

SWD Visual Ecology: Response To Visual Cues and Their Potential Role in a Behavioral Control System

Leskey Laboratory

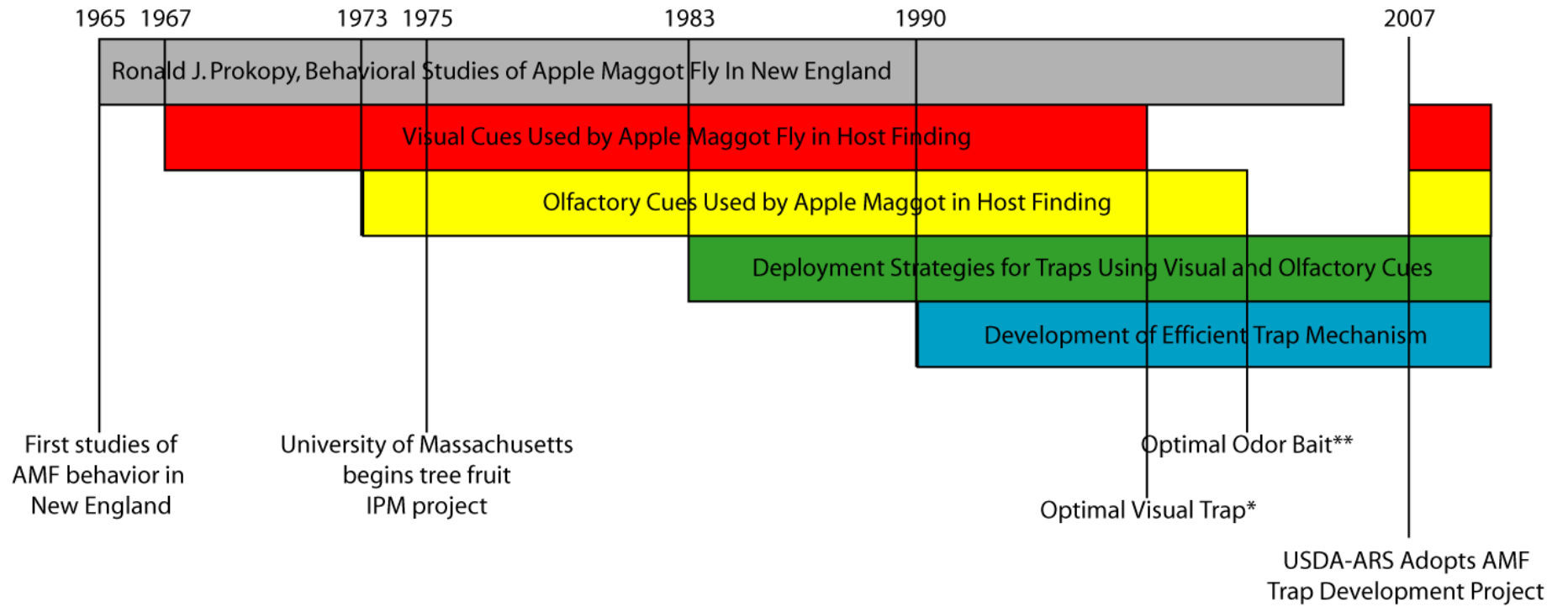
USDA ARS

Appalachian Fruit Research Station

Kearneysville, WV 25430



Development of Effective Monitoring and Management Tools for Apple Maggot Fly

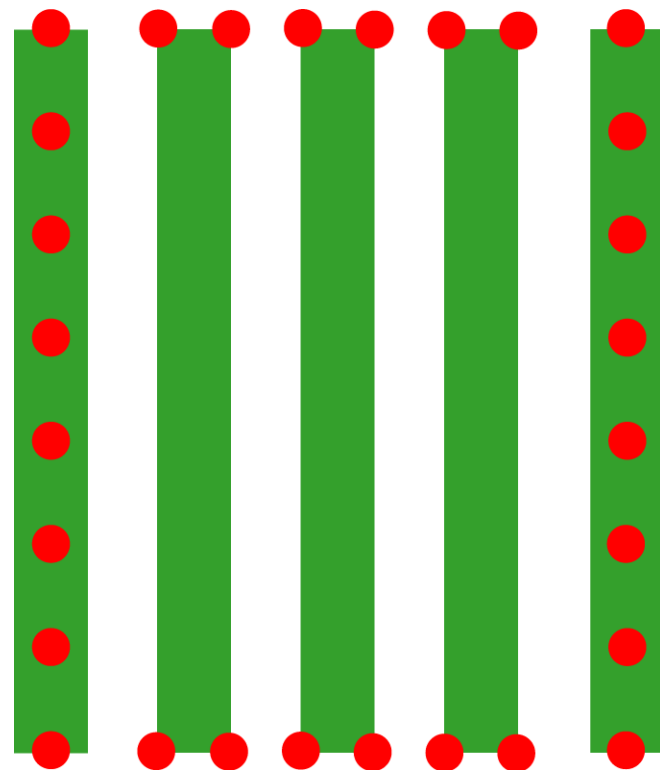


Optimizing Components of Trap-Based Monitoring and Management Systems

- Visual Stimulus
- Olfactory Stimulus
- Deployment Strategy
- Capture Mechanism



Perimeter-Based Attract and Kill System for Apple Maggot



Can We Use A Similar Approach With SWD?

- Identifying Attractive Visual Cues
- Development and integration into an Attract-and-Kill System

Does SWD Respond To Visual Cues?



What Did We Know?

- Visual cues used by drosophilids to discriminate among hosts (Menne and Spatz 1977).
- *Drosophila melanogaster* utilizes visual cues, particularly vertical edges, when responding to odor (Frye et al. 2003).
- Basoalto et al. (2013) reported that flies responded in greatest numbers to red and black stimuli in laboratory studies, but didn't necessarily translate in the field.

SWD Visual Trials

- Trials
 - Laboratory - No-Choice and Choice
 - Semi-field
 - Field
- Treatments
 - Color
 - Shape
 - Size

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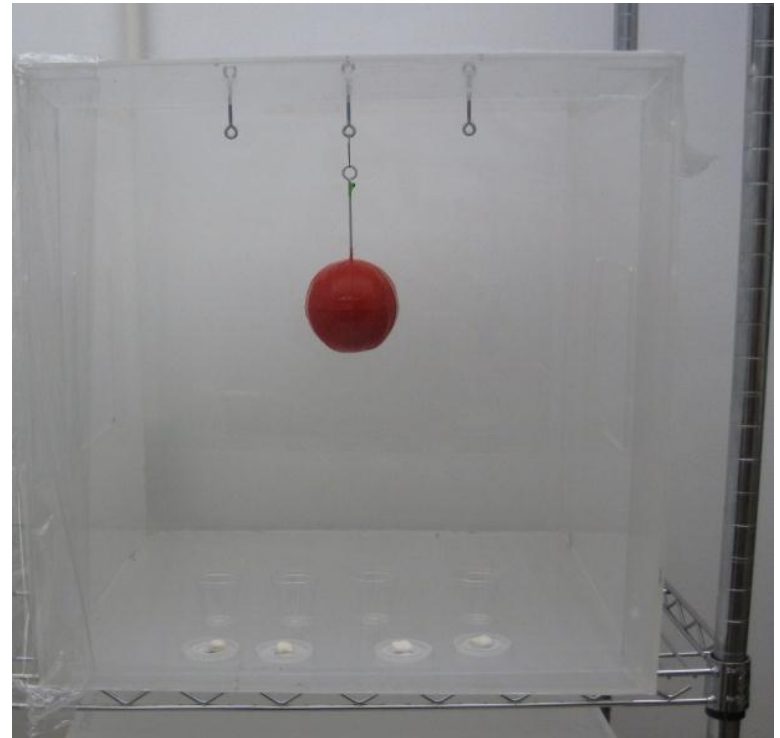
Visual Stimuli: Color

