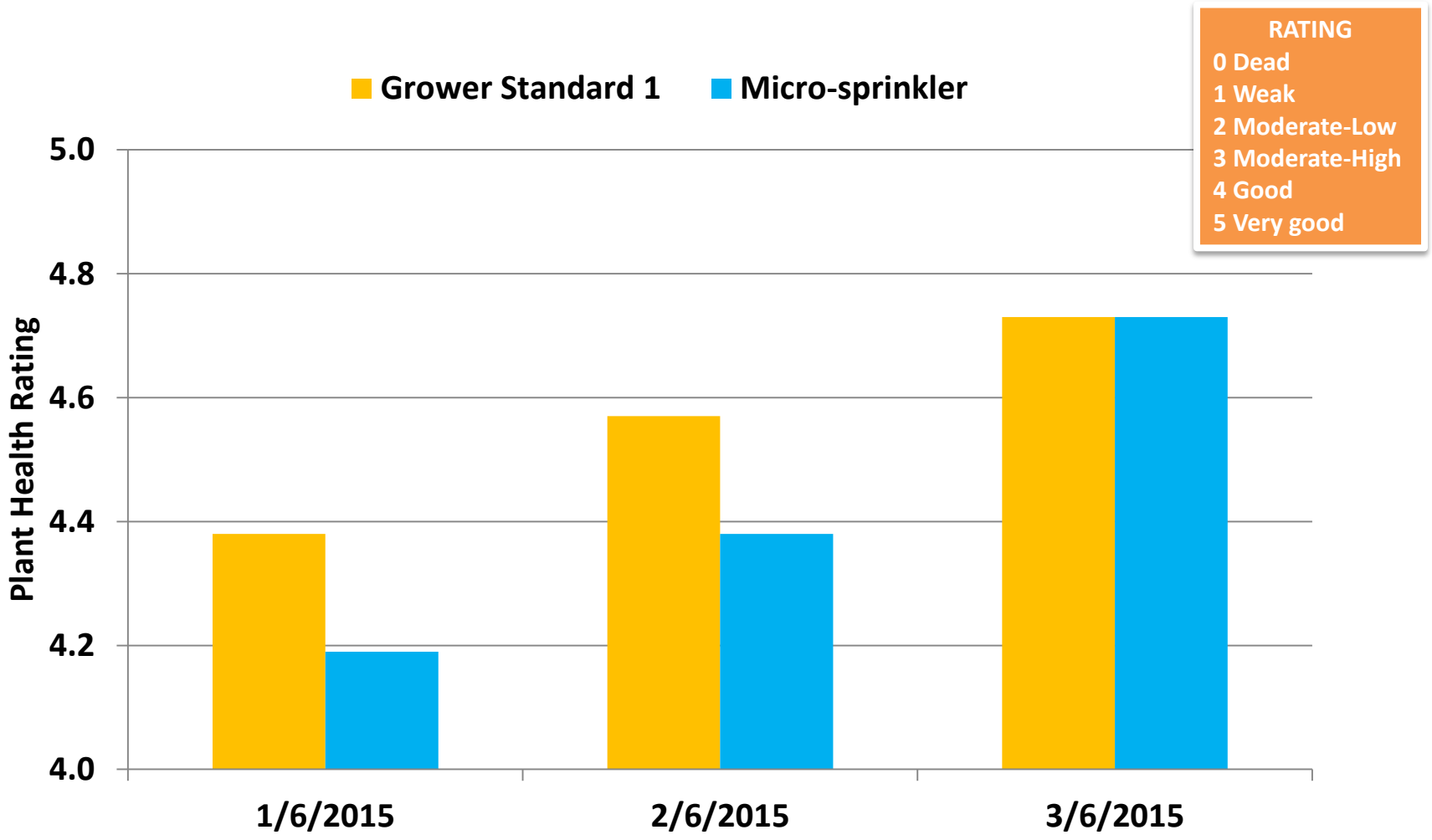
Cumulative irrigation volume



Canopy size


Grower Standard 1
Micro-sprinkler
Canopy Size (cm2)
1000
800
600
400
200
0
1/6/2015
2/6/2015
3/6/2015

Plant health rating



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Botrytis fruit rot

RATING
0 None
1 1-25%
2 26-50%
3 51-75%
4 76-100%

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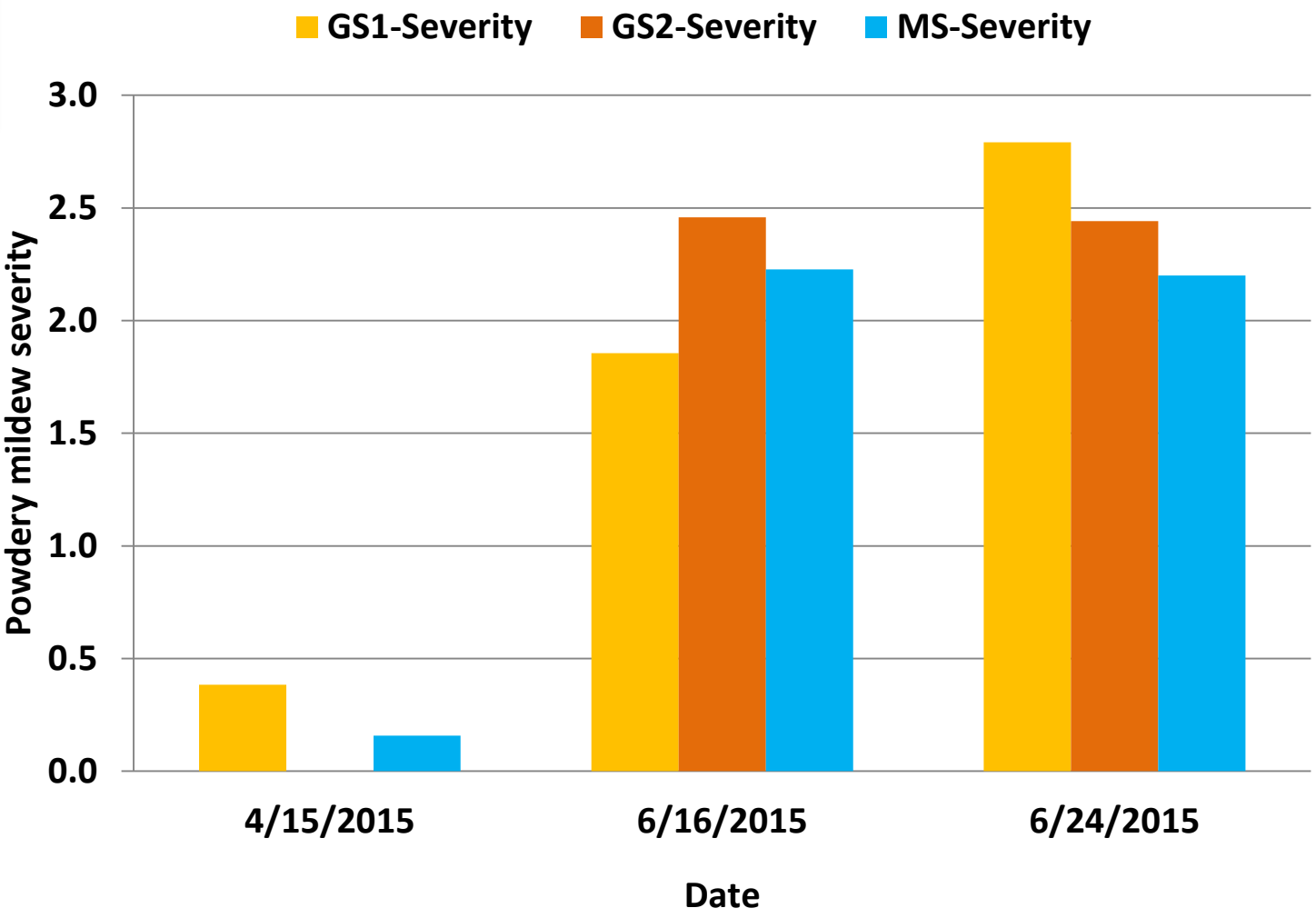
Powdery mildew

RATING
0 None
1 1-25%
2 26-50%
3 51-75%
4 76-100%



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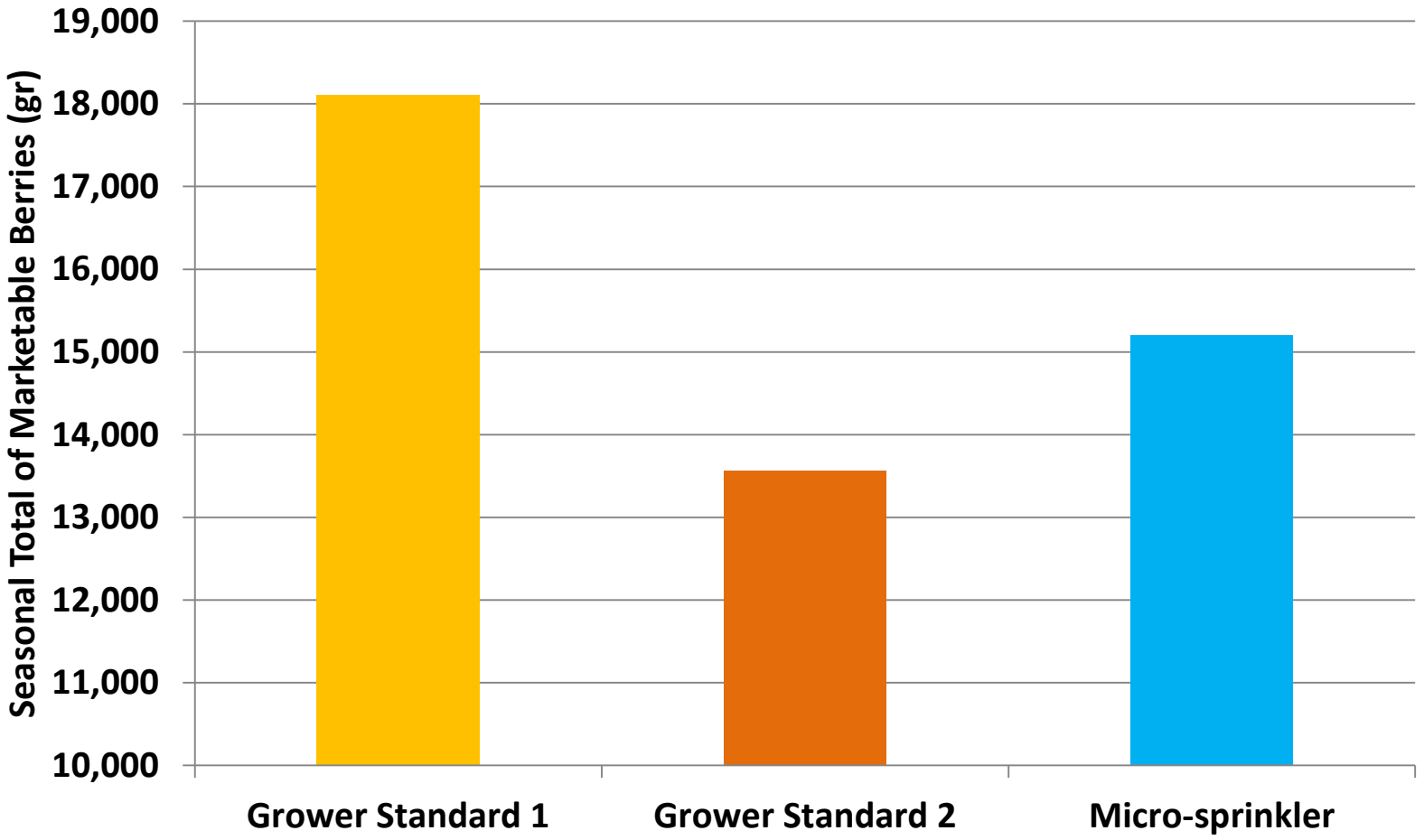
Yield – Seasonal total of marketable berries



