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Managing Lygus Bugs in Strawberries and the Microbial Control Potential

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California strawberries

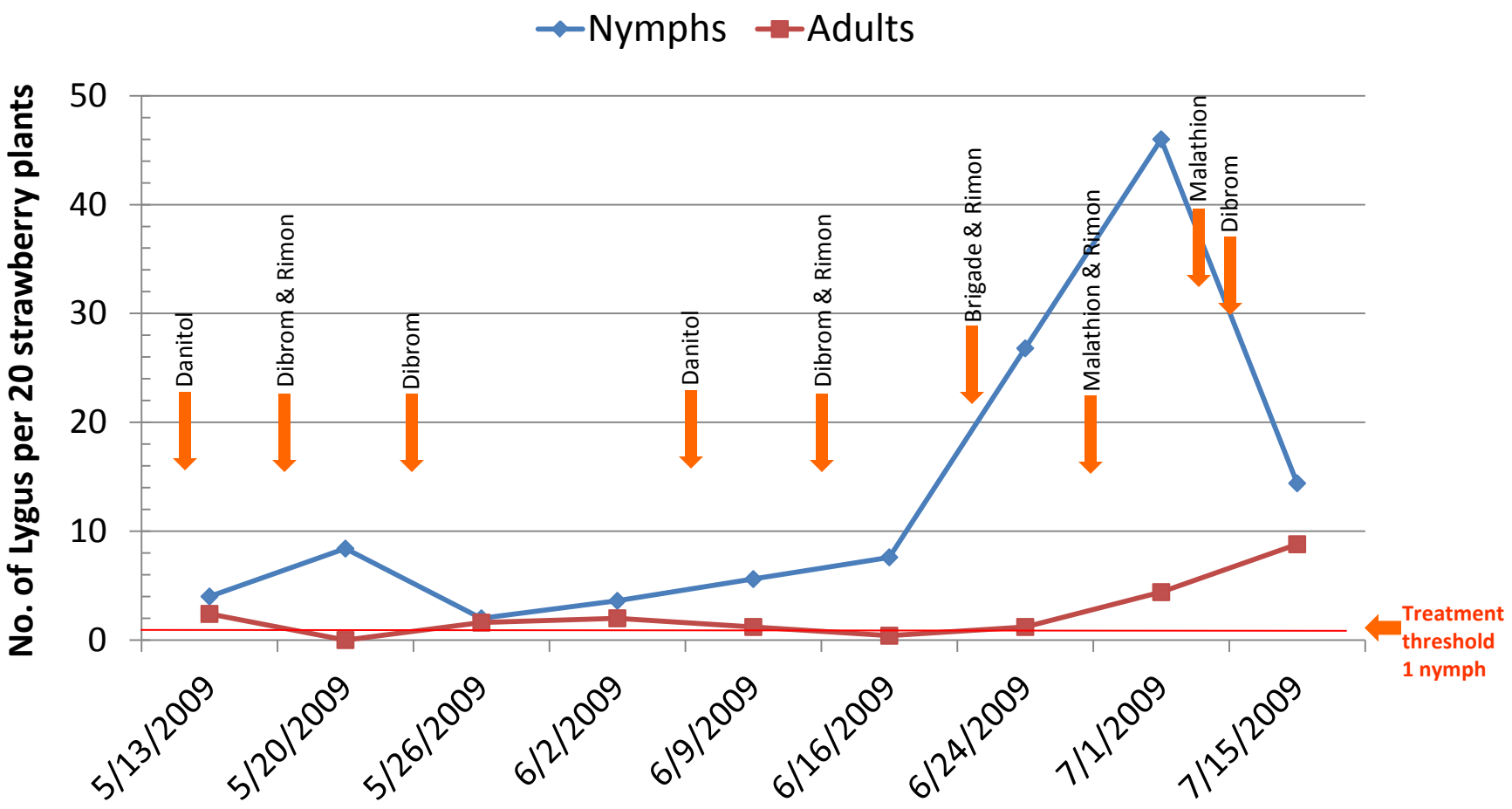
- Value $2.3 billion for fresh market strawberries in 2011
- About 88% of strawberries produced in the US come from California
- Total acreage 37,336 acres in 2011

Strawberry pests

Strawberry pests

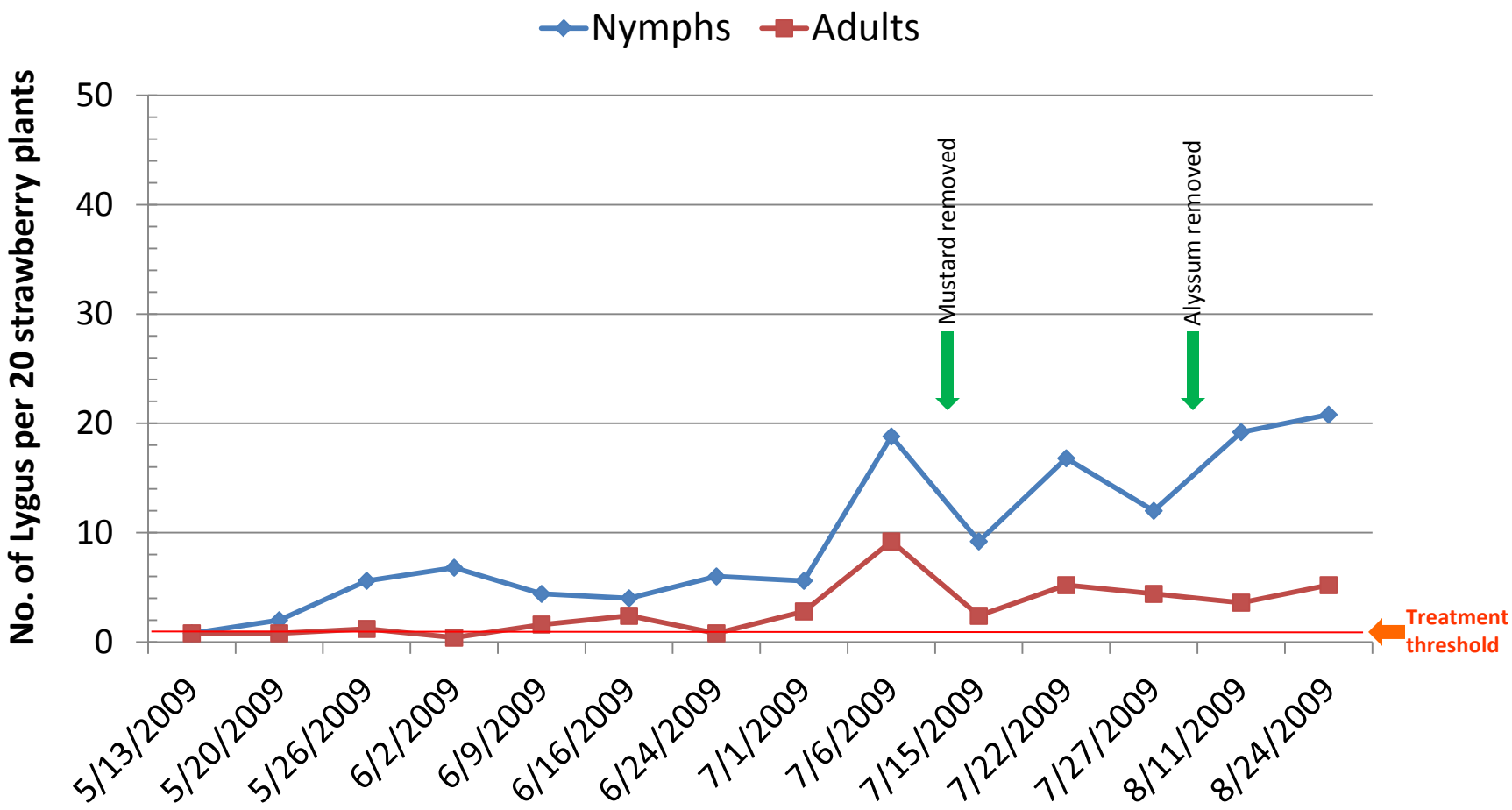
Seasonal occurrence of lygus bug

Conventional strawberry field (second year)