- All spheres 9 cm in diam.
- $\sim 254 \text{ cm}^2$

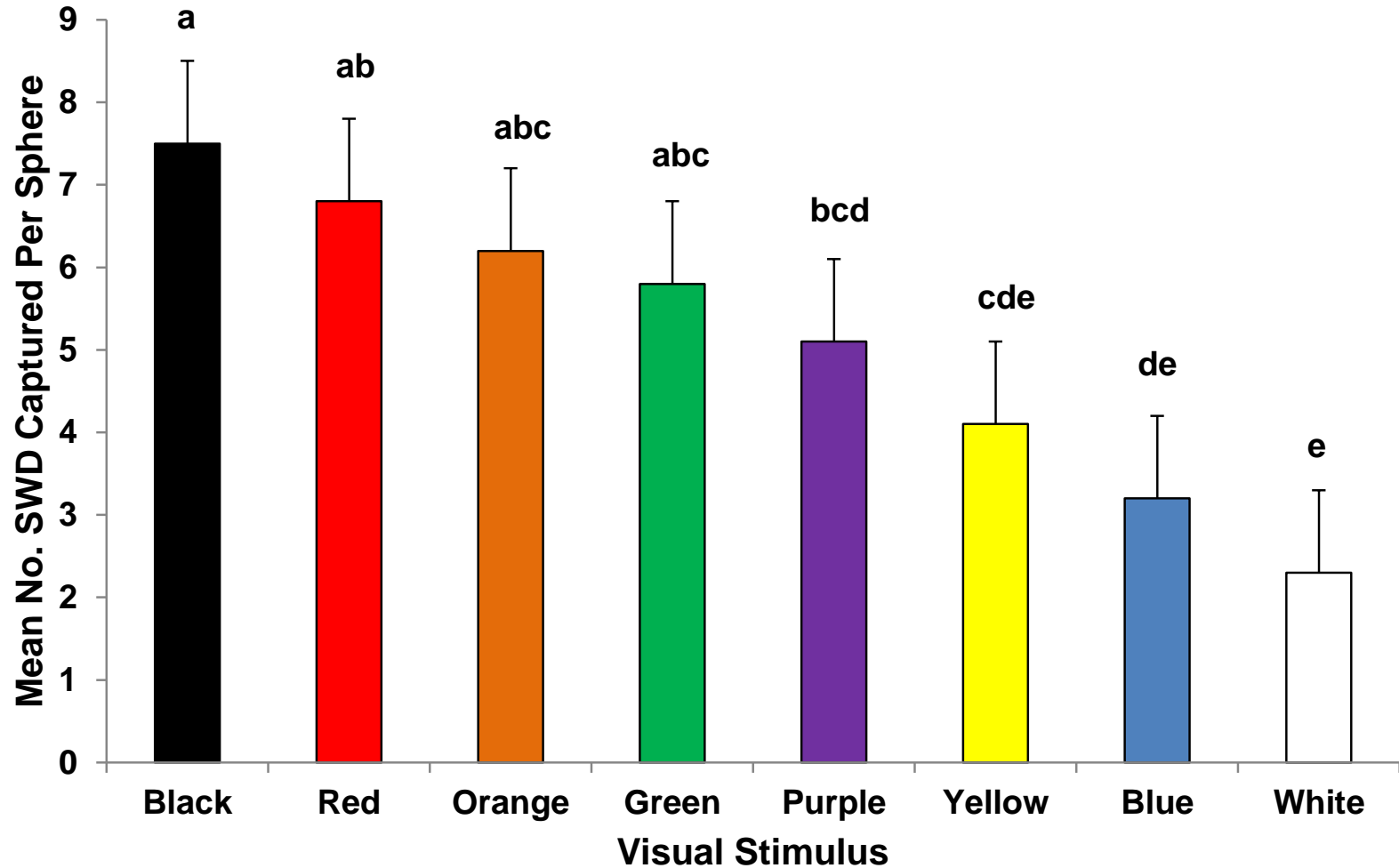


Laboratory Trials

- Release 20 sexually- mature anesthetized SWD into cage.
- SWD permitted to freely forage for 6h.
- Single stimulus per cage.
- Flies counted and removed at end of trial.

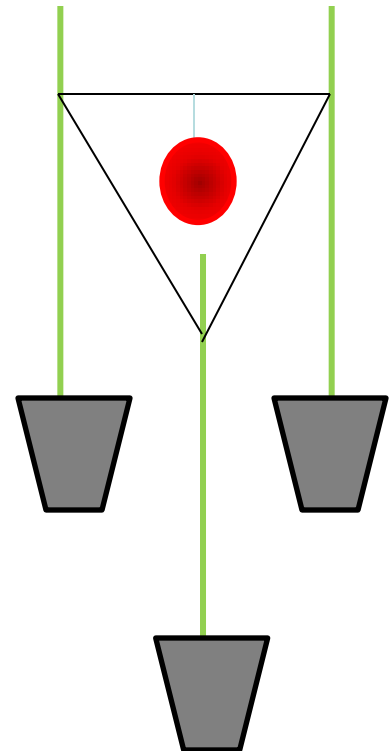


Color: No-Choice Laboratory Trials

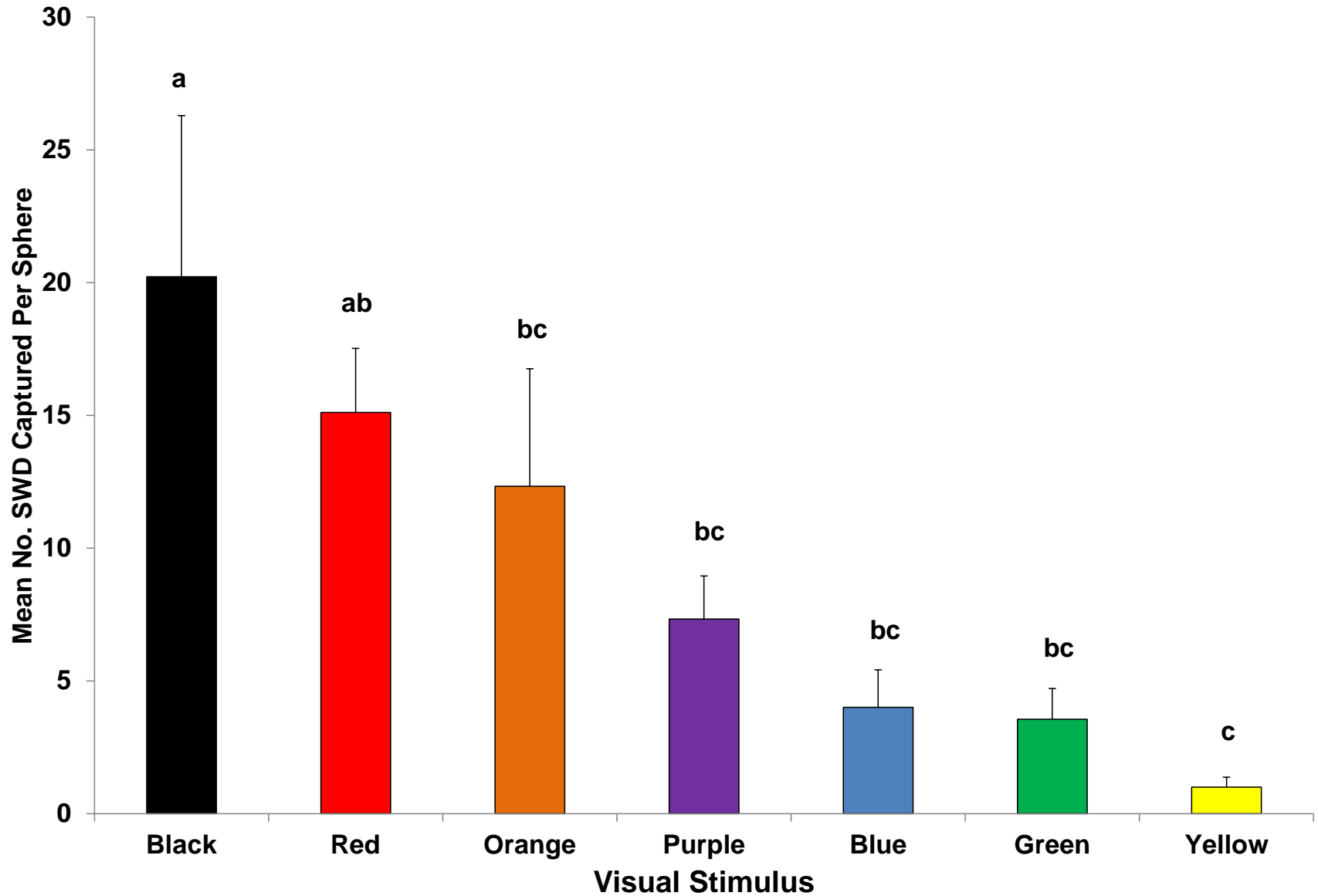


Semi-field Trials

- Three potted raspberry plants arranged in a triangular configuration.
- Visual stimulus hung at center of plants.
- Release 30 sexually-mature anesthetized SWD at the base of potted plants.
- SWD allowed to freely forage for 48h.
- SWD counted and removed at end of trial.



Color: Semi-Field Trials

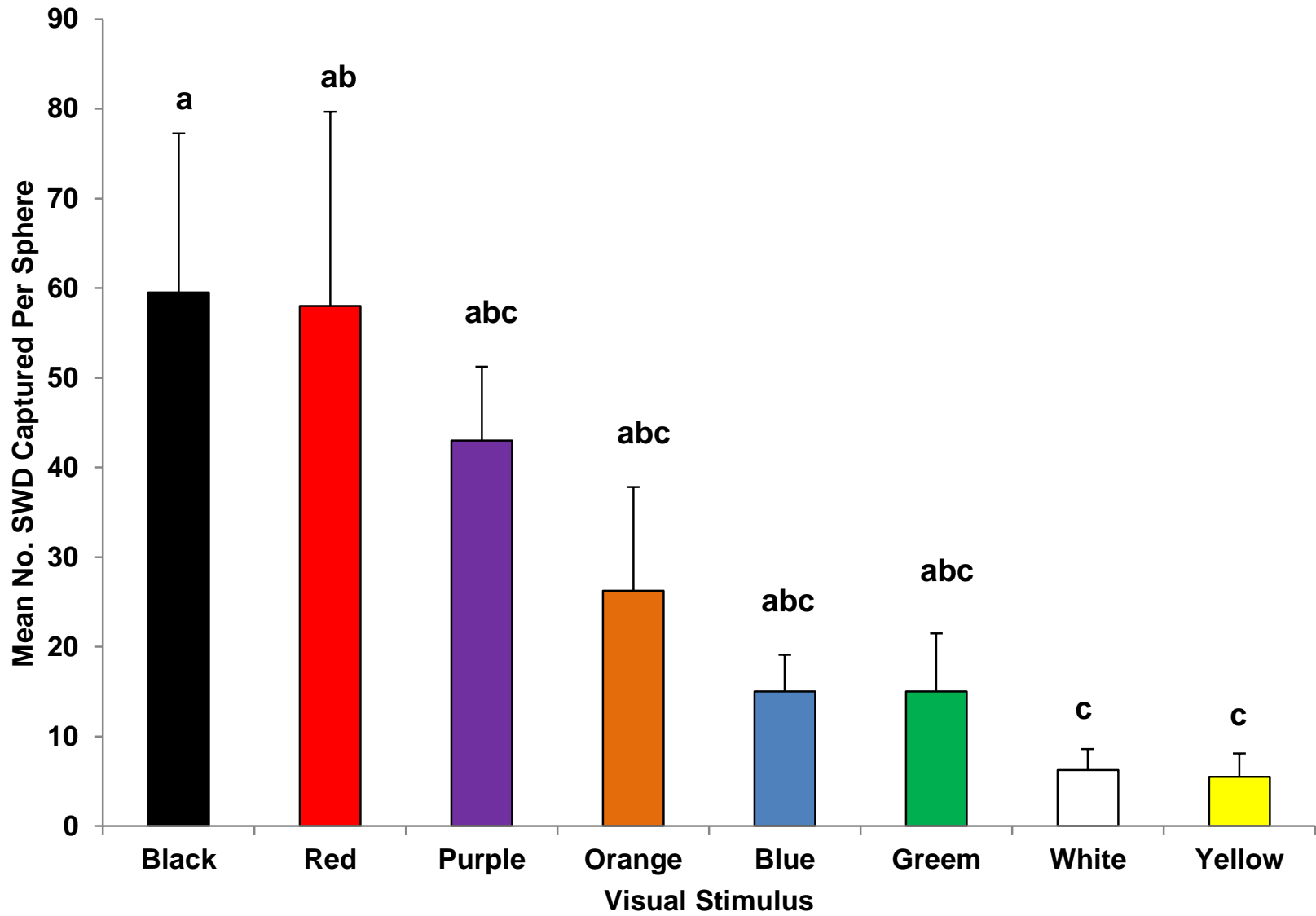


Field Trials

- Unsprayed block of mature peaches.
- Visual stimulus hung at head-height on outer third of canopy.
- Stimuli remained in the field for 48h to assess wild population response.
- SWD counted and removed at end of trial.

