Insecticide effects on natural enemies

David Lowenstein

Oregon State University

Funding

USDA United States Department of Agriculture National Institute of Food and Agriculture

Specialty Crop Research Initiative

Collaborating Institutions

NC State University, PennState, OSU Oregon State, University of Maryland, University of Georgia, Washington State University, Northeastern IPM Center, Cornell University, Utah State University, Rutgers University, The Ohio State University, University of Kentucky, UC Davis, University of Minnesota, Virginia Tech, Berkeley, Michigan State University, UC Riverside

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Specialty Crop Research Initiative under award number 2016-51181-25409.

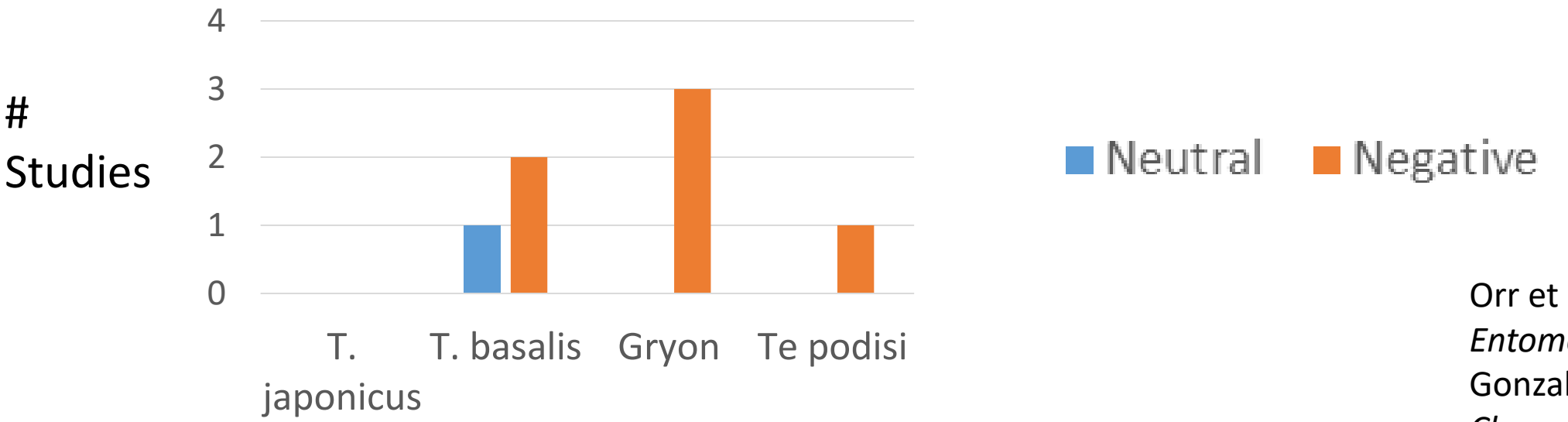
Compatibility with chemical management?

- BMSB and biocontrol only 1 component of IPM
- Fungicide/herbicide/insecticide for other pests and pathogens
- BMSB recommendations include neonicotinoids and pyrethroids

Active Ingredient (IRAC class*)	Product Name(s)
beta-cyfluthrin (3A)	Baythroid XL
beta-cyfluthrin (3A) + imidacloprid (4A)	Leverage 360
bifenthrin (3A)	Bifenture, Brigade, Sniper
clothianidin (4A)	Belay
cyfluthrin (3A)	Tombstone
diflubenzuron (15) + lambda-cyhalothrin (3A)	DoubleTake
dinotefuran (4A)	Scorpion[1], Venom[1]
fenpropathrin (3A)	Danitol
gamma-cyhalothrin (3A)	Declare, Proaxis
imidacloprid (4A)	Admire Pro, Alias, Wrangler
lambda-cyhalothrin (3A)	Warrior II, Lambda-Cy, Silencer
lambda-cyhalothrin (3A) + thiamethoxam (4A)	Endigo
methomyl (1A)	Lannate
permethrin (3A)	Permethrin 3.2EC, Perm-UP
thiamethoxam (4A)	Actara
zeta-cypermethrin (3A)	Mustang Maxx

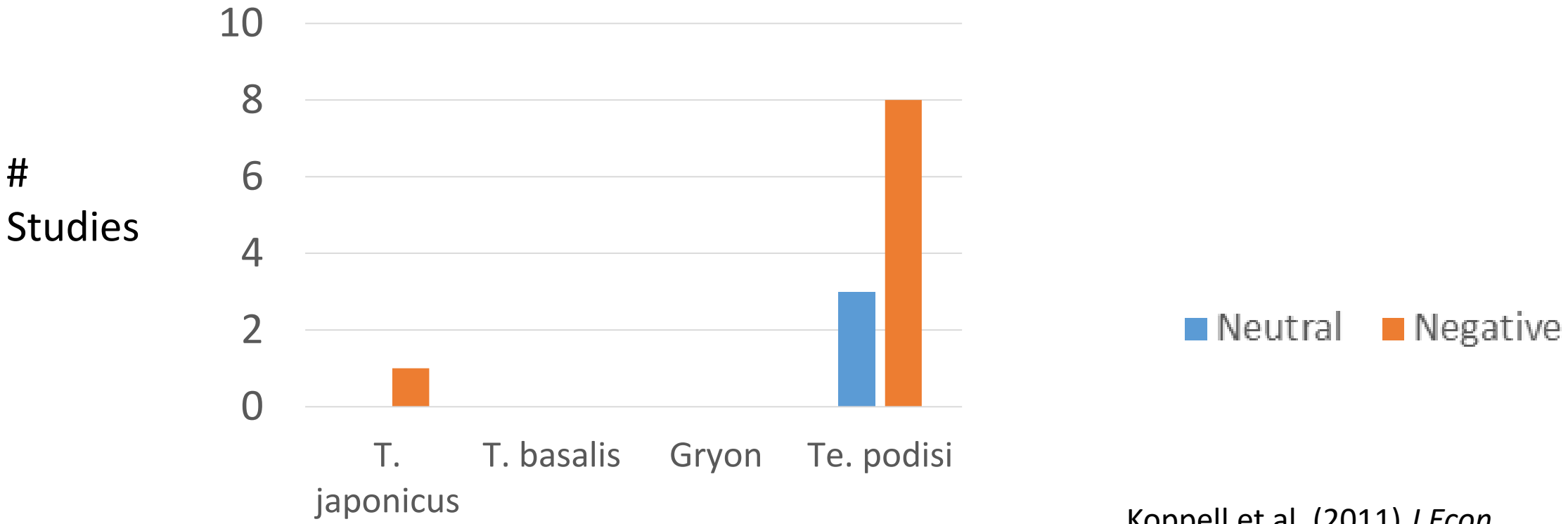
Lit review- Mostly negative effects on adults