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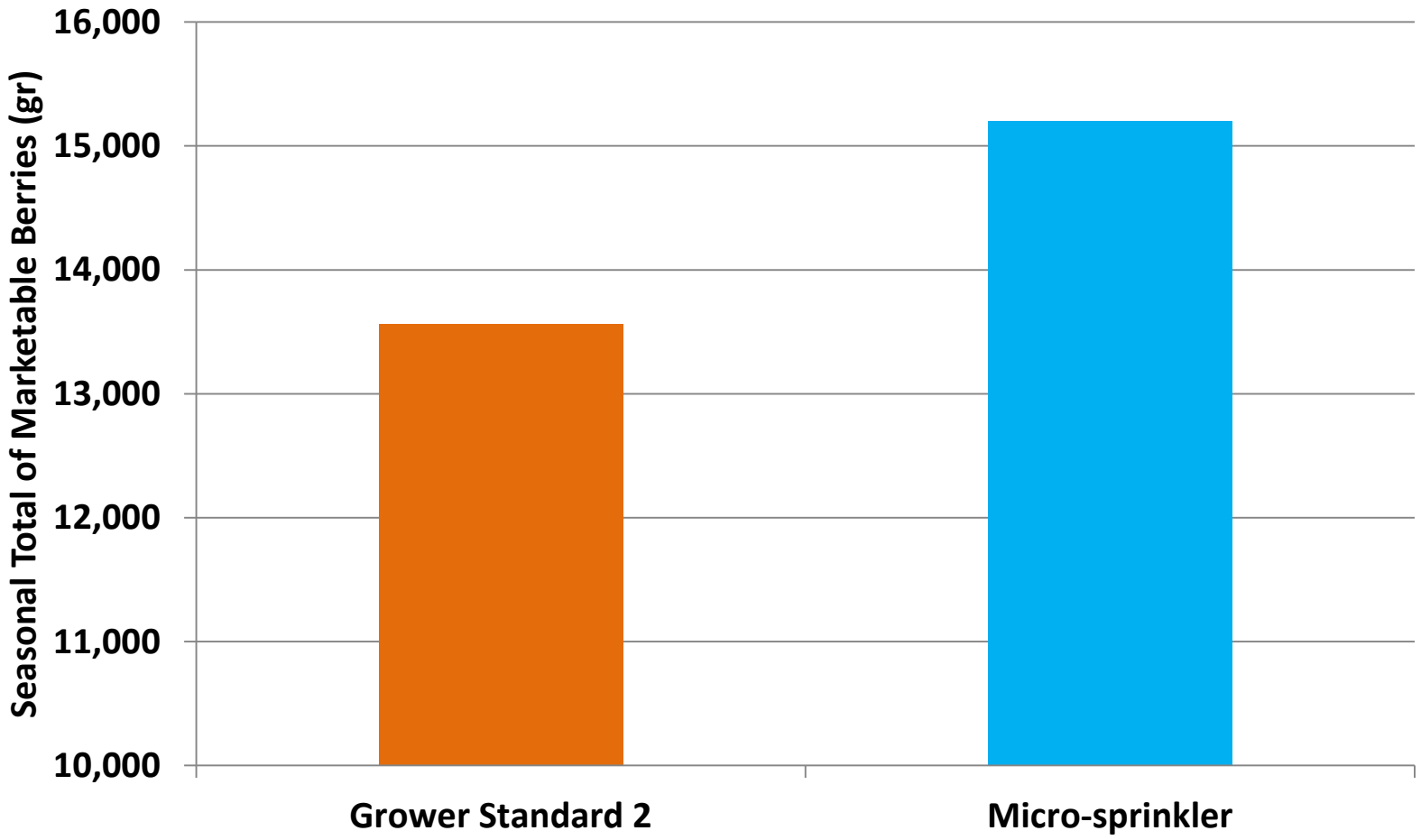
Yield – Seasonal total of marketable berries



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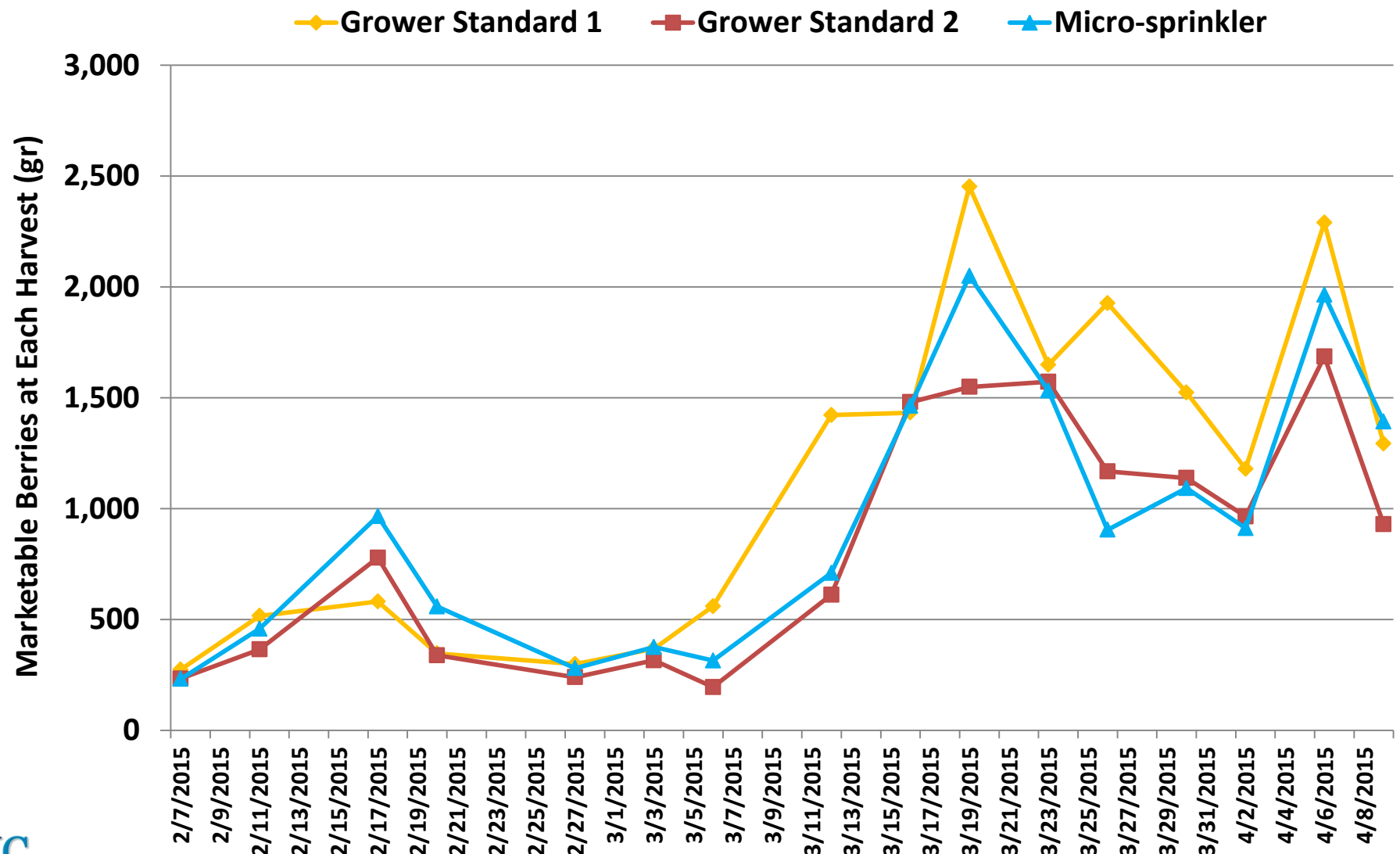
Yield –Marketable berries