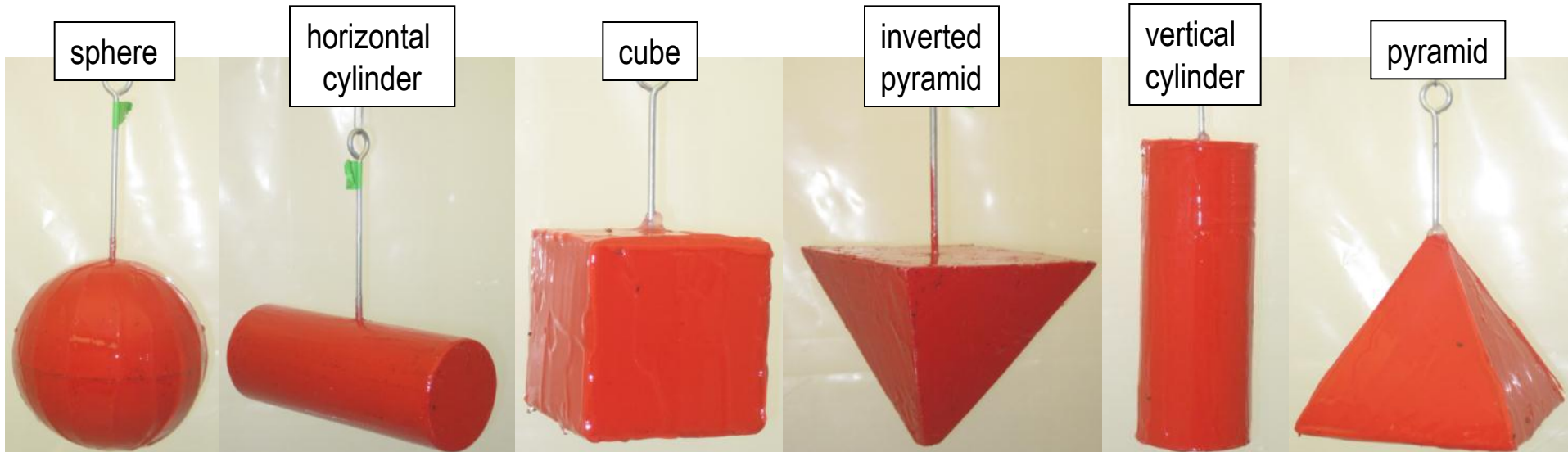


Color: Field Trials

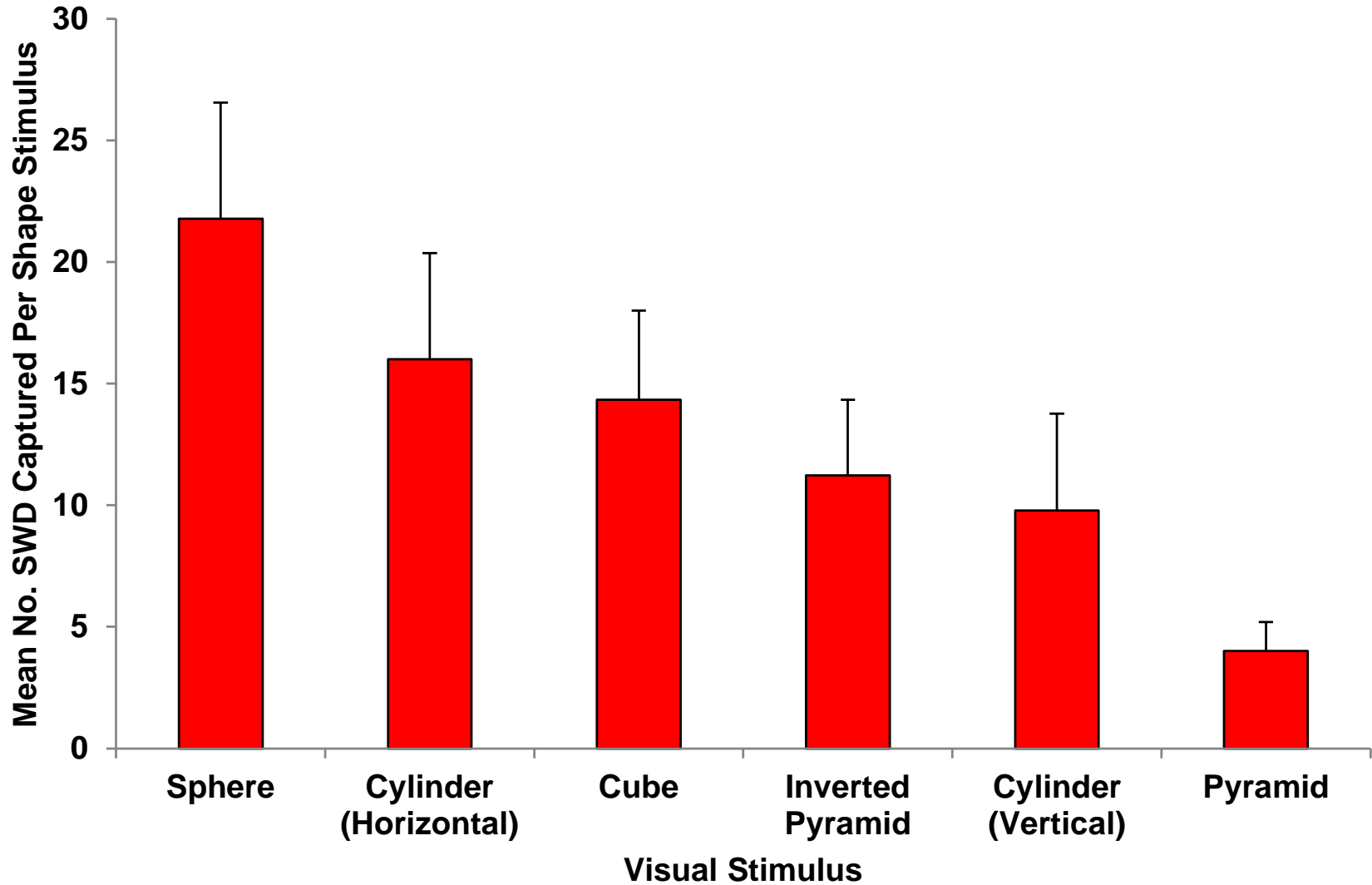


Visual Stimuli: Shape

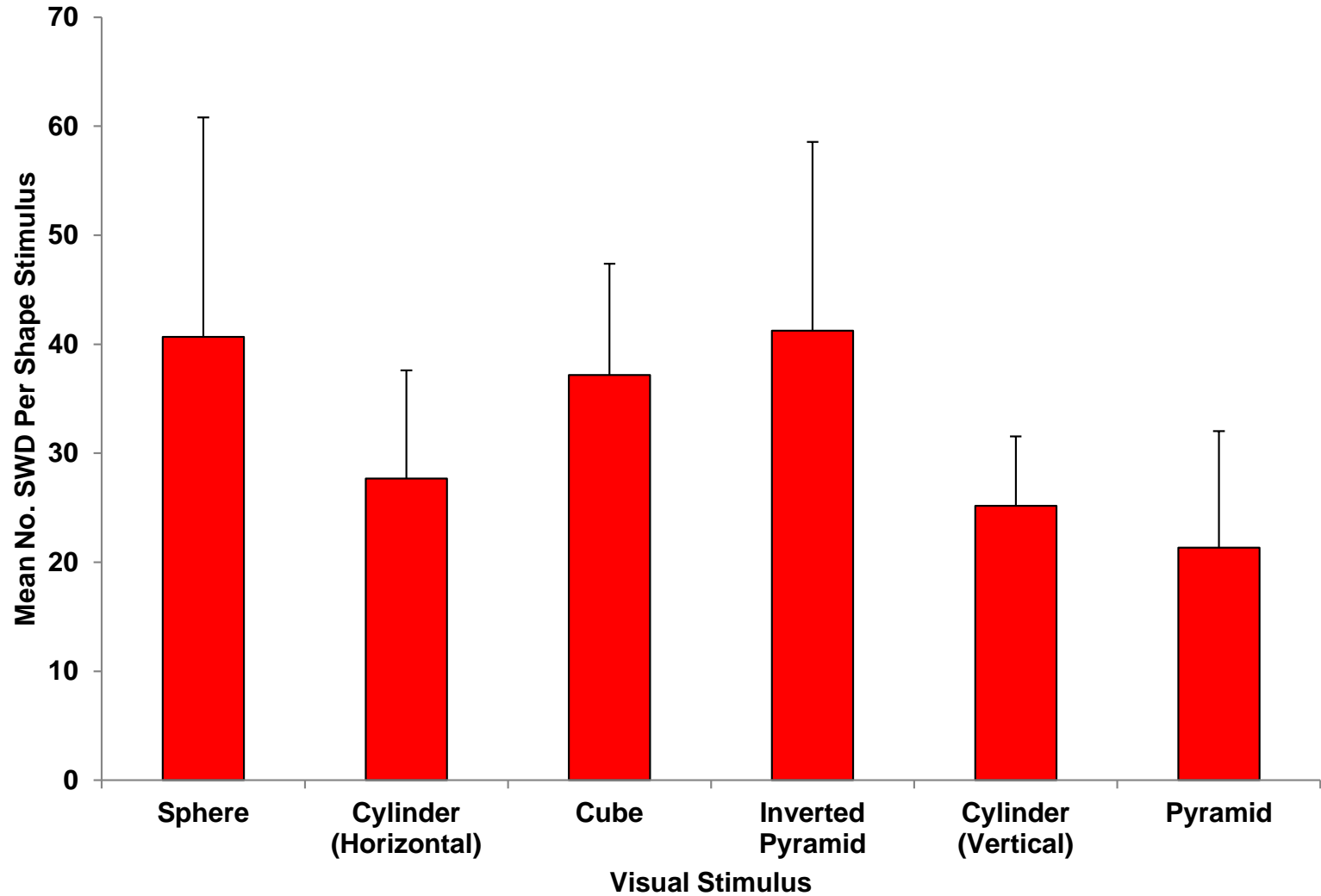
- All shape stimuli have identical surface area.
- $\sim 254 \text{ cm}^2$



Shape: Semi-Field Trials



Shape: Field Trials



Conclusions

- SWD do respond to visual cues in the laboratory and under semi-field and field conditions.
- Black and red appear to be most visually stimulating.