- Tested insecticides include thiamethoxam, spinosad, lambda-cyhalothrin



Orr et al (1989) *J Econ Entomol*
Gonzalez et al (2013) *Chemosphere*
Alim and Lim (2015) *J Asia Pac Entomol*

Lit review- Negative effects on reproduction/parasitism



Koppell et al. (2011) *J Econ Entomol*

Turchen et al (2016) *J Econ Entomol*

Penca and Hodges (2017) *J Pest Sci*

How to evaluate natural enemy toxicity?

- Primarily lab assays
  - Emily Ogburn – NC
  - David Lowenstein - OR
- Field effects from border sprays
  - Anne Nielsen – NJ

Information is needed on the role of native natural enemies in biological control and how to conserve natural enemies in agricultural systems.

Dip eggs in insecticides- Lab

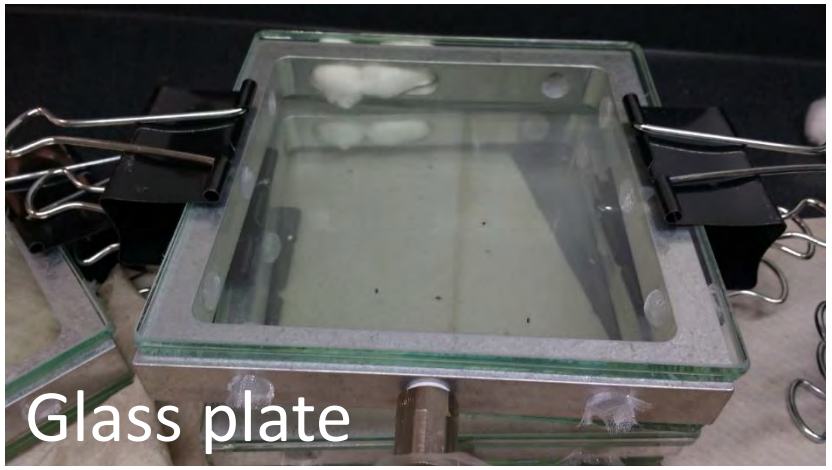
1)

Evaluate emergence - Lab

1)

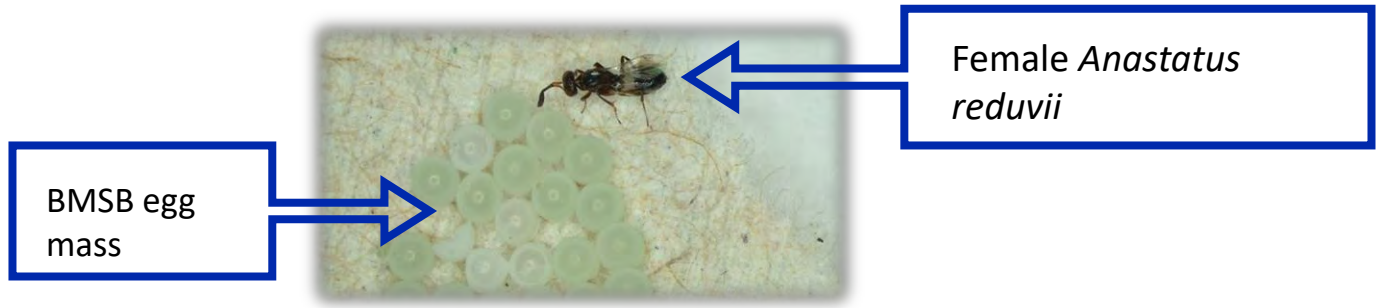
2)

Expose adults to chemical residues - Lab



North Carolina:
Native Parasitoid Insecticide Bioassays

- *Anastatus reduvii*: U.S. wasp that parasitizes eggs of pestivorous stink bugs, including BMSB.