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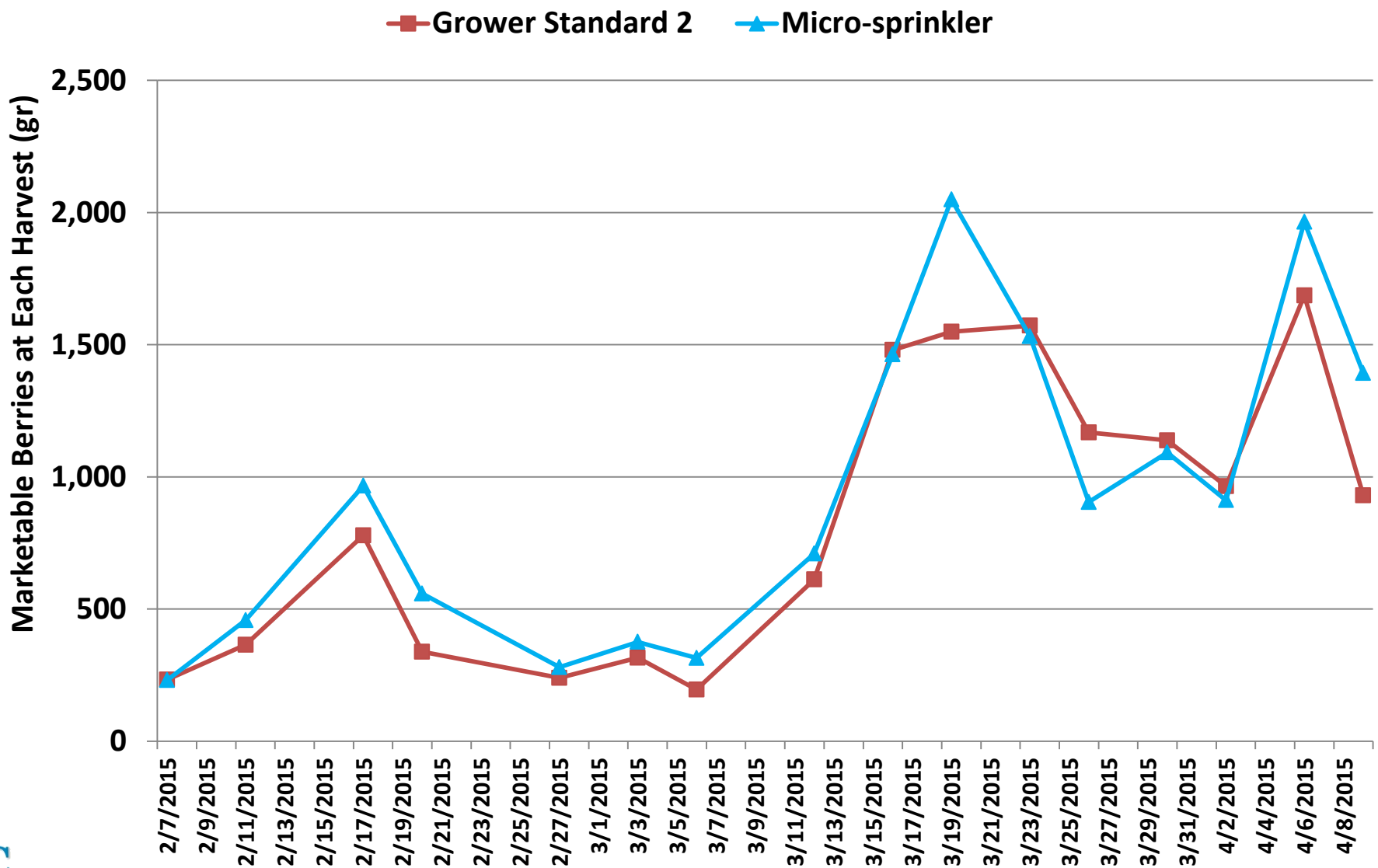
Yield – Marketable berries



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Brent Wellington, Netafim

Danilu Ramirez, RDO Water

Technical assistance

Chris Martinez

Fritz Light

Manzanita Field Crew

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Strawberries and microbial enhancers

- Canopy size
- Plant health condition
- Yield
- Powdery mildew severity
- Botrytis fruit rot severity
- Spider mite and predatory mite numbers

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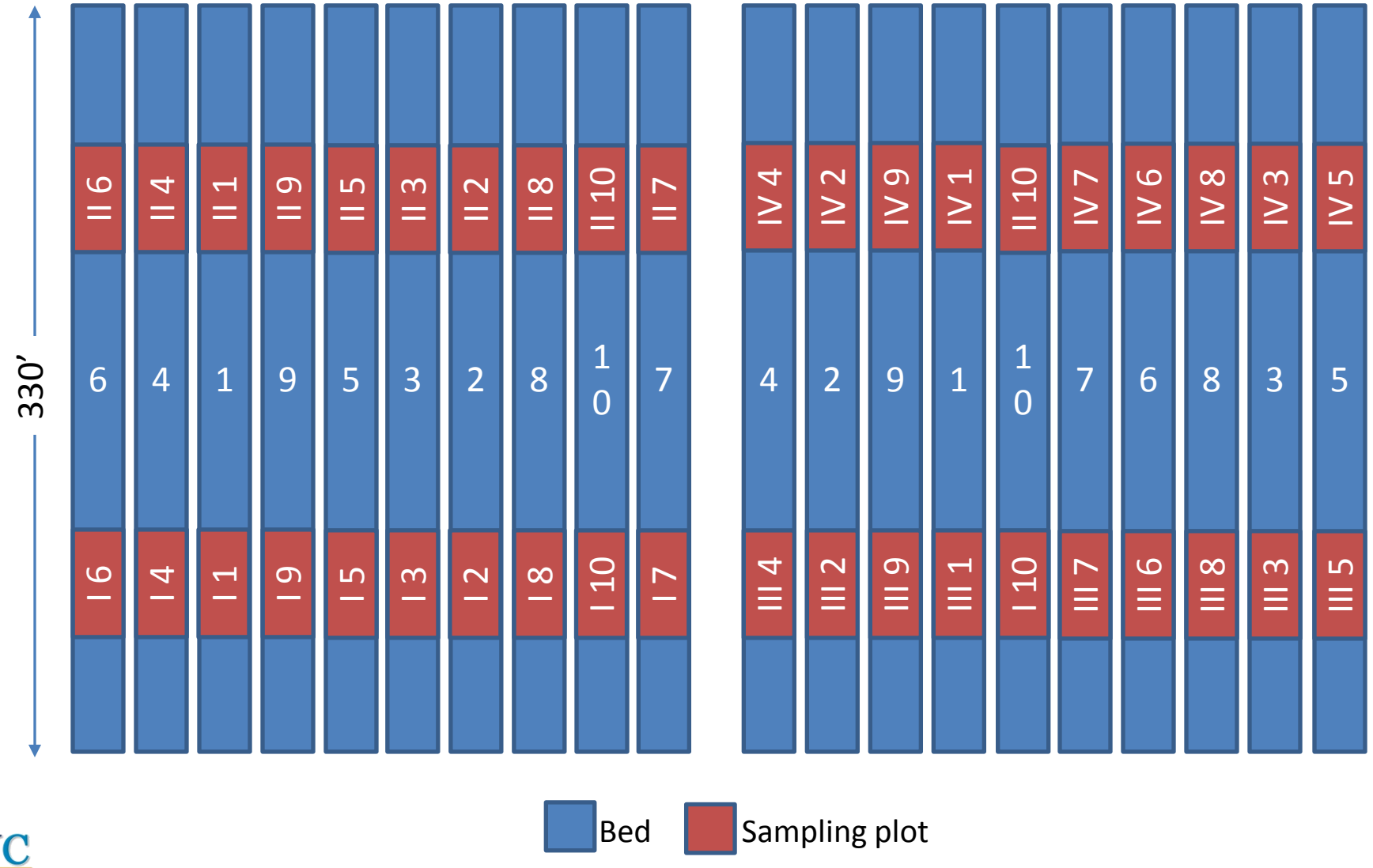
Strawberries and microbial enhancers

	Treatment	Active Ingredient(s)	Application Dates
1	Untreated		
2	HealthySoil (Grower Standard)	Proprietary	
3	BotaniGard ES	*Beauveria bassiana* GHA	11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, and 4/9/ 15
4	Met52 EC	*Metarhizium brunneum* F52	11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, and 4/9/15
5	NoFly	*Isaria fumosorosea* FE 9901	11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, and 4/9/15
6	Actinovate AG	*Streptomyces lydicus* WYEC 108	11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, 4/9/15, 5/1/15, 5/29/15, and 6/26/15
7	TerraClean 5.0	Hydrogen dioxide, peroxyacetic acid	11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, 4/9/15, 4/17/15, 5/1/15, 5/29/15, 6/12/15, and 7/3/15
8	TerraGrow	*Bacillus licheniformis, B. subtilis, B. pumilus, B. amyloliquefaciens, B. megaterium, Trichoderma harzianum, and T. reesei*	11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, and 4/9/ 15
9	TerraClean + TerraGrow		11/7/14, 12/5/14, 1/6/15, 1/15/15, 2/3/15, 3/5/15, and 4/9/15
10	O-MEGA	Bat guano, turmeric, stevia, ginger, cinnamon, *Azotobacter chroococcum*, *Azospirillum lipoferum*, *Aspergillus niger, Lactobacillus acidophilus, Pseudomonas fluorescens, Cellulomonas cellulans*	11/7/14,11/14/14, 11/21/14, 11/28/14, 1/2/15, 1/6/15, 1/9/15, 1/16/15, 1/23/15, 1/30/15, 2/6/15, 2/13/15, 2/20/15, 2/27/15, 3/6/15, 3/13/15, 3/20/15, 3/27/15, 4/3/15, 4/10/15, 4/17/15, 4/24/15, 5/1/15, 5/8/15, 5/15/15, 5/22/15, 5/29/15, 6/5/15, 6/12/15, 6/19/15, 6/26/15, 7/3/15, and 7/10/15

Strawberries and microbial enhancers



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Strawberries and microbial enhancers