Can We Develop an Attract and Kill System for SWD?

- Visual Stimulus
- Olfactory Stimulus
- Deployment Strategy
- Capture Mechanism



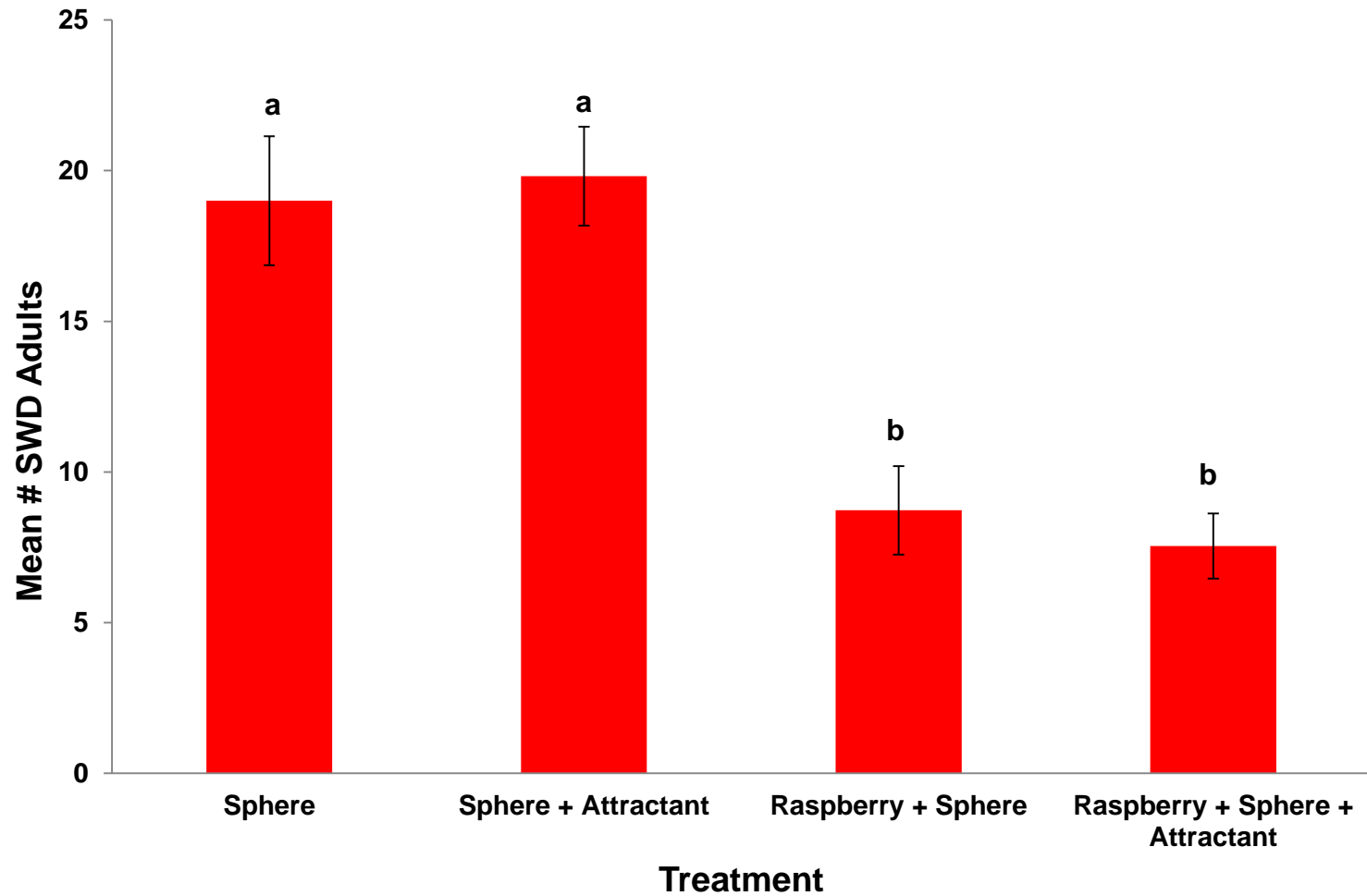
Semi-Field Attract-and-Kill Study

- Released 25 males and 25 females into field cages.
- Treatments
 - Sphere
 - Sphere + olfactory attractant
 - Sphere + raspberry plant
 - Sphere + olfactory attractant + raspberry plant
 - Raspberry plant
- Flies foraged freely for 48 h.
- Recorded number of SWD captured (kill) and number of larvae + pupae recovered from fruit (control).

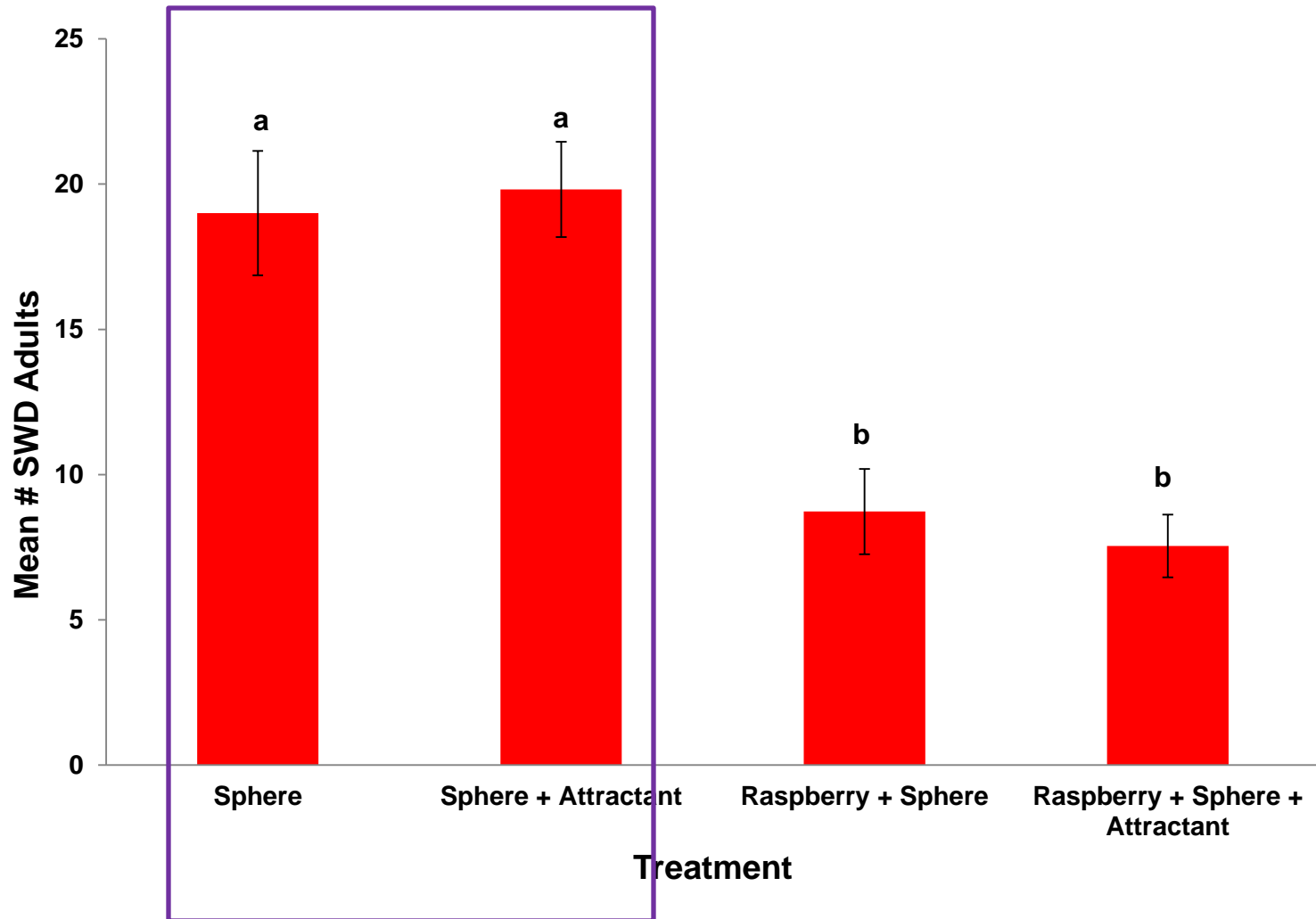
1. Can we capture flies on red spheres?
2. What effect does their presence have on infestation?