Seasonal occurrence of lygus bug

Organic strawberry field



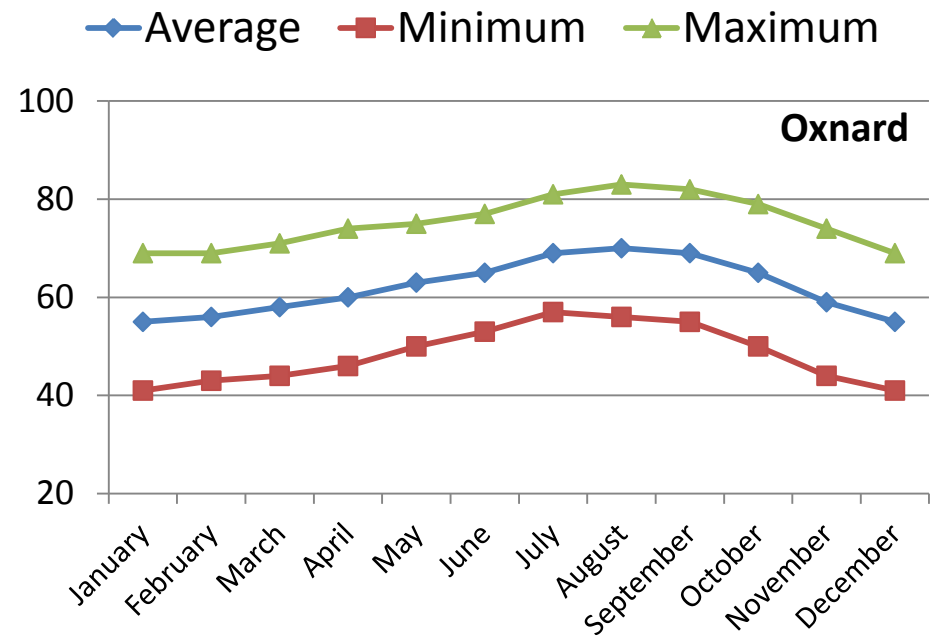
Current pest management practices

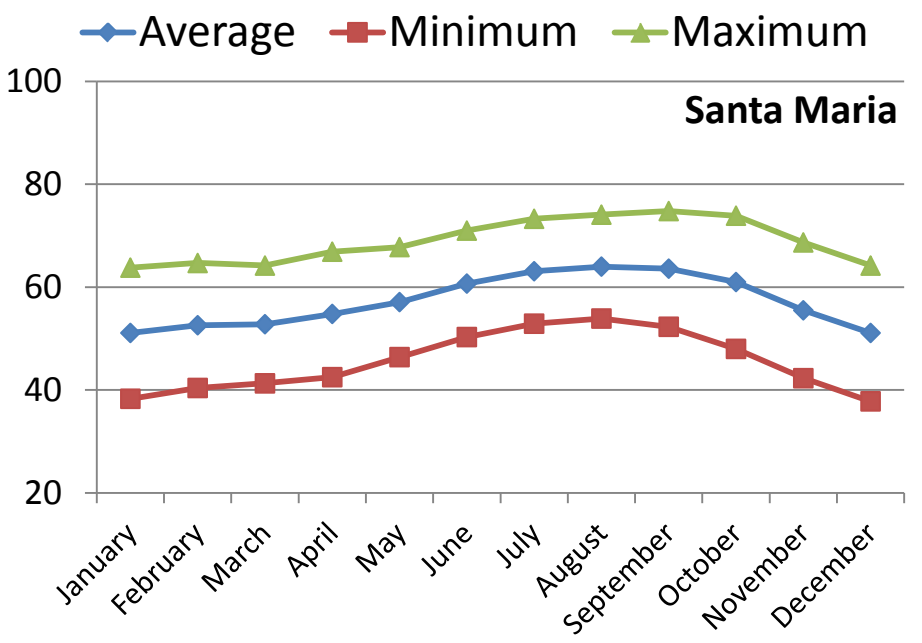
- Chemical pesticides and to a limited extent insecticidal soaps, oils, pyrethrin, spinosad, and *Bt*
- Release of predatory mites is also common

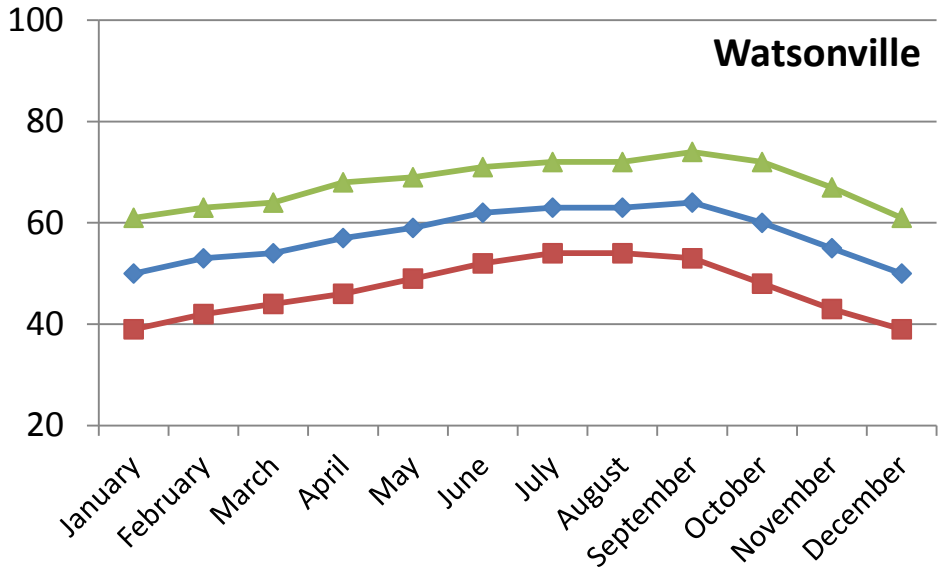
Potential of entomopathogens

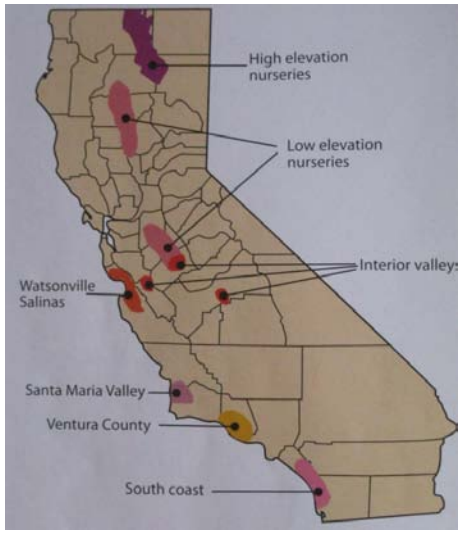
- Entomopathogens like *Beauveria bassiana* are pathogenic to most of the strawberry pests
- California Central Coast weather is favorable for entomopathogens

Potential of entomopathogens









Strawberry pests-entomopathogens

- Strawberry plant structure is ideal

Acres treated with insecticides in strawberries

Insecticide	2006	2007	2008	2009	2010
Acres treated with different insecticides					
Oil	690	7,408	20,204	36,957	53,860
Novaluron (Rimon)				24,497	41,149
Fenpyroximate (Akari)					41,149
Sulfur	129,069	139,486	134,076	146,790	157,125
Naled (Dibrom)	18,681	23,819	33,916	51,937	44,587
Spiromesifen (Oberon)	10,375	16,225	18,439	22,485	29,404
Fenpropathrin (Danitol)	20,217	21,272	25,688	27,885	21,229
Abamectin (Agri-Mek)	13,024	16,962	26,103	29,751	35,876
Total	**191,366**	**217,764**	**238,222**	**278,848**	**288,221**
Total amount of pesticides in pounds (fungicides, insecticides, and herbicides used)					
	9,394,745	**9,669,764**	**9,918,143**	**10,041,462**	**10,972,995**