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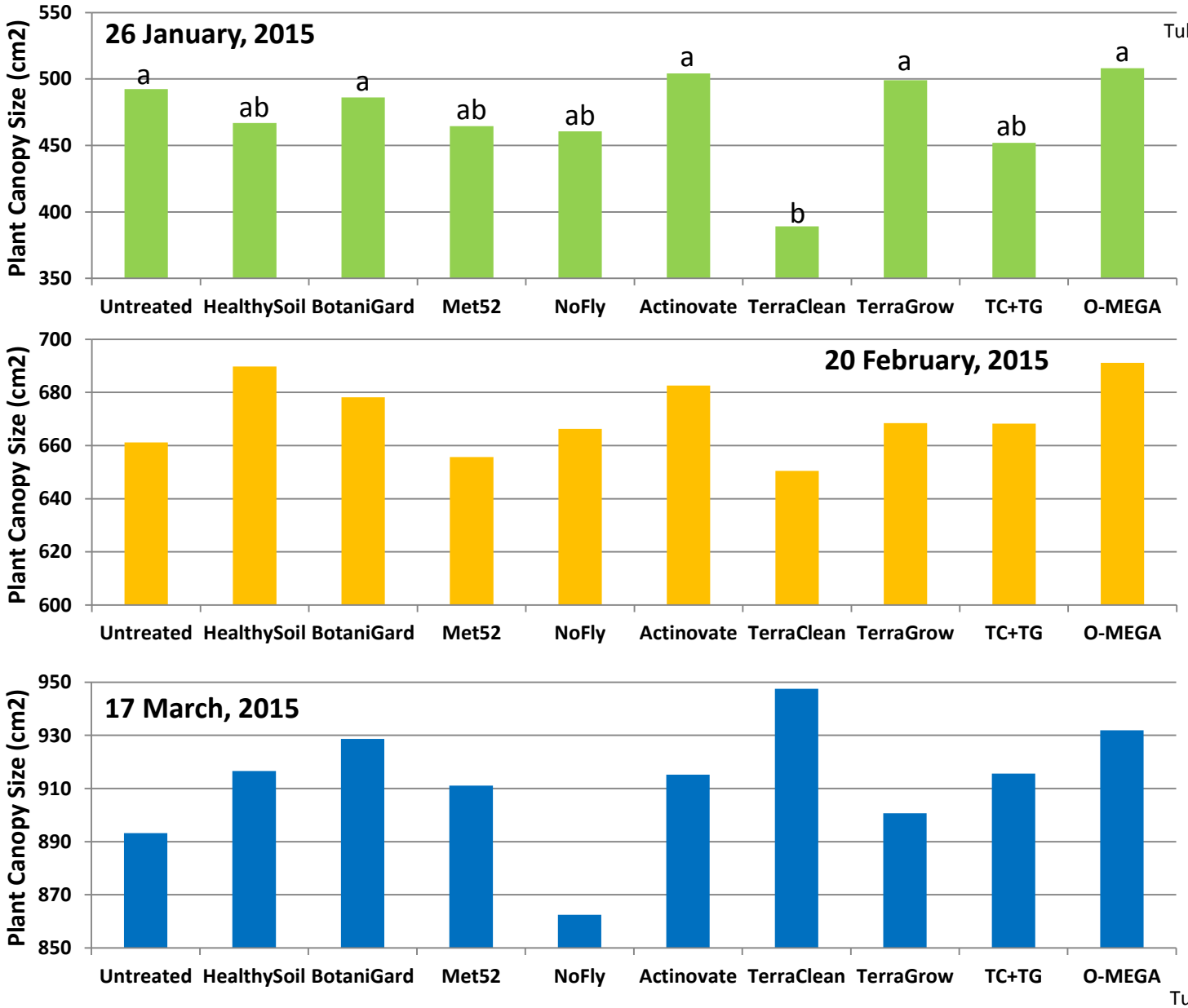
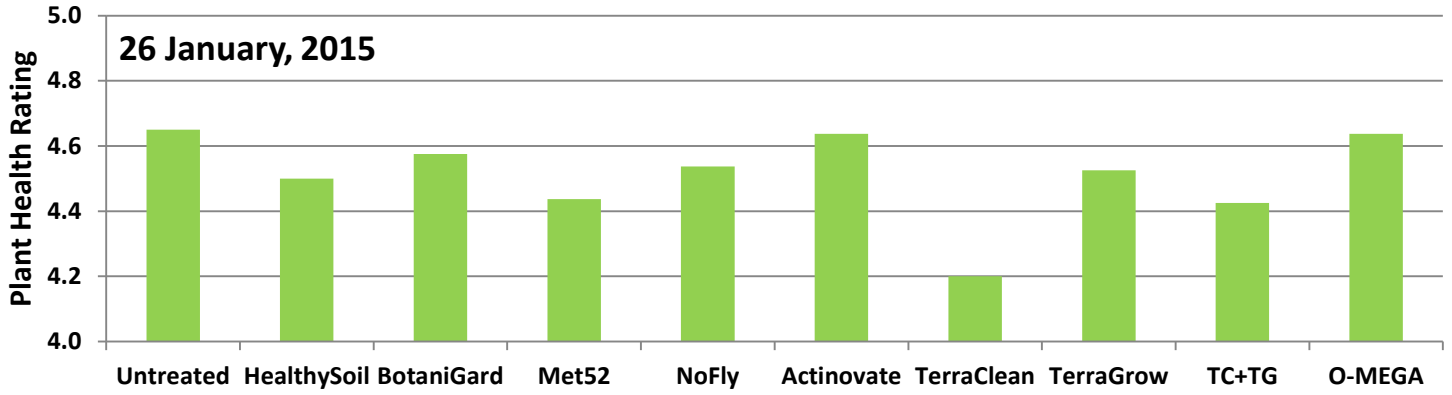
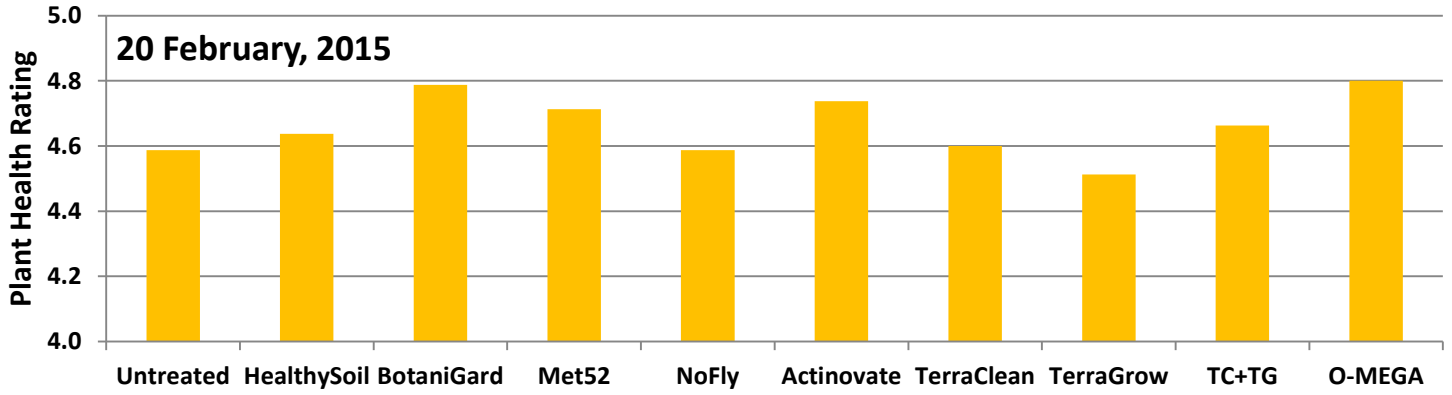
Impact on plant canopy