Objective

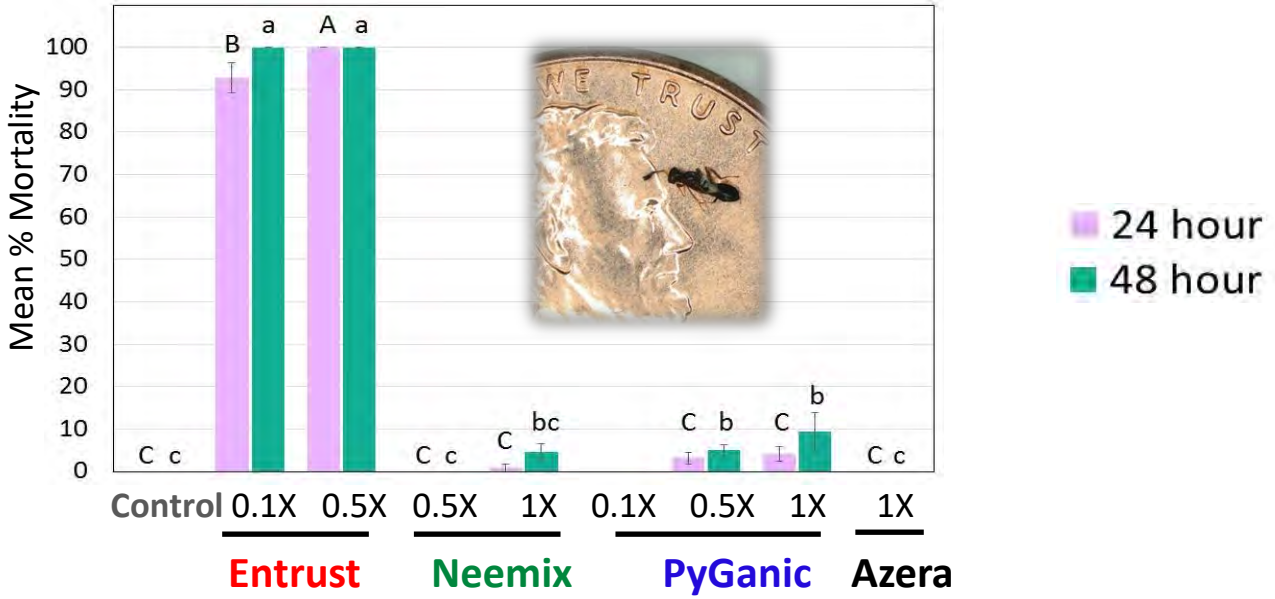
- Evaluate lethal and sublethal effects of OMRI-approved insecticides commonly used in organic production systems on *Anastatus reduvii* and *Telenomus podisi*

Bioassays:

- **Organically-approved insecticides tested: Entrust** (active ingredient: Spinosad), **Neemix** (Azadirachtin), **PyGanic** (Pyrethrin), and (Bioassay 1 only) **Azera** (Pyrethrin + Azadirachtin).
- Treatment rates were 1X, 0.5X, and 0.1X of the suggested field rates.

Bioassay 1 *Lethality, Substrate residue treatments*

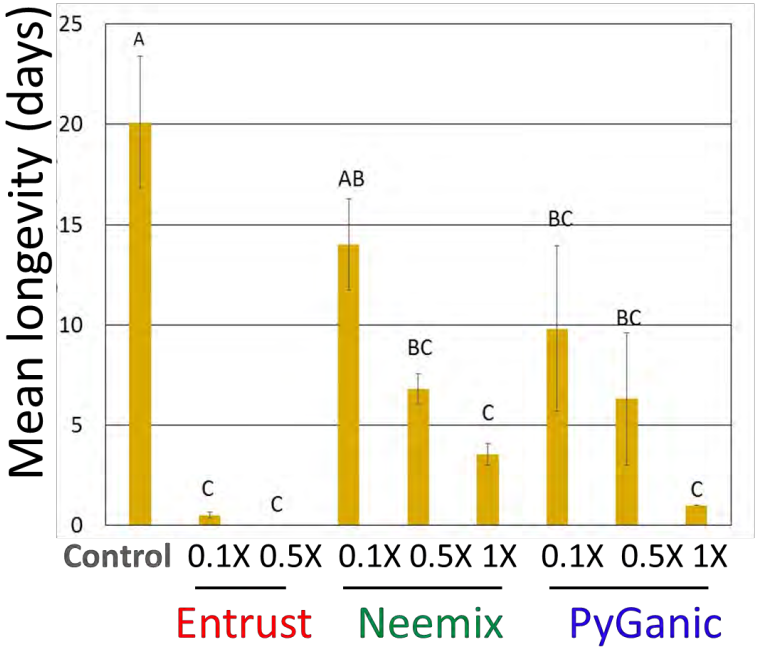
- Adult parasitoids exposed to dried pesticide residues on filter paper
- 10-16 parasitoids <24h-old were placed in each vial and checked for mortality 24 and 48 hrs post-setup.



- **Entrust** caused the highest mortality and 1X **PyGanic** caused higher mortality compared to the **Control** (24 hrs: DF= 8, F= 321, P <.0001; 48 hrs: DF=8, F=327, P <.0001).

Bioassay 2 *Feeding treatments*

- Sucrose-insecticide solutions were prepared by dissolving 10% sucrose in 90% pesticide solution. Dental cotton was placed in the lid of each vial and saturated with 20µl of solution.
- <24 hr old *A. reduvii* were placed individually in vials with insecticide-laced sucrose as the sole food source and monitored until their death.

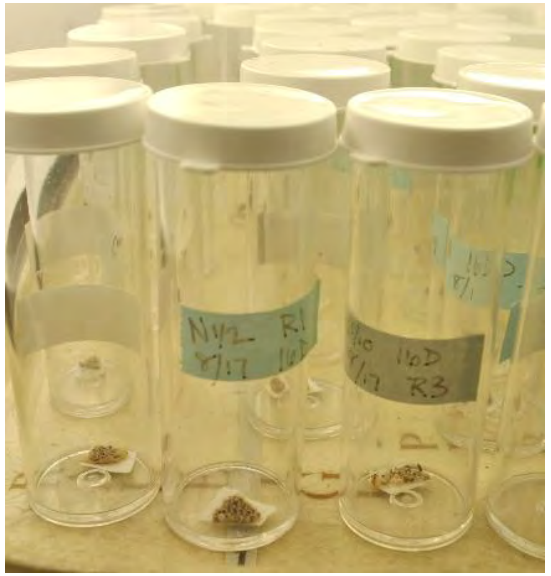


- All insecticide treatments, except 0.1X **Neemix**, resulted in significantly reduced longevity versus the **Control**.