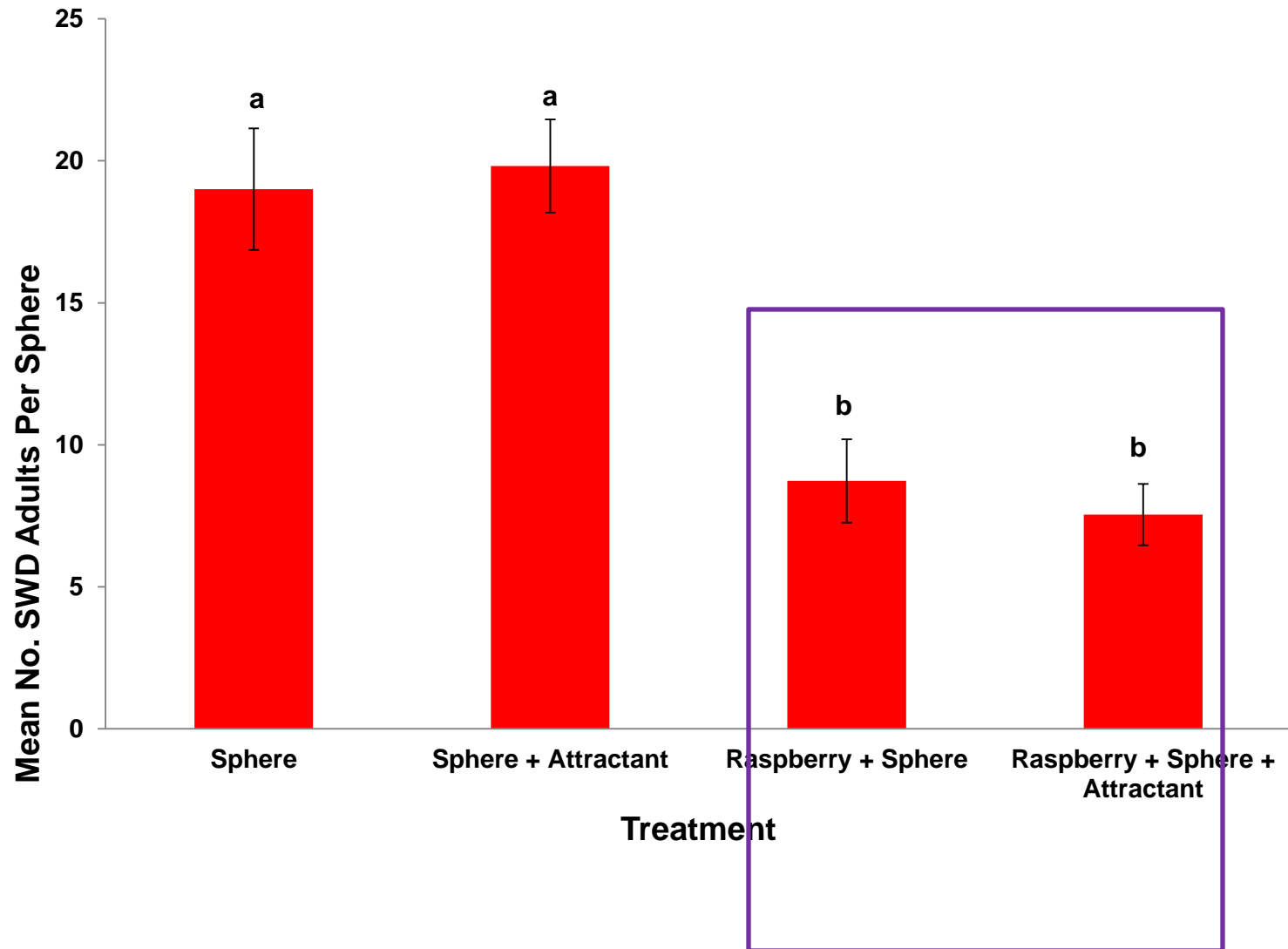
SWD Captures on Red Spheres



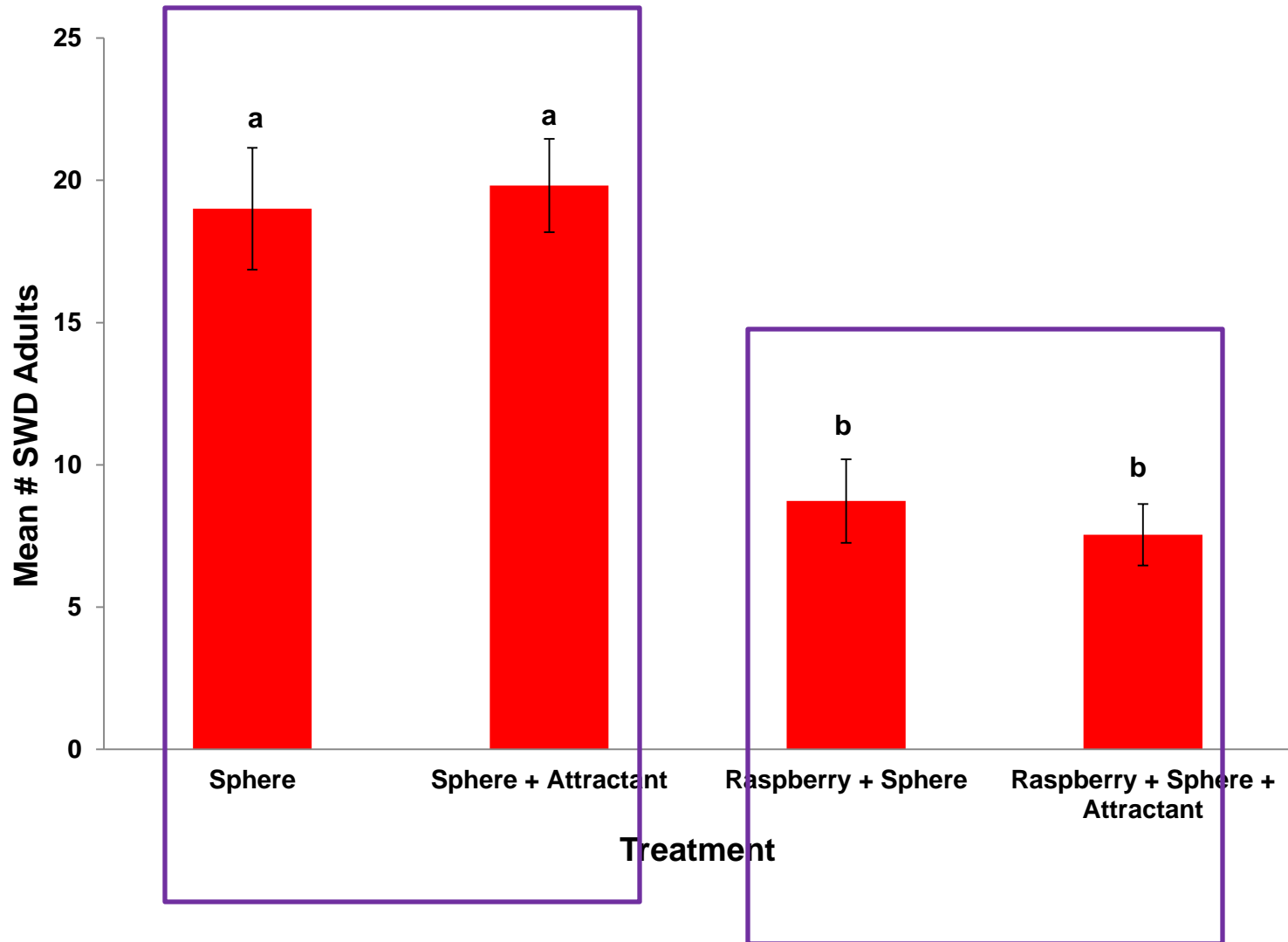
SWD Captures on Red Spheres



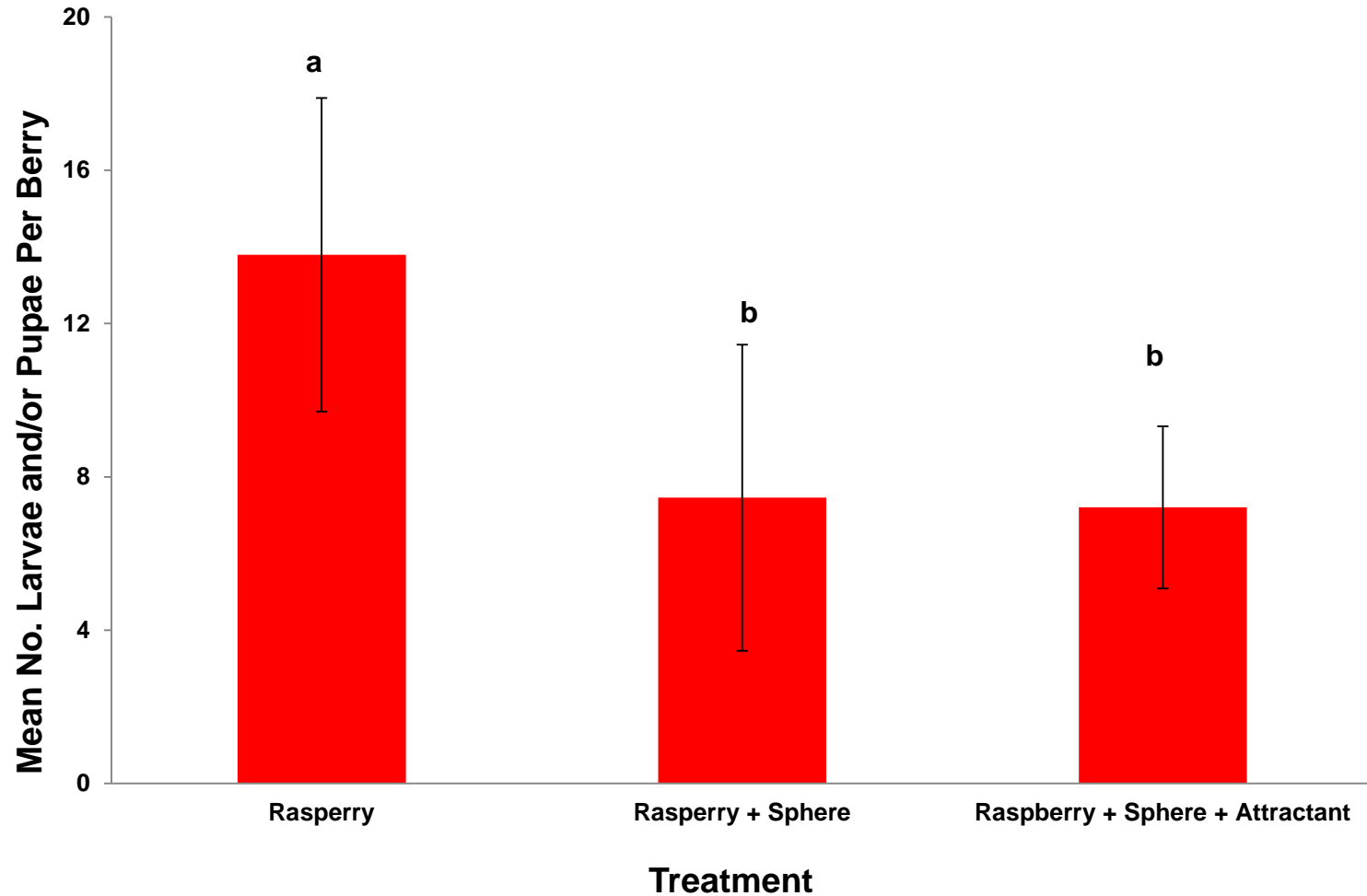
SWD Captures on Red Spheres



SWD Captures on Red Spheres



Larval / Pupal Infestation in Fruit



Can We Replace Tangletrap as Killing Agent?