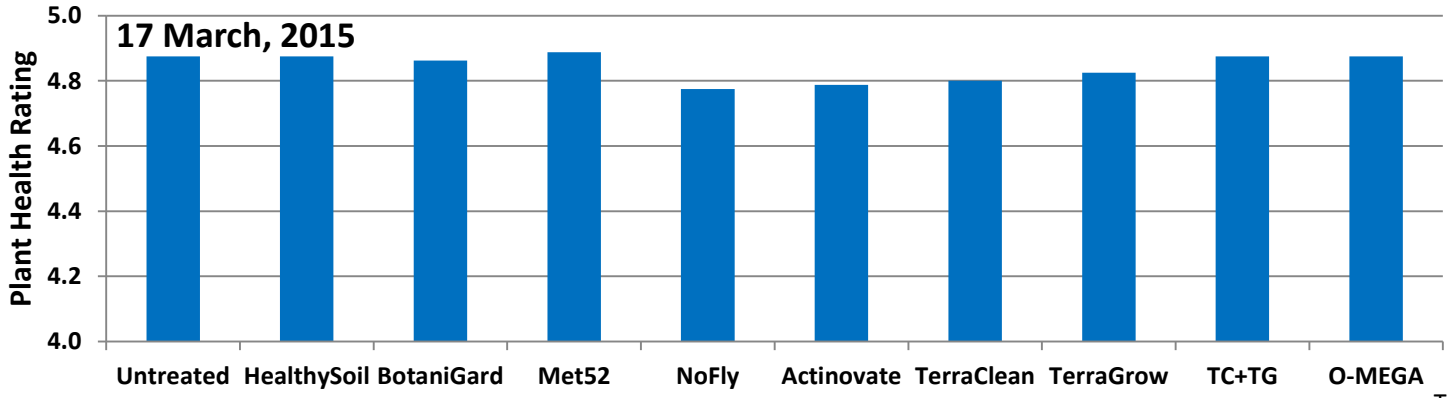


Impact on plant health

RATING
0 Dead
1 Weak
2 Moderate-Low
3 Moderate-High
4 Good
5 Very good

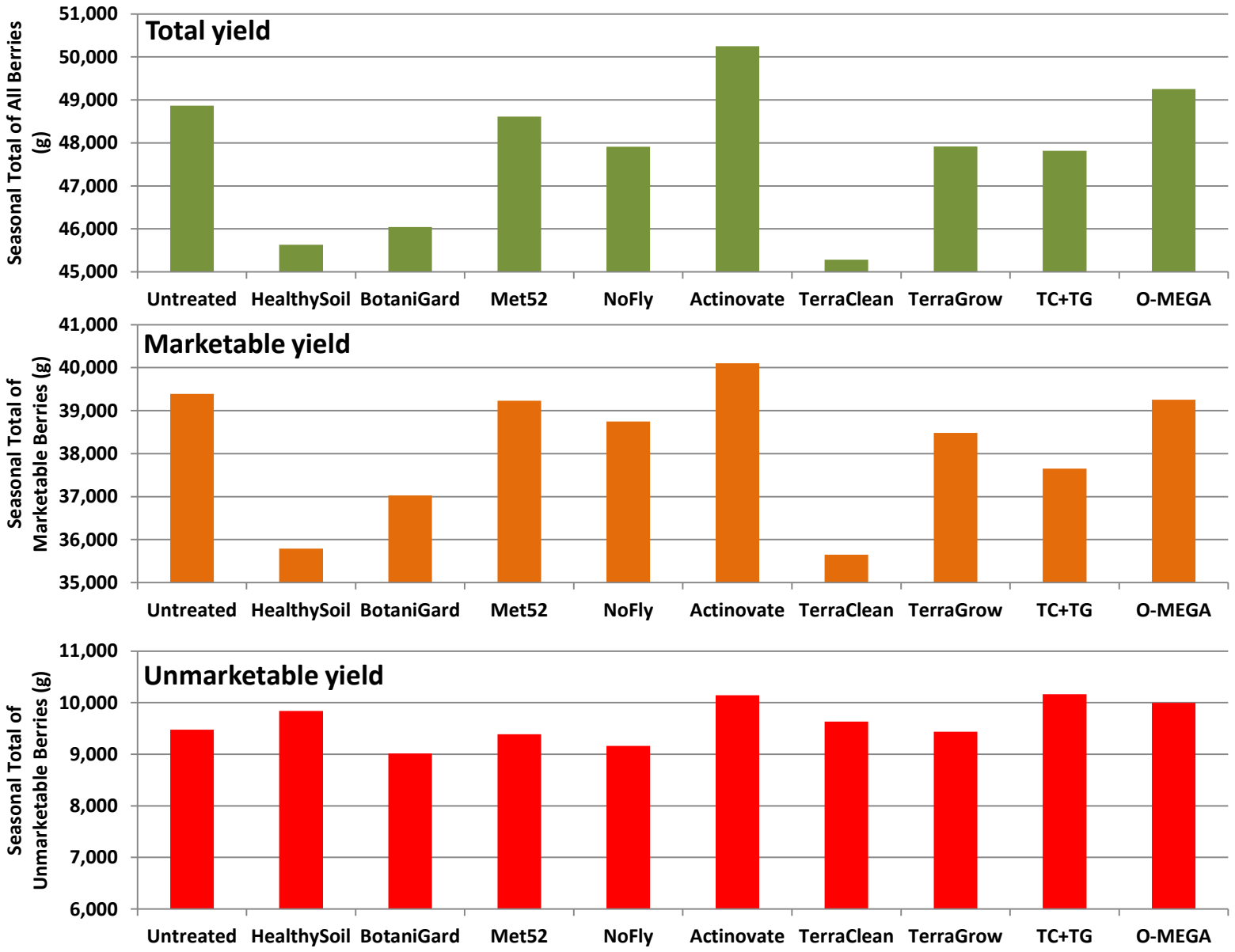






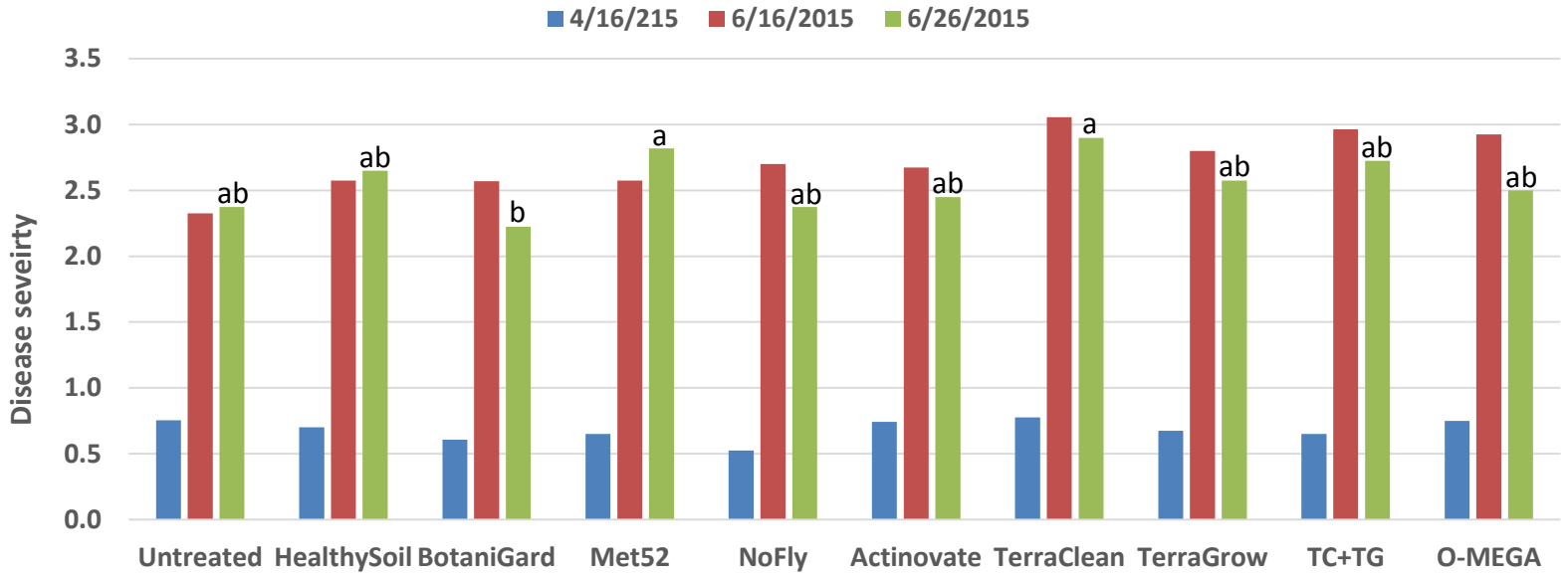
Tukey's HSD $P \geq 0.05$

Impact on berry yield



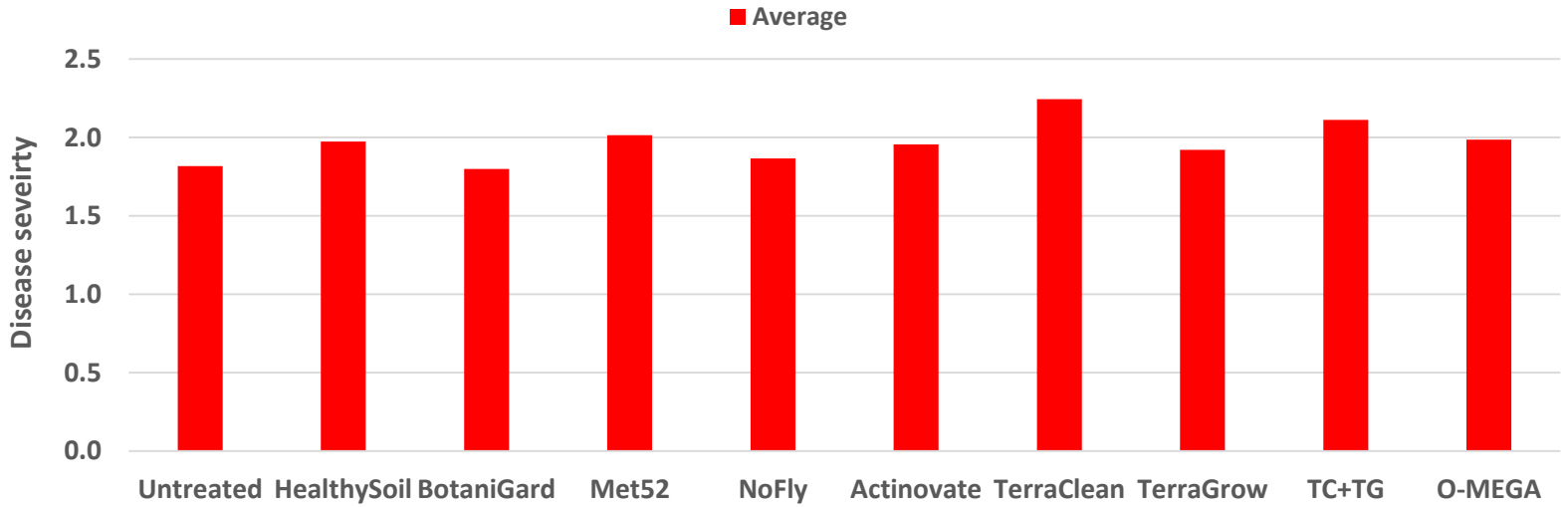
Tukey's HSD $P \geq 0.05$

Impact on powdery mildew



Severity rating 1: 1-24%, 2: 25-50%, 3: 51-75% and 4: 76-100%

Tukey's HSD $P = 0.008$



Tukey's HSD $P \geq 0.05$

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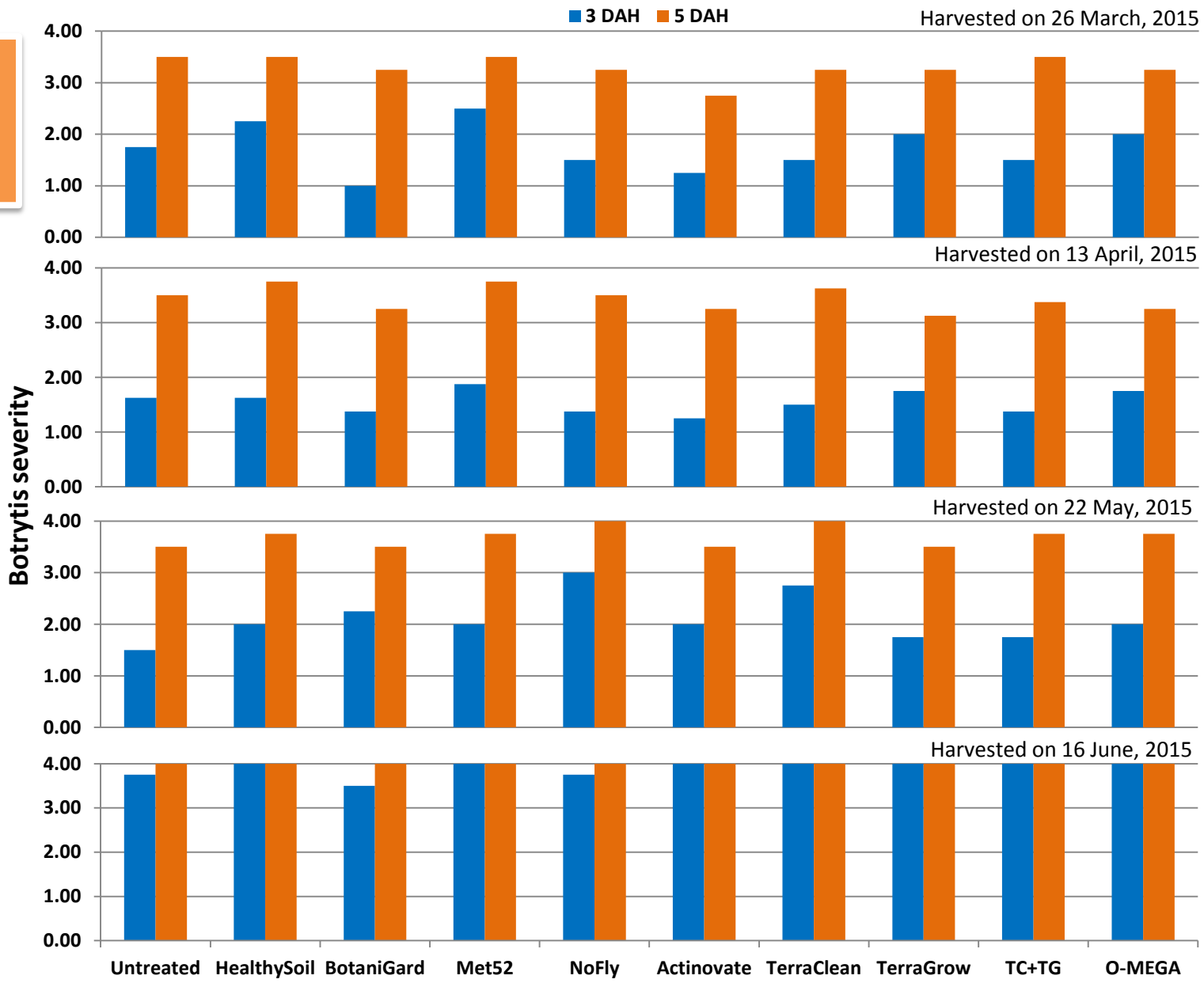
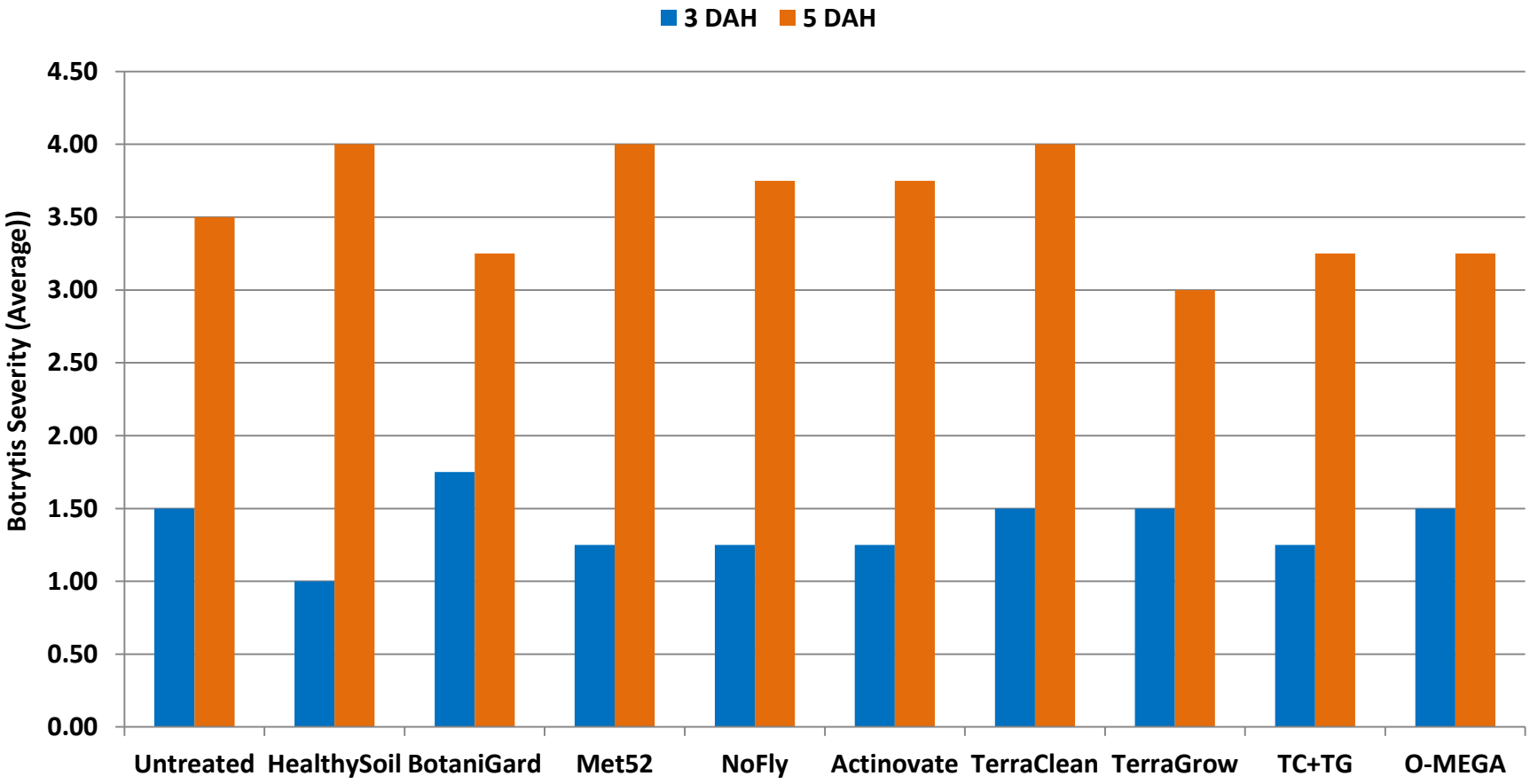
Impact on botrytis fruit rot

Severity rating
1: 1-24%,
2: 25-50%,
3: 51-75%
4: 76-100%



Tukey's HSD $P \geq 0.05$

Impact on botrytis fruit rot



Severity rating 1: 1-24%, 2: 25-50%, 3: 51-75% and 4: 76-100%

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Tukey's HSD $P \geq 0.05$

Conclusions

- Entomopathogenic fungi could be useful in crop production and crop protection
- Additional studies are needed to enhance our understanding of their interaction with plants, arthropods, and pathogens

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BioSafe Systems, Bioworks, Healthy Soil, Monsanto BioAg, O-MEGA

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Chris Martinez