Mean longevity of *A. reduvii* post-exposure to insecticide-laced sucrose (DF= 8, F= 9.84, P <.0001).

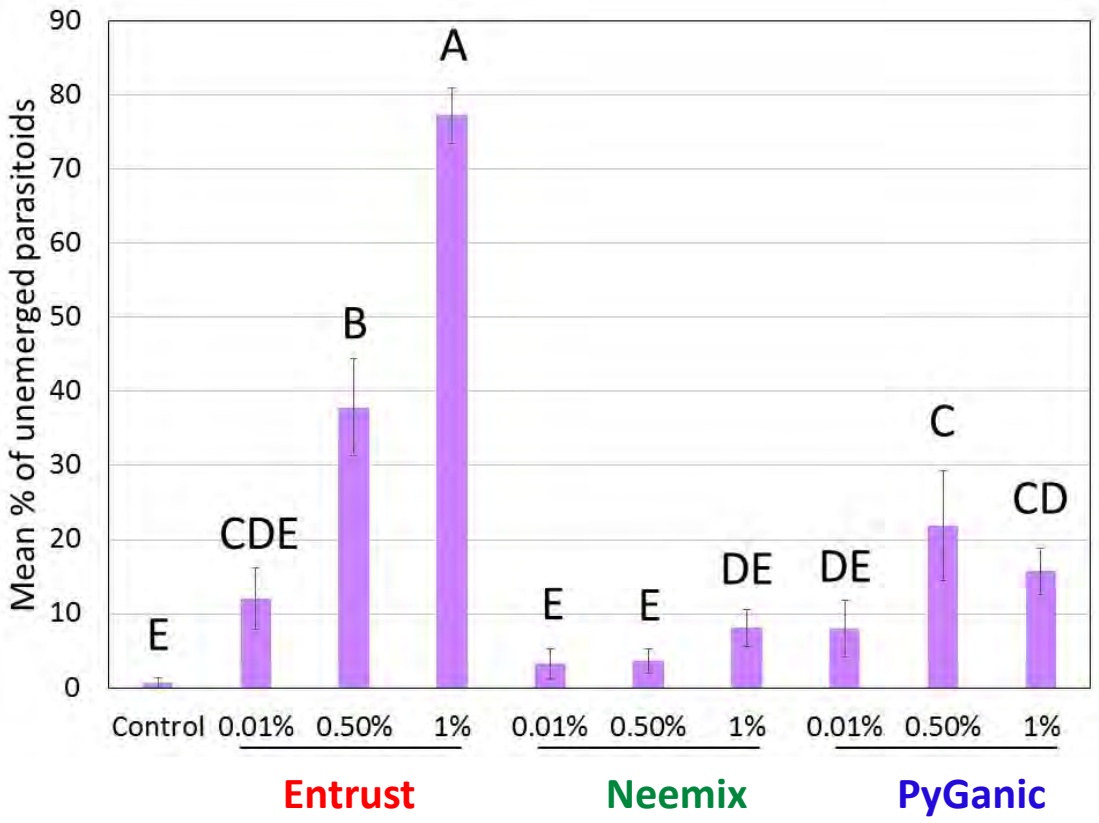
Bioassay 3 *Emergence, Egg exposure treatments*

- Parasitized eggs were treated 2 days after parasitism.
- Masses were submerged in treatment solutions until saturated (10 sec) and allowed to dry.
- Vials were monitored daily for emergence.
- Unhatched eggs were held for 5 weeks, then dissected.



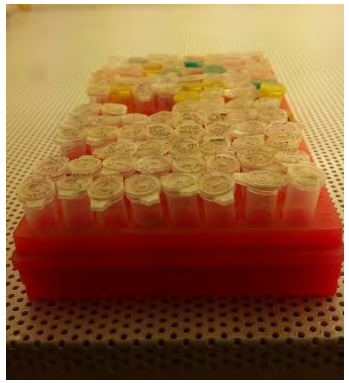
Results:

Significantly fewer parasitoids emerged from eggs submerged in 1X Entrust versus all other treatments. Emergence of *A. reduvii* from eggs treated with 0.5X **Entrust**, and 0.5X & 1X **PyGanic** was significantly lower than the **Control** (DF= 9, F= 47.83, P <.0001).