Pesticide Use Report Data 2010, CDPR

Pesticide use in California strawberries-2009

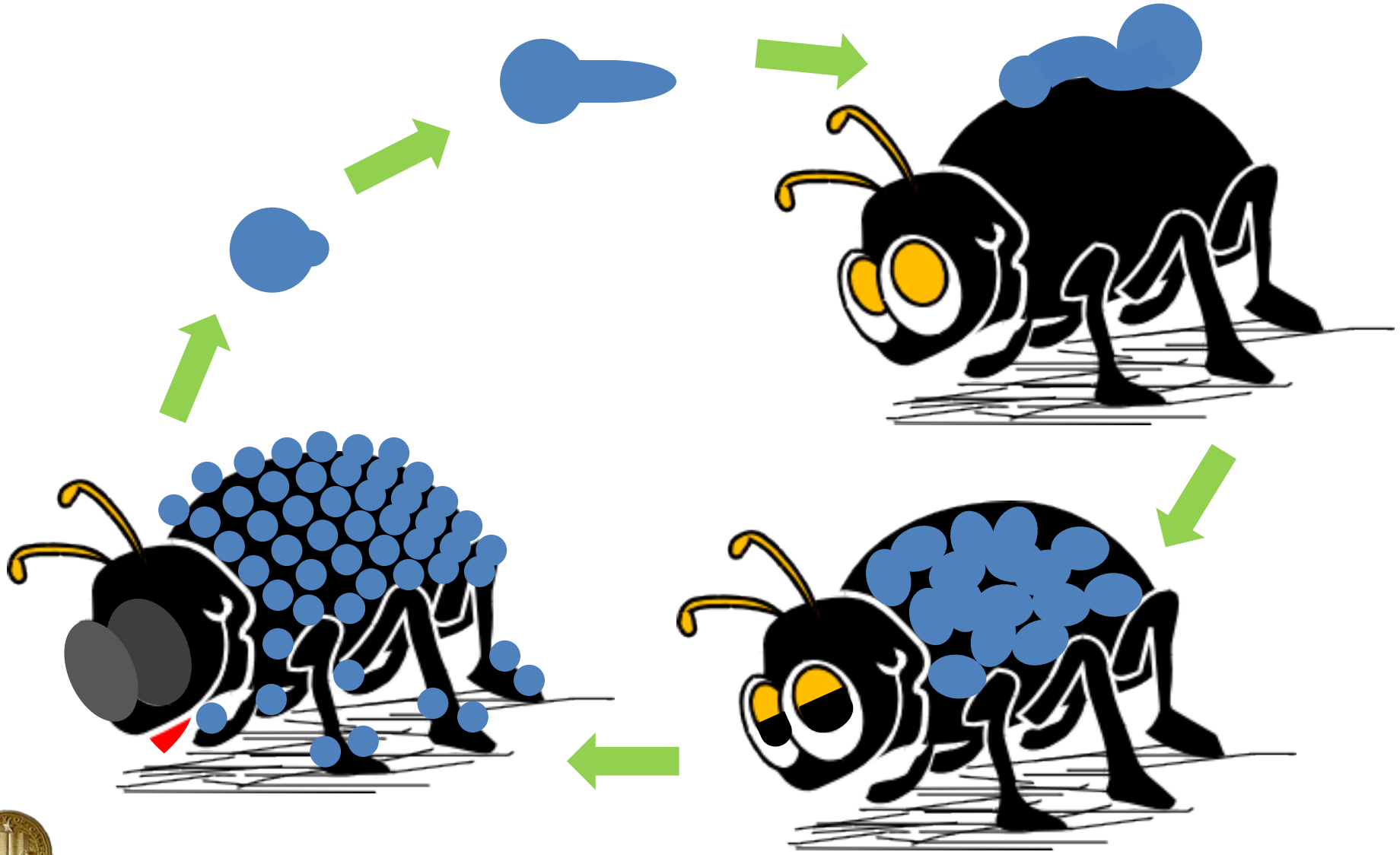
Chemical name	Chemical class	Trade name	Gross pounds	Acres treated
Bifenazate	Unclassified	Acramite, Floramite	17,353	35,480
Bifenthrin	Pyrethroid	Brigade	4,485	41,235
Chlorpyrifos	Organophosphorus	Lorsban	11,323	11,384
Fenpropathrin	Pyrethroid	Danitol	9,243	27,783
Malathion	Organophosphorus	Malathion	144,417	76,208
Methomyl	N-methyl carbamate	Lannate	6,104	7,641
Naled	Organophosphorus	Dibrom	48,723	51,689
Spiromesifen	Keto-enol	Oberon	5,338	22,477
Total			**246,986**	**273,897**

Pesticide Action Network North America
http://www.pesticideinfo.org/DS.jsp?sk=1016

Possible microbial control strategy

- Incorporating microbial control into IPM
- Foliar application – alone and along with chemical pesticides
- Endophytic colonization of the strawberry plants
- Colonized *B. bassiana* against
  - -European corn borer on corn (Lewis and Cossentine, 1986, Lewis and Bing, 1991)
  - -Banana weevil on banana (Akello et al, 2008)
  - -Other reports
- Laboratory, greenhouse, and field studies