- Evaluate lethality of attracticidal spheres developed for AMF for SWD.
- Cap contains a feeding stimulant (sugar) and toxicant.
- Exploits environmental moisture to continuously renew toxicant on sphere surface.

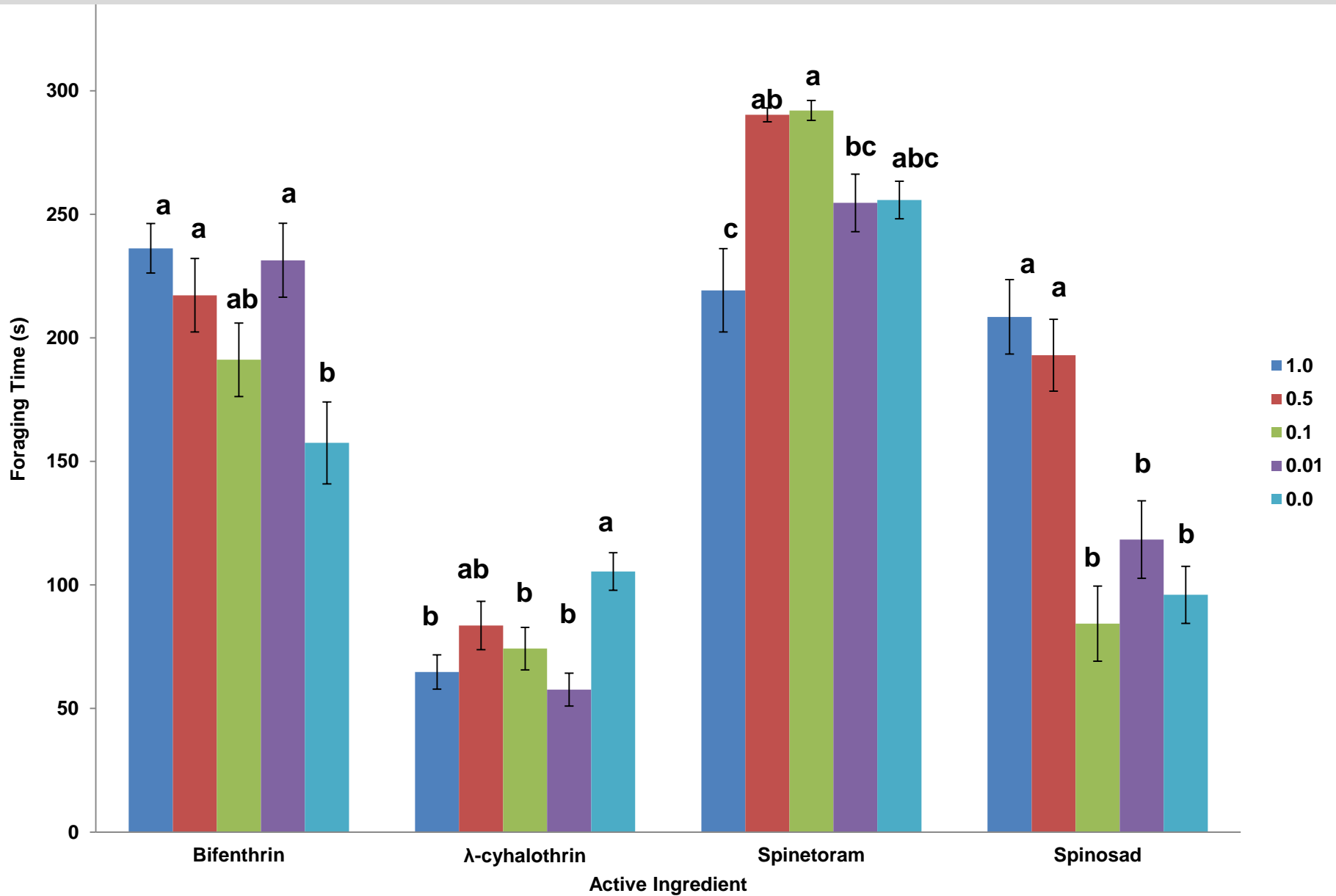


Laboratory Evaluation of Lethality

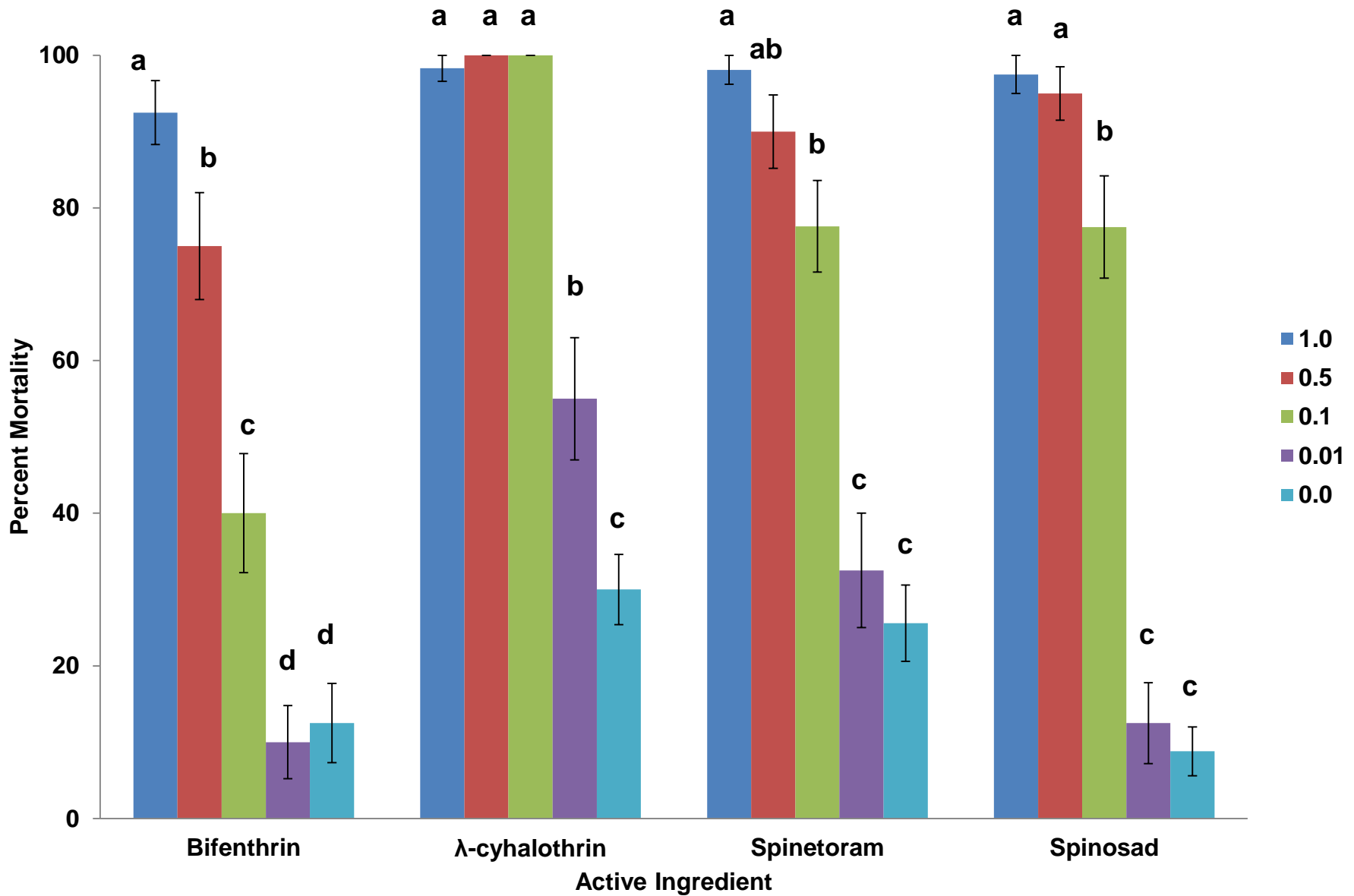
- Insecticides: Bifenthrin, Lambda-cyhalothrin, Spinetoram, and Spinosad.
- Rates: 0.0, 0.01, 0.1, 0.5 and 1.0% a.i.
- Evaluated a minimum 20 males and 20 females/insecticide/rate.
- Released at sphere equator and allowed to forage freely for 5 min. Measured foraging time.
- Evaluated toxic effects at 0, 24 and 48 h after exposure



Foraging Time



Lethality



Field Trial of Attracticidal Spheres

Can we reduce SWD infestation in a susceptible crop using attracticidal spheres?