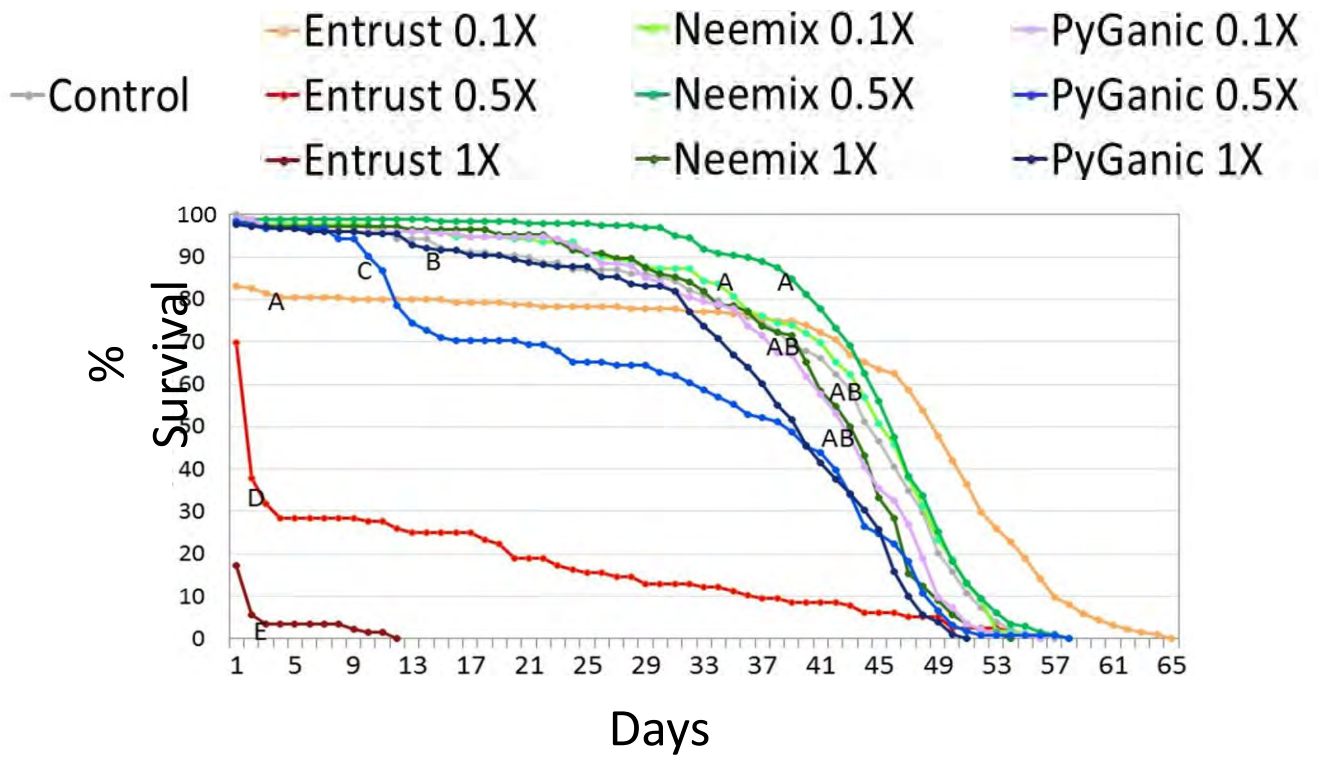


Bioassay 4 *Longevity, sub-lethal effects of egg exposure*

- Emerged females from Bioassay 3 were placed individually into 1.5ml centrifuge tubes with honey on the lid and checked daily until parasitoid death.



Results: Emerged females from eggs treated post-parasitism had a significantly shorter lifespan in 1X and 0.5X **Entrust** treatments than all other treatments.



Bioassay 4 Percent daily survival of all emerged female *A. reduvii* (DF= 9, F= 120.30, P <.0001) from parasitized egg masses submerged in Bioassay 3 treatments.

Conclusion

- In general, **Entrust** (active ingredient: Spinosad) and in some cases **PyGanic** (Pyrethrin), especially at higher doses, had negative impacts on the native parasitoid, *Anastatus reduvii.*

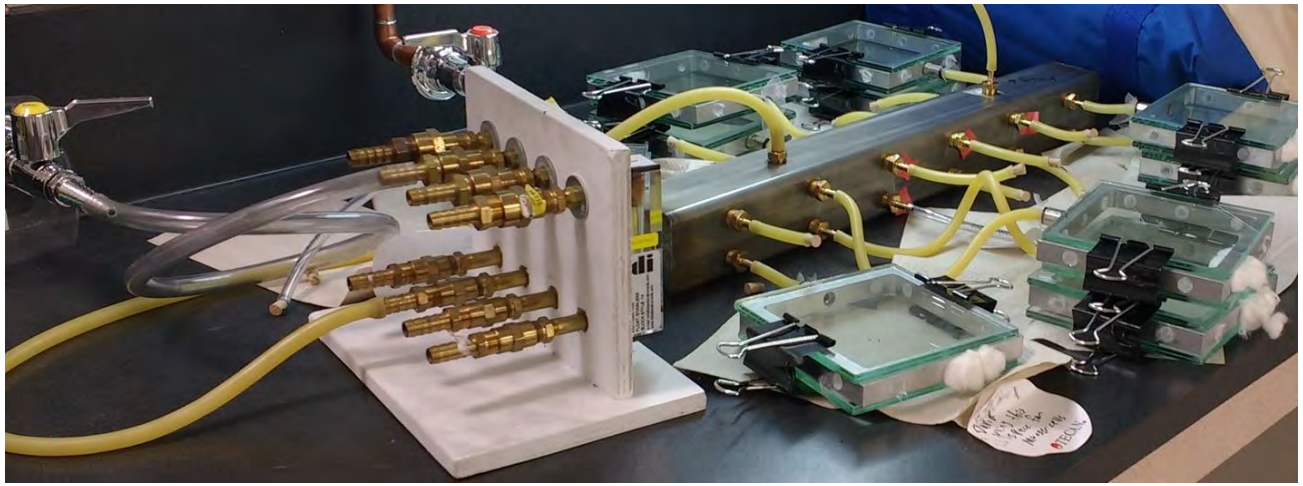
Acknowledgements: USDS-NIFA OREI grant no. 2012-51300-20097, and USDA-NIFA SCRI grant no. 2016-51181-25409 provided funding for this research.