How entomopathogenic fungi infect insects

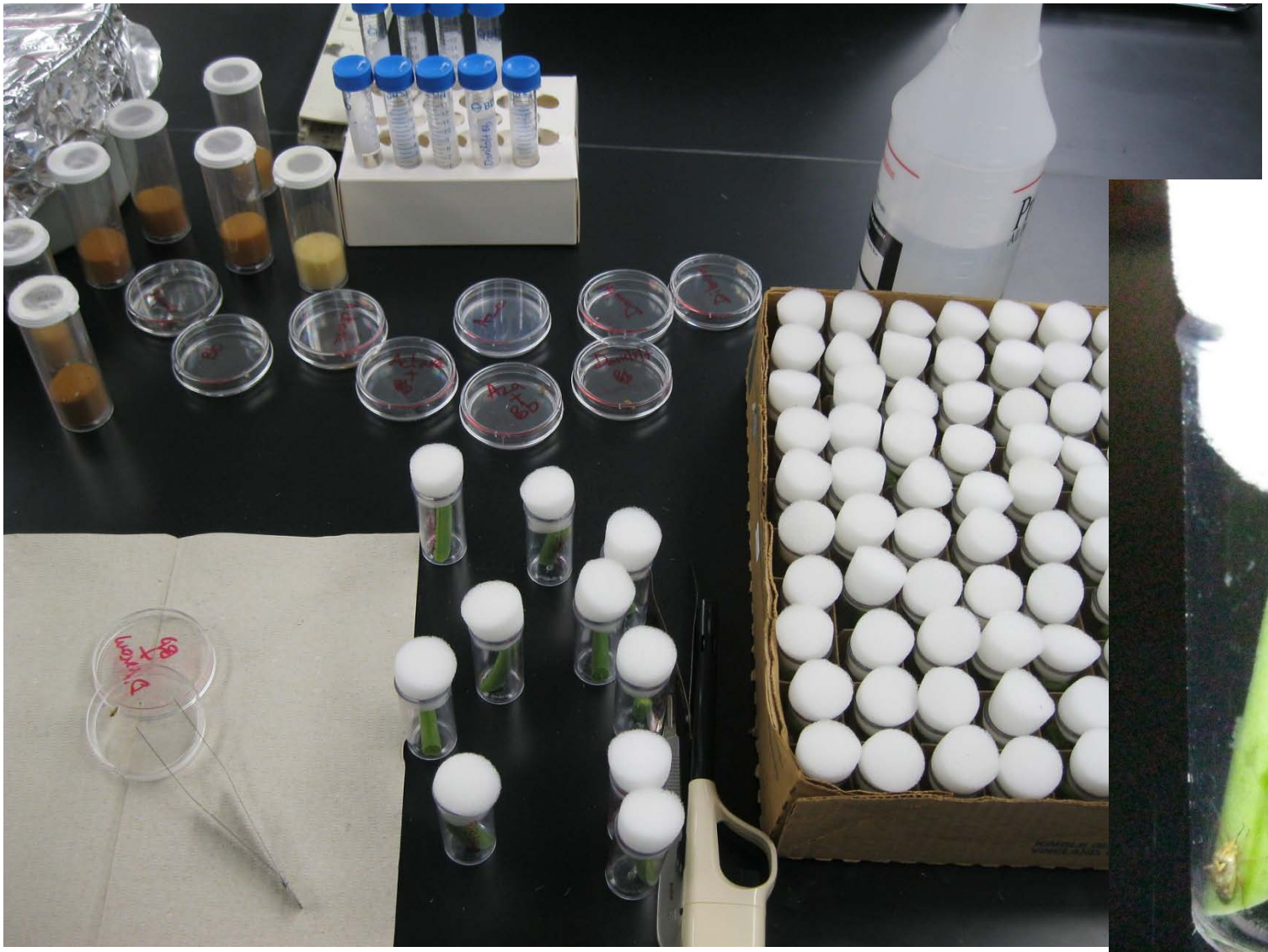


Assay with *B. bassiana* and chemicals

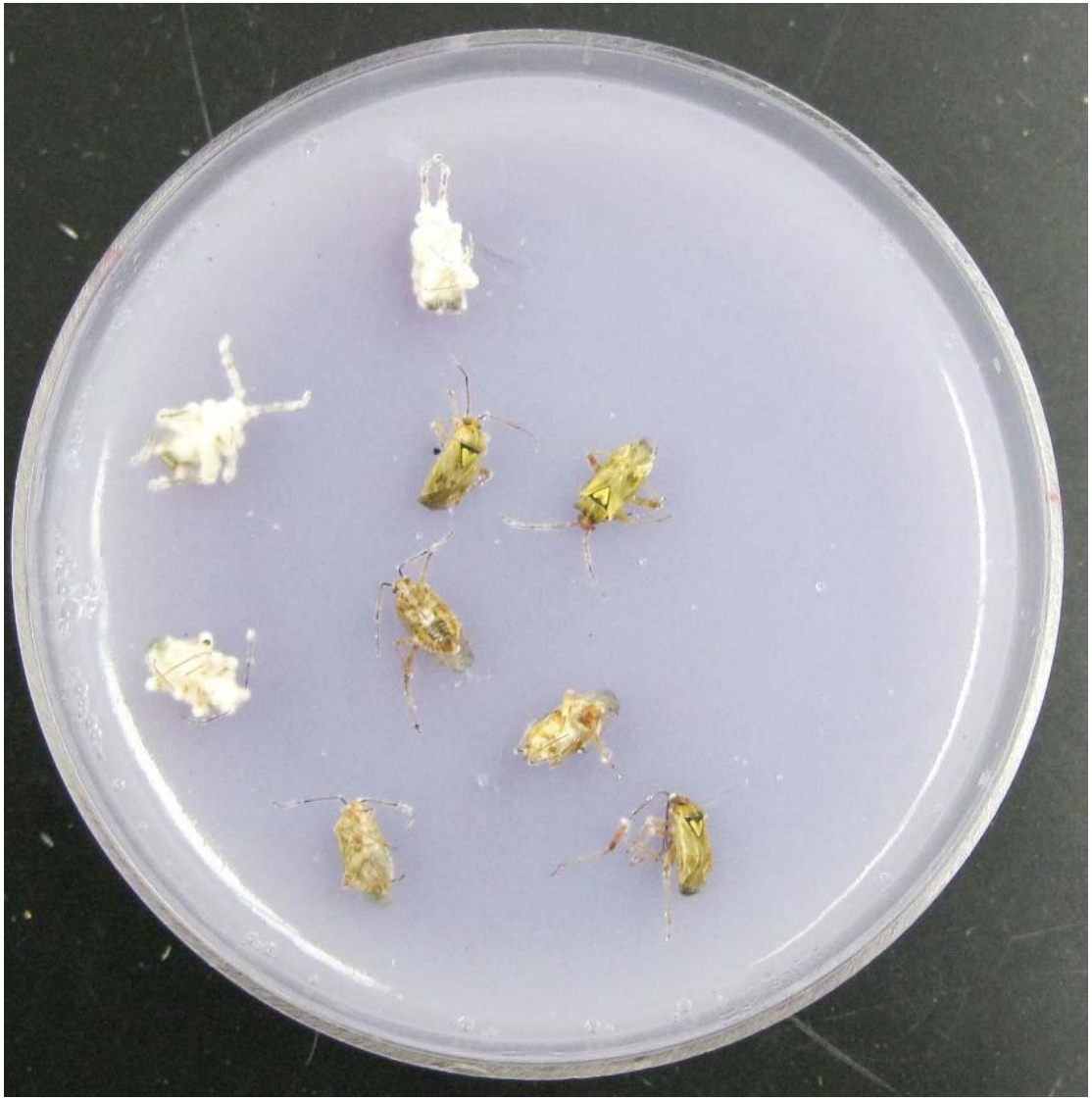
- Objective
  - Use reduced rates of chemicals along with *B. bassiana*

- Treatments
  - 0.19 lb/ac or $1X10^7$ conidia/ml of BotaniGard 22 WP (label rate 1/2-2 lb/acre)
  - 1/5 the label rate of
    - Actara-thiomethaxam (1 pt/ac) - neonicotinoid
    - Aza-Direct-azadirachtin (2 qrt/ac) - IGR
    - Danitol-fenpropathrin (11 oz/ac) - pyrethroid and
    - Dibrom-naled (1 pt/ac) - organophosphate

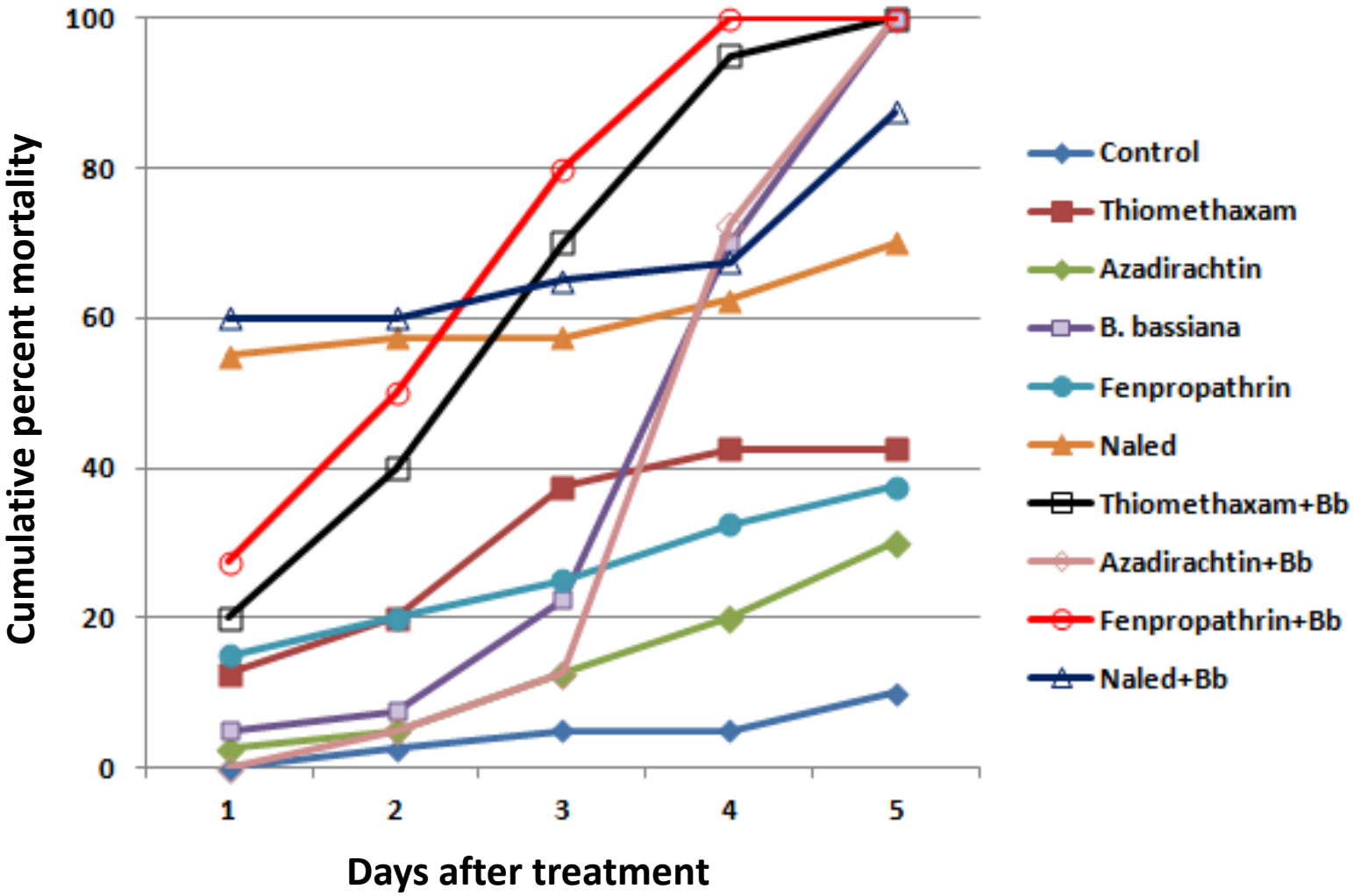
Assay with *B. bassiana* and chemicals



Assay with *B. bassiana* and chemicals



Assay with *B. bassiana* and chemicals



Conclusion

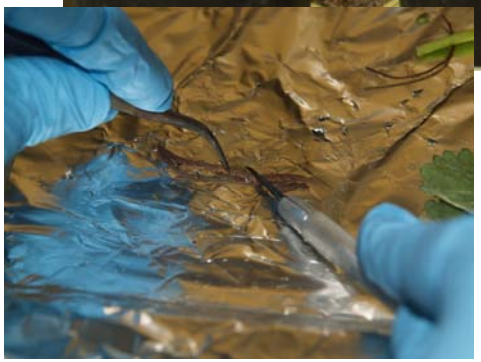
- Certain combinations of reduced rates of chemicals and *B. bassiana* were effective in bioassays