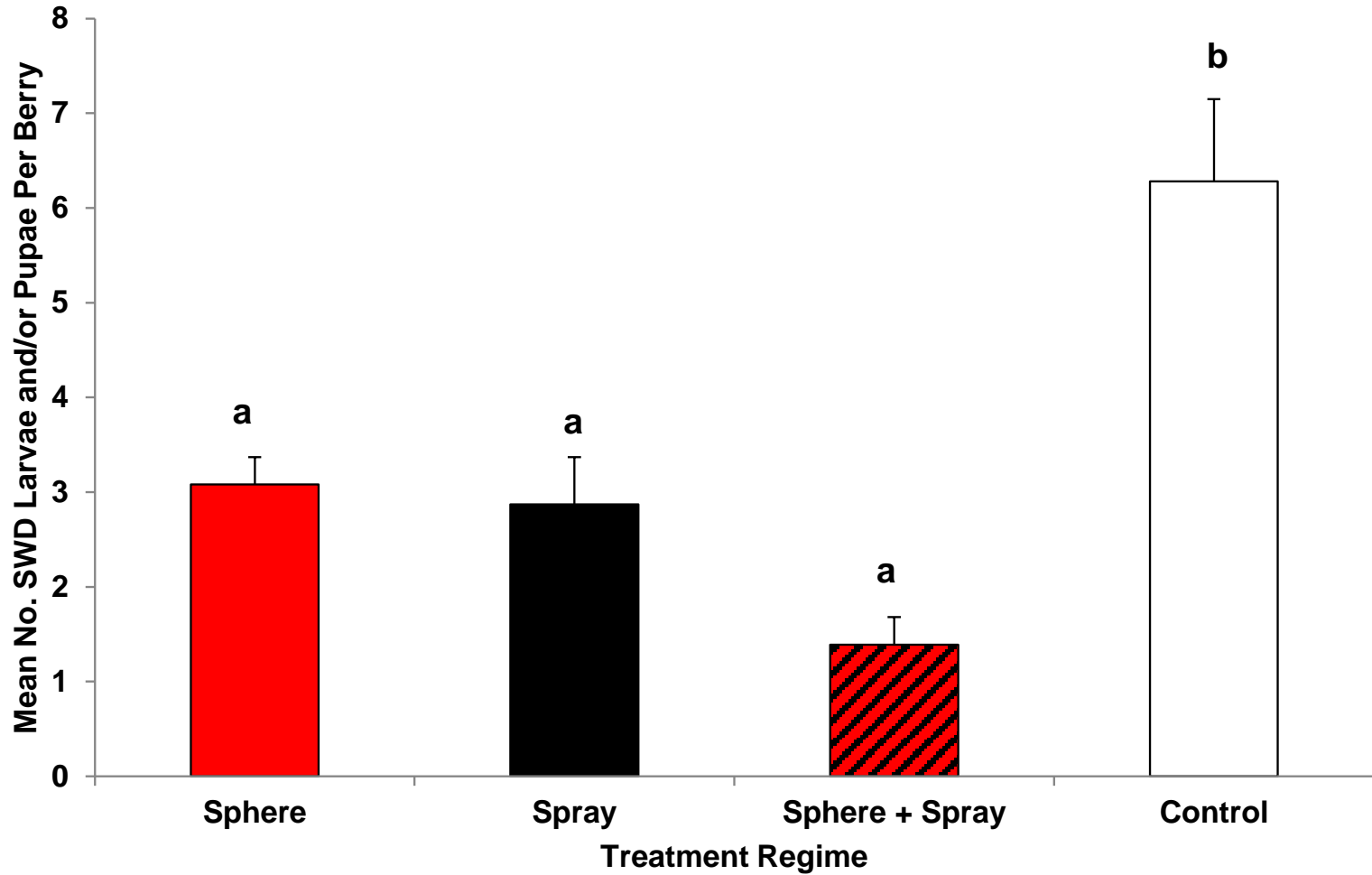


Experimental Set-Up

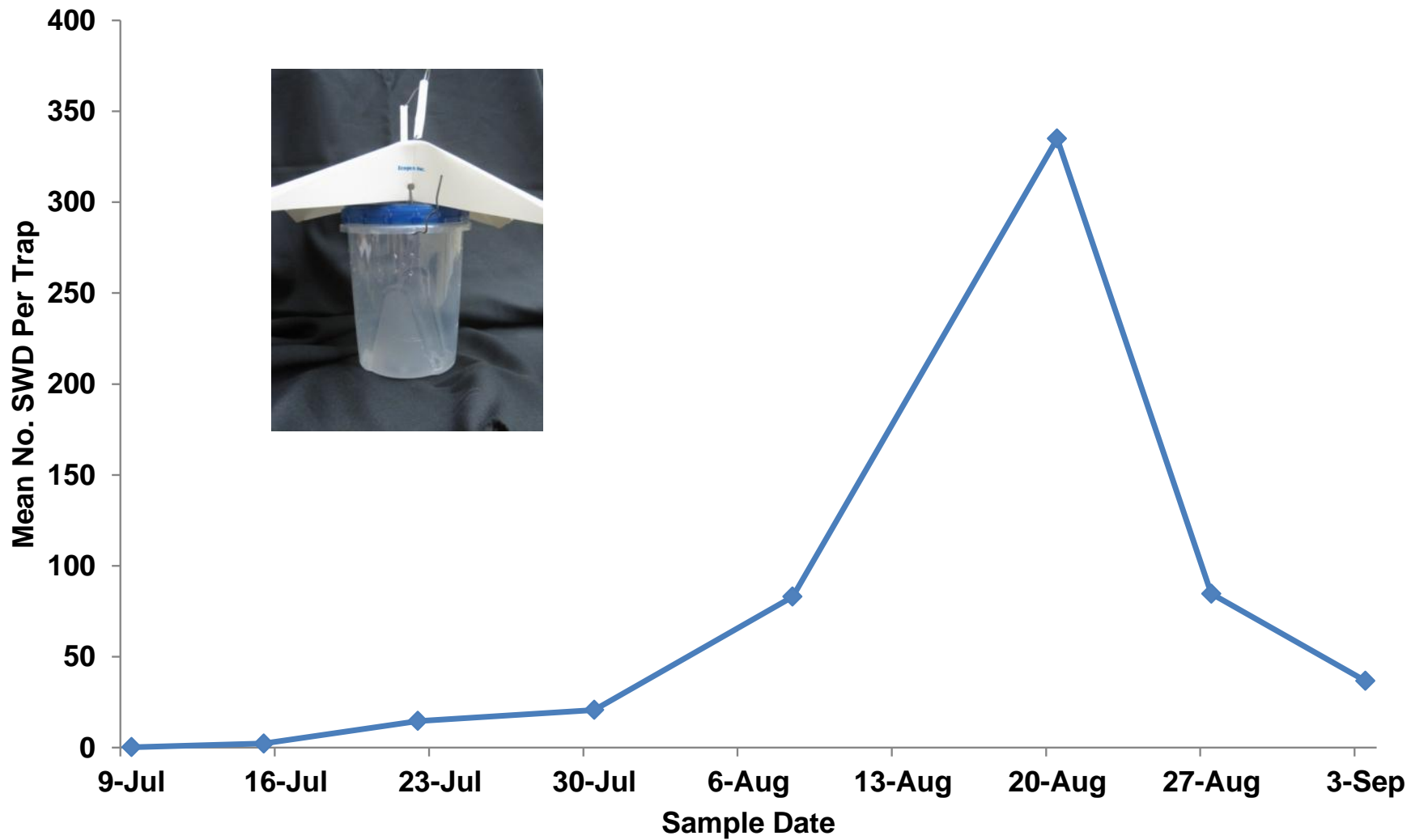


- Potted raspberries with ripe fruit placed in field.
- Four experimental treatments evaluated for SWD management.
 - 1) weekly sprays (Brigade, Entrust or Danitol)
 - 2) 1% Delegate attracticidal spheres (1 per plant)
 - 3) sprays + spheres
 - 4) Control
- Monitored SWD populations with traps baited with yeast/sugar.
- Harvested ripe berries and evaluated infestation rates.

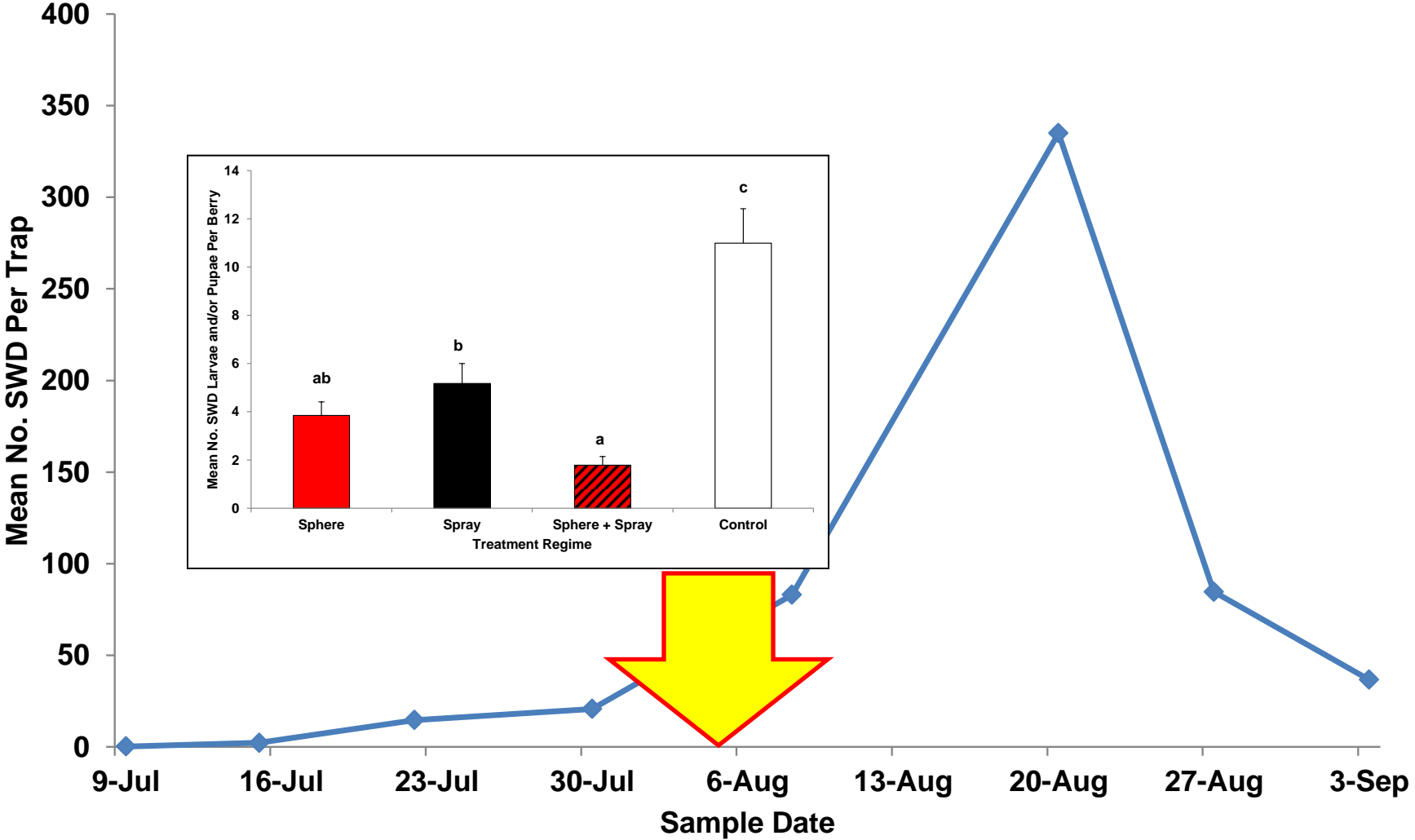
Infestation Rates from Attracticidal Sphere Field Trial