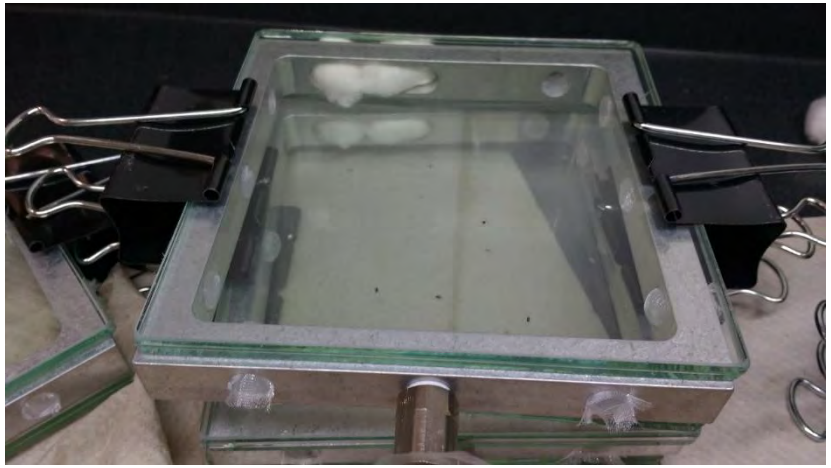
Oregon: Insecticide exposure on *T. japonicus*

- Adults (< 36 h old) exposed to dried residue on glass plates
- Tested compounds used in hazelnuts and caneberry
  - Neonicotinoids, Pyrethroids, Spinosad, Diamides
- Mortality assessed at 1, 2, 4, 6, 24 hours
  - Survivors presented with egg mass

Funding from Oregon Raspberry and Blackberry Commission

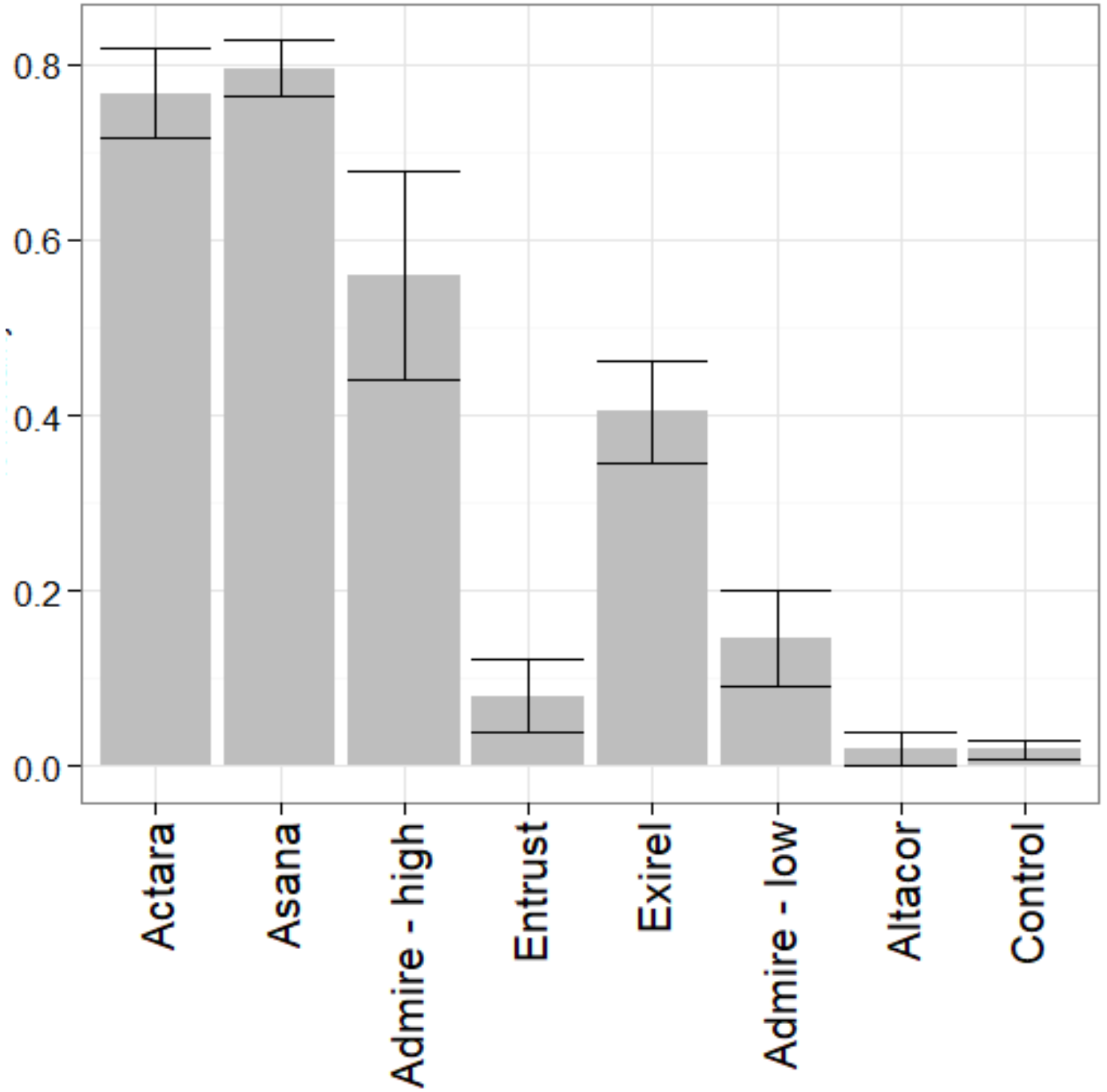
Exposing *T. japoncius* to chemical residues