Endophytic colonization

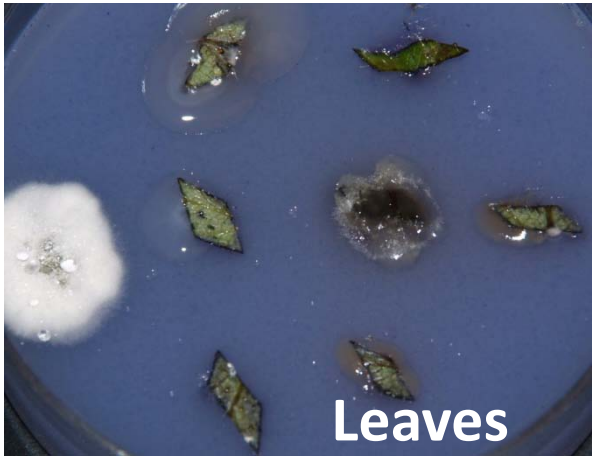
- **Inoculation**
  - 200 ml suspension of $1X10^{9}$, $1X10^{10}$ or $1X10^{11}$ conidia by applying at the plant base
- **Fungal isolates**
  - Commercial isolate, GHA
  - California isolate, SfBb1
- **Sampling**
  - 1, 3, 6 and 9 weeks after inoculation

Endophytic colonization

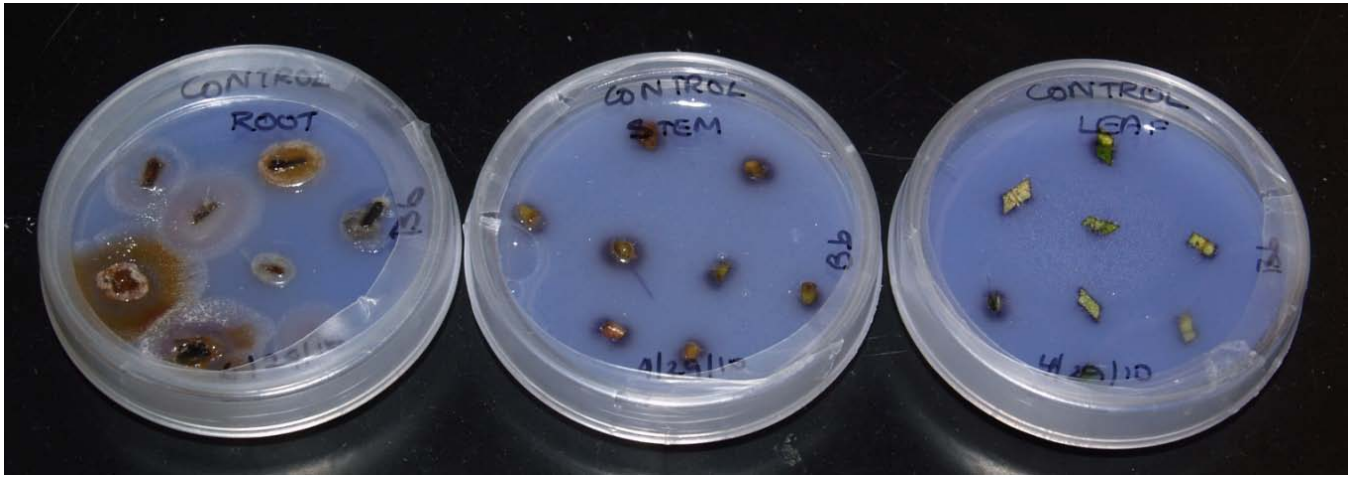
- Rinsed, surface-sterilized and rinsed the plant material
- Plated plant tissue on selective medium
- Plated rinsate on medium to verify contamination