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Manzanita Field Crew

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Miticide evaluation study

Treat	I Spray	Rate/ac	II Spray	Rate/ac	III Spray	Rate/ac	IV Spray	Rate/ac
1	Untreated		Untreated		Untreated		Untreated	
2	Acramite 50WS	1 lb	Kanemite 15 SC	24 fl oz	Nealta	13.7 fl oz	Oberon 2SC	16 fl oz
3	Epi-Mek 0.15EC	16 fl oz	Acramite 50WS	1 lb	Epi-Mek 0.15EC	16 fl oz	Acramite 50WS	1 lb
4	Nealta	13.7 fl oz	XPulse	1 qt	Nealta	13.7 fl oz	Met52 EC + AzaGuard	16 fl oz + 12 fl oz
5	XPulse	1 qt	Acramite 50WS	1 lb	Met52 EC + AzaGuard	16 fl oz + 12 fl oz	Kanemite 15 SC	24 fl oz
6	Epi-Mek 0.15 EC + Grandevo	16 fl oz + 3 lb	Grandevo	3 lb	Grandevo	3 lb	Grandevo	3 lb
7	MBI-206EP	1 qt	MBI-206EP	1 qt	MBI-206EP	1 qt	MBI-206EP	1 qt
8	MBI-206EP	2 qt	MBI-206EP	2 qt	MBI-206EP	2 qt	MBI-206EP	2 qt
9	MBI-206EP	4 qt	MBI-206EP	4 qt	MBI-206EP	4 qt	MBI-206EP	4 qt
10	Epi-Mek 0.15EC	16 fl oz	Grandevo	2 lb	Epi-Mek 0.15EC	16 fl oz	Grandevo	2 lb
11	Epi-Mek 0.15EC	16 fl oz	MBI-206EP	2 qt	Epi-Mek 0.15EC	16 fl oz	MBI-206EP	2 qt
12	Epi-Mek 0.15EC	16 fl oz	Grandevo	3 lb	MBI-206EP	4 qt	Epi-Mek 0.15EC	16 fl oz

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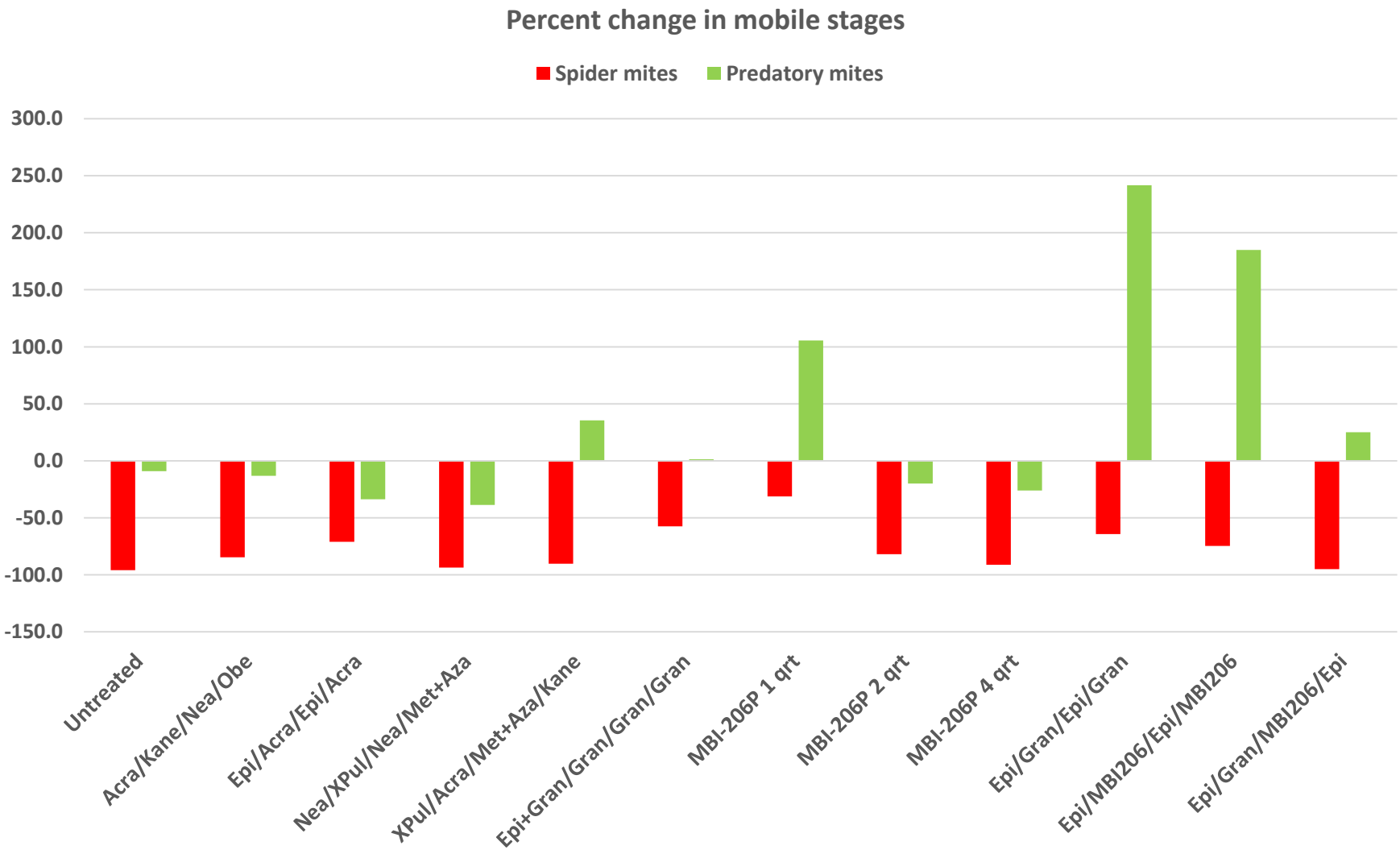
Miticide evaluation study