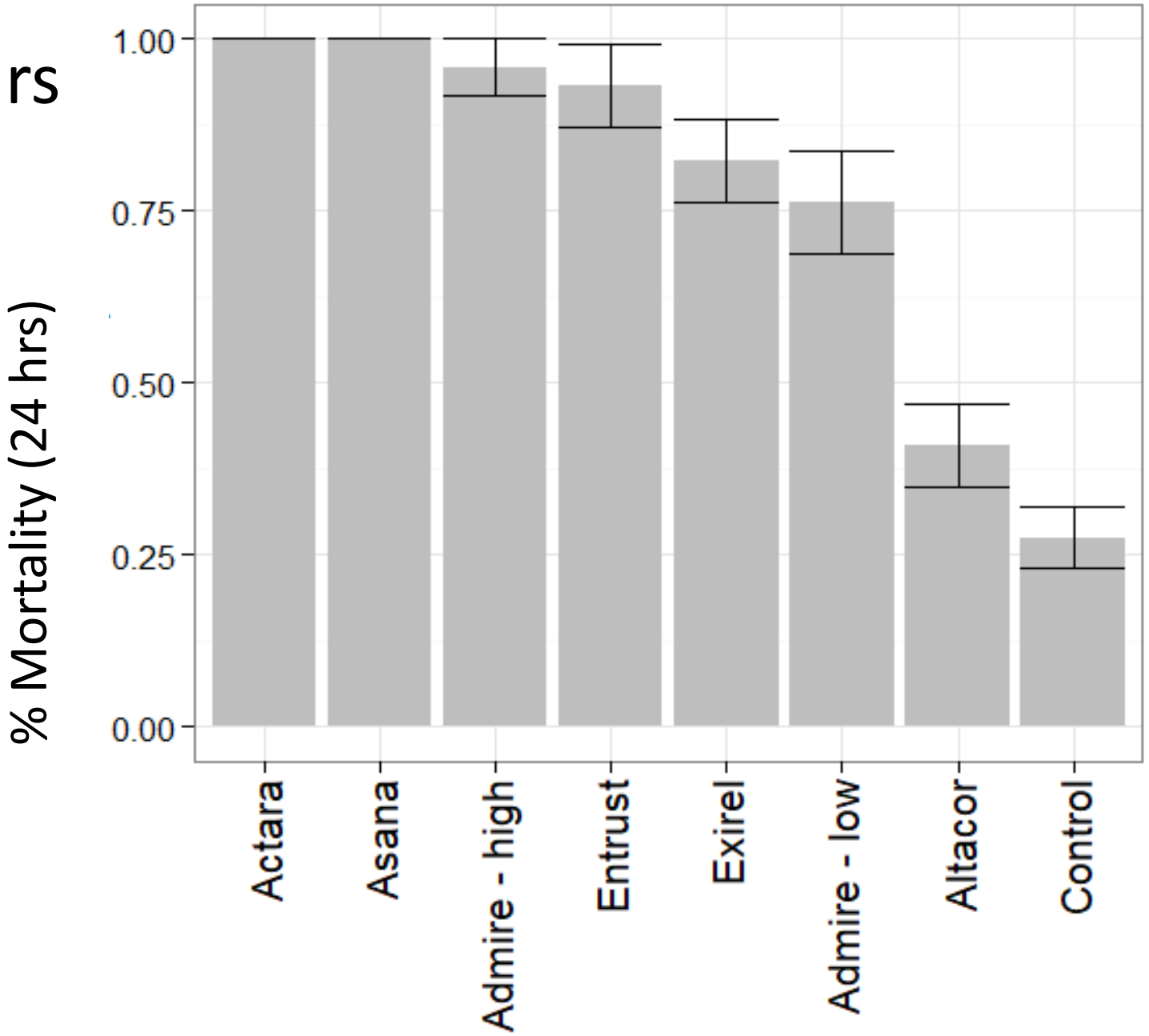
% Mortality – 1 hour

- Several products with immediate negative effects



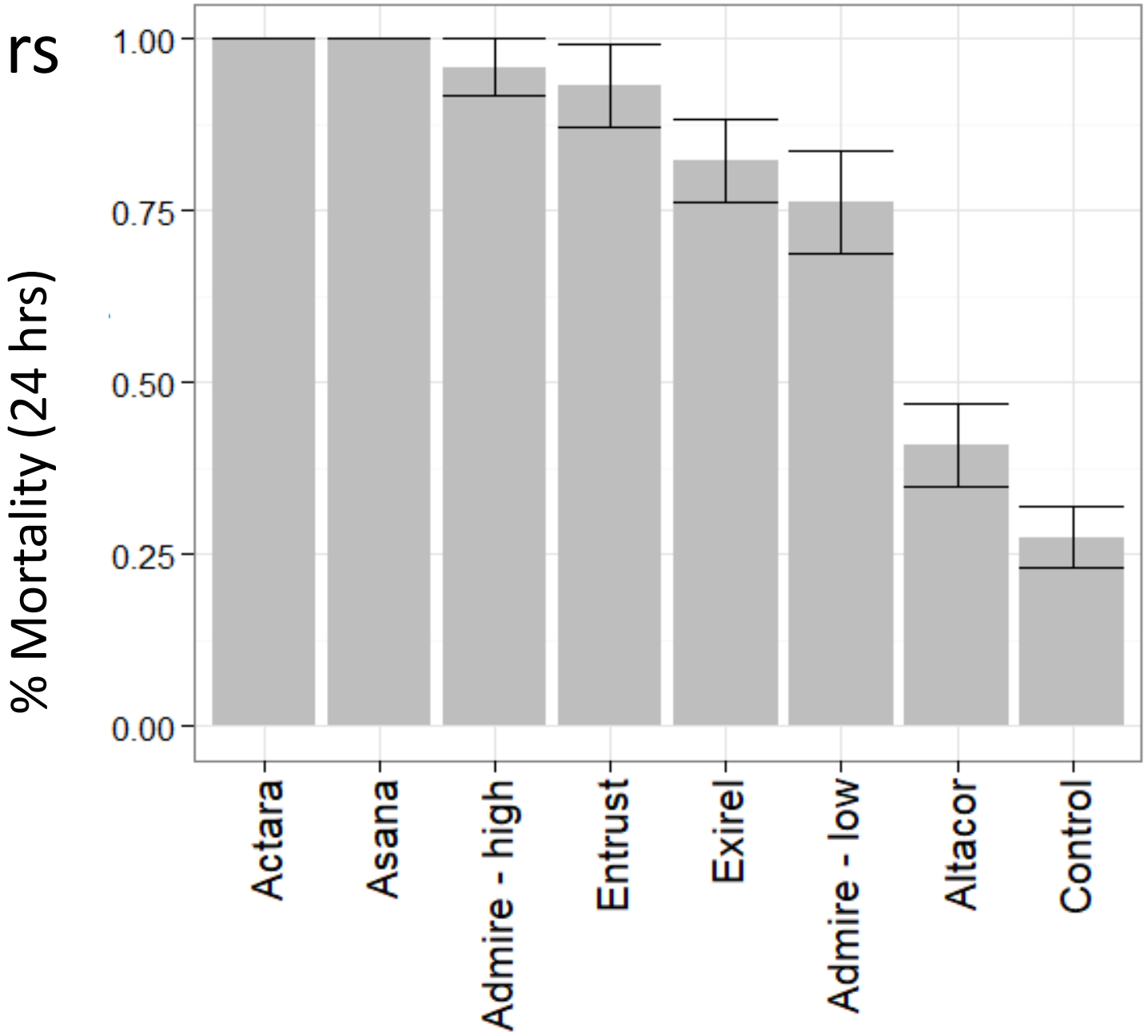
% Mortality – 24 hours

- High mortality from exposure to neonicotinoids and pyrethroids



% Mortality – 24 hours

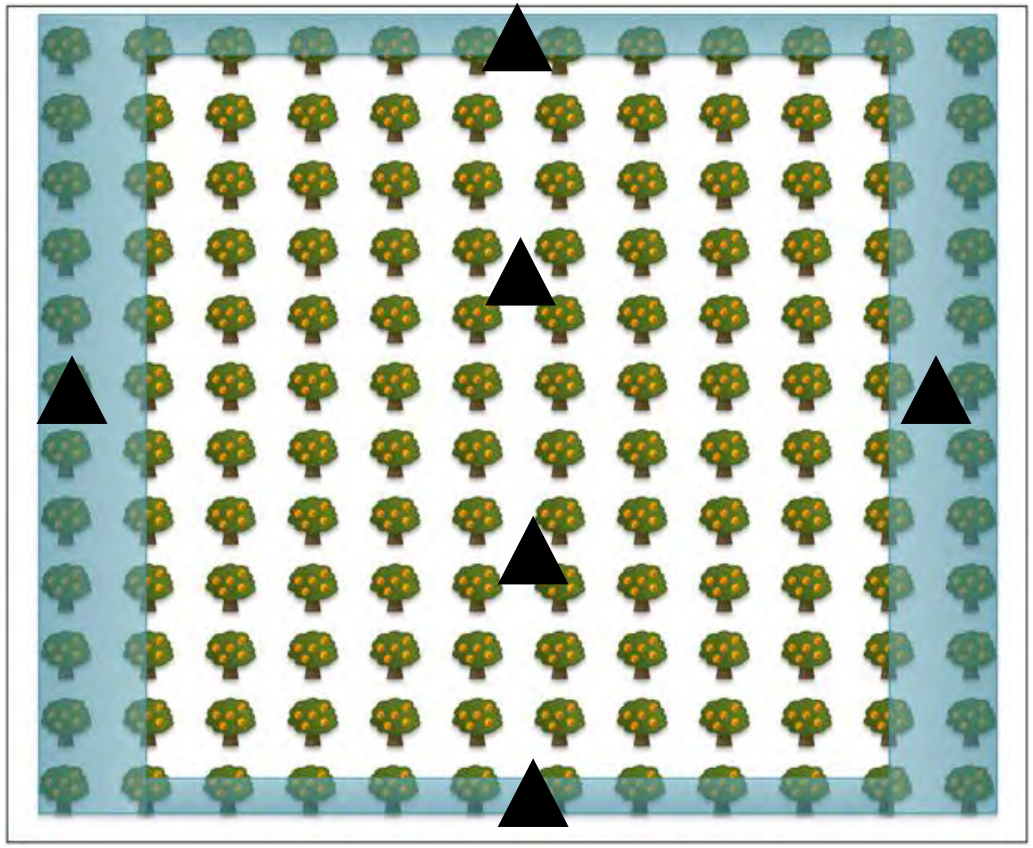
- Parasitized eggs only from survivors of Altacor and Control
- Analyses and additional treatments ongoing



NJ: Applications to field – border sprays to reduce chemical application area

Perimeter sprays to reduce inputs

- Peach damage similar or reduced between border and interior (Blaauw et al 2015 *Pest Manag Sci*)
- Natural enemy community similar between IPM-CPR and standard management (Nielsen unpub.)
- 1-5-2% greater biocontrol services in IPM-CPR
- Samurai wasp found in 2 IPM-CPR orchards



To consider for natural enemies

- Lab assays represent worst-case scenario for toxicity
- Field confirmation of insecticides' effect on foliage
- Location of parasitoid releases
  - Establishment and reservoirs outside of orchards
  - Timing releases based on chemical applications