Endophytic colonization

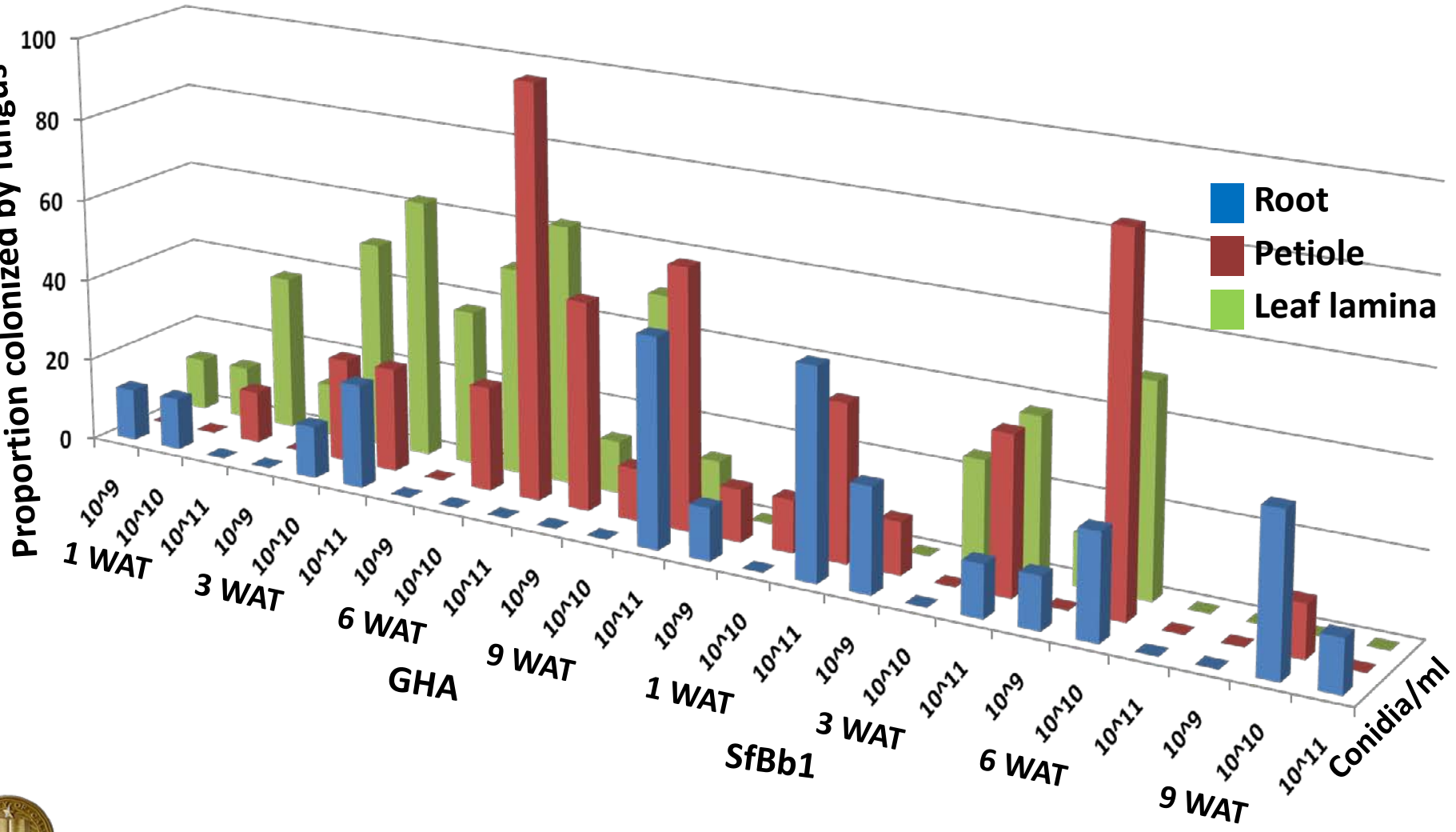


Emergence of colonized *B. bassiana* from treated plant tissue



No *B. bassiana* detected in controls

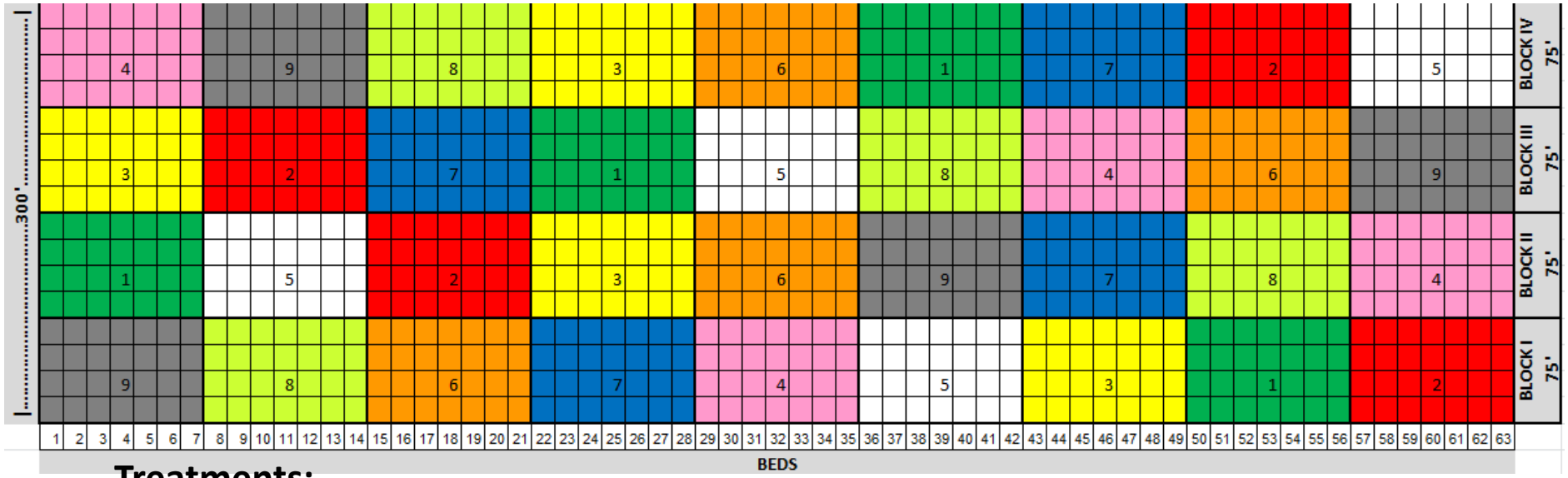
Endophytic colonization



Conclusion

- *B. bassiana* successfully colonized strawberry plant and persisted for up to 9 weeks after inoculation
- Impact of colonized fungus on herbivores needs to be evaluated

Large commercial field IPM trial 2012

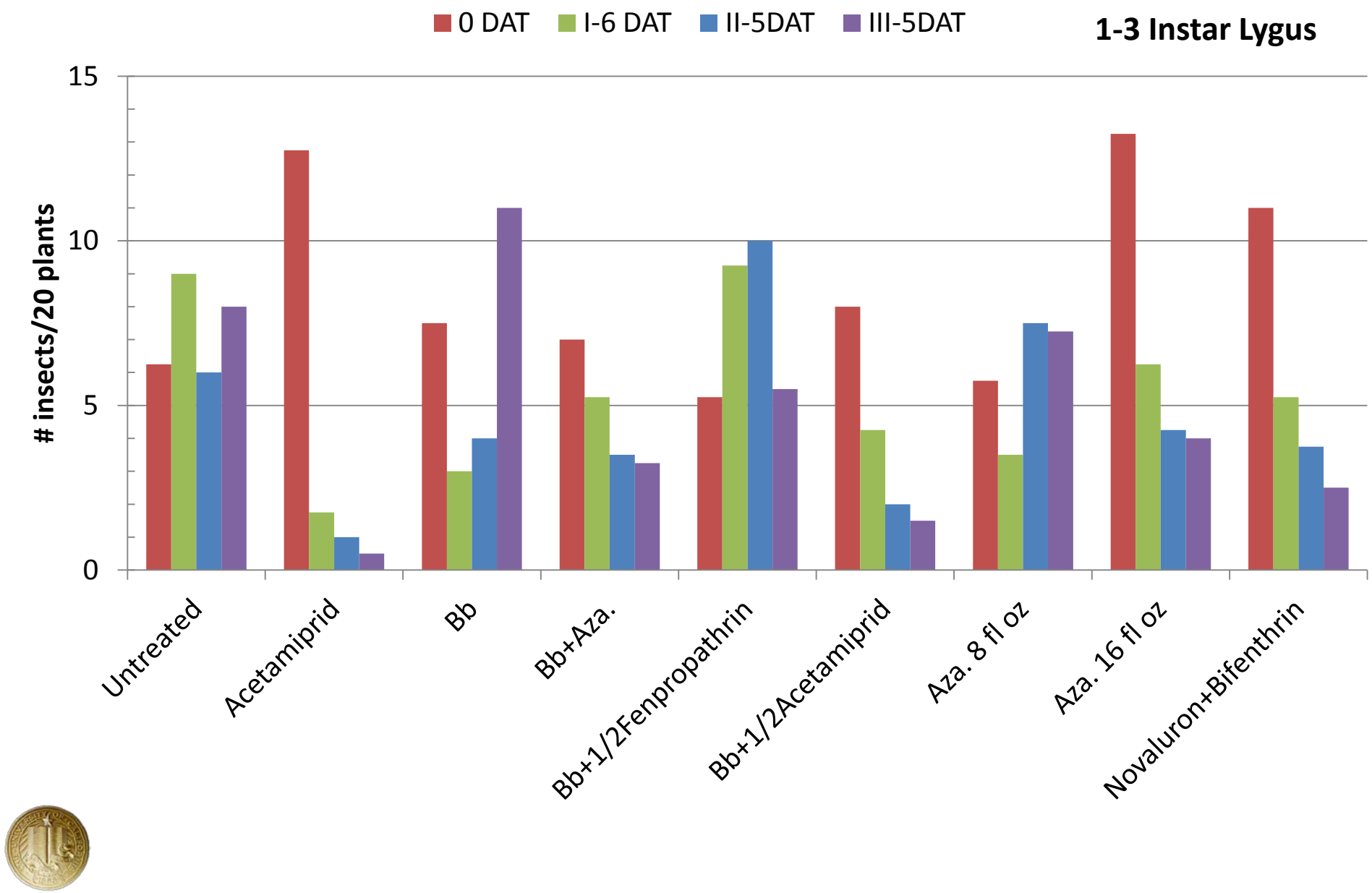


Treatments:

1. Untreated control
2. Assail 70 WP (3 oz/ac) in 50 gal
3. BotaniGard WP (2lb/ac) in 50 gal
4. BotaniGard WP (2lb/ac) + Molt-X (8 fl oz/ac) in 50 gal
5. BotaniGard WP (2lb/ac) + Danitol 1/2 label rate (5.3 fl oz/ac) in 50 gal
6. BotaniGard WP (2lb/ac) + Assail 1/2 label rate (1.5 oz/ac) in 50 gal
7. AzaGuard (8 fl oz/ac) in 50 gal
8. AzaGuard (16 fl oz/ac) in 50 gal
9. Rimon (12 fl oz/ac) + Brigade (16 oz/ac) in 50 gal