Acknowledgements

Grower
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Daniel Ibarra

Industry partners
BASF, BioSafe Systems, Marrone BioInnovations, Laverlam

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Fritz Light
Tamas Zold

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Strawberry fruit deformation

Strawberry fruit deformation

Lygus bug damage

Deformity due to poor pollination, genetic, environmental, and other factors

Role of lygus bug on fruit deformation

- Conventional (18) and organic (10) fields
- 9 Sampling dates
- 4 replications (different parts of the field)
- At least 100 deformed berries/replication

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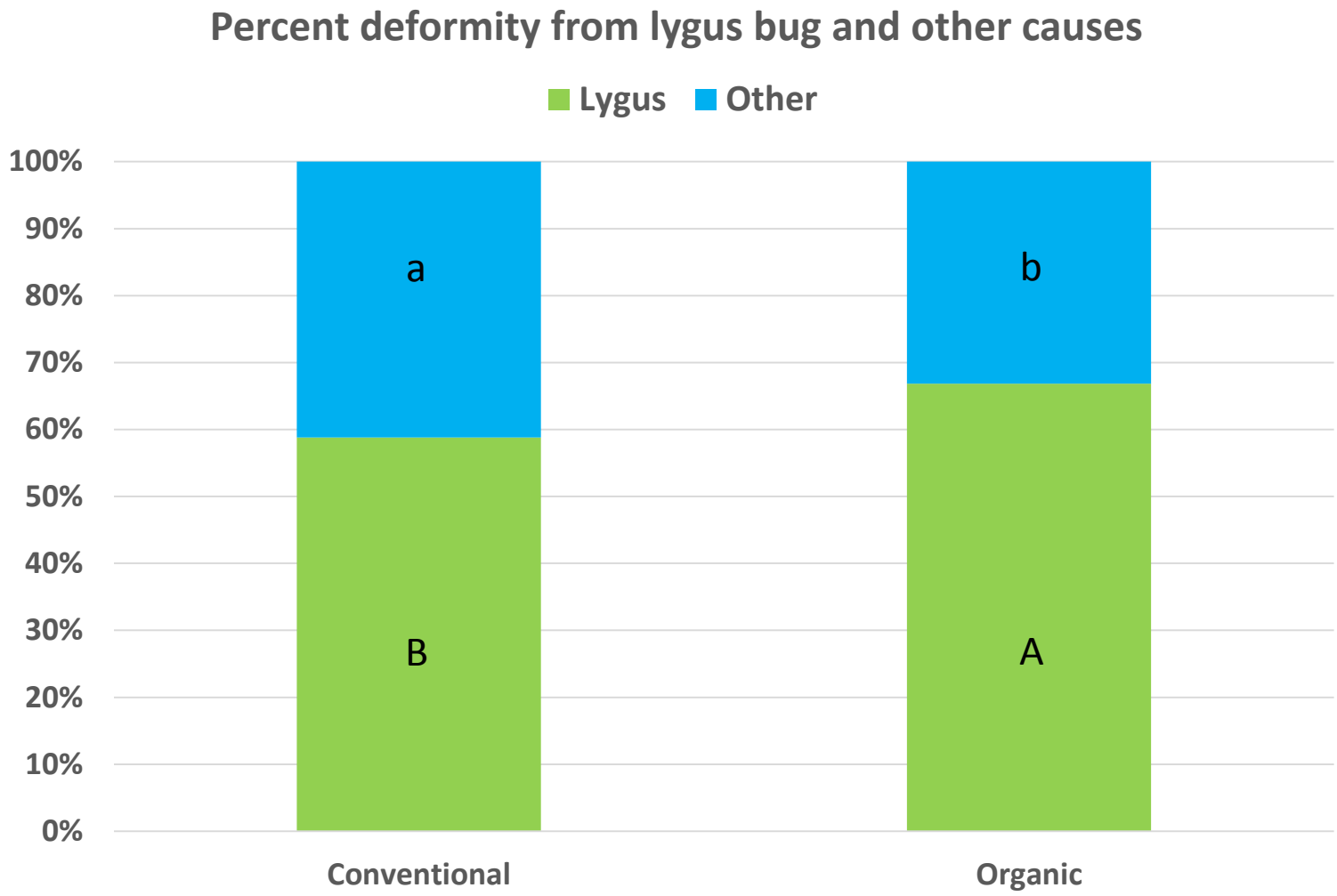
Role of lygus bug on fruit deformation



Tukey's HSD at $P = 0.0008$

Conclusions

- In both conventional (59%) and organic (67%) fields majority of the deformity was related to lygus bug feeding
- Lygus-related damage was significantly higher in organic fields and damage due to other factors was significantly higher in conventional fields
- Sampling for lygus is the most reliable way to make treatment decision

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Technical assistance

Fritz Light

Tamas Zold

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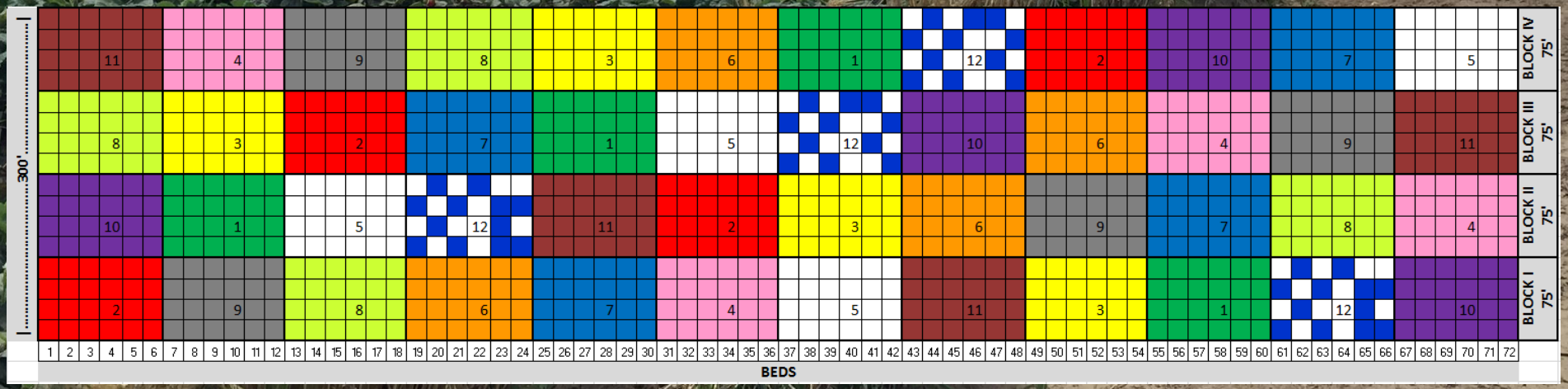
2015 Strawberry IPM trial

Sundance Berry Farms, Santa Maria



Chemicals-Mode of action groups

3A Pyrethrins-Sodium channel modulators

4A	Neonicotinoids	Nicotinic acetylcholine receptor competitive modulators
4C	Sulfoximines	
4D	Butenolides	

9C Flonicamid – Modulators of chordotonal organs

15 Benzoylureas - Inhibitors of chitin biosynthesis

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Non-chemical alternatives

- Entomopathogenic fungi, *Beauveria bassiana*, *Isaria fumosorosea*, and *Metarhizium brunneum*
- Botanical insect growth regulator, azadirachtin
- Mechanical removal - vacuuming

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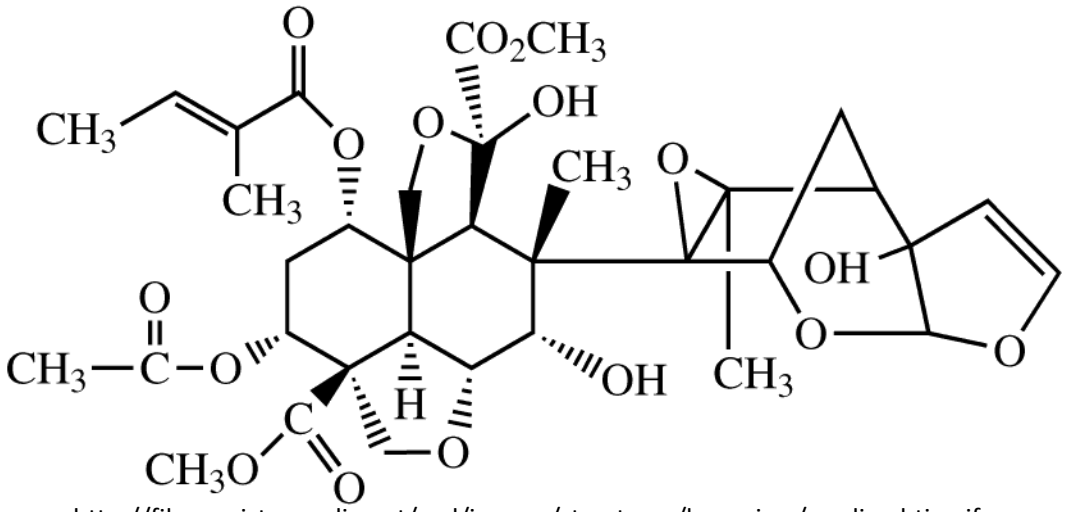
Azadirachtin mode of action



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

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	Vacuum	Vacuum	Vacuum
4	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**	Met52 EC(16 fl oz) + Debug Turbo (104 fl oz)	Met52 EC (16 fl oz) + AzaGuard (16 fl oz)
5	Sequoia (4.5 oz) **4C**	Sequoia (4.5 oz) **4C**	Vacuum
6	Pfr-97 (2 lb) + Neemix (9 fl oz)	Pfr-97 (2 lb) + Neemix (9 fl oz)	Vacuum
7	Vacuum	Sivanto (14 fl oz) **4D** + Debug Turbo (104 fl oz)	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**
8	Sivanto (14 fl oz) **4D**	Sivanto (14 fl oz) **4D**	Vacuum
9	Sequoia (4.5 oz) **4C**	Sivanto (14 fl oz) **4D**	Beleaf 50 SG (2.8 oz) **9C**
10	*B. bassiana*+neem (1qrt)	*B. bassiana*+pyrethrum **3A**+neem (1qrt)	*B. bassiana*+pyrethrum **3A** (1qrt)
11	*B. bassiana*+pyrethrum **3A** (1qrt)	*B. bassiana*+neem (1qrt)	Beleaf 50 SG (2.8 oz) **9C**
12	*B. bassiana*+pyrethrum **3A** (1qrt)	Vacuum	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**