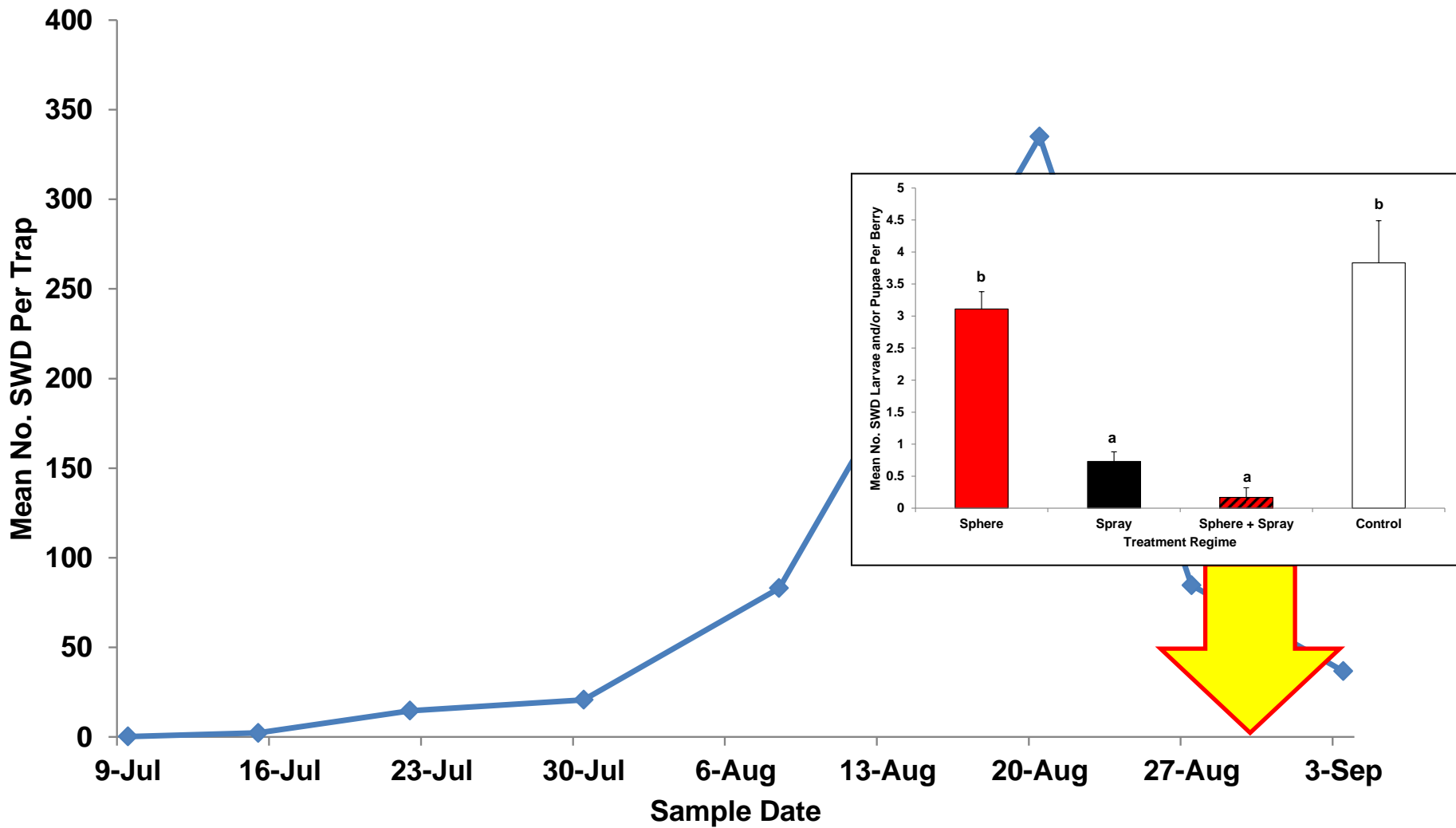
Monitoring Trap Captures



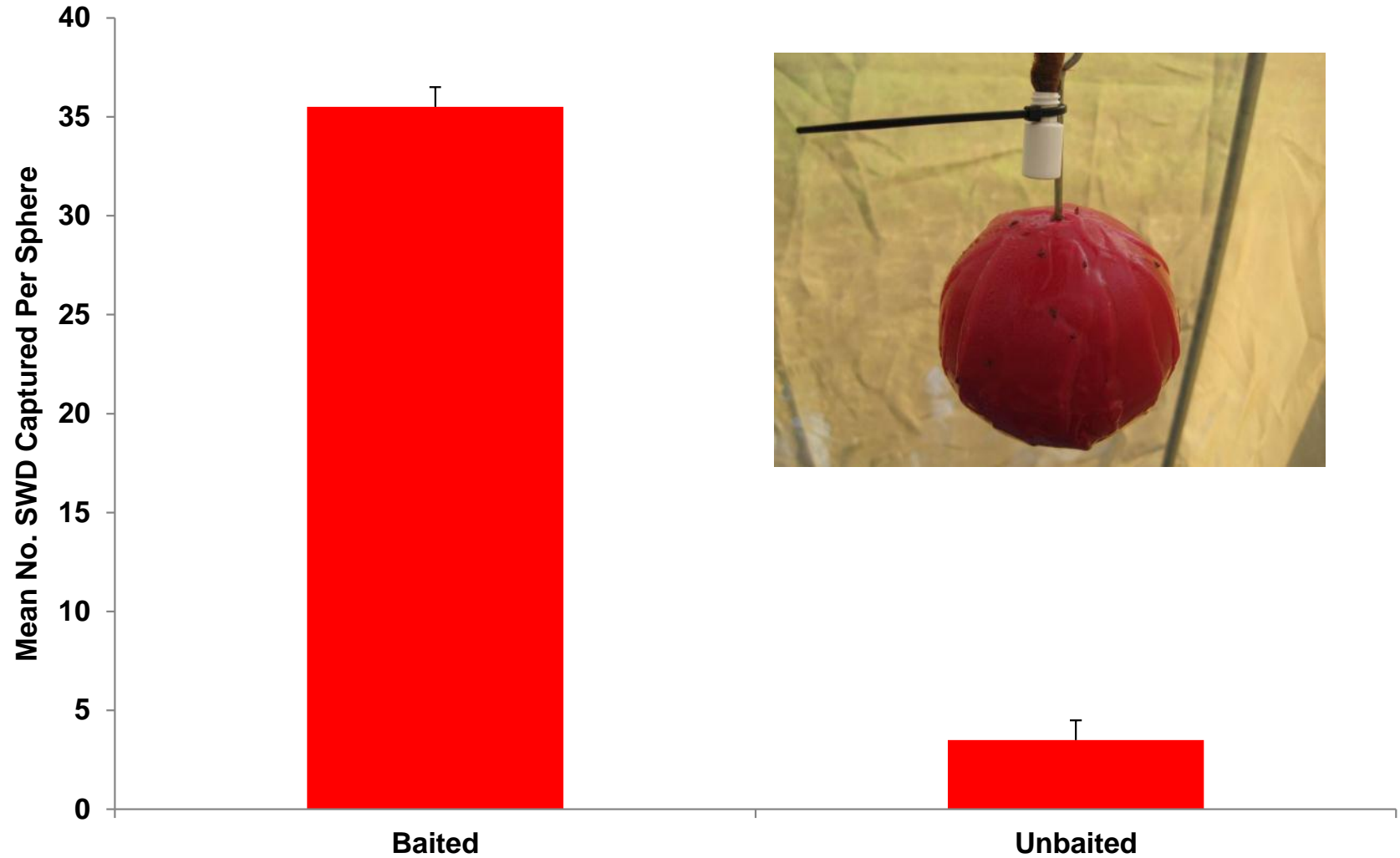
Late July-Early August Results



Late August-Early September Results



Could An Olfactory Attractant Improve Efficacy?



Can We Find a Better Insecticide Formulation?



Conclusions and Next Steps

- Visual ecology of SWD can be exploited to improve monitoring tools and for development of attract and kill systems.
- Attracticidal sphere holds promise, but could be improved with competitive olfactory attractants.
- Insecticide formulation issue still poses challenge.

Acknowledgments

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- A group of ten people, five men and five women, are standing in two rows in front of a building with large glass windows and a stone wall on the left. They are dressed in casual attire, including t-shirts, button-down shirts, and shorts. The group is diverse in age and appearance. The woman in the center of the front row is wearing a grey t-shirt and blue shorts. The woman to her right is wearing a bright cyan button-down shirt over a white top and dark pants. The woman on the far right of the back row is wearing a white t-shirt and grey shorts with a yellow stripe. The man on the far left of the front row is wearing a grey t-shirt with a cartoon character on it and khaki pants. The man in the center of the back row is wearing an orange t-shirt and has his arms crossed. The woman in the center of the back row is wearing a yellow top. The woman to her right is wearing a white t-shirt. The woman on the far right of the front row is wearing a white t-shirt and grey shorts with a yellow stripe. The man on the far right of the back row is wearing a white t-shirt and grey shorts with a yellow stripe. The man on the far left of the back row is wearing a grey t-shirt and khaki pants. The man in the center of the back row is wearing an orange t-shirt and has his arms crossed. The woman in the center of the back row is wearing a yellow top. The woman to her right is wearing a white t-shirt. The woman on the far right of the back row is wearing a white t-shirt and grey shorts with a yellow stripe. The man on the far left of the front row is wearing a grey t-shirt with a cartoon character on it and khaki pants. The man in the center of the front row is wearing a grey t-shirt and blue jeans. The woman in the center of the front row is wearing a grey t-shirt and blue shorts. The woman to her right is wearing a bright cyan button-down shirt over a white top and dark pants. The woman on the far right of the front row is wearing a white t-shirt and grey shorts with a yellow stripe. The man on the far left of the back row is wearing a grey t-shirt and khaki pants. The man in the center of the back row is wearing an orange t-shirt and has his arms crossed. The woman in the center of the back row is wearing a yellow top. The woman to her right is wearing a white t-shirt. The woman on the far right of the back row is wearing a white t-shirt and grey shorts with a yellow stripe.
- Northeastern Regional IPM Award
 - North American Raspberry and Blackberry Association
 - Driscoll Strawberry Associates, Inc.
 - Monterey AgResources
 - Dow AgroSciences, LLC
 - Nufarm Americas