Experimental period: July-August, 2012

Large commercial field IPM trial 2012



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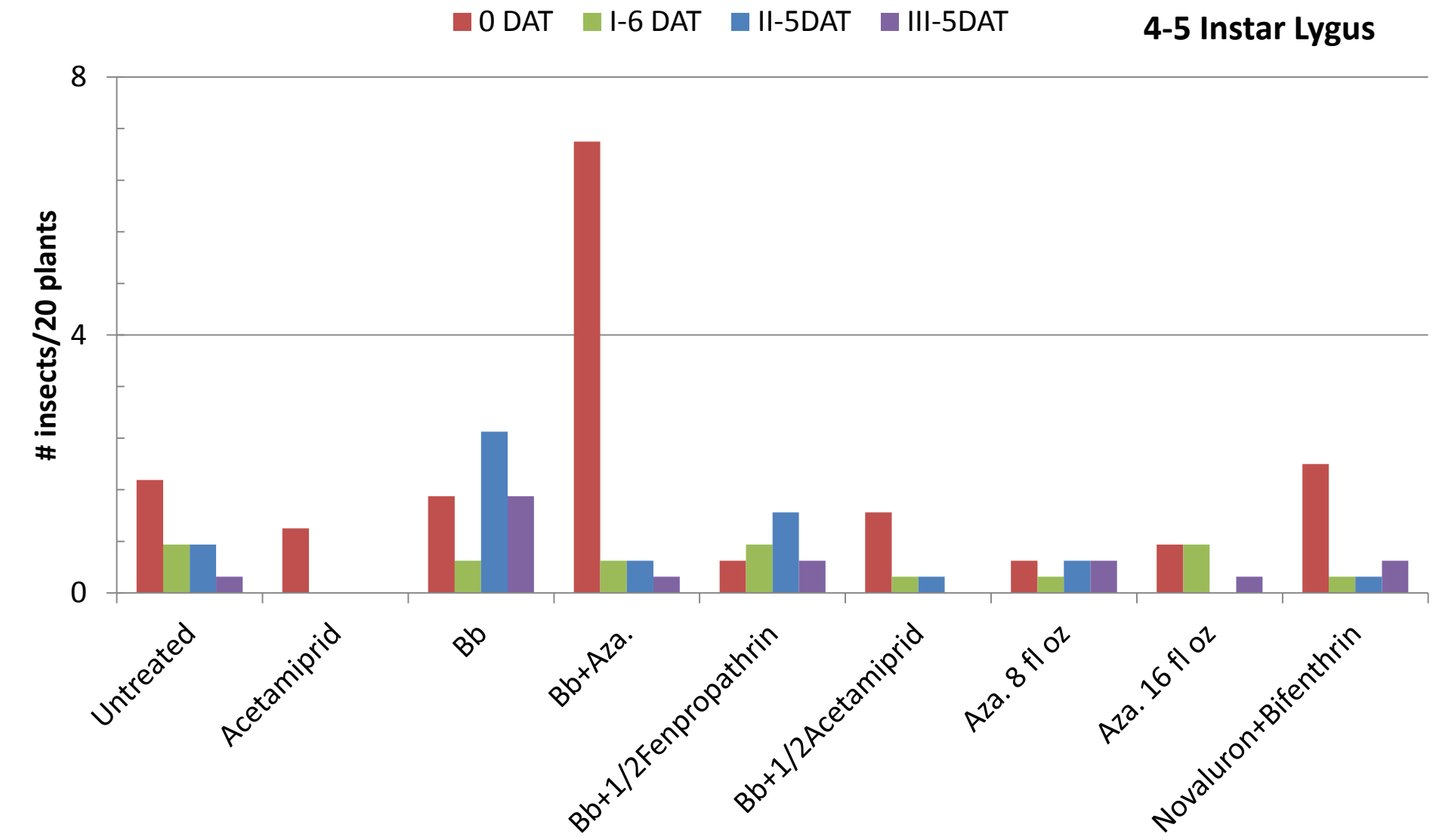

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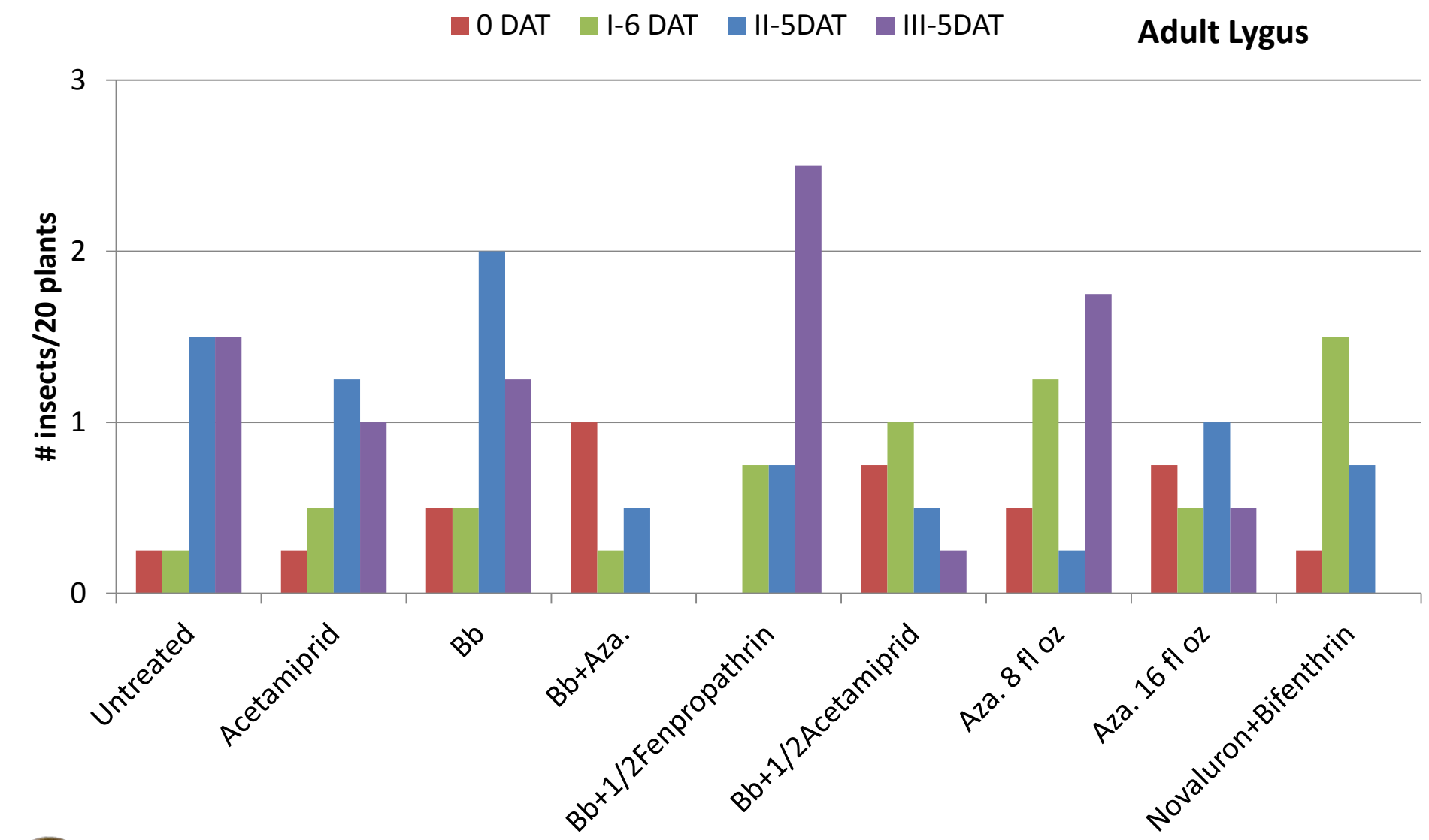