*MoA group

3A Pyrethrins-Sodium channel modulators

4A Neonicotinoids
4C Sulfoximines
4D Butenolides
} Nicotinic acetylcholine receptor competitive modulators

9C Flonicamid – Modulators of chordotonal organs

15 Benzoylureas - Inhibitors of chitin biosynthesis

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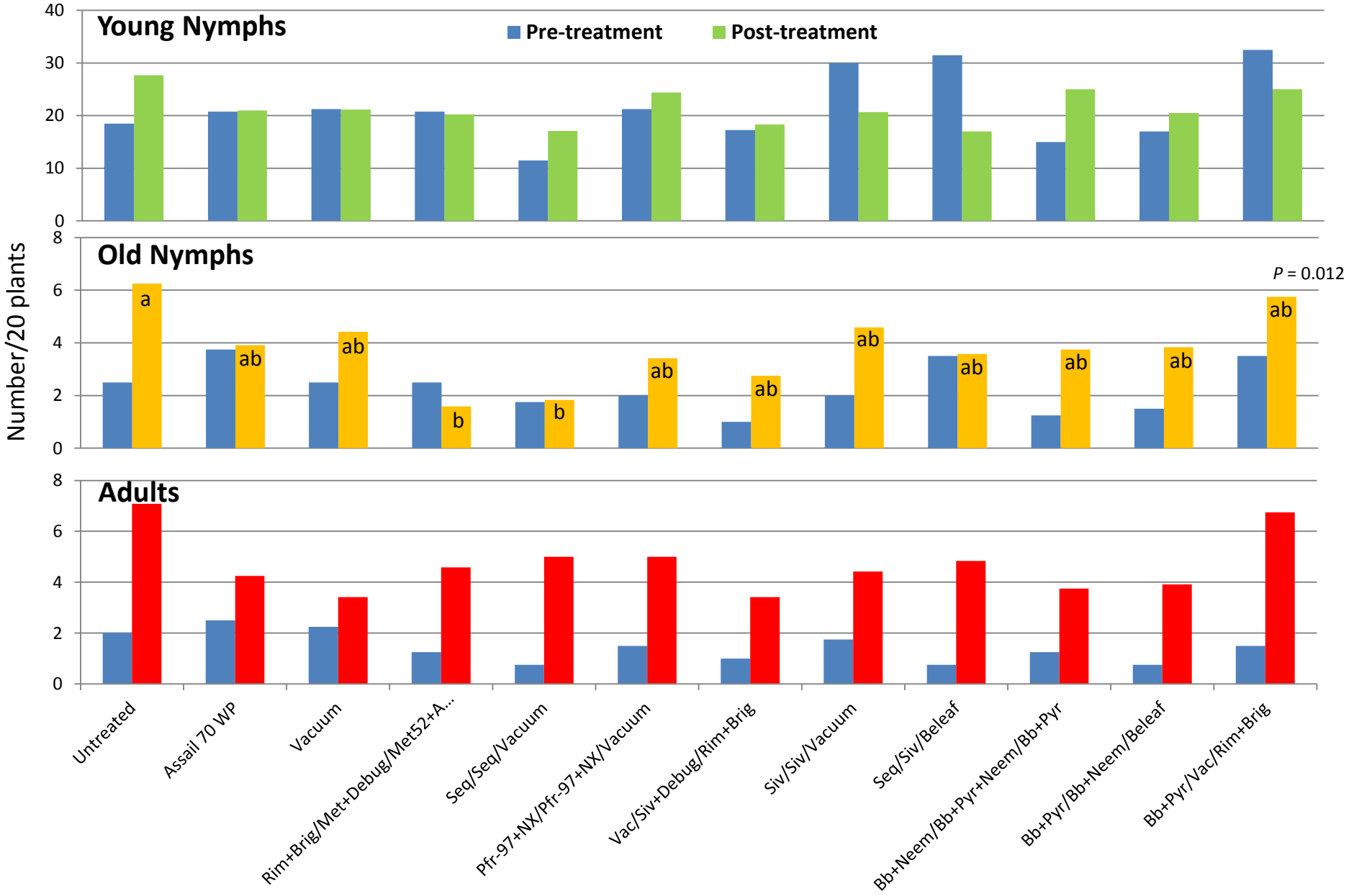
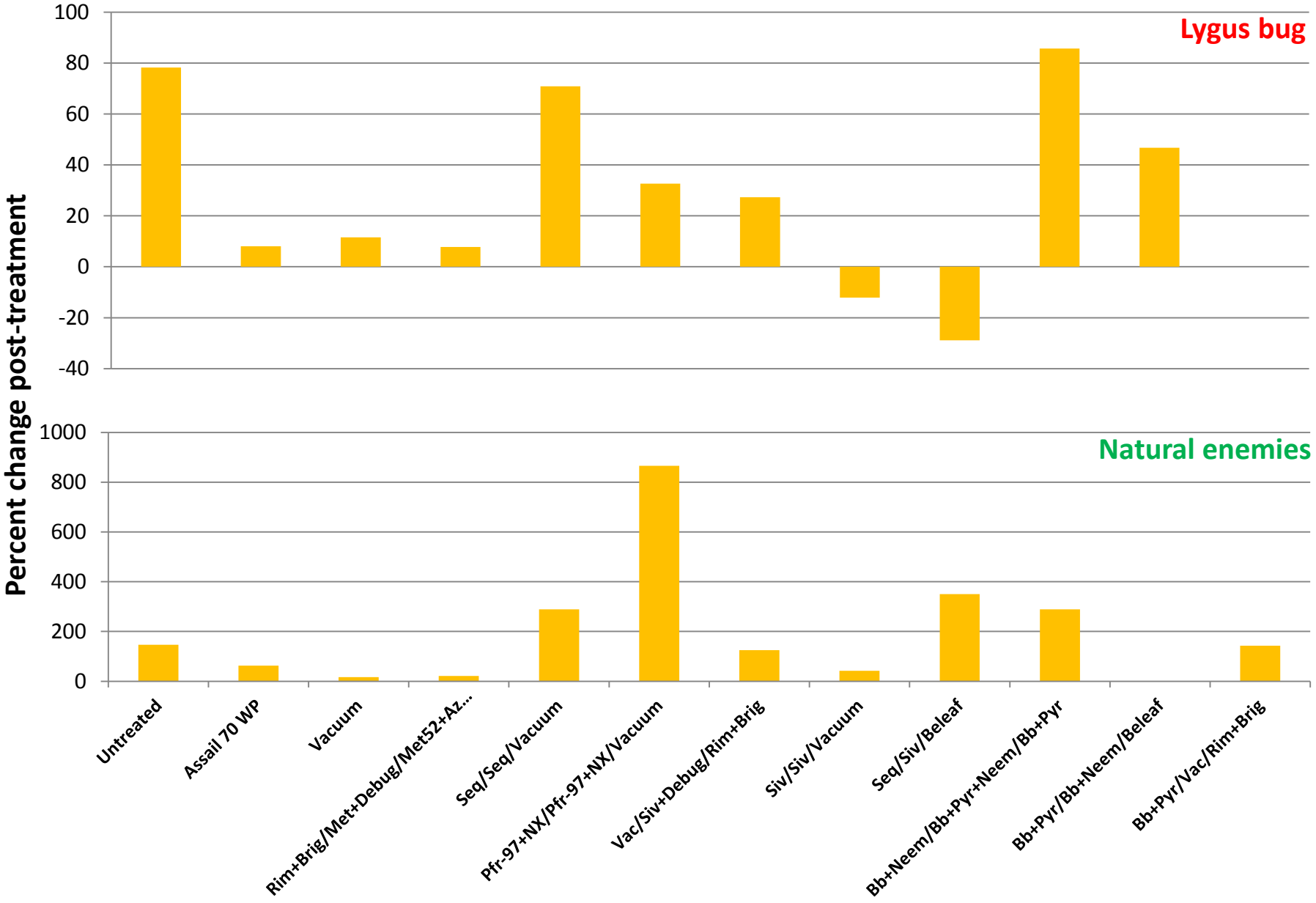
Treatments and sampling

- Treatments applied on 26 August, 2 and 9 September, 2015
- Vacuuming was done twice a week only in vacuum treatments
- Spray volume was 100 gpa for all treatments
- Sampled 6 days after each application

Lygus life stages after three applications



Change in lygus and natural enemy populations



Treatment efficacy

Rank	% Change	I Spray	II Spray	III Spray
I	-28.9	Sequoia (4.5 oz) **4C***	Sivanto (14 fl oz) **4D**	Beleaf 50 SG (2.8 oz) **9C**
II	-12.1	Sivanto (14 fl oz) **4D**	Sivanto (14 fl oz) **4D**	Vacuum
III	0.0	*B. bassiana*+pyrethrum **3A** (1qrt)	Vacuum	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**
IV	7.8	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**	Met52 EC(16 fl oz) + Debug Turbo (104 fl oz)	Met52 EC (16 fl oz) + AzaGuard (16 fl oz)
V	8.0	Assail 70 WP (3 oz) **4A***	Assail 70 WP (3 oz) **4A**	Assail 70 WP (3 oz) **4A**
VI	11.5	Vacuum	Vacuum	Vacuum
VII	27.3	Vacuum	Sivanto (14 fl oz) **4D** + Debug Turbo (104 fl oz)	Rimon 0.83 EC (12 fl oz) **15** + Brigade (16 oz) **3A**
VIII	32.7	Pfr-97 (2 lb) + Neemix (9 fl oz)	Pfr-97 (2 lb) + Neemix (9 fl oz)	Vacuum
IX	46.8	*B. bassiana*+pyrethrum **3A** (1qrt)	*B. bassiana*+neem (1qrt)	Beleaf 50 SG (2.8 oz) **9C**
X	70.8	Sequoia (4.5 oz) **4C**	Sequoia (4.5 oz) **4C**	Vacuum
XI	78.3	Untreated	Untreated	Untreated
XII	85.7	*B. bassiana*+neem (1qrt)	*B. bassiana*+pyrethrum **3A** +neem (1qrt)	*B. bassiana*+pyrethrum **3A** (1qrt)

*Mode of action group

Conclusions

- Lygus infestations were very high and only two treatments reduced their populations and one treatment prevented their buildup
- Consider IPM strategy by using chemical, botanical, microbial, and mechanical tools

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Technical assistance
Sundance Berry Farms field crew
Chris Martinez
Fritz Light
Kristin Nicole Stegeman
Tamas Zold

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Thank you!

Presentations from this meeting canbe downloaded from: http://ucanr.edu/meetingpresentations