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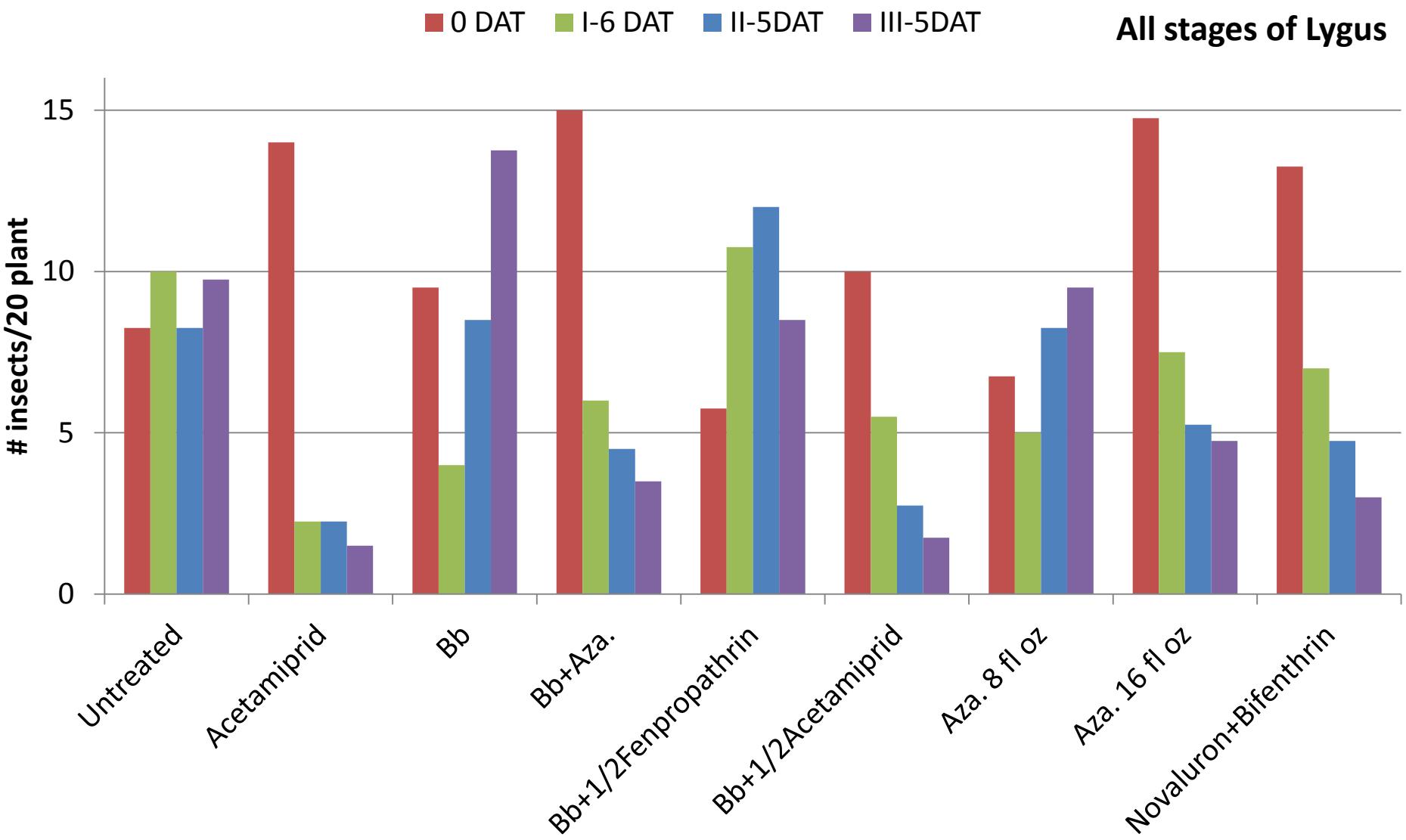
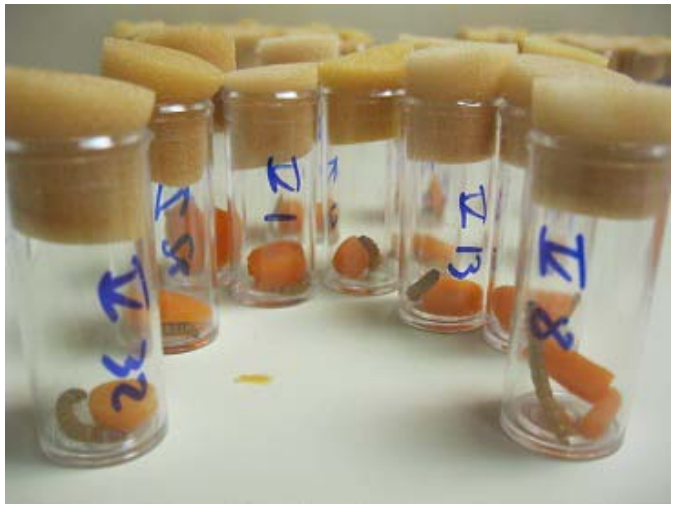


Conclusion

- *B. bassiana* has a potential for strawberry pest management

Compatibility of *B. bassiana* and fungicides

Lab assay with mealworms (*Tenebrio molitor*), *B. bassiana*, and some common strawberry fungicides



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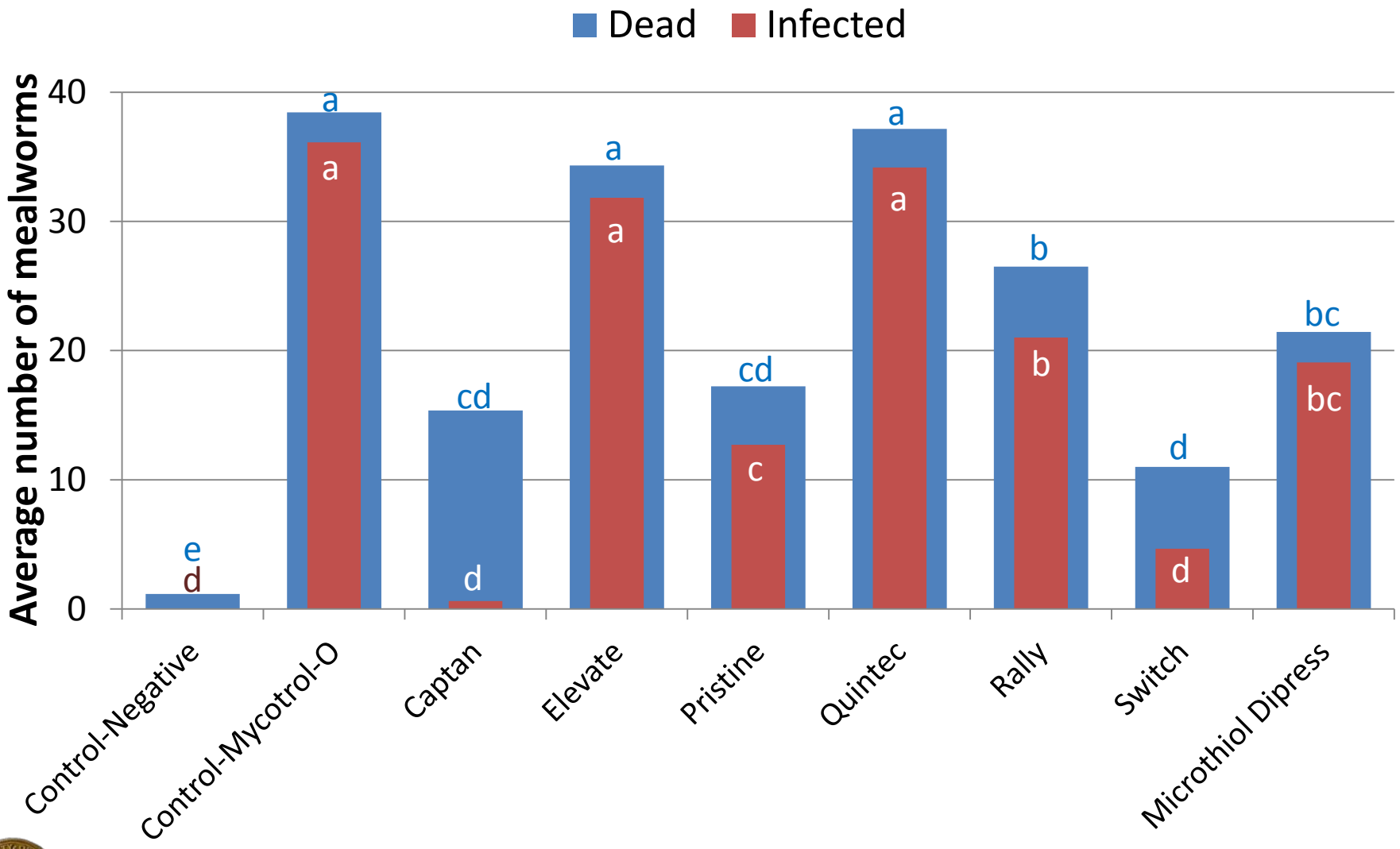

Average of 6 assays

Conclusion

- Some fungicides are compatible with *B. bassiana*
- Appropriate time intervals for fungicide and *B. bassiana* applications need to be determined

Conclusion

- Microbial control has a good potential in strawberry IPM

Acknowledgments

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Pest infestations